APPENDIX 2.2-B

ICF International / R2 Resource Consultants, Inc., *Assessment of Construction-Related Impacts on Fish in Santa Clara River, Newhall Ranch Resource Management and Development Plan,* October 2016

Assessment of Construction-Related Impacts on Fish in Santa Clara River, Newhall Ranch Resource Management and Development Plan

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EXECUTIVE SUMMARY

Project Background

The Newhall Ranch Resource Management and Development Plan (RMDP) component of the RMDP/Spineflower Conservation Plan (RDMP/SCP) Project ("Project") proposes to construct transportation and flood control infrastructure in support of the Newhall Ranch Specific Plan (Specific Plan) which the County of Los Angeles approved in 2003.The Newhall Ranch Resource Management and Development Plan/Spineflower Conservation Plan (RMDP/SCP) is a conservation, mitigation, and permitting plan for sensitive biological resources within the previously approved Newhall Ranch Specific Plan area. The Specific Plan was approved by the County of Los Angeles on May 27, 2003. The RMDP/SCP is the source document that the Newhall Land and Farming Company (Newhall) relies on for securing federal and state permits for the infrastructure improvements required to build-out the approved Specific Plan.

The Project area is located in a portion of the Santa Clara River Valley within northwestern Los Angeles County, between the City of Santa Clarita to the east and the Los Angeles County/Ventura County jurisdictional boundary line to the west.

Between 2003 and 2010, the United States Army Corps of Engineers (Corps) and the California Department of Fish and Wildlife (CDFW) collaborated to produce a joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) that analyzed the Newhall Ranch RMDP/SCP implementing the Newhall Ranch Specific Plan, collectively the "Project"s environmental effects pursuant to the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). CDFW certified the EIR portion of the document (2010 FEIR) and approved the Project on December 3, 2010. The Corps completed its review of the EIS portion of the document and issued its Record of Decision for the Project on August 31, 2011. This technical report addresses CDFW's 2010 FEIR.

As explained in the 2010 FEIR, the Project contemplates construction of two permanent bridges over the Santa Clara River (River), as well as two temporary haul route bridges that will allow heavy equipment to cross the River during grading and construction operations. The Project also contemplates the installation of bank stabilization in proximity to the River and long term maintenance of Project infrastructure. The 2010 FEIR stated that some of the bridge construction work would occur in the wetted channel of the River, where special status fish, such as the unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), might be present.

Adopted Mitigation Measures in the 2010 FEIR

To prevent harm of unarmored threespine stickleback from implementation of the Project, the 2010 FEIR proposed, and CDFW adopted, mitigation measures that authorized diversion of the wetted channel of the River away from work zones, thereby preventing fish from being present in the work zones during construction. The mitigation measures also authorized biologists from the United States Fish and Wildlife Service (USFWS), or agents designated by USFWS, to collect any stranded unarmored threespine stickleback and relocate them to a safe part of the River. These same measures could be applied, if necessary, to construction work associated with the bank stabilization infrastructure. The 2010 FEIR designated these mitigation measures "BIO-43" through "BIO-47." As explained below, this report focuses on BIO-44 and BIO-46, the two measures that authorized the collection and relocation of stranded fish, including unarmored threespine stickleback.

Listing Status of UTS

The unarmored threespine stickleback is listed as "endangered" under both the federal and state Endangered Species Acts. The unarmored threespine stickleback is also identified as a "fully protected" fish species under California Fish and Game Code section 5515. This latter designation means that the CDFW may not authorize "take" of unarmored threespine stickleback except under limited circumstances that do not apply to the Project, as discussed below (Fish & Game Code, § 5515(a)). Fish and Game code section 86 defines "take" to mean hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.

Litigation Background

CDFW certified the 2010 FEIR and approved the Project, including the RMDP, on December 3, 2010. In January 2011, the Center for Biological Diversity (CBD) and other groups brought a lawsuit against CDFW and Newhall in trial court, alleging various deficiencies in the 2010 FEIR and claiming CDFW violated Fish and Game Code section 5515 by authorizing "take" of the fully-protected unarmored threespine stickleback. The trial court ruled in favor of the CBD petitioners, but that decision was reversed by Division Five of the Second District Court of Appeal. The California Supreme Court then granted review of the Court of Appeal's decision as to three issues including: whether CDFW, in adopting BIO-44 and BIO-46, authorized take of unarmored threespine stickleback in violation of Fish and Game Code section 5515.

The Supreme Court, in an opinion issued on November 30, 2015, held that although the "collect and relocate" activities described in BIO-44 and BIO-46 were to protect unarmored threespine stickleback and would be performed only by the USFWS, they nevertheless met the definition of "take" set forth in Fish and Game Code section 86. Consequently, the Supreme Court held that BIO-44 and BIO-46, in allowing the collection and relocation of unarmored threespine stickleback, violated the Fish and Game Code section 5515 prohibition against the take of the protected unarmored threespine stickleback.

Purpose of Analysis / Corrective Action

To comply with the Supreme Court's decision, the Project proposes to modify its construction methods to avoid all construction-related contact with the wetted channel of the Santa Clara River (River), thereby avoiding all take of unarmored threespine stickleback.

The Project has been modified to eliminate any need to divert the wetted channel of the River and therefore obviate any need to implement BIO-44 and BIO-46. The modified permanent bridge and bank stabilization construction methods and additional restrictions on construction locations and timing are incorporated into the project as Project Design Features (PDF's) and mitigation measures to ensure no take of unarmored threespine stickleback will occur during construction. Furthermore, the temporary haul routes have been modified to require temporary modular bridges to span the wetted channel, in addition to specifying other PDFs and mitigation measures to ensure no take of unarmored threespine stickleback during temporary bridge installation, use for grading and construction, and subsequent removal. Specific detail of the "No Water Contact" construction methods are included in Table XX in Section 5. This table also identifies whether the revised construction method requires additional analysis. A summary of the PDFs and Mitigation measures that will be adopted to ensure no take of the unarmored threespine stickleback are provided in Table YY.

Fish and Game Code section 5515 compliance: The purpose of this analysis is to evaluate whether implementation of a proposed "no water contact" construction program for the Project infrastructure will accomplish the objective of avoiding construction in the wetted channel of the Santa Clara River, thereby eliminating the potential for take of unarmored threespine stickleback. If it meets this critical criterion, it will fully comply with the "take" prohibition in the Fish and Game Code section 5515.

CEQA section 21166 and CEQA Guidelines section 15162 compliance: A secondary purpose of this report is to assess whether the proposed "no water contact" construction approach would result in any new or more severe significant biological impacts than those addressed in the 2010 FEIR.

Summary of Findings

Based on the analysis set forth below, ICF has made the following determinations:

- Project permanent bridges crossing the Santa Clarita River (River) can be constructed using a "no water contact" approach (Moffatt & Nichol, October 2016) and, therefore avoid takeof unarmored threespine stickleback. More specifically:
    - Vegetation clearing and access grading in the dry riverbed can be accomplished from the north or south bank of the River, without entering the wetted channel.
    - Spacing the bridge piers wider than the dry season wetted channel width allows for all piers to be constructed (Geosyntec, October 2016, PACE, October 2016).
    - CIDH pier construction and conventional, false-work supported bridge superstructure construction can be completed during the dry season, when construction zones are not subject to inundation by flood flows (Moffat & Nichol, October 2016).

- CIDH piles will be constructed using a steel casing method that limits contact between drilling materials and the alluvial groundwater and wetted channel of the River. A minimum 5 feet of permanent steel casing above ground provides additional protection against inundation and the 20 feet of permanent steel casing below ground limits contact between the upper alluvial groundwater and the concrete poured into the pile boring holes (Moffat& Nichol, GSI, October 2016).

- Cast-in-place concrete box-girders and the bridge deck frames, both supported on conventional falsework, can be completed during the summer dry season in the second year of bridge construction, without entry into the wetted channel (Mofatt & Nichol, October 2016).

- A pre-cast girder can be installed "in the air" using cranes at the location of the wetted channel. Construction in this manner eliminates entry into the wetted channel at this location (Moffat & Nichol, October 2016).

- No construction dewatering will take place for construction of the CIDH piers (Mitigation Measure).

- Protective barriers, BMPs and containment systems will be deployed during all of the work within the dry riverbed, preventing inadvertent equipment or personnel access to the wetted channel while also providing a preventive containment system to preclude discharge of construction related pollutants in to the wetted channel (Mitigation Measure).

- Maintaining a clear weather window, defined for the Project as less than a 40 percent chance of 0.1 inches of precipitation in the coming 48 hours per NOAA, and suspending any concrete pours in the event of rain that is not forecasted, ensures that uncontrolled runoff of stormwater containing construction related pollutants will not occur (Mitigation Measure).

- By increasing the span between bridge piers from 100 to 165 feet, the number of piers to be constructed for the two permanent bridges would be reduced from 18 to 13, resulting in less fill in the Santa Clara River and fewer hydrology and morphology impacts on the river than originally contemplated.

- The 2010 FEIR concluded that the Project infrastructure, including its bridges, would not significantly alter the amount of refugia available to unarmored threespine stickleback during flood events affecting the Santa Clara River. Because the proposed modified bridge construction methods would reduce the number of bridge piers in the river from what was originally contemplated in the 2010 FEIR, those modifications would not result in any significant effect on refugia for unarmored threespine stickleback.

- Although storm-flow scour depressions will likely develop around and behind some of the pier rows that support the permanent bridges, there will be fewer pier rows and furthermore, unarmored threespine stickleback are unlikely to enter these depressions, even though the depressions may afford temporary refuge from fast-moving flood waters. If any unarmored threespine stickleback do enter the scour depressions, the fish are well-adapted to such storm-related refuges when flood flows return to normal. Scour pools will not result in take of unarmored threespine stickleback.

Project temporary haul route bridges crossing the River can be constructed using a "no water contact" approach (Moffat & Nichol, October 2016) and, therefore avoid take of unarmored threespine stickleback. More specifically :

- The temporary haul route bridge decks will span the wetted channel of the River.
- The temporary haul route bridge steel support piles will be located a minimum of 10 feet from the edge of the wetted channel.
- BMPs would be deployed as a precautionary containment for construction related pollutants (ie., equipment leak) during pile installation. Equipment used to install the steel piles is highly mobile, allowing for immediate egress from the riverbed in the event of a forecast storm event.
- There would be no contact with the water; no risk of inundation; and because timing of construction is only during a clear weather window, there would be no risk of take of unarmored threespine stickleback.
- Temporary bridge decks would be removed from the riverbed during the winter flood flow period. Temporary bridges would only be in place and operational between the period from May 1 through November 30 (Geosyntec 2016).
- Temporary bridge steel piles result in less scour than the permanent bridges, and as with the permanent bridges, any scour pools will not result in take of unarmored threespine stickleback (PACE, October 2016).

- Bank protection and related construction activities are set back sufficiently from the wetted channel to preclude any need to divert the flowing river, and therefore will not result in take of unarmored threespine stickleback.
  - No crossing of the wetted channel of the Santa Clara River is required to construct the bank stabilization.
  - To avoid contact with the wetted channel, construction of bank stabilization would take place when the excavation and equipment operations would not be inundated by winter storm flows. By restricting construction to the period between May 1 through November 30, excavations would not be at risk of fish stranding therefore there would be no risk of take of unarmored threespine stickleback.
  - The San Jose Flats bank stabilization (related to a water quality basin) is not set back from the edge of the riverbed and is at risk of inundation during late spring or early fall storm events; therefore a construction period matching the bridge construction summer dry season is prescribed for this specific area.
  - As bank stabilization excavations will not create risk of fish stranding; thus, there would be no take of unarmored threespine stickleback.
  - Operational restrictions on dewatering addressed in the 2010 FEIR require that any dewatering be conducted in a manner that does not affect river flow, and these same restrictions will be observed going forward. Construction dewatering, if necessary,

will be conducted in a manner that does not affect the wetted channel of the River and is further restricted to upland discharge. No temporal habitat will be created where fish could be stranded. As such, dewatering will be conducted in a manner that will not result in take of unarmored threespine stickleback.

- Where the wetted channel is within 1,000 feet of dewatering activities, monitoring will occur at least one week prior to and during pump operations and then continue for at least one week subsequent to completion of such operations to ensure no significant drawdown of the wetted channel. If there are any indications that dewatering is affecting the River flow, dewatering operations would be suspended. If no change to the wetted channel flow occurs there would be no risk of take of unarmored threespine stickleback.

- Implementing the Project with these modified construction methods and additional mitigation measures ensure: i) fewer or less impacts, which were already mitigated to less than significant impact without reliance on BIO-44 or BIO-46, than those disclosed in the 2010 FEIR, ii) no entry into the wetted channel will be necessary for construction; iii) there will not be drawdown of the river flow, nor creation of temporal wetted channel habit, from construction dewatering; and iv) that contaminants will not be allowed to be discharged to the wetted channel.

- Implementing the Project with these methods and mitigation measures ensures no take of unarmored threespine stickleback.

These findings support a “no take” determination and indicate that the proposed modified construction methods for the bridges and bank stabilization would not result in impacts to or “take” of unarmored threespine stickleback. Implementation of such construction methods also would eliminate the need for prior EIR mitigation measures BIO-44 and BIO-46.

1 Introduction

1.1 Project Background

The Newhall Ranch Resource Management and Development Plan/Spineflower Conservation Plan (RMDP/SCP) is a conservation, mitigation, and permitting plan for sensitive biological resources within the previously approved Newhall Ranch Specific Plan (Specific Plan) area. The Specific Plan was approved by the County of Los Angeles on May 27, 2003. The Newhall Ranch Resource Management and Development Plan (RMDP) component of the RMDP/SCP proposes to construct transportation and flood control infrastructure in support of the Newhall Ranch Specific Plan, which the County of Los Angeles approved in 2003. The RMDP is the source document that the Newhall Land and Farming Company (Newhall) relies on for its federal and state permits for the infrastructure improvements required to build-out the approved Specific Plan. For purposes of the impact analysis discussed in this document, the RMDP constitutes the "Project".

The Project area is located in a portion of the Santa Clara River Valley within northwestern Los Angeles County, between the City of Santa Clarita to the east and the Los Angeles County/Ventura County jurisdictional boundary line to the west. The Los Padres National Forest is located to the north of the Project area, the Angeles National Forest is to the north and east, and the Santa Susana Mountains are to the south. Note that the boundary of the RMDP encompasses the same area as the boundary of the previously approved Specific Plan site, and also includes the Salt Creek conservation area in Ventura County adjacent to the Specific Plan site. 2010 FEIR, **Figure ES-1** depicts the RMDP project areas and vicinity.

Between 2003 and 2010, the United States Army Corps of Engineers (Corps) and the California Department of Fish and Wildlife (CDFW) collaborated to produce a joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR) that analyzed the Newhall Ranch RMDP/Spineflower Conservation Plan (RMDP/SCP) project's environmental effects pursuant to the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). TCDFW certified the Final EIR (2010 FIER) portion of the document and approved the Project on December 3, 2010 (2010 FEIR). The Corps completed its review of the EIS portion of the document and issued its Record of Decision for the Project on August 31, 2011. This technical report addresses the CDFW's 2010 FEIR, and more specifically the RMDP infrastructure, on or adjacent to, the Santa Clara River (River).

As explained in the 2010 FEIR, the Project contemplates construction of two permanent bridges over the River, as well as two temporary haul route bridges that will allow heavy equipment to cross the River during grading and construction operations. The Project also contemplates the installation of bank stabilization in proximity to the River and long term maintenance of Project infrastructure. The 2010 FEIR stated that some of the bridge construction work would occur in the wetted channel of the River, where special status fish[1], such as the unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), might be present.

[1] For purposes of this document, the use of the term "fish" is limited specifically to *wild fish or part, spawn, or ovum of wild fish*, as identified in the Fish and Game Code section 45 ("Fish" means a wild fish, mollusk, crustacean, invertebrate, amphibian, or part, spawn, or ovum of any of those animals").

1.1.1 Mitigation Measures / Listing Status Background

To prevent such harm, the 2010 FEIR proposed, and CDFW adopted, mitigation measures that authorized diversion of the wetted channel of the Santa Clara River (River) away from work zones, thereby preventing fish from being present in the work zones during construction. The mitigation measures also described biologists from the United States Fish and Wildlife Service (USFWS), or agents designated by USFWS, to collect any stranded unarmored threespine stickleback and relocate them to a safe part of the River. These same measures could be applied, if necessary, to construction work associated with the bank stabilization infrastructure. The 2010 FEIR designated these mitigation measures "BIO-43" through "BIO-47." As explained below, this report focuses on BIO-44 and BIO-46, the two measures that required the collection and relocation of stranded fish, including unarmored threespine stickleback.

The unarmored threespine stickleback is listed as "endangered" under both the federal and state Endangered Species Acts. The unarmored threespine stickleback is also identified as a "fully protected" fish species under California Fish and Game Code section 5515. This latter designation means that CDFW may not authorize "take" of unarmored threespine stickleback except under limited circumstances that the California Supreme Court determined do not apply to the Project, as discussed below (Fish & Game Code, § 5515(a)). Fish and Game code section 86 defines "take" to mean hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.

1.1.2 Litigation Background

CDFW certified the 2010 FEIR and approved the Project on December 3, 2010. In January 2011, the Center for Biological Diversity (CBD) and other groups brought a lawsuit against CDFW and Newhall in trial court, alleging various deficiencies in the 2010 FEIR and claiming CDFW violated Fish and Game Code section 5515 by authorizing "take" of the fully-protected unarmored threespine stickleback. The trial court ruled in favor of the CBD petitioners, but that decision was reversed by Division Five of the Second District Court of Appeal. The California Supreme Court then granted review of the Court of Appeal's decision as to three issues including: whether CDFW, in adopting BIO-44 and BIO-46, authorized take of unarmored threespine stickleback in violation of Fish and Game Code section 5515.

As to the second issue, the Supreme Court, in an opinion issued on November 30, 2015, held that although the "collect and relocate" activities described in BIO-44 and BIO-46 were to protect unarmored threespine stickleback and would be performed only by the USFWS, they nevertheless met the definition of "take" set forth in Fish and Game Code section 86. Consequently, the Supreme Court held that BIO-44 and BIO-46, in allowing the collection and relocation of unarmored threespine stickleback, violated the Fish and Game Code section 5515 prohibition against the take of the protected unarmored threespine stickleback.

This report analyzes whether modified construction techniques would remove the need for BIO-44 and BIO-46, effectively avoiding take of unarmored three spine stickleback.

1.2 Purpose of this Analysis / Corrective Action

Fish and Game Code section 5515: To comply with the Supreme Court's decision, the Project proposes to modify its construction methods to avoid all construction-related contact with the wetted channel of the Santa Clara River, thereby avoiding take of unarmored threespine stickleback. The purpose of this analysis is to evaluate whether implementation of the proposed

"no water contact" construction program for the permanent bridges, temporary haul route bridges, and bank stabilization will accomplish the objective of avoiding construction in the wetted channel of the Santa Clara River, thereby eliminating the potential for take of unarmored threespine stickleback. If it meets this critical criterion, it will fully comply with the Fish and Game Code section 5515 "take" prohibition.

This report determines whether the proposed "no water contact" approach to bridge and bank stabilization construction would support a "no take" finding with regard to unarmored threespine stickleback.This report also describes the monitoring message CDFW should adopt to ensure that the proposed construction approach is implementing property fo as to avoid impacts to unarmored threespine stickleback.

CEQA section 21166 and CEQA Guidelines section 15162 compliance: A secondary purpose of this report is to assess whether the proposed "no water contact" construction approach would result in any new or more severe significant biological impacts than those addressed in the 2010 FEIR.

1.3 Summary of Findings

Pursuant to the impact analysis provided in this report, the findings support a "no impact" determination and indicate that the proposed modified construction methods for the bridges and bank stabilization would not result in "take" of unarmored threespine stickleback. Implementation of such construction methods also would remove the need for prior EIR mitigation measures BIO-44 and BIO-46.

2 Characteristics of Unarmored Threespine Stickleback

2.1 Life History

The characteristics of unarmored threespine stickleback were described in the 2010 FEIR on pages, 4.5-671 to 4.5-672. The following is excerpted from the 2010 FEIR to provide context for this analysis.

Although originally widespread throughout the Los Angeles basin, the unarmored threespine stickleback is currently found in few locations, all of which are situated outside of the Los Angeles River basin (Swift *et al.* 1993). The unarmored threespine stickleback is a known resident species in the Santa Clara River throughout the Project reach, and the Project site is within the Del Valle Zone of the designated essential habitat for this species (2010 FEIR, **Figure 4.5-60**, Habitat in RMDP/SCP for Unarmored Threespine Stickleback).

The unarmored threespine stickleback is a small territorial fish that can grow up to a maximum of approximately 4 inches in length (CDFG 2000). There are numerous subspecies and morphs of threespine stickleback (*G. aculeatus*) found throughout the Northern Hemisphere, and these are thought to represent a superspecies[2] whose ancestral form is the completely plated morph inhabiting marine waters and some freshwaters (Moyle 2002; McPhail 2007; Östlund-Nilsson

[2] A superspecies is a set of closely related species.

2007). Threespine stickleback lack scales that are common to other fish, and they are related to pipefish and seahorses (ITIS 2007). Their spines and plating are thought to provide protection against piscivorous fish such as salmonids by disrupting the capture biomechanics of the predator's jaws, inhibiting capture and providing increased opportunities for escape (Reimchen 1992, 2000). Studies of threespine stickleback systematics suggest that reduction of plating is a common convergent morphological change in freshwater populations; many such populations colonized inland streams and lakes after the Pleistocene (ice-age) glacial retreat (O'Reilly *et al.* 1993; Orti *et al.* 1994).

To inform the discusstion of vibration and noise effects on stickleback, additional life history beyond that included in the 2010 FEIR, is incorporated herein. Unarmored threespine stickleback are not typically weighed when studied, and we are not aware of any published document that provides an average weight for this particular species. Other stickleback species typically weigh 4 grams less (The Great Sovet Encyclodpedia, 3rd Edition (1970-1979)), but it is unclear whether this weight “translates” well for purposes of determining the weight of unarmored threespine stickleback.

2.2 Habitat Requirements

As explained in the 2010 FEIR, unarmored threespine stickleback require slow-moving water – i.e., flows less than 2 feet per second (fps) – to avoid being washed downstream. (2010 FEIR, p. 679, citing USFWS 1985). The Santa Clara River is often described as “flashy” (i.e., highly episodic) due to storm-induced fluctuations in its flow regime. (See 2010 FEIR, pp. 4.2-16—18.) Unarmored threespine stickleback have adapted to this aspect of the Santa Clara River’s hydrology. For example, during storm events, when flows in the Santa Clara River are high and swift, unarmored threespine stickleback are especially vulnerable and need to find and gain access to slower eddies and backwaters – known as “refugia” – in order to survive. In the Santa Clara River, such refugia may be found behind rocks or trees or other obstructions, at the interface of floodwater and floodplain, and at other locations where flows are less than 2 fps. This behavioral adaptation has allowed the unarmored threespine stickleback to survive large floods and inundation events in the River.

2.3 Reproduction

The unarmored threespine stickleback reproduce throughout the year with less breeding activity occurring from October to January (USFWS, 2009, Unarmored Threespine Stickleback (Gasterosteus aculeatus williamsoni) 5-Year Review: Summary and Evaluation). Similar to other threespine stickleback species, male unarmored threespine stickleback create a nest in slow-moving water, by gluing together bits of vegetation, such as grass and sticks, using a kidney-secreted protein, and will vigorously defend the established nest territory. After egg fertilization, the male will care for and protect the eggs until the young leave. The male unarmored threespine stickleback will fan the eggs with his pectoral fins, helping to ensure proper development of the embryos. The amount of suitable breeding habitat may be a limiting factor in the population of the unarmored threespine stickleback (CDFG 2000). The unarmored threespine stickleback lives for about one year, and few if any survive to breed again (USFWS 1985, ESIS 1998).

2.4 Protective Status (Federal)

The unarmored threespine stickleback (Gasterosteus aculeatus williamsoni) is listed asa both state and federally endangered and is a California fully-protected species, The USFWS listed

unarmored threespine stickleback as an endangered species on October 13, 1970 (35 Fed.Reg. 16047). Although the USFWS has not designated critical habitat for the unarmored threespine stickleback, the Recovery Plan for the species, published on December 26, 1985, identifies three areas as very important for the survival of the species: (1) two disjunct reaches of the Santa Clara River in Los Angeles County; (2) a short reach of San Francisquito Canyon; and (3) and the lowermost 8.4 miles in San Antonio Creek in Santa Barbara County. One of the reaches in the Santa Clara River is the area from San Martinez Grande Canyon upstream to the I-5 Bridge, which runs through the Project area.

