Draft

CE&G
Pragmatic Expertise™

CAL ENGINEERING & GEOLOGY
785 Ygnacio Valley Road | Walnut Creek | CA94596
6455 Almaden Expwy., Suite 100| San José | CA 95120
23785 Cabot Blvd., Suite 321 | Hayward | CA 94545
www.caleng.com

DRAFT GEOTECHNICAL DESIGN REPORT

SAN LORENZO VALLEY WATER DISTRICT 2019 WATERLINE PROJECT

CE&G DOCUMENT NO.: 191110.001

JANUARY 30, 2020

Prepared for:

Schaaf & Wheeler Consulting Civil Engineers
Attn: Andrew Sterbenz, P.E.
3 Quail Run Circle, Suite 101
Salinas, CA 93907-2348

Kevin Loeb, PG 9665
Project Geologist

PROFESSIONAL GEOLOGIST
KEVIN P. LOEB
No. 9665
STATE OF CALIFORNIA

Dan Peluso, PE 49562, GE 2367
Principle Engineer

REGISTERED PROFESSIONAL ENGINEER
DANIEL J. PELUSO
GE 2367
GEOTECHNICAL
STATE OF CALIFORNIA

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 GENERAL

Cal Engineering & Geology, Inc. (CE&G) has provided geotechnical design services to Schaaf & Wheeler Consulting Civil Engineers (S&W), for the 2019 pipeline Project. The pipeline system is owned and maintained by SLVWD. The project includes five pipeline segments located in the Santa Cruz Mountains in the vicinity of Boulder Creek, California. The project sites are identified based on the roads where they are located; as follows: Hillside Drive, Sequoia Avenue, HWY 236 (Lyon Zone), California Drive, and Quail Hollow Road (Figures 1 & 2). This report has been prepared to provide geotechnical recommendations for the construction of the pipelines.

1.2 PROJECT DESCRIPTION

The project consists of 5 waterline segments, totaling approximately 17,300 lineal feet, that are to be replaced. Each pipeline segment ranges in length from 800 to 7,500 feet. Existing pipe diameters range from 2 to 12-inch pipe. It is anticipated the replacement pipes will consist of a variety of materials, including ductile iron, PVC and HDPE. Each pipe segment will generally be replaced with pipes larger than existing service pipes. Pipe replacement is anticipated to consist of open trench replacement.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of CE&G's geotechnical investigation was to assess the existing surface and subsurface conditions along the planned pipeline alignments, develop geotechnical design recommendations, and prepare this geotechnical design report for the proposed installation of the new water pipelines.

The scope of work completed for this geotechnical investigation and report include: project coordination and consultation with SLVWD and S&W; geologic reconnaissance to observe current site conditions and to mark for USA (Underground Service Alert); subsurface exploration using a truck-mounted drill rig and hand excavation equipment; laboratory testing to determine selected engineering properties; development of geotechnical design recommendations; and the preparation of this report.

2.0 SITE DESCRIPTION

2.1 SITE DESCRIPTION

The five planned water line replacement segments are located in the central area of Santa Cruz County, in the vicinity of Boulder Creek, California. Each of the five pipeline segments vary in topographic settings and have differing site features, which are describe below.

Site specific topographic surveys were provided by (S&W) and is used as the primary base in the attached Site Plan (Figure 2).

2.1.1 Hillside Drive Alignment

The Hillside Drive alignment is located in a forested, residential area of Boulder Creek California (Figure 2A). Starting at, this segment of the pipeline extends from the intersection of Fern Drive and Reynolds Drive southwest along Reynolds drive and continues north along Hillside Drive to the intersection with Fern Drive. Existing vegetation along the roadway consists of large trees and shrubs. Residential properties along the road consist of single-family homes. Overall, the project area is on moderately steep hillside terrain that slopes to the east/northeast towards the San Lorenzo River. The elevation within the project area varies between approximately 617 and 673 feet above sea level (WGS84).

2.1.2 Sequoia Avenue Alignment

The Sequoia Avenue segment of the pipeline extends from the southern end of Sequoia Avenue across an east/west trending ridge to the northwestern end of Margaret Drive (Figure 2B). The area is densely vegetated with shrubs and trees with moderately steep terrain. The elevation within the project area varies between approximately 679 and 730 feet above sea level (WGS84).

2.1.3 Lyon Zone Alignment

The Lyon Zone segment of the pipeline begins at the intersection of Lomond Street and State Highway 9 in downtown Boulder Creek (Figure 2C). The alignment extends southwest along Lomond Street, then continues northwest along Pine Street to the intersection with HWY 236 (Big Basin Way), where it extends west/northwest to the intersection with South Redwood Drive. The alignment trends southwest along South Redwood Drive and continues along Madrone Drive. The southeastern portion of the segment is located in a residential and gently sloping area of downtown. The northwestern portion of the alignment is in moderately steep and densely vegetated terrain. The elevation within the project area varies between approximately 492 and 680 feet above sea level (WGS84) but increase overall from southeast to northwest.

2.1.4 California Drive Alignment

This segment is in a residential area of unincorporated Ben Lomond, California. This pipeline segment extends along Middle Drive from the intersection of Riverside Drive and Middle Road to the intersection with California Drive, trends along California Drive to the intersection with Riverside Drive (Figure 2D). The topography in this area slopes gently down to the east towards the San Lorenzo River. Single family homes are located along both sides of the streets along this alignment. The elevation within the project area varies between approximately 374 feet and 400 feet above sea level (WGS84).

2.1.5 Quail Hollow Road Alignment

This segment is located along Quail Hollow Road between Cumora Lane and West Zayante Road in Felton, California (Figure 2E). The hillside areas along this segment are generally moderately vegetated with grass, shrub, and trees, with some areas along the segment that are more sparsely vegetated, with grassy land and scattered trees and shrubs. The elevation within the project area varies between approximately 344 feet and 655 feet above sea level (WGS84).

2.2 INFORMATION PROVIDED

Prior to beginning work, S&W provided a request for proposal (RFP) that contained a plan view of the five pipeline alignments to aid in developing a work plan and determine boring locations.

3.0 GEOLOGIC CONDITIONS

3.1 REGIONAL GEOLOGIC SETTING

The five pipeline alignments are located in the Santa Cruz Mountains, within the Coast Ranges geomorphic province of California (Fig. 1). This province is characterized by northwest-southeast trending mountain ranges such as the Santa Cruz Mountains and intervening valleys such as that occupied by San Francisco Bay. The Santa Cruz Mountains mark a mountain-range scale regional uplift centered on the San Andreas fault. The geologic setting is shown on our Regional Geologic Map (Figure 3).

The general vicinity of the pipeline alignments has been mapped several times, at different scales, and with different emphasis. Notable compilations include: Brabb and others (1997); Wentworth and others (1999); and Graymer and others (2006). The resulting geologic maps from these studies are in general agreement. For the purposes of this study, we reference the site geology using Brabb and others (1997).

The various pipeline segments are geographically separated and mapped within different geologic units. In the sections below, we review the dominant bedrock type in each segment's area.

3.1.1 Hillside Drive Alignment

The southern portion of the Hillside Drive alignment is in an area mapped as the Twobar Shale Member (Eocene) of the San Lorenzo Formation (Brabb and others, 1997). This unit is described as "very thin bedded and laminated olive-gray shale." The northern portion of the alignment is in an area mapped as the Rices Mudstone Member (Oligocene and Eocene) of the San Lorenzo Formation and is described as "olive-gray mudstone and massive medium light-gray, very fine- to fine-grained arkosic sandstone" (Brabb and others, 1997). The Twobar Shale and Rices Mudstone Members are shown as having been juxtaposed by the Butano Fault, which crosses the center of the Hillside Drive alignment (Brabb and others, 1997).

3.1.2 Sequoia Avenue Alignment

Brabb and others (1997) show the area of the Sequoia Avenue segment overlying southwesterly dipping Vaqueros Sandstone (Lower Miocene and Oligocene). This unit is described as "thick-bedded to massive yellowish-gray, very fine- to fine-grained arkosic sandstone containing interbeds of olive-gray shale and mudstone."

3.1.3 Lyon Zone Alignment

The Lyon Zone segment extends across three different geologic units as mapped by Brabb and others (1997). The northwestern portion of the alignment is in an area mapped as Lompico Sandstone (Middle Miocene in age), which is shown dipping to the southwest and is described as "thick-bedded to massive yellowish-gray, medium- to fine-grained calcareous arkosic sandstone." The center portion of the alignment is in an area mapped as Monterey Formation bedrock, which is shown in the site vicinity as dipping southwest and overlying the Lompico Sandstone. The Monterey Formation bedrock is described as "medium- to thick bedded and laminated olive-gray to light-gray semi-siliceous organic mudstone and sandy siltstone" (Brabb and others, 1997). The southeastern portion of the segment is shown in an area mapped as undifferentiated alluvial deposits (Holocene), which overlie both the Monterey Formation and Lompico Sandstone. The alluvium is described as "unconsolidated, heterogenous, moderately sorted silt and sand containing discontinuous lenses clay and silty clay, which locally includes large amounts of gravel" (Brabb and others, 1997).

The entire Lyon Zone segment is in an area mapped northeast of the Ben Lomond Fault (see Figure 3; Brabb and others, 1997).

3.1.4 California Drive Alignment

The California Drive segment is in an area mapped as Quaternary age, undifferentiated alluvial deposits (described above), concentrated along a valley floor. Monterey Formation bedrock (Middle Miocene) appears to underlie the alluvium (Brabb and others, 1997).

The northwest-trending Ben Lomond Fault is shown as crossing the southwestern portion of the California Drive segment (Brabb and others, 1997).

3.1.5 Quail Hollow Road Alignment

Mapping by Brabb and others (1997) show the Quail Hollow Road segment on the northeastern side of the Scotts Valley Syncline, in an area underlain by the Santa Margarita sandstone (Upper Miocene). This sandstone is described as "very thick-bedded to massive thickly cross bedded, yellowish-gray to white, friable, medium- to fine-grained arkosic sandstone" (Brabb and others, 1997). The southeastern part of the alignment is in an area mapped as northeasterly dipping Monterey Formation bedrock, described above.

3.2 GEOHAZARD MAPPING

3.2.1 State and Regional Geohazard Mapping

The California Geological Survey (CGS) has not established Seismic Hazard Zone maps for the quadrangles encompassing the project alignments, and/or has not evaluated the vicinity of the segments. This map series identifies zones of required investigation for liquefaction and landslides.

The United States Geological Survey (USGS) produced an Interactive Fault Map using their Quaternary Fault and Fold Database (USGS, 2006). This database includes of information on faults and associated folds throughout the U.S. that show geological evidence of coseismic surface deformation in large earthquakes during the past 1.6 million years. These faults and folds are divided into various categories based on evidence of their most recent movement and include: Historic (< 150 years); Latest Quaternary (< 15,000 years); Late Quaternary (< 130,000 years); Middle and Late Quaternary (< 750,000 years); and Undifferentiated Quaternary (< 1.6 million years). According the Fault Interactive Map, there are no Quaternary faults shown crossing the pipeline alignments for the Sequoia Avenue, Lyon Zone, California Drive, and Quail Hollow Road segments (Figure 4) (USGS, 2015). A splay of the Butano fault, labeled as undifferentiated Quaternary, is shown as crossing the Hillside Drive pipeline segment (see Figure 4; USGS, 2006)

3.2.2 Local Geohazard Mapping

Santa Cruz County produced maps showing Fault Zone Hazard Areas, which included review of the Butano, Sargent, Zayante, Corralitos, and San Andreas faults (County of Santa Cruz, Emergency Management GIS web page (http://www.co.santacruz.ca.us/Departments/ GeographicInformation Systems(GIS).aspx), accessed January 2020). According to Santa Cruz County, the Hillside Drive, Sequoia Avenue, California Drive, and Quail Hollow Road alignments are not in areas mapped as fault hazard zones. The Lyon Zone alignment is shown in an area mapped as lying within a 0.5-mile buffer of fault zones but not within a fault zone itself.

Santa Cruz County also produced maps showing Liquefaction Hazard Areas, which designate various liquefaction potential levels varying from low to very high potential (County of Santa Cruz, Emergency Management GIS web page (http://www.co.santacruz.ca.us/Departments/ GeographicInformation Systems(GIS).aspx), accessed January 2020). The pipeline alignments for Hillside Drive, Sequoia Avenue, and Quail Hollow Road are not shown in areas mapped as potentially liquefiable. The eastern portion of the Lyon Zone segment as well as most of the California Drive segment are mapped in areas of moderate liquefaction potential.

The County of Santa Cruz produced landslide hazard maps in 2018, which uses Landslide Hazard Areas derived from various USGS open files and a 1975 Landslide Deposit Map of Santa Cruz County by Cooper-Clark and Associates. According to the Santa Cruz County (2018) Big Basin, Felton, and Castle Rock Ridge quad series, the five pipeline alignments are not mapped within landslide hazard zones. (County of Santa Cruz, Emergency Management GIS web page (http://www.co.santacruz.ca.us/Departments/ GeographicInformation Systems(GIS).aspx), accessed January 2020).

3.3 REGIONAL GROUNDWATER

The pipeline alignments, with the exception of Hillside Drive, are located in an area within the Santa Margarita groundwater basin. (County of Santa Cruz, Emergency Management GIS web page (http://www.co.santacruz.ca.us/Departments/ GeographicInformation Systems(GIS).aspx), accessed January 2020).

Groundwater within the hillslope areas encompassing the some of the pipeline alignments is likely variable, with the water table commonly sloping downhill toward the closest drainage axis. We did not identify long-term springs and seeps in the site vicinities, although expressions of these are likely present seasonally.

3.4 SEISMICITY

3.4.1 Active Faults

The five pipeline alignments are located within the greater San Francisco Bay Area, which is recognized as one of the more seismically active regions of California. The right-lateral strike-slip San Andreas fault system controls the northwest-southeast structural grain of the Coast Ranges and the Bay Area. The fault system marks the major boundary between two of earth's tectonic plates, the Pacific Plate on the west and the North American Plate on the east. The Pacific Plate is moving north relative to the North American plate at approximately 40 mm/yr in the Bay Area (WGCEP, 2003).

The transform boundary between these two plates has resulted in a broad zone of multiple, subparallel faults within the North American Plate, along which right-lateral strike-slip faulting predominates. In this broad transform boundary, the San Andreas Fault accommodates less than half of the average total relative plate motion. Much of the remainder in the greater South Bay Area is distributed across faults such as the San

Gregorio-Hosgri, Monte Vista-Shannon, Sargent, Berrocal, Hayward (southern segment), Calaveras, Zayante-Vergeles, and Greenville fault zones.

