

Sentinel Peak Resources

Baldwin Hills Community Standards District Ground Movement Survey - 2021

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Executive Summary

This document reports on the Ground Movement Surveys (GMS) conducted as part of the requirements of the Baldwin Hills Community Standards District (CSD). The CSD states that the operator shall conduct ground movement surveys once every 12 months and will use both vertical and horizontal ground movement surveys, at specified survey locations within, and in the vicinity of, the oil field, utilizing high precision Global Positioning System technology, in combination with a network of ground stations.

Due the unique circumstances of the COVID-19 pandemic the ground movement surveys were not started until midway through 2021 and represents an approximate twelve month interval from the 2020 ground movement surveys. The ground movement survey report prepared in 2020 represents an eighteen (18) month period from the previous ground movement survey performed by Forkert Engineering in 2019.

The purpose of this survey is to monitor for ground movement as stipulated in the CSD, using Global Positioning System (GPS), Geodetic Leveling, and InSAR processes and procedures. Each process is detailed in the ground movement monitoring plan component of the Implementation Plan prepared and accepted for this project.

This report documents the eleventh (11) year of ground survey monitoring following the development of the baseline ground survey monitor conducted in April 2010.

This GMS report will provide a comparison between the 2020 and 2021 results.

During the preparation of this report, it was discovered that the 2020 GMS misreported the elevation for Monitor Station 134. A 20mm spacer was applied during measuring, but the resulting elevation was not reduced by 0.0656' from the leveled elevation. **This 2021 report corrects the 2020 elevation for Monitor Station 134.**

For the 2020 to 2021 ground movement analysis, six (6) Monitor Stations met or exceeded the 0.6-inch tolerance of ground motion in the vertical vector:

Station 110	0.094 feet =	1.13 inches
Station 116	0.058 feet =	0.70 inches
Station 117	0.054 feet =	0.65 inches
Station 304	0.061 feet =	0.73 inches
Station 308	0.097 feet =	1.16 inches
Station 50000	0.095 feet =	1.14 inches

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Acronyms

AGMS	Accumulated Ground Movement Study
AOI	Area of Interest
APS	Atmospheric Phase Screen
BFFB	Backsight/Foresight/Foresight/Backsight
BM	Benchmark
CGPS	Continuous Global Positioning Station
CMS	Corresponding Monitor Station
CORS	Continuously Operating Reference Station
CSD	Baldwin Hills Community Standards District
DEM	Digital Elevation Model
DifSAR	Differential Interferometric Synthetic Aperture Radar
DOGGR	California Division of Oil, Gas & Geothermal Resources
DSM	Digital Surface Model
FGCS	Federal Geographic Control Subcommittee
GMS	Ground Movement Survey
GPS	Global Positioning System
HMS	Historical Monitor Station
InSAR	Interferometric Synthetic Aperture Radar
IOF	Inglewood Oil Field
LOS	Line of Sight
LACDPW	Los Angeles County Department of Public Works
MS	Monitor Station
NAD83	North American Datum of 1983
NAVD88	North American Vertical Datum of 1988
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
PCS	Primary Control Station
PID	Permanent Identifier (NGS)
SAR	Synthetic Aperture Radar
SMS	Supplemental Monitor Station

SECTION

1 Introduction

This document reports on the ground movement surveys conducted as part of the requirements of the Baldwin Hills Community Standards District that is described in Section 2.0. The significance of the movement and comparison to existing oil field operations information will be analyzed in a separate document prepared by others.

1.1 Report Organization

This report is organized as follows:

- Section 1 provides the introduction and report organization.
- Section 2 describes the purpose of the monitoring program, project objectives and scope of the survey, study area and monitoring locations included in the survey.
- Section 3 describes the field survey methodology used in the monitoring program including the horizontal and vertical datum, GPS and geodetic leveling survey methods and equipment and processing employed during the field survey, including the use of the spacer during the leveling survey.
- Section 4 describes the Ground Movement Survey Results.
- Section 5 discusses the quality assurance and quality control procedures employed as part of the ground movement survey program.
- Section 6 provides a summary of the results of the ground movement survey program and any recommendations for future activities.
- Section 7 provides the certification of ground movement survey results by a California licensed Professional Land Surveyor.
- Section 8 provides a list of references used in the report.
- Section 9 includes technical appendices to the various applicable sections of the report.

SECTION 2 Project Overview

2.1 Purpose of the Monitoring Program

The purpose of this monitoring program is to monitor for ground movement as stipulated in the Baldwin Hills Community Standards District (CSD), using Global Positioning System (GPS), Geodetic Leveling, and Satellite InSAR processes and procedures as documented in the Implementation Plan for this project. The Los Angeles County Code that established the CSD (County of Los Angeles, 2008) and set forth the requirements for Ground Movement Surveys is present in Section 2.1.1. The Implementation Plan is described in section 2.1.2.