For actions requiring a federal permit, the USFWS will assess whether the action will result in "take" of unarmored threespine stickleback, and if there is potential for such take, the USFWS will issue a Biological Opinion describing the impact and the measures necessary to minimize take of the species. The Biological Opinion may also include an incidental take authorization or statement, pursuant to which the permit applicant may "take" a certain number of unarmored threespine stickleback, provided all identified "reasonable and prudent" measures are implemented.

In this case, the Project requires a Clean Water Act section 404 permit from the Corps. Based on that federal nexus and the potential for the Project to affect unarmored threespine stickleback, the Corps was required to consult with the USFWS pursuant to section 7 of the federal Endangered Species Act. As a result of that consultation, on June 6, 2011, the USFWS issued a Biological Opinion stating that the Project had the potential to take unarmored threespine stickleback, but that such take would not jeopardize the continued viability of the species. The Biological Opinion then authorized take – in the form of injury or death – of up ten (10) unarmored threespine stickleback. The Biological Opinion also authorized take – in the form of captured and relocated fish – of up to 100 unarmored threespine stickleback. (USFWS BiOp (2011), pp. 104-105.) To minimize the possibility of take, the Biological Opinion also required that the Corps and Newhall implement a series of "reasonable and prudent measures," including the following:

- "The Corps must require Newhall to employ only qualified biologists to capture and relocate any unarmored threespine sticklebacks at risk of desiccation or other injury or mortality during construction, maintenance, or restoration activities." (USFWS BiOp (2011), p. 105.)

- "The Corps must require Newhall to screen any pumps used in dewatering in unarmored threespine stickleback habitat to prevent entrainment." (USFWS BiOp (2011), p. 105.)

The Project's proposed modified construction methods eliminate impacts to unarmored threespine stickleback, including those from collecting and relocating stranded unarmored threespine stickleback, because there would be no river diversion techniques or construction work in the wetted channel of the Santa Clara River. Nor would there be any need to screen pumps because bridge and bank stabilization construction would no longer require dewatering of the wetted channel of the river; nor would any other dewatering activities outside the wetted channel result in a risk of desiccation of unarmored threespine stickleback habitat in the river.

2.5 Protective Status (State)

In the State of California, the unarmored threespine stickleback has two protective designations. Since 1971, unarmored threespine stickleback has been listed as endangered under the California Endangered Species Act found in Fish and Game Code section 2050 et. seq. It is

also listed as a fully-protected species under Fish and Game Code section 5515(b)(9). Although the California Endangered Species Act provides for the "incidental take" of endangered species (see Fish & Game Code § 2081), Fish and Game Code section 5515(a) prohibits the take of fully-protected species except under very limited circumstances, even for those species that are also listed under the California Endangered Species Act. For this reason, CDFW is not authorized to issue Incidental Take Permits for fully-protected species for the Project. Take of such species may only be permitted when it occurs pursuant to a scientific research permit or a Natural Community Conservation Program, none of which are being sought by the Project proponent. (Fish & Game Code, §§ 5515(a), 2835.)

Therefore the Project must avoid take of unarmored threespine stickleback, consistent with Fish and Game Code section 5515.

3 Prior Surveys for Unarmored Threespine Stickleback in the Santa Clara River

3.1 Surveys for Project Area (1988-2009)

The unarmored threespine stickleback was observed during surveys within the Santa Clara River portion of the Specific Plan area in 1988, 1995, 2000, 2002–2005, and 2007 (Aquatic Consulting Services 2002A, 2002B, 2002C, 2002D; ENTRIX 2009; Haglund 1989; SMEA 1995, 2000; Impact Sciences 2003A, 2003B, 2003C).

ENTRIX (2009) conducted surveys for the unarmored threespine stickleback in 2004 and 2005 within the Newhall Ranch "reach" (i.e., segment) of the River. ENTRIX (2009) surveyed for unarmored threespine stickleback habitat by targeting habitat attributes between Salt Creek Canyon and The Old Road Bridge. The survey recorded habitat type, length and mean width, mean and maximum depth, substrate composition, water and air temperature, and percent edgewater vegetation.

The surveys showed that the presence of unarmored threespine stickleback is variable in the Project reach (ranging from rare or absent in certain reaches of the River, to locally abundant in any given year). For this reason, the 2010 FEIR assumed that unarmored threespine stickleback was present at all suitable locations (i.e., where Project-related impacts might occur) within the Project's reach of the River. This analysis (ICF 2016) makes the same assumption.

3.2 Cardno Surveys Conducted in 2014 and 2015

Cardno conducted additional surveys on August 19, September 4, and September 5, 2014. On August 19, the survey was conducted by Cardno biologist Joel Mulder, accompanied by United Water Conservation District (UWCD) biologists Steve Howard and Michael Booth. On September 4 and September 5, the survey was conducted by Joel Mulder, accompanied by Cardno biologist Sarah Horwath.

The study area included the mainstem Santa Clara River from near Salt Canyon to near Castaic Junction, approximately 1.5 miles downstream of the Valencia Water Reclamation Plant (WRP). The four study segments covered a total distance of approximately 6 river miles (Figure 1). River segments within the survey area were delineated based on those identified in the previous fish and habitat surveys conducted by ENTRIX in 2005 (ENTRIX 2009).

Within each study segment, the wetted channel was walked from downstream to upstream to assess habitat availability and quality for fish. The survey included a general, qualitative habitat characterization of each reach, including estimated stream gradient, water depths, riparian canopy cover and composition, and habitat unit types present.

Detailed habitat characteristics (habitat type, habitat length, and substrate composition) were recorded for a subset of the habitat units encountered at fairly regular intervals, and also for areas containing special-status species or other notable points of interest (i.e., suitable habitat for unarmored threespine stickleback, areas with large concentrations of exotic species, etc.). Habitat units typically consisted of one habitat type and were delineated by transitions between habitat types (i.e., from riffle to pool). At each of the subsampled habitat units, biologists snorkeled to visually identify and enumerate fish and aquatic vertebrate species. Photographs were taken of each subsampled habitat unit and of additional notable habitat or species locations. Water and air temperatures were recorded at the start and end of each survey using a handheld thermometer.

Cardno (Mulder and Horwath) also visited the river on multiple dates (June 27 through September 1) in 2015 to conduct a southern western pond turtle study, and aquatic species observations during that study are included here.

During the 2014 and 2015 surveys, no unarmored threespine stickleback or other fish species native to the Santa Clara River were observed. During a river survey conducted in August 2015, however, CDFW biologists observed unarmored threespine stickleback between The Old Road Bridge and the Valencia WRP discharge (pers. comm. Tim Hovey, CDFW), upstream of the current study area. Habitat where unarmored threespine stickleback were found matched the preferred habitat of the species, with slow-moving waters containing substantial emergent vegetative cover. Unarmored threespine stickleback were numerous in this segment and were represented by all size classes.

Arroyo chub (Gila orcuttii), although native to southern California, is not recognized as native to the Santa Clara River and was likely introduced to this watershed from basins of the Los Angeles plain to the south (Moyle 2002). Until recently, Santa Ana sucker (Catostomus santaanae), also native to southern California, was also believed to be introduced to this watershed from basins of the Los Angeles plain to the south (Moyle 2002). However, recent genetics work data provide no indication that C. santaanae were introduced to the Santa Clara River from the LA Basin, and are therefore likely native to the River (Richmond et al. 2016). Non-native species originating from outside California that were observed included mosquitofish (*Gabusia affinis*), common carp (*Cyprinus carpio*), and largemouth bass (*Micropterus salmoides*).

During Cardno's southern western pond turtle study in 2015, biologists incidentally observed fish species in the river while conducting turtle trapping between the Wolcott Road river crossing and Magic Mountain, as well as in a side drainage channel, termed the Old Road Drain, which enters the river on the north side approximately 1.3 river miles downstream of the Old Road Bridge. Habitat in the study areas of the river, at the time of the survey, did not provide suitable habitat for UTS. Study sites in the main-stem river lacked suitable water velocities (<2 fps), and low velocity edgewater or backwater areas were largely absent. Incidental fish observations found similar species in the River to those encountered during the focused 2014 study. Again, however, no unarmored threespine stickleback were observed.

In conclusion, the Cardno surveys from 2014 and 2015 recorded no fish species native to the Santa Clara River watershed. More specifically, no unarmored threespine stickleback were found within the study segments, although they are known to occur upstream (ENTRIX 2009; pers. Comm. Tim Hovey, CDFW) of the Project site. Nevertheless, as stated above, this assessment assumes the unarmored threespine stickleback have the potential to be present in those portions of the River where construction activities are anticipated to occur.

4 RMDP EIS/EIR Findings Regarding Impacts to Unarmored Threespine Stickleback

4.1 2010 FEIR Bridge and Bank Stabilization Assumptions

The Project proposes the construction of bridges and the installation of bank stabilization (for flood control), both of which have the potential to impact fish species in the Santa Clara River (River). As originally analyzed in the 2010 FEIR, some of the support piers for the bridges would have been installed in the wetted channel of the River, allowing for bridge deck spans of 100 feet. To install the in-channel piers, the River was to be temporarily diverted and/or dewatered from the pier installation sites during construction. The temporary dewatering activities, along with the actual in-channel construction and dewatering work, created the potential for significant impacts to aquatic habitat and fish, including the unarmored threespine stickleback (see discussion below). These impacts required the development of mitigation measures to protect the species, two of which (BIO-44 and BIO-46) the California Supreme Court determined were in conflict with Fish and Game Code section 5515.

Bank stabilization, however is located along the margins of the riparian corridor and is not located within the wetted channel of the River. The 2010 FEIR assumed that bank stabilization could be constructed at any time of the year, and therefore included measures to relocate the wetted channel of the River should it be necessary during winter storm flows. As such, it may be necessary to divert the river with construction equipment placed near or in the wetted channel. Furthermore, dewatering of the construction excavation could have resulted in some increased river flows or a reduction in the wetted channel in the vicinity of construction, although restrictions were included in the 2010 FEIR. Therefore, the bank stabilization construction work had the potential to impact aquatic species, including unarmored threespine stickleback. Mitigation Measures BIO-44 and BIO-46 were intended to address this impact.

4.2 Bridge and Bank Stabilization Impacts on Unarmored Threespine Stickleback

4.2.1 <u>Impacts on Habitat</u>

As explained above, the original design called for the Project permanent bridge piers to be installed in the wetted channel of the Santa Clara River (River), where the flow of the River would be temporarily diverted to create dry construction zones. Culverted temporary haul routes crossing the River would have impacted the wetted channel as well. Excavations and equipment for installing the bank stabilization also had the potential to impact the wetted channel due to their proximity to areas subject to inundation by winter storm flows.

Based on the above facts, the 2010 FEIR found that construction of Project infrastructure would temporarily but directly affect aquatic habitat. Specifically, the 2010 FEIR stated that installation of infrastructure "could directly affect aquatic habitat occupied by unarmored threespine stickleback through direct impacts to the flowing stream, stream diversion, and dewatering" during construction within the River. (2010 FEIR, p. 4.5-683.) The 2010 FEIR identified these direct temporary impacts (loss of habitat) as significant absent mitigation. (2010 FEIR, p. 4.5-684.)

With respect to permanent habitat impacts, the 2010 FEIR analyzed the Project's potential to reduce the amount of floodplain refugia available to the unarmored threespine stickleback. This analysis focused specifically on the potential for the proposed bridge piers and bank stabilization elements to alter stream flow and, by extension, affect available refugia. Based on hydrological modeling, the 2010 FEIR found that the proposed Project would result in slight increases in backwater refuge habitat (defined as areas with flows of less than 2 fps) during the 5-year and 10-year flood events, and slight decreases in such habitat during the 20-, 50-, and 100-year flood events. The 2010 FEIR concluded, however, that the "decrease is not expected to be significant, as the area lost during these flood events is in terraced agricultural land that is not suitable floodplain refugia habitat for the unarmored threespine stickleback." (2010 FEIR, 4.5-682 (Alt. 2), 4.5-688 (Alt. 3); see also ENTRIX (2010).) In addition, the 2010 FEIR, relying on the analysis prepared by fish experts at ENTRIX, determined that "the alteration of the stream hydrology would not result in significant impacts related to unarmored threespine stickleback access to floodplain refugia during flood events, since the general morphology of the Santa Clara River, adjacent rearing habitat, and high-flow floodplain refugia would not be substantially altered." (2010 FEIR, 4.5- 683 (Alt. 2), 4.5-688 (Alt. 3); see also ENTRIX (2010).)

4.2.2 Impacts on Individuals

In addition to impacts on unarmored threespine stickleback habitat, the 2010 FEIR analyzed and made findings with respect to Project impacts on unarmored threespine stickleback individuals. These impacts were generally related to construction activities associated with the Project bridge piers and bank stabilization, including:

- Stream diversion and /or species exclusion;
- Unauthorized entry of construction equipment into ponded or flowing water;
- Placement of fill in occupied waters;
- Construction dewatering activities;
- Discharge of pollutants, including silt, sediment, fresh concrete, trash/debris, and petroleum or other deleterious materials or pollutants, and/or;
- Unauthorized personnel entry into occupied waters.

(2010 FEIR, p. 4.5-685.)

The 2010 FEIR then determined that these activities could result in the following impacts:

- Inadvertently directing fish to unsuitable habitats, blocking fish passage, stranding of fish in unsuitable habitat, or directing fish into unsuitable flow regimes;
- Causing water quality conditions unsuitable for the fish survival;
- Direct mechanical crushing or entombment of fish;

- Unauthorized collection of individuals and/or physical disturbance of river edge habitats.

(2010 FEIR, p 4.5-685.)

The 2010 FEIR concluded that these impacts – all of which are associated with construction of bridges and bank stabilization improvements in the wetted channel of the River – would be significant absent mitigation. (2010 FEIR, pp. 4.5-681-686.) Mitigation Measures BIO-44 and BIO-46, described below, were designed to avoid these significate impacts.

4.2.3 Secondary Impacts

Further, the 2010 FEIR found that the proposed Project infrastructure would result in (i) short-term secondary impacts to unarmored threespine stickleback individuals and suitable habitat, including hydrology and water quality impacts; and (ii) long-term secondary impacts, such as potential physical changes in the River, altered base and flood flows, biochemical changes, substrate and temperature alterations, vegetative changes, (e.g., invasive plant species), increased human activity, and impacts from fecal material from pet, stray, and feral cats and dogs. These secondary impacts were considered significant absent mitigation.

As to such impacts, the 2010 FEIR concluded that mitigation measures from the certified Newhall Ranch Specific Plan Program EIR plus additional mitigation measures recommended in the 2010 FEIR would reduce such impacts to less-than-significant levels. However, Mitigation Measures BIO-44 and BIO-46 were not among the mitigation measures adopted for this purpose; other measures, described below, were designed to do so and would also be implemented for the modified Project.

With respect to the long-term secondary impacts of Project infrastructure on unarmored threespine stickleback, Entrix made two conclusions in support of the 2010 FEIR:

- The Project infrastructure (bridges, bank stabilization) would not alter the general morphology of the River or adjacent rearing habitat or high flow riparian refugia. Under flood events, there would not be any discernable difference in mainstem Santa Clara River marginal unarmored threespine stickleback habitat and refugia, between the existing conditions and the Project (including alternatives).

- The totality of the Project infrastructure would not interfere with the persistence and overall survival of the Del Valle population of unarmored threespine stickleback. The effects of the Project infrastructure are typically very localized and occur only under extreme high-flow flood events. The modeling data analyzed suggests there would be little change between the existing conditions and the Project (including alternatives).

4.2.4 Mitigation Measures for Construction-Related Impacts on Fish

To reduce construction-related impacts to unarmored threespine stickleback and other sensitive fish species, as well as a suitable habitat, CDFW worked with expert biologists to devise a series of mitigation measures that would temporarily divert water – and therefore the fish – away from the in-river construction zones. Recognizing that River diversion and associated dewatering could cause some fish, including unarmored threespine stickleback, to become stranded, CDFW and the Corps adopted mitigation measures – identified in the 2010 FEIR as BIO-44 and BIO-46 – that allowed qualified biologists to collect any stranded fish and place

them back in the Santa Clara River at a safer location outside of the construction zone. As an additional caveat, BIO-46 stated that no unarmored threespine stickleback could be collected or relocated except by a United States Fish and Wildlife Service (USFWS) employee or his or her agent.

The 2010 FEIR concluded that these mitigation measures would adequately protect unarmored threespine stickleback and other fish species, reducing the identified impacts to less than significant. CDFW adopted this conclusion in its CEQA Findings of Fact and determined that, with these mitigation measures in place, the Project could be implemented consistent with the California Fish and Game Code, which includes section 5515, the statute that identifies the unarmored threespine stickleback as a "fully protected" species.

To reduce secondary impacts to unarmored threespine stickleback and other sensitive fish species, as well as suitable habitat, CDFW prescribed mitigation that will avoid or substantially lessen secondary impacts on the unarmored threespine stickleback and its habitat. Impacts such as increased chemical pollutants, sedimentation, and increased human activity will be mitigated by measures such as the protection and management of the River Corridor SMA, creation of buffer areas between the River Corridor SMA and development, water quality requirements, and restrictions on public access. In addition, the technical studies conducted by ENTRIX (2009) concluded that suitable unarmored threespine stickleback habitat would not be significantly affected by the RMDP and buildout of the Specific Plan. Further, the Flood Hydraulics Impact Assessment (PACE 2009) found that there would be no significant impacts to water flows, velocities, depth, sedimentation, or floodplain and channel conditions downstream of the Project area over the long term as a result of the Project. These hydrologic effects were also found to be insufficient to alter the amount, location, and nature of aquatic and riparian habitats within the Project area and downstream into Ventura County. The PACE study determined that the River would still retain sufficient width to allow natural fluvial processes to continue. As a result, the mosaic of habitats in the River that support various special-status fish species would be maintained and the populations of the species within and immediately adjacent to the River corridor would not be substantially affected. The specific mitigation measures that address secondary impacts on unarmored threespine stickleback are set forth in the 2010 FEIR (2010 FEIR, pp. 4.5-695, 700-702).

4.3 Supreme Court Opinion Invalidating Mitigation Measures for Collecting and Relocating Stranded Unarmored Threespine Stickleback

Soon after CDFW certified the 2010EIS/EIR and approved the RMDP in 2010, the Center for Biological Diversity and four other organizations (collectively, CBD) filed suit in Los Angeles County the Superior Court challengingCDFW's decision on various grounds. Specifically, the lawsuit claimed that CDFW, among several other claims: (i) violated CEQA by approving an inadequate EIR, and (ii) violated the Fish and Game Code by authorizing the "take" of the fully-protected unarmored threespine stickleback.

The trial court ruled in favor of CBD on the unarmored threespine stickleback issue and a number of the CEQA claims, but was reversed by the Court of Appeal. CBD sought and was granted review by the California Supreme Court on two CEQA issues (greenhouse gas emissions and exhaustion of administrative remedies) and on the unarmored threespine stickleback claim. As to the unarmored threespine stickleback, CBD argued that mitigation measures BIO-44 and BIO-46 – because they authorized USFWS biologists to collect and relocate the fish during bridge construction activities – violated the "no take" provision of section 5515 of the Fish and Game Code.

In an opinion issued on November 30, 2015, the Supreme Court held that although CDFW adopted BIO-44 and BIO-46 to protect unarmored threespine stickleback, the "collect and relocate" activities described in those mitigation measures nevertheless constituted "take" as that term is defined in section 86 of the Fish and Game Code. Because section 5515 prohibits take of unarmored threespine stickleback except in limited circumstances not applicable to the Project, the Supreme Court determined that BIO-44 and BIO-46 violated the Fish and Game Code and could not lawfully be implemented.

5 Proposed "No Water Contact" Construction of Project Bridges and Bank Stabilization Improvements

To comply with the Supreme Court's decision, the Project proposes to modify its construction methods for bridges and bank stabilization to avoid all construction-related contact with the wetted channel of the Santa Clara River, as this would eliminate the need to divert or dewater the Santa Clara River flow – activities that might cause fish to become stranded and necessitate collection and relocation pursuant to BIO-44 and BIO-46. The "no water contact" construction requires use of construction methods that allow work to occur above the wetted channel of the Santa Clara River without water contact. A major component of ensuring no water contact is limiting the construction schedule for work within the dry riverbed to periods where work zones are not at risk of inundation. A summary of the modified Project is provided below in **Table 1 – Summary of Modified Project Description**.

Newhall retained the engineering firm of Moffatt & Nichol to evaluate whether the Project permanent bridges and temporary haul route bridges could be constructed without contact with the wetted channel of the River. Moffatt & Nichol prepared a memorandum highlighting its findings. It is summarized below.

5.1 Project Permanent Bridges

The proposed Project permanent bridges would provide the necessary connection between the northern and southern portions of the Project but would do so without affecting the wetted channel of the Santa Clara River. This is because the permanent bridge piers would be installed in the dry riverbed, outside the wetted channel of the River. This means no construction work would take place where fish may be present or become stranded. To implement a "no water contact" construction program, the permanent bridge piers would be placed at a minimum of 165 feet apart over the wetted channel of the River.

Moffatt & Nichol confirmed that the permanent bridge pile supports and bridge columns (collectively the piers) and deck work could be performed without any contact with the wetted channel of the River, and that the work that requires access to the dry riverbed would take place during the summer dry season, which is defined as running from June 1 through September 30 (Geosyntec, July 2016). According to Moffatt & Nichol, installation of the permanent bridge piers could be accomplished within the defined dry season, when the River is in a low flow mode. Moffatt & Nichol also stated that the permanent bridges could be constructed, as proposed, using conventional engineering techniques within the dry portion of the riverbed with pre-cast girders installed using overhead cranes.

This permanent bridge construction approach eliminates the need for mitigation measures BIO-44 and BIO-46, because there would be no construction in the wetted channel of the River and thus no diversion activities that might lead to stranded unarmored threespine stickleback. Because there will be no water contact and, thus, no stranded unarmored threespine stickleback, there is no reason to “collect” or “relocate” the fish.

Specifically, Moffatt & Nichol determined the following aspects of bridge construction were relevant to the analysis:

- Removal of vegetation from the bridge construction work zone can be accomplished from north or south without entering or crossing the wetted channel.

- Bridge construction that requires access to the dry riverbed can be accomplished in a restricted construction schedule defined for the Project as the summer dry season.

- Bridge support piers are spaced more than 165 feet apart, and therefore, can be installed outside the wetted channel.

- Piers (consisting of CIDH piles, cast-in-place columns, and bent caps to support pre-cast girders) can be completed during the summer dry season.

- CIDH piles will be constructed using a steel casing method that limits contact between drilling materials and alluvial groundwater. A minimum five feet of permanent steel casing above ground and 20 feet of permanent steel casing below ground have been incorporated into the bridge foundation design.

- Cast-in-place girders, supported on conventional falsework, can be completed during the summer dry season in the second year of bridge construction. These girders will span the space between the completed piers except for the location of the wetted channel (ie., where the bent cap was constructed). The bridge deck frames can be poured at the same time as the cast-in-place girders.

- Maintaining a clear weather window, defined for the Project as less than a 40 percent chance of 0.1 inches of precipitation in the coming 48 hours per NOAA, and suspending any concrete pours in the event of rain that is not forecasted, ensures that uncontrolled runoff of stormwater containing construction related pollutants will not occur.

- By increasing the span between bridge piers from 100 to 165 feet, the number of piers to be constructed for the two permanent bridges would be reduced from 18 to 13, resulting in less fill in the Santa Clara River and fewer hydrology and morphology impacts on the river.

- For additional security against inundation, Moffatt & Nichol recommend that each pier installation area be protected by a barrier constructed of K-rails, sandbags, or equivalent to prevent inadvertent personnel or equipment entry into the wetted channel as well as to act as a containment area for any pollutants that may result from cast-in-drilled-hole construction activities.

5.2 Temporary Haul Route Bridges

The Project also allows for two temporary haul route bridges. The purpose of the temporary haul route bridges is to allow construction equipment – more formally known as Material Hauling Equipment – to move back and forth between the north and south portions of the Project site, which is bisected by the Santa Clara River. These temporary haul route bridges will facilitate earthwork operations associated with construction of the Project.[3] These pier supports are pre-fabricated steel piles and can be installed in a manner of hours, not days, as is the case for the piers related to the permanent bridges.

