OAKRIDGE GEOSCIENCE, INC.

GEOTECHNICAL REPORT

LINDERO CANYON PIPELINE ALIGNMENT, LAS VIRGENES MUNICIPAL WATER DISTRICT / CALLEGUAS MUNICIPAL WATER DISTRICT INTERCONNECTION PROJECT (PROJECT 450), THOUSAND OAKS, CALIFORNIA

Prepared for:
Phoenix Civil Engineering, Inc.

February 2019
Job No. 003.001

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February 10, 2019
Project No. 003.001

Phoenix Civil Engineering, Inc.
535 E. Main Street
Santa Paula, California 93060

Attention: Mr. Jon Turner, PE

Subject: Geotechnical Report, Lindero Canyon Pipeline Alignment, Las Virgenes Municipal Water District/Calleguas Municipal Water District Interconnection Project (Project 450), Thousand Oaks, California

Dear Mr. Turner:

Oakridge Geoscience, Inc. (OGI) is pleased to present this geotechnical report for the pipeline alignment along Lindero Canyon Road for the Las Virgenes Municipal Water District/Calleguas Municipal Water District Interconnection Project (Project 450) in Thousand Oaks, California. The geotechnical report for the pump station portion of the project is being performed separately and will be provided under separate cover.

The purpose of this report is to summarize the anticipated geotechnical conditions along the proposed pipeline alignment and provide geotechnical recommendations in support of the project design by Phoenix Civil Engineering, Inc. Our understanding of the project is based on discussions with you, review of the Preliminary Design Report (PDR, August 2018), PDR Addendum No. 1 (September 10, 2018), the draft Alignment Study Technical Memorandum (currently underway), the Notice of Preparation / Initial Study (October 31, 2018), and our experience in the project area.

Closure

We appreciate the opportunity to provide geotechnical services for this project and to continue our relationship with Phoenix Civil Engineering, Inc. Please contact us if you have any questions regarding information presented herein.

SINCERELY,
OAKRIDGE GEOSCIENCE, INC.

Lori E. Prentice, CEG
President

Rory "Tony" Robinson, PE, GE
Principal Geotechnical Engineer

Copies Submitted: (one pdf via email)

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1.0 INTRODUCTION

1.1 GENERAL STATEMENT

This geotechnical report summarizes the findings and recommendations of the geotechnical study performed by Oakridge Geoscience, Inc. (OGI) for the pipeline alignment primarily along Lindero Canyon Road for the Las Virgenes Municipal Water District (LVMWD)/Calleguas Municipal Water District (CMWD) Interconnection Project (Project 450) in Thousand Oaks, California. The geotechnical report for the pump station portion of the project was performed separately and provided under separate cover.

The purpose of this report is to summarize the anticipated geotechnical conditions along the proposed pipeline alignment and provide geotechnical recommendations in support of the project design by Phoenix Civil Engineering, Inc. (PCE). Our understanding of the project was based on work performed for the geotechnical desktop study (OGI, 2015), discussions with PCE staff, review of the Preliminary Design Report (PDR, August 2018), PDR Addendum No. 1 (September 10, 2018), the draft Alignment Study Technical Memorandum (currently underway), the Notice of Preparation / Initial Study (October 31, 2018), and our experience in the project area.

The proposed pipeline alignment is located within the Thousand Oaks area of Ventura County as shown on Plate 1.

1.2 PROJECT DESCRIPTION

Calleguas Municipal Water District (CMWD) and Las Virgenes Municipal Water District (LVMWD) are considering design and construction of an interconnection between their systems that would allow transfer of water between the Districts. The CMWD portion of the project involves the design of about 7,500 feet of 30-inch inside-diameter, cement mortar lined and coated, welded steel pipe (CMWD interconnection pipeline) with a 0.25-inch wall thickness (excluding lining and coatings), a pump station to convey the water into the CMWD system, and a pressure regulating station to flow water to the LVMWD system. The approximate pipeline alignment is shown on Plate 1.

The CMWD interconnection pipeline consists of the pipeline between the proposed co-located pump station (PS) / pressure regulating station (PRS) and the connection to CMWD's existing Lindero Feeder No. 2 pipeline located near the intersection of Kanan Road and Falling Star Avenue. The proposed pipeline would be buried under the traffic lanes of Lindero Canyon Road northward from the PS/PRS site to Lakeview Canyon Road. The alignment from Lakeview Canyon Road to the point of interconnection with Lindero Feeder No. 2 has yet to be determined. Alternative alignments under consideration include Lakeview Canyon Road and Falling Star Avenue, Kanan Road, and through the adjacent North Ranch Pavilions shopping center at the southwest corner of Lindero Canyon Road and Kanan Road (see Plate 1). A preferred alignment will be identified and evaluated in the Draft EIR along with alternatives. The final preferred alignment will be the basis of design for the CMWD interconnection pipeline.

The project alignment is anticipated to be constructed using cut and cover techniques, however, trenchless construction may be required if an alternative alignment is selected that requires crossing the existing Oak Park Feeder pipeline within Kanan Road.

1.3 PURPOSE

The purpose of the geotechnical study is to evaluate the subsurface geologic and geotechnical conditions along the pipeline alignment. At the request of CMWD, explorations for the pipeline alignment were only performed along Lindero Canyon Road south of Lakeview Canyon Road.

1.4 WORK PERFORMED

The scope of services for this pipeline study consists of project coordination, project-specific field exploration, laboratory testing, geotechnical engineering evaluation, and preparation of this report. Our proposed scope of services was presented in our proposal dated November 7, 2017 and was authorized by the PCE Agreement Between Consultant and Subconsultant, dated February 5, 2018.

1.4.1 Project Coordination

Prior to field exploration, OGI performed a site reconnaissance to locate and mark the exploration locations for coordination with Underground Service Alert. We also applied for an encroachment permit from the City of Thousand Oaks for the exploration work within Lindero Canyon Road.

1.4.2 Field Exploration

The project-specific subsurface exploration program consisted of advancing six drill holes along the proposed alignment in Lindero Canyon Road to depths of about 15 to 30 feet below the ground surface (bgs). The approximate locations of the drill holes are shown on Plates 2a through 2c and the drill hole logs are presented in Appendix A.

The project exploration was performed along the proposed alignment in the Lindero Canyon Road traveled way under traffic control provided by Total Barricade Service of Oxnard in general accordance with the approved traffic control plans and encroachment permit. The drill holes were advanced on March 13 and 14, 2018 by S/G Drilling, Inc. of Lompoc using a CME 85 truck-mounted drill rig equipped with eight-inch-diameter hollow-stem augers. The drill holes were sampled using a three-inch-outside-diameter modified California split spoon sampler fitted with one-inch-high brass liners and a two-inch-outside-diameter standard penetration test (SPT) split spoon sampler without liners. The split spoon samplers were driven into the materials at the bottom of the drill hole using a 140-pound CME automatic trip hammer with a 30-inch drop. The blowcount is the number of blows from the hammer that were needed to drive the sampler one foot (unless otherwise noted) after the sampler had been seated at least six inches into the material at the bottom of the hole. The sample intervals, blowcounts, and a description of the subsurface conditions encountered are presented on the logs of the drill holes in Appendix A.

Following logging and sampling at each location, each drill hole was backfilled with the drill cuttings mixed with Portland cement and compacted during backfill using the downward pressure of the drill rig hydraulics on a downhole tamper. Excess cuttings, if any, were spread in earthen planter areas (e.g. planter areas with dirt surfaces) per our discussion with the City inspector prior to mobilizing to site. The pavement was patched with quick-set concrete dyed black.

1.4.3 Laboratory Testing

Geotechnical laboratory testing was performed on selected earth materials sampled in the drill holes to characterize the materials and estimate relevant engineering design parameters. The testing program consisted of moisture/density relationships, grainsize, shear strength (direct shear and unconsolidated undrained compression tests), and corrosion testing. The laboratory test results are presented on the drill hole logs in Appendix A and in Appendix B.

1.4.4 Geologic/Geotechnical Evaluation and Reporting

We evaluated the field and laboratory geotechnical data, developed geotechnical engineering recommendations for design and construction of the project, and prepared this report to summarize our findings, opinions, and recommendations. Our report includes the following:

- Summary of soil, pavement, and groundwater conditions encountered;
- Suitability of onsite soil for use as fill and select fill material;
- Excavation and trenching conditions of earth materials;
- Trenchless considerations;
- Preliminary geotechnical input for temporary shoring design; and
- E' Modulus for pipeline trench backfill/trench sidewall soil system.

2.0 FINDINGS

2.1 SITE DESCRIPTION

The project alignment is primarily located within Lindero Canyon, a southerly draining alluvial valley. USGS (1981) indicates the elevations (El.) range from about El. +1,200 feet near Falling Star Avenue/Kanan Road to about El. +1,120 feet near the Ventura/Los Angeles County line. Based on our data review, the majority of the development in the project area occurred in the mid- to late-1980's to early-1990's and consisted of cut and fill grading to establish the current grades. The majority of the pipeline alignment will be constructed within Lindero Canyon Road, a multi-lane, arterial street with medians and shoulder areas serving residential and commercial properties in the Ventura County area. Lakeview Canyon Road and Falling Star Avenue are two-lane streets. Kanan Road is also a multi-lane, arterial street with medians and shoulder areas serving residential and commercial properties in the project vicinity.

Lindero Creek, shown on the USGS topographic map as a blue line stream, runs sub-parallel to the existing Lindero Canyon Road, crossing from the westerly side to the easterly side of the road in the vicinity of Rockfield Street in the City of Thousand Oaks' below-grade 12-foot by 12-foot box culvert structure. South of the crossing, the creek is an unlined drainage within the project limits.

2.2 GEOLOGIC SETTING

2.2.1 Regional Geology

The project site is located within the Transverse Ranges geologic/geomorphic province of California. The province is characterized by generally east-west-trending mountain ranges composed of sedimentary and volcanic bedrock units ranging in age from Cretaceous to Recent. Major east-west trending folds, reverse faults, and left-lateral strike-slip faults reflect regional north-south compression and are characteristic of the province.

2.2.2 Local Geology

The geology of the project area has been mapped by several authors including Dibblee (1993), Weber (1973), and the California Geological Society (CGS, formerly California Division of Mines and Geology; 2000). Regional mapping by Dibblee (1993) suggests the Lindero Canyon area, including the majority of the pipeline alignment from about Lakeview Canyon Road to the Ventura/Los Angeles County line, is predominately underlain by unconsolidated alluvial sediments (Qa) consisting of gravel, sand, and clay underlain by bedrock of the Monterey Formation (Tm) as indicated on Plate 3. Monterey Formation bedrock materials are exposed in the slopes west of Lindero Canyon Road from about Westcreek Lane to about the Ventura/Los Angeles County line. Dibblee indicates the Monterey Formation consists of white weathering, thinly bedded, locally brittle siliceous to punky (e.g. light weight and airy) siltstone materials that have been folded into a series of northwest-trending synclines and anticlines that result in varying dip magnitudes and directions in the project vicinity. The Monterey Formation can contain well-indurated siliceous and dolomitic beds that can range from several inches to several feet in thickness and can be difficult to excavate. As mapped by Dibblee, the bedrock materials of the Monterey Formation generally dip favorably into the hillsides within the project limits, however, bedding within the Monterey Formation can vary significantly locally and/or over short distances.

North of about Lakeview Canyon Road, Dibblee maps older alluvial sediments (Qoa) consisting of unconsolidated to partially consolidated gravel deposits underlain by sandstone bedrock of the Topanga Formation (Tlc). Based on our data review, medium dense to dense clayey sand bedrock of the Topanga Formation was encountered at a depth of about five feet in a boring advanced near the intersection of Kanan Road and Falling Star Avenue (Fugro, 2009).

Weber (1973) and the CGS (2000) map landslide deposits on the northeasterly-facing bedrock slope north of the Ventura/Los Angeles County line south of Rockfield Street. The landslide deposits are beyond the limits of the proposed project elements and therefore would not affect the project design or project elements. Weber also maps potential "conjectured" faults within the alluvial sediments east of the Lindero Creek drainage, about 500 to 1,000 feet east of Lindero Canyon Road. The mapped conjectured faults are not considered active or potentially active, are northerly-trending (not consistent with the structural grain of the project area), are sub-parallel to the pipeline alignment, and do not cross the alignment as mapped.

2.3 SUBSURFACE CONDITIONS AND ENGINEERING PROPERTIES

Subsurface materials encountered by our explorations are interpreted to consist of artificial fill, alluvium, and bedrock of the Monterey Formation. Earth material descriptions are presented in the following sections.

2.3.1 Artificial Fill (af)

The artificial fill materials encountered in our explorations consist of asphalt concrete, base materials, and underlying soils imported or processed as prepared subgrade. The estimated fill thicknesses range from about two and a half- to three-feet at the exploration locations based on observations during drilling and materials recovered during sampling. The sampled fill materials consisted of sand, sand with clay, clayey sand, and sandy clay described as damp to moist. Moisture content tests performed on selected samples range from nine to 31 percent. The thicknesses of the asphalt concrete and base materials encountered in our explorations are summarized in the following table.

Table 1. Summary of Pavement Profiles

Drill Hole No. and Approx. Location	Asphalt Concrete Thickness (inches)	Base Thickness (inches)	Subgrade Material Description
DH-2 NB No. 2 Lane Lindero Canyon Road, S of Lakeview Canyon Road	6	9	Sand (SP)
DH-3 NB No. 2 Lane Lindero Canyon Road, N of Westcreek Lane	4	7	Sand (SP)
DH-4 NB No. 2 Lane Lindero Canyon Road, N of Rockfield Street	9	--	Sand with Clay (SP-SC)
DH-5 SB No. 1 Lane Lindero Canyon Road, N of Rockfield Street	7	--	Clayey Sand (SC)
DH-6 SB No. 1 Lane Lindero Canyon Road, S of Rockfield Street	6	6	Sandy Clay (CL)
DH-7 NB No. 1 Lindero Canyon Road, S of Symphony Lane	6	5	Sandy Clay (CL)

2.3.2 Alluvium (Qal)

Alluvial soils sampled in the drill holes consisted of loose to dense clayey sand and medium stiff to very stiff sandy clay and clay. SPT blowcounts within the clayey alluvium generally ranged from about five to 23 blows per foot (bpf). The results of the laboratory tests on samples of alluvial materials suggest:

- In-place dry densities ranged from about 90 to 113 pounds per cubic foot (pcf) and the moisture contents ranged from about 11 to 30 percent for the tested samples.
- The results of grainsize evaluations indicate fines contents of about 29 to 76 percent.
- Two direct shear tests performed on selected samples of alluvial soil from drill holes DH-2 and DH-4 indicate friction angles of about 34 and 37 degrees with cohesions of 50 to 150 pounds per square foot (psf).
- Two unconsolidated undrained tests performed on samples from drill holes DH-4 and DH-5 indicate undrained shear strengths of 0.9 to 3.5 ksf.