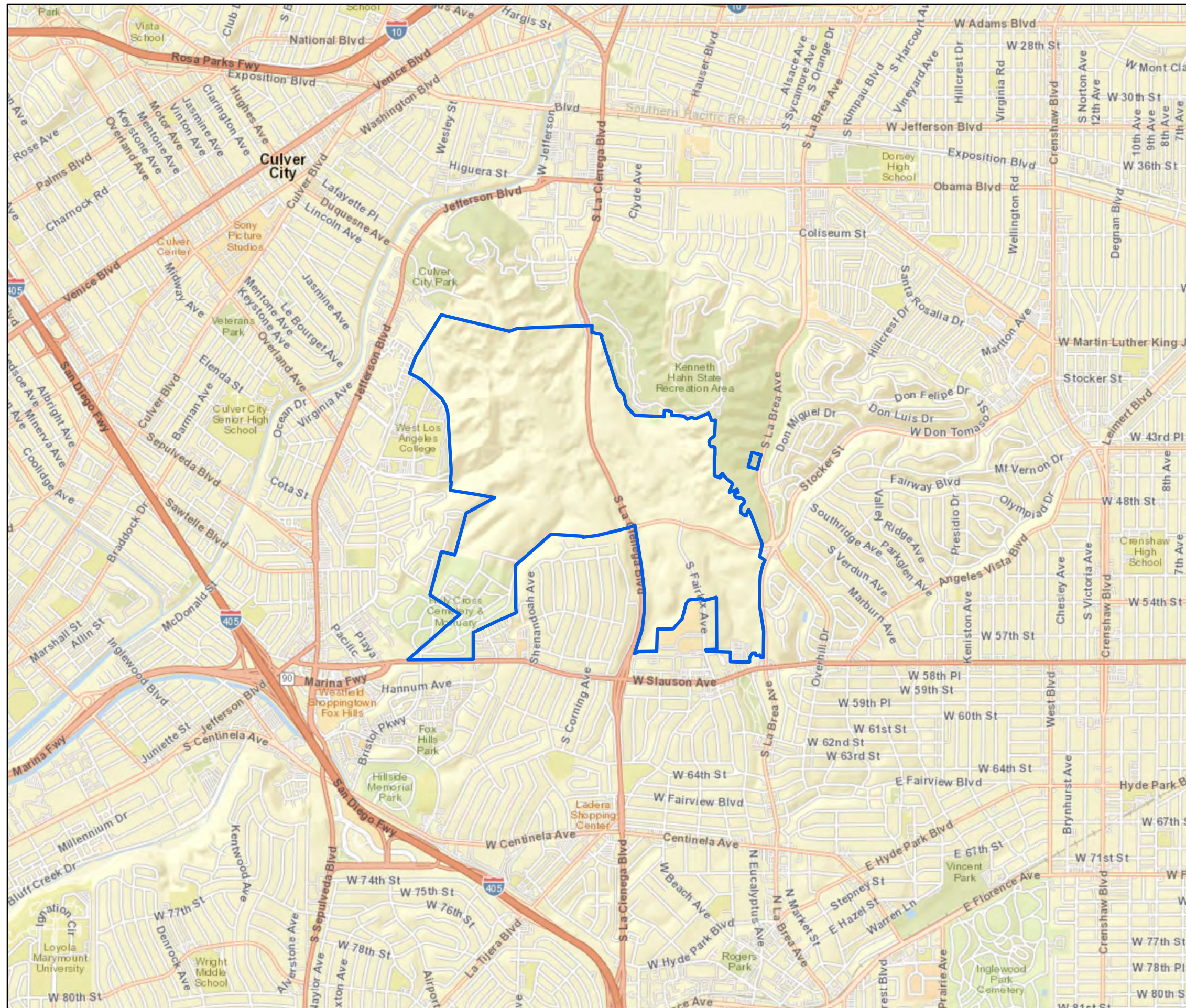
2.1.1 Baldwin Hills Community Standards District (CSD)

In October 2008, the County of Los Angeles amended Title 22 – Planning and Zoning of The Los Angeles County Code that established the Baldwin Hills Community Standards District (CSD) for the unincorporated portion of the Inglewood Oil Field located in the Baldwin Hills Zoned District and is shown in Figure 2-1. As part of the amendment, Chapter 22.310, Subsection 050 - Oil Field Development Standards, D. Geotechnical, 5. Ground Movement Surveys states:

The operator shall conduct ground movement surveys once every 12 months, or more frequently if determined necessary by the director of public works, following all provisions of a ground movement monitoring plan that is acceptable to DOGGR and the director of public works, that calls for both vertical and horizontal ground movement surveys, at specified survey locations within, and in the vicinity of, the oil field, utilizing high precision Global Positioning System technology, in combination with a network of ground stations (or any alternative technology specified in the ground movement monitoring plan approved by the director of public works), and following other survey methods outlined in the plan. The surveys shall be conducted by a California-licensed surveyor. The survey results shall be analyzed in relation to oil field activities, such as production, steam injection, and water flooding, taking into consideration individual oil producing zones, injection schedules, rates, volume, and pressure. The analysis shall be completed in collaboration by a California-registered professional petroleum engineer, registered geotechnical engineer, and certified engineering geologist. The results of the annual monitoring survey and analysis shall be forwarded to DOGGR and the director of public works. If requested by DOGGR or the director of public works, the operator shall make modifications to the ground movement monitoring plan. In the event that survey indicates that on-going ground movement, equal to or greater than 0.6 inches at any given location, or a lesser value determined by the director of public works is occurring in an upward or downward direction in the vicinity of or in the oil field, the operator shall review and analyze all claims or complaints of subsidence damage that have been submitted to the operator or the county by the public or a public entity in the 12 months since the last ground movement survey. Based thereon, the operator shall prepare a report that assesses whether any of the alleged subsidence damage was caused by oil operations and submit said report to DOGGR and the department of public works. The department of public works shall review the report to determine if it concurs with its conclusions.

Figure 2-1
Location of Baldwin Hills Community Standards District

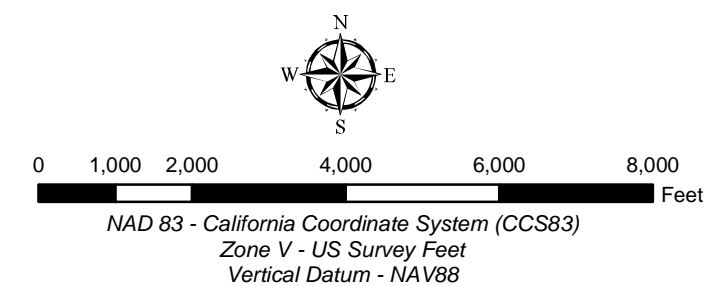
***Baldwin Hills Community
Standards District
Ground Movement Survey - 2021***



Legend

 Baldwin Hills Community Standards District Boundary

Source: Base map from ESRI World Street Map



***Location of Baldwin Hills
Community Standards District***

If the report concludes that damage has not been caused by oil operations, and the department of public works does not concur in that conclusion, it shall forward its conclusions to DOGGR for its review and possible action. If the report concludes that damage was caused by oil operations and the department of public works concurs with any such conclusion, the department of public works shall forward the department of public works' conclusions to DOGGR and ask DOGGR to evaluate the operator's fluid injection and withdrawal rates to determine whether adjustments to these rates may alleviate the ground movement, and if so, where in the oil field such adjustments should be made. The operator shall implement whatever adjustments in the rates of fluid injection and/or withdrawal that DOGGR determines are necessary and appropriate to alleviate any ground movement damage. The county shall promptly notify the CAP of any such action that is taken pursuant to this subsection. Injection pressures associated with secondary recovery operations (i.e., water flooding) or disposal of produced fluids shall not exceed reservoir fracture pressures as specified in Title 14 of the California Code of Regulations, section 1724.1 0, and as approved by the DOGGR.