The haul route bridges will not be permanent or attached to a standard road used by passenger vehicles; therefore the bridges need not be placed as high over the wetted channel as the Long Canyon Road Bridge and the Commerce Center Drive Bridge. Consequently, the temporary haul route bridges can be constructed using methods that greatly reduce pier installation time. The most important of these methods is vibratory pile installation. Under this method, no hole is pre-augered and then filled with rebar and concrete. Instead, a prefabricated steel pile is placed in a predetermined location within the dry riverbed and mechanically vibrated while pressure is applied from the top. This combination of forces pushes the pile down through the soil to the appointed depth, at which point it can serve as the foundation for the temporary bridge deck. Each pile can be vibrated into place in less than two hours (approximately five (5) per day). By comparison, at the permanent bridges, each cast-in-drilled-hole pile takes up to 5 days to complete. By maintaining a minimum of 10 feet between pile installation locations and the edge of the wetted channel, vibration effects on aquatic species would be avoided.[4] The spans of the haul route bridges will be wide enough to allow for installation of the support piers in dry portions of the riverbed, safely outside the areas where unarmored threespine stickleback and other fish might be affected.

Once the piers are in place, modular bridge decks can be installed overhead or “in the air” using cranes positioned on the dirt portion of the haul route or a completed bridge deck section. Consultation with weather forecasts during all construction periods would ensure that activities are conducted during a clear weather window. This will ensure that no storms are forecast to occur during the short period of time required to install the piers and demobilize the pier vibrating equipment. Temporary bridge decks, consisting of modular bridge deck sections, K-rail barriers, soil cover, and fencing, would be removed from the riverbed during the winter flood flow period. Temporary bridges would only be in place and operational between the period from May 1 through November 30, outside of the time that winter flood flows may occur (PACE 2016, Geosyntec 2016).

5.3 Bank Stabilization

As stated above, the Project contemplates that state-of-the-art flood control infrastructure – known as bank stabilization – would be installed in certain areas in proximity to the Santa Clara

[3] According to Caltrans’ Bridge Memo to Designers (MTD) 15-15, Material Hauling Equipment (MHE) is defined as construction equipment such as dump trucks, trailers, earthmovers, scrapers, and transit-mix trucks. Additionally, per MTD 15-15, MHE lanes are generally designed for a minimum 20-ft wide lane. We used these same parameters when designing the temporary haul route concepts for the Project.

[4] Background information on the effects of exposure to sound from vibratory pile driving in general is included as Exhibit A (ICF memorandum: Vibratory Pile Installation Impacts on Special Status Fish, October 11, 2016).

River (River). The final Project was approved with minimal encroachment into jurisdictional waters. As described in the final LEDPA[5] design, the bank stabilization improvements are substantially pulled back from the center, or perennial channel, of the River, occurring primarily within upland areas (farm and ranch land) with minimal encroachment into the riparian corridor of the River. This means that the bank stabilization can be installed without construction equipment or material contacting the wetted channel of the River. All the bank stabilization excavation and placement activities can take place during the non-flood flow conditions in the River, i.e., during the months between May 1 and November 30. Historical data indicate that during these periods, flood levels do not reach bank stabilization excavation areas (PACE, 2016).). More specifically:

- Bank stabilization infrastructure also would be installed without encroaching into the wetted channel of the River.

- Bank protection and related construction activities are set back sufficiently from the wetted channel to preclude any need to divert the flowing river.

- No crossing of the wetted channel of the River is required to construct the bank stabilization.

- Bank stabilization excavation and placement activities, where at risk of winter flood inundation, is proposed to be restricted to the time period outside of the winter flooding season, i.e., between the months between May 1 and November 30. Historical flow data and HEC-RAS flood elevation analysis illustrates that flood flows during this period are not anticipated to reach bank stabilization excavation areas. (PACE, 2016).

- The San Jose Flats bank stabilization (related to a water quality basin) is not set back from the edge of the riverbed and is at risk of inundation during late spring or early fall storm events. Thus, it should be constructed during the defined dry season (between June 1 and September 30).

- Perimeter Best Management Practices, typically required of construction projects covered under the federal Environmental Protection Agency's Construction National Pollutant Discharge Elimination System permits, would deflect minor flood flows (less than 12" deep, and less than 15 fps velocities) from entering bank protection construction work zones.

- Operational restrictions on dewatering addressed in the 2010 FEIR require that any dewatering be conducted in a manner that does not affect river flow, and these same restrictions will be observed going forward. Bank stabilization dewatering will be implemented in a manner that (1) does not create temporary wetted channel habitat suitable for unarmored threespine stickleback; (2) does not diminish existing river flow, and therefore will not result in stranding of unarmored threespine stickleback; and (3) does not introduce pollutants to surface waters.

[5] LEDPA is the term used by the Corps when referring to projects that satisfy the requirements for a Clean Water Act section 404(b) permit, and represents the Corps' Least Environmentally Damaging Practicable Alternative.

- Dewatering activities associated with bank stabilization would not involve direct removal of surface water from, or discharge to, the wetted channel of the River. Nor will such activities result in any draw-down of the River's flow such that fish may become stranded. Any groundwater discharges will be directed to an appropriate and legal disposal site in an upland location.

- Where the wetted channel is within 1,000 feet of dewatering activities, monitoring will occur at least one week prior to and during pump operations and then continue for at least one week subsequent to completion of such operations to ensure no significant drawdown of the wetted channel. If there are any indications that dewatering is affecting the River flow, dewatering operations would be suspended.

TABLE 1 – SUMMARY OF MODIFIED PROJECT DESCRIPTION

2010 FEIR Project Infrastructure	2010 FEIR Construction	Modified Project Description "No Water Contact" Construction	Does Modified Project Require Additional Analysis?
Permanent Santa Clara River Bridges: Commerce Center Drive and Long Canyon Road	• Span and clearance for bridges allowed for 100 foot girder spans between piers. • Diversion of the wetted channel and conventional false-work supported construction allowed in all areas of riverbed. • Vibratory method of installation allowed for steel casing in CIDH pile construction. • Year-round bridge construction is allowed. • The combined bridges have a total of 18 piers.	• Span and clearance increased to 165 foot girder spans. • No Water Contact construction requires piers to be relocated from wetted channel, with a pre-cast girder span of the wetted channel. • Oscillator/rotary installation methods are required for steel casing. • Construction in dry riverbed is restricted to dry season, between June 1 and September 30. • The combined bridges have 5 fewer piers, with a total of 13.	• No additional analysis is required because the change represents a reduced project from that analyzed in 2010 FEIR as it relates to construction and operation of the bridges. • Additional technical appendices have been provided to verify constructability of the "No Water Contact" approach, determine a dry season, and provide a literature review of elevated pH effects on fish.
Bank Stabilization along the Santa Clara River	• No seasonal construction restrictions for bank stabilization, allowing diversion of wetted channel during winter storm season. • Construction dewatering includes returning flows to the Santa Clara River.	• Bank stabilization areas not at risk of winter flood flows would be constructed year-round. Bank stabilization locations susceptible to winter flood flows will be restricted to May 1 through November 30. Bank stabilization construction at the San Jose Flats restricted to the dry season. • Construction dewatering is restricted to upland discharge.	• No additional analysis is required because the change represents a reduced project from that analyzed in the 2010 FEIR as it relates to construction of bank stabilization. • Additional technical appendices have been provided to inform the period where inundation of the bank stabilization project areas is not likely (outside of the heavy flooding or winter storm season).
Temporary Haul Routes crossing Santa Clara River	• Temporary haul routes would involve contact with, including diversion of, the wetted channel to install culverts. • Temporary haul routes would be used during construction of all four planning areas (Mission Village, Landmark Village, Homestead Village, and Potrero Village),	• Temporary haul routes will be installed, used, and removed without contact with wetted channel. • Temporary haul routes would only be used during construction of Landmark Village, and limited to three years of use.	• No additional analysis is required because the change represents a reduced project from that analyzed in the 2010 FEIR as it relates to installation and operation of temporary haul routes.

2010 FEIR Project Infrastructure	2010 FEIR Construction	Modified Project Description "No Water Contact" Construction	Does Modified Project Require Additional Analysis?
	spanning the 25 year build out of the Project • Temporary haul routes may include culverts or simple span bridge crossings of flowing water.	• Temporary haul routes restricted to bridge spans crossings the flowing water with additional bridge sections included in the dry riverbed beyond the wetted channel. • Temporary haul route bridges will be supported on steel pile supports. • Piles shall be installed and removed only if the pier locations are outside of the wetted portion of the Santa Clara River. • Modular bridge decks shall be removed from the river prior to November 30 and shall not be installed until after May 1 of each year they are in use.	• Additional technical appendices have been provided to verify constructability of the "No Water Contact" approach, determine a dry season, and to inform discussion of impacts from vibratory pile driving.
Maintenance of RMDP Infrastructure on the Santa Clara River	• Maintenance of infrastructure includes diversion of the wetted channel, in the same manner as for construction.	• Maintenance is restricted to areas outside of the wetted channel, and no River diversion is allowed. • Maintenance requiring access to the riverbed is restricted to the period from June 1 to September 30. • Maintenance dewatering is restricted to upland discharge.	• No additional analysis is required because the change a reduced project from that analyzed in the 2010 FEIR as it relates to maintenance of RMDP infrastructure on the Santa Clara River.

6 Analysis of Modified Project Impacts on Fish

6.1 Biological Resource Impacts of Proposed Permanent Bridge Construction and Operation

The following analysis evaluates whether and to what extent the proposed bridges at Commerce Center Drive and Long Canyon Road would result in construction-related and operational impacts on unarmored threespine stickleback and/or other sensitive biological resources.

6.1.1 Construction-Related Impacts of the Proposed Permanent Bridges on Unarmored Threespine Stickleback

Project permanent bridges would be constructed in a manner that avoids entry into or contact with the wetted channel of the Santa Clara River, with all work done either in the dry riverbed (i.e., the pier installations), or in the air above (i.e., through cantilevered lowering of bridge deck sections). The pier installation work would be scheduled during the dry season – June 1 through September 30 – when the River is in a low-flow mode. The pile holes would be capped when not in use, and each pier installation area would employ a barrier system to contain project activities and any pollutants within the work zone and prevent their entry into the wetted channel. Based on these facts and the memorandum provided by Moffatt & Nichol, the proposed Project permanent bridges would not contact the wetted channel of the River, and, therefore, would avoid take of unarmored threespine stickleback.

In addition, to prevent construction debris or uncured concrete from falling into the river while the permanent bridges are being built above, Moffatt & Nichol recommend the contractor install an underslung debris tarp, debris platform, or equivalent that would span across the wetted portion of the River. The contractor also shall perform periodic maintenance and inspection to ensure that the debris protection system is performing correctly. Moffatt & Nichol also recommend consulting weather data to maintain a clear weather window for construction activities. Containment and collection of runoff from any uncured concrete is also integrated into the bridge design to prevent direct discharge of construction stormwater runoff to the wetted channel.

Based on these facts, construction of the permanent bridges, including the support piers and deck segments, would not cause take of unarmored threespine stickleback.

The modified bridge construction methods would not result in impacts on unarmored threespine stickleback or other special status fish that are additional to or more severe than the effects analyzed in the 2010 FEIR.

6.1.2 Operational Impacts of the Proposed Permanent Bridges on Unarmored Threespine Stickleback

With respect to the operational impacts of the two permanent bridges, none are expected beyond those already assessed and disclosed in the 2010 FEIR. Then as now, the primary concern is that the bridge piers would permanently add fill to the Santa Clara River and thereby affect the River's flow regime, resulting in possible changes in the amount of storm refugia

available to unarmored threespine stickleback. However, when compared to the original bridge design, the proposed modifications to bridge construction will actually reduce by five the number of bridge piers to be installed in the River. Thus, the proposed construction modifications would not have habitat-related impacts, including impacts on stream morphology and unarmored threespine stickleback refugia, greater than those associated with the original bridge plan – impacts that the 2010 FEIR determined were less than significant. (2010 FEIR, 4.5- 683 (Alt. 2), 4.5-688 (Alt. 3); see also ENTRIX (2010).) Based on these facts, the proposed modifications to bridge construction would not result in significant impacts to refugia habitat used by unarmored threespine stickleback.

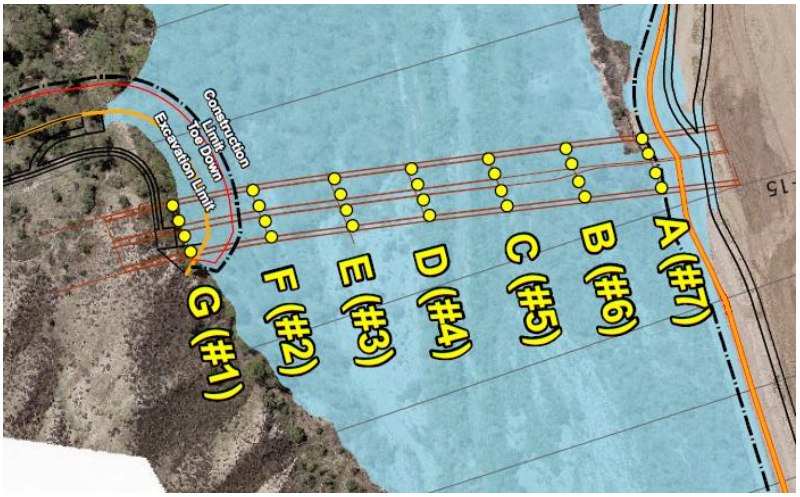
A second concern relates to the scour depressions that tend to form around and behind bridge piers during medium to heavy flows and whether unarmored threespine stickleback may become stranded within them when flow levels diminish and return to normal. Any obstruction in an active natural-bottom river system has the potential to cause scour depressions in areas of the riverbed that are subject to flood flows with erosive flow velocities (Brandimarte et al. 2012). This is true of natural structures, such as trees and rocks, as well as man-made structures, such as bridge piers. In the context of the proposed bridges at Commerce Center Drive and Long Canyon Road, four factors must be considered when assessing scour depressions and their potential to isolate unarmored threespine stickleback when flow velocities in the Santa Clara River return to non-flood levels: (1) what size storm events have the potential to cause such depressions at bridge piers; (2) what residual pool depth may be expected from such events; (3) what flow velocities are likely to occur during the peak and recession of such storm events; and (4) what is the ability and preference of unarmored threespine stickleback -- a fish that depends on slow-moving water – to access such depressions.

To address the first factor, and to provide context for the size of storms that may result in scour at the proposed bridge piers, PACE analyzed the amount of pier scour for the Commerce Center Drive bridge under a 10-year and a 25-year storm event. These storms represent the "reset" events for this portion of the Santa Clara River, where major sediment transport and significant fluvial geomorphic processes alter the morphology of the river within a large portion of the floodplain. For perspective, the PACE analysis, which is set forth in a technical memorandum dated August 2016 and attached hereto as **Exhibit B,** indicates as follows: During the peak of the 10-year storm, maximum scour depth would range from **2.7 feet** to **8.3 feet**, with greater scour occurring at piers closest to the current wetted, low flow channel of the River. During the peak of the 25-year storm conditions, maximum scour depth would range from **4.2 feet** to **10.0 feet**. Under both scenarios, six of the seven piers would experience velocities high enough to cause some pier scour. Note, however, that similar depths would occur near natural obstructions in the river (such as trees and large boulders). During smaller storm events, less of the floodplain would experience flow, and the depth and velocity of flow would be less, resulting in little to no scour at any given pier row.

The second factor relates to residual pool depth, which is the depth of the scour hole after it is refilled by sedimentary material redeposited by the river. Specifically, as storm flows recede, the resulting scour depressions at trees, rocks, bridge piers, and other obstructions begin to diminish as they fill up with sediment. This is a natural process: As the flow velocity is reduced, bed-mobilized sediments (also known as bedload) and suspended sediments settle out to reform the riverbed and active channel. There is no accepted method for calculating a precise post-storm (residual) depression depth; however, PACE estimates that sediment reclaims two-thirds (2/3rds) of the maximum scour depth, leaving a residual pool depth that is one-third (1/3rd) of the maximum scour depth at peak flows. Thus, for context, it is assumed that immediately after a 10-year event, the maximum residual depression will be 2.8-ft deep.

Immediately after a 25-year event, the maximum residual depression will be 3.3-ft deep. Much shallower residual depressions, or no depression at all, may be expected at piers located further away from the wetted channel.

The third factor relates to the velocity of the flow at the scour pools during the storm event, as this will greatly affect whether unarmored threespine stickleback can access the scour pools. As the PACE analysis shows, the pier rows with the deepest depressions are those which encounter the highest flow velocities. (See Figure 1.) Or to put it the other way, the higher the flow velocity, the deeper the pier scour depression. As explained in an earlier analysis by ENTRIX (2009), unarmored threespine stickleback cannot withstand flow rates in excess of 2 feet per second (fps); even during non-storm or non-flood periods, stickleback tend to concentrate in the slow-moving waters and eddies (ENTRIX 2009, Alexandre and Almeida



2009, Williams 2014, USFWS 2009) such as those found along the margins of the Santa Clara River, including inundated riparian zones. During a storm event, as the flood plain widens and the flow rates in the middle of the wetted channel increase, stickleback swim to the edges of the river where the flow rates are reduced and seek refuge there until the flood waters recede (Williams 2014, Baker 2008).

Pier Designation		Flow Velocity (fps)	
(alpha)	(numeric)	(10 yr return Interval)	(25 yr return Interval)
A	7	0.81	1.62
B	6	0.99	1.46
C	5	2.45	3.32
D	4	4.71	6.72
E	3	4.58	6.78
F	2	0.61	1.06
G	1	0.58	1.00

Figure 1 – Flow velocities at 10 and 25 year flow return intervals at the Commerce Center Drive Bridge piers.

Behavioral responses of fish have been found to be an important predictor of fish stranding susceptibility; species favoring littoral, backwater habitats generally moved out during periods of drawdown (either through self-propulsion or passive drift) (Adams et al. 1999). Unarmored threespine stickleback in the Santa Clara River favor littoral, backwater habitats; thus, after storm events, the expectation is that they will swim or passively float out with the retreating tide and resume their normal positions in the standard margins of the river where flow rates are 2 fps or less. This behavior has been observed during dewatering efforts in rivers (e.g., Carmel River, Santa Clara River) (Mulder, pers. comm.). At the locations with the deepest residual scour pools (center channel), the velocity during the storm events are expected to be well in excess of 2 fps. Unarmored threespine stickleback would avoid these areas, as the water is moving too fast and the scour pools provide no refuge from the flood or storm flows. Where residual scour pools are minimal in depth or non-existent (e.g., the pier rows at floodplain margins), the flow velocities may be in the range preferred by unarmored threespine stickleback (i.e., less than 2 fps). Such areas would be indistinguishable from the numerous other side channels, depressions, and scour holes present throughout the Santa Clara River's natural riverbed habitat, particularly after a reset event. As with any natural depression in this size range, unarmored threespine stickleback at a shallow pier scour pool would be expected to follow their natural life history by pursuing the receding flood flows to slow-moving marginal waters along the wetted channel of the river.

The Santa Clara River is dynamic and subject to "flashy" (i.e., highly episodic) flows. Following large storm events, the river is characterized by braided channels and denuded riverbed conditions, where most of the vegetation cover, especially emergent vegetation along the margins of the river channel, has been uprooted and swept downstream. It is evident that unarmored threespine stickleback have adapted to this type of periodic disturbance. Furthermore, there are no published studies indicating that stickleback, or other small fish with a similar life history, become routinely stranded during storm induced flood flows. Instead, the literature shows that larger fish such as salmon and trout tend to be the most susceptible to stranding, but even for these species, the greatest incidence of stranding occurs below hydroelectric dams where river flows are rapidly increased due to large water releases and then very quickly shut off, resulting in dramatic flow reductions (Quinn and Buck 2001).

In conclusion, the data indicate that unarmored threespine stickleback are not likely to enter the scour depressions/holes that may form at the bridge pier rows. This is especially the case for the scour depressions at the pier rows located in the middle of the wetted channel where flow velocities are too high for unarmored threespine stickleback to negotiate. With respect to the

potential scour depressions at the pier rows located at the edges of the floodplain, the flow velocities in this part of the Santa Clara River are low enough to support unarmored threespine stickleback and thus there would be no need for the fish to seek refuge in a scour pool at the pier rows. Nevertheless, if any unarmored threespine stickleback were to enter a scour pool at one of these locations, the pool itself would likely be very shallow and virtually indistinguishable from the many other natural depressions in the riverbed, and thus should pose no special risk to the fish.

The modified bridge design, including larger spans resulting in 5 fewer piers than the 2010 FEIR, will result in less severe impacts on unarmored threespine stickleback or other special status fish than those analyzed in the 2010 FEIR. No new impacts on unarmored threespine stickleback are created with the modified bridge design.

6.1.3 Construction-Related Impacts of the Temporary Haul Route Bridges on Unarmored Threespine Stickleback

The temporary haul route bridges likewise would be constructed in a manner that does not require contact with the wetted channel of the Santa Clara River. The bridge support piles would be vibrated into the dry riverbed to a depth sufficient to support the bridge – a process that takes only hours per pile. No hole is created. In addition, the set-up and take-down time for the pier installation equipment is short. Thus, as long as the climate forecast shows a clear weather window and the work area is not inundated, the temporary haul route bridge piers can be installed without contacting the wetted channel of the River. Installation of the modular bridge decks after the winter storm season, and then their use and removal prior to the winter flood flow period, would eliminate the potential for inundation of the bridges and, therefore, eliminate any risk of road materials or bridge components being washed into the wetted channel as could happen during a high flow winter storm event.

Based on these facts, construction of the temporary haul route bridges, including the support piers and deck segments, would not i cause take of unarmored threespine stickleback.

The use of temporary bridge decks that span the wetted channel of the River, instead of installing culverts directly in the flow, will result in less severe impacts on unarmored threespine stickleback or other special status fish than those analyzed in the 2010 FEIR. Mitigation measures recommended in this report avoid or further reduce any impacts. The installation of the temporary haul route bridges does not create any new significant impacts on unarmored threespine stickleback or other special status fish species.

6.1.4 Operational Impacts of the Temporary Haul Route Bridges on Unarmored Threespine Stickleback

The temporary haul route bridges have been designed to provide two-lane travel for heavy grading equipment, including the CAT 657 scraper, which is the largest and heaviest machine commercially available for this purpose. ICF and Moffat & Nichol assessed the potential for dirt and other debris to fall from the temporary haul route bridges into the Santa Clara River where unarmored threespine stickleback or its habitat may be affected. It was determined that the risk of debris discharge is very small. This is because the bridge design includes berms along the bridge deck edges that extend 12 inches above the bridge deck surface. The sole purpose of the berms is to prevent debris from falling into the river. As for potential scour depressions at the bridge piers, these are expected to be much smaller and shallower than those at the Commerce Center Drive Bridge and the Long Canyon Road Bridge, due to the smaller piers

used in the temporary haul route bridges. More importantly, based on the pier scour/fish stranding analysis performed for the permanent bridges (see subsection 6.1.2 of this report, above), it is highly unlikely that any unarmored threespine stickleback will enter the pier scour depressions at the temporary haul route bridges; and if any unarmored threespine stickleback do, in fact, enter such depressions, they are not likely to become stranded there.

The use of temporary bridge decks that span the wetted channel of the River, instead of installing culverts directly in the flow, will result in less severe impacts on unarmored threespine stickleback or other special status fish than those analyzed in the 2010 FEIR. Mitigation measures recommended in this report avoid or further reduce any impacts. The installation of the temporary haul route bridges does not create any new significant impacts on unarmored threespine stickleback or other special status fish species.

6.1.5 Bridge-Related Impacts on Other Sensitive Fish

ICF assessed whether the proposed permanent bridges and temporary haul route bridges, if constructed per the “no water contact” approach, would result in impacts to biological resources *other than unarmored threespine stickleback,* such as arroyo chub and Santa Ana sucker – two other special-status fish. The 2010 FEIR evaluated all impacts associated with construction of permanent bridges and temporary haul routes. The proposed modified construction approach does not change the location, use, or the impact areas of these infrastructural components. Thus, ICF has determined that the proposed modified construction approach for the permanent bridges and temporary haul route bridges would not add to or increase the intensity of any significant biological effect previously identified in the 2010 FEIR. Nor will the infrastructure create any new or more severe significant effects not assessed in the 2010 FEIR. Further, because this analysis indicates that the proposed designs for the permanent and the temporary bridges will not adversely affect unarmored threespine stickleback, and because arroyo chub and Santa Ana sucker use habitats similar to those used by the unarmored threespine stickleback, there would be no additional adverse impacts on these other two fish species. In short, with a “no water contact” approach to construction, no aspects of the Santa Ana sucker and arroyo chub life histories are affected or implicated, and thus no further analysis regarding these species is necessary.

6.2 Biological Resource Impacts of Proposed Bank Stabilization Improvements

As to the bank stabilization improvements, excavation and construction would occur well outside the wetted channel of the Santa Clara River (River), and would not require diversion of the river from work zones. Bank stabilization would be installed during the period from May 1 through November 30, when the work zones would not be subject to inundation by winter flood flows.