2.3.3 Monterey Formation (Tm)

Bedrock materials of the Monterey Formation were encountered in five of the six drill holes advanced for this study. Monterey Formation bedrock is also exposed in the cutslopes on the western side of Lindero Canyon Road between about Westcreek Lane and the Ventura/Los Angeles County line. The bedrock materials encountered in our explorations were interpreted as thinly interbedded claystone, siltstone, sandy siltstone, and sandy claystone. At location DH-7, the driller noted the drilling conditions within the bedrock were harder below depths of about 10 feet to drilling termination at 15 feet. Based on the blowcount data, the weathered bedrock materials have the consistency of medium stiff to hard soil materials. Bedrock materials exposed in the cutslopes west of Lindero Canyon Road appear to contain zones of more indurated, harder bedrock materials than encountered by our explorations.

Table 2. Summary of Bedrock Depths Encountered by Explorations

Drill Hole No.	Approximate Depth of Bedrock (ft)
DH-2	> 16-1/2
DH-3	9-1/2
DH-4	29
DH-5	29
DH-6	4
DH-7	6

The results of the laboratory tests on samples of bedrock materials suggest:

- In-place dry densities of 80 to 98 pcf at moisture contents of 17 to 38 percent. The low dry densities and high moisture contents suggest the tested bedrock materials are diatomaceous.
- Three unconsolidated undrained tests performed on samples from drill holes DH-5, DH-6, and DH-7 indicate undrained shear strengths of 2.3 to 4.8 ksf.

2.4 GROUNDWATER

Groundwater was encountered at depths of about 20.6 and 26.9 feet in drill holes DH-4 and DH-5, respectively; groundwater was not encountered in the other explorations advanced for this study. Review of CGS (2000) indicates the historic high groundwater may be within 10 feet or less of the ground surface within the vicinity of the pipeline alignment along Lindero Canyon Road between about Rockfield Street and the Ventura/Los Angeles County line.

We note groundwater may be encountered at shallower depths, especially in areas adjacent to irrigated parks or landscaped areas, areas underlain by less permeable alluvial or bedrock materials, or in areas proximal to the Lindero Creek drainage. Also, as described in the desktop study (OGI, 2015), we observed areas of groundwater seepage from the bedrock materials exposed in the cutslopes west of Lindero Canyon Road north of the Ventura/Los Angeles County line.

2.5 POTENTIAL VARIATION OF SUBSURFACE MATERIALS

The drill holes performed for this study are widely spaced and there is a potential for variation in the consistency, density, and strength/hardness of the materials. There is also potential for oversized materials (greater than eight inches in diameter); perched water; zones of poorly consolidated soils; well indurated, very hard bedrock materials; or other conditions not indicated on the drill hole logs. If significant variation in the geologic conditions is observed during construction, we recommend that the geotechnical engineer, in conjunction with the project designer, evaluate the impact of those variations on the project design.

2.6 SEISMIC CONSIDERATIONS AND GEOHAZARDS

2.6.1 Faults

No known active or potentially active faults traverse or trend toward the pipeline alignment. However, there are numerous faults considered active and potentially active by the USGS within an about 20-mile radius of the approximate mid-point of the alignment as indicated in the following table.

Table 3. Nearby Faults

Fault	Approximate Distance (miles)	Maximum Moment Magnitude (Mmax) USGS
Simi-Santa Rosa	7.1	7.1
Malibu Coast	9.4	7.1 - 7.5
Anacapa-Dume	9.7	7.3 – 7.4
Northridge Hills	10.8	7.7
Santa Susana	12.0	7.3
Oak Ridge (onshore)	12.8	7.6

[1] Earthquake distances and magnitudes obtained from the USGS website (2017)

2.6.2 Ground Rupture Potential

The alignment is not located within a State of California Earthquake Fault Zone (formerly Alquist-Priolo Special Studies Zone). Also, no known active or potentially active faults traverse or trend toward the alignment. Weber (1973) maps potential fault traces within about 500 feet of the southern portion of the proposed improvements, however, those faults are not considered active or potentially active and do not trend toward or cross the proposed alignment. Thus, the potential for fault rupture is considered low.

2.6.3 Potential for Strong Ground Motion

Thousand Oaks (2014) indicates the estimated peak ground acceleration (pga) for the alignment and vicinity is about 0.65g for an earthquake with a 10 percent probability of exceedance in a 50-year exposure period (return period of 475 years).

The 2016 California Building Code (CBC) specifies that risk targeted, maximum considered earthquake (MCE_R) ground motion response accelerations be used to evaluate seismic loads for design of buildings and other structures. The target-risk MCE_R equivalent to peak ground acceleration (PGA_M) with a 2-percent probability of exceedance in a 50-year exposure period for the project site is 0.50g. We utilized the 2017 USGS Interactive web site to estimate the potential for strong ground motion at the site. For the analyses, we used latitude N 34.1785° and longitude W 118.7871º for the site location (approximate mid-portion of the alignment) and assumed alluvial site conditions (Site Class D). We note that the MCE_R is not directly applicable to pipeline projects.

2.6.4 Liquefaction and Dry Seismic Settlement Potential

The 2016 CBC requires the potential for liquefaction and soil strength loss be evaluated, where applicable, using the procedure established by the American Society of Civil Engineers (ASCE) 7-10 Standard. We note liquefaction evaluation is generally not required for pipelines and the exploration for this study did not extend to depths of 50 feet as generally required to evaluate liquefaction per ASCE 7-10.

Soil liquefaction occurs as a result of a loss of shear strength or shearing resistance in loose, saturated soils subjected to earthquake-induced ground shaking. Soil liquefaction occurs in the underlying soils and can be manifested at the ground surface by the formation of sand boils, ground surface settlement and lateral spreading. Dry seismic settlement occurs in weakly- to non-cemented, very loose to medium dense granular soils above the groundwater in response to strong earthquake ground shaking.

Based on our data review and drill holes performed for this study, the alignment is underlain by loose to dense clayey sand, medium stiff to very stiff sandy clay, and clay alluvial sediments overlying bedrock materials of the Monterey Formation. The thickness of the alluvial sediments ranges from several feet to a maximum of about 25 to 30 feet near the Lindero Canyon drainage/culvert near Rockfield Street. Perched groundwater was encountered above the fine-grained siltstone/claystone bedrock of the Monterey Formation at depths of about 20 to 25 feet near the culvert crossing. Based on our evaluation, there is a limited potential for liquefaction-related settlement (less than 2 inches) within the granular soil layers. The medium stiff to stiff clay soil and Monterey Formation bedrock are not considered susceptible to liquefaction. Granular soil layers above the groundwater have the potential for dry seismic settlement. The medium dense granular sediments are composed of clayey sand which have a reduced potential for seismic settlement versus clean sand (limited fines content). Based on the limited data set, the dry seismic settlement potential is approximately equal to the estimated liquefaction potential, about 2 inches.

2.6.5 Landsliding and Slope Instability

The pipeline alignment is located within Lindero Canyon Road adjacent to relatively flat developed areas, thus the potential for landsliding to affect those portions of the alignment is low. The southern portion of the alignment from about Westcreek Lane to near the Ventura/Los Angeles County line is adjacent to Monterey Formation bedrock hillsides that have mapped potential landslides (Thousand Oaks, 2014; Weber, 1973; and CGS, 2000) on the west side of Lindero Canyon Road. However, those landslides should not impact the project.

2.7 EXPANSIVE SOIL

The fine-grained clay soil in the upper 10 feet of the drill holes consists primarily of sandy clay with about 30 to 40 percent sand (60 to 70 percent silt and clay fines). The sandy clay soil exhibits low plasticity and is estimated to have a low expansion potential (EI of less than 50). The clay layers from about 20 to 30 feet in drill holes DH-4 and DH-5 have about 75 percent fines (material passing the No. 200 sieve) and exhibit characteristics of a plastic clay with a moderate expansion potential (EI of 50 to 90).

3.0 RECOMMENDATIONS

3.1 SUMMARY OF SUBSURFACE SITE CONDITIONS

The geotechnical conditions in the project area were evaluated from the drill holes advanced for this study and from our review of existing geotechnical data as referenced herein. From the geotechnical perspective, the site conditions appear favorable for construction of the proposed pipeline alignment.

3.2 SOIL CHEMISTRY AND CORROSION

3.2.1 Test Results

Selected soil samples obtained from our explorations were provided to Cooper Testing Laboratories for resistivity, pH, chloride, and sulfate testing. The test results are summarized below and the laboratory test report is included in Appendix B.

Table 4. Summary of Chemical Test Results

Drill Hole	USCS Classification	Depth (feet)	Sulfate (mg/kg)	Sulfate) (%)	Chloride (mg/kg)	Resistivity (ohm-cm)	pH
DH-2	Sandy Clay	1 - 5	125	0.0125	6	1,467	7.6
DH-5	Clay	12.5	578	0.0578	78	652	7.6
DH-7	Sandy Clay	1 - 5	117	0.00117	8	1,594	7.7

3.2.2 Corrosion and Cement Considerations

Many factors can affect the corrosion potential of soil including soil moisture content, resistivity, permeability, and pH, as well as chloride and sulfate concentration. In general, soil resistivity, which is a measure of how easily electrical current flows through soils, is the most influential factor. As a general rule, Caltrans (2015) indicates a resistivity value of 1,000 ohm-cm or lower is an indicator of high soluble salt content and a general indicator of corrosion potential. Caltrans considers soils to be corrosive or to represent a corrosive environment if one of the following criteria is met:

- Resistivity value of less than 1,000 ohm-cm;
- Chloride content of 500 ppm or greater;
- Sulfate concentration of 2,000 ppm or greater; or
- pH is 5.5 or less.

As summarized in the table above, the measured electrical resistivity (ASTM G57) for the sample from DH-5 is 652 ohm-cm, which is below the minimum of 1,000 ohm-cm per Caltrans. Based on the laboratory test data, the soil from DH-5 is considered corrosive; the tested materials from DH-2 and DH-7 are not considered corrosive to concrete or steel based on the test data and Caltrans limits.

The test results should be evaluated by a corrosion specialist to confirm the opinions regarding the potential corrosion impacts from the onsite soils to the construction materials proposed for the project.

3.3 EXCAVATIONS

3.3.1 Excavation Conditions

The earth materials encountered in the drill holes advanced for this study consist of loose to dense clayey sand and medium stiff to very stiff sandy clay and clay soils underlain by bedrock interpreted as extremely to highly weathered, thinly interbedded claystone, siltstone, sandy siltstone, and sandy claystone of the Monterey Formation. Based on our observations during drilling, we anticipate conventional heavy grading equipment in good working order should be capable of excavating the earth materials encountered along the alignment. However, we note difficulty may be encountered when excavating hard, siliceous and dolomitic beds within the Monterey Formation bedrock materials as described below.

Bedrock is exposed in the cutslopes on the western side of Lindero Canyon Road between about Westcreek Lane to about the Ventura/Los Angeles County line and was encountered in five of the six drill holes advanced for this study. The bedrock materials encountered in our explorations were interpreted as thinly interbedded claystone, siltstone, sandy siltstone, and sandy claystone. At location DH-7, the driller noted the drilling conditions within the bedrock were harder below depths of about 10 feet to drilling termination at 15 feet. Additionally, based on our data review, (Fugro, 2009), the potential exists for bedrock materials to be encountered at relatively shallow depths at the northern portion of the alignment near Kanan Road and Lakeview Canyon Road.

Review of the existing data and our experience suggests the Monterey Formation can contain well-indurated siliceous and dolomitic beds that can range from several inches to several feet in thickness and can be difficult to excavate. Bedrock materials exposed in the cutslopes west of Lindero Canyon Road appear to contain zones of more indurated, harder bedrock materials than encountered by our explorations. The potential exists for difficult excavation conditions to be encountered in bedrock materials.

3.3.2 Dewatering

Groundwater was encountered at depths of about 20.6 and 26.9 feet in drill holes DH-4 and DH-5, respectively; groundwater was not encountered in the other explorations advanced for this study. Review of CGS (2000) indicates the historic high groundwater may be within 10 feet or less of the ground surface within the vicinity of the pipeline alignment along Lindero Canyon Road between about Rockfield Street and the Ventura/Los Angeles County line.

We note that groundwater seepage may be encountered at shallower depths, especially in areas adjacent to irrigated parks or landscaped areas, areas underlain by less permeable alluvial or bedrock materials, or in areas proximal to the Lindero Creek drainage. Also, as described in the desktop study (OGI, 2015), we observed areas of groundwater seepage from the bedrock materials exposed in the cutslopes west of Lindero Canyon Road north of the Ventura/Los Angeles County line. Therefore, the potential exists to encounter groundwater and that dewatering may be required.

If dewatering is required as part of the project, a dewatering system capable of dewatering project elements likely will need to be designed and installed by an experienced company specializing in groundwater dewatering systems. That system should be capable of lowering the groundwater surface to a depth of at least three-feet below the required depth of excavation.

3.4 OPEN CUT CONSTRUCTION AND EXCAVATIONS

3.4.1 Existing Utilities

Project alignment plans by PCE indicate the alignment will cross or will be parallel to and/or subparallel to many existing utilities. Trenches should be excavated no closer than a 1h:1v projection up from the bottom of the excavation in areas where an existing utility/pipeline parallels or subparallels the trench excavation. The minimum clear distance between an existing utility and the trench should be evaluated by the contractor. We recommend existing utility/pipelines be supported/ protected or that the trench be shored to prevent loss of lateral support for existing utility/pipelines when: 1) the trench is closer than a 1h:1v projection to the existing utility, 2) the stability of the existing utility is in question, or 3) there is a potential for sloughing of the trench sidewalls adjacent to the existing utility. CMWD Standard Drawings 1101, 1102, and 1103 apply to crossing of new and existing utilities.

3.4.2 Trenching and Temporary Excavations

Excavations more than four feet deep should be sloped, shored, or shielded in accordance with federal and state standards, project specifications, and safe construction practices. The contractor is responsible for providing and maintaining safe excavations, according to Occupational Safety and Health Administration (OSHA) regulations.

Loose to dense clayey sand, medium stiff to very stiff sandy clay and clay, and siltstone/claystone bedrock of the Monterey Formation were encountered in the explorations advanced for this study in the proposed construction depths (OSHA Type B and C soils). Therefore, per OSHA's 29 CFR Part 1926, unsupported excavations in these soils should be sloped no steeper than 1h:1v in clay soils/claystone or 1.5h:1v in granular soils. In addition, flatter slopes may be warranted depending on exposed soil conditions. Temporary excavations should be monitored for stability during construction and be modified, if necessary. Excavations lacking adequate sidewall support could move or become unstable and result in damage to existing improvements, pavements, and utilities adjacent to the pipeline trench or excavations.

Vertical excavations in granular soil units have the potential to slough and undermine the adjacent asphalt concrete pavement. The contractor and construction inspectors should monitor the trench sidewalls. If the trench walls slough, the area should be repaired by placing flowable fill (slurry) beneath the pavement or removing the pavement section and replacing with compacted fill.

3.5 FILL MATERIALS

3.5.1 General Fill

Soil generated during excavation for the proposed pipeline may be suitable for use as general fill, provided that oversize materials are removed and debris and other deleterious materials are excluded.