2.1.2 Implementation Plan

The implementation plan for the Accumulated Ground Movement Study as required in Title 22 sections 22.310.120.D.4 and 22.310.050.D.5 was prepared and submitted to DOGGR and LACDPW on February 23, 2009, with final acceptance of the plan as evidenced by a letter of acceptance from LACDPW dated November 10, 2009. This approved implementation plan identified those survey measurement parameters and other processes for determining the accumulated ground movement since the post-Baldwin Hills reservoir failure studies. This Study was submitted and accepted by LACDPW in 2010. Contained in the implementation plan were components of the annual ground movement monitoring plan as specified by subsection 050.D.5.

The implementation plan as described in the CSD states:

Within 90 days following the effective date, or at such later date as may be approved by the director after consultation with the director of public works for good cause shown, the operator shall submit to DOGGR and the director of public works an implementation plan for determining the accumulated ground movement (Subsidence and/or Uplift/rebound) (since post-Baldwin Hills Reservoir failure studies) that is acceptable to DOGGR and the director of public works. The plan shall identify the survey measurement parameters, including fixed reflector locations (as appropriate), that shall be used in the survey. The plan shall include points within the vicinity of and in the oil field. Measurements shall be made using repeat pass differentially interferometric synthetic aperture radar technology. Within 90 days following acceptance of the plan, or such later date as may be approved by the director after consultation with the director of public works for good cause shown, the operator shall conduct the accumulated ground movement study. The study results shall be forwarded to DOGGR and the director of public works. The results of this study shall establish the initial baseline for future ground movement studies.

Within 180 days following the effective date, or at such later date as may be approved by the director after consultation with the director of public works for good cause shown, the operator shall submit to DOGGR and the director of public works an acceptable annual ground movement (Subsidence and/or Uplift/rebound) monitoring plan, as called for by subsection 050.D.5.

The purpose of the ground movement monitoring plan is to provide for the basis of the Ground Movement Surveys which shall measure, on an annual basis, the amount of ground movement in the vicinity of and at the oil fields.

The requirements of the ground movement monitoring plan were accomplished by implementing the following plan:

1. The establishment of the initial primary control station network.
2. The establishment of the monitor stations.
3. The horizontal positioning of the primary control and monitor stations utilizing GPS technology.
4. The vertical positioning of the monitor stations utilizing geodetic leveling procedures which shall adhere to the Federal Geographic Control Subcommittee (FGCS) for Second Order, Class I requirements as modified for this project.

2.2 Project Objective and Scope

The objective of the ground movement monitoring program is to provide measurements of ground deformation that may be occurring in the CSD using a combination of GPS field observations and Geodetic leveling survey methods.

2.3 Study Area

The study area is in the Inglewood Oil Field in the unincorporated area of the County of Los Angeles. The Inglewood Oil Field active surface boundary occupies an irregularly shaped area that extends diagonally across the trend of the hills along the axis of the faulted Inglewood anticline and covers approximately 1,000 acres. Figure 2-1 shows the area encompassed by the CSD.

Figure 2-2
Location of Primary Control Stations and Monitoring Stations

Baldwin Hills Community Standards District Ground Movement Survey - 2021

Legend

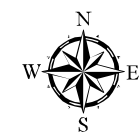
Monuments

Station Type

- ★ Primary Monitoring Control Station (Set Lead & Tag)
- ◆ Monitoring Station (FD LACDPW Benchmark)
- ▲ Monitoring Station (FD LACDPW Historical Monument)
- Monitoring Station (FD Lead & Tack)
- ▲ Monitoring Station (SSM Monument)
- Monitoring Station (Set Lead and Tag)
- ▲ Monitoring Station (Set SS Rod w/Brass Cap)
- ▲ Supplemental Monitor Station (Set SS Rod w/Brass Cap)
- Baldwin Hills Community Standards District Boundary

Full descriptions of monitoring locations are available in Appendix A.

Source: Base map from ESRI World Street Map



0 1,500 3,000 6,000
Feet

NAD 83 - California Coordinate System (CCS83)
Zone V - US Survey Feet

Location of Primary Control Stations and Monitoring Stations






Figure 2-3
Location of Supplemental Monitor Stations and Corresponding Monitor Stations

Baldwin Hills Community Standards District Ground Movement Survey - 2021

Legend

SurveyPts2020

Station Type

-  Monitoring Station (FD LACDPW Historical Monument)
-  Monitoring Station (FD Lead & Tack)
-  Monitoring Station (Set SS Rod w/Brass Cap)
-  Supplemental Monitor Station (Set SS Rod w/Brass Cap)
-  Baldwin Hills Community Standards District Boundary

Full descriptions of monitoring locations are available in Appendix A.

Source: Base map from ESRI World Street Map



0 1,500 3,000
Feet

NAD 83 - California Coordinate System (CCS83)
Zone V - US Survey Feet

Location of Supplemental Monitor Stations and Corresponding Monitor Stations

SECTION

3 Field Survey Methodology

3.1 Datums used for Horizontal and Vertical Control

The horizontal coordinates are based upon the North American Datum of 1983 (NAD83) California Coordinate System (CCS83), Zone V, US Survey Feet, Epoch 2007.0.

The North American Vertical Datum of 1988 (NAVD88) was used for all vertical control.

3.2 GPS and Geodetic Leveling Observations and Adjustments

The 2021 GPS Survey campaign included observations of both the Primary Control Network and Monitor Station Network. The GPS field observations were conducted in August and September 2021.

All baselines were measured by GPS static and fast static methods utilizing Trimble R8-4 and R-10 receivers on a fixed height tripod. A total of 57 stations were positioned, the 45 Monitor Stations and the 12 Supplemental Monitor Stations. Static GPS methods consisting of two 60 minute sessions of a minimum of 5 satellite L1/L2 frequency data at 1 second intervals were used for the Primary control. All other stations were surveyed using fast static methods, consisting of two 15-30 minute sessions of a minimum of 5 satellites L1/L2 frequency data at 1 second intervals.

The 2021 Geodetic Leveling campaign included the Project Benchmarks, Stations SF 133 and 116-45, as described in PID No. AE1731; PID No. AE1732; and 57 monitor stations. The Geodetic Leveling observations were conducted between August and September 2021.

The vertical (elevation) values for the monitor stations were established utilizing Geodetic Leveling procedures which adhered to specifications established by the FGCS Second Order, Class I (FGCS, 1984) modified. The modifications to those specifications included a backsight/foresight/foresight/backsight (BFFB) measuring sequence format. This measuring sequence assured that the level measurements to those monitor stations not in a loop, but rather on a spur, had redundant measurements. These procedures will achieve the detection of vertical movement of 0.6 inches as specified in the ordinance (see Section 2.1.1).

Due to access and stability issues related to the leveling, a 20 mm (0.0656') spacer was used at times to facilitate access to those GMS monuments which could not accommodate the full width of the Invar leveling rod. The protocol would be for the Rodman to notify the Survey Crew Chief when the spacer was being used. The Survey Crew Chief would then place a unique code that into the data collector as the observation was being made to digitally record the fact that the spacer was being used and additionally notate that fact into the daily field notes.

3.2.1 Equipment

GPS Survey

Equipment used as part of the GPS Survey included:

- Four Trimble R8-4/R-10 GNSS receivers
- Fixed height tripods

Geodetic Leveling Survey

Equipment used as part of the Geodetic Level Survey included Leica DNA03 Digital Level with paired Invar rods, rod supports and leveling turtles/pins.

3.2.2 Data Processing

GPS observations were downloaded daily, and the GPS baselines processed using Trimble Business Center (TBC V.5.51). Loop closures were conducted within the TBC software and, prior to final export of the GPS baselines; a precise ephemeris was retrieved from the NGS/NOAA website and applied to the GPS baselines. Digital level data was collected and downloaded through the Leica DNA03 software with the DNA03 digital level.

Network adjustments were completed using Star*Net Professional Version 9.02.06.556 software. Star*Net software is a software suite that handles general purpose, rigorous least squares analysis and adjustments of 2D, 3D and 1D land survey networks. Star*Net software is designed to handle highly redundant surveys performed for deformation monitoring of dams, walls, tunnels, and other structures.

The horizontal and vertical control networks were adjusted independently and the results of each are presented in the following subsections.

3.2.3 GPS Primary Control Network

The 2010 adjustment of the Primary Control Network was comprised of a minimally constrained and constrained adjustment to produce the NAD83 horizontal coordinates. Geodetic coordinates values published by the California Spatial Reference Center (CSRC) and /or National Geodetic Survey (NGS) for Continuously Operating Reference Stations (CORS) “NOPK(PID – AJ1897)” and “UCLP (PID – AI4475) and Continuous Global Reference Stations (CGPS) “WRHS(PID – AJ1940), “DSHS (PID – AJ1858), and “FXHS(PID-AJ1866) were originally used in a constrained adjustment to produce horizontal coordinates for primary control stations 201, 202, 203, 204, and 205 in the 2010 baseline ground movement survey.

Due to construction activities associated with the Expo Light Rail project, Primary Control Station 203 was destroyed in 2014. Another Primary Control Station named 206 was established during the 2015 GMS and was destroyed by construction in 2020. Primary Control Station 207 was established for use in the 2020 GMS in the general vicinity of Primary Control Station 206, and a new baseline elevation was established for this position via the Geodetic leveling process.

Additionally, Monitor Station 133 was found to be destroyed upon execution of the 2020 AGMS. Monitor Station 140 was established in the general vicinity of Monitor Station 133 and a new baseline elevation was established for this position via the Geodetic Leveling process.

3.2.4 Monitor Station Control Network

Minimally Constrained Adjustment

A minimally constrained adjustment was performed for these measurements to determine the integrity of the baseline observations. Station 201 was fixed in three dimensions (northing, easting, and elevation). The standard errors were evaluated, and the adjustment weighted. A variance factor of 1.00 was produced and the adjustment passed the Chi Square Test. This means there was good agreement and valid a priori error estimates for the observations.

NAD83 Constrained Adjustment

A NAD83 constrained adjustment was performed to coordinate the survey and determine if the baseline measurements fit the existing control values. Primary Control Station 201 was held in two dimensions (northing and easting) with Control Station 106 (LACDPW BM Y9624) held for elevation. The grid bearing between Primary Control Stations 201 and 202 (North 51 Degrees 46 Minutes 02.37 Seconds West) was held for the basis of bearings. This adjustment was modified by a factor determined through the minimally constrained adjustment. A variance factor of 1.011 was produced and horizontal values in the California Coordinate System (NAD83) Zone 5 produced for 57 Primary Control, Monitor Stations and Supplemental Monitor Stations. A fully constrained network adjustment was not performed as this would 'adjust' the lengths of the GPS baselines between the Monitor Stations, introducing anomalies that were not the subject of this survey.

Station Coordinate Error Ellipses

The GPS Survey Control Network Report contains the resulting error ellipses for each measured Primary Control and Monitor Station. The error ellipses are generated from the network adjustment and are based upon a statistical confidence level of 95 percent. This means that after performing the network adjustment there is a 95 percent probability that the monitor position lies within the resulting error ellipse. The CSD details that the GSM must be designed to monitor 0.6-inch displacement at each monitor station in subsequent surveys. In order to meet the CSD criteria, this requires that a confidence level of 95 percent must be achieved for each monitor station to generate error ellipses with a semi-major and semi-minor length not to exceed 0.03 of a foot.

3.2.5 Monitor Station Vertical Control Network

Minimally Constrained Adjustment

A minimally constrained adjustment was performed for these measurements to determine the integrity of the leveling observations. Station SF 133 was fixed in elevation. The standard errors were evaluated, and the adjustment weighted. A variance factor of 1.00 was produced and the adjustment passed the Chi Square Test. This means there was good agreement and valid a priori error estimates for the observations.

NAVD88 Constrained Adjustment

A constrained adjustment was performed to coordinate the survey and determine if the leveling measurements fit the existing control values. Stations SF 133 and 1 16 45 were held for elevation. A variance factor of 1.004 was produced and vertical values in the North American Vertical Datum of 1988 (NAVD88) was produced for the 57 Primary Control, Monitor Stations and Supplemental Monitor Stations as part of the leveling campaign.