Since the pipeline alignments are in the seismically active San Francisco Bay Area, they will likely experience significant ground shaking from moderate or large (M_W >6.7) earthquakes on one or more of the nearby active faults during the design lifetime of the project. Some of the seismic sources in the San Francisco Bay area and their distances from the sites are summarized in Table 3-1.

Seismogenic (capable of generating significant earthquakes) earthquake faults near the site include the Zayante-Vergeles and the San Andreas fault.

Table 3-1. Distances to Selected Major Active Faults

Pipeline Segment	Fault Name	Approximate Distance and Direction from Site to the nearest Surface Fault Traces
Hillside Drive	Butano	0.0 km
	Zayante-Vergeles-Upper	4.5 km southwest
	San Andreas	8.6 km northeast
	Berrocal	10.9 km northeast
	San Gregorio	14.9 km southwest
	Monte Vista-Shannon	15.0 km northeast
	Sargent	18.2 km east-southeast
	Monterey Bay-Tularcitos	28.7 km south
	Hayward (southern segment)	35.2 km northeast
Sequoia Avenue	Zayante-Vergeles-Upper	1.3 km southwest
	Butano	2.7 km north-northeast
	San Andreas	10.6 km northeast
	Berrocal	13.4 km northeast
	San Gregorio	13.7 km southwest
	Sargent	16.8 km east
	Monte Vista-Shannon	17.2 km northeast
	Monterey Bay-Tularcitos	24.8 km south-southeast
	Hayward (southern segment)	36.7 km northeast
Lyon Zone	Zayante-Vergeles-Upper	0.6 km northeast
	Butano	5.0 km north
	San Andreas	11.7 km northeast
	San Gregorio	12.8 km southwest
	Berrocal	15.2 km northeast
	Sargent	15.8 km east-northeast
	Monte Vista-Shannon	18.7 km northeast
	Monterey Bay-Tularcitos	22.0 km south-southeast
	Hayward (southern segment)	37.5 km northeast

Table 3-1. Continued

Pipeline Segment	Fault Name	Approximate Distance and Direction from Site to the nearest Surface Fault Traces
California Drive	Zayante-Vergeles-Upper	2.7 km northeast
	Butano	9.0 km northwest
	San Andreas	12.2 km northeast
	Sargent	14.0 km northeast
	San Gregorio	15.1 km southwest
	Berrocal	16.2 km northeast
	Monterey Bay-Tularcitos	18.9 km south
	Monte Vista-Shannon	19.2 km northeast
	Hayward (southern segment)	37.2 km northeast
Quail Hollow Road	Zayante-Vergeles-Upper	2.8 km north
	San Andreas	11.2 km northeast
	Butano	11.4 km northwest
	Sargent	12.2 km northeast
	Berrocal	16.0 km northeast
	Monterey Bay-Tularcitos	16.5 km south-southwest
	San Gregorio	16.5 km southwest
	Monte Vista-Shannon	18.9 km northeast
	Hayward (southern segment)	35.7 km northeast

3.4.2 Liquefaction and Seismic Densification

Soil liquefaction is a phenomenon in which saturated, cohesionless soils (generally sands) lose their strength due to the build-up of excess pore water pressure during cyclic loading, such as that induced by earthquakes. Soils most susceptible to liquefaction are saturated, clean, loose, fine-grained sands and silts. The primary factors affecting soil liquefaction include: 1) intensity and duration of seismic shaking; 2) soil type and relative density; 3) overburden pressure; and 4) depth to ground water.

Based on subsurface information collected during this investigation, we judge the potential for liquefaction within the upper 10 feet at the sites to be moderate for the California Drive segment and eastern portion of the Lyon Zone segment due to the presence of shallow groundwater in loose to medium dense alluvial soils. We judge the potential for liquefaction within the upper 10 feet of the Hillside Drive, Sequoia Avenue, and Quail

Hollow Road segments, as well as the western portion of the Lyon Zone segment to be to be low.

Seismic densification is the densification of unsaturated, loose to medium dense granular soils due to strong vibration such as that resulting from earthquake shaking. We judge the potential for seismic densification at the pipeline alignments to be moderate for the encountered alluvial materials because they are loose to medium dense, granular, and generally unsaturated in the upper 10 feet. The uppermost sandy, weathered bedrock along the Quail Hollow Road alignment are unsaturated and granular but is judged too dense for seismic densification.

4.0 FIELD INVESTIGATIONS

4.1 SITE RECONNAISSANCE

CE&G performed geologic reconnaissance of the project site in advance of performing subsurface exploration. Site reconnaissance consisted of photographic documentation of the project pipeline alignments, identification and marking of the boring locations, and marking for USA.

4.2 SUBSURFACE EXPLORATIONS

4.2.1 Scope of Explorations

Subsurface exploration consisted of drilling 15 borings along the proposed pipeline alignments to assess the soil and/or bedrock conditions. Before drilling, CE&G marked and coordinated utility clearance through USA. The approximate locations of the borings are shown on Figures 2A through 2E.

Fourteen of the borings (B-1 through B-14) were drilled by Cenozoic Exploration, LLC., from November 18, 2019 to November 20, 2019 using a SIMCO 2400 truck-mounted drill rig equipped with 6-inch-diameter, solid flight augers. An additional boring (B-15) was drilled by a CE&G geologist on December 16, 2019 using a hand auger. The depths of each boring as well as the pipeline segment along which the borings were drilled are listed in Table 4.1 below. The ground surface conditions are also listed in the table.

Table 4.1

Pipeline Segment	Boring ID	Depth (feet)	Ground Surface Conditions
Lyon Zone	B-1	10	Asphalt Pavement (approx. 3")
	B-2	10	Asphalt Pavement (approx. 4")
	B-3	10	Asphalt Pavement (approx. 4")
	B-5	10	Asphalt Pavement (approx. 3")
Quail Hollow Road	B-6	9.5	Asphalt Pavement (approx. 5")
	B-7	10	Asphalt Pavement (approx. 7")
	B-8	10	Asphalt Pavement (approx. 5")
	B-9	9.5	Asphalt Pavement (approx. 4")
	B-10	10	Asphalt Pavement (approx. 4")
Hillside Drive	B-11	10	Gravel
	B-12	10	Asphalt Pavement (approx. 3")
California Drive	B-4	10	Asphalt Pavement (approx. 4")
	B-13	10	Asphalt Pavement (approx. 3")
	B-14	10	Asphalt Pavement (approx. 3")
Sequoia Avenue	B-15	6.5	Topsoil & weeds

Upon completion of drilling, the boreholes were backfilled neat cement grout. The upper two feet of the boreholes were backfilled with concrete and troweled smooth to match the existing grade, where appropriate. Boring B-15 was backfilled with soil cuttings from the hand auger.

4.2.2 Logging and Sampling

The soil material encountered in the borings were logged in the field by a CE&G professional geologist. The soil was visually classified in the field, office, and laboratory according to the Unified Soil Classification System (USCS) in general accordance with ASTM D2487 and D2488.

During the drill operation, soil samples were obtained using the following sampling methods:

- California Modified (CM) Sampler; 3-inch outer diameter (O.D.), 2.5-inch inner diameter (I.D.) (ASTM D1586)
- Standard Penetration Test (SPT) Split-Spoon Sampler; 2-inch O.D., 1.375-inch I.D. (ASTM D1586)

The samplers were driven 18 inches, unless otherwise noted on the boring logs, with a 140-pound hammer dropped from a height of 30 inches. The number of blows required to drive the samplers through 6-inch intervals was recorded and are included on the boring logs in Appendix A. The number of blows on the boring logs is an uncorrected value and represents the field count.

Soil samples obtained for the borings were packaged and sealed in the field to reduce the potential for moisture loss and disturbance. The samples we taken to CE&G's local laboratory for storage and further analysis.

4.3 SOIL CONDITIONS ENCOUNTERED

Subsurface soil conditions encountered in our borings were generally consistent with regional geologic mapping. Following are descriptions of the soils encountered in our borings along each pipeline segment:

4.3.1 Hillside Drive Alignment

Borings B-11 and B-12 were drilled along this alignment. Subsurface materials encountered beneath the eastern portion of the alignment consists of approximately 5 feet of what was interpreted to be artificial fill composed of medium dense sandy silt. Underlying this fill is alluvial deposits consisting of medium dense, poorly graded sand. The materials encountered along the western portion of the alignment also consisted of artificial fill composed of medium dense sandy silt. This fill overlies colluvium, which is composed of very stiff to hard sandy lean clay with gravel.

4.3.2 Sequoia Avenue Alignment

Boring B-15 was drilled along this alignment. Subsurface materials encountered in a boring along the center of the proposed segment consist of loose, sandy silt topsoil over loose to medium dense sandy silt colluvium/residual soil, which extends to approximately 4 feet bgs where completely weathered silty sandstone was encountered.

4.3.3 Lyon Zone Alignment

Borings B-1, B-2, B-3 and B-5 were drilled along this alignment. Subsurface materials encountered beneath the center and eastern portions of the Lyon Zone segment primarily consist of alluvial deposits. Alluvium encountered near the eastern portion of the segment consists of medium dense, silty and clayey sand, whereas the alluvium encountered along the central portion of the alignment generally consists of loose to medium dense, well graded sand of granitic source with varying amounts of silt in gravel. Subsurface materials encountered beneath the western end of the alignment consist of hard, gravely lean clay and sandy lean clay (colluvium), which overly extremely weak and highly weathered siltstone.

4.3.4 California Drive Alignment

Borings B-4, B-13 and B-14 were drilled along this alignment. Borings drilled along the eastern portion of this segment encountered alluvial soils generally consisting of medium dense sandy silt and silty sand. Very stiff lean clay was encountered in one of the eastern borings. The boring drilled along the western portion of the segment consists of alluvium composed of stiff, elastic silt to approximately 5 feet bgs. Beneath this elastic silt is loose to medium dense sandy silt and silty sand. Slightly weathered siltstone was encountered in the western boring at approximately 9.5 feet bgs, but it is unknown whether the retrieved siltstone is part of underlying bedrock or a boulder.

4.3.5 Quail Hollow Road Alignment

Borings B-6, B-7, B-8, B-9 and B-10 were drilled along this alignment. Subsurface materials encountered beneath the Quail Hollow Road segment primarily consists of medium dense to very dense silty sand and poorly graded sand. These sands are most likely representative of completely weathered bedrock from the underlying, weathered sandstone, which was encountered along the segment at depths ranging from 2 to greater than 10 feet bgs.

For a more detailed description of the materials encountered during this investigation, the boring logs and laboratory test results are included in Appendices A and B.

4.4 GROUNDWATER CONDITIONS ENCOUNTERED

Groundwater was only encountered in 2 of the 15 borings during this investigation. Groundwater was encountered in Boring B-1 at approximately 6 feet bgs and in Boring B-4 at approximately 5.5 feet bgs.

4.5 GEOTECHNICAL LABORATORY TESTING

Testing was performed to obtain information concerning the qualitative and quantitative physical properties of the subsurface soil from the samples recovered. Testing was performed by CE&G's testing laboratory in Hayward, California and Cooper Testing Laboratory in Palo Alto, California, in general conformance with the applicable ASTM and the California Department of Transportation (Caltrans) standards:

- Moisture Content and Dry Unit Weight (ASTM D2216)
- Particle Size Analysis (ASTM D422 and D1140)
- Atterberg Limits (ASTM D4318; dry method)
- Minimum Resistivity (Caltrans 643)
- pH (Caltrans 643)
- Sulfate Content (Caltrans 417)
- Chloride Content (Caltrans 422)

The results of the laboratory tests are summarized in Appendices A and B.

5.0 CONCLUSION AND DISCUSSION

The design for the proposed improvements is being completed by Schaaf & Wheeler. The primary geotechnical issues to be considered in the design of the planned improvements include the following:

- Excavatability of encountered materials;
- Shoring and excavation stability;
- Groundwater
- Effects of seismic loading and anticipated ground motions on design and performance; and
- Corrosion.

5.1 EXCAVATABILITY

Subsurface exploration was completed using solid flight augers and did not encounter auger refusal to the depths explored. Based on the subsurface exploration, we anticipate that an appropriately sized backhoe or excavator will be capable of excavating the soil and weathered bedrock underlying the project pipeline alignments in the areas explored. Medium to very dense sandstone that was encountered in our borings along Quail Hollow Road will likely require more effort if encountered in the pipeline trench excavations.

5.2 SHORING AND EXCAVATION STABILITY

The excavations for the pipelines are anticipated to extend to depths between approximately 4 and 6 feet below grade. The sides of the excavations are anticipated to be shored where required.

The soil conditions along the pipeline alignments within the anticipated trench depth of approximately 5 feet primarily consisted of sandy and silty soils of variable in consistency, from loose to medium dense to very dense, sand and silt mixtures, with some areas containing lean clays. Although some subsurface materials along the anticipated trench locations contain some cohesion and/or are likely to be stable in a temporary open trench, shoring will be required for excavations greater than 4 feet.

5.3 GROUNDWATER

Groundwater was only encountered in two of our exploratory borings, both of which were drilled in the valley alluvial deposits along the Lyon Zone and California Drive alignments.

Groundwater depths at these locations ranged from 5.5 to 6 feet bgs. There is a possibility that similar or shallower groundwater conditions will be encountered during construction within alluvial soils, especially during the winter and spring rainy season. If groundwater is encountered for any of the alignments, elevated groundwater may affect the design and construction of temporary shoring, the design and performance of the below ground structures as it pertains to the potential for buoyant uplift, and the means and methods to be considered for construction and future maintenance.

Although it is not anticipated, if high groundwater is encountered at the sites along some portions of the pipeline alignments, the excavation and possibly adjacent areas will need to be dewatered for construction and compaction of trench backfill materials.

5.4 SEISMIC LOADING

Geologic research has revealed that the proposed Quail Hollow Road, California Drive, Lyon Zone, and Sequoia Avenue alignments do not cross mapped active faults. These pipeline alignments are not expected to be damaged as a result of direct fault displacement. However, the planned Hillside Drive alignment crosses an active fault (Butano fault) that shows evidence of activity during the past 1.6 million years. Over the operational life of the Hillside Drive pipeline alignment, the pipelines are likely to be affected by seismic loading from a large earthquake. The most significant potential impacts from ground motions are displacements and possible rupturing of the pipelines due to soil softening or liquefaction of underlying cohesionless deposits.