General fill materials should meet the following requirements:

- No rocks larger than 6 inches in maximum dimension;
- No more than 15 percent material larger than 2 inches;
- Low expansive potential (EI ≤ 50);
- Plasticity Index less than 15; and
- Less than 60 percent passing the No. 200 sieve.

On the basis of the data from our explorations and review of previous data, we anticipate most of the on-site soils will meet the above criteria for general fill.

3.5.2 Imported Fill

Imported fill materials may be used for general fill or select fill (bedding, pipe zone, trench backfill, aggregate base), provided that the imported fill satisfies the requirements for its intended use. Imported fill material should be evaluated by the project engineer to verify suitability for its intended use.

3.5.3 Bedding and Pipe Zone Materials

Bedding and pipe zone backfill consist of material placed beneath and around the pipe. The pipe zone materials will be placed in accordance with CMWD Standard Drawing 301. Soil materials used for pipe bedding should meet CMWD specifications and consist of granular soils with a minimum sand equivalent (SE) of at least 30. Backfill should be placed in loose lift thicknesses no greater than eight inches and mechanically compacted. Bedding and pipe zone backfill should be compacted to at least 95 percent relative compaction as determined from ASTM D1557. Bedding should extend at least six inches below the pipe and extend at least 12 inches above the pipe as depicted on CMWD Drawing 301A.

The trench width should be sufficient to allow compaction equipment to operate between the pipe springline and trench wall (minimum of 18 inches wider than pipe springline). We recommend jetting or flooding of pipe zone materials not be allowed.

3.5.4 Trench Backfill Material

Trench backfill consists of material placed above the pipe zone backfill and, in paved areas, extends to the base of the structural section. We understand that permit conditions from the City of Thousand Oaks likely will require the trench backfill to consist of sand-cement slurry meeting Greenbook requirements.

If soil materials are used for pipe trench backfill, onsite soils can be used provided they meet Greenbook requirements for trench backfill. In general, backfill should be moisture conditioned to within 2 percent of optimum, placed in loose lift thicknesses no greater than eight inches, and mechanically compacted. Trench backfill should be compacted to at least 90 percent relative compaction, as determined from ASTM D1557. We recommend that jetting or flooding of pipe trench backfill materials not be allowed.

We note the test results from this study indicate the moisture contents of the onsite materials within the anticipated trench zone are above optimum, ranging from about 15 to as high as 27 percent. The test results suggest the moisture contents are 2 to 12 percent above optimum moisture content for clay soils (assuming optimum moisture content of around 12 to 14 percent). Therefore, the onsite soils likely will need to be dried back to use as compacted fill.

3.5.5 Backfill Loads on Pipes

Backfill loads on the pipes will depend on the pipe type (i.e., rigid or flexible), geometrical conditions (embankment or trench configuration), depth of backfill, and on the characteristics of the backfill and in-situ soils. The pipeline for this project will be constructed of welded steel. For design purposes, we recommend a total unit weight of 125 pcf be used to estimate backfill loads. Based on discussions with PCE staff, we understand the pipeline will be designed to resist an HS-20 traffic loading.

3.5.6 Soil Modulus E'

Introduction. Flexible and semi-rigid pipes are typically designed to withstand a certain amount of deflection from applied earth loads. Those deflections can be estimated with the aid of the Reclamation Equation described by Howard (2016) and US Bureau of Reclamation (USBR, 2016). As described by Howard and the USBR, the E' value is based on the type of pipe bedding material and relative compaction of the bedding, assuming the pipe bedding is at least one- to two-pipe diameters on each side of the pipeline at springline. If the pipe bedding is less than one- to two-pipe diameters, the soil modulus is based on a combination of the bedding materials and native soil in the trench walls ($E'_{composite}$).

Anticipated permit requirements from the City of Thousand Oaks likely will require the trench excavation be backfilled with sand-cement slurry above the trench zone. To reduce the amount of soil material trucked offsite and volume of slurry backfill, we anticipate the design will use the minimum bedding material width (18-inches each side) which will result in a minimum trench width of about six feet for the 30-inch diameter pipe. The minimum burial depth is estimated to be four and a half feet between the top of pipe and bottom of pavement section. PCE indicates the approximate total pipeline excavation depth below the top of the pavement will be approximately nine feet to provide for the pipe bedding as required by CMWD Drawing No. 301A. The CMWD pipe trench detail (CMWD Drawing No. 301A-E) indicates 24-inch diameter pipes or larger have 12- to 24-inches of pipe bedding on each side of the pipe at springline. Bedding materials are specified as sand compacted to 95 percent relative compaction.

As described by Howard (2016), the E' of the embedment materials ($E'_{embedment}$, sand bedding) is based on the gradation and the relative compaction or relative density of the sand bedding materials. Sand bedding that classifies as SP or SW has less than six percent passing the No. 200 sieve (fines content) and less than 25 percent passing the No. 50 sieve (fine sand). Soil that classifies as SP or SW compacted to 95 percent relative compaction has an $E'_{embedment}$ value of 4,000 pounds per square inch (psi) (Howard, 2016). Sand bedding with greater than six percent fines classifying as sand with silt (SP-SM; six to 12 percent fines) or silty sand (SM; 12 to

30 percent fines) compacted to 95 percent relative compaction, has an $E'_{embedment}$ of 2,500 psi (Howard, 2016). By comparison, bedding sand (SP/SW) compacted to 90 percent relative compaction has an $E'_{embedment}$ of 2,000 psi.

The E' value for the native soil materials (E'_{native}) in the trench walls is based on the SPT N-values of granular soils and/or shear strength (q_u) of cohesive soils. As summarized in Tables 9-3 and 9-4 (Howard, 2016), the loose to dense granular and stiff fine-grained clay soils at the springline of the pipeline have estimated E'_{native} values of 850 psi to 1,600 psi. Highly weathered, soft, claystone bedrock materials (equivalent to very stiff to hard soil), if encountered at springline, have an estimated E'_{native} of about 3,000 psi.

As described by Howard (2016), the $E'_{composite}$ value is estimated using the strength of both the sand bedding and native soil materials in the trench wall and incorporates a multiplier (S Factor, Howard, 2016, Table 9-1). The estimated $E'_{composite}$ values for the Lindero Canyon Road pipeline range from 1,140 to 2,240 psi. Those $E'_{composite}$ values assume the pipeline is bedded in a minimum of 12-inches of bedding sand on each side of the pipe at springline, the sand classifies as SP/SW as described above, and is compacted to a minimum 95 percent relative compaction as depicted in CMWD Standard Drawing 301A-E.

Based on the site-specific drill holes performed for this study, the lowest $E'_{composite}$ value estimated for the project is near the intersection of Lindero Canyon Road and Lakeview Canyon Road (as encountered in DH-2). The $E'_{composite}$ value at that location is about 1,140 psi. The $E'_{composite}$ value estimated at drill holes DH-3 though DH-7 range from about 1,600 to 2,240 psi. An overall $E'_{composite}$ value of 1,600 psi is recommended for design of the 30-inch diameter CMLC steel pipe assuming 95 percent relative compaction of the sand bedding per CMWD Standard Drawing 301A.

3.5.7 Thrust Resistance

Where the proposed pipeline changes direction abruptly, resistance to thrust forces can be provided by mobilizing frictional resistance between the pipe and the surrounding soil, by use of a thrust-block, or by a combination of the two. For thrust-blocks bearing directly against undisturbed native soils, the allowable lateral pressure may be computed using 300 pounds per square foot (psf) up to an ultimate value of 1,500 psf. Lateral bearing should be neglected from the ground surface to a depth of one-foot below the lowest adjacent grade in areas not underlain by asphalt or concrete hard surface.

3.5.8 Frictional Resistance

Thrust resistance can also be developed from soil friction on the pipeline. Frictional resistance from the proposed backfill materials will vary with embedment depth, groundwater levels, and trench conditions. Assuming normal trench conditions and compacted backfill around the pipe, the ultimate soil friction can be estimated using a friction coefficient of 0.30. The recommended values assume a coefficient of friction between the soil and the cement mortar lined and coated steel pipe of at least 20 degrees. A factor of safety of at least 1.5 should be used to estimate the allowable resistance.

3.6 TRENCHLESS CONSTRUCTION

We note site-specific exploration for a potential trenchless crossing of the existing Oak Park Feeder pipeline within Kanan Road was not part of this study. Although historical geotechnical data exist for the area, we recommend site-specific exploration be performed to characterize the subsurface materials at the potential trenchless crossing site if a trenchless crossing of the Oak Park Feeder pipeline is included in the project.

4.0 LIMITATIONS

4.1 REPORT USE

This report was prepared for exclusive use of Phoenix Civil Engineering, Inc., Calleguas Municipal Water District, and their authorized agents only for the LVMWD/CMWD Interconnection Project (Project 450). The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted geotechnical engineering practices of the project region. No other warranty, express or implied, is made.

Although information contained in this report may be of some use for other purposes, it may not contain sufficient information for other parties or uses. If any changes are made to the project as described in this report, the conclusions and recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this report are modified or validated in writing by OGI.

4.2 HAZARDOUS MATERIALS

This report does not provide information regarding the presence of hazardous/toxic materials in the soil, surface water, groundwater, or atmosphere.

4.3 LOCAL PRACTICE

In performing our professional services, we have used generally accepted geologic and geotechnical engineering principles and have applied the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical engineers currently practicing in this or similar localities. No other warranty, express or implied, is made as to the professional advice included in this report.

4.4 PLAN REVIEW

We recommend OGI be provided the opportunity to review and comment on the geotechnical aspects of any project plans and specifications prepared for this project before they are finalized. The purpose of that review will be to evaluate if the recommendations in this report have been properly interpreted and implemented in the design and specifications.

4.5 CONSTRUCTION MONITORING

Users of this report should recognize the construction process is an integral design component with respect to the geotechnical aspects of a project, and geotechnical engineering is inexact due to the variability of natural and man-induced processes, which can produce unanticipated or changed conditions. Proper geotechnical observation and testing during construction is imperative in allowing the geotechnical engineer the opportunity to verify assumptions made during the design process. Therefore, we recommend that OGI be retained during project construction to observe compliance with project plans and specifications and to recommend design changes, if needed, in the event that subsurface conditions differ from those anticipated.

5.0 REFERENCES

American Society of Testing and Materials (ASTM) (latest edition).

California Division of Mines and Geology (now California Geological Survey [CGS], 2000), *Seismic Hazard Zone Report for the Thousand Oaks Quadrangle, Ventura and Los Angeles Counties, California,* Seismic Hazard Zone Report 042.

Calleguas Municipal Water District (2018), **Notice of Preparation / Initial Study** *for the Calleguas MWD / Las Virgenes MWD Interconnection Project*, dated October 31.

Dibblee T.W., Jr. (1993), *Geologic Map of the Thousand Oaks Quadrangle, Ventura and Los Angeles Counties, California, DF-49.*

"Greenbook" Standard Specifications for Public Works Construction (2015), Published by BNI Building News, Los Angeles, California.

Howard, A.K., (2016), *Pipeline Installation 2.0*, Relativity Publishing, 629 pp.

Fuerst, R, Robertson, S.J., Bowles, L.M., (2016), *Method of Prediction of Flexible Pipe Deflection, United States Bureau of Reclamation Manual M-25, Water Conveyance Group*, Second Edition, 57pp.

Fugro West, Inc. (2009), *Summary of Anticipated Geotechnical Conditions, Proposed Turnout Site Alternatives, Calleguas Municipal Water District, Oak Park Reclaimed Water System, Oak Park Area, Ventura County, California,* dated May 15.

Howard, A.K., Kinney, L., and Fuerst, R. (1995), "Prediction of Flexible Pipe Deflection," prepared for U.S. Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, Colorado, January 31.

Oakridge Geoscience, Inc. (2015), *Geotechnical Desktop Study for Calleguas Municipal Water District's CMWD/LVMWD Interconnection Project (Project 450), Ventura County, California.*

Occupational Safety and Health Administration (1926), *Subpart B - Excavations,* Table V:2-1 "Allowable Slopes".

Phoenix Civil Engineering (2018a), Calleguas Municipal Water District – Las Virgenes MWD/Calleguas MWD Interconnection, Project 450 Preliminary Design Report, August.

_____ (2018b), Calleguas Municipal Water District – Las Virgenes MWD/Calleguas MWD Interconnection (Project 450) – PDR Addendum 1, dated September 10.

_____ (2018c), Calleguas Municipal Water District – Las Virgenes MWD/Calleguas MWD Interconnection (Project 450) – Draft Alignment Study Technical Memorandum, currently underway.

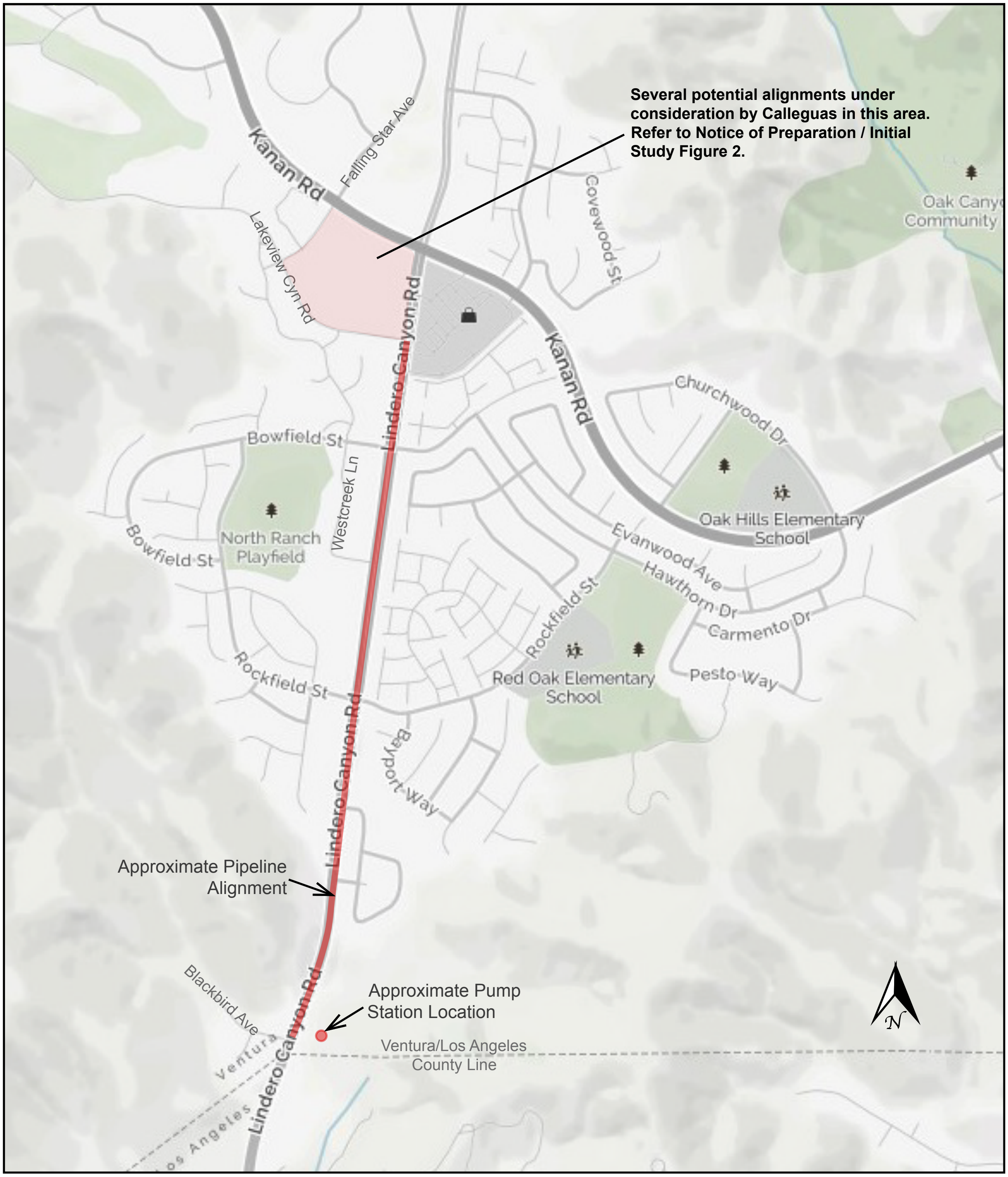
Staal Gardner & Dunne Inc (SGD [now Fugro], 1991), *Geotechnical Study, Oak Park/North Ranch Reclaimed Water Distribution System Tank, Pump Station, and Pipelines, Ventura County, California,* prepared for Boyle Engineering Corporation, dated October 1991.