SECTION

4 Ground Movement Survey Results

The objective of the ground movement survey was to determine the amount of movement for each of the established Monitor Stations within, and in the vicinity of the oil field. The criteria detailed in the CSD by LACDPW for the GMS is to monitor any on-going ground movement equal to or greater than 0.6 inches at any given location, or a lesser value determined by the Director of LACDPW is occurring in an upward or downward direction. This ground movement survey employed those techniques previously described in this report.

Table 4-1 (List of Primary Control Stations and Resulting 2020 Coordinate Values) and Table 4-2 (List of Monitoring Station Network and Resulting 2020 Coordinate Values within the CSD) present the resulting 2020 NAD83 coordinates values for each of the Primary Control Stations and the Monitoring Stations.

Table 4-1
2020 Primary Control Station Coordinate Values

Station Designation	2020 Northing (US Survey feet - NAD83)	2020 Easting (US Survey feet - NAD83)	2020 Elevation (feet NAVD88)
201	1815212.625	6449589.853	148.622
202	1824705.196	6437541.092	44.134
203	DESTROYED	DESTROYED	DESTROYED
204	1830371.656	6455183.682	103.125
205	1818605.944	6462527.707	155.052
206	DESTROYED	DESTROYED	DESTROYED
207	1832735.413	6445075.420	99.773

Table 4-2
2020 Monitor Station Coordinate Values

Station Designation	2020 Northing (US Survey feet - NAD83)	2020 Easting (US Survey feet - NAD83)	2020 Elevation (feet NAVD88)
101	1820713.968	6451263.074	350.091
102	1818842.221	6451426.098	289.588
103	1823091.789	6454098.431	347.501
104	1825920.222	6450594.915	451.010
105	1819930.151	6454361.485	399.133
106	1819859.749	6452965.417	337.752
107	1819695.434	6448856.246	286.064
108	1827207.319	6448685.699	241.350
109	1827506.831	6446067.940	317.390
110	1824777.850	6448990.492	343.713
111	1825238.511	6446284.990	377.613
112	1823057.097	6445253.543	184.027
113	1828706.222	6444084.504	81.307
114	1824143.553	6442412.136	49.948

Station Designation	2020 Northing (US Survey feet - NAD83)	2020 Easting (US Survey feet - NAD83)	2020 Elevation (feet NAVD88)
116	1823177.989	6451550.943	467.373
117	1824481.384	6450224.942	299.281
118	1819805.531	6449990.071	266.332
120	1824453.347	6445334.101	251.535
121	1825959.672	6444727.540	145.437
122	1827663.933	6444546.145	140.616
123	1821574.094	6447896.844	344.354
126	1823505.954	6450071.354	331.273
127	1818177.421	6449601.665	193.865
128	1820765.287	6453599.015	445.533
129	1821519.987	6454926.782	404.957
130	1825600.246	6454723.941	337.673
131	1827151.087	6452183.890	363.548
132	1829301.737	6450336.046	111.803
133	DESTROYED	DESTROYED	DESTROYED
134	1828258.380	6442300.495	76.613
135	1826477.054	6440720.612	66.801
136	1823027.001	6440834.032	38.295
137	1820002.179	6443138.799	31.865
138	1819144.341	6446151.789	178.560
139	1824589.539	6451696.488	501.571
140	1830005.985	6445686.360	79.604
301	1818878.653	6451628.216	285.476
302	1821407.559	6450750.273	338.740
303	1821763.172	6452619.227	476.037
304	1823209.312	6451666.462	469.099
305	1829239.481	6450456.923	112.423
306	1826978.426	6450690.998	467.876
307	1822335.603	6448419.583	376.209
308	1824335.627	6447544.733	392.784
309	1825199.603	6446191.559	379.058
310	1823234.032	6445383.973	193.029
311	1824538.860	6445452.957	256.534
312	1825311.332	6444999.818	143.454
50000	1823982.265	6447601.893	398.266
50002	1822520.773	6448418.948	379.711
50003	1821523.348	6450768.822	336.418
50004	1821811.582	6452590.011	481.047
50010	1827142.131	6450509.389	500.720

Table 4-3 (List of Primary Control Stations and Resulting 2020 Coordinate Values) and Table 4-4 (List of Monitoring Station Network and Resulting 2020 Coordinate Values within the CSD) present the resulting 2020 NAD83 coordinates values for each of the Primary Control Stations and the Monitoring Stations.

Table 4-3
2021 Primary Control Station Coordinate Values

Station Designation	2021 Northing (US Survey feet - NAD83)	2021 Easting (US Survey feet - NAD83)	2021 Elevation (feet NAVD88)
201	1815212.625	6449589.853	148.635
202	1824705.195	6437541.094	44.135
203	DESTROYED	DESTROYED	DESTROYED
204	1830371.644	6455183.694	103.123
205	1818605.938	6462527.710	155.041
206	DESTROYED	DESTROYED	DESTROYED
207	1832735.413	6445075.445	99.773

Table 4-4
2021 Monitor Station Coordinate Values

Station Designation	2021 Northing (US Survey feet - NAD83)	2021 Easting (US Survey feet - NAD83)	2021 Elevation (feet NAVD88)
101	1820713.949	6451263.097	350.129
102	1818842.205	6451426.125	289.610
103	1823091.781	6454098.474	347.532
104	1825920.237	6450594.984	450.018
105	1819930.155	6454361.516	399.148
106	1819859.726	6452965.461	337.784
107	1819695.403	6448856.250	286.083
108	1827207.339	6448685.746	241.353
109	1827506.855	6446067.946	317.403
110	1824777.856	6448990.553	343.807
111	1825238.518	6446284.944	377.654
112	1823057.097	6445253.537	184.040
113	1828706.243	6444084.516	81.307
114	1824143.541	6442412.135	49.944
116	1823177.991	6451550.991	467.431
117	1824481.393	6450225.029	299.335
118	1819805.514	6449990.086	266.331
120	1824453.349	6445334.076	251.551
121	1825959.700	6444727.524	145.448
122	1827663.967	6444546.163	140.613
123	1821574.073	6447896.853	344.387
126	1823505.938	6450071.417	331.319
127	1818177.393	6449601.660	193.878
128	1820765.280	6453599.065	445.572
129	1821519.982	6454926.827	404.976
130	1825600.240	6454723.970	337.678
131	1827151.098	6452183.917	363.558
132	1829301.724	6450336.070	111.789
133	DESTROYED	DESTROYED	DESTROYED
134	1828258.401	6442300.512	76.617