5.4.1 Seismically Induced Displacements

Due to the flexible nature of HDPE and PVC pipe, other specific design components for seismic elements to mitigate displacements are judged to be unwarranted. For Ductile Iron Pipe, consideration should be given for flexible connections.

5.4.2 Liquefaction

We judge the potential for liquefaction within the upper 10 feet at the sites to be moderate for the California Drive segment and eastern portion of the Lyon Zone segment due to the presence of shallow groundwater in loose to medium dense alluvial soils. We judge the potential for liquefaction at Hillside Drive, Sequoia Avenue, and Quail Hollow Road segments, as well as the western portion of the Lyon Zone segment to be to be low due to the lack of encountered groundwater.

5.5 CORROSION

Corrosion testing was performed on two soil samples in general accordance with Caltrans methods. Testing results are presented below:

Table 5-1. Corrosion Testing Results

Boring (depth in feet)	Resistivity (Ohm-cm)	Chloride (mg/kg)	Sulfate (mg/kg)	pH
B-1 (3.5-5)	3378	5	98	8.6
B-10 (3.5-5)	47581	4	20	7.8

Caltrans Corrosion Guidelines, January 2015, identifies a site to be corrosive for structural elements if one or more of the following conditions exist:

- Chloride concentration is 500 ppm or greater;
- Sulfate concentration is 2000 ppm or greater;
- pH is 5.5 or less.

A minimum resistivity value for soil and/or water less than 1000 ohm-cm indicates the presence of high quantities of soluble salts and a higher propensity for corrosion. Based on the results of the laboratory testing performed, the soil sample tested had values for Chloride, Sulfate, pH that do not meet the Caltrans criteria for a corrosive site. The resistivity of the tested soil sample was above the 1000 ohm-cm threshold defined.

According to ACI 318 Section 4.3, Table 4.3.1:

- Sulfate concentration below 0.10 percent by weight (1,000 ppm) is negligible (no restrictions on concrete type)
- Water-soluble chloride content of less than 500 ppm is generally considered non-corrosive to concrete.

Based on the results of the laboratory testing performed, the soil sample tested had values for Sulfate and Chloride that do not meet ACI criteria and is considered non-corrosive to concrete.

Corrosion results are to be considered preliminary and are an indicator of potential soil corrosivity for the sample tested. Other soils or bedrock found onsite may be more, less, or of similar corrosive nature. Our scope of services does not include corrosion engineering; therefore, a detailed analysis of the corrosion tests is not included.

6.0 DESIGN AND CONSTRUCTION RECOMMENDATIONS

6.1 DESIGN GROUNDWATER LEVEL

For the design of the planned improvements, a design groundwater level of 5 feet below the ground surface is recommended for design and construction in the valley floor portions of the sites that lie within alluvial soils. The contractor and shoring designer should refer to our boring logs presented in Appendix A.

6.2 DEWATERING

Dewatering is generally not anticipated to be required since groundwater was only encountered in two of the borings at depths greater than the anticipated trenching depths. However, within the lower portion of excavations for the replacement waterlines and associated manholes within alluvial soils, especially if work is performed during the winter and spring months, groundwater could be encountered in the excavations. Dewatering, if needed, will be the responsibility of the contractor.

The area within the excavations should be dewatered to at least 3 feet below the bottom of the excavation or deeper as determined by the contractor to facilitate their operations. We recommend the contractor prepare and submit a dewatering plan prior to beginning work in this area. It is anticipated that the contractor will need to be prepared to provide a sump system as a minimum; the need for dewatering well points is not currently anticipated.

6.3 SHORING

The design of temporary excavation shoring should be made the responsibility of the contractor. Shoring design should be completed for the contractor by a qualified California-registered civil engineer and submitted to the Engineer for review and approval prior to construction. It is recommended that all temporary shoring be designed in conformance with the State of California, Department of Transportation, Trenching and Shoring Manual.

The soil conditions along the pipeline alignments within the anticipated trench depth of approximately 5 feet primarily consisted of sandy and silty soils of variable relative density/consistency, from loose to medium dense to very dense, sand and silt mixtures, with some areas containing lean clays. Although some subsurface materials along the anticipated trench locations contain some cohesion and/or are likely to be stable in a temporary open trench, shoring should still be required for excavations greater than 4 feet.

Shoring design should be based on OSHA Type C Soil. The impact of elevated groundwater conditions on the temporary shoring can be mitigated by implementing contractor-designed dewatering measures and designing the shoring to be water-tight and to account for the loading imposed by the groundwater in accordance with the recommendations provided herein.

Shoring should be designed to resist static (braced) earth pressures in combination with hydrostatic pressures where groundwater is encountered. Construction-induced vibrations should be minimized during shoring placement.

6.3.1 Lateral Earth Pressures

Static lateral earth pressure will be imposed on all shored excavations. Table 6-1 summarizes the lateral earth pressures recommended for use in design of unbraced temporary shoring. Active pressure should be assumed for conditions where the top of the wall is free to deflect up to ½ inch. Passive pressure should be ignored for a depth of 24 inches and may be utilized to resist overturning and sliding. Where structures will be located below groundwater, hydrostatic pressures should be added to the passive lateral earth pressure values shown in Table 6-1. As noted previously, the design of unbraced shoring will likely be controlled by deflections, as a result, calculations should also consider allowable ground deformations.

Table 6-1: Lateral Earth Pressures

Pressure Type	Above Groundwater Level (Equiv. Fluid Pressure)	Below Groundwater Level (Buoyant Equiv. Fluid Pressure + Hydrostatic)
Active	42 pcf	83 pcf
At-Rest	63 pcf	94 pcf
Passive	375 pcf	250 pcf

If the temporary shoring will be braced, a rectangular or trapezoidal loading diagram such as those recommended by Terzaghi & Peck, Tschebortarioff, and others (Caltrans Trenching and Shoring Manual and FHWA GEC No. 4) should be used. These methods generally correlate the earth pressure load to a percentage of the unit weight of the soil times the height of the excavation. The method and loading should be determined by the contractor and provided to the Engineer for review.

Surcharge loading from traffic on the adjacent pavement and construction equipment can be modeled as a minimum uniform ground pressure of 250 psf or higher as otherwise determined by the contractor's shoring design engineer.

6.3.2 Installation and Removal of Shoring

To reduce the potential for vibration induced settlements during construction, it is recommended that the contractor monitor the soils encountered during excavation and at a minimum avoid the generation of vibrations at locations where loose cohesionless soils are encountered. Settlement of adjacent improvements during the removal of shoring should not be allowed and should be monitored during removal.

6.4 PIPELINE DESIGN LOADS AND INSTALLATION

6.4.1 Pipe Loading

The pipe should be evaluated and designed for earth, surcharge, and hydrostatic loads, in conformance with Chapter 7 of the Plastic Pipe Institute's *Handbook of Polyethylene Pipe 2nd Edition* (PPI, 2007). Overburden loads should be calculated using the total unit weights of 130 pcf or buoyant unit weights of 67 pcf while the hydrostatic pressure should be determined based on the design groundwater level. In addition to the soil and hydrostatic loads, the pipe will be subjected to live load from vehicular traffic. At a minimum, the pipe design should assume H20 loading for vehicular traffic. The County Traffic Engineer should be consulted to determine if these loadings are appropriate.

6.4.2 Foundation Material

Foundation material should be installed where the excavation bottom is unstable (pumping subgrade, boiling, etc.) and where over excavation of the trench occurs as a result of an unstable or soft trench bottom.

Where required, foundation material should consist of a minimum of 12 inches of clean, durable, 1½-inch crushed rock wrapped in a 6 oz./sy non-woven geotextile. The geotextile shall be designed for separation, stabilization and permeability and constructed of polyester, nylon, and/or polypropylene formed into a stable network meeting the minimum parameters shown in Table 6-2.

Table 6-2 – Geotextile Fabric Requirements

Property	Test Value	Test Method
Weight	6 oz/yd^2	ASTM D5261
Grab tensile strength	150 lbs.	ASTM D4632
Puncture strength	80 lbs.	ASTM D4833
Permittivity	1.0 sec^{-1}	ASTM D4491
UV Resistance	70%	ASTM D4355

6.5 MANHOLES AND OTHER STRUCTURES

Design and construction of manholes within areas of high groundwater will require a means of preventing uplift of the manhole. This may be accomplished with an extended base around the perimeter of the manhole over which soil backfill is placed. Other means of preventing buoyancy uplift include using a cone or reducer section in the manhole and considering friction on the sides of the manhole. If the groundwater encountered during construction is found to be much higher than at the time of drilling, the potential for buoyant uplift should be reevaluated.

6.5.1 Bearing Capacity

It is recommended that the structures be designed as fully compensated structures. Fully compensated structures are those which do not result in a net increase in the load on the soil underlying the structure. If fully compensated design is not possible, the increase in earth pressure should be limited to less than 800 psf to limit total settlement and differential settlement. All permanent buried structures that extend below the design groundwater elevation should be designed with consideration of hydraulic uplift forces due to buoyancy effects.

6.5.2 Lateral Loads

In addition to hydrostatic pressure, the water pipeline should be designed to resist an at-rest lateral earth pressures of 63 pcf for soil above the design groundwater elevation and 94 pcf for soil below the groundwater elevation. These values are consistent with the lateral earth pressures previously described.

6.6 EARTHWORK

6.6.1 Excavation

We anticipate that an appropriately sized backhoe or excavator will be capable of excavating the soil and weathered bedrock underlying the project sites. Medium to very dense sandstone that was encountered in our borings along Quail Hollow Road will likely require more effort if encountered in the pipeline trenches. We note that narrower trenches and use of heavier excavating equipment will reduce excavation difficulty.

6.6.2 Subgrade Preparation

The bottom of the water line pipes will generally encounter moist, medium dense sandy and silty materials, although denser and more cohesive materials may be encountered at some locations. In the event the excavation bottom becomes unstable and difficult to achieve compaction of the backfill, the bottom of the excavation should be lined with a layer of geotextile such as Mirafi 500X (or equivalent) and then a minimum 12 inch thick layer of ¾-inch or 1-½-inch crushed rock. The crushed rock should be compacted with a manual vibratory compaction plate by making a minimum of three passes until a firm non-yielding surface is achieved.

6.6.3 Bedding and Shading

The utility pipes should be bedded in accordance with the requirements of the SLVWD. The bedding and shading material shall be a minimum 6 inches below and over the pipes and should consist of uniformly-graded sand or other material approved by the Engineer. This sand backfill shall be compacted to a minimum of 95 percent relative compaction in lifts not exceeding 8 inches in uncompacted thickness. All imported bedding and shading material should be sampled, tested and approved by the engineer prior to being transported to site.

6.6.4 Utility Trench Backfill

Following placement and compaction of sand over the pipes, Santa Cruz County design requirements indicate the remainder of the trench under County roads be backfilled with "2-Sack cement/sand slurry", also known as controlled density fill (CDF), controlled low strength material – CLSM, or flowable fill, which is comprised of cementitious material, sand, and water, and has a compressive strength between 100 and 200 psi.

Due to the low percentage of fine-grained material anticipated in excavations, the on-site sandy soil is anticipated to be suitable for use as structure backfill under Caltrans roadways and under non-pavement areas. Imported granular backfill materials, such as aggregate base or quarry fines, may be used. Structure backfill shall be compacted to at least 95 percent relative compaction; 90 percent relative compaction under non-pavement areas. Backfill material should be placed in lifts not exceeding 8 inches in uncompacted thickness. Thinner lifts may be necessary to achieve the recommended level of compaction of the backfill due to equipment limitations. Compaction should be performed by mechanical means only. Water jetting to attain compaction shall not be permitted.

6.6.5 Import Fill

Import fill is anticipated for bedding and shading of the new pipelines as well as for pavement subgrade. All imported fill must be reviewed and approved by the geotechnical engineer prior to importation to the site. A minimum of five days will be required to evaluate and test the suitability of all planned imported materials. All imported materials should conform to the appropriate provisions of the 2018 Caltrans Standard Specifications.

The imported materials should be non-expansive and have a Plasticity Index less than 15 percent and a Liquid Limit of 30 percent or less. The imported material shall be free of organic debris or contaminated materials.

6.7 PAVEMENT REPLACEMENT

As a minimum, replacement of structural pavement sections above trenches is anticipated to be replaced in-kind, that is, with the same thickness as the existing pavement. the pavement section should meet the requirements of the County or Caltrans, as appropriate.

Pavement sections shall be placed on soil surfaces that have been prepared as outlined in the Earthwork section of this report. The full section of aggregate base as well as the upper 12 inches of subgrade soils should be compacted to a minimum of 95 percent relative compaction (ASTM D1557, latest edition).

Asphalt concrete should meet the requirements for 1/2- or 3/4-inch maximum, medium Type A Hot Mix Asphalt (asphalt concrete), Section 39, Caltrans Standard Specifications, latest edition. The Class 2 aggregate base material should conform to Section 26 of the Caltrans Standard Specifications.

6.8 TECHNICAL REVIEW AND CONSTRUCTION OBSERVATION

Prior to construction the geotechnical engineer should review the project plans for conformance with the intent of the recommendations presented in this report. The geotechnical engineer should be contacted a minimum of 48 hours in advance of earthwork and excavation operations to observe the subsurface conditions.

7.0 LIMITATIONS

The conclusions and recommendations presented in this report are based on the information provided regarding the planned construction, and the results of the geologic mapping, subsurface exploration, and testing, combined with interpolation of the subsurface conditions between boring locations. Site conditions described in the text of this report are those existing at the time of our last field reconnaissance and are not necessarily representative of the site conditions at other times or locations. This information notwithstanding, the nature and extent of subsurface variations between borings may not become evident until construction. If variations are encountered during construction, Cal Engineering & Geology, Inc. should be notified promptly so that conditions can be reviewed and recommendations reconsidered, as appropriate.

It is the owner's responsibility to ensure that recommendations contained in this report are carried out during the construction phases of the project. This report was prepared based on preliminary design information provided which is subject to change during the design process. At approximately the 90 percent design level, Cal Engineering & Geology, Inc. should review the design assumptions made in this report and prepare addenda or memoranda as appropriate. Any modifications included in these addenda or memoranda should be carefully reviewed by the project designers to make sure that any conclusions or recommendations that are modified are accounted for in the final design of the project.

The findings of this report should be considered valid for a period of three years unless the conditions of the site change. After a period of three years, CE&G should be contacted to review the site conditions and prepare a letter regarding the applicability of this report.

This report presents the results of a geotechnical and geologic investigation only and should not be construed as an environmental audit or study. The evaluation or identification of the potential presence of hazardous materials at the site was not requested and was beyond the scope of this investigation and report.