USGS (2014), http://geohazards.usgs.gov/cfusion/hazfaults_search/hf_search_main.cfm

______ (2014), https://geohazards.usgs.gov/deaggint

Weber, H.F., Jr., et al. (1973), in *Geology and Mineral Resources Study of Southern Ventura County, California*, California Division of Mines and Geology (CDMG) Preliminary Report No. 14, 102 pp.

PLATES



Source: Mapquest (2018)

LOCATION MAP
LVMWD/CMWD Interconnection Project (Project 450)
Thousand Oaks, California

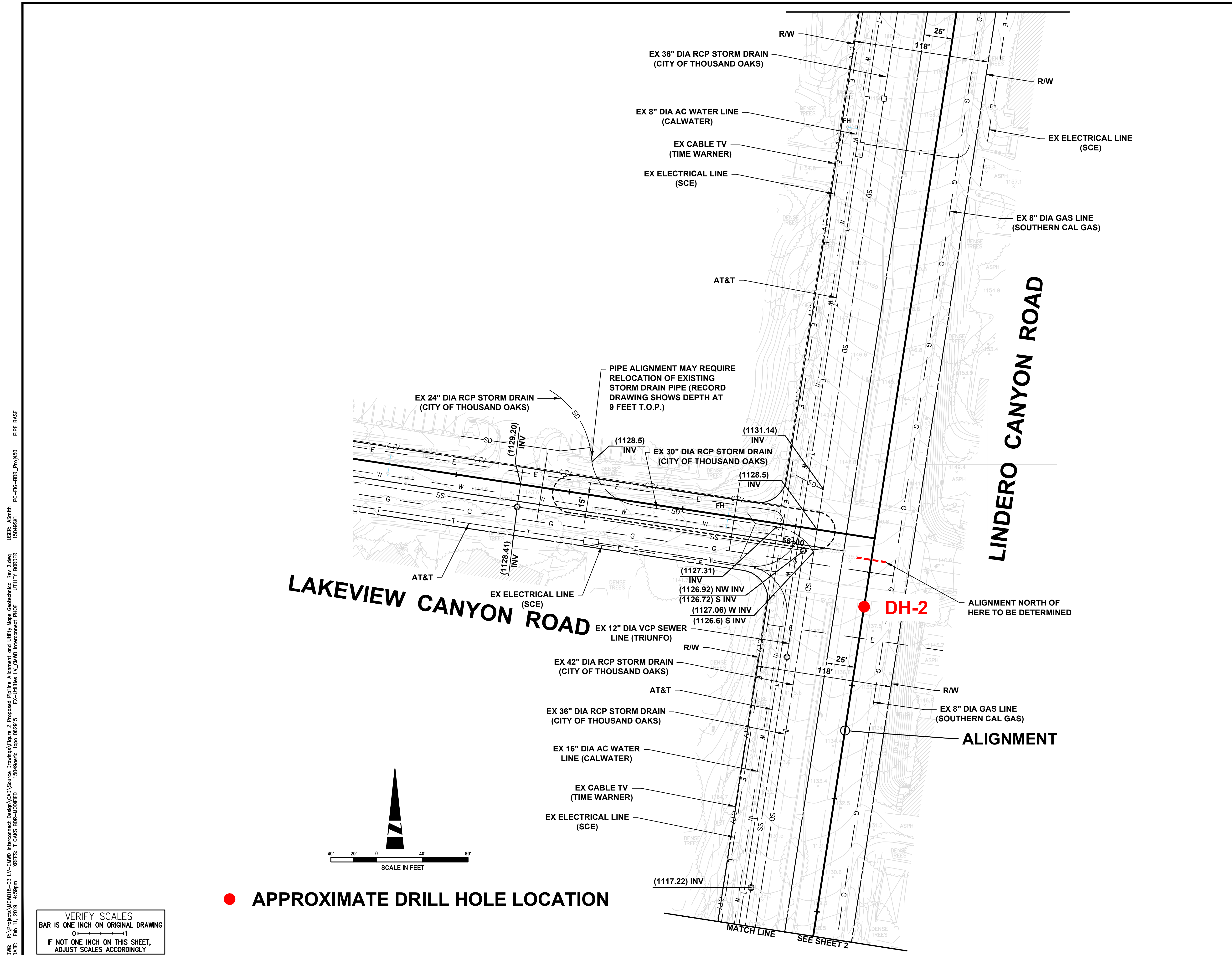


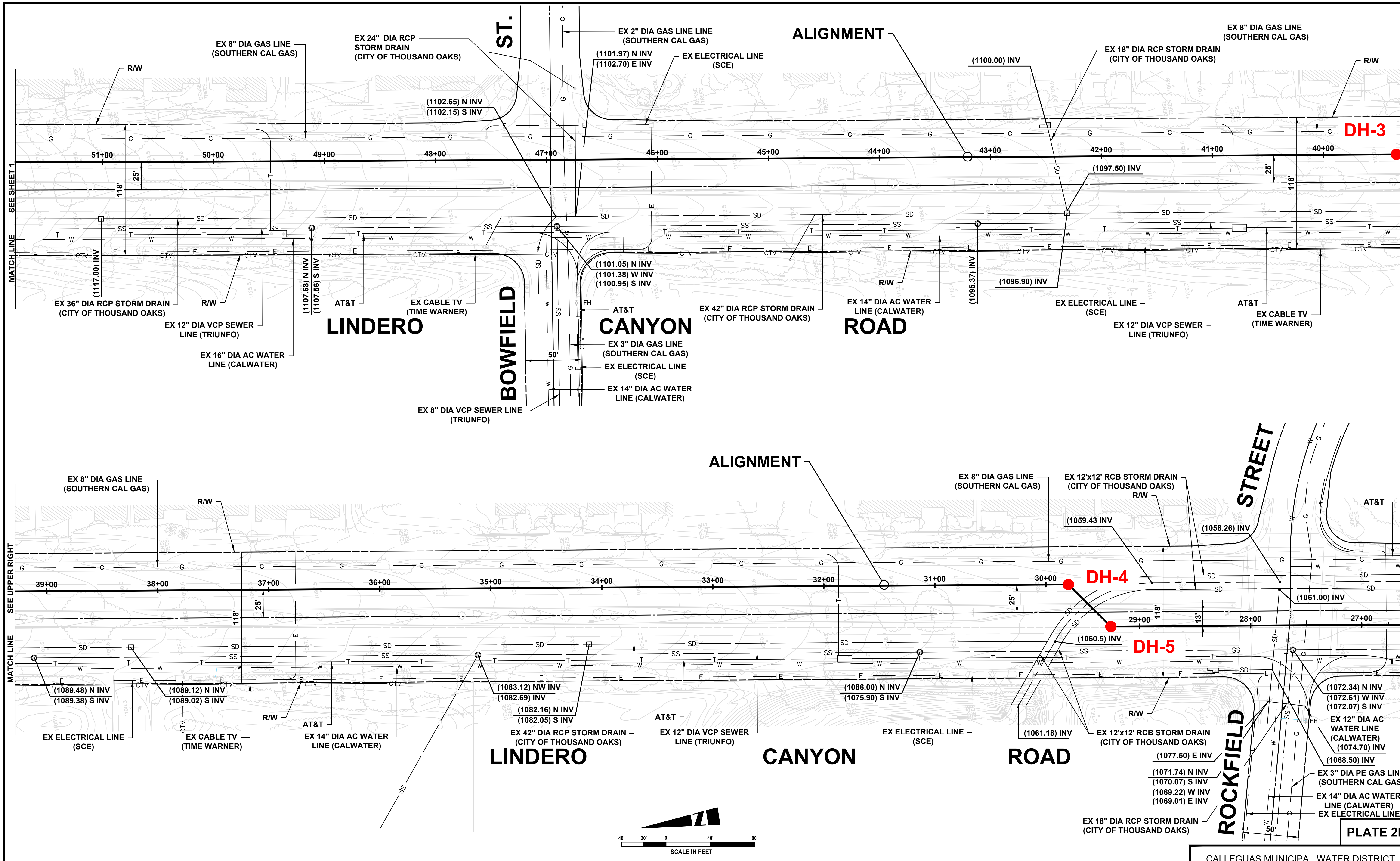
PLATE 2a

CALLEGUAS MUNICIPAL WATER DISTRICT

CMWD/LVMWD INTERCONNECTION
PROJECT 450

FIGURE 2
GEOTECHNICAL BORING LOCATIONS

SHT-1



● APPROXIMATE DRILL HOLE LOCATION

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

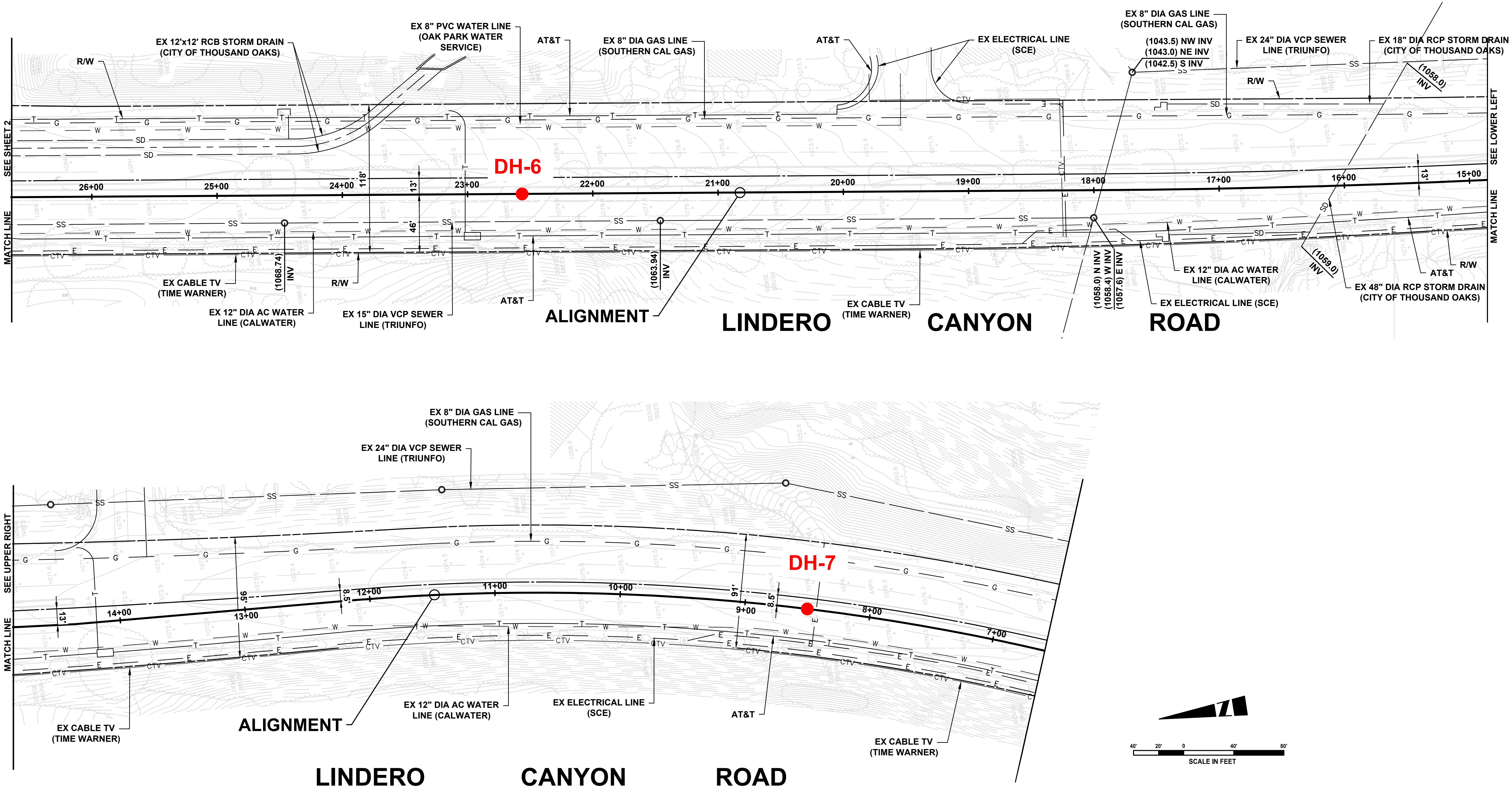
PLATE 2b

CALLEGUAS MUNICIPAL WATER DISTRICT

CMWD/LVMWD INTERCONNECTION
PROJECT 450

FIGURE 2
GEOTECHNICAL BORING LOCATIONS

SHT-2



● APPROXIMATE DRILL HOLE LOCATION

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

DWG: C:\Users\asmith\appdata\local\temp\AcPublish_4276\Figure 2 Proposed Pipiline Alignment and Utility Maps Geotechnical Rev 2.dwg USER: ASmith 15049SK1 PC-FIG-BDR_Proj450 PIPE BASE
DATE: Feb 11, 2019 3:48pm XREFS: T OAKS BDR-MODIFIED 15049aerial topo 062915 EX-Utilities LV_CMWD Interconnect PHOE UTILITY BORDER

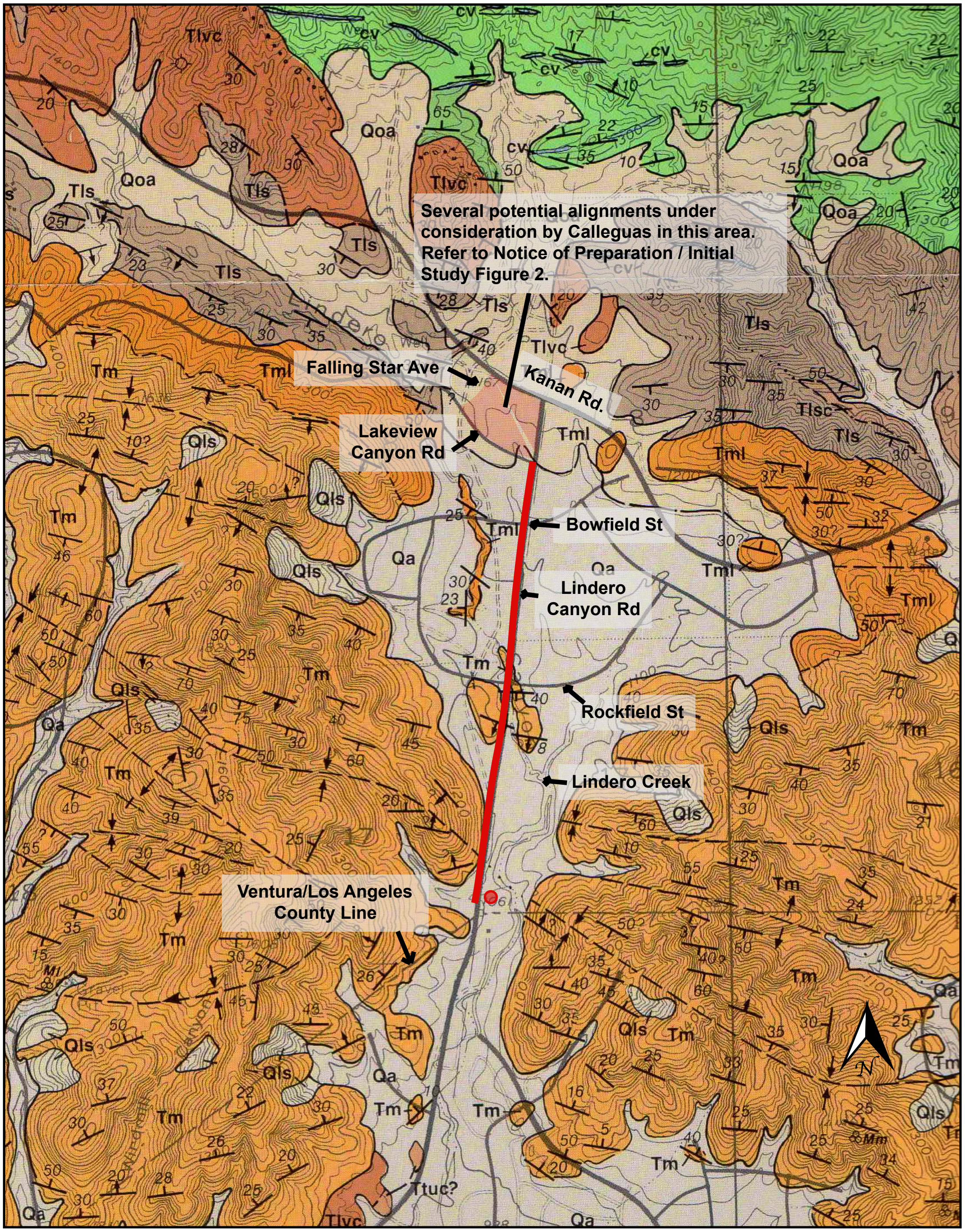
PLATE 2c

CALLEGUAS MUNICIPAL WATER DISTRICT

CMWD/LVMWD INTERCONNECTION
PROJECT 450

FIGURE 2
GEOTECHNICAL BORING LOCATIONS

SHT-3



Source: Dibblee (1993)

Qa - Alluvium
Qoa - Older Alluvium
Qls - Landslide Deposits

Tm/Tml - Monterey Formation
Tls/Tlvc - Topanga Formation

23 Geologic Bedding Orientation
Approximate Pipeline Alignment
Approximate Pump Station Location

REGIONAL GEOLOGIC MAP
LVMWD/CMWD Interconnection Project (Project 450)
Thousand Oaks, California

APPENDIX A

LOG OF DRILL HOLE DH-2

LOCATION: NB No. 2 Lane Lindero, S of Lakeview

SURFACE EL. (ft): +1,138'

ELEV. (ft) DEPTH (ft)	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
			ARTIFICIAL FILL (af)					
			6" asphalt concrete; 9" clayey gravel base					
			SAND (SP): dark brown, damp					
2	1	--						
	2a		**ALLUVIUM (Qal)**					
		17	Sandy CLAY (CL): very stiff, dark brown, damp, with few scattered coarse sand					
4	2b				15		52	
			- with caliche veins and scattered fine gravel, at 3-1/2'					
			Clayey SAND (SC): loose, light brown, moist, with pinhole voids					
6	3	(12)		109	13			
			- medium dense, light to moderate brown, damp, at 7.5'					
8	4	12						
					11		29	
10			- loose, light brown, damp, fine grained, silty, with pinhole voids,					
	5	(12)	at 10'	104	17			
12			- medium dense, coarser grained, with trace of fine caliche					
	6	16	veins, at 12.5'		13		37	
14			- very stiff clay with common fine caliche veins in sampler tip, at 14'					
			- moist, with common caliche veins, with iron oxide staining, and					
16	7	(32)	with fine rock fragments, at 15'	113	17			
18								

CONTRACTOR:	S/G Drilling, Inc.	TOTAL DEPTH (ft):	16.5'
METHOD:	8" hollow-stem auger	WATER DEPTH (ft):	Not Encountered
BACKFILL:	Cuttings w/Portland	LOGGED BY:	S Prentice
DATE:	March 13, 2018	CHECKED BY:	L Prentice

NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.

LVMWD/CMWD INTERCONNECTION PROJECT (PROJECT 450)
Thousand Oaks, California

LOG OF DRILL HOLE DH-3

LOCATION: NB No. 2 Lane Lindero , N of Westcreek Ln

SURFACE EL. (ft): +1,102'

ELEV. (ft) DEPTH (ft)	SAMPLE	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
0				**ARTIFICIAL FILL (af)** 4" asphalt concrete; 7" clayey sand with gravel base					
1				SAND (SP): moderate brown, moist, medium-grained with few scattered coarse sand					
2			--						
3		1a				9		8	
			(17)	**ALLUVIUM (Qal)?**					p2.5
4		1b		CLAY (CL): stiff, moderate brown and moderate yellowish brown, damp, with fine roots, and with silty pockets and fine angular siltstone inclusions	102	19			
5				- with fine sand and fine weak sandstone inclusions, at 5'					
6		2	46						
7.5		3a		Clayey SAND (SC): dense, reddish brown, damp to moist, with fine gravel and siltstone inclusions and faint light brown veinlets					
8			(33)						
9		3b			111	12			
9.5				**MONTEREY FORMATION (Tm) ?**					
10				CLAYSTONE interbedded with SILTSTONE (Rx): extremely weathered, poorly indurated, soft [CLAY (CL) thinly interbedded with SILT (ML): very stiff, orangish brown mottled with light gray, moist, with silty and sandy pockets, diatomaceous pockets, siltstone and sandstone fragments, and iron oxide stain]					p>4.5
11		4	16			29			
12.5				Sandy SILTSTONE thinly interbedded with CLAYSTONE (Rx): extremely weathered, poorly indurated, soft [Sandy SILT (ML) thinly interbedded with CLAY (CL): very stiff, moderate yellowish brown and light gray, with orangish mottling, moist, with caliche veining and with near-vertical fractures/bedding]					
13		5	(44)		98	27			
15				- thinly interbedded with light gray fine sandy silt, at 15'					
16		6	22			27			
18									

CONTRACTOR:	S/G Drilling, Inc.	TOTAL DEPTH (ft):	16.5'
METHOD:	8" hollow-stem auger	WATER DEPTH (ft):	Not Encountered
BACKFILL:	Cuttings w/Portland	LOGGED BY:	S Prentice
DATE:	March 13, 2018	CHECKED BY:	L Prentice

NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.

LOG OF DRILL HOLE DH-4

LOCATION: NB No. 2 Lane Lindero , N of Rockfield

SURFACE EL. (ft): +1,086.5'

ELEV. (ft) DEPTH (ft)	MATERIAL SYMBOL	SAMPLE	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
					ARTIFICIAL FILL (af)					
					9" asphalt concrete; no discernable base					
					SAND with Clay (SP-SC): grayish brown, moist					
2										
					ALLUVIUM (Qal)?					
			1	15	Clayey SAND (SC): medium dense, pale yellowish brown mottled with moderate yellowish brown, damp, with veinlets, and few coarse sand and scattered gravel and fine sandstone and siltstone fragments and iron oxide staining		15			
4										
					Sandy CLAY (CL)/Clayey SAND (SC): very stiff/medium dense,					
6			2	(28)	moderate yellowish brown, damp, with silty pockets and with orangish brown iron oxide staining	103	21			
8			3	21	Sandy CLAY (CL)/Clayey SAND (SC): very stiff, dark brown, damp, with scattered coarse sand and sandstone fragments and with subrounded gravel to 3/4"-dia; possible soil horizon		17		49	
10					Clayey SAND (SC): loose, dark brown, damp, with scattered coarse					
			4	(10)	gravel to 1"-dia.	96	14			
12					Sandy CLAY (CL): stiff, moderate yellowish brown, damp, mottled					
			5	12	with tan, fine sand, few scattered fine gravel and rock fragments		25		64	
14										
					- moist, with few fine sand, and with angular siltstone fragments					p2.5
16			6	(14)	and orangish inclusions, at 15'	90	27			p3.0
18										
			7	11	SAND with Clay (SP-SC): medium dense, moderate brown, wet, with iron oxide veins at 19-1/4' and 20-3/4'		24			

CONTRACTOR:	S/G Drilling, Inc.	TOTAL DEPTH (ft):	30.5'
METHOD:	8" hollow-stem auger	WATER DEPTH (ft):	20.6'
BACKFILL:	Cuttings w/Portland	LOGGED BY:	S Prentice
DATE:	March 13, 2018	CHECKED BY:	L Prentice

NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.

LOG OF DRILL HOLE DH-4 (Continued)

LOCATION: NB No. 2 Lane Lindero , N of Rockfield
SURFACE EL. (ft): +1,086.5'

ELEV. (ft) DEPTH (ft)	MATERIAL SYMBOL	SAMPLE	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
	▼				- water measured at 20.6' after sampling at 25'					
22										
24			8	(12)	CLAY (CL/CH): medium stiff, grayish brown, wet, with silt, sand, and fine gravel fragments, sticky, plastic	97	24			p1.5 tv0.72
26										
28										
30			9	12	**MONTEREY FORMATION (Tm) ?** Sandy CLAYSTONE thinly interbedded with SILTSTONE (Rx): extremely weathered, poorly indurated, soft, diatomaceous; [Sandy CLAY (CL): thinly interbedded with SILT (ML): stiff, orangish brown and light gray, moist, with iron oxide stain]		30			
32										
34										
36										
38										

CONTRACTOR:	S/G Drilling, Inc.	TOTAL DEPTH (ft):	30.5'
METHOD:	8" hollow-stem auger	WATER DEPTH (ft):	20.6'
BACKFILL:	Cuttings w/Portland	LOGGED BY:	S Prentice
DATE:	March 13, 2018	CHECKED BY:	L Prentice

NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.

LOG OF DRILL HOLE DH-5

LOCATION: SB No. 1 Lane Lindero, N of Rockfield

SURFACE EL. (ft): +1,086.5'

ELEV. (ft) DEPTH (ft)	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
			ARTIFICIAL FILL (af)					
			7" asphalt concrete; no discernable base					
			Clayey SAND (SC): light brown, moist					
2	1	--			18			
			ALLUVIUM (Qal)					
	2	(23)	Clayey SAND (SC): medium dense, pale yellowish brown, damp, with light gray siltstone and dark brown claystone inclusions, and with iron oxide staining	100	22			
4								
			Sandy CLAY (CL): very stiff, moderate yellowish brown, damp, with					
6	3	19	medium dense Clayey SAND (SC) pockets		19		57	
			- stiff, increased moisture content, with clay pockets, at 7-1/2'					
8	4	(24)		111	18			
10			Sandy CLAY (CL): very stiff, dark brown, damp, with angular fine					
	5	17	gravel fragments and with siltstone inclusions; possible soil horizon		22		59	
12			CLAY (CL): stiff, moderate yellowish brown, moist, with fine gravel					
	6	(25)	fragments and sandy pods		26			
14			- stiff, moderate brown, sandy, with few scattered coarse sand, and					
16	7	13	fine siltstone and rock fragments, at 15'		27		76	p2.0
18								
	8	(13)	- medium stiff, with scattered coarse sand, increased moisture content, sticky, plastic, at 19'	91	30			p1.5 tv0.32

CONTRACTOR:	S/G Drilling, Inc.	TOTAL DEPTH (ft):	30.5'
METHOD:	8" hollow-stem auger	WATER DEPTH (ft):	26.9'
BACKFILL:	Cuttings w/Portland	LOGGED BY:	S Prentice
DATE:	March 14, 2018	CHECKED BY:	L Prentice

NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.

LOG OF DRILL HOLE DH-5 (Continued)

LOCATION: SB No. 1 Lane Lindero, N of Rockfield

SURFACE EL. (ft): +1,086.5'

ELEV. (ft) DEPTH (ft)	MATERIAL SYMBOL	SAMPLE	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
22										
24			9	12	Sandy CLAY (CL): stiff, moderate brown, moist, sticky, with scattered fine gravel		22		59	
26					- water measured at 26.9' after sampling at 30'					
28										
30			10	(45)	**MONTEREY FORMATION (Tm) ?** SILTSTONE thinly interbedded with CLAYSTONE (Rx): extremely weathered, poorly indurated, soft [SILT (ML) thinly interbedded with CLAY (CL): very stiff, damp to moist, light gray and orangish brown]	95	28			
32										
34										
36										
38										

CONTRACTOR:	S/G Drilling, Inc.	NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.	TOTAL DEPTH (ft):	30.5'
METHOD:	8" hollow-stem auger		WATER DEPTH (ft):	26.9'
BACKFILL:	Cuttings w/Portland		LOGGED BY:	S Prentice
DATE:	March 13, 2018		CHECKED BY:	L Prentice

LVMWD/CMWD INTERCONNECTION PROJECT (PROJECT 450)
Thousand Oaks, California

LOG OF DRILL HOLE DH-6

LOCATION: SB No. 1 Lane Lindero, S of Rockfield
SURFACE EL. (ft): +1,080.5'

ELEV. (ft) DEPTH (ft)	MATERIAL SYMBOL	SAMPLE	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
					ARTIFICIAL FILL (af)					
					5" asphalt concrete; 6" sandy clay with gravel base					
					Sandy CLAY (CL): moderate brown, damp					
2										
			1a		**ALLUVIUM (Qal)**					
4				22	Sandy CLAY (CL): very stiff, moderate brown, damp, with siltstone fragments and sandy pockets, and with orangish brown stain		23		66	
			1b							
					MONTEREY FORMATION (Tm)?					
					Clayey SANDSTONE faintly interbedded with SILTSTONE (Rx): extremely weathered, poorly indurated, soft, diatomaceous; [Clayey SAND (SC): medium dense, orangish brown, damp,					
6			2	(74/11)	faintly interbedded with very stiff, light gray SILT (ML)]	90	28			
					- extremely to highly weathered, light brown interbedded with yellowish brown and light tan, hard, at 6'					
8										
10			3	62			17			
12										
14					- highly weathered, increased induration, with very fine sandy	96	27			
			4	(67)	lenses, at 14'					
16										
18										

CONTRACTOR:	S/G Drilling, Inc.	TOTAL DEPTH (ft):	15.5'
METHOD:	8" hollow-stem auger	WATER DEPTH (ft):	Not Encountered
BACKFILL:	Cuttings w/Portland	LOGGED BY:	S Prentice
DATE:	March 14, 2018	CHECKED BY:	L Prentice

NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.

LOG OF DRILL HOLE DH-7

LOCATION: NB No. 1 Lane Lindero, S of Symphony

SURFACE EL. (ft): +1,076.5'

ELEV. (ft) DEPTH (ft)	NUMBER	BLOW COUNT	MATERIAL DESCRIPTION	DRY DEN. (pcf)	MOISTURE CONTENT %	PLASTICITY (LL/PI)	% PASSING No. 200	TV or PP (tsf)
			ARTIFICIAL FILL (af)					
			6" asphalt concrete; 5" sandy clay with gravel base					
	1	--	Sandy CLAY (CL): grayish brown, damp to moist,		26		52	
2								
	2a		**ALLUVIUM (Qal)?**					
		(37)	SAND with Clay (SP-SC): medium dense, grayish brown, damp to moist, with scattered rounded gravel					
4	2b			97	26			
			Clayey SILT (ML): very stiff, light brown mottled with dark brown, moist					
			Sandy CLAY (CL): medium stiff to stiff, dark brown, damp, possible soil horizon					
6	3	15			27		66	
			MONTEREY FORMATION (Tm)					
			SILTSTONE thinly interbedded with CLAYSTONE (Rx): extremely to highly weathered, light brown interbedded with yellowish brown and light tan, diatomaceous, [SILT (ML) thinly interbedded with CLAY (CL): hard, damp]					
8	4	(38)		80	36			
10			- faintly bedded, appears steeply dipping, with caliche, at 10'					
	5	25			38			
			- driller reports hard drilling below 10'					
12								
14			- increased induration, distinct bedding, steeply dipping, at 14'	86	28			
	6	(86/11)						
16			NOTE: 1/4"-dia. yellow rope wrapped around bottom of lead auger when pulled from hole prior to backfill.					
18								

CONTRACTOR:	S/G Drilling, Inc.	TOTAL DEPTH (ft):	15.5'
METHOD:	8" hollow-stem auger	WATER DEPTH (ft):	Not Encountered
BACKFILL:	Cuttings w/Portland	LOGGED BY:	S Prentice
DATE:	March 14, 2018	CHECKED BY:	L Prentice

NOTE: The log and data presented herein are a simplification of actual subsurface conditions encountered at the time of exploration at the specific location explored. Subsurface conditions may differ at other locations and at this location with the passage of time.

LVMWD/CMWD INTERCONNECTION PROJECT (PROJECT 450)
Thousand Oaks, California

SUMMARY OF SAMPLING DETAILS

Symbol	Sample Number	Blowcount Push, or Grab	Sampler Type
	1	Bulk	Bulk Sample
	2	23	Standard Penetration Test (SPT) Sampler (1-3/8" ID/2" OD) driven
	3	(23)	Modified California Liner Sampler driven (2-3/8" ID/3" OD)
	4	Push	Thin-walled sampler pushed (2-7/8" ID/3" OD)
	5	(23)	Modified California Liner Sampler (disturbed) driven (2-3/8" ID/3" OD)

Blowcount Information

Blowcount	Description
63	63 blows for 1' penetration after initial 6" seating
89/11	89 blows for 11" penetration after initial 6" seating
33/6	33 blows for 6" drive after initial 6" seating
Ref	>50 blows for initial 6" seating
(23)	Blowcounts for modified California sampler

MATERIAL SYMBOLS AND CLASSIFICATIONS

Lean CLAY (CL)	Sandy SILT (ML)	CLAYSTONE	PAVING AND BASE MATERIALS
Fat CLAY (CH)	Silty SAND (SM)	SILTSTONE	CONCRETE
Sandy CLAY (CL)	SAND with Silt (SP-SM and SW-SM)	SANDSTONE	GRAVEL (GP and GW)
SILT (ML)	SAND (SP and SW)	VOLCANIC	GRAVEL with Sand (GP and GW)
Elastic SILT (MH)	Clayey SAND (SC)	DOLOMITIC	SAND with Gravel (SP and SW)
Clayey SILT (ML)	SAND with Clay (SP-SC and SW-SC)	SILICEOUS	SAND with Silt and Gravel (SP-SM and SW-SM)
Clayey GRAVEL (GP and GW)			Silty SAND with Gravel (SM)
			Clayey SAND with Gravel (SC)

Other Symbols

- Groundwater
- Strata break

SUMMARY OF TERMS AND SYMBOLS USED ON LOGS

Summary of Rock Logging Descriptions

Weathering for Intact Rock (after USBR 2001)

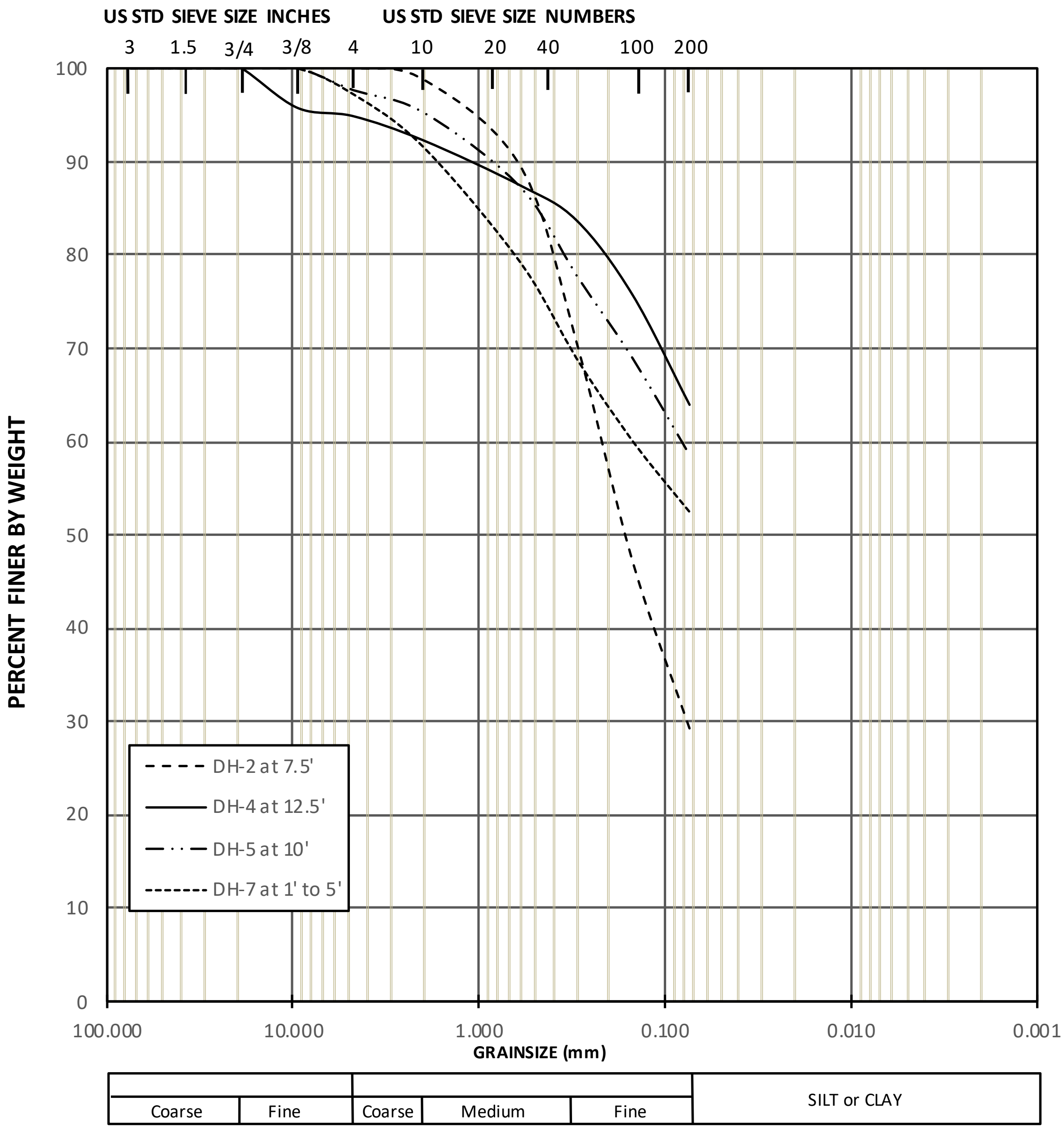
Descriptors	Diagnostic Features: Chemical weathering-Discoloration And/or oxidation – Body of rock	Chemical weathering – Fracture Surfaces	Mechanical weathering- Grain boundary conditions (disaggregation) primarily for granitics and some coarse-grained sediments	Texture and solutioning – Texture	Texture and solutioning – Leaching	General characteristics (strength, excavation, etc.) §
Fresh	No discoloration, not Oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No leaching	Hammer rings when crystalline rocks are struck. Almost always rock excavation except for naturally weak or weakly cemented rocks such as siltstones or shales.
Slightly weathered	Discoloration or oxidation is Limited to surface of, or short distance from, fractures; some feldspar crystals are dull	Minor to complete discoloration or oxidation of most surfaces	No visible separation, intact (tight)	Preserved	Minor leaching of some soluble minerals may be noted	Hammer rings when crystalline rocks are stuck. Body of rock not weakened. With few exceptions, such as siltstones or shales, classified as rock excavation.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty" feldspar crystals are "cloudy"	All fracture surfaces are discolored or oxidized	Partial separation of boundaries visible	Generally preserved	Soluble minerals may be mostly leached	Hammer does not ring when rock is struck. Body of rock is slightly weakened. Depending on fracturing, usually is rock excavation except in naturally weak rocks such as siltstones or shales.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation, see grain boundary conditions	All fracture surfaces are discolored or oxidized, surfaces friable	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated	Texture altered by chemical disintegra -tion (hy-dration, argillation)	Leaching of soluble minerals may be complete	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened. Usually common excavation.
Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay		Complete separation of grain boundaries (disaggregated)	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete		Can be granulated by hand. Always common excavation. Resistant minerals such as quartz may be present as "stringers" or "dikes."

Rock Hardness (after USBR 2001)

Descriptor	Criteria
Extremely hard	Cannot be scratched with a pocketknife or sharp knife. Can only be chipped with repeated hammer blows.
Very hard	Cannot be scratched with a pocketknife. Breaks with repeated hammer blows.
Hard	Can be scratched with a pocketknife with difficulty (heavy pressure). Breaks with heavy hammer blows.
Moderately hard	Can be scratched with a pocketknife with light or moderate pressure. Breaks with light hammer blow or heavy manual pressure.
Moderately soft	Can be grooved 2 mm (1/6 inch) deep with a pocketknife with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure.
Soft	Can be grooved or gouged easily with a pocketknife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
Very soft	Can be readily indented, grooved or gouged with fingernail, or carved with a pocketknife. Breaks with light manual pressure.

SUMMARY OF ROCK TERMS USED ON LOGS

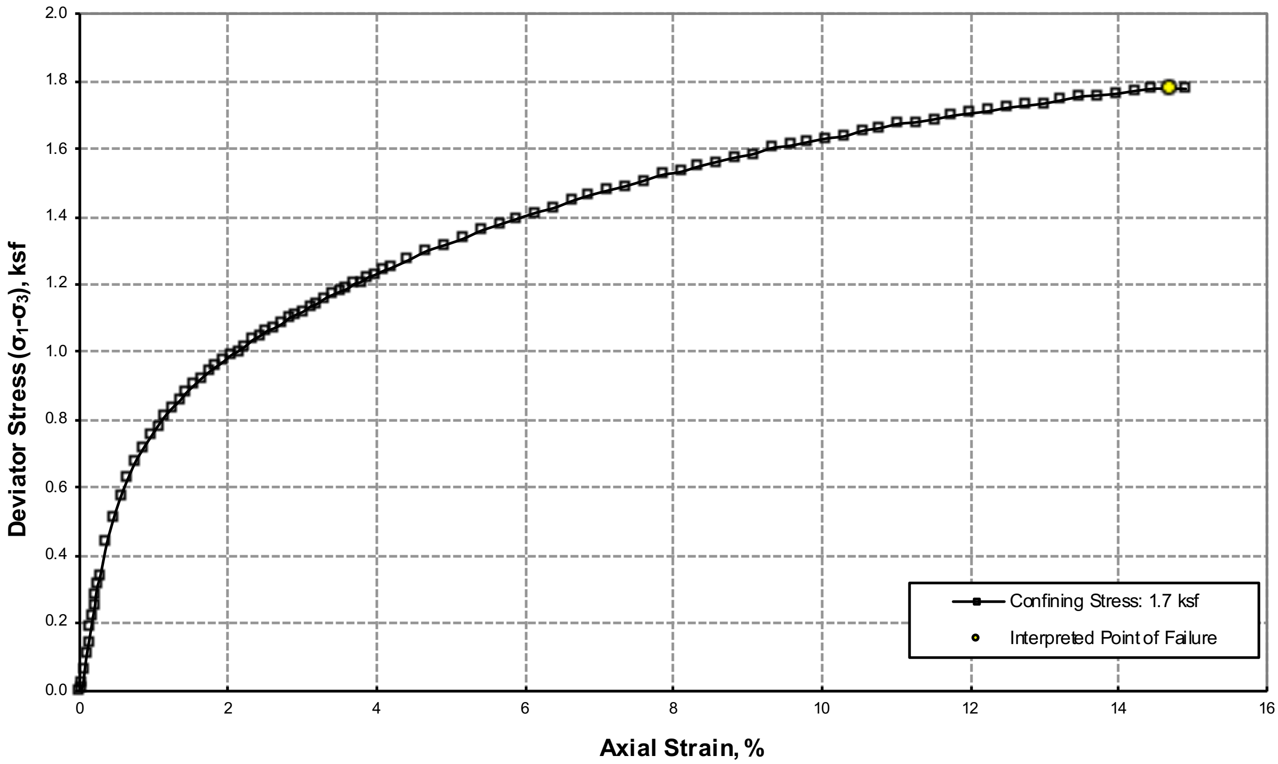
APPENDIX B



LOCATION	DEPTH	CLASSIFICATION	PASSING NO. 200 (%)
DH-2	7.5'	Clayey SAND (SC)	29
DH-4	12.5'	Sandy CLAY (CL)	64
DH-5	10'	Sandy CLAY (CL)	59
DH-7	1' to 5'	Sandy CLAY (CL)	52

GRAINSIZE DISTRIBUTION
LVMWD/CMWD INTERCONNECTION PROJECT (PROJECT 450)
Thousand Oaks, California

PLATE B-1



SAMPLE ID

Boring Number:	DH-4
Sample Number:	8
Sample Depth:	25.0 ft
USCS Classificatio	Lean CLAY with sand (CL): gray brown, moist

PROPERTIES

Water Content, %	24.1%
Dry Unit Weight, p	96.9
Saturation, %	86%
Void Ratio	0.77
Diameter, in	2.42
Height, in	5.00

SAMPLE IMAGES

CLASSIFICATION

Sieve Size	% Passing	Other Parameters	
3/8-in. (9.5mm)	---	Liquid Limit	---
#4 (4.75mm)	---	Plastic Limit	---
#16 (1.18mm)	---	Plasticity Index	---
#30 (0.6mm)	---	Estimated Gs	2.75
#100 (0.150mm)	---	S_u from T_v, ksf	---
#200 (0.075mm)	---	S_u from PP, ksf	---

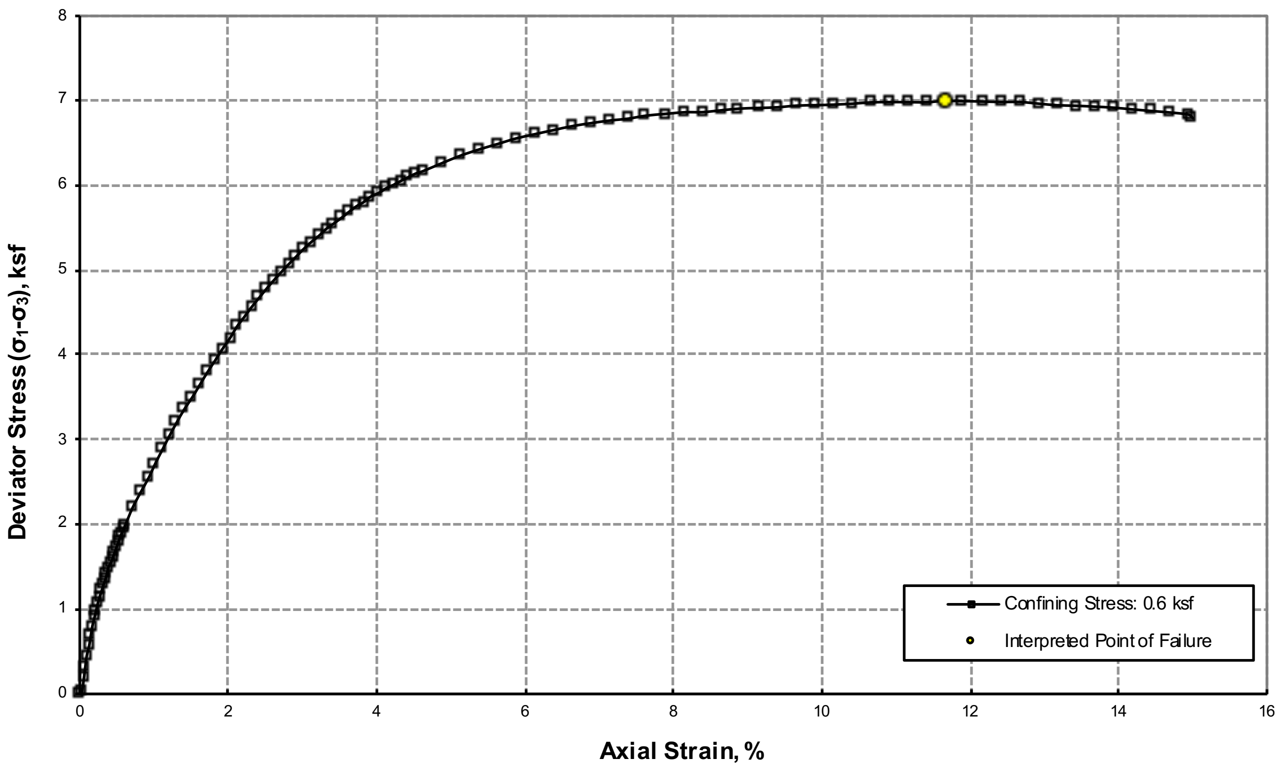
TEST SUMMARY

Maximum Deviator Stress, ksf	1.8
Undrained Shear Strength, ksf	0.9
Axial Strain at Failure, %	14.7
Strain Rate, %/min	0.5
Cell Pressure, ksf	1.7
Tested By:	JC
Date Tested:	4/3/18

REMARKS

Test Method: ASTM 2850
Project: Lindero Canyon Road Pipeline

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



SAMPLE ID		
Boring Number:	DH-5	
Sample Number:	4	
Sample Depth:	7.5 ft	
USCS Classificatio	Sandy lean CLAY (CL): moderate brown, moist	

PROPERTIES	
Water Content, %	17.7%
Dry Unit Weight, p	111.0
Saturation, %	89%
Void Ratio	0.55
Diameter, in	2.42
Height, in	5.00

SAMPLE IMAGES

CLASSIFICATION

Sieve Size	% Passing	Other Parameters	
3/8-in. (9.5mm)	---	Liquid Limit	---
#4 (4.75mm)	---	Plastic Limit	---
#16 (1.18mm)	---	Plasticity Index	---
#30 (0.6mm)	---	Estimated Gs	2.75
#100 (0.150mm)	---	S_u from T_v, ksf	---
#200 (0.075mm)	---	S_u from PP, ksf	---

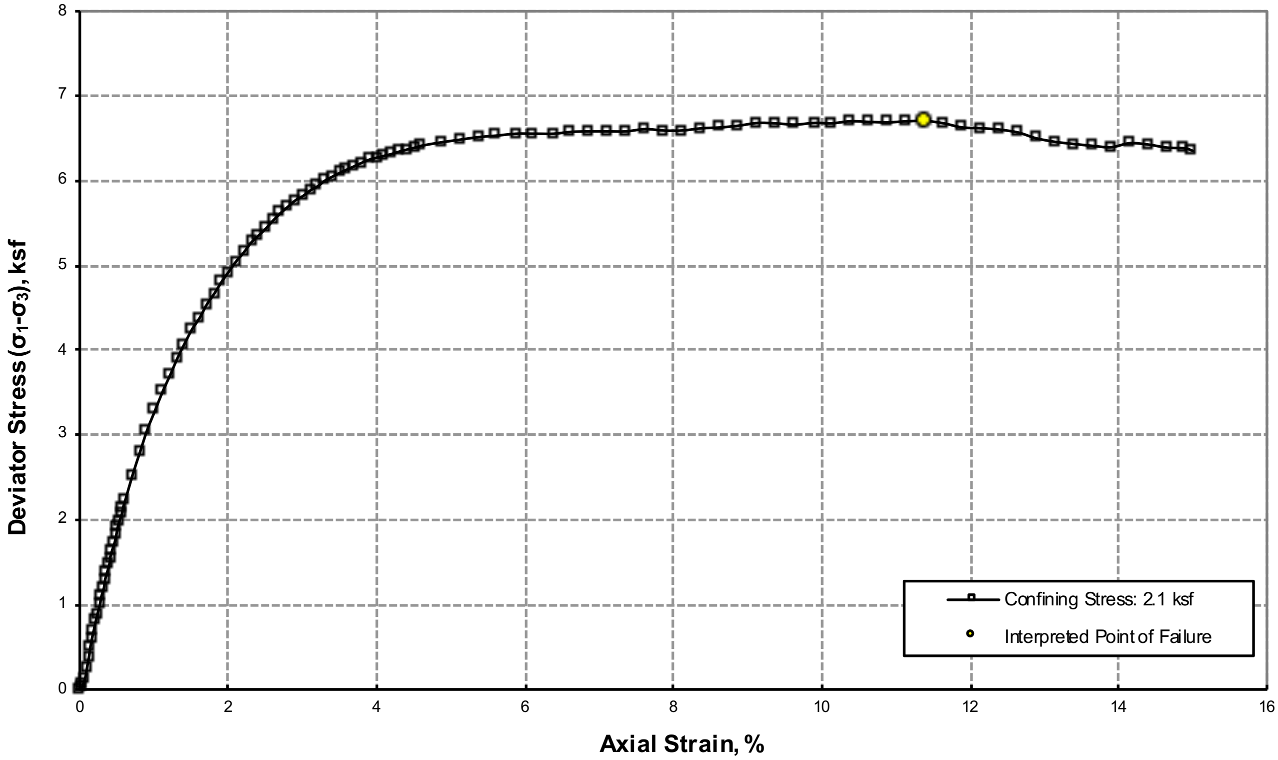
TEST SUMMARY

Maximum Deviator Stress, ksf	7.0
Undrained Shear Strength, ksf	3.5
Axial Strain at Failure, %	11.7
Strain Rate, %/min	0.5
Cell Pressure, ksf	0.6
Tested By:	JC
Date Tested:	4/3/18

REMARKS

Test Method: ASTM 2850
Project: Lindero Canyon Road Pipeline

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



SAMPLE ID

Boring Number:	DH-5
Sample Number:	5
Sample Depth:	30.0 ft
USCS Classificatio	Lean CLAY (CL): brown and red yellow, moist

PROPERTIES

Water Content, %	27.7%
Dry Unit Weight, p	94.8
Saturation, %	94%
Void Ratio	0.81
Diameter, in	2.41
Height, in	5.03

SAMPLE IMAGES

CLASSIFICATION

Sieve Size	% Passing	Other Parameters	
3/8-in. (9.5mm)	---	Liquid Limit	---
#4 (4.75mm)	---	Plastic Limit	---
#16 (1.18mm)	---	Plasticity Index	---
#30 (0.6mm)	---	Estimated Gs	2.75
#100 (0.150mm)	---	S_u from T_v, ksf	---
#200 (0.075mm)	---	S_u from PP, ksf	---

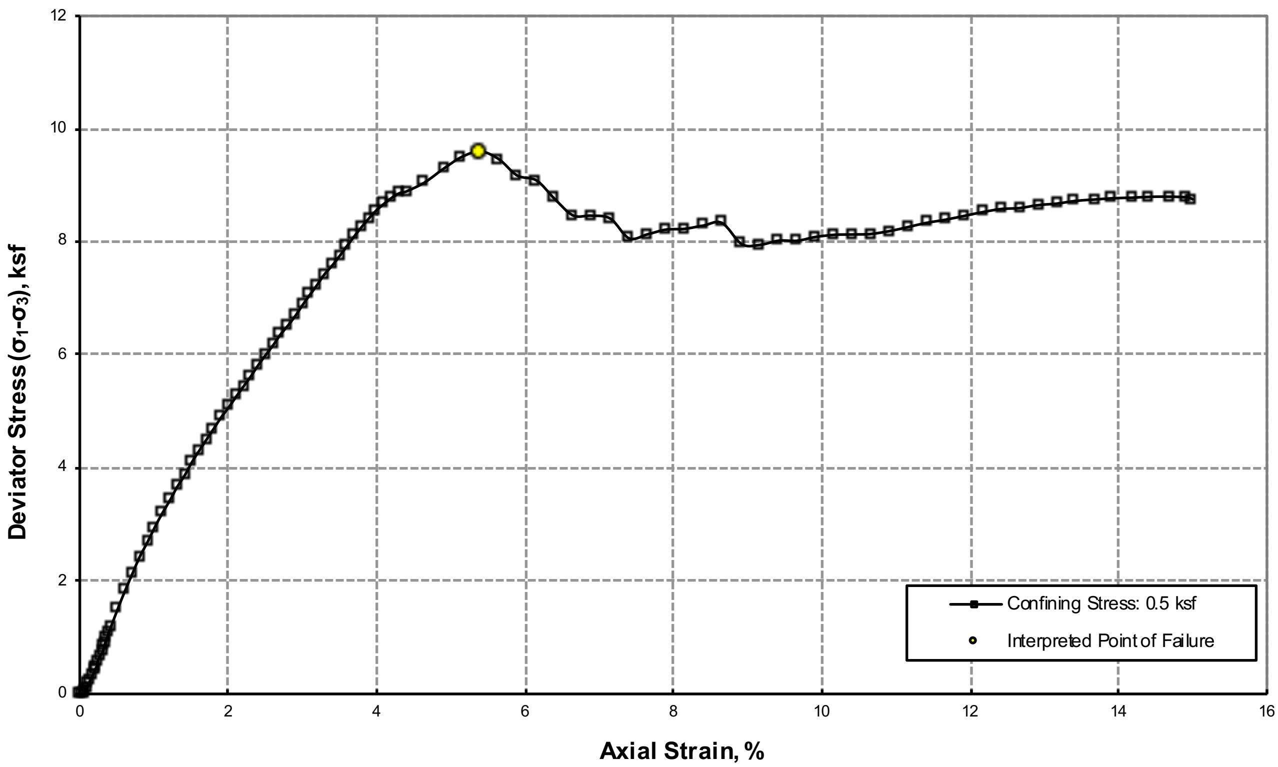
TEST SUMMARY

Maximum Deviator Stress, ksf	6.7
Undrained Shear Strength, ksf	3.4
Axial Strain at Failure, %	11.4
Strain Rate, %/min	0.5
Cell Pressure, ksf	2.1
Tested By:	JC
Date Tested:	4/5/18

REMARKS

Test Method: ASTM 2850
Project: Lindero Canyon Road Pipeline

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



SAMPLE ID

Boring Number:	DH-6
Sample Number:	2
Sample Depth:	6.0 ft
USCS Classificatio	Lean CLAY (CL): light brown and red yellow, moist

PROPERTIES

Water Content, %	28.2%
Dry Unit Weight, p	90.1
Saturation, %	86%
Void Ratio	0.90
Diameter, in	2.42
Height, in	5.00

SAMPLE IMAGES

CLASSIFICATION

Sieve Size	% Passing	Other Parameters	
3/8-in. (9.5mm)	---	Liquid Limit	---
#4 (4.75mm)	---	Plastic Limit	---
#16 (1.18mm)	---	Plasticity Index	---
#30 (0.6mm)	---	Estimated Gs	2.75
#100 (0.150mm)	---	S_u from T_v, ksf	---
#200 (0.075mm)	---	S_u from PP, ksf	---

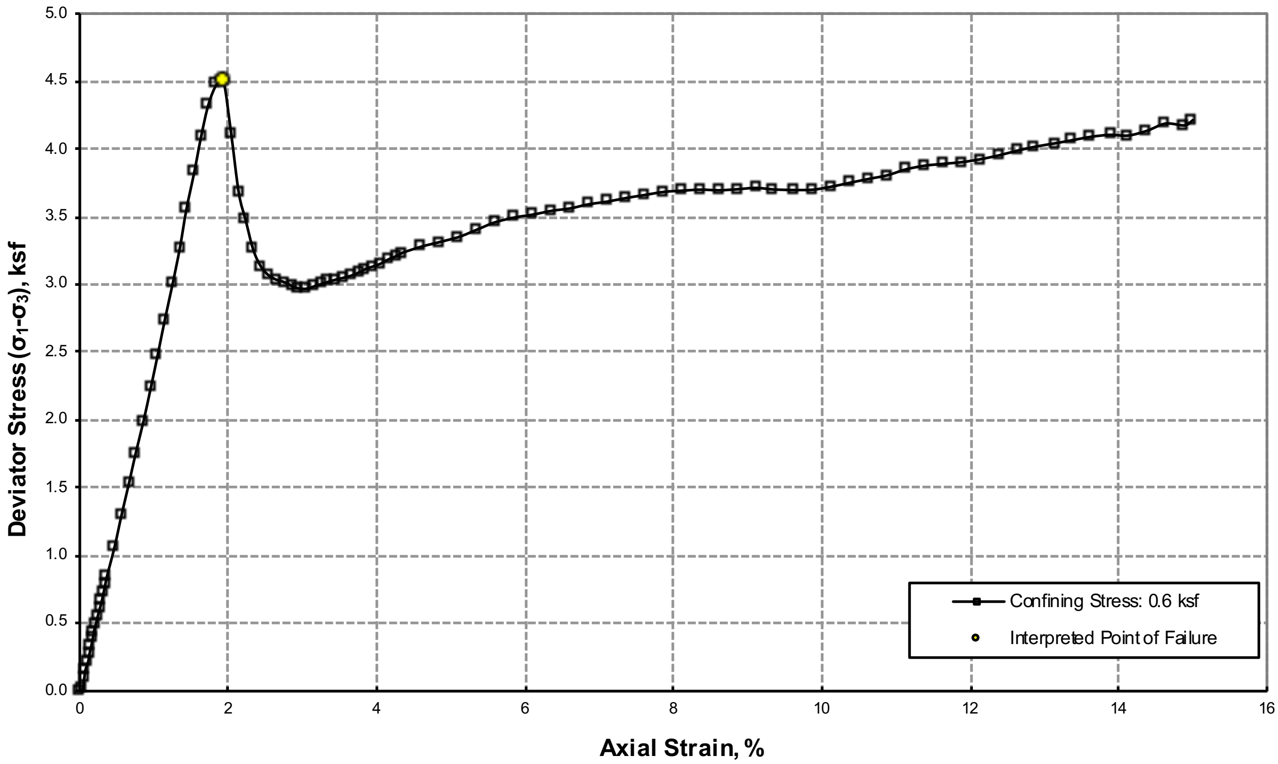
TEST SUMMARY

Maximum Deviator Stress, ksf	9.6
Undrained Shear Strength, ksf	4.8
Axial Strain at Failure, %	5.4
Strain Rate, %/min	0.5
Cell Pressure, ksf	0.5
Tested By:	JC
Date Tested:	4/5/18

REMARKS

Test Method: ASTM 2850
Project: Lindero Canyon Road Pipeline

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



SAMPLE ID

Boring Number:	DH-7
Sample Number:	4
Sample Depth:	7.5 ft
USCS Classificatio	Lean CLAY(CL): light brown, moist

PROPERTIES

Water Content, %	36.1%
Dry Unit Weight, p	79.5
Saturation, %	86%
Void Ratio	1.16
Diameter, in	2.41
Height, in	5.07

SAMPLE IMAGES

CLASSIFICATION

Sieve Size	% Passing	Other Parameters	
3/8-in. (9.5mm)	---	Liquid Limit	---
#4 (4.75mm)	---	Plastic Limit	---
#16 (1.18mm)	---	Plasticity Index	---
#30 (0.6mm)	---	Estimated Gs	2.75
#100 (0.150mm)	---	S_u from T_v, ksf	---
#200 (0.075mm)	---	S_u from PP, ksf	---

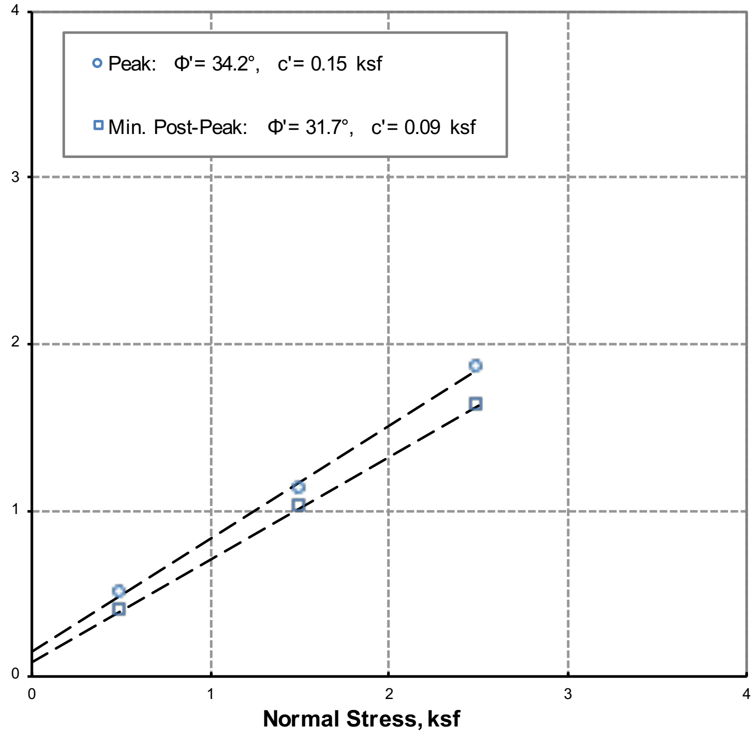
TEST SUMMARY

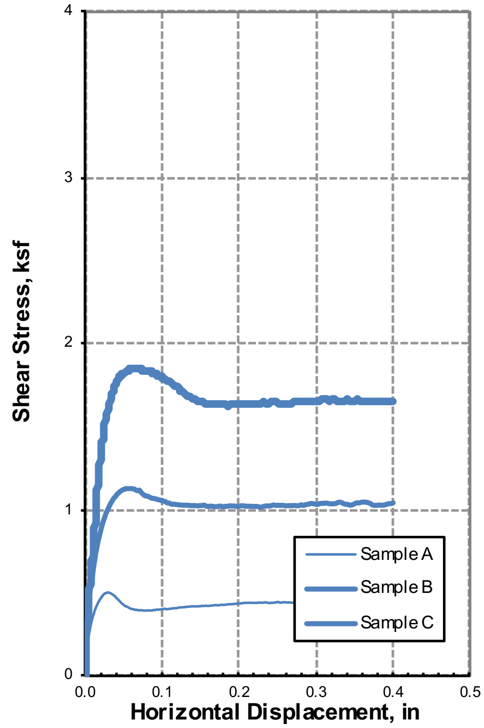
Maximum Deviator Stress, ksf	4.5
Undrained Shear Strength, ksf	2.3
Axial Strain at Failure, %	1.9
Strain Rate, %/min	0.5
Cell Pressure, ksf	0.6
Tested By:	JC
Date Tested:	4/5/18

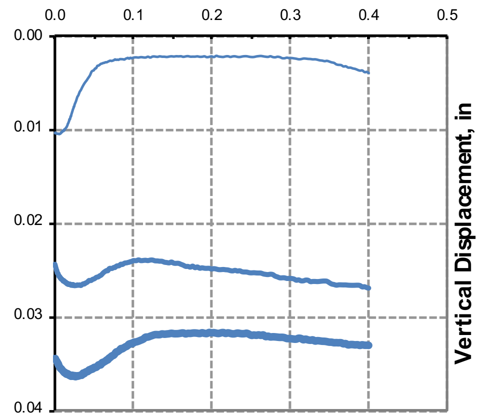
REMARKS

Test Method: ASTM 2850
Project: Lindero Canyon Road Pipeline

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST







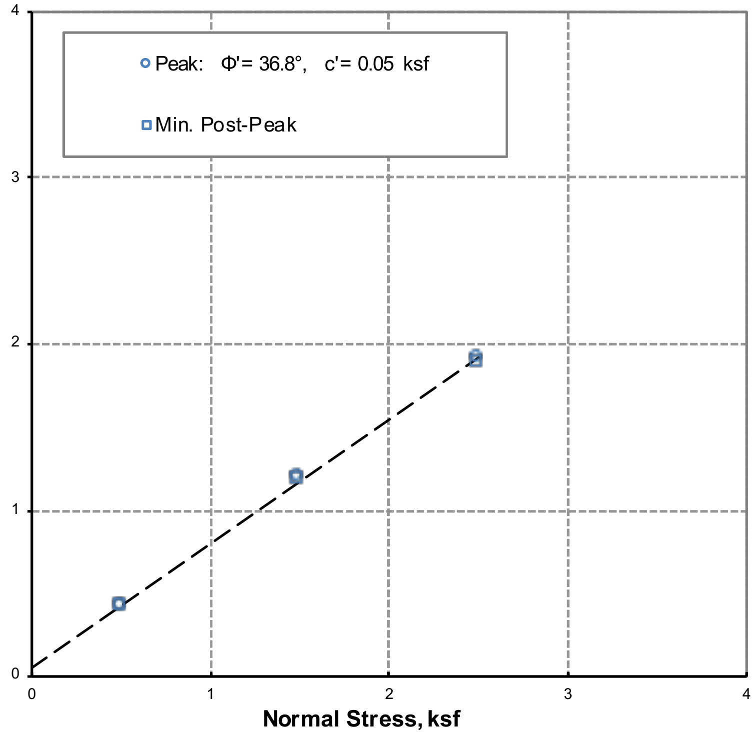
SAMPLE ID		
	Boring Number:	DH-2
	Sample Number:	3
	Sample Depth:	4.0 ft
	USCS Classification:	Clayey SAND (SC): red brown, moist

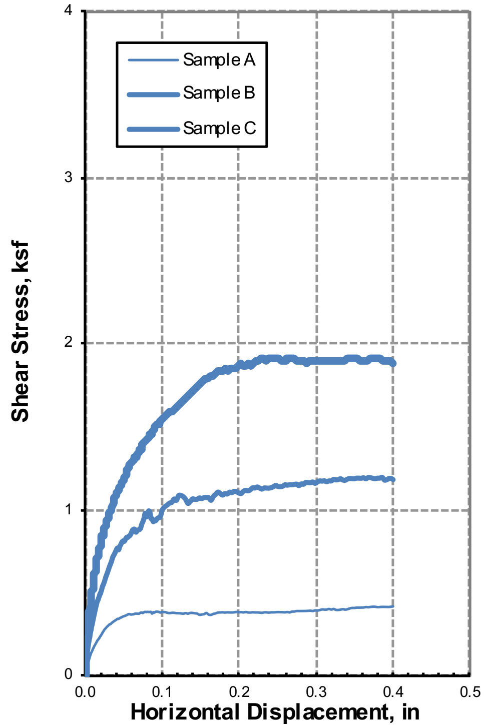
	Specimen	A	B	C	D
INITIAL	Water Content, %	12.6%	12.6%	12.6%	
	Dry Unit Weight, pcf	109.0	109.1	113.0	
	Saturation, %	64%	64%	71%	
	Void Ratio	0.53	0.53	0.47	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	21.4%	18.9%	17.6%	
	Dry Unit Weight, pcf	104.9	108.7	113.1	
	Void Ratio	0.59	0.53	0.47	
TEST SUMMARY	Displacement at Peak, in	0.03	0.06	0.06	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.5	2.5	
	Peak Shear Stress, ksf	0.50	1.13	1.85	
	Min. Post-Peak Stress, ksf	0.39	1.02	1.63	

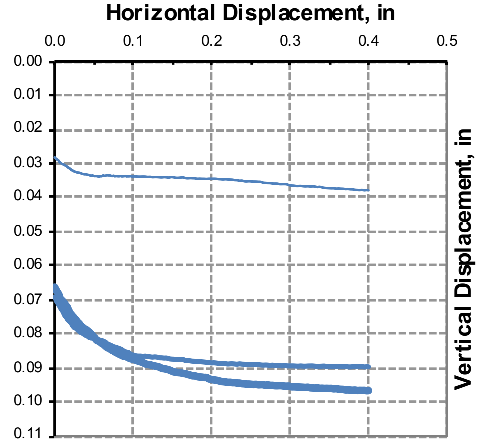
REMARKS	
	Project: Lindero Canyon Road Pipeline
	Test Method: ASTM D3080

CLASSIFICATION	Sieve Size	% Passing
	3/8-in. (9.5mm)	---
	#4 (4.75mm)	---
	#16 (1.18mm)	---
	#30 (0.6mm)	---
	#100 (0.150mm)	---
	#200 (0.075mm)	---
	Atterberg Limits	
	Liquid Limit, %	---
	Plastic Limit, %	---
	Plasticity Index, %	---
	Estimated Gs	2.67
	k_{avg} 20ºC, cm/sec	---

DIRECT SHEAR TEST







SAMPLE ID	Boring Number:	DH-4			
	Sample Number:	4			
	Sample Depth:	10.0 ft			
	USCS Classification:	Clayey SAND (SC): brown, moist			
	Specimen	A	B	C	D
INITIAL	Water Content, %	13.9%	13.9%	13.9%	
	Dry Unit Weight, pcf	98.3	95.6	95.4	
	Saturation, %	55%	52%	51%	
	Void Ratio	0.65	0.70	0.70	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	22.9%	20.0%	21.1%	
	Dry Unit Weight, pcf	98.6	103.0	100.4	
	Void Ratio	0.65	0.58	0.62	
TEST SUMMARY	Displacement at Peak, in	0.40	0.39	0.35	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.5	2.5	
	Peak Shear Stress, ksf	0.42	1.20	1.92	
	Min. Post-Peak Stress, ksf	0.42	1.18	1.88	
REMARKS	Project: Lindero Canyon Road Pipeline Test Method: ASTM D3080				

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.6
k_{avg} 20ºC, cm/sec	---

DIRECT SHEAR TEST

COOPER TESTING LABORATORY

Corrosivity Tests Summary

CTL # 903-034 **Date:** 4/4/18 **Tested By:** PJ **Checked:** PJ
Client: Oakrdige Geoscience **Project:** Lindero Cyn Rd Pipeline **Proj. No:** 003.001
Remarks:

Sample Location or ID			Resistivity @ 15.5 °C (Ohm-cm)			Chloride	Sulfate		pH	ORP		Sulfide	Moisture	Soil Visual Description
			As Rec.	Min	Sat.	mg/kg	mg/kg	%		(Redox)		Qualitative	At Test	
						Dry Wt.	Dry Wt.	Dry Wt.		E_H (mv)	At Test	by Lead	%	
Boring	Sample, No.	Depth, ft.	ASTM G57	Cal 643	ASTM G57	ASTM D4327	ASTM D4327	ASTM D4327	ASTM G51	ASTM G200	Temp °C	Acetate Paper	ASTM D2216	
DH-2	1	1-5	-	-	1,467	6	125	0.0125	7.6	-	-	-	14.0	Olive Brown Sandy CLAY
DH-5	6	12.5	-	-	652	78	578	0.0578	7.6	-	-	-	25.8	Olive Brown Sandy CLAY
DH-7	1	1-5	-	-	1,594	8	117	0.0117	7.7	-	-	-	25.5	Light Olive Brown Sandy CLAY