Station Designation	2021 Northing (US Survey feet - NAD83)	2021 Easting (US Survey feet - NAD83)	2021 Elevation (feet NAVD88)
135	1826477.069	6440720.608	66.799
136	1823027.003	6440834.028	38.285
137	1820002.167	6443138.815	31.860
138	1819144.336	6446151.800	178.570
139	1824589.528	6451696.535	501.615
140	1830005.970	6445686.378	79.570
301	1818878.627	6451628.245	285.487
302	1821407.566	6450750.293	338.761
303	1821763.190	6452619.283	476.081
304	1823209.310	6451666.507	469.160
305	1829239.466	6450456.948	112.445
306	1826978.426	6450691.048	467.890
307	1822335.585	6448419.631	376.256
308	1824335.652	6447544.718	392.881
309	1825199.596	6446191.518	379.096
310	1823234.014	6445383.959	193.041
311	1824538.864	6445452.909	256.552
312	1825311.344	6444999.779	143.474
50000	1823982.242	6447601.889	398.361
50002	1822520.751	6448418.974	379.758
50003	1821523.357	6450768.843	336.445
50004	1821811.600	6452590.086	481.089
50010	1827142.158	6450509.428	500.731

Table 4-5
2021 -2020 Delta Northing, Easting, Elevation Monitor Station Coordinate Values

Station Designation	2021 - 2020 Delta Northing		2021 - 2020 Delta Easting		2021 - 2020 Delta Elevation	
	Change in feet	Change in inches	Change in feet	Change in inches	Change in feet	Change in inches
101	-0.019	-0.23	0.023	0.28	0.038	0.46
102	-0.016	-0.19	0.027	0.32	0.022	0.26
103	-0.008	-0.10	0.043	0.52	0.031	0.37
104	0.015	0.18	0.069	0.83	0.008	0.10
105	0.004	0.05	0.031	0.37	0.015	0.18
106	-0.023	-0.28	0.044	0.53	0.032	0.38
107	-0.031	-0.37	0.004	0.05	0.019	0.23
108	0.020	0.24	0.047	0.56	0.003	0.04
109	0.024	0.29	0.006	0.07	0.013	0.16
110	0.006	0.07	0.061	0.73	0.094	1.13
111	0.007	0.08	-0.046	-0.55	0.041	0.49
112	0.000	0.00	-0.006	-0.07	0.013	0.16
113	0.021	0.25	0.012	0.14	0.000	0.00
114	-0.012	-0.14	-0.001	-0.01	-0.004	-0.05
116	0.002	0.02	0.048	0.58	0.058	0.70

Station Designation	2021 - 2020 Delta Northing		2021 - 2020 Delta Easting		2021 - 2020 Delta Elevation	
	Change in feet	Change in inches	Change in feet	Change in inches	Change in feet	Change in inches
117	0.009	0.11	0.087	1.04	0.054	0.65
118	-0.017	-0.20	0.015	0.18	-0.001	-0.01
120	0.002	0.02	-0.025	-0.30	0.016	0.19
121	0.028	0.34	-0.016	-0.19	0.011	0.13
122	0.034	0.41	0.018	0.22	-0.003	-0.04
123	-0.021	-0.25	0.009	0.11	0.033	0.40
126	-0.016	-0.19	0.063	0.76	0.046	0.55
127	-0.028	-0.34	-0.005	-0.06	0.013	0.16
128	-0.007	-0.08	0.050	0.60	0.039	0.47
129	-0.005	-0.06	0.045	0.54	0.019	0.23
130	-0.006	-0.07	0.029	0.35	0.005	0.06
131	0.011	0.13	0.027	0.32	0.010	0.12
132	-0.013	-0.16	0.024	0.29	-0.014	-0.17
134	0.021	0.25	0.017	0.20	0.004	0.05
135	0.015	0.18	-0.004	-0.05	-0.002	-0.02
136	0.002	0.02	-0.004	-0.05	-0.010	-0.12
137	-0.012	-0.14	0.016	0.19	-0.005	-0.06
138	-0.005	-0.06	0.011	0.13	0.010	0.12
139	-0.011	-0.13	0.047	0.56	0.044	0.53
140	-0.015	-0.18	0.018	0.22	-0.034	-0.41
201	0.000	0.00	0.000	0.00	0.013	0.16
202	-0.001	-0.01	0.002	0.02	0.001	0.01
204	-0.012	-0.14	0.012	0.14	-0.002	-0.02
205	-0.006	-0.07	0.003	0.04	-0.011	-0.13
207	0.000	0.00	0.025	0.30	0.000	0.00
301	-0.026	-0.31	0.029	0.35	0.011	0.13
302	0.007	0.08	0.020	0.24	0.021	0.25
303	0.018	0.22	0.056	0.67	0.044	0.53
304	-0.002	-0.02	0.045	0.54	0.061	0.73
305	-0.015	-0.18	0.025	0.30	0.022	0.26
306	0.000	0.00	0.050	0.60	0.014	0.17
307	-0.018	-0.22	0.048	0.58	0.047	0.56
308	0.025	0.30	-0.015	-0.18	0.097	1.16
309	-0.007	-0.08	-0.041	-0.49	0.038	0.46
310	-0.018	-0.22	-0.014	-0.17	0.012	0.14
311	0.004	0.05	-0.048	-0.58	0.018	0.22
312	0.012	0.14	-0.039	-0.47	0.020	0.24
50000	-0.023	-0.28	-0.004	-0.05	0.095	1.14
50002	-0.022	-0.26	0.026	0.31	0.047	0.56
50003	0.009	0.11	0.021	0.25	0.027	0.32
50004	0.018	0.22	0.075	0.90	0.042	0.50
50010	0.027	0.32	0.039	0.47	0.011	0.13

SECTION

5 Quality Assurance and Quality Control

Quality assurance is defined as a set of procedures designed to ensure that quality standards and processes are adhered to and that the final product meets or exceeds the required technical and performance requirements. The requirements are to be able to measure ground movement at any of the defined ground monitoring points to within 0.05 feet (0.6 inches).