The conclusions and recommendations contained in this report are valid only for the project described in this report. We have employed accepted geotechnical engineering procedures, and our professional opinions and conclusions are made in accordance with generally accepted geotechnical engineering principles and practices. This standard is in lieu of all other warranties, either expressed or implied.

8.0 REFERENCES

ASTM Standard D1586, 2011, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils," ASTM International.

ASTM Standard D2487, 2017, " Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)," ASTM International.

ASTM Standard D2488, 2017, " Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)," ASTM International.

ASTM International, 2017. Volume 04.08 Soil and Rock (I): D421-D5876.

Brabb, E.E., and others, 1997, Geologic map of Santa Cruz County, California: a digital database: U.S. Geological Survey Open-File Report 97-489.

California Department of Transportation Division of Engineering Services Materials Enginering and Testing Services Corroison and Structural Concrete Field Investigation Branch, 2015, Corrosion Guidelines, Version 2.1. January 2015.

Cooper-Clark and Associates, 1975, Preliminary map of landslide deposits in Santa Cruz County, California: unpublished consultants' report to Santa Cruz County Planning Dept. (see Roberts and Baron, 1998).

County of Santa Cruz GIS Department, http://www.co.santa-cruz.ca.us/Departments/GeographicInformationSystems(GIS).aspx, accessed January 2020).

Graymer, R.W. and others (2006), Geologic Map of the San Francisco Bay Region: U.S. Geological Survey Scientific Investigations Map 2918.

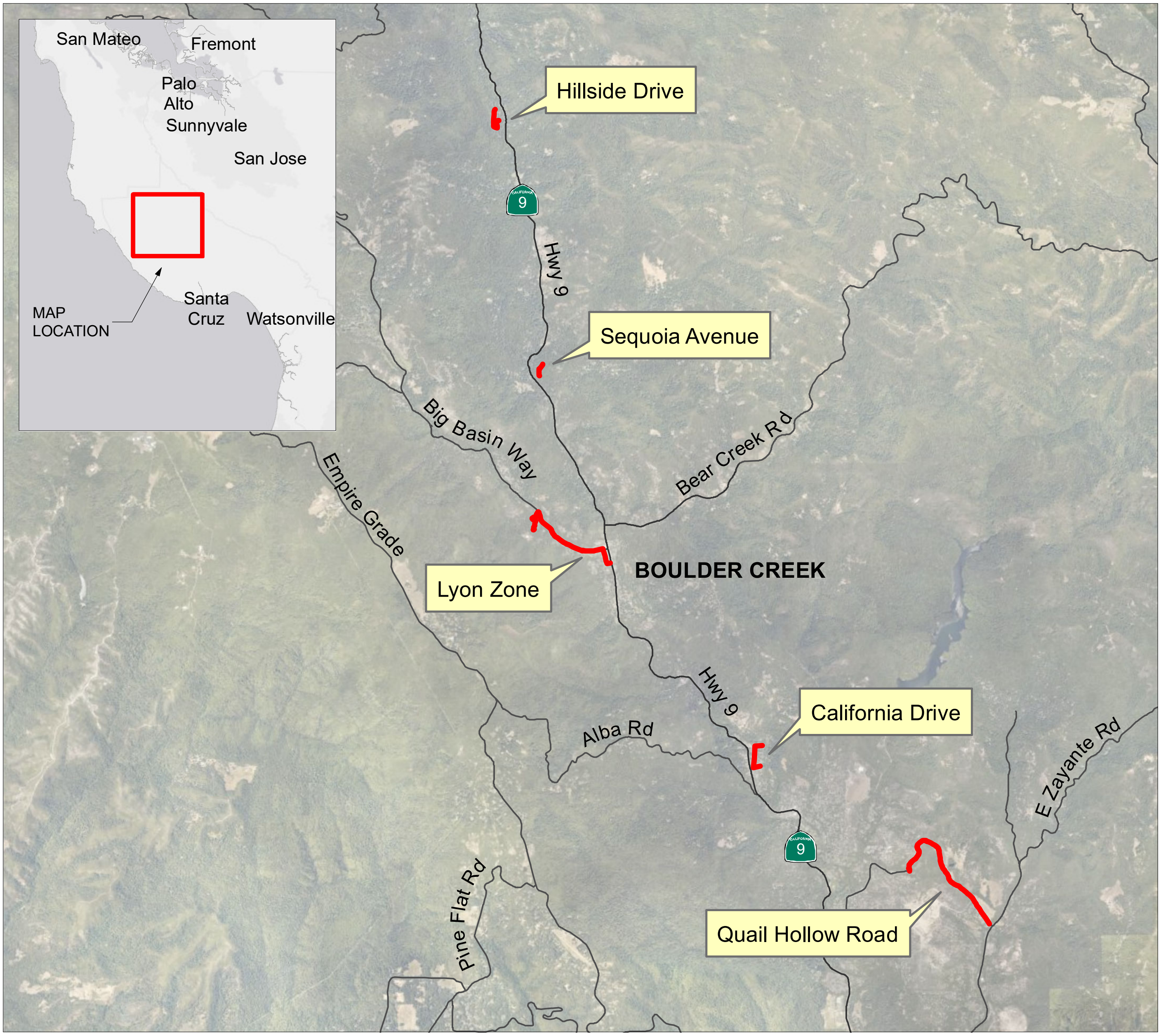
U.S. Geological Survey and California Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed January 2020, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/.

Wentworth, C. M., and others, 1999, Geologic Materials of the San Francisco Bay Region. Open-File Report 97-744 Part 5, v.1.

Working Group on California Earthquake Probabilities (WGCEP), 2003, Earthquake Probabilities in the San Francisco Bay Region: 2002-2031: U.S. Geological Survey Open File Report 2003-214.

Youd, T. L., et. al. (2001). Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF. Workshops on Evaluation of Liquefaction Resistance of Soils, ASCE Journal of Geotechnical and Geoenvironmental Engineering, Vol. 127, No. 10.

Figures



BASEMAP REFERENCE

1. ORTHOIMAGERY FROM SANTA CRUZ COUNTY, 2016.
2. STREET CENTERLINES FROM CALTRANS CALIFORNIA ROAD SYSTEM, DOWNLOADED ON 15 MAY 2016.

N

0 0.75 1.5 3
MILES

CE&G
CAL ENGINEERING & GEOLOGY

6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY
BOULDER CREEK, CALIFORNIA

SITE LOCATION MAP

191110	JANUARY 2020	FIGURE 1

M:\2019\191110-SchaafWheeler-SanLorenzoWDPipeline\GIS\ArcGIS\Fig1-Site-Location.mxd; 1/24/2020; jhausen

BASEMAP REFERENCE

1. 5-FEET CONTOURS DERIVED FROM 2010 LIDAR DATA.
2. ORTHOIMAGERY FROM SANTA CRUZ COUNTY, 2016
3. PIPE ALIGNMENT LOCATIONS ARE APPRIOXIMATE.
4. PARCEL DATA FROM SANTA CRUZ GIS DATABASE, ACCESSED ONLINE ON 08/03/2018.

LEGEND

B-10 BORING LOCATIONS BY CE&G, DRILLED ON 18-20 NOV AND 16 DEC 2019

0 100 200 400
FEET

CE&G
CAL ENGINEERING & GEOLOGY
6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY WATER DISTRICT
SANTA CRUZ COUNTY, CALIFORNIA

HILLSIDE DRIVE

191110	JANUARY 2020	FIGURE 2A

M:\2019\191110-SchaafWheeler-SanLorenzoWDPipeline\GIS\ArcGIS\Fig2A-SitePlan-Hillside-Drive.mxd; 1/28/2020; jhausen

BASEMAP REFERENCE

1. 5-FEET CONTOURS DERIVED FROM 2010 LIDAR DATA.
2. ORTHOIMAGERY FROM SANTA CRUZ COUNTY, 2016
3. PIPE ALIGNMENT LOCATIONS ARE APPRIOXIMATE.
4. PARCEL DATA FROM SANTA CRUZ GIS DATABASE, ACCESSED ONLINE ON 08/03/2018.

LEGEND

B-10 BORING LOCATIONS BY CE&G, DRILLED ON 18-20 NOV AND 16 DEC 2019

N

0 100 200 400 FEET

CE&G
CAL ENGINEERING & GEOLOGY
6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY WATER DISTRICT
SANTA CRUZ COUNTY, CALIFORNIA

SEQUOIA AVE

191110	JANUARY 2020	FIGURE 2B

M:\2019\191110-SchaafWheeler-SanLorenzoWD\Pipeline\GIS\ArcGIS\Fig2D-SitePlan-Sequoia-Ave.mxd; 1/28/2020; jhausen

BASEMAP REFERENCE

1. 5-FEET CONTOURS DERIVED FROM 2010 LIDAR DATA.
2. ORTHOIMAGERY FROM SANTA CRUZ COUNTY, 2016
3. PIPE ALIGNMENT LOCATIONS ARE APPRIOXIMATE.
4. PARCEL DATA FROM SANTA CRUZ GIS DATABASE, ACCESSED ONLINE ON 08/03/2018.

LEGEND

B-10 BORING LOCATIONS BY CE&G, DRILLED ON 18-20 NOV AND 16 DEC 2019

N

0 200 400 800
FEET

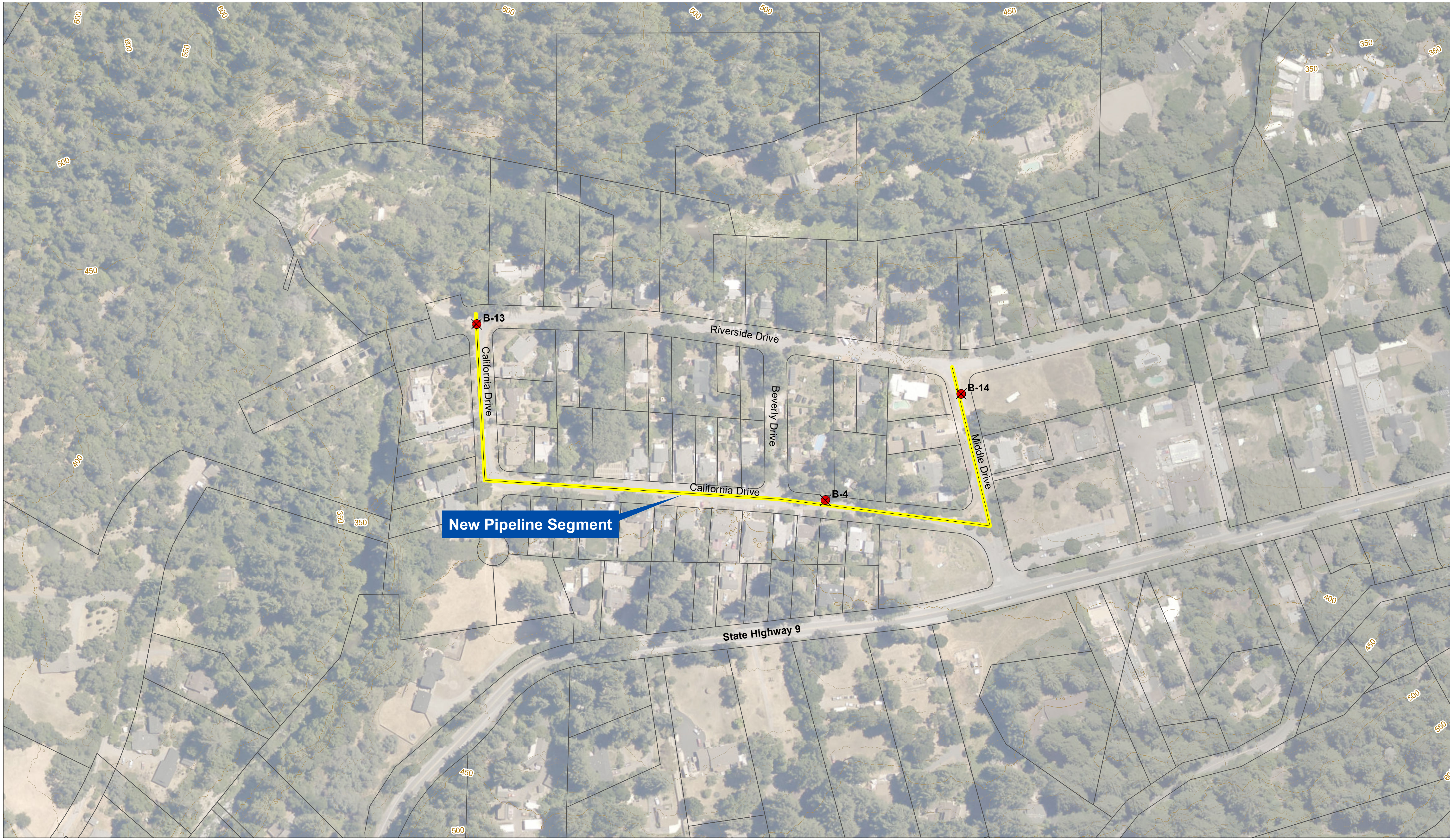
CE&G
CAL ENGINEERING & GEOLOGY
6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY WATER DISTRICT
SANTA CRUZ COUNTY, CALIFORNIA

LYON ZONE

191110	JANUARY 2020	FIGURE 2C

M:\2019\191110-SchaafWheeler-SanLorenzoWD\Pipeline\GIS\ArcGIS\Fig2C-SitePlans-Lyon-Zone.mxd; 1/28/2020; jhausen



BASEMAP REFERENCE

1. 5-FEET CONTOURS DERIVED FROM 2010 LIDAR DATA.
2. ORTHOIMAGERY FROM SANTA CRUZ COUNTY, 2016
3. PIPE ALIGNMENT LOCATIONS ARE APPRIOXIMATE.
4. PARCEL DATA FROM SANTA CRUZ GIS DATABASE, ACCESSED ONLINE ON 08/03/2018.