Construction equipment likewise can be deployed and used without contacting or encroaching into the river’s wetted channel. Consequently, installation of the bank stabilization improvements would not result in take of unarmored threespine stickleback under these two restrictions. Nor will such installation result in any take of unarmored threespine stickleback. Bank stabilization dewatering will be implemented in a manner which does not create temporary wetted channel habitat suitable for unarmored threespine stickleback, and, therefore, will not result in stranding of unarmored threespine stickleback. Dewatering would be subject to water quality restrictions and would not discharge pollutants to the River.

As with the Project bridges, Newhall must implement standard best management practices to avoid water quality impacts during construction, as described in the RMDP Master Streambed Agreement and other Project approvals (i.e., LARWQCB Waste Discharge Requirements/401 Certification).

The restriction of timing of bank stabilization construction and elimination of any river diversion will further avoid impacts on unarmored threespine stickleback or other special status fish than those analyzed in the 2010 FEIR. Mitigation measures recommended in this report also avoid or further reduce any impacts on unarmored threespine stickleback. The additional construction season and dewatering restrictions do not create any new impacts on unarmored threespine stickleback or other special status fish species.

6.3 Required Impact Avoidance Measures

Prior to the commencement of construction activities, a qualified biologist shall survey the proposed infrastructure project work zone to confirm that the construction zone is outside the wetted channel of the River. Such surveys will ensure that no work will take place in the wetted channel of the river where unarmored threespine stickleback and other special status fish species may persist. During permanent bridge construction, installation of temporary haul route bridges, and excavation and installation of bank stabilization, a qualified biologist shall monitor all activities that could adversely impact adjacent natural habitats or nearby special status species and ensure no equipment, personnel, or debris enters or makes contact with the wetted channel of the River.

6.4 Conclusion

Based on the foregoing analysis, the Project Infrastructure can be constructed without making contact with the wetted channel of the Santa Clara River, thereby avoiding any potential take of unarmored threespine stickleback or other sensitive fish species. This eliminates any need to collect or relocate unarmored threespine stickleback during construction activities. Consequently, no take of unarmored threespine stickleback would occur.

The modified Project will result in less severe or similar impacts on unarmored threespine stickleback or other special status fish than those analyzed in the 2010 FEIR. No new impacts on unarmored threespine stickleback are created with the modified Project.

7 Satisfying the Writ of Mandate

The Supreme Court's ruling requires CDFW to avoid take of unarmored threespine stickleback, as required under Fish and Game Code section 5515(a). The analysis set forth above shows that CDFW can meet this directive by authorizing construction of the Project Infrastructure in a manner that avoids all contact with the wetted channel of the Santa Clara River. The "no water contact" construction approach would avoid all take of unarmored threespine stickleback, eliminating the need for mitigation measures BIO-44 and BIO-46. **Table 2 – Modified Project Impacts and Determination of Take of Unarmored Threespine Stickleback** provides a summary of the impact analysis and take determinations.

TABLE 2 –MODIFIED PROJECT IMPACTS AND DETEMINATION OF TAKE OF UNARMORED THREESPINE STICKLEBACK

2010 FEIR Project Infrastructure	Project Design Features and Mitigation Measures to Avoid Take of Unarmored Threespine Stickleback	Does Modified Project Result in Take of Unarmored Threespine Stickleback or Other New or Increased Impact to Other Sensitive Fish Species
Permanent Santa Clara River Bridges: Commerce Center Drive and Long Canyon Road	• 165 foot girder spans between piers • Bridge piers adjusted to match the current wetted channel conditions • Piers located outside the wetted channel and the girders span the wetted channel • CIDH piles installed with temporary casing, reducing the need for slurry during drilling, minimizing the threat of discharge during boring • CIDH pile temporary casing method limited to use of oscillator/rotary methods • Pre-cast girder bridge design for section of bridge spanning the wetted channel with installation using “over-head” cranes • No contact with wetted channel of the Santa Clara River, and therefore no river diversion and no fish stranding surveys/rescue required • Construction barriers and other BMPs to contain, collect, or deflect any construction materials, including wet concrete, from entering the wetted channel (K-rail, underslung tarp, and other protections) • Monitor the water quality at a point, upstream, downstream, and immediately adjacent to the bridge construction Work Zone daily during concrete bridge-related pouring operations and report the results monthly to CDFW • All deck work to be completed from above the bridge structure • Conventional Construction with falsework except for span crossing the wetted channel. • Limited construction season access to the dry riverbed (dry season June 1 to September 30) • Bridge work zone cleared of vegetation, including 100 feet upstream and downstream, same as 2010 FEIR.. • Concrete pours limited to clear weather window (less than 40% chance of 0.1” rain event in next 48 hours) • The combined bridges would include 13 piers which is 5 fewer than the 2010 FEIR	• The change to the project represents less impact than the 2010 FEIR. The avoidance of contact with the wetted channel to construct piers and the bridge superstructure, including measures to prevent pollution by construction materials, ensure that there will be no take of unarmored threespine stickleback.

2010 FEIR Project Infrastructure	Project Design Features and Mitigation Measures to Avoid Take of Unarmored Threespine Stickleback	Does Modified Project Result in Take of Unarmored Threespine Stickleback or Other New or Increased Impact to Other Sensitive Fish Species
	• 7 piers at Commerce Center Drive and 6 piers at Long Canyon Road • Bridge abutments set back from river edge, same as 2010 FEIR. • Bridge decks elevated above riverbed with maximum vertical clearance, same as 2010 FEIR. • Bridge designed to not affect continued habitat connectivity, same as 2010 FEIR. • River bottom remains as soft bottom channel without impeding wildlife passage, same as 2010 FEIR. • Maintenance restricted to areas outside of the wetted channel	
Bank Stabilization along the Santa Clara River	• Bank stabilization set back from river edge, predominately in existing agricultural fields, same as 2010 FEIR. • Allows for preservation of the river as a natural resource, same as 2010 FEIR. • Excavation dewatering restricted to implementation in a manner that would not affect the extent of the wetted channel and would not result in water quality impacts with additional restrictions where the wetted channel is within 1,000 feet of dewatering activities, monitoring will occur at least one week prior to and during pump operations and then continue for at least one week subsequent to completion of such operations to ensure no significant drawdown of the wetted channel. If there are any indications that dewatering is affecting the River flow, dewatering operations would be suspended. • Dewatering activities shall not involve direct removal of surface water from, or discharge to, the wetted channel of the Santa Clara River • Bank stabilization construction at the San Jose Flats area of Mission Village will be restricted to the dry season, as defined as the time period between June 1 and September 30, to preclude the construction work zone from being inundated by seasonal flood flows. • Other bank stabilization installation locations susceptible to winter flood flows shall be conducted from May 1 through November 30, when winter flood flows do not occur on the Santa Clara River. • Bank stabilization areas not at risk of winter flood flows would be constructed year-round, same as 2010 FEIR.	• The change to the project represents less impact than the 2010 FEIR. The avoidance of contact with the wetted channel to construct bank stabilization and additional monitoring and restrictions on dewatering ensure that there will be no take of unarmored threespine stickleback.

2010 FEIR Project Infrastructure	Project Design Features and Mitigation Measures to Avoid Take of Unarmored Threespine Stickleback	Does Modified Project Result in Take of Unarmored Threespine Stickleback or Other New or Increased Impact to Other Sensitive Fish Species
Temporary Haul Routes crossing Santa Clara River	• Allow two temporary haul routes to cross the Santa Clara River between the Homestead South Village and Landmark Village in the vicinity of Long Canyon Road Bridge, same as 2010 FEIR. • Temporary haul routes would only be used during construction of Landmark Village, with only three years of use. • Passage of river flows would be maintained for all periods when the temporary haul routes were in use, same as 2010 FEIR. • Temporary haul routes restricted to bridge spans crossings the flowing water with additional bridge sections included in the dry riverbed beyond the wetted channel • Temporary haul route bridges will be supported on steel pile supports • Piles shall be installed and removed when the pier locations are outside of the wetted portion of the Santa Clara River. • Modular bridge decks, and all travel surface materials above the deck, shall be removed from the river prior to November 30 and shall not be installed until after May 1 of each year they are in use. • Once the temporary haul route bridges are no longer required for grading operations, the pile caps would be removed and piles would be extracted using equipment similar to that used for installation.	• The change to the project represents less impact than the 2010 FEIR. The avoidance of contact with the wetted channel for the temporary haul routes that there will be no take of unarmored threespine stickleback.
Maintenance of RMDP Infrastructure on the Santa Clara River	• Maintenance is restricted to areas outside of the wetted channel, and no River diversion is allowed. • Maintenance requiring access to the riverbed is restricted to the period from June 1 to September 30. • Maintenance dewatering is restricted to upland discharge.	• The change to the project represents less impact than the 2010 FEIR. The avoidance of contact with the wetted channel any RMDP infrastructure on the Santa Clara River ensures that there will be no take of unarmored threespine stickleback.

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Memorandum

Date: October 11, 2016

To: Matt Carpenter
Newhall Land and Farming

From: Joel Mulder, ICF International

RE: Vibratory Pile Installation Impacts on Special Status Fish

Introduction / Background

The Newhall Ranch Resource Management and Development Plan (RMDP) component of the RMDP/Spineflower Conservation Plan (RMDP/SCP) Project ("Project") proposes to construct transportation and flood control infrastructure in support of the Newhall Ranch Specific Plan, which the County of Los Angeles approved in 2003. The RMDP/SCP is a conservation, mitigation, and permitting plan for sensitive biological resources within the previously approved Specific Plan area. Certain infrastructure elements are located in and along the Santa Clara River (River) and include (i) a permanent bridge across the at Commerce Center Drive, (ii) a permanent bridge across the River at Long Canyon Road, (iii) two temporary haul routes across the River near Long Canyon Road, and (iv) bank stabilization along portions of the banks of the River.

This memorandum addresses a specific component of the temporary haul route bridge construction: vibratory pile installation of steel HP piles, as described in a technical memorandum titled *Commerce Center Drive and Long Canyon Road Bridges (CIDH) Temporary Haul Route Bridges (Temporary Steel HP Piles)* (Moffatt & Nichol, October 2016). More particularly, this memorandum evaluates whether and to what extent vibratory pile installation (and extraction) at the proposed temporary haul route bridges will significantly affect fish in the River.

The River supports several sensitive fish species. The unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*) is native to the River and is listed as both state and federally endangered and is a California fully-protected species. The arroyo chub (*Gila orcuttii*), although native to southern California, is not considered native to the River and was likely introduced to this watershed from basins of the Los Angeles plain to the south (Moyle 2002). Until recently, Santa Ana sucker (*Catostomus santaanae*), also native to southern California, was believed to be introduced to this watershed from basins of the Los Angles plain to the south (Moyle 2002). However, recent genetics data show no evidence that *C.santaanae* were introduced to the River from the Los Angeles plain; thus, *C.santaanae* are likely native to the River (Richmond et al. 2016).

The Newhall Ranch Specific Plan development includes two temporary haul route bridges (near the Long Canyon Bridge). The locations of the two temporary haul routes are shown on Figure

1. The temporary haul route bridges will only be a portion of the haul routes shown, with a section of bridge deck spanning the wetted channel and additional spans to the north and south of the wetted channel. Support pilings, consisting of pre-fabricated steel piles having an H-shaped cross section ("steel HP piles"), for the temporary bridges would be driven into the substrate using vibratory driving. This memorandum provides a summary of the potential impacts of the Project's temporary pile installation and extraction on fish. The vibration noise caused during installation and extraction of the piles is analyzed considering existing literature, relevant observations, current interim sound level criteria (Fisheries Hydroacoustic Working Group, 2008), and pile installation locations, which are restricted to dry riverbed locations.

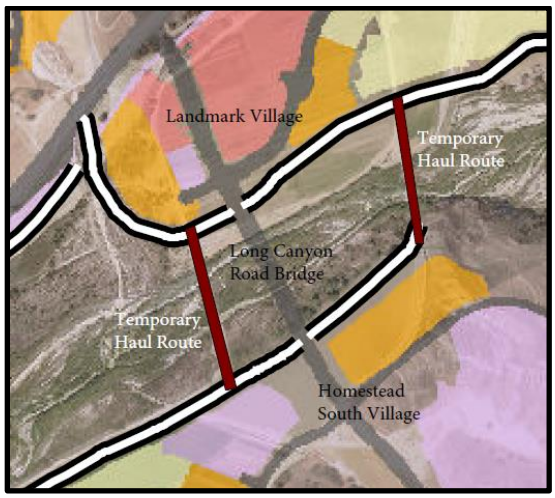

Figure 1. Temporary Haul Route Locations

Vibratory Pile Driving

Vibratory pile driving is commonly used to install and extract temporary piles. Vibratory hammers are suspended by an excavator and then fastened atop the pile. The vibratory hammers consist of a series of oscillating weights which continuously transfer vertical vibrations into the pile at a specific frequency. These vertical vibrations cause the sediment surrounding the base of the pile to liquefy, allowing the pile to penetrate the substrate. This is in contrast to a hammer (impact) pile driver which raises a dead-weight and drops it onto the top of the pile, forcing the pile to penetrate the substrate. Vibratory hammers use several different vibration rates, ranging from about 1200 to 2400 vibrations per minute. The vibration rate chosen is influenced by soil conditions at the site (DOSITS 2016).

Vibratory pile driving in an aquatic system (under water) produces a continuous sound with peak pressures lower than those observed in pulses generated by hammer pile driving. Sound signals (pressure waves) generated by vibratory pile driving usually consist of a low fundamental frequency, from 25 to 50 Hz, with near source, peak sound pressure levels ranging from 165 to 185 underwater dB (California Department of Transportation (Caltrans) 2007).

Note that the interim sound level criteria considered in this analysis specifically apply to pile driving conducted in *underwater* environments. The Project, however, will install piles in a soil matrix, which does not conduct or transmit vibrations as readily as water. During the vibratory

installation of the piles, two different energy waves will be generated: (i) a pressure wave from vibration of the pile that is transmitted in-air; and (ii) a ground vibration wave (ground wave or peak particle velocity (PPV) wave) that will propagate through the soil strata (Federal Railroad Administration (FRA) Guidance Manual for High-Speed Ground Transportation Noise and Vibration Impact Assessment 2005). With regard to the ground waves, if they encounter a material with resonance frequencies matching the ground wave, they will create audible noise, as illustrated in Figure 2 below. The concept of reflection[1] will determine whether a pressure wave in-air will diffuse into, or bounce off-of, the flat plane of the water surface. In either case, very little of the pressure wave from the "sound" will diffuse into the water body due to the dissimilar materials (air and water or soil and water).

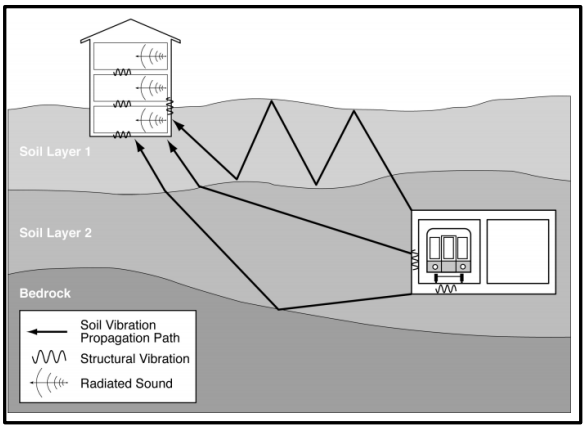

Figure 2. Typical Vibration Propagation and Radiated Sound[2]

Effects of Sound on Fish

Exposure to sound is defined to include a measure of both the received sound level (pressure wave level in dB) and the duration of the pressure wave (time duration or exposure by an observer). For example, the received sound level can be expressed in terms of acoustic pressure, particle velocity, or intensity (energy flux), which all vary with time over the duration of the sound. Sound exposure metrics (e.g., what is important to record about the exposure) usually convey an integration of the received level (pressure wave level in dB) over the time duration of exposure of a single acoustic event (such as a 5 minute phone call where the speaker is at 70 dB). The effects of multiple events primarily depend on the degree of damage caused by a single event, recovery of the damaged region during the time interval between events, and the total number of events. In this way, repeated exposures to a damaging pressure wave are likely to result in more damage to the observer.

Potential effects of a sound event (measured in dB and time duration) on fish include tissue damage that might make the fish less fit until healing takes place, resulting in lower chances of survival. There is also the potential for temporary hearing loss due to exposure to intense sound sources, and this too could lower fitness until hearing recovers. Behavioral changes

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[1] https://en.wikipedia.org/wiki/Reflection (physics)
[2] Federal Railroad Administration (FRA) *Guidance Manual for High-Speed Ground Transportation Noise and Vibration Impact Assessment* (2005)

might also occur, resulting in animals leaving feeding or reproduction grounds (Popper and Hastings 2009).

Existing Literature Review

In 2005, a report was prepared for Caltrans (Popper and Hastings 2005) which provided a comprehensive review of available literature on the effects of sound on fish. The report determined that the effects of sound on fishes are variable and the literature provides no clear-cut "rules" as to what sounds will affect fish and how the fish will be affected. Although there is little existing literature assessing the effects of vibratory pile installation on fish, the author did locate and review the following studies on the issue:

> Nedwell et al. (2003) examined the effects of both vibratory pile driving and impact pile driving on caged brown trout at the Red Funnell's Southampton Terminal, England. Caged fish were placed at distances of 25 to 400 meters (82 to 1,312 feet) from the piles being driven in water, with a control cage 10 kilometers (6.2 miles) away. Animals were observed by closed circuit TV as they were exposed to pile-driving sounds. During the vibratory pile driving ("vibropiling") portion of the investigation, researchers found that vibropiling generated no measurable increases in sound when compared to other background noise sources, such as passing vessels. "[I]n general, there was no discernable difference between recordings of sound pressure level versus time history made on days on which vibropiling was being conducted and those on which there was no vibropiling" (Nedwell et al., p. 7). Behavioral results showed that the fish did not react to vibratory piling as close as 25 meters (82 feet) to the source. For example, the report indicates that "[n]o startle response was seen in any of the vibropiling sequences for any of the piles driven by this method"(Nedwell et al., p. 10). The authors also observed no injuries to the fish. As this project was completed within water, there is no correlation of the sound pressure levels to the Project, as vibratory piles will be installed in the dry riverbed. However the study does inform the reader about the risk of any vibropiling activities on fish.
>
> Dolat (1997) measured underwater Sound Pressure Level (SPL) from construction activities during the Baldwin Bridge demolition project in Connecticut. Machinery recorded included a hoe ram used to drive H-piles, and vibratory drivers used to drive sheet piles within the water where fish were monitored. The monitoring vessel was positioned at different distances from the pile driving activities, and underwater sounds were recorded at different depths. The maximum SPL from the vibratory drivers was 156 dB re 1 µPa at 20 Hz measured at a range of 110 feet (33.5 m). No impacts on fish were noted. As this project was completed within water, there is no correlation of these pressure wave levels to the Project vibratory piles installed in the dry riverbed.
>
> In November 2004, the City of Everett, Washington, completed repairs to a water-transmission pipeline where it crossed the bottom of the Snohomish River. The repairs included inserting steel H-piles about 60 feet into the wetted channel of the riverbed using a vibratory pile driver. Technicians monitored the underwater sounds produced during the vibratory pile driving and assessed the potential impact of those sounds on protected fish species, including threatened bull trout (*Salvelinus confluentus*) and Chinook salmon (*Oncorhynchus*

> *tshawytscha)*. A series of underwater acoustic measurements took place at a variety of depths and distances from the piles being driven. Short-term avoidance to the vibratory driver may have occurred, although any such avoidance was likely to have had no greater potential impact than the avoidance behavior commonly carried out by Snohomish salmonids in response to other natural and anthropogenic stimuli in their habitat (Greeneridge Sciences 2005).

As these studies indicate, vibratory pile driving does not appear to cause adverse impacts on fish. This conclusion is supported by the 2015 Caltrans report, *Hydroacoustic Effects of Pile Driving on Fish*, which states that "there are no established injury criteria for vibratory pile driving, and resource agencies in general are not concerned that vibratory pile driving will result in adverse effects on fish" (Caltrans 2015, p. 2-26).

Vibratory pile driving has been permitted by State and Federal for agencies for a number of other recent projects in southern California in waters supporting federally listed fish species, such as steelhead (*Oncorhynchus mykiss)* and tidewater goby (*Eucyclogobius newberryi*) (NMFS 2008, NMFS 2000, USFWS 2007, USFWS 2011, CDFG 2009a, CDFG 2009b).

Cardno biologists observed tidewater goby within a few feet of vibratory sheet pile installation in the wetted channel of Mission Creek, Santa Barbara County in 2011, and determined the vibrations did not alter fish behavior (Cardno ENTRIX 2011). These findings are consistent with the technical literature summarized above.

Interim Sound Level Criteria

In 2008, the Fisheries Hydroacoustic Working Group developed Interim Sound level Criteria for the protection of fish during pile driving.[3] These criteria, which were based on the work of Popper and Hastings (2005), are currently being used on projects on the West Coast (ICF 2010).

The Interim Sound Level criteria are as follows:

> Peak: 208 dB
>
> Cumulative Sound Level Exposure (SEL): 187 dB
>
> Cumulative Sound Level Exposure (SEL) for Fish Less Than 2 Grams: 183 dB

Rodkin and Pommerenck (2014) compiled for Caltrans a large collection of measured underwater sound level data in a variety of construction configurations, including various types of pile driving for coastal and river bridges, harbors and wharfs, and a major structure over water being built for the US Navy. According to this compendium, the sound exposure level (SEL) for in-water vibratory driving of a 12-inch steel H-type pile was 155 dB at a distance of 10 meters (33 feet), with a peak level of 165 dB. These figures are well below the Interim Sound Criteria for (i) cumulative SEL for fish less than 2 grams (183 dB), and (ii) peak (208 dB).

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[3] The Fisheries Hydroacoustic Working Group consists of engineers, biologists, and administrators from Caltrans, the Federal Highways Administration, and the departments of transportation in Oregon and Washington. The term "interim" reflects the fact that the Working Group intends for the criteria to be further refined in the future and later adopted as permanent guidelines.

With respect to the proposed vibratory installation of piles at the temporary haul route bridges, sound tranmission would also be attenuated (materially dampened) by the river bottom substrate (Heckman & Hagerty 1978, Woods and Jedele 1985). For this reason, sound levels as received by fish in the wetted channel are expected to be even less than those measured during in-water installation on other projects.

Conclusion

Based on (i) the existing literature, (ii) documented sound level readings from vibratory pile installations, (iii) interim limits on pile-driving sound impacts to fish, and (iv) engineering calculations of the expected noise and vibration effects of vibratory installation and extraction of steel HP14 piles 10 feet (3 meters) from the wetted channel of the Santa Clara River (River), it is unlikely that vibratory pile installation for the temporary haul route bridges will result in take of unarmored threespine stickleback or otherwise cause significant impacts to unarmored threespine stickleback or other fish in the River.

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PACE
Advanced Water Engineering

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Technical Memorandum

REGISTERED PROFESSIONAL ENGINEER
JOSE CRUZ
No. 72249
Exp. 06-30-18
CIVIL
STATE OF CALIFORNIA

Date: September 30, 2016

To: Sam Rojas and Matt Carpenter – Newhall Land

From: Mark Krebs, PE and Jose Cruz, PE

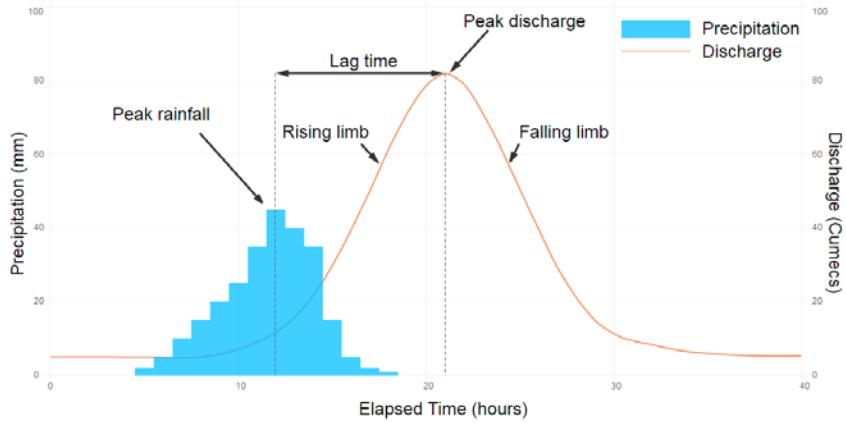
Re: Pier Scour Analysis - Newhall Ranch RMDP Permanent Bridges #8238E

Purpose and Background

The purpose of this memorandum is to provide additional context to the issue of bridge pier scour as it relates to the potential for stranding of fish in scour holes that may result from large storm events. This memorandum provides an analysis of pier scour at the proposed permanent bridges of the Newhall Ranch RMDP: the Commerce Center Drive and Long Canyon Road Bridges. Specifically, the memorandum describes pier scour during two different "reset" storm events – the first where peak flow corresponds to a 10-year storm, and second where peak flow corresponds to a 25-year storm. PACE ran the HEC-RAS[1] model to establish the river hydraulics for the 10-year and 25-year storms, using hydrologic data that PACE had previously prepared for the Santa Clara River watershed. For the Commerce Center Drive Bridge (located upstream of Castaic Creek confluence), flow rates are 11,700-cubic feet per second (cfs) (10-year) and 23,000 cfs (25-year), respectively. For the Long Canyon Road Bridge location (downstream of Castaic Creek confluence), the flow rates are 14,300-cfs (10-year) and 28,100-cfs (25-year), respectively. A separate memorandum, following the same methodologies contained herein, has been prepared by PACE to provide an analysis of pier scour related to the Newhall Ranch RMDP temporary haul route bridge piles (steel HP).