5.1 Procedures

GPS Survey procedures using dual frequency receivers, geodetic antennas, double redundant observations, and fixed height tripods insured for consistent GPS measurements. Geodetic Leveling procedures which adhered to specifications established by the Federal Geographic Control Subcommittee Second Order, Class I (FGCS, 1984) modified.

Equipment

5.1.1 GPS Receivers

All GPS receivers were dual frequency, full-wavelength and had sufficient free memory to record project data. The necessary tracking data was entered (i.e., tracking rate, minimum number of satellites, elevation mask, height of instrument, and 4-character ID) for each monitoring period.

5.1.2 Antennas

All antennas were of geodetic quality.

5.2 Post Field Survey Inspections

Following the 2021 GMS field survey, a second visual inspection was performed at selected monitor positions to ensure that no disturbance or outside influence had occurred to those monitor stations. This was done as an additional quality control measure after the data adjustments had been reviewed.

SECTION

6 Summary and Recommendations

The 2021 Ground Movement Survey (GMS) was performed according to the specifications as documented in the Implementation Plan and the Baldwin Hills Community Standards District. An analysis of the differences in the positions of the Primary Control and the Monitor Stations as documented in the 2020 GMS against those positions as documented in the 2021 GMS.

SECTION 7 Certification

I hereby certify that this GPS and Leveling Survey were prepared under my personal direction and supervision. The copies of field notes and computer files contained herein are true copies of the original GPS observations, leveling data, and final adjustment files. These surveys were performed between August and September 2021.

Vincent Lungari, PLS
PLS No. 9437

Dated



SECTION

8 References

- County of Los Angeles, 2008. Minutes of Board of Supervisors October 28, 2008. Ordinance for adoption amending the County Code, Title 22 Planning and Zoning to establish Baldwin Hills Community Standards District.
- County of Los Angeles, 2009. Letter regarding Baldwin Hills Community Standards District Review of Implementation Plan for Accumulated Ground Movement Determination and Baseline Survey. From Gail Farber, County of Los Angeles, Department of Public Works to G. L. Cales (PXP) dated May 12, 2009.
- Federal Geographic Control Subcommittee, 1984. Standards and Specifications for Geodetic Control Networks, September 1984.
- PXP, 2009. Accumulated Ground Movement Implementation Plan for the Baldwin Hills Community Standards District. Letter to Division of Oil, Gas and Geothermal resources from G.L. Cales, dated February 23, 2009.

SECTION 9 Appendices

APPENDIX A

Monitor Station Descriptions

Appendix A

2021 Monitor Station Descriptions

<u>Monitor Station</u>	<u>Description</u>
101	Stainless Steel Rod, approximately 14' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" easterly side of Fairfax Ave between Stocker Dr. and Slauson Dr. and Slauson Ave. (dn. 0.35 ft.)
102	Lead & Tag set in curb stamped "LA CO DPW" @ BCR at NW corner of Fairfax Ave. & West Goldleaf Cir. at entrance to FMO&G field office.
103	Lead & Tag set in easterly curb stamped "LA CO DPW" in median of Stocker Dr. 135 ft. northerly of West Don Lorenzo Dr. per LACDPW PWFB 1118 Page 1241.
104	Stainless Steel Rod, approximately 16' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" at northwest corner of the Baldwin Hills Reservoir site (dn. 0.25 ft.)
105	Stainless Steel Rod, approximately 12' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" south side of Overhill Dr. 45 ft. west of BC (dn. 0.25 ft.)
106	RDBM Tag near center catch basin return at southeast corner La Brea Avenue and Northridge (LACDPW BM Y9624).
107	Lead & Tag on catch basin stamped LS 5490 at northwest corner of 55 th Street and Corning Avenue.
108	Lead & Tag on catch basin stamped LS 5490 at northeast corner of La Cienega & Kenneth Hahn Park entrance.
109	Stainless Steel Rod, approximately 23' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" (dn. 0.23 ft.)
110	Stainless Steel Rod, approximately 23' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" (dn. 0.35 ft.)

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2021 Monitor Station Descriptions

<u>Monitor Station</u>	<u>Description</u>
111	Stainless Steel Rod, approximately 23' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" (dn. 0.32 ft.)
112	Stainless Steel Rod, approximately 23' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" (dn. 0.25 ft.)
113	City of Los Angeles SSM with Brass Plate stamped "CITY OF LOS ANGELES ENGINEERING" at the intersection of Duquesne Ave. and Jefferson Blvd. (dn. 0.75 ft.)
114	City of Los Angeles SSM stamped – "CITY OF LOS ANGELES DEPT. OF PUBLIC WORKS TRAVERSE STATION, BUREAU OF ENGINEERING SURVEY DIVISION, 1952" at the intersection of Jefferson Blvd. and Overland Ave. (dn. 1.5 ft.)
116	Stainless Steel Rod, approximately 14' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" on ridge west of La Brea Ave. (dn. 0.20 ft.)
117	Stainless Steel Rod, approximately 15' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" inside Inglewood Oil Field approximately 100 ft. southwest transmission tower 1620, approximately 60 ft. northeast of Oil Well LA1BC L/W403 (dn. 0.25 ft.)
118	Stainless Steel Rod, approximately 24' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" on east side of La Cienega Ave. (dn. 0.15 ft.)
120	Stainless Steel Rod, approximately 38' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" (dn. 0.20 ft.)
121	Stainless Steel Rod, approximately 11' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490

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2021 Monitor Station Descriptions

<u>Monitor Station</u>	<u>Description</u>
	PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" (dn. 0.31 ft.)
122	Lead & Tag, LS 5490 on catch basin at entrance to the Culver City Dog Park at Duquesne Ave. and Leash Lane.
123	Lead & Tack in concrete curb end of cul-de-sac on Pendleton Ct. between 5001 and 5003 Pendleton Court.
126	Stainless Steel Rod, approximately 15' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" (dn. 0.25 ft.)
127	Lead & Tag, LS 5490 on catch basin at northeast corner of Slauson Ave. and La Cienega Blvd.
128	Stainless Steel Rod, approximately 23' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" westerly side of Overhill Dr. approximately 890 ft. southeasterly of La Brea Ave. (dn. 0.38 ft.)
129	Lead & Tag, LS 5490 on concrete curb at northwest corner of Northridge Dr. and Inadale Ave.
130	Lead & Tack in concrete curb on northerly side of Hillcrest Dr. approximately 50 ft. east of Don Milagro Dr.
131	City of Los Angeles SSM with 2 inch Brass Disc stamped "CITY OF LOS ANGELES SURVEY DIVISION 1-78" at the intersection of Veronica St. and El Mirador Dr. (dn. 1.00 ft.)
132	Lead & Tag, LS 5490 on concrete curb at northwest corner of Carmona Ave. & Coliseum St.
133	Lead & Tag, LS 5490 on catch basin at southwest corner of Jefferson Blvd. and Hetzler Rd. (DESTROYED 2020)
134	Lead & Tag, LS 5490 on concrete curb at northwest corner of Farragut Dr. and Baldwin Ave.
135	Spike in lead plug (no tag) in catch basin at northwest corner of Farragut Dr. and Overland Ave.