LEGEND

B-10 BORING LOCATIONS BY CE&G, DRILLED ON 18-20 NOV AND 16 DEC 2019

0 100 200 400
FEET

CE&G
CAL ENGINEERING & GEOLOGY

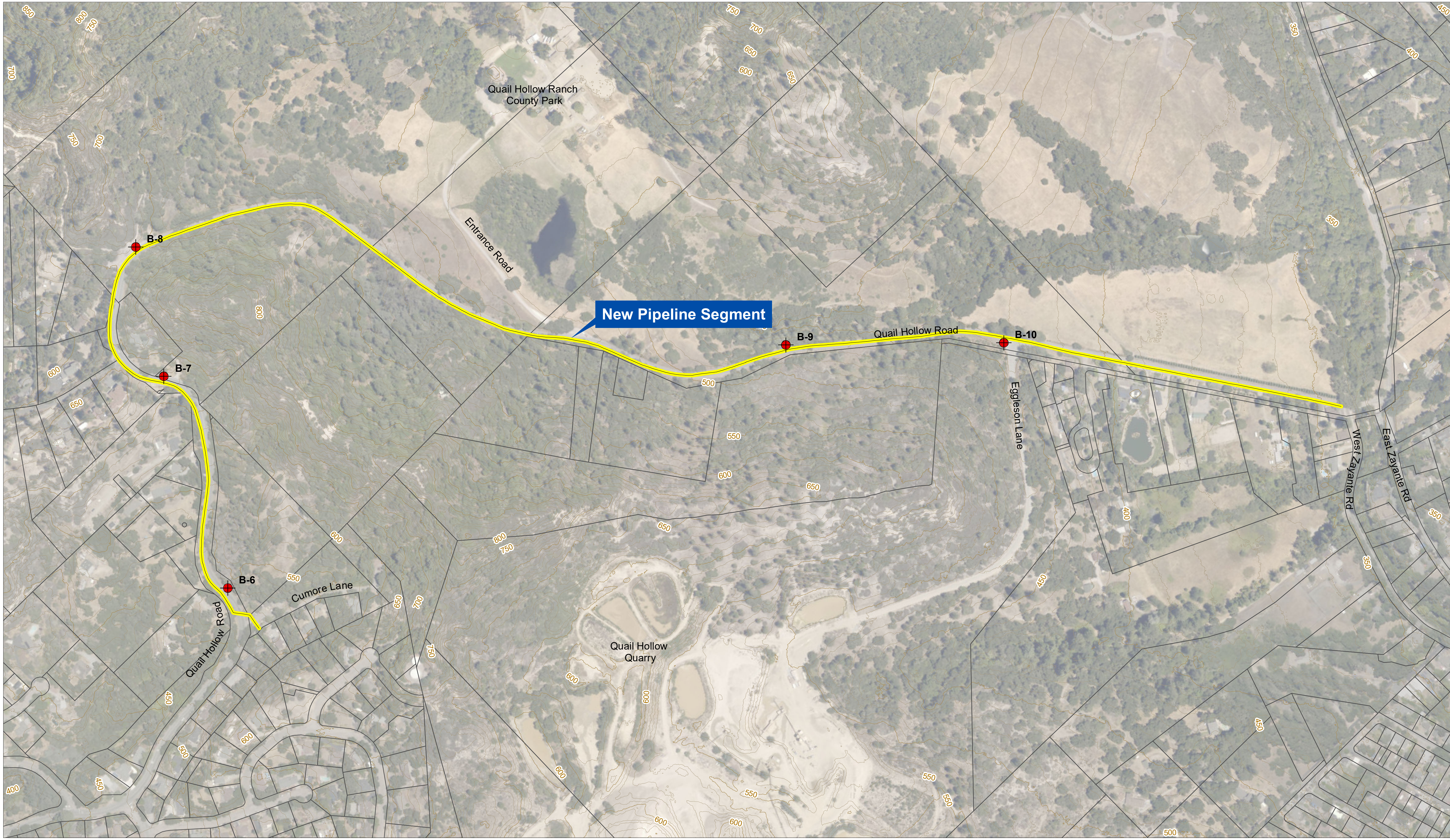
6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY WATER DISTRICT
SANTA CRUZ COUNTY, CALIFORNIA

CALIFORNIA AVE

191110	JANUARY 2020	FIGURE 2D

M:\2019\191110-SchaafWheeler-SanLorenzoWDPipeline\GIS\ArcGIS\Fig2D-SitePlan-California-Drive.mxd; 1/28/2020; jhausen



BASEMAP REFERENCE

1. 5-FEET CONTOURS DERIVED FROM 2010 LIDAR DATA.
2. ORTHOIMAGERY FROM SANTA CRUZ COUNTY, 2016
3. PIPE ALIGNMENT LOCATIONS ARE APPRIOXIMATE.
4. PARCEL DATA FROM SANTA CRUZ GIS DATABASE, ACCESSED ONLINE ON 08/03/2018.

LEGEND

B-10 — BORING LOCATIONS BY CE&G, DRILLED ON 18-20 NOV AND 16 DEC 2019

0 200 400 800
FEET

CE&G
CAL ENGINEERING & GEOLOGY
6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY WATER DISTRICT
SANTA CRUZ COUNTY, CALIFORNIA

QUAIL HOLLOW ROAD

191110	JANUARY 2020	FIGURE 2E

M:\2019\191110-SchaafWheeler-SanLorenzoWDPipeline\GIS\ArcGIS\Fig2E-SitePlans-Quail-Hollow.mxd; 1/28/2020; jhausen

MAP UNIT DESCRIPTION

Qcu	COASTAL TERRACE DEPOSITS, UNDIFFERENTIATED (PLEISTOCENE)
Qal	ALLUVIAL DEPOSITS, UNDIFFERENTIATED (HOLOCENE)
Tp	PURISIMA FORMATION (PLIOCENE AND UPPER MIOCENE)
Tsc	SANTA CRUZ MUDSTONE (UPPER MIOCENE)
Tsm	SANTA MARGARITA SANDSTONE (UPPER MIOCENE)
Tm	MONTEREY FORMATION (MIDDLE MIOCENE)
Tlo	LOMPICO SANDSTONE (MIDDLE MIOCENE)
Tvq	VAQUEROS SANDSTONE (LOWER MIOCENE AND OLIGOCENE)
Tz	ZAYANTE SANDSTONE (OLIGOCENE)
Tsl	SAN LORENZO FORMATION, UNDIVIDED (OLIGOCENE AND EOCENE)
Tsr	RICES MUDSTONE MEMBER (OLIGOCENE AND EOCENE)
Tst	TWOBAR SHALE MEMBER (EOCENE)
Tbu	BUTANO SANDSTONE (EOCENE) UPPER SANDSTONE MEMBER
Tbm	MIDDLE SILTSTONE MEMBER
Tl	LOCATELLI FORMATION
Tlss	SANDSTONE
qd	QUARTZ DIORITE (CRETACEOUS)
gd	GNEISSIC GRANODIORITE (CRETACEOUS)
hcg	HORNBLENDE-CUMMINGTONITE GABBRO (CRETACEOUS)
sch	METASEDIMENTARY ROCKS (MESOZOIC OR PALEOZOIC)
m	MARBLE (MESOZOIC OR PALEOZOIC)

CONTACT

FAULT

ANTICLINE

SYNCLINE

80 STRIKE AND DIP OF BEDS INCLINED

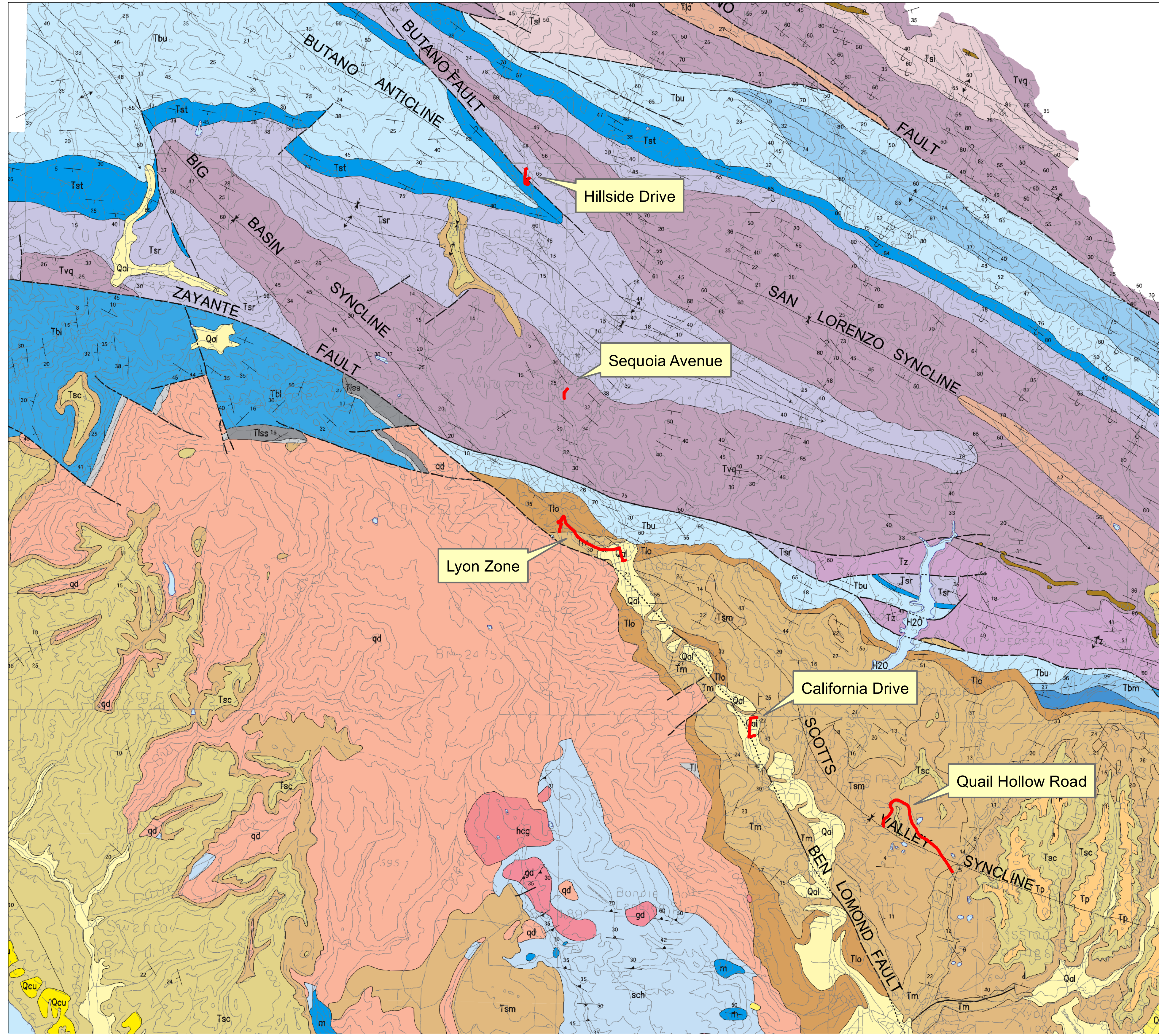
50 APPROXIMATE DIP OF BEDS

VERTICAL

HORIZONTAL

60 OVERTURNED

20 STRIKE AND DIP OF FOLIATION



N

0 0.625 1.25 2.5

MILES

BASEMAP REFERENCE

1. REGIONAL GEOLOGY FROM BRABB ET AL. 1997.

CE&G CAL ENGINEERING & GEOLOGY

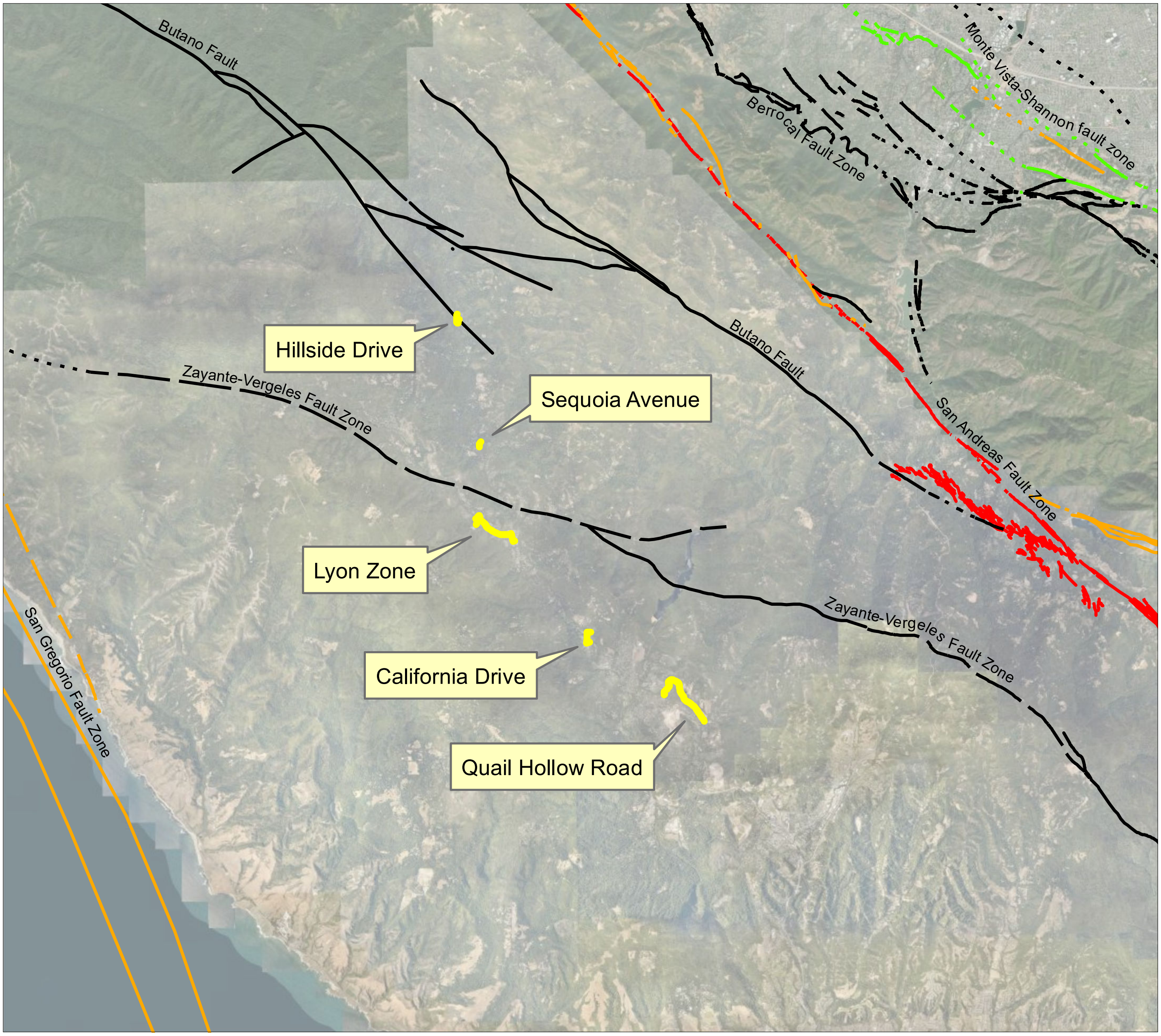
6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY
BOULDER CREEK, CALIFORNIA

REGIONAL GEOLOGY MAP

191110	JANUARY 2020	FIGURE 3

M:\2019\191110-SchaafWheeler-SanLorenzoWDPipeline\GIS\ArcGIS\Fig3-Regional-Geology-Large.mxd; 1/24/2020; jhausen



BASEMAP REFERENCE

1. BASEMAP FROM SANTA CRUZ COUNTY, 2016.
2. FAULT LOCATIONS FROM US GEOLOGICAL SURVEY QUATERNARY FAULT AND FOLDS DATABASE, ACCESSED ONLINE ON 12 DECEMBER 2017.