The relationship between rainfall and river-flow over time is typically illustrated in a storm hydrograph. Peak flood flows recede back to, or near, pre-storm flow levels on the falling limb of the discharge curve, as illustrated on **Figure 1** below. The analysis provided herein reports on the maximum local pier scour expected at the peak flow of each modeled event and then presents a methodology to estimate the aerial extent and depth of local residual scour pools that might be expected to persist as flood flows from these events abate. Therefore, this analysis is only applicable to the period immediately after such events and does not consider or analyze conditions from multiple storm events nor does it provide information on what scour hole conditions may be expected at the end of the winter storm season. As the flow velocity is diminished, entrained sediment and fluvial bed movement settle, resulting in a residual scour hole that is smaller in aerial extent and shallower than the maximum scour that occurs during the peak discharge. Furthermore, subsequent storm events may interrupt the falling limb of the hydrograph, resulting in a new peak discharge curve and/or a new elevated base river flow.

[1] Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS), US Army Corps of Engineers (USACE).



https://geographyas.info/rivers/discharge-and-hydrographs/

Figure 1 – Example Storm Hydrograph

The US Geological Survey (USGS) defines scour as the hole left behind when sediment (sand and gravel) is washed away from the bottom of a river. Although scour may occur at any time, scour action is especially strong during floods. Swiftly flowing water has more energy than calm water to lift and carry sediment down river. In general, local pier scour is a concern for structural stability of a bridge, however for the RMDP bridges the foundation design extends far below the scour zone, and as such scour is not a structural design concern at the pier locations.

Hydraulic analysis results from the HEC-RAS modeling were used to perform the subsequent scour analysis, which followed the procedures outlined in the Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 18 (HEC-18), Evaluating Scour at Bridges, 2001. The scour calculations were performed in a module embedded directly in HEC-RAS. Using HEC-18, bridge scour is comprised of three individual components: (1) Contraction scour, (2) Pier scour, and (3) Abutment scour. This memo addresses only the pier scour.

Pier Scour Calculation Methods

Several factors influence the magnitude of pier scour, including pier size, pier shape, bed material characteristics, and orientation and configuration of bridge piers. These elements are considered in the present calculations, and are expressed as form factors (or correction factors) for pier nose shape, angle of attack of flow, bed condition, and bed armoring. Within the HEC-18 module, there are two different options available for calculating pier scour: (1) using local hydraulic conditions in the vicinity of each bridge pier, herein referred to as the local method, and (2) using maximum hydraulic conditions occurring at any location along the cross-section, herein referred to as the maximum method.

Local Method. The local method calculates scour at each pier using the maximum flow velocity and depth that corresponds to the centerline of each of the pier rows (measured along the cross-section immediately upstream of the bridge).

Maximum Method. The maximum method calculates scour at each pier using the maximum flow velocity and depth calculated at any location along the cross-section immediately upstream of the bridge, regardless of the actual location of the bridge piers. Since the maximum method uses one value for velocity and depth, one value for pier scour is calculated for all pier rows.

It is important to note HEC-18 performs these calculations on the pier located at the upstream end of the bridge for each row of piers (i.e., the pier that makes initial contact with the river flow). The upstream end of the bridge provides the worst-case scenario in terms of impacts to hydraulic performance due to the obstruction created by the piers. Any subsequent impacts caused by the other piers in each pier row would not exceed the impacts caused by the most upstream pier.

Calculations were performed using both the local method and maximum method to obtain an envelope of largest scour anticipated for each of the storm events analyzed. Pier scour calculations were performed using the Colorado State University (CSU) equation, outlined in the FHWA publication. This approach is the default method within the HEC-18 module in HEC-RAS.

Commerce Center Drive (CCD) Bridge Pier Scour

Commerce Center Drive currently ends at its intersection with Henry Mayo Drive, just shy of the Santa Clara River. The proposed CCD Bridge will be constructed as part of the Mission Village development project (TTM No. 61105) with the goal of providing secondary access to the development. Currently, the nearest bridge crossing over the River is 2 miles upstream (I-5 freeway and Old Road bridges), and the main access to the Mission Village development is through Magic Mountain Parkway on the northeastern side of the project boundary. The proposed bridge will vary in width from 120-feet to 129-feet and will carry three lanes of traffic in each direction to and from the development.

Local Method

Results for pier scour at CCD Bridge using the local method are shown in **Table 1** and **Table 2**, below.

Table 1 – Pier Scour for CCD Bridge (10-year storm event)

Pier Number (Pier Row)	Pier Scour (feet)
	Local Method
1 (G)	-
2 (F)	3.0
3 (E)	8.1
4 (D)	8.3
5 (C)	6.3
6 (B)	4.2
7 (A)	2.7

Notes:

1. *Values shown are for pier scour only (excludes contraction & abutment scour)*
2. *Pier #1 is located on the floodplain fringe, therefore no scour at this location*
3. *See Figures 2 and 3 for Plan View Layout of Bridge Piers*

Table 2 – Pier Scour for CCD Bridge (25-year storm event)

Pier Number (Pier Row)	Pier Scour (feet)
	Local Method
1 (G)	-
2 (F)	4.2
3 (E)	9.9
4 (D)	10.0
5 (C)	7.4
6 (B)	5.2
7 (A)	4.6

Notes:

1. *Values shown are for pier scour only (excludes contraction & abutment scour)*
2. *Pier #1 is located on the floodplain fringe, therefore no scour at this location*
3. *See Figures 2 and 3 for Plan View Layout of Bridge Piers*

When the calculations are performed using the local scour method, the pier scour ranges from 2.7-feet to a maximum of 8.3-feet for the 10-year event, and from 4.2-feet to a maximum of 10.0-feet for the 25-year event. Based on the results of the local scour method, the piers located towards the center of the River (piers 3, 4 and 5) have larger values of pier scour, which is likely due to the larger flow depths and higher velocities that occur in this region. Limits of inundation for the 10-year and 25-year storm events are shown on **Figure 2** and **Figure 3**, respectively, as well as the bridge pier configurations and pier rows.

Maximum Method

Using the maximum method, the calculated pier scour (for all CCD Bridge piers) is approximately 8.4-feet for the 10-year event, and 10.0-feet for the 25-year event. See **Table 3** below. As the data show, the maximum method yields slightly larger values for pier scour than does the local method for both storm events. Accordingly, these values represent the maximum pier scour that is expected to occur during the respective storm events. A graphical representation of the pier scour results are also provided in a cross sectional view on **Figure 4**.

Table 3 – Pier Scour for CCD Bridge (Maximum Method)

CCD Bridge	Pier Scour (feet)
	Maximum Method
10-year storm event	8.4
25-year storm event	10.0

Long Canyon Road Bridge Pier Scour

Long Canyon Road is a proposed infrastructure link to connect the Newhall Ranch Landmark Village development (VTTM No. 53108) to the north with the Homestead South development (VTTM No. 60678) to the south. A preliminary layout of the bridge yields an overall length of approximately 1,088 feet. The bridge will carry two lanes of traffic in each direction (for a total of four lanes), resulting in an overall width of 89-feet. Similar to the CCD Bridge, the majority of the structure would consist of two parallel structures separated by an open median.

Local Method

Results for pier scour at Long Canyon Road Bridge using the local method are shown in **Table 4** and **Table 5**, below.

Table 4 – Pier Scour for Long Canyon Road Bridge (10-year storm event)

Pier Number (Pier Row)	Pier Scour (feet)
	Local Method
1 (F)	-
2 (E)	-
3 (D)	-
4 (C)	8.4
5 (B)	8.5
6 (A)	-

Notes:

1. *Values shown are for pier scour only (excludes contraction & abutment scour)*
2. *Pier #1, 2, 3 & 6 are located outside of active flow (no scour at these locations)*
3. *See Figures 5 and 6 for Plan View Layout of Bridge Piers*

Table 5 – Pier Scour for Long Canyon Road Bridge (25-year storm event)

Pier Number (Pier Row)	Pier Scour (feet)
	Local Method
1 (F)	-
2 (E)	3.2
3 (D)	7.1
4 (C)	10.1
5 (B)	10.1
6 (A)	7.5

Notes:

1. *Values shown are for pier scour only (excludes contraction & abutment scour)*
2. *Pier #1 is located on the floodplain fringe, therefore no scour at this location*
3. *See Figures 5 and 6 for Plan View Layout of Bridge Piers*

When the calculations are performed using the local scour method, the pier scour is approximately 8.5-feet for the 10-year event, and ranges from 3.2-feet to a maximum of 10.1-feet for the 25-year event. Based on the results of the local scour method, the piers located towards the center of the River (piers 4 & 5) have larger values of pier scour, which is likely due to the larger flow depths and higher velocities that occur in this region. Limits of inundation for the 10-year and 25-year storm events are shown on **Figure 5** and **Figure 6**, respectively, as well as the bridge pier configurations and pier rows.

Maximum Method

Using the maximum method, the calculated pier scour (for all Long Canyon Road Bridge piers subject to flood flow) is approximately 10.4-feet for the 10-year event, and 11.8-feet for the 25-year event. See **Table 6** below. As the data show, the maximum method yields slightly larger values for pier scour than does the local method for both storm events. Accordingly, these values represent the maximum pier scour that is expected to occur during the respective storm events. A graphical representation of the pier scour results are also provided in a cross sectional view on **Figure 7**.

Table 6 – Pier Scour for Long Canyon Road Bridge (Maximum Method)

Long Canyon Road Bridge	Pier Scour (feet)
	Maximum Method
10-year storm event	10.4
25-year storm event	11.8

Residual Scour

As previously discussed, the values for maximum pier scour represent the maximum scour expected to occur during the peak flow of a specified storm event. Residual scour is an estimate of the resulting depression in the riverbed immediately after a large scour producing storm event has occurred and the river returns to a relatively static flow. Refer to the storm hydrograph discussion above for further information regarding the timing of precipitation and peak flood flows. Residual scour presented herein has assumed that no subsequent storm event occurs, and as such is a limited snap-shot of riverbed conditions, only representing modeled storm event flow velocities. The results are informative as an estimate of the remaining depressional area that might be present until such time as any subsequent storm event occurs or the depression is filled in with additional sediment as deposition occurs if the depression is within the active river flow (i.e., wetted channel).

Residual scour present after the storm flow has ended is expected to be less than the maximum scour presented above, reflecting fill-in of the scour pockets by material transported during the receding leg of the hydrograph. Relying on anecdotal experience and best engineering judgment for the present study, the residual scour is estimated to be approximately one-third of the maximum pier scour calculated using the FHWA procedure.

This presentation of residual scour is not intended to be a complete description of all likely storm flows and resulting scour that the bridge piers and riverbed may experience nor is this intended to be an overall description of the river geomorphology. For an extensive discussion of overall sediment transport and fluvial mechanics of the Santa Clara River, the reader is directed to the RMDP 2010 FEIR, more specifically the geomorphology section and associated appendices. Also note, that laboratory studies have been performed to evaluate scour at bridge piers in an attempt to estimate residual scour, however these studies are typically performed for clear-flow conditions. In alluvial channels such as the Santa Clara River, storm flows carry a substantial sediment load that tends to restore areas of local erosion that

occur during peak flow as the flood flow subsides. It is generally not feasible to model a flow that is sediment-laden in a laboratory setting, therefore no standard calculation methods are available to determine residual scour.

Commerce Center Drive (CCD) Bridge Residual Scour

As shown on **Figure 4**, the post-storm (residual) scour is estimated to be 2.8-feet for the 10-year event, and 3.3-feet for the 25-year event. These results are summarized in **Table 7** below.

Long Canyon Road Bridge Residual Scour

As shown on **Figure 7**, the post-storm (residual) scour is estimated to be 3.5-feet for the 10-year event, and 3.9-feet for the 25-year event. These results are summarized in **Table 7** below.

Aerial Extent of Scour Hole

Another component to be considered when evaluating pier scour is the aerial extents (length and width) of the scour hole created during a storm. According to FHWA, the top-width of the scour hole at a pier is dependent on the angle of repose of the bed material, as well as the depth of scour. For practical applications, FHWA suggests using a value equal to twice the scour depth to determine the top-width of a scour hole, as shown on **Figure 8**.

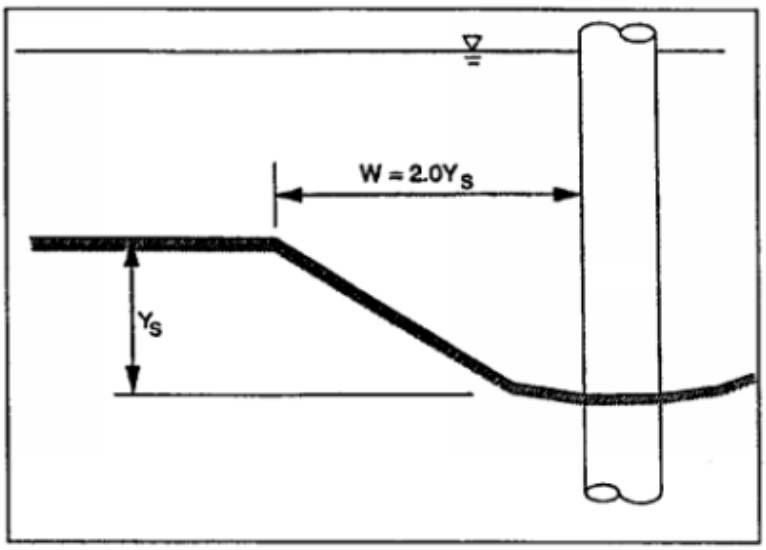


Figure 8 – Top width of Scour Hole (FHWA, 2001)

However, based on research of model studies, there is evidence that indicates the limit of scouring will extend farther downstream due to the existence of vortices created by water flowing around the bridge pier. The basic mechanism that causes pier scour is the formation of a “horseshoe” vortex, as shown in **Figure 9**. The horseshoe vortex is a result of downward movement of flow caused by the flow impingement at the upstream face of the pier. These downward forces create a scour hole at the base of the pier. As the depth of scour increases, the intensity of the vortex decreases and the flow begins to move downstream, creating a horseshoe-like shaped hole around the bridge pier. As flow travels around the pier, the separation of flow caused by the obstruction of the pier forms a “wake” vortex that extends the limits of the scour hole downstream of the pier.

There are currently no published guidelines for determining the extents of the additional scour caused by the wake vortex as this phenomenon is specific to site conditions and flow characteristics. PACE has estimated the horizontal limits at the bottom of the scour hole (downstream of the pier) to be roughly 1.5 times the pier diameter.

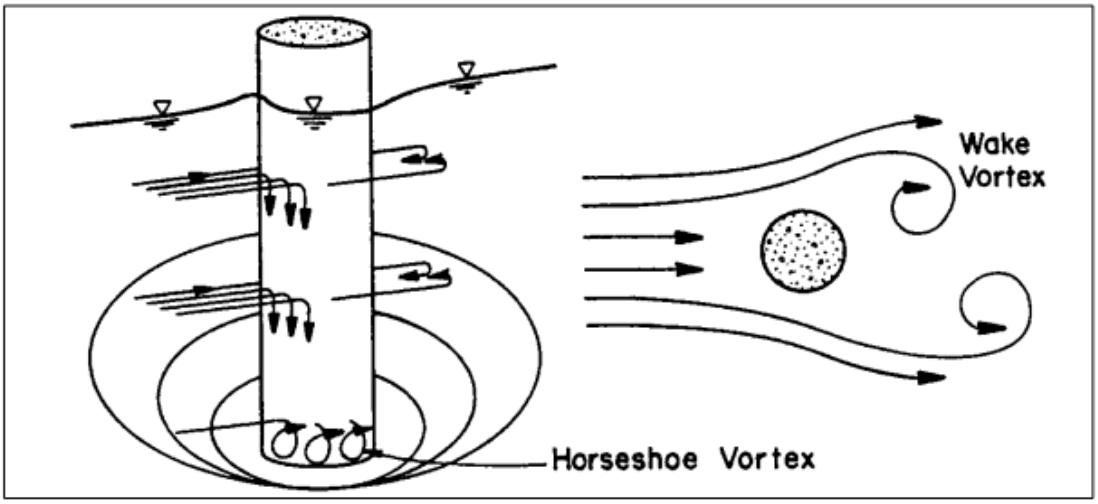


Figure 9 – Schematic Representation of Scour at Cylindrical Pier (FHWA, 2001)

Commerce Center Drive (CCD) Bridge Aerial Extent

Using the approaches outlined above, the top-width of the residual scour hole is estimated to be 5.6-feet for the 10-year event and 6.6-feet for the 25-year event. The length of the scour hole (downstream of the pier) is projected to be 14.6-feet for the 10-year event, and 15.6-feet for the 25-year event. These results are summarized in **Table 7** below.

Long Canyon Road Bridge Aerial Extent

Using the approaches outlined above, the top-width of the residual scour hole is estimated to be 7.0-feet for the 10-year event and 7.8-feet for the 25-year event. The length of the scour hole (downstream of the pier) is projected to be 16.0-feet for the 10-year event, and 16.8-feet for the 25-year event. These results are summarized in **Table 7** below.

Conclusion

The 10-year and 25-year events were presented as they are representative of what is considered major reset events on the Santa Clara River, and in the recent record (post Saint Francis Dam failure), have been observed on a periodic basis.. Based on these modeled 10-year and 25-year storm events, which are reflective of these large "reset events" on the Santa Clara River it is likely that residual scour pools will persist at one or more of the bridge piers at the Commerce Center Drive and Long Canyon Road Bridges. **Table 7** provides a summary of the maximum extent of the 10-year and 25-year residual scour that could be expected. For smaller storm events and as you move upland away from the wetted channel of the Santa Clara River, scour will be less. For larger storm events, greater scour would be expected.

Table 7 – Residual Pier Scour

Storm Event	CCD Bridge			Long Canyon Road Bridge		
	Residual Scour (feet)	Aerial Extent Top Width (feet)	Aerial Extent Length (feet)	Residual Scour (feet)	Aerial Extent Top Width (feet)	Aerial Extent Length (feet)
10-year	2.8	5.6	14.6	3.5	7.0	16.0
25-year	3.3	6.6	15.6	3.9	7.8	16.8

Attachments:

Figures:

Figure 2 – CCD Bridge 10-Year Floodplain Limits
Figure 3 – CCD Bridge 25-Year Floodplain Limits
Figure 4 – CCD Bridge Cross-Sectional View of Pier Scour
Figure 5 – Long Canyon Road Bridge 10-Year Floodplain Limits
Figure 6 – Long Canyon Road Bridge 25-Year Floodplain Limits
Figure 7 – Long Canyon Road Bridge Cross-Sectional View of Pier Scour

Appendix:

Appendix A – CCD Bridge Results of Pier Scour Analyses for 10-year Storm Event

- Local Scour Method
- Maximum Scour Method

Appendix B – CCD Bridge Results of Pier Scour Analyses for 25-year Storm Event

- Local Scour Method
- Maximum Scour Method

Appendix C – Long Canyon Road Bridge Results of Pier Scour Analyses for 10-year Storm Event

- Local Scour Method
- Maximum Scour Method

Appendix D – Long Canyon Road Bridge Results of Pier Scour Analyses for 25-year Storm Event

- Local Scour Method
- Maximum Scour Method

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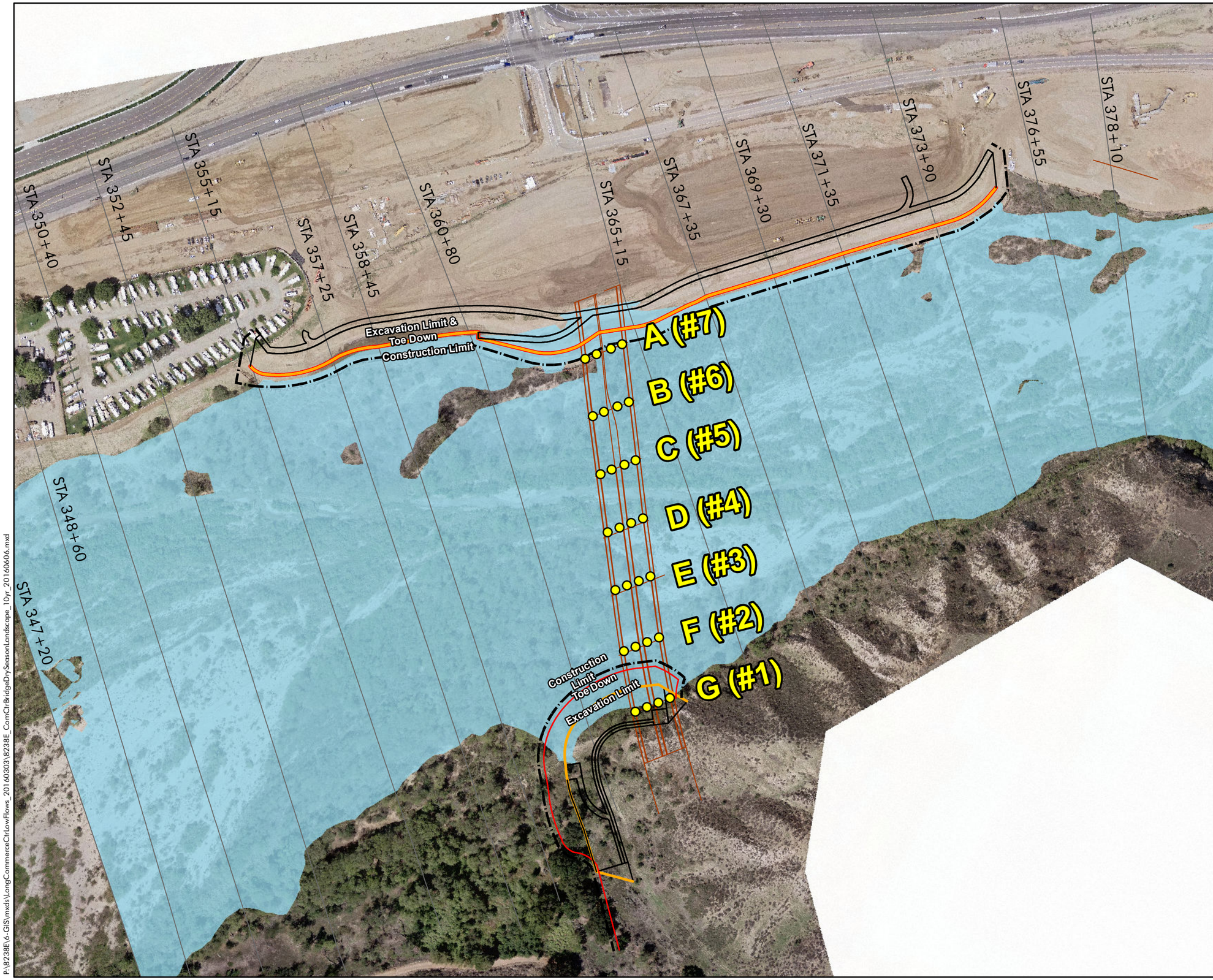
Figures



NEWHALL RANCH

LA County CA

Legend

- Pier Row (Pier # in HEC-RAS model)
- 10 Year Floodplain

0 125 250 500 Feet

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Job Number 8238E

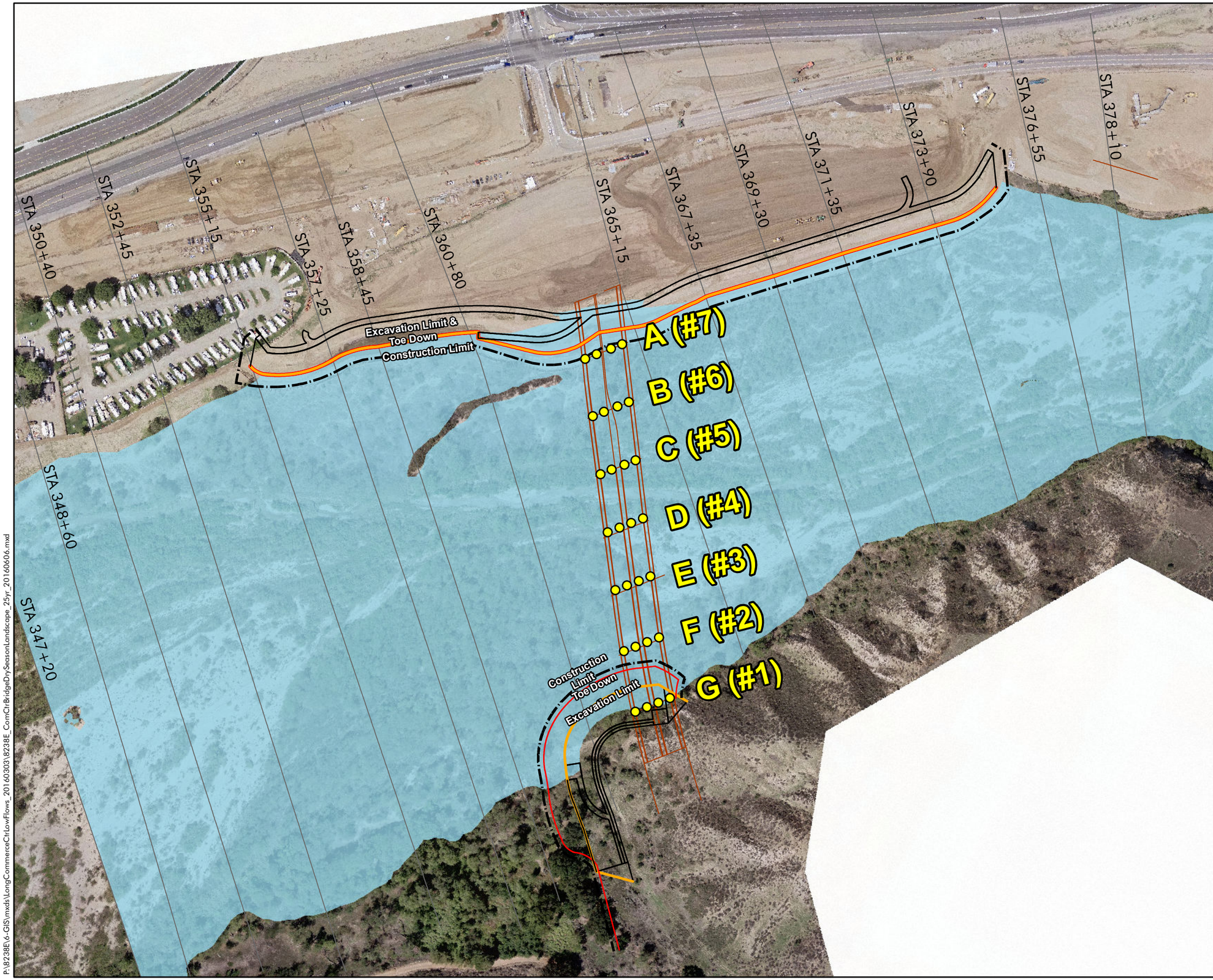
Drawn By thowze

FIGURE 2

COMMERCE CENTER DRIVE BRIDGE 10 YEAR FLOODPLAIN

Aerial Imagery collected in 2014

P:\8238E\6-GIS\mxds\LongCommerceCtrLowFlows_20160303\8238E_ComCtrBridgeDrySeasonLandscape_10yr_20160606.mxd



NEWHALL RANCH

LA County CA

Legend

- Pier Row (Pier # in HEC-RAS model)
- 25 Year Floodplain

0 125 250 500 Feet

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Date: 8/12/2016

Job Number 8238E

Drawn By thowze

FIGURE 3
COMMERCE CENTER
DRIVE BRIDGE
25 YEAR FLOODPLAIN

Aerial Imagery collected in 2014

P:\8238E\6-GIS\mxds\LongCommerceCtrLowFlows_20160303\8238E_ComCtrBridgeDrySeasonLandscape_25yr_20160606.mxd

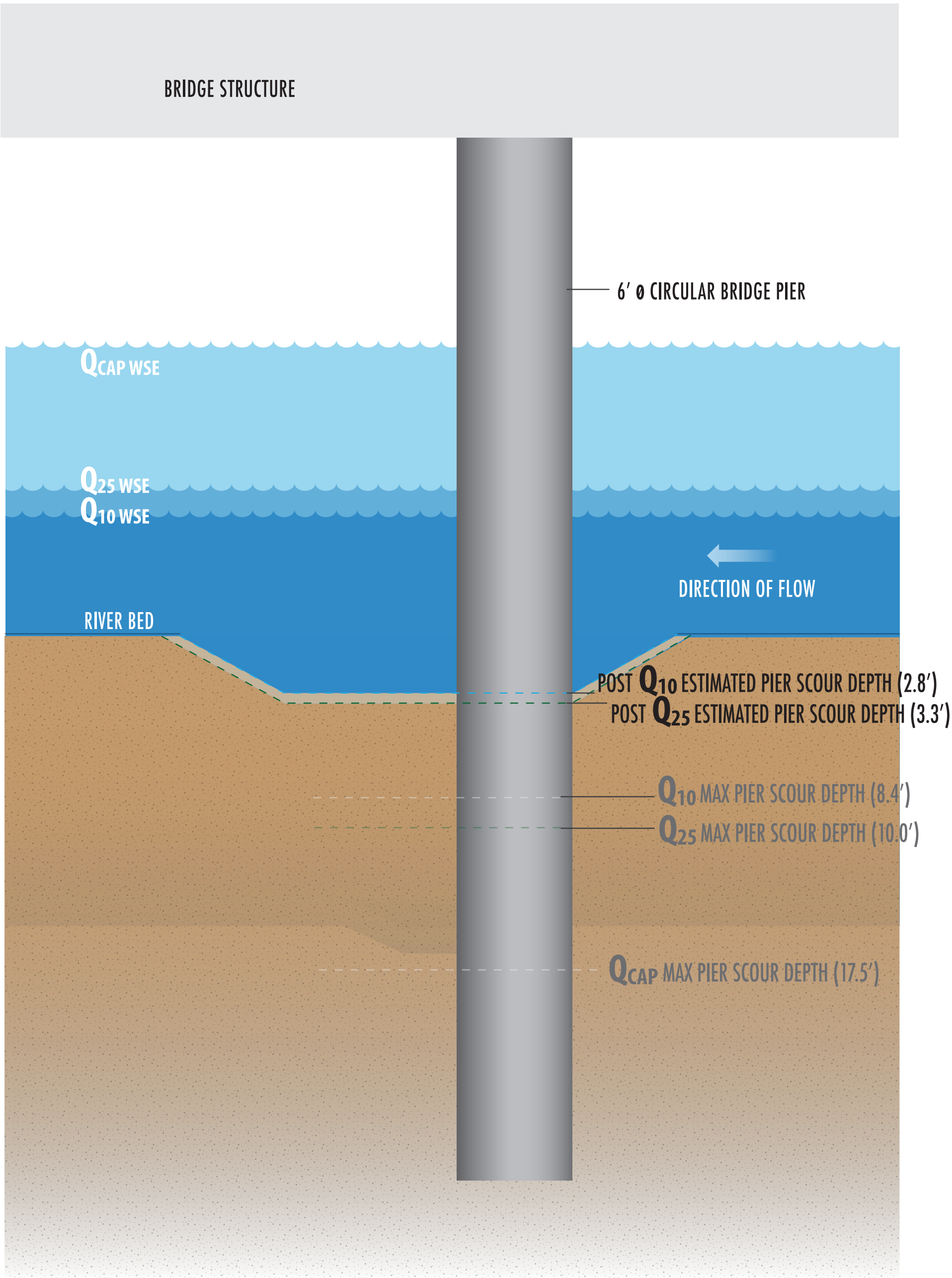
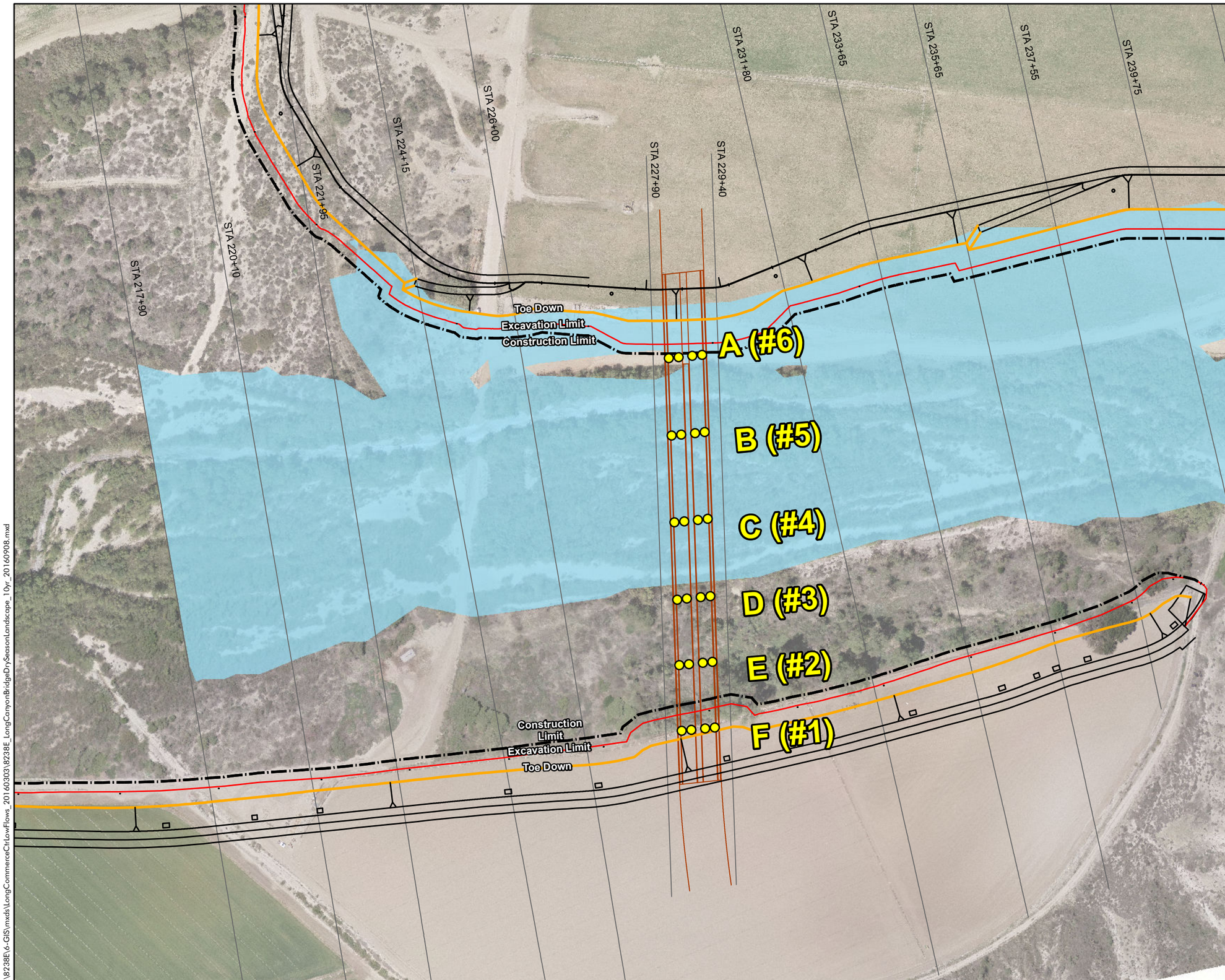


FIGURE 4 – CROSS SECTIONAL VIEW OF PIER SCOUR AT COMMERCE CENTER DRIVE BRIDGE

Q_{CAP} = LOS ANGELES COUNTY CAPITAL STORM EVENT



NEWHALL RANCH

LA County CA

Legend

- Pier Row (Pier # in HEC-RAS model)
- 10 Year Floodplain

0 100 200 400 Feet

PACE Advanced Water Engineering

Date: 9/30/2016

Job Number 8238E

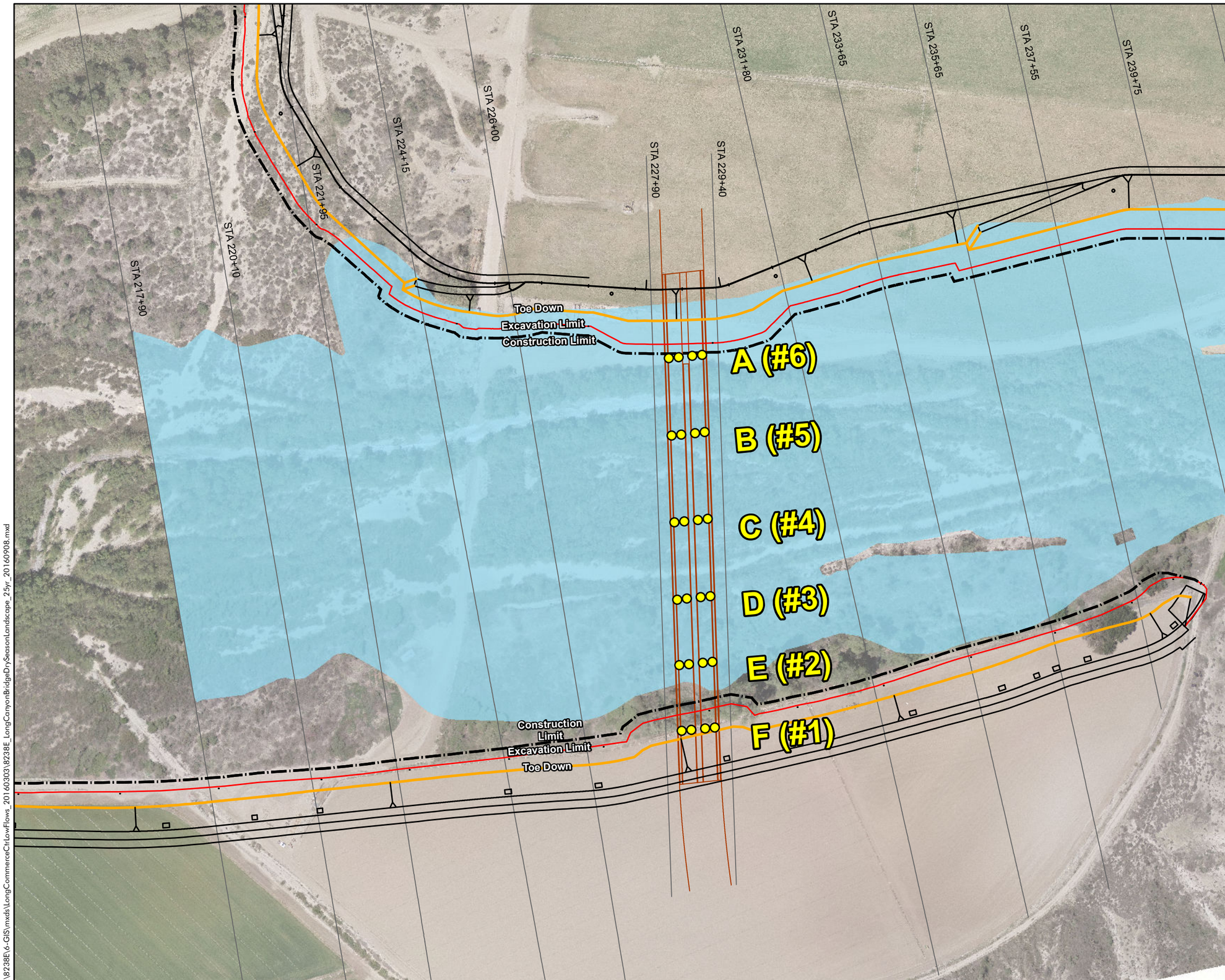
Drawn By thowze

FIGURE 5

LONG CANYON BRIDGE
10 YEAR FLOODPLAIN

Aerial Imagery collected in 2014

P:\8238E\6-GIS\mxds\LongCommerceCtrLowFlows_20160303\8238E_LongCanyonBridgeDrySeasonLandscape_10yr_20160908.mxd



NEWHALL RANCH

LA County CA

Legend

- Pier Row (Pier # in HEC-RAS model)
- 25 Year Floodplain

0 100 200 400 Feet

PACE Advanced Water Engineering

Date: 9/12/2016

Job Number 8238E

Drawn By thowze

FIGURE 6

LONG CANYON BRIDGE
25 YEAR FLOODPLAIN

Aerial Imagery collected in 2014

P:\8238E\6-GIS\mxds\LongCommerceCtrLowFlows_20160303\8238E_LongCanyonBridgeDrySeasonLandscape_25yr_20160908.mxd

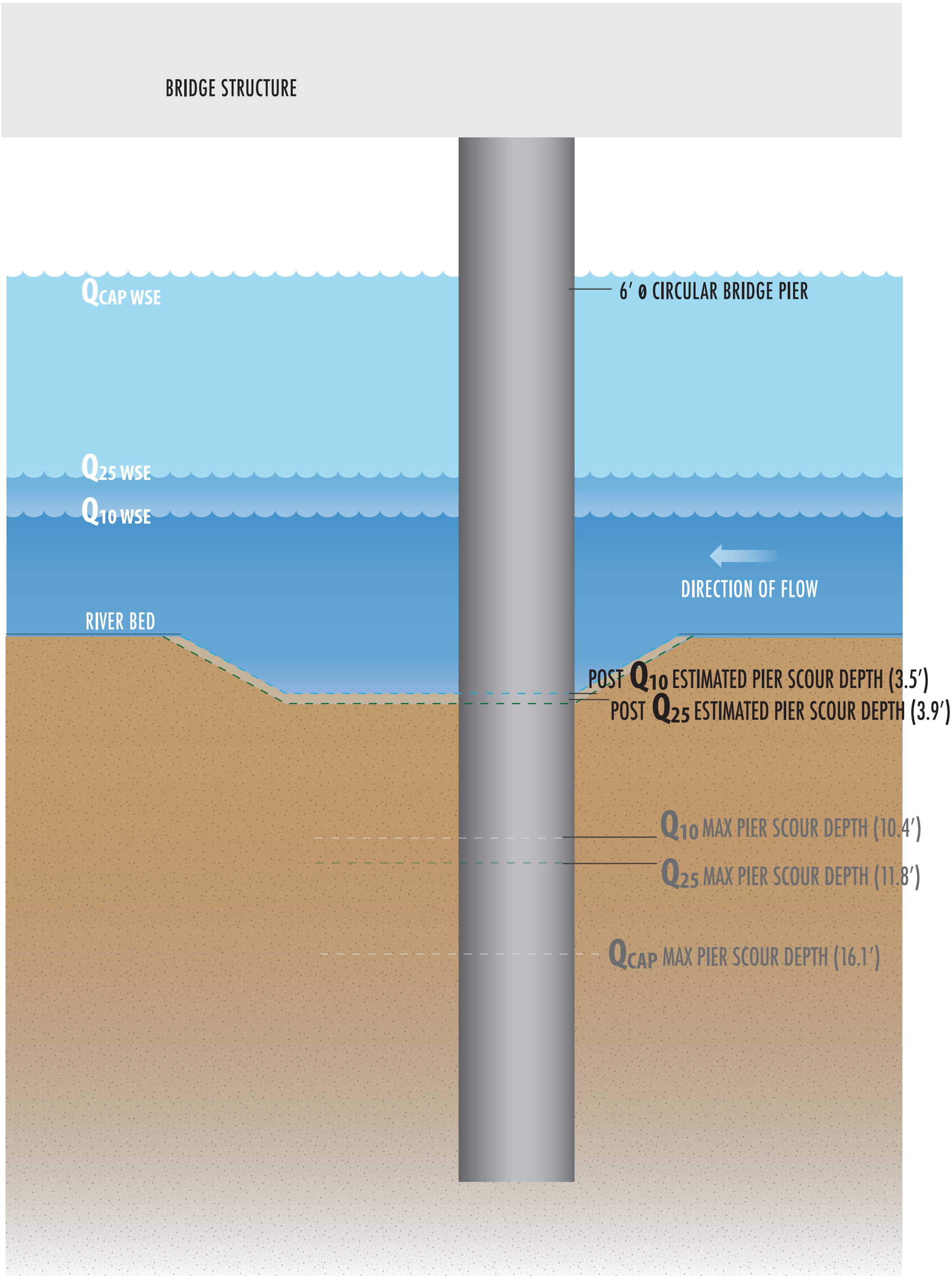


FIGURE 7 - CROSS SECTIONAL VIEW OF PIER SCOUR AT LONG CANYON ROAD BRIDGE

Q_{CAP} = LOS ANGELES COUNTY CAPITAL STORM EVENT

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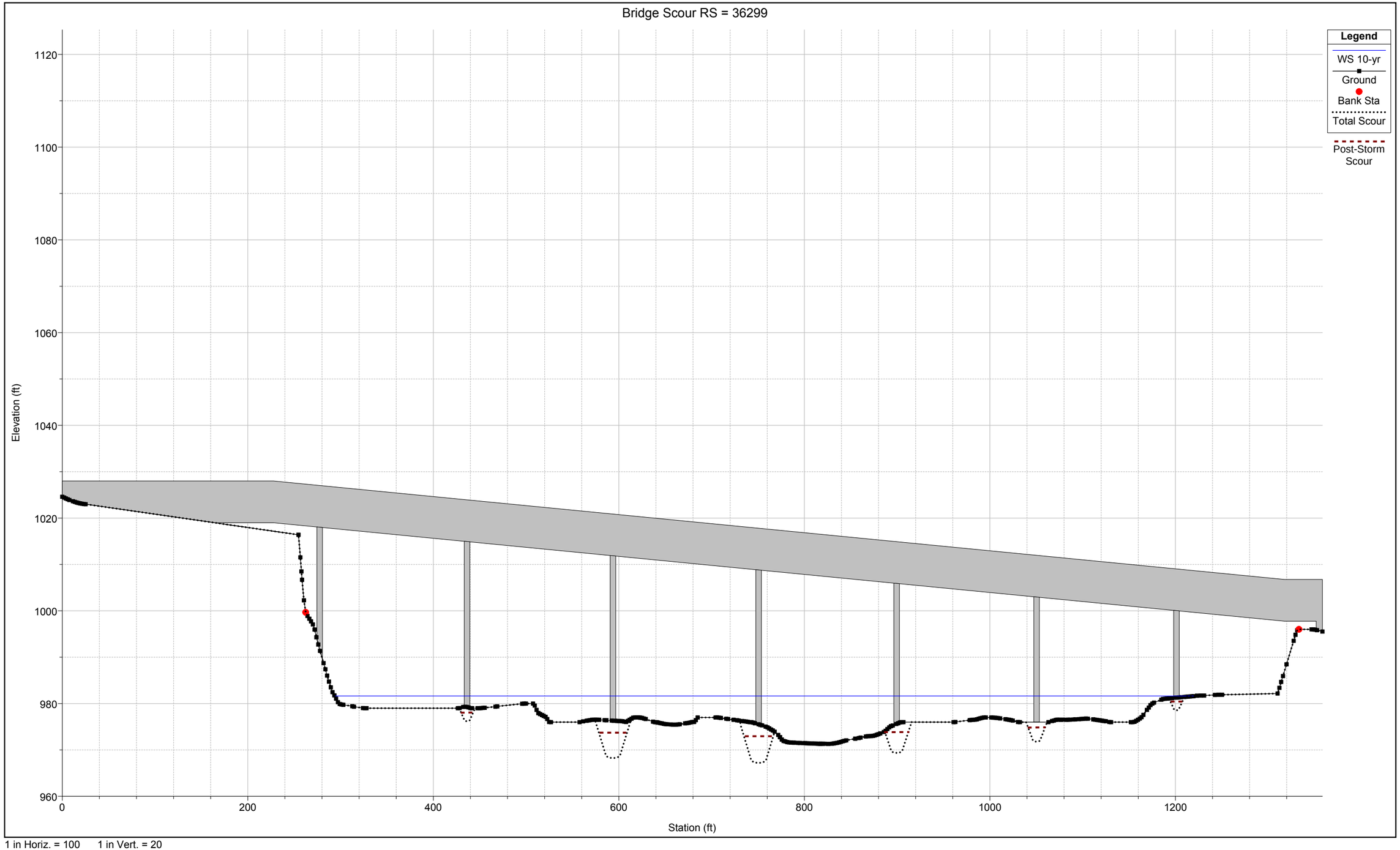
Appendix A

Pier Scour for CCD Bridge - Local Scour Method (10-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Hydraulic Design Data

Pier Scour

Pier: #1 (CL = 277.501)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	0.00
Velocity Upstream (ft/s):	0.00
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	
Froude #:	
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #2 (CL = 436.405)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	2.43
Velocity Upstream (ft/s):	0.61
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	3.0
Froude #:	0.07
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #3 (CL = 593.677)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	5.35
Velocity Upstream (ft/s):	4.58
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	8.1
Froude #:	0.35
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #4 (CL = 750.698)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	6.15
Velocity Upstream (ft/s):	4.71
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	8.3
Froude #:	0.33
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #5 (CL = 899.557)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	6.05
Velocity Upstream (ft/s):	2.45
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	6.3
Froude #:	0.18
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #6 (CL = 1050.338)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	5.67
Velocity Upstream (ft/s):	0.99
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	4.2
Froude #:	0.07
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #7 (CL = 1201.109)

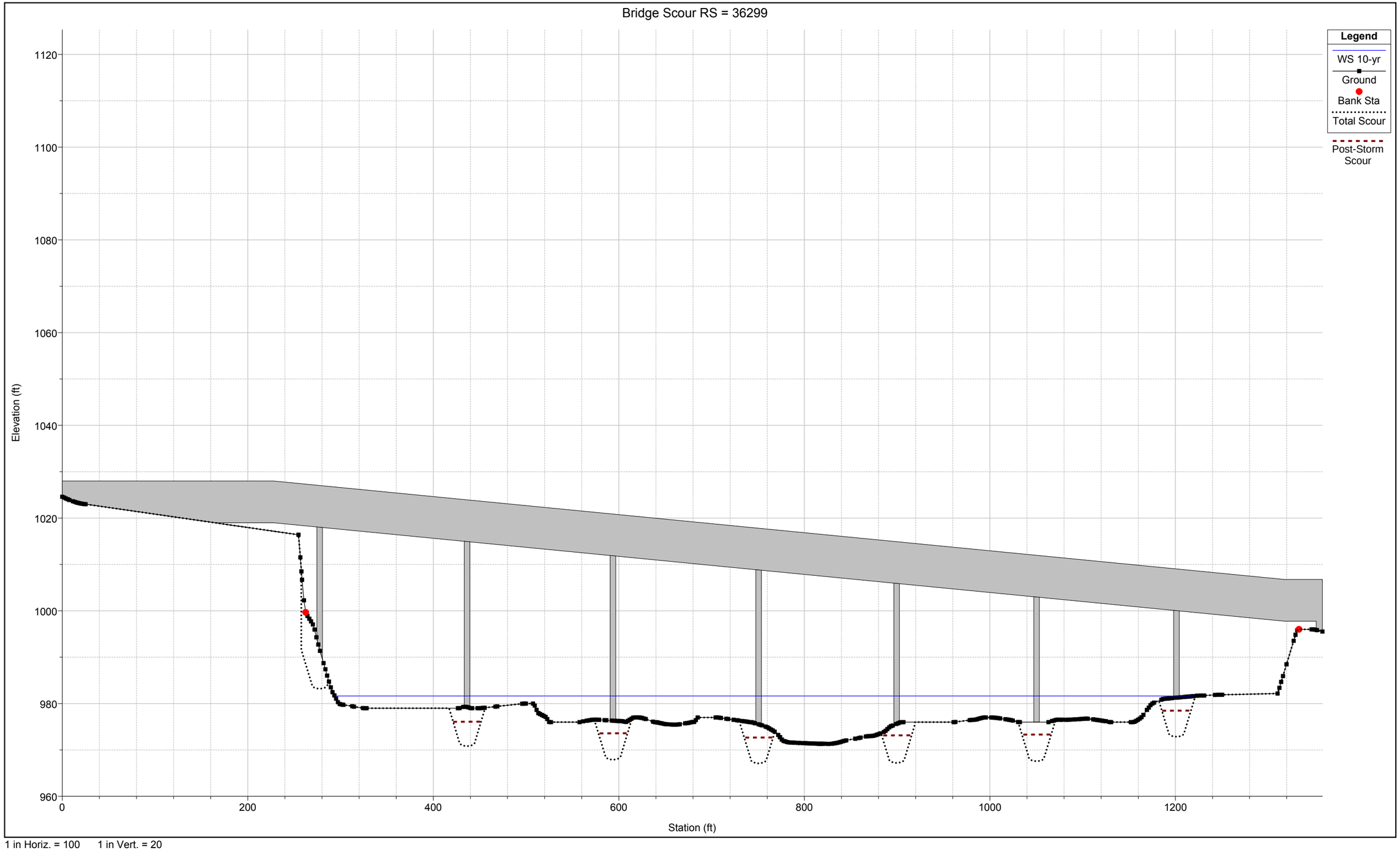
Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	0.40
Velocity Upstream (ft/s):	0.81
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	2.7
Froude #:	0.23
Equation:	CSU equation

Pier Scour for CCD Bridge - Maximum Scour Method (10-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Maximum Scour Method (Q_{10})

Hydraulic Design Data

Pier Scour

All piers have the same scour depth

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	6.67
Velocity Upstream (ft/s):	4.71
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	8.4
Froude #:	0.32
Equation:	CSU equation

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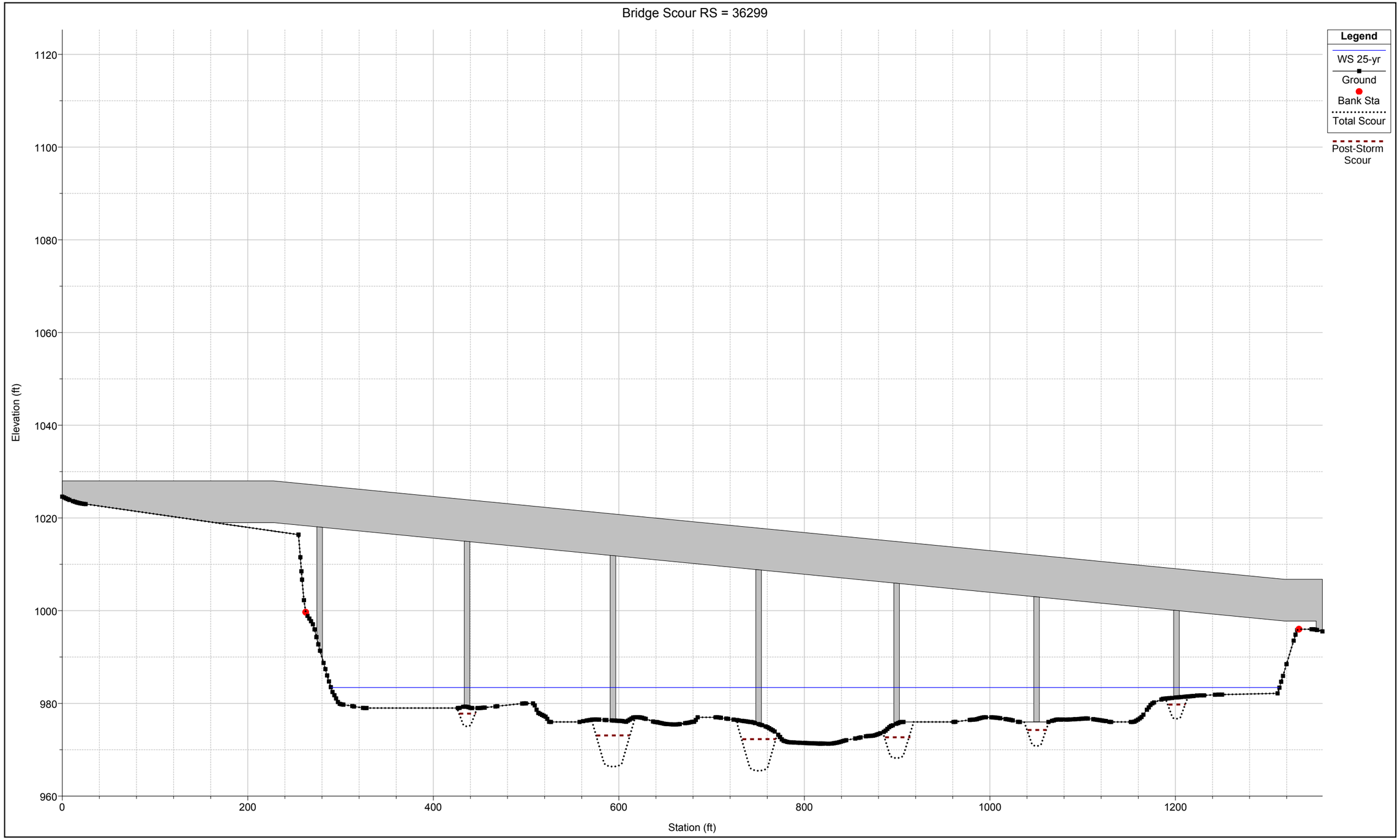
Appendix B

Pier Scour for CCD Bridge - Local Scour Method (25-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Hydraulic Design Data

Pier Scour

Pier: #1 (CL = 277.501)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	0.00
Velocity Upstream (ft/s):	0.00
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	
Froude #:	
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #2 (CL = 436.405)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	4.29
Velocity Upstream (ft/s):	1.06
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	4.2
Froude #:	0.09
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #3 (CL = 593.677)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	7.21
Velocity Upstream (ft/s):	6.78
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	9.9
Froude #:	0.45
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #4 (CL = 750.698)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	8.01
Velocity Upstream (ft/s):	6.72
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	10.0
Froude #:	0.42
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #5 (CL = 899.557)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	7.91
Velocity Upstream (ft/s):	3.32
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	7.4
Froude #:	0.21
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #6 (CL = 1050.338)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	7.53
Velocity Upstream (ft/s):	1.46
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	5.2
Froude #:	0.09
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #7 (CL = 1201.109)

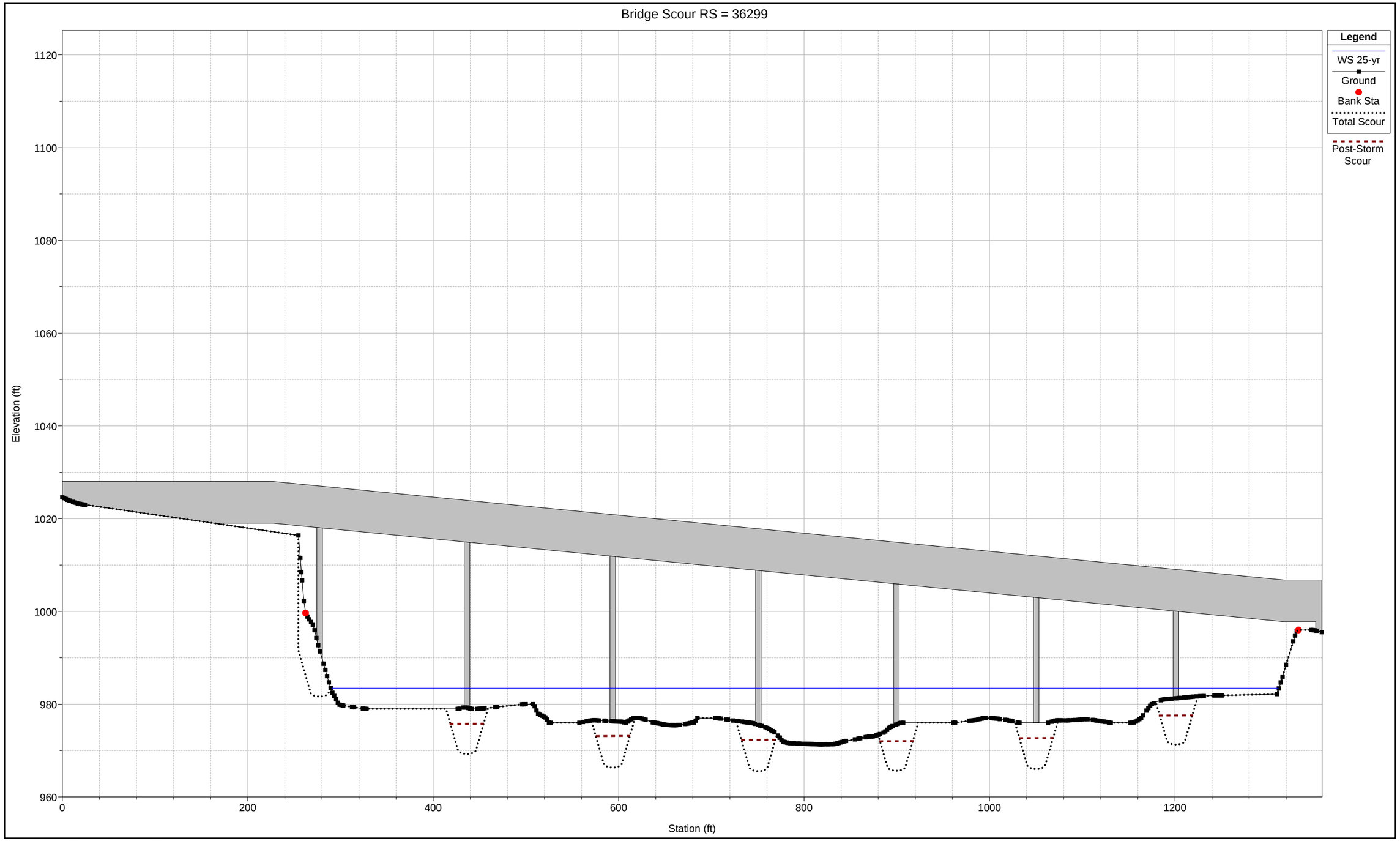
Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	2.26
Velocity Upstream (ft/s):	1.62
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	4.6
Froude #:	0.19
Equation:	CSU equation

Pier Scour for CCD Bridge - Maximum Scour Method (25-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Maximum Scour Method (Q_{25})

Hydraulic Design Data

Pier Scour

All piers have the same scour depth

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	0.70
Depth Upstream (ft):	7.34
Velocity Upstream (ft/s):	6.78
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	120.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	9.50
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	10.0
Froude #:	0.44
Equation:	CSU equation

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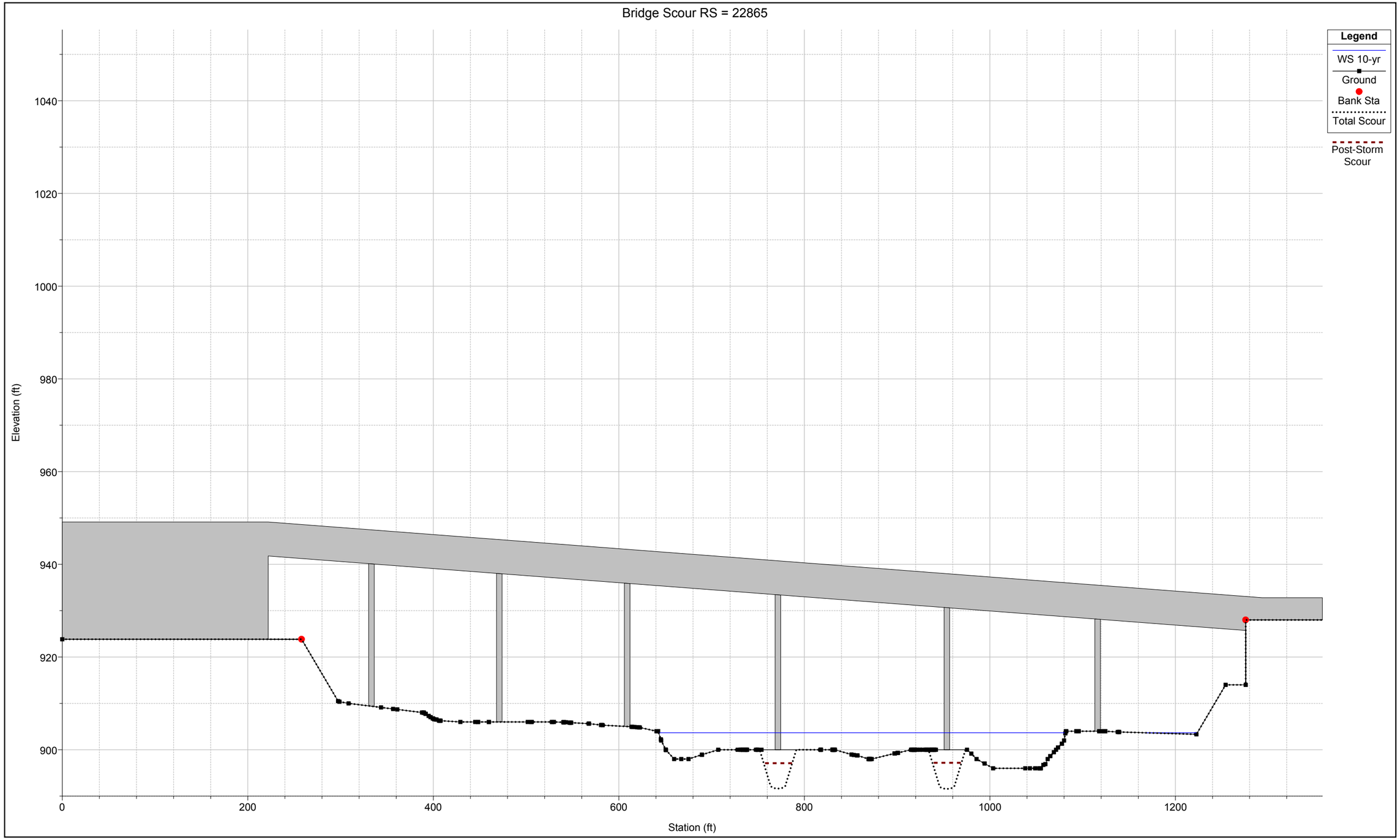
Appendix C

Pier Scour for Long Canyon Bridge - Local Scour Method (10-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Hydraulic Design Data

Pier Scour

Pier: #1 (CL = 333.279)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	0.00
Velocity Upstream (ft/s):	0.00
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.33
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	
Froude #:	
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #2 (CL = 471.152)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	0.00
Velocity Upstream (ft/s):	0.00
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.33
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	
Froude #:	
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #3 (CL = 609.025)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	0.00
Velocity Upstream (ft/s):	0.00
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.33
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	
Froude #:	
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #4 (CL = 771.518)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	4.00
Velocity Upstream (ft/s):	5.48
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.33
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	8.4
Froude #:	0.48
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #5 (CL = 953.707)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	4.00
Velocity Upstream (ft/s):	5.60
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.33
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	8.5
Froude #:	0.49
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{10})

Pier: #6 (CL = 1116.201)

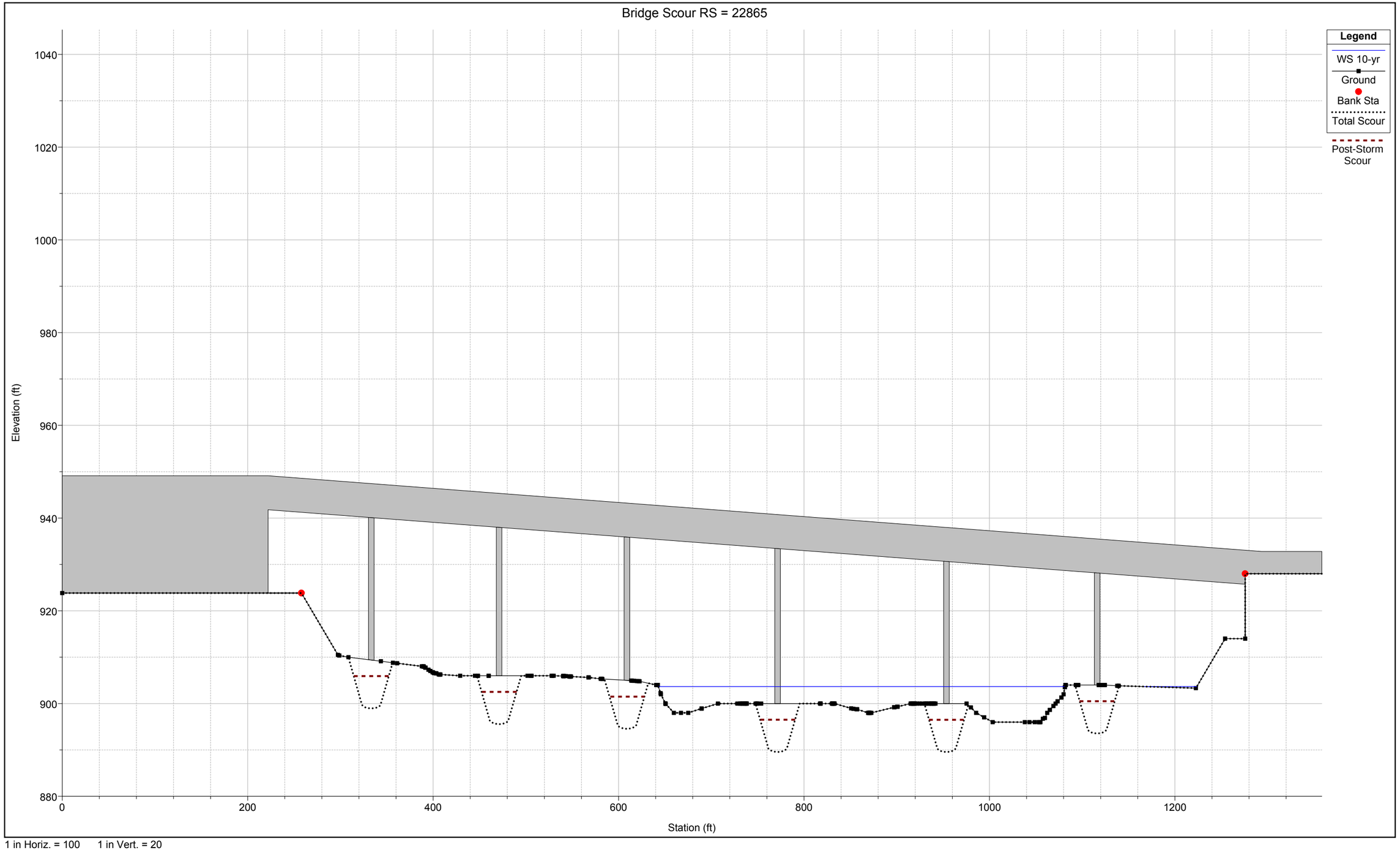
Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	0.00
Velocity Upstream (ft/s):	2.80
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.33
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	
Froude #:	
Equation:	CSU equation

Pier Scour for Long Canyon Bridge - Maximum Scour Method (10-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Maximum Scour Method (Q_{10})

Hydraulic Design Data

Pier Scour

All piers have the same scour depth

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	6.96
Velocity Upstream (ft/s):	7.66
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

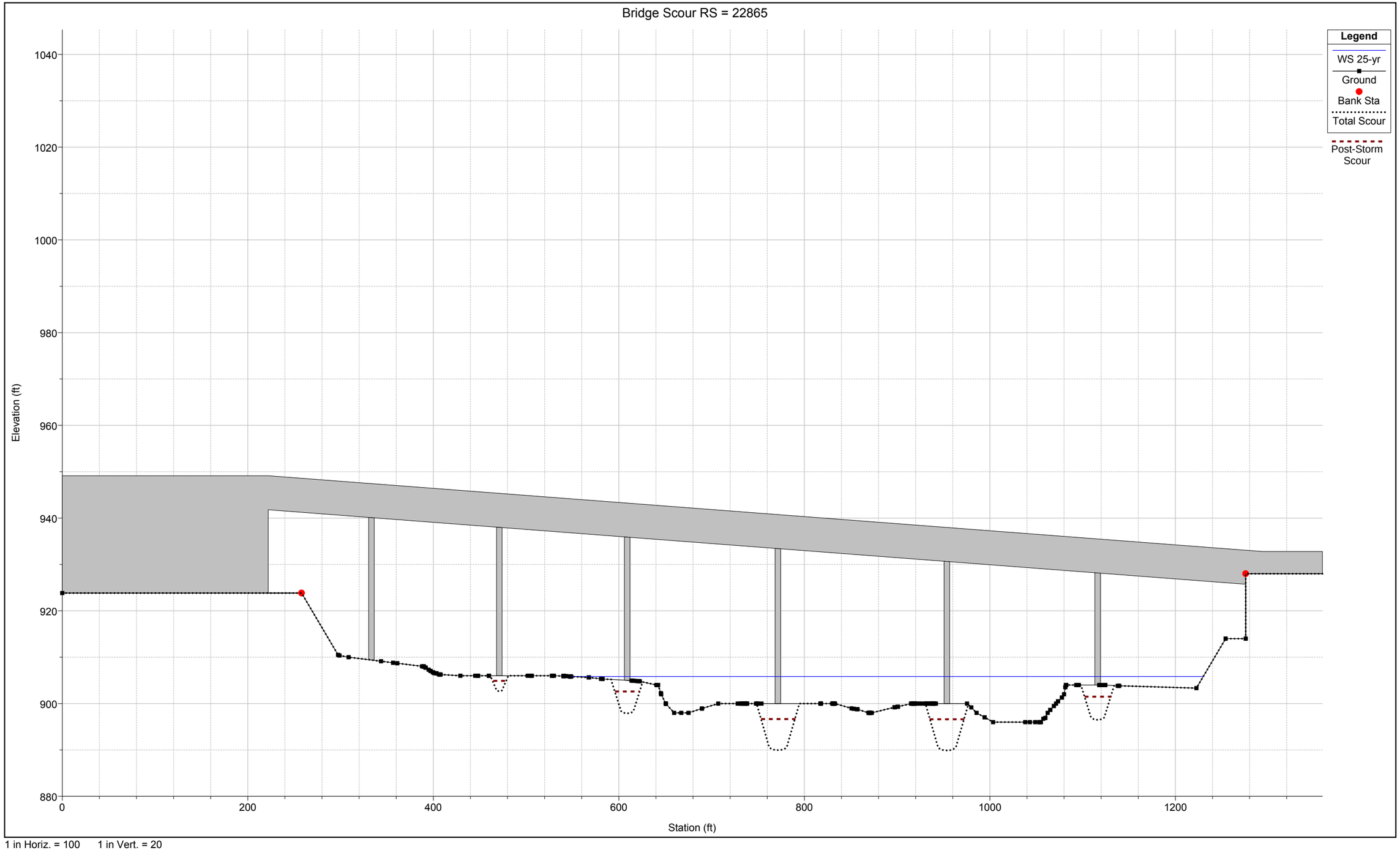
Results

Scour Depth Ys (ft):	10.4
Froude #:	0.51
Equation:	CSU equation

Appendix D

Appendix D

Pier Scour for Long Canyon Bridge - Local Scour Method (25-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Hydraulic Design Data

Pier Scour

Pier: #1 (CL = 333.279)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	0.00
Velocity Upstream (ft/s):	0.00
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	
Froude #:	
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #2 (CL = 471.152)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	0.27
Velocity Upstream (ft/s):	1.37
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	3.2
Froude #:	0.47
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #3 (CL = 609.025)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	1.27
Velocity Upstream (ft/s):	5.31
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	7.1
Froude #:	0.83
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #4 (CL = 771.518)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	6.27
Velocity Upstream (ft/s):	7.28
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	10.1
Froude #:	0.51
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #5 (CL = 953.707)

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	6.27
Velocity Upstream (ft/s):	7.39
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	10.1
Froude #:	0.52
Equation:	CSU equation

Results of Pier Scour Analysis - Local Scour Method (Q_{25})

Pier: #6 (CL = 1116.201)

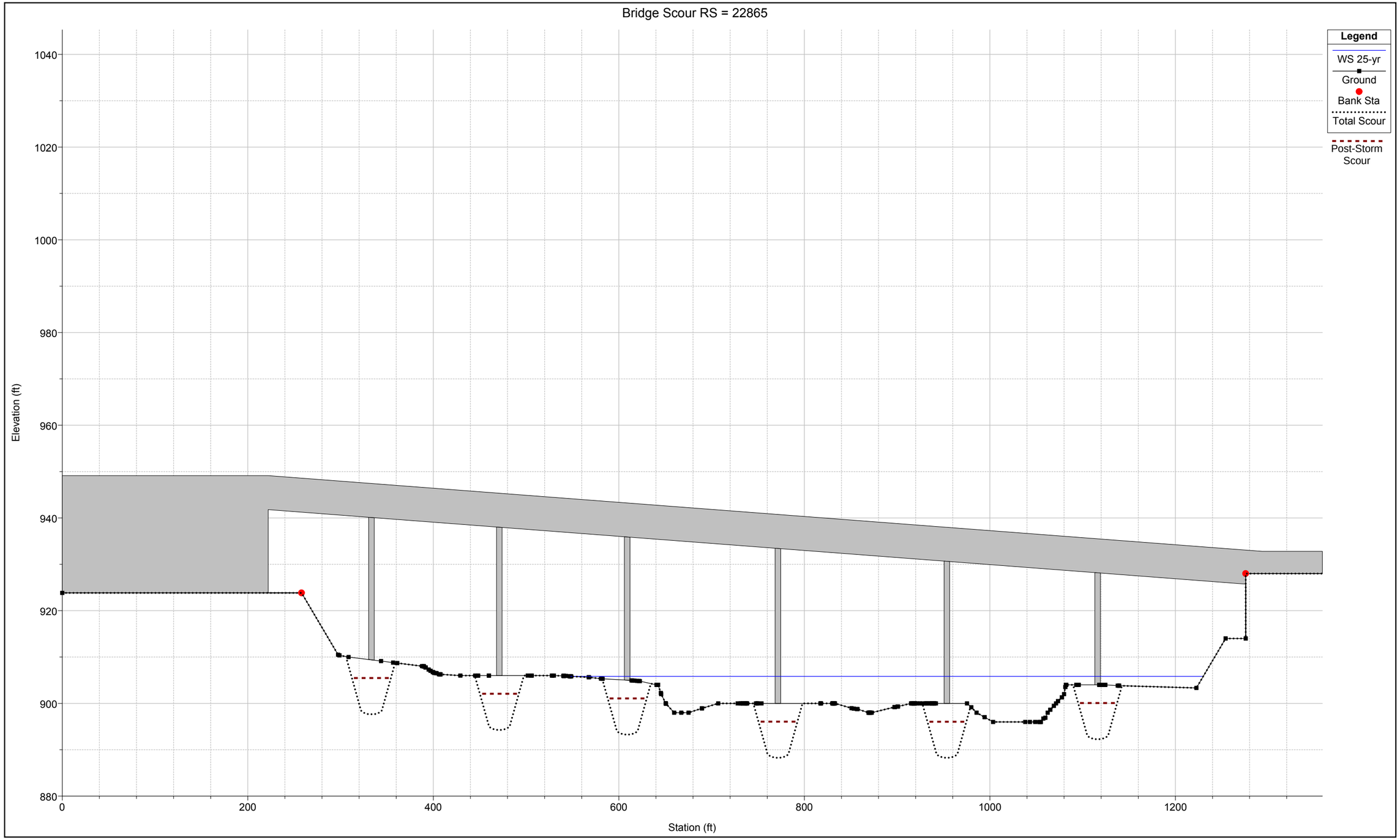
Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	2.27
Velocity Upstream (ft/s):	5.06
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	7.5
Froude #:	0.59
Equation:	CSU equation

Pier Scour for Long Canyon Bridge - Maximum Scour Method (25-yr Storm Event)



1 in Horiz. = 100 1 in Vert. = 20

Results of Pier Scour Analysis - Maximum Scour Method (Q_{25})

Hydraulic Design Data

Pier Scour

All piers have the same scour depth

Input Data

Pier Shape:	Group of Cylinders
Pier Width (ft):	6.0
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	9.23
Velocity Upstream (ft/s):	9.28
K1 Nose Shape:	1.0
Pier Angle:	0.0
Pier Length (ft):	89.3
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	11.8
Froude #:	0.54
Equation:	CSU equation

PACE
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Technical Memorandum

Date: October 3, 2016

To: Sam Rojas and Matt Carpenter – Newhall Land

From: Mark Krebs, PE and Jose Cruz, PE

Re: Pier Scour Analysis – Newhall Ranch RMDP Temporary Haul Route Bridge #8238E

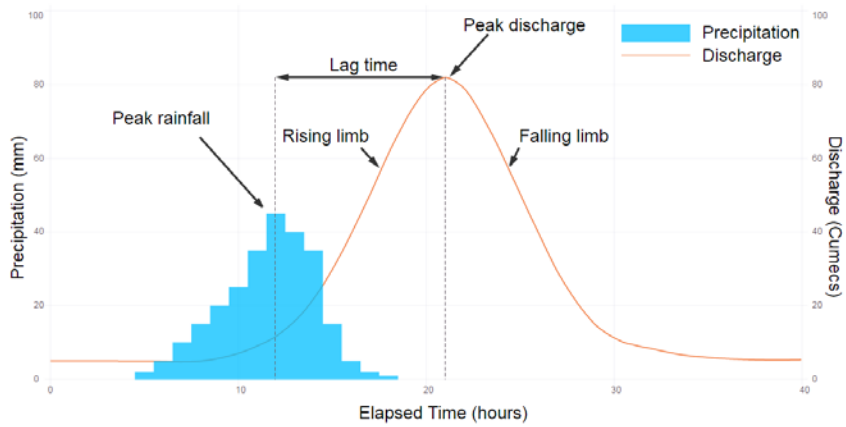
Purpose and Background

The purpose of this memorandum is to provide additional context to the issue of bridge pier scour as it relates to the potential for stranding of fish in scour holes that may result from large storm events. This memorandum provides an analysis of pier scour at the proposed Newhall Ranch RMDP temporary haul route bridge piles located near the proposed Long Canyon Bridge. The support piles (steel HP piles) for the temporary bridges will be in place during the winter season (December 1 – April 30), however the bridge decks will not be present. The temporary haul route bridges, including the temporary steel HP piles will be removed once grading operations at Landmark Village have been completed. Specifically, the memorandum describes pier scour for two different "reset" events – the first where peak flow corresponds to a 10-year storm, and second where peak flow corresponds to a 25-year storm. PACE ran the HEC-RAS[1] model to establish the river hydraulics for the 10-year and 25-year storms, using hydrologic data that PACE had previously prepared for the Santa Clara River watershed. For this analysis, the flow rates are 14,300-cubic feet per second (cfs) (10-year) and 28,100 cfs (25-year), respectively. The pier scour has been estimated using the HEC-RAS model as prepared for the September 30, 2016 technical memorandum to determine pier scour for the proposed Newhall Ranch RMDP permanent bridges. The previously prepared HEC-RAS scour model was adjusted to include the proposed temporary bridge with much smaller piers (i.e. 14-inch steel "I" beam versus 6-foot diameter circular concrete columns for the permanent bridge). Additionally, the bridge deck width in the model was set to 20-feet width for the temporary bridge, which corresponds to the width of each pile row of the temporary bridge. It should be noted that the model used in this analysis is specific to the Long Canyon bridge location, including hydraulic effects of the larger bridge and therefore is not reflective of the temporary bridge, which during the storm season will only consist of the piles (no bridge deck). However, pier scour determined in this analysis are representative of conditions for the temporary bridge crossing as it will be located near the proposed Long Canyon Bridge, with similar flow velocities. Therefore, this analysis should be viewed only as an estimate of local scour for the steel HP piles and not as an analysis of a complete bridge with piers and deck. As stated, the bridge deck is not to be present during the winter season, and therefore modeling of such a condition is not applicable.

The relationship between rainfall and river-flow over time is typically illustrated in a storm hydrograph. Peak flood flows recede back to, or near, pre-storm flow levels on the falling limb of the discharge curve, as illustrated on **Figure 1** below. The analysis provided herein reports on the maximum local pier scour expected at the peak flow of each modeled event and then presents a methodology to estimate the aerial extent and depth of local residual scour pools that might be expected to persist as flood flows from these

[1] Hydrologic Engineering Center's (CEIWR-HEC) River Analysis System (HEC-RAS), US Army Corps of Engineers (USACE).

events abate. Therefore, this analysis is only applicable to the period immediately after such events and does not consider or analyze conditions from multiple storm events nor does it provide information on what scour hole conditions may be expected at the end of the winter storm season. As the flow velocity is diminished, entrained sediment and fluvial bed movement settle, resulting in a residual scour hole that is smaller in aerial extent and shallower than the maximum scour that occurs during the peak discharge. Furthermore, subsequent storm events may interrupt the falling limb of the hydrograph, resulting in a new peak discharge curve and/or a new elevated base river flow.



https://geographyas.info/rivers/discharge-and-hydrographs/

Figure 1 – Example Storm Hydrograph

The US Geological Survey (USGS) defines scour as the hole left behind when sediment (sand and gravel) is washed away from the bottom of a river. Although scour may occur at any time, scour action is especially strong during floods. Swiftly flowing water has more energy than calm water to lift and carry sediment down river. In general, local pier scour is a concern for structural stability of a bridge. In the case of the temporary steel HP piles, they will be installed to a depth below the Qcap scour zone to ensure they are not damaged during a large storm season. However, as the bridge decks will not be in place, and the bridges will therefore not be in use during the storm season, scour is not a structural design concern at the pier locations.

Hydraulic analysis results from the HEC-RAS modeling were used to perform the subsequent scour analysis, which followed the procedures outlined in the Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 18 (HEC-18), Evaluating Scour at Bridges, 2001. The scour calculations were performed in a module embedded directly in HEC-RAS. Using HEC-18, bridge scour is comprised of three individual components: (1) Contraction scour, (2) Pier scour, and (3) Abutment scour. This memo addresses only the pier scour. For the reason stated above, the other types of scour are not applicable (the lack of a bridge deck eliminates contraction scour and the temporary bridges do not have abutments).

Pier Scour Calculation Methods

Several factors influence the magnitude of pier scour, including pier size, pier shape, bed material characteristics, and orientation and configuration of bridge piers. These elements are considered in the present calculations, and are expressed as form factors (or correction factors) for pier nose shape, angle of attack of flow, bed condition, and bed armoring. Within the HEC-18 module, there are two different options available for calculating pier scour: (1) using local hydraulic conditions in the vicinity of each

bridge pier, herein referred to as the local method, and (2) using maximum hydraulic conditions occurring at any location along the cross-section, herein referred to as the maximum method.

Local Method. The local method calculates scour at each pier using the maximum flow velocity and depth that corresponds to the centerline of each of the pier rows (measured along the cross-section immediately upstream of the bridge).

Maximum Method. The maximum method calculates scour at each pier using the maximum flow velocity and depth calculated at any location along the cross-section immediately upstream of the bridge, regardless of the actual location of the bridge piers. Since the maximum method uses one value for velocity and depth, one value for pier scour is calculated for all pier rows.

As the temporary haul route bridges and associated pier supports are anticipated to be in close proximity to where velocity and depth of flow are expected to be highest, the maximum scour method is recommended. Calculations were performed using the maximum method to determine the largest scour anticipated for each of the storm events analyzed. Pier scour calculations were performed using the Colorado State University (CSU) equation, outlined in the FHWA publication. This approach is the default method within the HEC-18 module in HEC-RAS. It is important to note HEC-18 performs these calculations on the pier located at the upstream end of the bridge for each row of piers (i.e., the pier, or in this case steel HP pile, that makes initial contact with the river flow). The upstream end of the bridge provides the worst-case scenario in terms of impacts to hydraulic performance due to the obstruction created by the piers. Any subsequent impacts caused by the other piers in each pier row would not exceed the impacts caused by the most upstream pier.

Temporary Bridge Pier Scour

The temporary haul routes will include a modular bridge deck section that spans the wetted channel of the Santa Clara River, supported on temporary steel HP piles, and would consist of the following elements:

(i) Support piers made of steel piles;
(ii) Pile cap to support each of the modular temporary bridge deck sections;
(iii) Modular temporary bridge decks; and
(iv) Deck work consisting of K-rail barriers/curbing, cover soil / road surface, and fencing.

Only elements (i) and (ii) above will be in place during the winter season and therefore are the only elements of the temporary haul route bridges that will influence local scour. Elements (iii) and (iv) will be removed prior to the winter season. The temporary steel HP piles will be removed from the riverbed upon completion of construction and it is expected that they may experience up to three winter seasons prior to removal.

Maximum Method

Results for the calculated pier scour for the 10-yr and 25-yr events using maximum method are shown in **Table 1**, below. Accordingly, these values represent the maximum pier scour that is expected to occur during the respective storm events.

Table 1 – Pier Scour for Temporary Bridge (Maximum Method)

RMDP Temporary Haul Route Bridge	Pier Scour (feet)
	Maximum Method
10-year storm event	4.0
25-year storm event	4.4

For perspective, note that maximum pier scour for the permanent bridge (Long Canyon Bridge) calculated for the 10-year and 25-year events are in the neighborhood of 10.4-feet and 11.8-feet, respectively.

Residual Scour

As previously discussed, the values for maximum pier scour represent the maximum scour expected to occur during the peak flow of a specified storm event. Residual scour is an estimate of the resulting depression in the riverbed immediately after a large scour producing storm event has occurred and the river returns to a relatively static flow. Refer to the storm hydrograph discussion above for further information regarding the timing of precipitation and peak flood flows. Residual scour presented herein has assumed that no subsequent storm event occurs, and as such is a limited snap-shot of riverbed conditions, only representing modeled storm event flow velocities. The results are informative as an estimate of the remaining depressional area that might be present until such time as any subsequent storm event occurs or the depression is filled in with additional sediment as deposition occurs if the depression is within the active river flow (i.e., wetted channel).

Residual scour present after the storm flow has ended is expected to be less than the maximum scour presented above, reflecting fill-in of the scour pockets by material transported during the receding leg of the hydrograph. Relying on anecdotal experience and best engineering judgement for the present study, the residual scour is estimated to be approximately one-third of the maximum pier scour calculated using the FHWA procedure.

This presentation of residual scour is not intended to be a complete description of all likely storm flows and resulting scour that the bridge piers and riverbed may experience nor is this intended to be an overall description of the river geomorphology. For an extensive discussion of overall sediment transport and fluvial mechanics of the Santa Clara River, the reader is directed to the RMDP 2010 FEIR, more specifically the geomorphology section and associated appendices. Also note, that laboratory studies have been performed to evaluate scour at bridge piers in an attempt to estimate residual scour, however these studies are typically performed for clear-flow conditions. In alluvial channels such as the Santa Clara River, storm flows carry a substantial sediment load that tends to restore areas of local erosion that occur during peak flow as the flood flow subsides. It is generally not feasible to model a flow that is sediment-laden in a laboratory setting, therefore no standard calculation methods are available to determine residual scour.

The post-storm (residual) scour is estimated to be 1.3-feet for the 10-year event, and 1.5-feet for the 25-year event. These results are summarized in **Table 2** below.

Aerial Extent of Scour Hole

Another component to be considered when evaluating pier scour is the aerial extents (length and width) of the scour hole created during a storm. According to FHWA, the top-width of the scour hole at a pier is dependent on the angle of repose of the bed material, as well as the depth of scour. For practical applications, FHWA suggests using a value equal to twice the scour depth to determine the top-width of a scour hole, as shown on **Figure 2**.

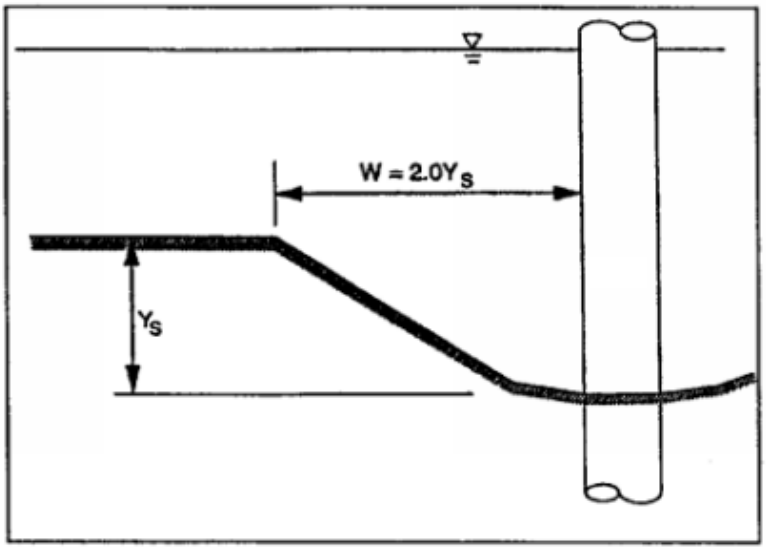


Figure 2 – Top width of Scour Hole (FHWA, 2001)

However, based on research of model studies, there is evidence that indicates the limit of scouring will extend farther downstream due to the existence of vortices created by water flowing around the bridge pier. The basic mechanism that causes pier scour is the formation of a "horseshoe" vortex, as shown in **Figure 3**. The horseshoe vortex is a result of downward movement of flow caused by the flow impingement at the upstream face of the pier. These downward forces create a scour hole at the base of the pier. As the depth of scour increases, the intensity of the vortex decreases and the flow begins to move downstream, creating a horseshoe-like shaped hole around the bridge pier. As flow travels around the pier, the separation of flow caused by the obstruction of the pier forms a "wake" vortex that extends the limits of the scour hole downstream of the pier.

There are currently no published guidelines for determining the extents of the additional scour caused by the wake vortex as this phenomenon is specific to site conditions and flow characteristics. PACE has estimated the horizontal limits at the bottom of the scour hole (downstream of the pier) to be roughly 1.5 times the pier diameter.

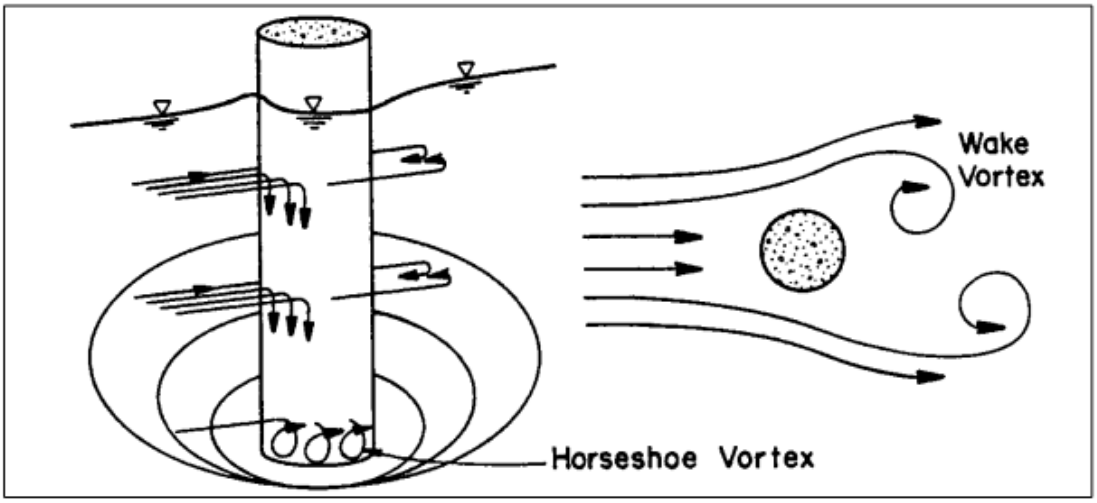


Figure 3 – Schematic Representation of Scour at Cylindrical Pier (FHWA, 2001)

Using the approaches outlined above, the top-width of the residual scour hole is estimated to be 2.6-feet for the 10-year event and 3.0-feet for the 25-year event. The length of the scour hole (downstream of the pier) is projected to be 4.4-feet for the 10-year event, and 4.8-feet for the 25-year event. These results are summarized in **Table 2** below.

Conclusion

The 10-year and 25-year events were presented as they are representative of what is considered major reset events on the Santa Clara River, and in the recent record (post Saint Francis Dam failure), have been observed on a periodic basis. Based on these modeled 10-year and 25-year storm events, which are reflective of these large "reset events" on the Santa Clara River it is suggested that residual scour pools could persist at one or more of the bridge piers at the Newhall Ranch RMDP temporary haul route bridges, however due to the very limited time period that the temporary bridge piles are in place, it is unlikely that such an event would occur. **Table 2** provides a summary of the maximum extent of the 10-year and 25-year residual scour that could be expected, if such an event were to occur. For smaller storm events, scour will be less. For larger storm events, greater scour would be expected.

Table 2 – Residual Pier Scour

Storm Event	RMDP Temporary Haul Route Bridge		
	Residual Scour (feet)	Aerial Extent Top Width (feet)	Aerial Extent Length (feet)
10-year	1.3	2.6	4.4
25-year	1.5	3.0	4.8

Attachments:

Appendix A:

Maximum Scour Method Results of Pier Scour Analyses for 10-yr Storm Event

Maximum Scour Method Results of Pier Scour Analyses for 25-yr Storm Event

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Appendix A

Results of Pier Scour Analysis - Maximum Scour Method (10-Year Storm)

Hydraulic Design Data

Pier Scour

All piers have the same scour depth

Input Data

Pier Shape:	Square nose
Pier Width (ft):	1.17
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	7.03
Velocity Upstream (ft/s):	7.58
K1 Nose Shape:	1.1
Pier Angle:	0.0
Pier Length (ft):	20.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	4.0
Froude #:	0.50
Equation:	CSU equation

Results of Pier Scour Analysis - Maximum Scour Method (25-Year Storm)

Hydraulic Design Data

Pier Scour

All piers have the same scour depth

Input Data

Pier Shape:	Square nose
Pier Width (ft):	1.17
Grain Size D50 (mm):	1.60
Depth Upstream (ft):	9.34
Velocity Upstream (ft/s):	9.07
K1 Nose Shape:	1.1
Pier Angle:	0.0
Pier Length (ft):	20.0
K2 Angle Coefficient:	1.0
K3 Bed Cond Coefficient:	1.1
Grain Size D95 (mm):	20.00
K4 Armouring Coefficient:	1.0

Results

Scour Depth Ys (ft):	4.4
Froude #:	0.52
Equation:	CSU equation