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2021 Monitor Station Descriptions

<u>Monitor Station</u>	<u>Description</u>
136	Lead & Tag, LS 5490 on catch basin as the southeast corner of Rhonda Way and Cota St.
137	Lead & Tag, LS 5490 on catch basin in concrete median on Playa St. 230 ft. north of Playa Ct.
138	Lead & Tack in concrete curb at the southeast corner of Buckingham Parkway approximately 550 ft. from West Slauson Ave.
139	Stainless Steel Rod, approximately 35' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 1.4 ft. south of 6 foot chain link fence approximately 250 ft. north of water tank (dn. 0.20 ft.)
140	Lead, Mag. Nail & Control washer at Northwest corner of catch basin on the Southwest corner of Jefferson Blvd. and Hetzler Rd.

<u>Station Number</u>	<u>Horizontal Control Station Description</u>
201	Lead & Tag, LS 5490 in concrete curb on the west side of La Tijera Blvd. approximately 300 ft. north of West Ellis Ave. and 40 ft. south of Fairview Blvd.
202	Lead & Tag, LS 5490 on catch basin on Culver Blvd. southwesterly of Commonwealth Ave. at curb return.
203	Lead & Tag, LS 5490 in concrete median on Venice Blvd. between Robertson Blvd. and National Blvd. at Ellis Ave. (DESTROYED 2014)
204	Lead & Tag, LS 5490 in catch basin at southeast corner of Rodeo Rd. & W. Martin Luther King, Jr. Blvd.
205	Lead & Tag, LS 5490 in catch basin at northwest corner of 9 th Ave. & W. Slauson Ave.
206	Lead & Tag, LS 5490 on southeast corner of catch basis on the west side of National Blvd. 130 feet north of the northwest curb return of Washington Blvd. (DESTROYED 2020)
207	Lead, Mag. Nail & Psomas Control Washer on southeast corner of catch basin located on the West side of Wesley Street cul-de-sac at 1' foot West of curb

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2021 Monitor Station Descriptions

<u>Monitor Station</u>	<u>Description</u>
<u>Station Number</u>	<u>Historical Monitor Station Description</u>
50000	4" Brass Disc in concrete post stamped "LA COUNTY SURVEY CONTROL SYSTEM, HOLLYWOOD C-12, 1961".
50002	4" Brass Disc in 1 ft. x 1 ft. concrete monument flush to ground, stamped "LA CNTY SURVEY CONTROL SYSTEM TRIANGULATION STATION INGLEWOOD D-1 1936 RE2177 SET BY COUNTY SURVEYOR 1961 LA CO ENG RE 5869".
50003	4" Brass Disc in 1 ft. x 1 ft. concrete monument flush to ground, stamped "LA CNTY SURVEY CONTROL SYSTEM TRIANGULATION STATION INGLEWOOD E-1 1961 SET BY LA COUNTY ENGR. RE 5869".
50004	4" Brass Disc in 8" diameter concrete post up 0.5' from ground at top of slope on oil well pad stamped "LA COUNTY SURVEY CONTROL SYSTEM REFERENCE MARK INGLEWOOD E-1C DISTANCE RM1 1972 SET BY RE7078"
50010	4" Brass Disc in well stamped "LA CNTY SURVEY CONTROL SYSTEM TRIANGULATION STATION HOLLYWOOD D-11 RESET (ILLEGIBLE) COUNTY SURVEYOR" (dn. 1.3 ft.)
<u>Station Number</u>	<u>Supplemental Monitor Station Description</u>
301	Stainless Steel Rod, 31.1' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 85 ft. east of gated entry at 5640 Fairfax Ave. (dn. 0.19')
302	Stainless Steel Rod, 8.7' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 65 ft. easterly of Fairfax Ave. and 600 ft. south of Stocker St. (dn. 0.27')
303	Stainless Steel Rod, 26.0' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 300 ft. north of Stocker St. and 470 ft. west of La Brea Ave. on oil well pad (dn. 0.27')
304	Stainless Steel Rod, 27.3' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with

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2021 Monitor Station Descriptions

<u>Monitor Station</u>	<u>Description</u>
	aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 400 ft. south of communications facility in oil field (dn. 0.38 ft.)
305	Lead & Tack in concrete curb approximately 75 ft. east of the centerline of Carmona Ave. at the southeast corner of Coliseum St. and Carmona Ave.
306	Stainless Steel Rod, 15.8' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" on north side of driveway at 4171 Cloverdale Ave. (dn. 0.58 ft.)
307	Stainless Steel Rod, 8.8' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 180 ft. south of Station No. 50002 (dn. 0.34 ft.)
308	Stainless Steel Rod, 22.0' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 350 ft. north of Station No. 50001 (dn. 0.31 ft.)
309	Stainless Steel Rod, 16.5' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 100 ft. southwest of Station 111 (dn. 0.22 ft.)
310	Stainless Steel Rod, 29.7' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 225 ft. northeast of Station No. 112 (dn. 0.15 ft.)
311	Stainless Steel Rod, 37.3' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 120 ft. northeast of Station No. 120 (dn. 0.24 ft.)
312	Stainless Steel Rod, 34.1' in length driven to refusal with domed Brass Cap stamped "BALDWIN HILLS CSD PLS 5490 PSOMAS" with aluminum access cover stamped "BALDWIN HILLS CSD - PSOMAS" 700 ft. southeast of Station No. 121 (dn. 0.14 ft.)