N

0 1.5 3 6
MILES

MAP UNIT DESCRIPTION

- Historical (<150 years), Well Constrained Location
- Historical (<150 years), Moderately Constrained Location
- Historical (<150 years), Inferred Location
- Latest Quaternary (<15,000 years), Well Constrained Location
- Latest Quaternary (<15,000 years), Moderately Constrained Location
- Latest Quaternary (<15,000 years), Inferred Location
- Late Quaternary (<130,000 years), Well Constrained Location
- Late Quaternary (<130,000 years), Moderately Constrained Location
- Late Quaternary (<130,000 years), Inferred Location
- Undifferentiated Quaternary (<1.6 million years), Well Constrained Location
- Undifferentiated Quaternary (<1.6 million years), Moderately Constrained Location
- Undifferentiated Quaternary (<1.6 million years), Inferred Location

CE&G
CAL ENGINEERING & GEOLOGY

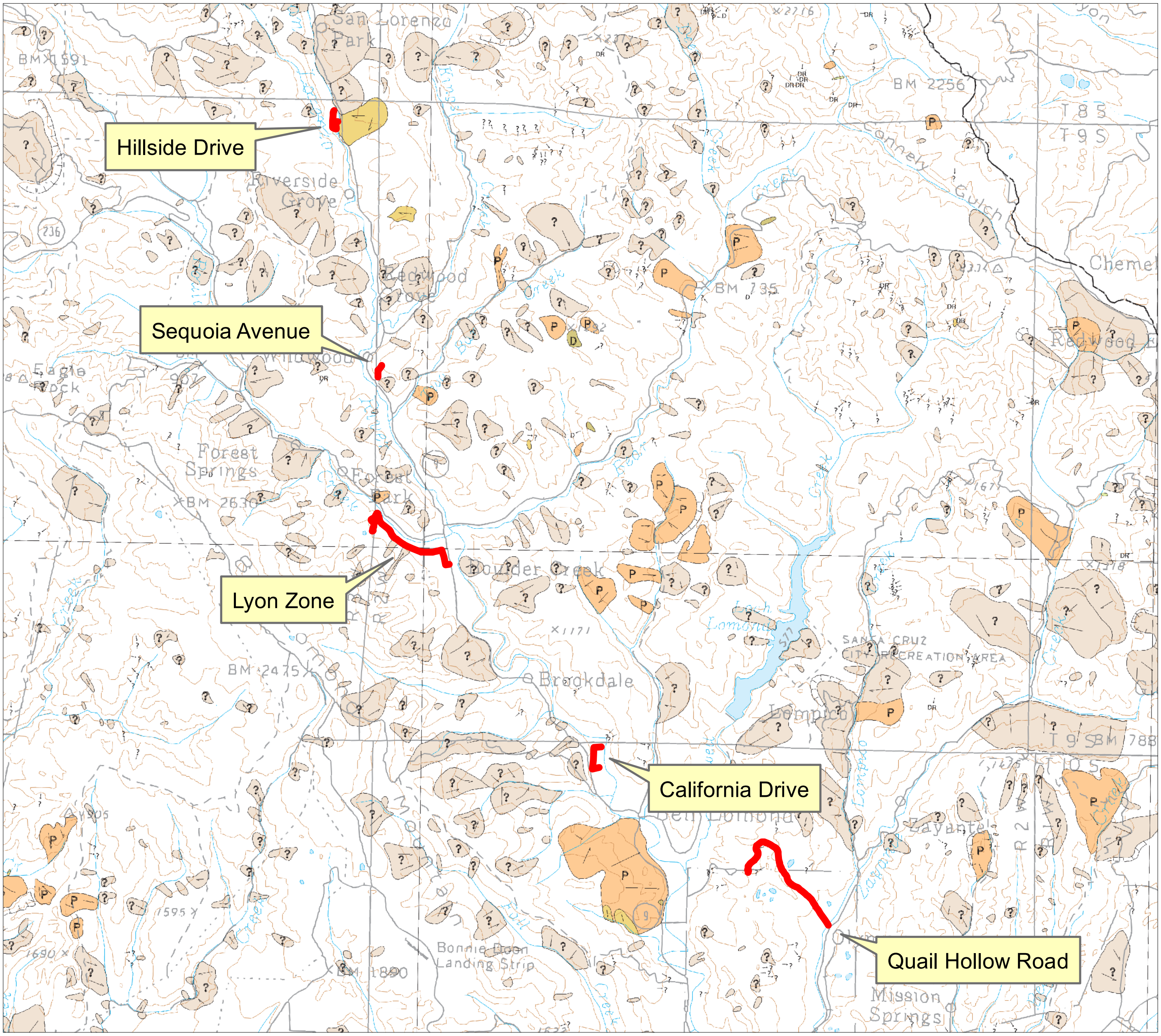
6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY
BOULDER CREEK, CALIFORNIA

FAULT ACTIVITY MAP

191110	JANUARY 2020	FIGURE 4

M:\2019\191110-SchaafWheeler-SanLorenzoWDPipeline\GIS\ArcGIS\Fig4-Fault-Activity.mxd; 1/24/2020; jhausen



BASEMAP REFERENCE

1. BASEMAP FROM SANTA CRUZ COUNTY, 2016.
2. LANDSLIDE DATA FROM COOPER-CLARK ET AL. 1975.

0 0.625 1.25 2.5
MILES

N

MAP UNIT DESCRIPTION

P LARGE LANDSLIDE DEPOSIT

SMALL LANDSLIDE DEPOSIT AND GULLY

D	DEFINITE LANDSLIDE DEPOSIT
DR	DEFINTE RAPID LANDSLIDE DEPOSIT
P	PROBABLE LANDSLIDE DEPOSIT
?	QUESTIONABLE LANDSLIDE DEPOSIT
	UNATTRIBUTED LANDSLIDE DEPOSIT

M:\2019\191110-SchaafWheeler-SanLorenzoWDPipeline\GIS\ArcGIS\Fig5-Landslide-Activity.mxd; 1/24/2020; jhausen

CE&G
CAL ENGINEERING & GEOLOGY

6455 Almaden Expwy.
Suite 100
San Jose, CA 95120
Phone: (408) 440-4542

SLVWD 2019 PIPELINE PROJECT
SAN LORENZO VALLEY
BOULDER CREEK, CALIFORNIA

LANDSLIDE ACTIVITY MAP

191110	JANUARY 2020	FIGURE 5

Appendix A. Boring Logs

KEY TO SYMBOLS

Cal Engineering & Geology

CLIENT Schaaf & Wheeler

PROJECT NUMBER 191110

PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project

PROJECT LOCATION Santa Cruz County, CA

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

- ASPHALT: Asphalt
- CH: USCS High Plasticity Clay
- CL: USCS Low Plasticity Clay
- FILL: Fill (made ground)
- MH: USCS Elastic Silt
- ML: USCS Silt
- SANDSTONE: Sandstone
- SC: USCS Clayey Sand
- SILTSTONE: Siltstone
- SM: USCS Silty Sand
- SP: USCS Poorly-graded Sand
- SP-SM: USCS Poorly-graded Sand with Silt
- SW: USCS Well-graded Sand
- SW-SM: USCS Well-graded Sand with Silt

SAMPLER SYMBOLS

- California Modified Sampler
- Standard Penetration Test

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL	- LIQUID LIMIT (%)
PI	- PLASTIC INDEX (%)
W	- MOISTURE CONTENT (%)
DD	- DRY DENSITY (PCF)
NP	- NON PLASTIC
-200	- PERCENT PASSING NO. 200 SIEVE
PP	- POCKET PENETROMETER (TSF)
TV	- TORVANE
PID	- PHOTOIONIZATION DETECTOR
UC	- UNCONFINED COMPRESSION
ppm	- PARTS PER MILLION
▽	Water Level at Time Drilling, or as Shown
▼	Water Level at End of Drilling, or as Shown
▼	Water Level After 24 Hours, or as Shown

BORING NUMBER B-01

CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/20/2019 **COMPLETED** 11/20/2019
GROUND ELEVATION 496 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.1242 **LONGITUDE** -122.12272
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
∇ **GROUNDWATER AT TIME OF DRILLING** 6.0 ft / Elev 490.0 ft
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- Not Measured
HAMMER TYPE 140 lb hammer with 30 in. cathead
▼ **GROUNDWATER AFTER DRILLING** 8.0 ft / Elev 488.0 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 3")									
		Aggregate Base (approximately 6")									
		Silty SAND w/ Gravel (SM): dark yellowish brown, moist, dense, fine to coarse sand, angular granitic gravel up to 1.5" [Fill]	CM	10-8-5		114	13				
		SIlty SAND (SM): black, moist, medium dense, fine sand [Alluvium]									
2.5											
		Clayey SAND (SC): dark gray mottled with dark yellowish brown, moist, medium dense, fine sand, medium plasticity fines (Corrosivity test at 3.5-5 feet)	SPT	3-4-10	3.25 3.25			38	17	21	
5.0		becomes very dark gray, fine to medium sand, trace angular gravel									
		∇									
		decrease in fines, fine to coarse sand, trace subrounded gravel	CM	11-12-14		127	14				
7.5		becomes wet poorly graded sand lens									
		▼									
		becomes moist to wet	SPT	7-9-11							
10.0											

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

CE&G
CAL ENGINEERING & GEOLOGY

BORING NUMBER B-02

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/20/2019 **COMPLETED** 11/20/2019
GROUND ELEVATION 527 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.12499 **LONGITUDE** -122.12744
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 4")									
		Aggregate Base (approximately 6")									
		Well Graded SAND w/ Silt and Gravel (SW-SM):: dark yellowish brown, dry, dense, angular granitic gravel up to 2.5 in., fine to coarse sand [Alluvium]	CM	23-28-29			4				6
2.5		Well Graded SAND with Silt (SW): dark yellowish brown, dense, fine to coarse sand, some angular granitic gravel [Alluvium]									
			SPT	13-12-21							
5.0											
			CM	10-13-19			4				
7.5		little fine gravel									
		becomes medium dense, increase in fine sand	SPT	15-15-13							
10.0											

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

CE&G
CAL ENGINEERING & GEOLOGY

BORING NUMBER B-03

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/20/2019 **COMPLETED** 11/20/2019
GROUND ELEVATION 551 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.12738 **LONGITUDE** -122.13196
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 4")									
		Aggregate Base (approximately 6")									
		Well Graded SAND with Silt and Gravel (SW-SM): dark yellowish brown, dry, medium dense, fine to coarse sand, strong granitic clasts in borehole over 5"	CM	7-7-9			3				
2.5		Well Graded SAND (SW): dark yellowish brown, dry, medium dense, little angular granitic gravel up to 1 in.									
			SPT	5-6-5							4
5.0											
		becomes little angular/subangular granitic gravel up to 1.5", mostly fine to medium sand	CM	6-14-12			4				
7.5											
			SPT	8-5-3							
10.0											

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

CE&G
Cal Engineering & Geology

BORING NUMBER B-04

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/18/2019 **COMPLETED** 11/18/2019
GROUND ELEVATION 395 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.09646 **LONGITUDE** -122.09654
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
▽ **GROUNDWATER AT TIME OF DRILLING** 5.5 ft / Elev 389.5 ft
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING ---
HAMMER TYPE 140 lb hammer with 30 in. cathead
▼ **GROUNDWATER AFTER DRILLING** 4.7 ft / Elev 390.3 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0	Asphalt Pavement (approximately 4")									
	Aggregate Base (approximately 6")									
	Elastic SILT w/ Sand (MH): brown, moist,stiff, high plasticity, little subangular gravel up to 2" [Alluvium]	CM	5-6-7	1.5	77	38	54	37	17	74
2.5										
	becomes dark gray	SPT	2-3-4	1.5 1.5						
5.0	▼ Sandy Elastic SILT (MH): dark gray, moist, stiff, high plasticity, fine sand									
	▽ Clayey SAND (SC): olive gray mottled with oxidized, wet, loose, fine to medium sand									
	Sandy SILT (ML): olive, moist, medium dense, very fine sand	CM	3-5-7		102	27				
7.5										
	Silty SAND (SM): olive, wet, dense, fine to coarse granitic sand	SPT	6-20-40							
10.0	SILTSTONE (BEDROCK or BOULDER?): dark gray, dry, very weak, slightly weathered									

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-05

CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/20/2019 **COMPLETED** 11/20/2019
GROUND ELEVATION 685 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.12818 **LONGITUDE** -122.13488
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0	Asphalt Pavement (approximately 3")									
	Aggregate Base (approximately 3")									
	Gravelly Lean CLAY (CL): dark brown, moist, hard, angular gravel up to 2 in., trace sand and root [Colluvium]	CM	9-10-11	>4.5	81	19				66
2.5										
	Sandy Lean CLAY (CL): dark brown, moist, hard, trace sand and root	SPT	5-8-7							
	Sandstone clast, roots									
5.0		CM	6-8-13							
	Sandy SILT (ML): olive gray mottled with dark yellowish brown, moist, hard,									
7.5										
	SILTSTONE: dark yellowish brown, moist, extremely weak, highly/moderately weathered [Weathered Bedrock]	SPT	6-9-14							
10.0										

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-06

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/18/2019 **COMPLETED** 11/18/2019
GROUND ELEVATION 525 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.08205 **LONGITUDE** -122.06961
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 5")									
		Aggregate Base (approximately 7")									
		Silty SAND (SM): light gray brown, dry, medium dense, fine to medium sand, little cementation [Weathered Bedrock]	CM	7-18-21							
2.5											
		decomes dense	SPT	10-16-30							32
5.0											
		SANDSTONE: olive, dry, extremely weak, slightly weathered, friable, oxidized, fine sand [Bedrock]	CM	39-50/5"							
7.5											
		becomes pale yellow	SPT	27-50							

Bottom of borehole at 9.5 ft. Borehole backfilled with cuttings.

BORING NUMBER B-07

CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/18/2019 **COMPLETED** 11/18/2019
GROUND ELEVATION 630 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.08458 **LONGITUDE** -122.06806
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 4")									
		Aggregate Base (approximately 6")									
		Silty SAND (SM): pale yellow, dry, medium dense, fine sand [Residual Soil]	CM	4-10-15		101	6				12
2.5											
			SPT	7-10-10							
5.0											
		becomes brown, moist	CM	9-12-17			5				
7.5											
			SPT	9-7-7							
10.0		SANDSTONE encountered in shoe, strong rock, fine to coarse sand, slightly weathered [Weathered Bedrock]									

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-08

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/18/2019 **COMPLETED** 11/18/2019
GROUND ELEVATION 659 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.08592 **LONGITUDE** -122.06702
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 5")									
		Aggregate Base (approximately 5")									
		Poorly Graded SAND (SP): light olive gray, dry, very dense, fine to medium sand [Residual Soil/Weathered Bedrock]	CM	16-22-43							4
2.5											
			SPT	17-33-50			3				
5.0											
			SPT	25-50							
7.5											
			SPT	26-40-50							
10.0											

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-09

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler	**PROJECT NAME** San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110	**PROJECT LOCATION** Santa Cruz County, CA
DATE STARTED 11/19/2019 **COMPLETED** 11/19/2019	**GROUND ELEVATION** 474 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.	**COORDINATES: LATITUDE** 37.07971 **LONGITUDE** -122.06109
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger	**GROUNDWATER AT TIME OF DRILLING** --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso	**GROUNDWATER AT END OF DRILLING** --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead	**GROUNDWATER AFTER DRILLING** --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 4")									
		Aggregate Base (approximately 6")									
		Silty SAND (SM): light gray, dry, dense, fine sand, possible soft sandstone [Residual Soil/Weathered Bedrock]	CM	22-24-20		108	7				23
		becomes light olive brown, trace subangular gravel up to 1"									
2.5											
		becomes medium dense, some oxidation	SPT	8-11-14							
5.0		Silty SAND w/ Gravel (SM): dark yellowish brown, moist, dense, fine to coarse sand									
7.5											
			CM	13-20-30							62
		SANDSTONE: light gray, dry, dense, fine sand [Weathered Bedrock]									

Bottom of borehole at 9.5 ft. Borehole backfilled with cuttings.

BORING NUMBER B-10

CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/19/2019 **COMPLETED** 11/19/2019
GROUND ELEVATION 424 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.07792 **LONGITUDE** -122.05874
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 4")									
		Aggregate Base (approximately 6")									
		Silty SAND (SM): dark olive brown, dry, medium dense, fine sand [Alluvium]	CM	13-11-7			4				6
2.5											
		(Corrosivity test at 3.5 to 5 feet)									
		becomes olive brown, loose, trace roots and gravel up to 1 in.	SPT	2-3-5							
5.0											
		Poorly Graded SAND (SP): pale olive, dry, dense, fine to medium sand [Residual Soil/Weathered Bedrock]	CM	10-18-30		104	6				
7.5											
		becomes fine sand, olive									
		becomes medium sand, pale yellow	SPT	10-19-33							
		Silty SAND (SM): olive brown, moist, very dense, fine sand									
10.0											

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-11

CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/19/2019 **COMPLETED** 11/19/2019
GROUND ELEVATION 641 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.18308 **LONGITUDE** -122.14259
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Sandy SILT (ML): very dark gray brown, moist, medium dense, some organics, fine sand [Fill]									
			CM	5-8-11		87	13				
2.5		becomes dark yellowish brown mottled with olive, dry, trace roots									
		no mottling	SPT	5-6-7							57
5.0											
		Poorly Graded SAND (SP): dark yellowish brown, moist, medium dense, fine to medium sand, trace subangular gravel up to 1.5" [Alluvium]									
			CM	5-10-9		106	11				
7.5		lens with gravel becomes fine sand									
		Poorly Graded SAND with Silt (SP-SM): dark yellowish brown, moist, medium dense, fine sand, trace fine gravel									
			SPT	4-6-8							
10.0											

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-12

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/19/2019 **COMPLETED** 11/19/2019
GROUND ELEVATION 651 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: **LATITUDE** 37.18344 **LONGITUDE** -122.14306
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 3")									
		Aggregate Base (approximately 3")									
		Sandy SILT (ML): dark yellowish brown, medium dense, fine sand some angular gravel [Fill]	CM	7-7-5		75	11				74
2.5		becomes brown, roots, no gravel									
		Sandy Lean CLAY with Gravel (CL): dark yellowish brown, moist, medium dense, little friable gravel, some organics, subangular gravel up to 2.5" [Colluvium]	SPT	3-5-7							
5.0											
7.5		becomes olive brown mottled with dark yellowish brown (oxidized), hard	CM	6-11-13	>4.5	104	19				
10.0			SPT	6-9-13	>4.5						

becomes olive brown mottled with dark yellowish brown (oxidized), hard
Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-13

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/18/2019 **COMPLETED** 11/18/2019
GROUND ELEVATION 374 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.09854 **LONGITUDE** -122.09525
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 3")									
		Aggregate Base (approximately 6")									
		Sandy SILT (ML): very dark gray brown, dry, medium dense, fine sand, trace roots [Alluvium]	CM	9-11-11		94	10				
2.5		Silty SAND (SM): dark yellowish brown, dry, medium dense, fine to medium sand, little subangular gravel									
		becomes dark brown, granitic sand	SPT	10-15-13							14
5.0											
7.5		becomes dark gray, moist, fine to coarse sand, one 2" round clast	CM	15-15-17		111	14				
10.0		becomes olive yellow, very dense, fine sand, oxidized	SPT	17-30-40							

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

BORING NUMBER B-14

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf & Wheeler
PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project
PROJECT NUMBER 191110
PROJECT LOCATION Santa Cruz County, CA
DATE STARTED 11/18/2019 **COMPLETED** 11/18/2019
GROUND ELEVATION 380 ft **DATUM** WGS84 **HOLE SIZE** 6" in.
DRILLING CONTRACTOR Cenozoic Exploration, LLC.
COORDINATES: LATITUDE 37.09567 **LONGITUDE** -122.09573
DRILLING RIG/METHOD Simco 2400/ 6-in. Solid Flight Auger
GROUNDWATER AT TIME OF DRILLING --- Not Encountered
LOGGED BY K. Loeb **CHECKED BY** D. Peluso
GROUNDWATER AT END OF DRILLING --- N/A
HAMMER TYPE 140 lb hammer with 30 in. cathead
GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Asphalt Pavement (approximately 3")									
		Aggregate Base (approximately 3")									
		Lean CLAY (CL): brown, moist, very stiff, roots, low plasticity [Fill]									
		Sandy Lean CLAY (CL): very dark gray, moist, very stiff, fine sand, trace coarse sand	CM	5-8-10	3.25	133	13				
2.5											
		Silty SAND (SM): dark olive brown, moist, medium dense, fine sand [Alluvium]	CM	6-7-8		103	15				
5.0		becomes dark yellowish brown, decrease in fines									
		becomes oxidized	CM	5-6-8							
7.5											
		increase in fines, light brown gray									
		Well Graded SAND (SW): dark brown/dark yellowish brown, moist, medium dense, fine to coarse granitic sand, trace subangular gravel	SPT	6-8-8							
10.0		Fat CLAY (CH): gray, moist, stiff, high plasticity									

Bottom of borehole at 10.0 ft. Borehole backfilled with cuttings.

CE&G

CAL ENGINEERING & GEOLOGY

BORING NUMBER B-15

CLIENT Schaaf & Wheeler

PROJECT NAME San Lorenzo Valley Water District 2019 Pipeline Project

PROJECT NUMBER 191110

PROJECT LOCATION Santa Cruz County, CA

DATE STARTED 12/16/2019 **COMPLETED** 12/16/2019

GROUND ELEVATION 740 ft **DATUM** WGS84 **HOLE SIZE** 3" in.

DRILLING CONTRACTOR N/a

COORDINATES: LATITUDE 37.14987 **LONGITUDE** -122.13425

DRILLING RIG/METHOD Hand Augered by CE&G Staff

GROUNDWATER AT TIME OF DRILLING --- Not Encountered

LOGGED BY K. Loeb **CHECKED BY** D. Peluso

GROUNDWATER AT END OF DRILLING --- N/A

HAMMER TYPE N/A

GROUNDWATER AFTER DRILLING --- N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	BLOW COUNTS (FIELD VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (%)	ATTERBERG LIMITS: PLASTIC LIMIT (%)	ATTERBERG LIMITS: PLASTICITY INDEX (%)	FINES CONTENT (%)
0.0		Sandy SILT (ML): dark brown, moist, loose, very fine sand, roots [Topsoil]									
		Sandy SILT (ML): dark yellowish brown, moist, loose to medium dense, very fine sand, roots [Colluvium/Residual Soil]									
2.5											
		Silty SAND (SM): olive brown to dark yellowish brown, moist, medium dense, oxidized [Completely Weathered Bedrock]									
5.0											

Bottom of borehole at 6.5 ft. Borehole backfilled with cuttings.

Appendix B. Laboratory Testing

CE&G

CAL ENGINEERING & GEOLOGY

SUMMARY OF LABORATORY RESULTS

CLIENT Schaaf Wheeler

PROJECT NAME San Lorenzo WD Pipeline

PROJECT NUMBER 191110

PROJECT LOCATION San Lorenzo, CA

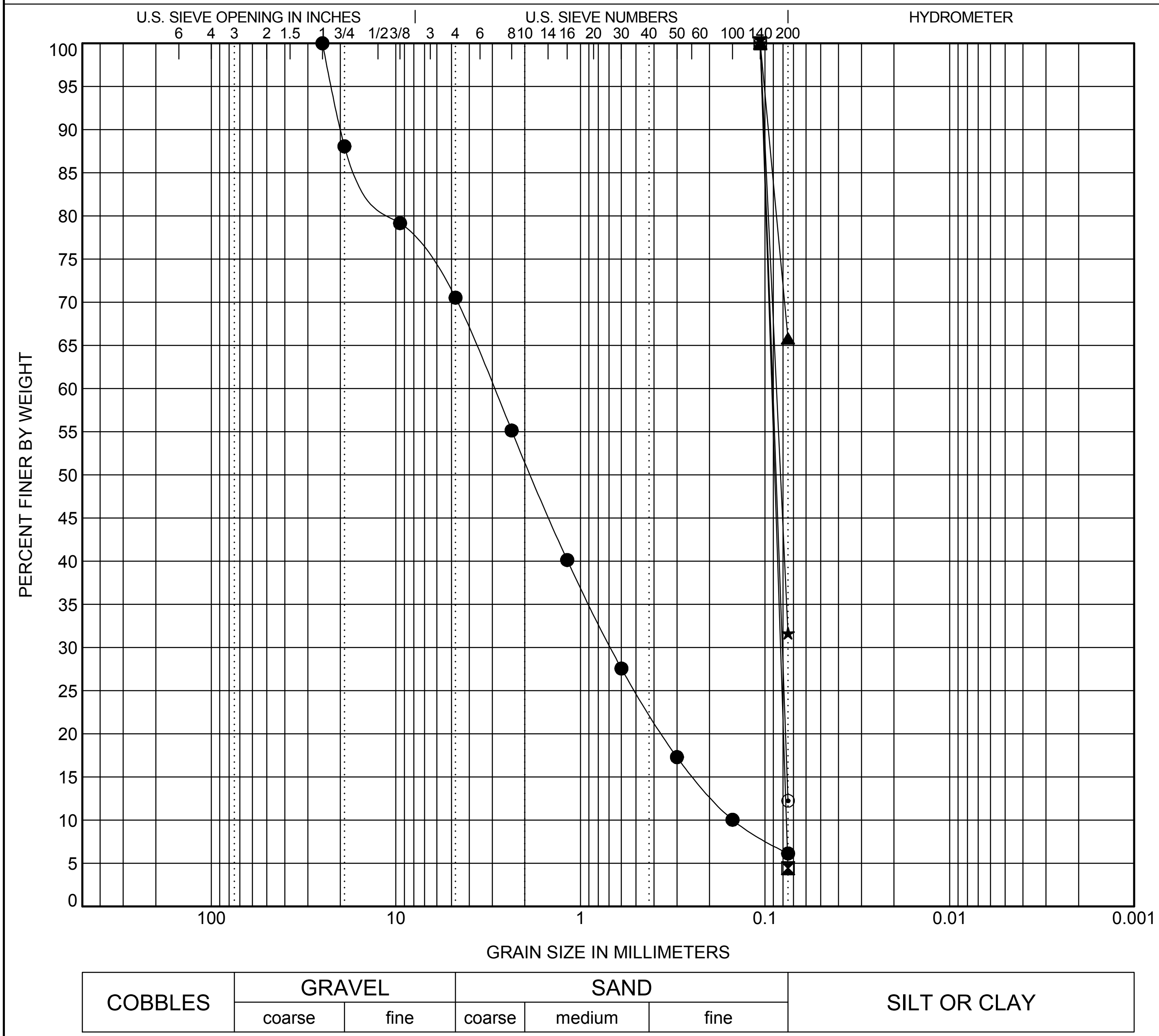
Borehole	Depth	Date Tested	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Screen Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-01	2.0	12/3/2019							13.2	114.3		
B-01	7.0	12/3/2019							14.2	126.8		
B-02	2.0	12/3/2019				25	6		4.0			
B-02	6.5	12/3/2019							4.4			
B-03	1.5	12/3/2019							3.4			
B-03	3.5	12/3/2019				0.106	4	SP				
B-03	7.0	12/3/2019							3.6			
B-05	2.0	12/3/2019				0.106	66		19.2	80.6		
B-06	3.5	12/3/2019				0.106	32					
B-07	2.0	12/3/2019				0.106	12		6.3	101.4		
B-07	7.0	12/3/2019							5.1			
B-08	1.5	12/3/2019				4.75	4	SP				
B-08	3.5	12/3/2019							2.8			
B-09	2.0	12/3/2019				0.106	23		7.3	108.2		
B-09	8.5	12/3/2019				9.5	62					
B-10	2.0	12/3/2019				0.106	6		3.8			
B-10	7.0	12/3/2019							5.6	103.9		
B-11	2.0	12/3/2019							13.4	87.3		
B-11	3.5	12/3/2019				0.106	57					
B-11	7.0	12/3/2019							10.9	106.2		
B-12	2.0	12/3/2019				0.106	74		10.6	75.1		
B-12	7.0	12/3/2019							18.6	103.5		
B-14	2.0	12/3/2019							12.9	133.3		
B-14	4.5	12/3/2019							15.4	102.5		

GRAIN SIZE DISTRIBUTION

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf Wheeler **PROJECT NAME** San Lorenzo WD Pipeline

PROJECT NUMBER 191110 **PROJECT LOCATION** San Lorenzo, CA



BOREHOLE	DEPTH	DATE TESTED	Classification	LL	PL	PI	Cc	Cu
● B-02	2.0	12/3/2019					1.07	19.74
⧗ B-03	3.5	12/3/2019	POORLY GRADED SAND(SP)				0.96	1.20
▲ B-05	2.0	12/3/2019						
★ B-06	3.5	12/3/2019						
⊙ B-07	2.0	12/3/2019					0.96	1.22

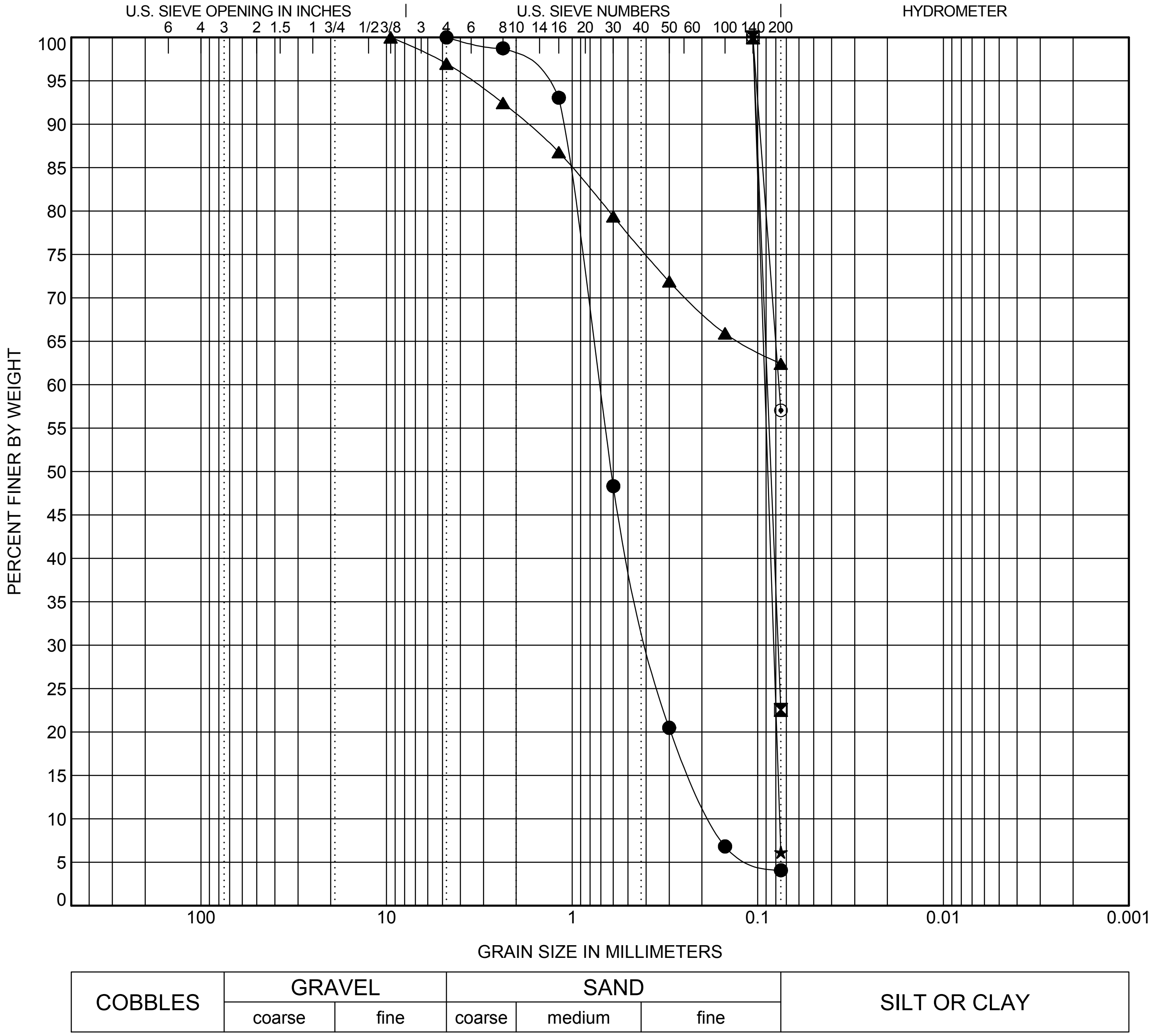
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-02	2.0	25	2.944	0.684	0.149	29.5	64.4	6.1	
⧗ B-03	3.5	0.106	0.092	0.082	0.077	0.0	95.6	4.4	
▲ B-05	2.0	0.106				0.0	34.2	65.8	
★ B-06	3.5	0.106	0.087			0.0	68.4	31.6	
⊙ B-07	2.0	0.106	0.091	0.08		0.0	87.8	12.2	

GRAIN SIZE DISTRIBUTION

CE&G
CAL ENGINEERING & GEOLOGY

CLIENT Schaaf Wheeler **PROJECT NAME** San Lorenzo WD Pipeline

PROJECT NUMBER 191110 **PROJECT LOCATION** San Lorenzo, CA



	BOREHOLE	DEPTH	DATE TESTED	Classification	LL	PL	PI	Cc	Cu
●	B-08	1.5	12/3/2019	POORLY GRADED SAND(SP)				1.15	4.06
⊠	B-09	2.0	12/3/2019						
▲	B-09	8.5	12/3/2019						
★	B-10	2.0	12/3/2019					0.96	1.20
⊙	B-11	3.5	12/3/2019						

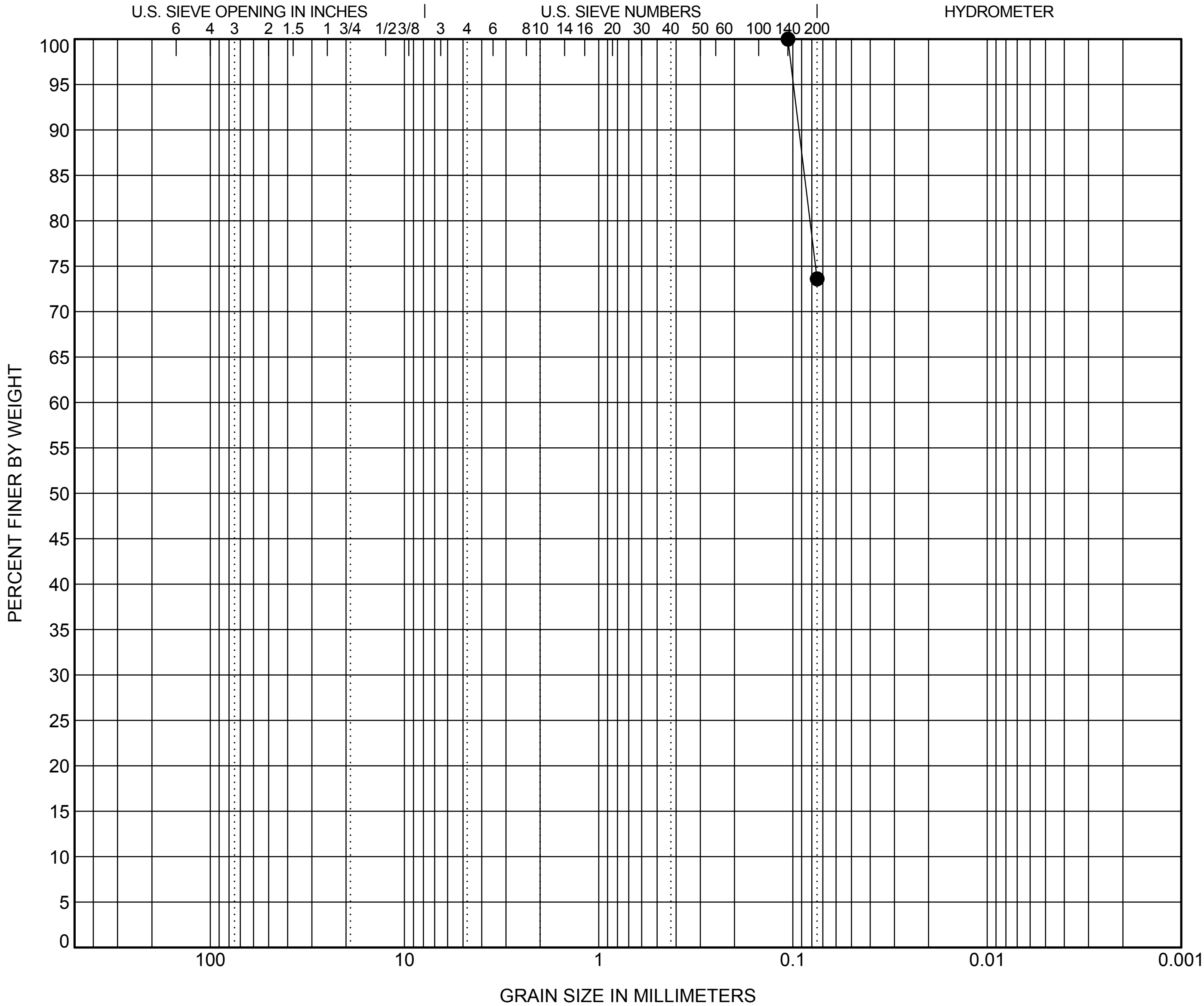
	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-08	1.5	4.75	0.716	0.38	0.176	0.0	95.9	4.1	
⊠	B-09	2.0	0.106	0.089	0.078		0.0	77.5	22.5	
▲	B-09	8.5	9.5				3.0	34.6	62.4	
★	B-10	2.0	0.106	0.091	0.082	0.076	0.0	93.9	6.1	
⊙	B-11	3.5	0.106	0.077			0.0	43.0	57.0	

GRAIN SIZE DISTRIBUTION

CAL ENGINEERING & GEOLOGY

CLIENT Schaaf Wheeler **PROJECT NAME** San Lorenzo WD Pipeline

PROJECT NUMBER 191110 **PROJECT LOCATION** San Lorenzo, CA



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	DATE TESTED	Classification	LL	PL	PI	Cc	Cu
●	**B-12**	**2.0**	**12/3/2019**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-12**	**2.0**	**0.106**				**0.0**	**26.4**	**73.6**	

COOPER TESTING LABORATORY

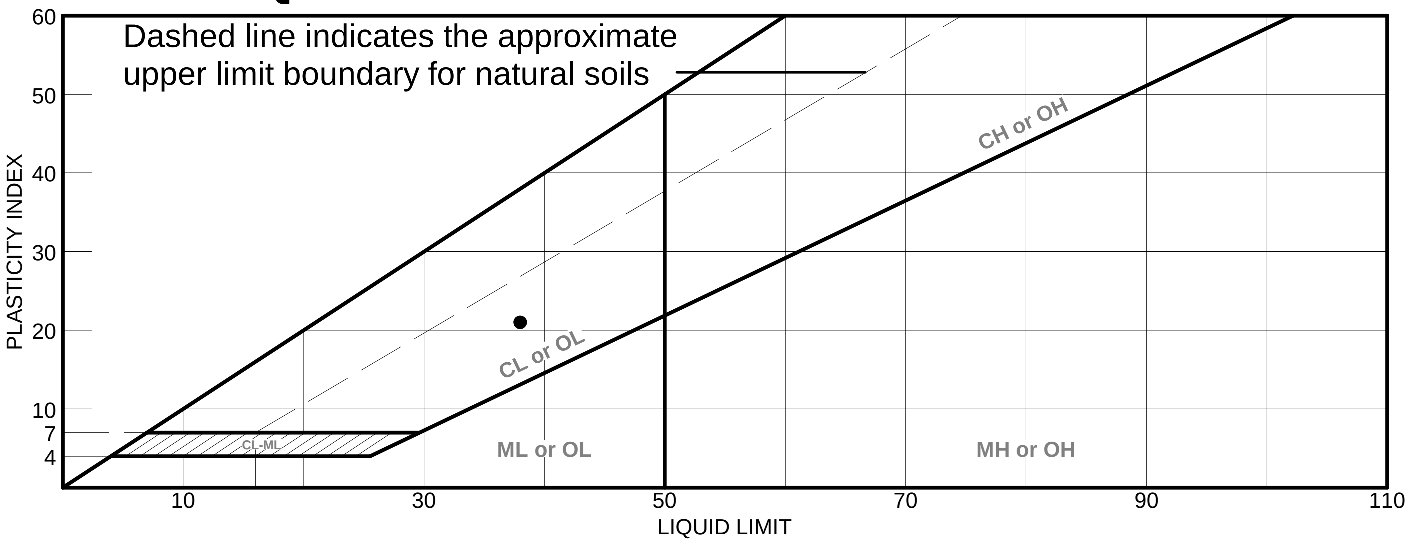
CTL # 471-290 **Date:** 12/4/2019 **Tested By:** PJ **Checked:** PJ

Client: Cal Engineering & Geology **Project:** SLVWD Pipeline **Proj. No:** 191110

Remarks:

Sample Location or ID			Resistivity @ 15.5 °C (Ohm-cm)			Chloride	Sulfate		pH	ORP	Moisture	Soil Visual Description
Boring	Sample, No.	Depth, ft.	As Rec.	Minimum	Saturated	mg/kg	mg/kg	%		(Redox)	At Test	
						Dry Wt.	Dry Wt.	Dry Wt.		mv	%	
			ASTM G57	Cal 643	ASTM G57	Cal 422-mod.	Cal 417-mod.	Cal 417-mod.	Cal 643	SM 2580B	ASTM D2216	
B-1	1-3	3.5-5.0	-	3378	-	5	98	0.0098	8.6	-	12.8	Dark Gray Lean Clayey SAND
B-10	10-2	3.5-5.0	-	47581	-	4	20	0.0020	7.8	-	2.6	Olive Brown SAND

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Lean Clayey SAND	38	17	21			

Project No. 471-290 **Client:** Cal Engineering & Geology

Project: SLVWD Pipeline - 191110

● **Source:** B-1 **Sample No.:** 1-3 **Elev./Depth:** 3.5-5'

Remarks:

●

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure