Appendix H-1

Geotechnical Report

Prepared for

Southern California Gas Company
555 West 5th Street
Los Angeles, California 90051

GEOTECHNICAL INVESTIGATION REPORT

HONOR RANCHO COMPRESSOR MODERNIZATION PROJECT

SANTA CLARITA, CALIFORNIA

Prepared by

engineers | scientists | innovators

2100 Main St, Suite 150
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Project Number SC0766U

April 2021

Geosyntec
consultants

April 29, 2021

Mehrshad Ketabdar, SE, PE, PMP, LEED AP
Southern California Gas Company
555 W 5th St.
Los Angeles, California 90013

Subject: **Geotechnical Investigation Report**
Honor Rancho Compressor Modernization Project
Santa Clarita, California

Dear Mr. Ketabdar:

Geosyntec Consultants (Geosyntec) is pleased to provide Southern California Gas Company (SoCalGas) with the accompanying report presenting the results of our geotechnical investigation and recommendations of the geotechnical study for the proposed Compressor Modernization Project at SoCalGas's Honor Rancho Facility in Santa Clarita, California.

Our services were performed in general agreement with the Standard Services Agreement with SoCalGas (Agreement No. 5660060731), dated December 8, 2020 and Amendment No.1 to the existing Agreement, dated March 29, 2021.

This report presents our conclusions and recommendations pertaining to the proposed improvements, and the results of our geotechnical field exploration and laboratory testing programs. The site is generally suitable for the proposed development, provided the design and construction incorporate the recommendations in this report.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us. We appreciate your business and look forward to our next project with you.

Sincerely,

CHRISTOPHER S. CONKLE
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EXP 6/30/21

JERKO KOCIJAN
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Exp. 12/31/21

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1. INTRODUCTION

This report presents results of Geosyntec Consultants' (Geosyntec's) geotechnical engineering investigations and evaluations for the proposed Compressor Modernization Project at the Southern California Gas Company's (SoCalGas) Honor Rancho Facility (Facility) in Santa Clarita, California. This report was prepared by Messrs. Chris Conkle, P.E., G.E., and Dennis Kilian, P.G., C.E.G., and has been reviewed by Dr. Jerko Kocijan, P.E., G.E., in accordance with the peer review policies of the firm. Geosyntec prepared this report for SoCalGas's use at the time of the front end engineering design (FEED) contractor's design effort for the project. An additional geotechnical report will be required to secure necessary grading related approvals from the building official.

1.1 Project Description

The Facility is located in Santa Clarita, California, and situated to the north of Newhall Ranch road (Figure 1).

The Facility currently includes an existing gas compressor facility and other related gas storage facilities. We understand that the planned upgrades include installation of a new hybrid compression plant which will be known as Injection Compressor Plant 2 (new Compressor Building) as well as several other facilities at various locations within the facility. The site plan, illustrating the existing facility, proposed construction, and surrounding areas are presented on Figure 2.

The new Compressor plant will among other items include the following components:

- four gas engine-driven reciprocating compressors (GDC),
- two electric motor-driven reciprocating compressors (EDC),
- a compressor building sized for seven compressors (four GDCs and three EDCs),
- power distribution center (PDC),
- an electrical and instrumentation (E&I) building, and
- other appurtenant facilities and utilities.

The proposed location of the new Compressor Plant as well as the associated power distribution center and Fuel Cells (see Figure 2) is currently mostly vacant, with high topography relief. Site preparation for the proposed compressor facility and fuel cells will require a substantial amount of excavation and grading to create a building pad at the appropriate elevation.

The proposed Substation (see Figure 2) is located in a mostly vacant with high topography relief and will also require a substantial amount of grading to create a building pad at the appropriate elevation.

The location of the proposed Advanced Renewable Energy (ARE) Facility has been previously graded and is currently relatively flat with a paved area containing several office trailers along with associated parking space.

The improvements are expected to be founded on either shallow or deep foundations, depending on their location and required performance. The foundation recommendations presented in this report include design input for both shallow and deep foundations, which can be used by the structural engineer for further planning and design purposes.

1.2 Purpose and Scope of Investigation

The purpose of our services is to investigate subsurface conditions and provide geotechnical engineering and geologic conclusions and recommendations for the design and construction of the project. The scope of the investigation is outlined in our contract agreement (Agreement No. 56600060731) dated December 8, 2020 and includes field exploration, laboratory testing, engineering evaluation and analyses, and preparation of this geotechnical engineering report.

Specifically, this report provides discussion and recommendations regarding:

- Geotechnical Investigation program;
- Geologic and seismic setting;
- Surface conditions;
- Anticipated geologic units;
- Potential geologic hazards;
- Potential seismic hazards (liquefaction, fault rupture, lateral spreading);
- Earthwork and grading;
- Recommendations for future slope stability evaluations;
- Seismic design criteria according to California Building Code (CBC) 2019 and ASCE 7-16;
- Allowable vertical and lateral capacities of shallow foundations;
- Allowable axial capacities of deep foundations and their response under lateral loading;
- Anticipated foundation settlements;
- Parameters regarding soil-structure-interaction;
- Retaining wall earth pressures (static and seismic);
- Concrete slabs and hardscapes;
- Utility trenches;
- Stormwater infiltration;
- Flexible and rigid pavement; and
- Construction considerations.

1.3 Previous Site Investigations

Geosyntec (2020) advanced twelve direct push borings to evaluate a potential historical release of natural gas odorant to the subsurface at the Facility. The investigation area was located approximately 450 feet (ft) southwest of the main operations building in an area adjacent to the current odorant injection system. The borings were drilled to depths between 15 and 24 ft below ground surface (bgs) using direct-push methods to facilitate soil sampling and installation of nested soil vapor probes. The information contained in this previous environmental investigation was reviewed during the preparation of this report.

2. GEOTECHNICAL FIELD EXPLORATION AND LABORATORY TESTING PROGRAM

2.1 Geotechnical Investigation

Pre-field activities, subsurface explorations, and geotechnical laboratory testing were performed as part of this study. The following subcontractors were engaged in the execution of the field exploration program and laboratory testing:

- Cone Penetration Testing and mud-rotary drilling by Gregg Drilling, LLC, California;
- OYO P-S suspension logging and Seismic Refraction by GEOVision, Inc., California;
- Hollow-stem auger drilling, temporary infiltration test well installation and well abandonment by Martini Drilling Corporation, California;
- Geotechnical laboratory testing by AP Engineering and Testing, Inc., California;
- Analytical testing of drilling mud stored in drums by Eurofins Calscience Environmental Labs, California; and,
- Drum disposal by NRC Environmental Services, Inc., California.

2.1.1 Pre-Field Activities

Prior to conducting field explorations, Geosyntec contacted Underground Service Alert (USA DigAlert) to coordinate clearance of the exploration locations with respect to below ground utilities. A site-specific health and safety plan was prepared in accordance with Geosyntec requirements. After arriving at the Facility, Geosyntec and subcontractors of Geosyntec (Gregg Drilling, LLC; GEOVision, Inc.; and Martini Drilling Corporation) attended site-specific environmental and safety training provided by SoCalGas representatives.

2.1.2 Cone Penetration Test (CPT)

Six cone penetration tests (CPT-1, CPT-2, CPT-3, CPT-4, CPT-5, and CPT-6) were performed at the Site on January 11, 2021 using a 25-ton CPT truck and a standard 15cm^2 cone. CPT-1 through CPT-4 were performed within the footprint of the compressor building, CPT-5 was performed within the footprint of the power distribution center, and CPT-6 was performed adjacent to the substation on the western side of the Site. The CPTs reached refusal in Saugus Formation materials at depths of between 11 to 39 ft bgs. At five of these locations, shear wave velocity tests were conducted to assess the subsurface seismic conditions. Groundwater was not encountered during the cone penetration testing. The CPT locations are shown on Figure 2. The results of the CPT tests are provided in Appendix A.

2.1.3 Exploratory Borings

Four mud-rotary/rock core boring (B-1, B-2, B-3, and B-4) were advanced to depths of 16 ft to 56 ft bgs using a truck-mounted Fraste Multidrill (XL 140T) drilling rig using alternately an 8-inch diameter mud rotary bit and 3.75-inch outer diameter HQ coring bit between January 13, 2021 and January 15, 2021. Five hollow-stem borings (HSA-1, HSA-2, TPB-1, TPB-2, and TPB-3) were advanced to depths between 6 ft and 31 ft bgs on January 4, 2021. The borings were advanced using a CME 75 high torque truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. The approximate boring locations (mud-rotary and hollow stem) are shown on Figure 2.

Soil samples from the borings were collected using a Standard Penetration Test (SPT) sampler or a 3-inch diameter split-spoon Modified California (Mod Cal) sampler driven with an automatic hammer (140-pound hammer falling approximately 30 inches). The blow counts for SPT and Mod Cal sampling were corrected with the help of the hammer energy ratios, as documented in Appendix B, in which the calibration report of the equipment is also provided. Bulk samples of the soil cuttings were also collected from the shallow zone (0 to 5 ft) of exploratory borings. Once bedrock was encountered in borings B-1 through B-4, the drill rig was retooled to perform HQ rock coring, and continuous rock core samples were retrieved. Select samples from the borings were sealed and transported to the geotechnical laboratory for testing. Upon completion of drilling activities, HSA-1 and HSA-2 were converted to infiltration test wells, as described in Section 2.1.6 below.

Descriptions and visual classification of the subsurface materials were logged by a Geosyntec Engineering Geologist (CEG) and reviewed by a registered Geotechnical Engineer (PE, GE). Subsurface descriptions were based on the recovered soil samples and soil cuttings. The subsurface descriptions were developed in general accordance with American Society for Testing and Materials International (ASTM) standard D2488. A summary of the exploratory borings is presented in Table 1, and the individual boring logs are presented in Appendix C. Sampling information and other pertinent field data and observations are included on the boring logs.

2.1.4 OYO Suspension Logging

OYO Suspension P-S logging system was used to measure the shear wave velocity in boring B-1 prior to backfilling. The detailed testing procedure and the results of the OYO P-S suspension logging are provided in Appendix D-1.

2.1.5 Seismic Refraction

To evaluate the rippability of the sedimentary rock of the Saugus Formation, a P-wave seismic refraction survey was conducted in the compressor facility area at the location shown in Figure 2. In this survey, acoustic energy was input to the subsurface using a sledgehammer impacting a metallic plate. The waves propagate into the subsurface at a velocity dependent upon the elastic properties of the material through which they travel. Receivers (geophones) laid out in linear array on the surface recorded the incoming refracted and reflected waves. The applied seismic line consisted of 24 geophones spaced 6 ft apart for a total line length of 138 ft. The seismic refraction method involved analysis of the travel times of the first energy to arrive at the geophones to constitute the seismic refraction model of the rock formation. A report of the seismic refraction survey is provided in Appendix D-2.

2.1.6 Temporary Well Construction and Field Infiltration Testing

Following completion of drilling and sampling, two boreholes were converted to infiltration test wells using the following procedure:

- A 2-inch diameter poly-vinyl chloride (PVC) well screen with 0.02-inch slots was placed into the boring from 15 to 25 ft bgs (for borehole HSA-1), from 5 to 15 ft bgs (for borehole HSA-2).
- A solid PVC pipe with no perforations was installed in the upper region of each borehole above the screened length.
- A 3-inch thick filter sand pack (Cemex Lapis Lustre #3 Sand) was placed around the slotted pipe section at each borehole.
- A 2 ft thick layer of Bentonite chips was used to fill annular space above the screened section of PVC to isolate it from the borehole annulus above. A 2 ft thick layer of Bentonite chips was used to fill the space under the screened section of pipe to isolate it from the borehole below at locations where the boring was originally extended beyond the infiltration well depth and then partially backfilled (i.e. between 15 ft to 30 ft bgs in HSA-2) with site soil prior to well construction.
- Site soil was used to fill the annular space above the Bentonite chips to the top of each well.

One infiltration test well (HSA-2) was constructed with screened interval at relatively shallow depths of 5 ft to 15 ft bgs. One well (HSA-1) was constructed with a deeper screened interval of 15 ft to 25 ft bgs to assess hydraulic conductivity of deeper soil layers. Screen depths were selected in the field based on a visual-manual classification of the soil samples obtained from each boring.

A constant-head infiltration test was conducted at HSA-1 in general accordance with United States Bureau of Reclamation test method USBR 7300-89, as presented in the County of Los Angeles Administrative Manual GS200.2 [GMED, 2017]. At HSA-2, a constant head infiltration test was initially attempted. However, water levels did not drop at a measurable rate due to very poor drainage (very low permeability) characteristics of soils at the screen interval. Therefore, a falling head infiltration test was conducted in general accordance with the guidance provided for “Boring Percolation Test Procedure” in the County of Los Angeles Administrative Manual GS200.2 [GMED 2017].

At each location, the zone immediately around the borehole was first saturated for a minimum of 30 minutes. For constant head set up (HSA-1), water was added to the borehole at a measured rate using a mechanical water meter and a stopwatch. The flow of water delivered to the test well was adjusted to maintain a relatively constant water level within the standpipe. Cumulative volume measurements were recorded at regular intervals until the rate of flow necessary to maintain constant head remained stable for a period of at least 30 minutes. At the end of the constant head test, falling water head within the well was recorded using a water level sounding meter after the supply of water was shut off. At location HSA-2, only the falling head test was performed due to low permeability soil characteristics at the screened interval.

Upon completion of infiltration tests, each temporary well was abandoned by pulling out the PVC casing and screen, over-drilling the borehole down to the drilling termination depth, and backfilling with bentonite and Portland cement to near ground surface. The upper 2 to 3 ft of each abandoned well was plugged with concrete. The surface was then brought back to the original state (coarse gravel) above the concrete plug.

2.2 Geotechnical Laboratory Testing

Selected soil samples from the borings were tested to evaluate the physical and engineering properties of the subsurface materials. The geotechnical laboratory testing was performed by AP Engineering & Testing. The laboratory tests were performed in general accordance with the testing procedures of ASTM or other generally accepted test methods. The geotechnical laboratory tests performed are summarized below.

Geotechnical Laboratory Test	Standard Designation
Sieve Analysis	ASTM D6913
#200 Wash	ASTM D1140
In-Situ Moisture Content and Density	ASTM D2216 and D7263
Atterberg Limits	ASTM D4318
Modified Proctor	ASTM D1557
R-Value	ASTM D2844
Direct Shear	ASTM D3080
Collapse Potential	ASTM D4546
Uniaxial Compressive Strength of Rock	ASTM D7012
Corrosion Suite (Soluble Sulfate, Chloride, pH, Resistivity)	CTM 643, 422, 417

A tabulated summary of the geotechnical laboratory test results is presented in Table 2, and Appendix E presents the geotechnical laboratory test result data sheets.

3. SITE AND GEOLOGIC CONDITIONS

Our understanding of the site conditions has been developed based on the results of our field exploration and laboratory testing program and review of published geologic literature for the site.

3.1 Regional Geology

The Facility is located in the eastern portion of the Ventura Basin within the Transverse Ranges Geomorphic Province. The Transverse Ranges province is characterized by a series of east-west trending steep mountain ranges and valleys that are oblique to the predominant northwest to southeast structural fabric of southern California. The atypical trend of the Transverse Ranges is the result of a restraining bend ("the Big Bend") on the San Andreas Fault system that has rotated and compressed the region to its current configuration. The compression has resulted in folding and reverse/thrust faulting with similar east to west trends, and regional uplift.

The Transverse Ranges Province extends from the Pacific Ocean to the west to the San Bernardino Mountains to the east, where it has been displaced along the south by the San Andreas Fault. The province is bounded to the northwest by the Coast Ranges Province, the northeast by the Mojave Desert Province, and to the south by the Peninsular Ranges and Colorado Desert Province.

Sedimentary rock units comprising the eastern Ventura basin include undifferentiated middle to late Eocene age rocks; middle Miocene age Topanga Formation; late Miocene age Modelo Formation; late Miocene to early Pliocene age Towsley Formation; Pliocene age Pico Formation; and Plio-Pleistocene Saugus Formation. The Saugus Formation is composed of interfingering shallow-water marine, brackish water, and nonmarine units [Dibblee, Jr. and Ehrenspeck, 1996]. These Tertiary period rocks rest unconformably on pre-Cretaceous age metamorphic and igneous basement rocks of the San Gabriel Mountains.

The Facility is underlain by fills, Quaternary-age alluvium deposits, and Saugus Formation sandstone, siltstone, and claystone. Topsoil, colluvium, and residual soils comprise the near surface (<5 ft bgs) materials found in the ungraded, vegetated areas of the site. The Saugus Formation bedding at the site generally dips to the southwest as the site lies on the southern limb of an east-west trending anticline. The surficial regional geologic map is shown as Figure 3.

3.2 Seismic Setting

Faults in southern California are generally classified as "active," "potentially active," and "inactive" faults. Division of these major groups are based on criteria by the California Geologic Survey (CGS, formerly known as California Division of Mines and Geology, CDMG) for the Alquist-Priolo Earthquake Fault Zoning Program [Bryant and Hart, 2007]. By definition, an "active" fault is one that has had displacement within Holocene time (last 11,000 years). A "potentially active" fault has demonstrated displacement of Quaternary-age deposits (last 1.6 million years). "Inactive" faults have not exhibited displacement in the last 1.6 million years.

The San Gabriel Fault – Palomar Section, which is a part of the San Gabriel fault system, is the closest major active fault to the Facility. A strand of the San Gabriel Fault is mapped approximately 0.3 miles northeast of the Facility. Other major nearby active faults include the Holser, Northridge Blind Thrust, Del Valle, Santa Felicia, Santa Susana, and San Andreas Faults.

These faults, their respective distances from the facility and design moment magnitudes are presented in Table 3. The locations of regional faults and historic earthquake epicenters are shown on Figure 5.

3.3 Surface Conditions

Generally, the Honor Rancho Facility lies within a previous alluvial valley drainage trending north-south ending at the Santa Clara River south of the site. Based on a review of historical aerial imagery [historicaerials.com, 2021] and topographic maps, the site was graded in the early 1950's to support the oil and gas facility improvements. Roads were created around the site and various pads were constructed in the early 1970's to achieve the general layout that exists today.

The surface conditions of the proposed improvement areas vary at each location. Present surface conditions in the western and northern portion of the proposed new compressor building include asphalt paved and gravel covered areas with existing facility improvements. The southern and eastern portions consist of an ungraded area covered in vegetation. Cut slopes descend from this ungraded area to the paved/gravel surfaced area below at gradients of 1.5:1 H:V (horizontal to vertical) and steeper. Elevations in this area range from 1,148 ft MSL (mean sea level) in the paved/gravel surfaced area facility area to 1,240 ft MSL at the crest of the ungraded area.

The Power Distribution Center and Fuel Cell areas are partially or fully located within the existing ungraded area which is anticipated to be cut to match the approximate facility grade within the valley (+/- 1,148 ft MSL).

At the proposed Advanced Renewable Energy location, the current site surface is asphalt paved and supports four existing portable trailer offices. The paved site lies at approximately 1,170 ft MSL. Slopes descend down from the site to the east and west at approximate gradients of 1:1 (H:V) and 2:1 (H:V), respectively. A slope to the north descends down to the site at an approximate gradient of 1.5:1 (H:V).

The proposed substation area is soil covered with scattered vegetation. A dirt road ascends through the site area from approximately 1,134 ft MSL at the existing paved street to approximately 1,206 ft MSL at the hilltop where some existing facility improvements are present. Cobbles and gravels were observed within surficial soils and observed in outcropped bedding along the access road.

3.4 Subsurface Conditions

Our understanding of the subsurface conditions at the Site is based on exploratory borings performed for the project, a review of published geologic information, and Site reconnaissance and mapping. Geosyntec's current subsurface explorations indicate that fill soils, alluvium soils, and Saugus Formation are anticipated to underlie the Site. Generalized Site geology and locations of geologic cross sections are presented in Figure 2. Geologic cross sections are presented in Figures 6A to 6F.

3.4.1 Fill

Fill was encountered beneath the paved and gravel surfaced areas at the site in Borings HSA-1, HSA-2, TPB-1 through TPB-3 and B-1, B-2, and B-4. (The CPT investigations passed through fill, but it was not able to directly identified visually.) Where encountered in explorations, fills were observed to extend to a maximum depth of approximately 14 ft bgs in the proposed Compressor Building area, and to approximately 3.5 ft bgs at the proposed Advanced Renewable Energy facility. Fills were not observed at the location of B-3, in the proposed Substation area, but they were inferred to existing in the area just immediately north in the area of CPT-6.

Fill soils may also be encountered along the roadways within the Saugus Formation based on typical construction practices. Fill soils observed primarily consist of medium dense, slightly moist, brown and reddish brown, silty and clayey fine-grained sands with occasional gravels.

The fills which were encountered during the investigations are considered undocumented in that the history of their placement is not known and compaction reports documenting that they were placed as engineered fill are not available.

3.4.2 Quaternary Young Alluvium (Q_{ya})

Based on geologic mapping [Dibblee, Jr. and Ehrenspeck, 1996] and observations during the explorations, Holocene-age alluvium underlies the valley area of the Facility overlying the Saugus Formation. Alluvium was encountered beneath the fill soils in the western part of the proposed Compressor building area to a maximum depth of about 39 ft bgs (i.e. CPT 2) as shown in Figure 2. The alluvium observed generally consists of loose to medium dense, slightly moist to moist, brown to red and gray brown, silty fine-grained sand with occasional medium to coarse sands and gravel. Some interbedded, poorly graded sands were also encountered in the alluvium.

3.4.3 Saugus Formation (Sandstone Unit) (Qss)

Based on the explorations as well as geologic mapping, Plio-Pleistocene age Saugus Formation underlies the Site. The Saugus Formation encountered during the explorations generally consists of interbedded, silty and clayey sandstones with gravels and cobbles, as well as red and light brown sandy claystones. The Saugus Formation was observed to be moderately to highly weathered and occasionally friable in the absence of fines. Based on geologic mapping the Saugus Formation indicated a general dip of 50 to 70 degrees to the southwest, correlating with the southern leg of an anticline with the axis located approximately parallel to the San Gabriel Fault, 1.5 miles north of the site. Based on the results of the seismic refraction survey (see Appendix D-2), the Saugus Formation within the footprint of the proposed Compressor Facility is interpreted to be rippable with Primary compression wave (P-wave) velocities in the range of 2,500 to 4,500 ft/s within the depth of the investigation of about 40 ft. The maximum P-wave velocities in the Saugus Formation underlying the alluvium in the valley area were approximately 5,500 to 6,000 ft/s.

3.4.4 Groundwater

Groundwater was not encountered during the current or the previous explorations at the site documented in Geosyntec [2020]. Site specific data regarding recent groundwater levels at the site was not available. Historical topographic maps and aerial imagery [online at: www.historicalaerials.com, 2021] indicate that a seasonal creek may have followed the valley floor at an elevation of approximately 1,150 ft MSL.

Figure 7 is an excerpt of the historically highest groundwater map from the CGS [1997] Seismic Hazard Zone Report for the Newhall 7.5 Minute Quadrangle. Information from this figure indicates that the “historically high” groundwater level near the Santa Clara River south of the Site is approximately 15 ft bgs. However, an interpretation specific to the Site is not available.

Based on a review of available information, the hydrostatic groundwater level at the Site is anticipated to be no shallower than 60 ft bgs. However, some minimal accumulation of perched groundwater may occur especially following periods of sustained precipitation or excessive irrigation as subsurface flows travel down the former alluvial valley. Fluctuations in groundwater are not anticipated to be significant enough to impact the Site or pose associated geohazards if proper site drainage is designed, installed, and maintained per the recommendations of the project civil engineer.

4. GEOLOGIC HAZARDS

4.1 Fault Surface Rupture

Seismically induced fault surface rupture occurs as the result of differential movement across a fault. The potential for fault surface rupture is generally considered to be significant along "active" faults and to a lesser degree along "potentially active" faults [CDMG, 1998]. A review of published geologic maps did not identify the presence of active or potentially active faults crossing or projecting towards the proposed Site. Therefore, the potential for fault-related surface rupture at the project sites is considered to be low. Furthermore, the site is not located within a delineated earthquake fault rupture hazard zone as defined by the California Geological Survey (CGS) [Bryant and Hart, 2007].

4.2 Strong Ground Shaking and Design Ground Motions

The Facility is situated within a seismically active region and will likely experience moderate to severe ground shaking in response to a large magnitude earthquake occurring on a local or more distant active fault during the expected lifespan of the proposed structures. As a result, seismically induced ground shaking in response to an earthquake occurring on a nearby active fault, such as the San Gabriel Fault, or a regional fault, such as the San Andreas fault zone, is considered to a major geologic hazard affecting the project.

Seismic design parameters were developed in accordance with 2019 CBC and ASCE 7-16. The risk category of the proposed facilities was assumed as IV per Table 1604.5 of the 2019 CBC. Site Class was assessed using site specific shear wave velocity measurements. Shear wave velocities were measured in the fill, alluvium, and Saugus Formation to a maximum depth of 44 ft using suspension logging (Appendix D-1) and seismic CPTs (Appendix A). Extrapolating the shear wave velocity in Saugus Formation down to 100 ft depth, the average shear wave velocity in the upper 30 m (V_{S30}) was estimated to range from 1,650 ft/sec to 2,300 ft/sec (about 500 m/s to 700 m/s), which falls within the range of V_{S30} values for Site Class C (very dense soil and soft rock) according to Table 20.3-1 of ASCE 7-16.

The risk-targeted maximum considered earthquake (MCE_R) ground motion parameters S_S and S_1 were obtained for the Site using the SEAOC/OSHPD Seismic Design Maps Tool (https://seismicmaps.org/). The output from the web tool is included in Appendix F. These mapped ground motion parameters were used to determine the MCE_R ground motion parameters adjusted for Site class effects, S_{MS} and S_{M1}, with appropriate site coefficients for Site Class C. The design ground motion parameters, S_{DS} and S_{D1}, were then determined as 2/3 of the site adjusted MCE_R ground motion parameters. The recommended seismic design parameters including the site adjusted Maximum Credible Earthquake Geometric Mean (MCE_G) peak ground acceleration (PGA_M) are summarized in Table 4.

The design ground motion parameters based on 2019 CBC and ASCE 7-16 are typically developed at 5% reference damping ratio. For damping ratio other than 5%, the design spectral accelerations can be estimated by using multiplicative factors to scale the 5% damped spectral accelerations to the spectral acceleration at desired damping levels. Damping scaling factors were calculated for 10% and 20% damping ratios over the range of periods following the model outlined in Rezaeian et al. [2014] using an input predominant earthquake moment magnitude of 7.0 and site to source distance of 9.5 km (6 miles), selected based on the review of the seismic source deaggregation. The damping scaling factors are presented in Table 5.

It should be noted that while the estimated V_{s30} values are consistent with Site Class C, some portions of the site are underlain by significant thickness of undocumented fill and alluvium (up to almost a 40 ft thickness was encountered at location of CPT-2 in the compressor building area). This may cause some additional localized ground motion amplifications at longer structural periods (based on the comparison of site class specific amplifications periods for Site Classes C and D), thus potentially affecting structures with periods (T) greater than about 0.5 seconds. Site Class D long term period site amplification would result in about a 20 percent increase in long period design spectral acceleration S_{D1}.

4.3 Expansive Soils

Based on the plasticity characteristics of the soils encountered (PI<18), the site soils are considered to have a low potential for expansion.

4.4 Collapsible Soils

Evaluations of settlement behavior from the current soil investigation indicate a significant collapse mechanism of soils upon inundation. The laboratory test results indicate collapse strain of up to about 2 to 3 percent for loading conditions consistent with expected bearing pressures. The response to inundation constitutes a significant hazard for shallow foundations that may be constructed at the site. Settlement sensitive structures supported on shallow foundations may be damaged if inundation of subgrade soils occurs. Additional discussion regarding potential soil collapse upon inundation is provided in Section 5.

4.5 Soil Liquefaction

Seismically induced liquefaction is a phenomenon in which saturated soils lose a significant portion of their strength and acquire some mobility from seismic shaking or other large cyclic loading. The material types considered most susceptible to liquefaction are granular and low-plasticity fine-grained soils that are saturated and loose to medium dense. A rapid increase in groundwater pressures (excess pore water pressures) causes the loss of soil strength.

Manifestations of soil liquefaction can include sand boils, surface settlements and tilting in level ground, lateral spreading, and global instability (flow slides) in areas of sloping ground. The impact of liquefaction on structures can include loss of bearing capacity, drag loads on deep foundations, liquefaction-induced total and differential settlement, and increased lateral and uplift pressures on buried structures. Other factors such as soil mineralogy, void ratio, over-consolidation ratio, and age are contributing factors to liquefaction susceptibility. In general, the older or denser a deposit, the less susceptible it is to liquefaction.

The California Geological Survey (CGS), Webservice of Official Maps of Seismic Hazard Zones [CGS, 2020] indicates that the Site is underlain by soils that are potentially susceptible to liquefaction. An excerpt of the liquefaction hazard zone map for the vicinity of the Site is shown in Figure 8. However, given the absence of shallow groundwater in the young alluvium and fill overlying the Saugus Formation liquefaction is not anticipated at the Site.

4.6 Lateral Spreading

Seismically induced lateral spreading is a potential hazard characterized by lateral movement of liquefied saturated soils in gently sloping ground with free-face (stream banks, and shorelines), when liquefiable soil layers are continuous over large lateral areas. Given the absence of shallow groundwater and the absence of a free-face within close proximity of the Site, the potential for lateral spreading is considered low.

4.7 Seismic Settlements

Poorly compacted fills and lower density alluvium materials may be subject to seismically induced settlements during strong ground shaking. Additionally, variable thickness of fill and alluvium materials across the proposed improvement footprint may result in significant differential settlements. An assessment of seismic-induced settlements of unsaturated soils at the Site was performed in general accordance with procedures outlined by Tokimatsu and Seed [1987] and Robertson and Shao [2010] using both SPT and CPT data. Seismic settlements were assessed for a design level shaking using a PGA of 0.70g, calculated as two-thirds of the peak ground acceleration (PGA_M). A predominant earthquake moment magnitude (M_w) of 6.84 was used in combination with PGA to define ground shaking level.

Based on the analysis of SPT data from Borings HSA-1, HSA-2, and B-1 and CPT data from SCPT-1, SCPT-2, CPT-3, SCPT-4, SCPT-5, and SCPT-6, seismically induced total settlements were estimated to be on the order of 2 to 5 inches. The higher end of the estimated settlements is related to localized areas of apparently looser fill. Differential settlements are typically estimated to be on the order of one-half to two-thirds of the total settlement over about 30 ft. However, considering the potential for significant variation of thickness of alluvium and fill soils over short distances, and the potential for presence of locally looser fill materials, differential settlements over these distances could be as much as the total settlements.

4.8 Flooding

The Federal Emergency Management Agency (FEMA) presents the flood hazard potential in the vicinity of the site as part of their Flood Insurance Rate Maps. FEMA Map No. 06037C0805F indicates that the Site is located in Zone D, which is defined as “area of undetermined flood hazard.” [FEMA, 2008].

Seiches typically occur when enclosed bodies of water are seismically shaken to generate oscillations and waves resulting in overtopping. Damage resulting from oscillatory waves (seiches) at the nearby Castaic Lake and Castaic Lagoon is considered unlikely due to the high relief topography between the lake and the Site.

Based on our review of the FEMA mapping, the geologic and physiographic setting, distance to the ocean and other large water bodies, and the project elevations, the potential for flooding or inundation is considered low at the Site.

4.9 Landslide

According to US Landslide Hazard Program [USGS, 2021], the Site is not located within a landslide zone. As CGS Webservice of Official Maps of Seismic Hazard Zones indicates that the site does not fall within a seismic induced landslide hazard zone either [CGS, 2020], landslides are not considered a potential hazard for the Site.

5. DESIGN RECOMMENDATIONS

The recommendations presented herein for the design of the proposed project are based on available information regarding the project, preliminary design information, results of our field investigation, laboratory testing, engineering and geologic evaluations, and professional judgment. In our opinion, the site is suitable for the construction of the proposed structures, provided the recommendations of this report are incorporated into design and construction. Recommendations are provided below for the three regions of the site where improvements are proposed: the proposed compressor building area, the proposed advanced renewable energy area, and the proposed substation area.

5.1 Earthwork

Based on our understanding of proposed foundation grades in both the proposed compressor building and substation areas substantial excavations in the Saugus Formation will be necessary. The mass excavations may extend to as much as 50 ft below existing grades in the compressor building area, and up to 60 ft in the Substation area. These excavations will require the construction of permanent and temporary cut slopes as discussed further in Section 6. In the ARE area, remedial excavations to remove undocumented fills prior to placement of foundation will be substantially smaller (<5 ft bgs). Based on the geotechnical investigation, conventional excavation construction equipment is anticipated to be capable of excavating subsurface materials for all three areas at the site.

This section provides general recommendations for earthwork activities that include removal of unsuitable (loose or soft) materials, and site grading, including engineered fill placement, foundation excavations, pavements, backfill of utility trenches, and other related operations. Earthwork should be performed in accordance with SoCalGas requirements, the recommendations of this geotechnical report, applicable sections of the 2019 CBC, applicable Los Angeles County and City of Santa Clarita grading regulations, the current version of the Standard Specifications for Public Works Construction “Greenbook,” as well as California Occupational Safety and Health Administration (Cal OSHA) safety requirements.

5.1.1 Remedial Grading and Site Preparation

Based on the exploratory borings advanced during this investigation, the Site is underlain by loose to medium dense fill and alluvial deposits that consist primarily of silty sand. Below the alluvial deposits, Saugus Formation was encountered consisting primarily of sandstone and claystone materials. Loose or soft soils or soils disturbed by construction activities within the proposed development areas, as identified by the geotechnical consultant during grading and foundation excavation, should be excavated, the base of excavations scarified, moisture conditioned, and compacted as recommended herein before placing additional fill. Soil containing organic or other deleterious matter, if encountered, should be removed from the site, and properly disposed of.

Topsoil where encountered should be segregated and reused as appropriate for landscaping purposes.

Subgrades should be proof rolled and moisture conditioned prior to placement and compaction of engineered fill.

5.1.2 Fill Materials

Based on the field investigation, the surficial fill, alluvial materials, and Saugus Formation materials are considered suitable for use as fill if properly prepared as recommended herein. Soil containing organic or other deleterious matter or other compressible material should not be used for engineered fill.

We recommend that if import soil is needed to achieve the design site grades, the import soil should be non-expansive in accordance with CBC 2019 Section 1803.5.3. The specifications for these soils generally correlate to materials with an expansion index of 20 or less and a plasticity index of 15 or less.

Controlled low strength material (CLSM) also referred to as “slurry backfill” or “flowable fill” may be used in lieu of soil for foundation pad backfill as described in Section 5.1.3.

Class 2 Aggregate Base may be utilized for construction of access roads and should conform to the State of California, Department of Transportation (Caltrans) “Standard Specifications” Section 26-1.02B.

5.1.3 Fill Placement and Compaction

Due to the predominately coarse-grained nature of existing site soils, fill should be moisture conditioned a minimum of two percent above the optimum moisture content and compacted in layers that do not exceed 8-inch loose lifts for heavy equipment compaction and 4-inch loose lifts for hand-held equipment compaction. Each lift of fill should be compacted to a minimum of 90 percent relative compaction unless otherwise specified. Relative compaction is defined as the ratio (in percent) of the in-place dry density to the maximum dry density determined using the latest version of ASTM D1557 as the compaction standard.

Modified Proctor Compaction Tests conducted on surficial fills (silty sand and clayey sand soils encountered between 1 and 5 ft bgs) indicated a maximum dry density of 130.8 pounds per cubic feet (pcf) at an optimum moisture content of 8.8%. The in-situ moisture content of the surficial fills encountered between 1 ft and 10 ft bgs varied between approximately 5% and 8%.

Based on this available information, as an initial input to estimates of the amount of cut and fill for the project involving existing undocumented fills and alluvium, a shrinkage factor of 0.9 (compacted volume / in-situ volume) can be assumed based on an average in situ dry unit weight of 110 pcf for fills between 1 ft and 10 ft bgs and an average dry unit weight of the compacted material assumed at 121.6 pcf (based on about 93% average relative Modified Proctor compaction). The calculated shrinkage factor represents the estimated ratio of the compacted soil volumes to the excavated volume of the soil.

Significant processing and moisture conditioning may be required to breakdown materials derived from cut in Saugus Formation for placement as compacted fill. For the purpose of preliminary estimates, a bulking factor of about 5 to 15 percent may be assumed if materials derived from the Saugus Formation are used as compacted fill after processing. Higher bulking factors may be appropriate when evaluating volumes of Saugus Formation derived from cut for transport purposes.

If CLSM is used in lieu of soil for backfill in foundation areas, the cement content of the CLSM shall not be less than 188 pounds per cubic yard (2 sacks). The ultimate compressive strength of the CLSM shall be no less than 100 pounds per square inch (psi) when tested on the 28th day per ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders. CLSM need not be compacted. Field tests should be conducted to evaluate the acceptability of the CLSM in general accordance with [LADBS, 2020].

Class 2 Aggregate Base (in areas of access roads, etc.) should be compacted to a minimum relative compaction of 95 percent of modified Proctor.

5.2 Surface Drainage

Surface drainage should be planned to prevent ponding and promote the drainage of surface water away from structure foundations, slabs, and edges of pavements, and towards suitable collection and discharge facilities. Paved areas should be sloped to drain water away from structures and flatwork at a minimum gradient of 1 percent, and unpaved areas should be finish graded with a minimum slope of 2 percent away from structures and pavements.

5.3 Foundations

Foundations recommendations were developed for the three proposed development areas (Compressor Building, Advanced Renewable Energy, and Substation) based on subsurface conditions encountered during the investigations. While each development area is unique, an overarching consideration is variability in subsurface conditions with respect to the thickness of undocumented fill and alluvium materials over Saugus Formation. Based on our understanding of the likely final grades in the three development areas, the thickness of the fill/alluvium materials could vary from as much as 30 to 40 ft on the upper end to none (i.e., final grade will be excavated into Saugus Formation). Furthermore, the geologic hazard assessments described in Section 4 indicate that areas underlined with fill/alluvium may experience significant settlements, thus rendering shallow foundations unsuitable for support of any significant structure other than smaller pieces of equipment that would not be adversely impacted by large total and differential settlements.

Based on these considerations three separate foundation recommendation developed as described below.

- Option 1 - Shallow foundations bearing on Saugus Formation or where thickness of existing fill/alluvium is sufficiently small that it can feasibly be excavated and replaced with compacted fill.
- Option 2 - Deep foundations socketed into Saugus Formation where thickness of fill/alluvium is such that excavation and replacement with compacted fill is not economically feasible.
- Option 3 - Shallow foundations bearing on fill/alluvium for smaller equipment not adversely impacted by larger total and differential settlements.

To aid in siting of equipment and assessment of suitable foundation approach we developed a preliminary zone map where the above foundation options are applicable. This map presented as Figure 9 was developed based on the interpreted thickness of the fill/alluvium materials below the expected final grade in each of the three development areas. Once final layout of the project and equipment is confirmed, additional confirmation of conditions at the final locations of the proposed structures using limited site exploration program may be advisable to limit the potential for unexpected conditions during construction. For this study we assumed that the final grade of the planned facilities are approximately at the same elevation of the existing paved roads at Site. The adjacent Edison Road elevations are assumed as the final grade elevation for the ARE (approximately 1,170 ft MSL) and Substation Facilities (approximately 1,140 ft MSL), while the existing gravel surfaced area (approximately 1,150 ft MSL) is assumed as the final grade elevation for the proposed compressor building.

The structural engineer in coordination with the SoCalGas should carefully review these recommendations and associated anticipated foundation performance (e.g., capacities, anticipated settlements) in their assessment as to which structures can adequately be supported by different foundation options.

5.3.1 Option 1 - Shallow Foundations on Saugus Formation or Engineered Fill

5.3.1.1 Subgrade Preparation

Subgrade preparation should include removal of all fill and alluvium materials down to the competent zone of Saugus Formation and backfill with engineered fill. Localized overexcavation of Saugus Formation material may be required if localized weaker claystone is encountered. This overexcavation should be conducted with observation and approval of the geotechnical engineer.

Excavation and backfill shall follow general grading recommendations discussed in previous sections. Fill should be compacted to a minimum of 90% of the maximum dry density at a minimum of two percent above optimum moisture content (per ASTM D1577).

To reduce the potential for differential settlements under larger footprint foundation in cut/fill transition area, Saugus Formation should be excavated and replaced with compacted fill for a minimum depth of 2 ft below the bottom of foundation in these areas.

When full foundation footprint can be placed directly on Saugus Formation, a limited thickness leveling course, minimum 6 inches thick, comprised of engineered fill or aggregate base can be used to level grades prior to foundation construction.

5.3.1.2 Allowable Bearing Capacity

The allowable bearing capacity of 3,000 psf can be used for the foundations with a minimum width of 2 ft and minimum embedment of 2 ft. For each additional foot of foundation width or foundation embedment, the allowable bearing capacity can be increased by 500 psf up to the maximum of 5,000 psf. The allowable bearing capacity can be increased by one-third for short term wind or earthquake loading conditions.

5.3.1.3 Settlement and Modulus of Subgrade Reaction

Foundation total settlements under the allowable loads are expected to be on the order of up to 0.5 to 1 inch, and possibly smaller when bearing directly on Saugus Formation. Differential settlements are expected to be about one-half of total settlements. For highly loaded improvements with high sensitivity to differential settlements, care should be exercised to avoid significant variations in engineered fill thickness below foundation.

A unit modulus of subgrade reaction for compacted subgrade can be assumed as 150 pci. The recommended value is valid for a unit area of one square foot. For larger loading areas, the modulus of subgrade reaction can be estimated by the following equation:

$$k_B = k_1 \left[(B + 1) / (2 B) \right]^2$$

where B is the foundation width in ft, and k_1 is the unit modulus of subgrade reaction.

5.3.1.4 Resistance to Lateral Loading

Resistance to lateral loads may be provided by passive resistance along the outside face of the foundation and frictional resistance along the bottom. For allowable passive resistance an equivalent fluid weight of 180 pcf can be used. Passive resistance of the top 1 ft of soil should be neglected unless the grade next to the foundation is paved. If friction is used to resist lateral loads, an allowable friction coefficient of 0.35 between the subgrade and foundation concrete can be used.

5.3.2 Option 2 – Deep Foundations Embedded in Saugus Formation

5.3.2.1 Subgrade Preparation

Since loads will bear on deep foundations, special preparation of subgrade is not required. Prior to concrete placement for the foundation slabs or grade breams which may be part of the deep foundation system, the subgrade should be non-yielding and free of deleterious material.

5.3.2.2 Axial Capacity and Settlement

Drilled shafts are the recommended deep foundation type for the site. Axial capacity of the drilled shafts is developed through a combination of shaft friction and end bearing. Drilled shafts should be embedded in competent materials of Saugus Formation and as such end bearing will be provided by the Saugus Formation. Shaft friction will be developed along the shaft portions both in undocumented fill and alluvium, as well as along the shaft portion embedded in competent formational materials.

As discussed in Section 4, undocumented fill and alluvium are subject to potential seismic and/or hydro-collapse settlements. Some settlement of shallow fill/alluvium may also occur due to vibrations induced from operation equipment. Since drilled shafts are anticipated to experience only small vertical settlements, downwards movement of fill and alluvium soils relative to the drilled shaft will cause downdrag loads. Small relatively movements of soil and shaft, on the order of 1/2 inch, are sufficient to fully activate downdrag loads. Therefore, the shaft friction along the portion of the shaft in fill/alluvium should not only be excluded from the capacity calculations but would also result in additional loading on the lower portion of the pile.

Estimated ultimate drilled shaft capacities are summarized in Table 6. Also included in Table 6 are estimate downdrag loads that could potentially be applied as the result of the fill/alluvium settlements. The available allowable compressive drilled shaft capacity can be calculated as:

$$\text{Allowable Compressive Capacity} = (Q + F \times L - DD) / FS$$

where Q is the ultimate end bearing, F is shaft friction per foot of shaft embedment in formational material, L is the length of shaft embedment in competent formation material, DD is downdrag load from fill/alluvium, and FS is desired factor of safety. Q, F and DD are provided in Table 6 for range of fill/alluvium thickness. Since the top of rock is variable, design plans may alternatively specify minimum embedment in competent formation as the function of the of shaft top loads as follows:

$$L = (\text{Pile Shaft Load} \times FS + DD - Q) / F$$

Embedment into competent formation material should be no less than 5 ft. The total drilled shaft length should be no less than 10 shaft diameters to ensure adequate response under lateral loading.

Allowable capacity under tension loads can be calculated as:

Allowable Tensile Capacity = (DD + F x L) / FS.

Factors of safety of 2 and 3 are recommended for compressive and tensile capacity, respectively. Factors of safety can be reduced to 1.5 and 2, respectively, for short term wind or earthquake loading conditions.

Shaft spacing should be a minimum of 3 shaft diameters, center to center, in which case no group effects are expected for axial loading.

5.3.2.3 Response under Lateral Loads

Response under lateral load of a single drilled shaft was evaluated using the program LPILE 2019.11.06 [Ensoft Inc., 2019a]. The assumed input parameters used for the LPILE calculations are summarized in Table 7a. The top of the shaft was assumed at 2 ft below finished grade. Results of analyses are summarized in Tables 7b.

The results of evaluations are presented in terms of lateral capacity associated with drilled shaft top lateral movements of 0.5, 1 and 2 inches with corresponding maximum moment in the shaft. Values are presented for both free and fixed head conditions. Fixed head condition values can be used if shaft-foundation connection is detailed such to be able to transfer significant moments with relative rotation, and if more than one shaft is laid out in the direction of loading, connected by stiff foundation slab or grade beam.

Lateral pile response evaluations were performed for two pile structural sections, one assumed that the full concrete section contributes to the moment of inertia and the second when only half of the moment of inertial is used. This is to account for possible concrete cracking at larger displacement and reduction of the section rigidity. The structural engineer should select the appropriate value based on the project performance targets and the internal capacity of the shaft.

The effect of applied axial loads on the calculated moments and shears was incorporated by applying 100 kips of axial load on the piles in the LPILE evaluations. The impact of axial load on calculated lateral force and moment was very limited to none.

Assuming groups of two by two shafts, group effects on lateral capacities should be accounted for by applying a reduction multiplier of 0.93, 0.77, and 0.6 for shaft center-to-center spacing of 5, 4, and 3 diameters, respectively. No reduction is required for shaft groups with 6-diameter or greater center-to-center spacing.

Assuming shaft groups of ten by ten, group effects on lateral capacities should be accounted for by applying a reduction multiplier of 0.75, 0.55 and 0.36 for shaft center-to-center spacing of 5, 4 and 3 diameters, respectively. Alternatively, the reduction multipliers integrated within software program GROUP by Ensoft Inc [Ensoft Inc., 2019b] can be used to directly calculate pile group effects and assess the pile group response. No reduction is required for shaft groups with 6 diameter or greater center-to-center spacing.

During assessment, a sensitivity analysis was performed to assess the impact of depth to Saugus Formation and relative contribution of undocumented fills and formational materials in the resistance to lateral loads. Based on our assessment a variability of about +/- 25 percent could occur in lateral capacity and maximum moments between drilled shafts in areas with shallower and deeper formation materials. Since detailed information depth to bedrock is not available, this variability should be accounted for when planning the foundation system and assessing their ability to resist lateral loads.

5.3.2.4 Construction Considerations

Drilled shafts or other techniques involving open-hole drilling should consider the potential for caving caused by loose sandy soils, especially considering the presence of undocumented fill and alluvial sandy soils at the Site. Casing may be required during drilled shaft construction. The construction process should ensure proper cleanup and observation of the bottom of the shaft prior to concrete placement due to the reliance of end bearing for capacity in compression. Geotechnical engineer should be present during construction to observe material cuttings and confirm adequate embedment in competent materials of Saugus Formation.

5.3.3 Option 3 - Shallow Foundations on Existing Fill / Alluvium

5.3.3.1 Subgrade Preparation

Subgrade preparation should include scarifying, moisture conditioning and compaction of fill and alluvium materials in the zone one foot below the bottom of footing. Earthwork shall follow general grading recommendations discussed in previous sections. Subgrade material should be compacted to a minimum of 90% of the maximum dry density at a minimum of two percent above optimum moisture content (per ASTM D1577). Localized overexcavation may be required if areas clayey materials are encountered.

The foundations should not be placed in cut/fill transition zones.

5.3.3.2 Allowable Bearing Capacity

The allowable bearing capacity of 2,000 psf can be used for the foundations with a minimum width of 2 ft and minimum embedment of 2 ft. The allowable bearing capacity can be increased by one-third for short term loading wind or earthquake loading conditions. The maximum foundation dimension should not exceed 6 ft.

5.3.3.3 Settlement and Modulus of Subgrade Reaction

Total settlement under the static loads are expected to be on the order of up to 1 to 1.5 inches. Differential settlements are expected to be about one-half of total settlements.

Additional settlements may occur under seismic loading or if subgrade is exposed to significant infiltration in a phenomenon called hydro-collapse. The settlements produced by either of these sources may be up to approximately 5 inches, as described in Section 4. Seismic or hydro-collapse induced settlements may produce significant differential settlements as the result of variable properties of historic undocumented fill and alluvium.

A unit modulus of subgrade reaction of 75 pci may be assumed for compacted subgrade prepared as described above. The recommended value is valid for a unit area of one square foot. For larger loading areas, the modulus of subgrade reaction can be estimated by the following equation:

$$k_B = k_1 \, [\, (B + 1) \, / \, (\, 2 \, B \,) \,]^2$$

where B is the foundation width in ft, and k_1 is the unit modulus of subgrade reaction.

5.3.3.4 Resistance to Lateral Loading

Resistance to lateral loads may be provided by passive resistance along the outside face of the foundation and frictional resistance along the bottom. For allowable passive resistance an equivalent fluid weight of 100 pcf can be used. Passive resistance of the top 1 ft of soil should be neglected unless the grade next to the foundation is paved. If friction is used to resist lateral loads, an allowable friction coefficient of 0.25 between the subgrade and foundation concrete can be used.

5.3.4 Soil Dynamic Properties for Soil-Structure Interaction Assessment

Some of the foundation may support vibration generation equipment. Structural engineer may need to assess the dynamic interaction of foundation and subsurface. This section provides summary of the expected range of dynamic soil properties. The values presented herein are based on the velocity measurements performed onsite as described in Section 2.

Existing undocumented fill and alluvium may be characterized by a small strain shear wave velocity in the range of 800 to 1,200 ft/sec and Poisson’s ration in the range of 0.3 to 0.35. The velocity generally increases with depth, but localized variations in velocity are possible in undocumented fill as the result of variable rate of compaction and material properties. Unit weight for conversion of shear wave velocity to shear modulus can be assumed to be about 110 pcf.

New compacted fill may be characterized by a small strain shear wave velocity in the range of 1,000 to 1,200 ft/sec and Poisson’s ration in the range of 0.3 to 0.35. Unit weight for conversion of shear wave velocity to shear modulus can be assumed to be about 120 pcf.

The bedrock of Saugus Formation may be characterized by a small strain shear wave velocity of about 1,500 ft/sec for upper 5 to 10 ft whether exposed at the ground surface or concealed by alluvium, increasing to about 2,500 to 3,000 ft/sec at greater depths within the formation. Poisson's ratio may be assumed in the range of 0.3 to 0.35. Unit weight for conversion of shear wave velocity to shear modulus can be assumed to be about 135 pcf. The analyses should review the impacts of significant impedance contrast between the Saugus Formation and fill/alluvium.

The small strain shear modulus (G_{max}) can be calculated based on following equation:

$$G_{max} = V_S^2 * \rho$$

The level of shear modulus reduction will depend on the shear strain levels. Typically, for strain levels below about 0.01 percent, the modulus reduction is limited to about 20 to 30 percent for sandy soils and are expected to be somewhat less for Saugus Formation.

Soil hysteretic damping at small strains can range from almost negligible up to about 3 to 4 percent. Additional radiation damping in the system will also occur, the value of which should be selected consistent with the modeling approach used.

5.3.5 Foundations on or Adjacent to Slopes

Available conceptual site development plans indicate that buildings or equipment foundations may be located in areas adjacent to either existing slopes or slopes constructed as part of site development. The provisions of Section 1808.7 of CBC 2019 should be complied with where occupied structures are located adjacent to slopes with an inclination of 3:1(H:V) or steeper.

5.3.5.1 Building Clearance from Ascending Slopes

As indicated conceptually in the cross sections in Figure 6, significant cut slopes may be required adjacent to the proposed compressor building. Buildings and other occupied structures in this area as well as other structures adjacent to ascending slopes should be setback from the toe of these slopes at the smaller of half the height of the slope or 15 ft to provide protection against slope erosion and shallow failures by complying with the requirements of section 1808.7.1 of CBC 2019.

5.3.5.2 Foundation Setback from Descending Slopes

Conceptual site development plans indicate foundations will be located near the tops of descending slopes. The construction of foundation of occupied structures in these areas should comply with the requirements of section 1808.7.2 of CBC 2019. Per that section the face of the proposed footings near the top of slopes should be located at least the smaller of the third of the height of the slope and 40 ft. An example of areas where these setbacks should be applied include the existing slopes in the Saugus Formation to the southeast of the ARE area along Figure 6E and adjacent areas. Other descending slopes may be produced by proposed develop and adjacent foundations should abide by the restrictions of this section.

5.4 Retaining Wall Earth Pressures (Static and Seismic)

In general, retaining walls should be designed to resist earth pressures, surcharge loads, and any anticipated hydrostatic pressure. The lateral earth pressure used in design of yielding walls, such as freestanding semi-gravity walls, should include a triangular distribution with an equivalent fluid weight of 45 pcf. The lateral earth pressure used in design of restrained walls, such as basement walls, should include a triangular distribution with an equivalent fluid weight of 65 pcf. Surcharge pressures (dead or live) should be added to the above lateral earth pressures where surcharge loads may be located above or adjacent to the wall. Surcharge pressures should be applied as a uniform rectangular pressure distribution by using a lateral earth pressure coefficient of 0.38 for yielding walls and 0.55 for restrained walls. Surcharges that are set back behind the wall a horizontal distance greater than the wall height need not be included in the design pressure. A uniform vertical pressure of 300 psf can be used to simulate traffic loads. Retaining walls greater than 6 ft in height should also be designed with an additional seismic lateral earth pressure. The recommended seismic active pressure increment should be applied as a uniform horizontal load 10 H psf and 24 H psf (where H is the height of the wall in ft) for the yielding and restrained walls, respectively, and should be added to the above respective static pressures. The lateral earth pressures recommended above are based upon the assumption that the grade behind the walls is level and the wall backfill is well-drained, preventing development of hydrostatic pressures behind the wall. Lateral earth pressures on walls for wall heights over 12 ft, unique surcharge conditions, or other special conditions not described herein can be developed once details and construction procedures are available.

5.5 Concrete Slabs and Hardscape

Concrete slabs and hardscape should be supported on a minimum of 1 ft of engineered fill with low expansion potential (EI<20). Expansion index testing should be performed on excavated site soils during grading.

The subgrade soils should be proof rolled prior to placing the concrete slabs and hardscape. Concrete slab thickness and steel reinforcement should be properly designed by a California-registered civil engineer for the anticipated loads.

Crack control or expansion/contraction joints should be provided at spacing appropriate for the slab thickness.

Concrete slabs should be underlain by a minimum of 4 inches of compacted clean, coarse sand or aggregate. Special care should be taken by the contractor so that a uniform thickness of sand is maintained so as to achieve uniformity in the concrete thickness for the slab. We recommend that the subgrade soils be wetted prior to placement of the sand or aggregate beneath the slab.

5.6 Utility Trenches

Utilities should be placed above and outside the envelope defined by 2:1 (H:V) lines drawn outward and down from the bottom edge of foundations. Trench backfill is defined as material placed in a trench starting 6 inches above the pipe, and bedding is all material placed in a trench below the backfill. Pipe trench backfill should conform to the recommendations presented in this report and Section 306 of the "Greenbook." Unless concrete bedding is required around utility pipes, free-draining clean sand should be used as bedding. Pavement and subgrade requirements provided in Section 5.9 should be incorporated for trench backfill. Compaction of backfill by water jetting should not be permitted.

5.7 Corrosion Potential

A tabulated summary of the soil chemical laboratory testing results is presented in Table 8. Appendix G presents the soil chemical laboratory test results.

Based on the criteria established by the County of Los Angeles Public Works [LACPW, 2013], soils are considered corrosive when soluble sulfate concentrations in the soil are equal to or greater than 2,000 parts per million (ppm) (or milligram per kilogram (mg/kg)), or chloride concentrations in the soil are equal or greater than 500 ppm (or mg/kg), or the pH value of the soil is equal or less than 5.5, or the soil's minimum resistivity value is less than 1,000 ohm-centimeters. Soil chemical test results from soil samples collected during the investigations indicate that the measured values are well outside the ranges typically considered harmful or deleterious to foundation elements.

In a review of American Concrete Institute (ACI) 318-19 [2019] Tables 19.3.1.1 and 19.3.2.1, per the criteria established by California Building Code (2019 edition), the measured values of sulphate concentration indicate moderate severity (class S1). The measured values of chloride concentration indicate low severity (class C0).

Based on the criteria discussed above, there is no special restriction on the planned concrete type based on the chloride and sulfate concentrations in the tested soil sample.

5.8 Subsurface Infiltration

Geosyntec followed the guidance contained in the County of Los Angeles Administrative Manual GS200.2 [GMED, 2017] to carry out field testing and develop input regarding infiltration rates. The tests were conducted within alluvium (in HSA-1) and the undocumented fill (in HSA-2) in the proposed compressor building area.

5.8.1 Field Estimates of Hydraulic Conductivity

Geosyntec used two separate methodologies to estimate the hydraulic conductivity at Site. The first method, developed by Hvorslev and outlined by Fang [1991] and Massmann [2004], employs a formula for a well point in uniform soil. According to this method, both deep and shallow flow conditions were evaluated. The method was employed for both constant head and falling head tests performed on Site.

The second estimation method presented by the U.S. Bureau of Reclamation (USBR) 7300-89 is often used under a constant gravity head. The permeability of the soil is evaluated using based on an assumed constant flow rate and constant height of water in the well. Permeability tests assume that the constant head maintained within the well during testing is at the top of screened section of the pipe, as this method was developed originally for open boreholes (without well screens or casings).

Based on these two methods, the estimated hydraulic conductivity ranges from approximately 3.2 x 10^{-5} centimeters per second (cm/s) [0.05 inches per hour (in./hr)] for the interval between 15 ft and 25 ft bgs at HSA-1 and 4.5 x 10^{-5} cm/s [0.06 in./hr] for the interval between 5 ft and 15 ft bgs at HSA-2. The field measurements obtained at each test location are summarized in Table 9.

5.8.2 Design Infiltration Rate

The undocumented fill and alluvial materials in which the infiltration tests were conducted classify predominantly silty and clayey sands (SM, SC) with relatively low permeabilities. Based on the results of field infiltration testing, the range of measures hydraulic conductivity for the in-situ soil varies between 3.2 x 10^{-5} cm/s [0.05 in./hr] and 4.5 x 10^{-5} cm/s [0.06 in./hr]. Guidance contained in GMED [2017] was applied to the selection of reductions factors to account for test type and site variability. These infiltration rates are below those typically acceptable for incorporation in a stormwater infiltration system. As such, it is recommended that infiltration best management practices not be employed as part of the development of this project.

5.9 Pavements

We recommend that the paved access roads within the site be designed for a traffic index selected by the project civil engineer, however we have provided preliminary recommendations based on existing site conditions.

The flexible pavement section should consist of asphalt concrete (as defined in Section 39 of the latest edition of the Caltrans Standard Specifications) over Class 2 aggregate base (as defined in Section 26 of the latest edition of the Caltrans Standard Specifications) over properly prepared subgrade. Properly prepared pavement subgrade consists of the uppermost 12 inches of subgrade that is moisture conditioned and compacted to a minimum relative compaction of 95 percent. Asphalt and aggregate base should be compacted to a minimum relative compaction of 95 percent.

Alternatively, Jointed Plain Concrete Pavement (JPCP) can be used as rigid pavements where heavy truck traffic is anticipated. The rigid pavement should consist of Class A Portland Cement Concrete (per Section 201 of the Greenbook) over Class 2 aggregate base (as defined in Section 26 of the latest edition of the Caltrans Standard Specifications) placed over properly prepared subgrade (moisture conditioned and compacted to a minimum relative compaction of 95 percent).

The JCPC shall be provided with longitudinal and traverse joints to control cracking. Longitudinal joints shall be provided with tie bars and transverse joints shall be embedded with dowels bars, conforming to guidelines provided in Caltrans' Concrete Pavement Guide (2015). Transverse construction joints for doweled pavement should coincide with the standard 14' joint spacing. Expansion joints are not recommended for JPCP.

The actual pavement section should be selected based on the anticipated traffic conditions. The pavement sections for different traffic indices are provided in Tables 10a and 10b for flexible and rigid pavements, respectively. Structural section thicknesses were based on an R-value of 18 per the limited available information. The geotechnical consultant shall observe the prepared subgrade for the pavements to confirm the subgrade conditions are consistent with the design assumptions. Additional R-value testing may be required if varying soil conditions are encountered during construction.

We recommend including subgrade enhancement geotextile or geogrid within the soil and aggregate base layer to reinforce the subgrade, distribute traffic loading and reduce the potential for cracking for flexible pavements. Non-woven geotextiles or geogrid used for subgrade enhancement shall conform to the requirement in Section 96 of the latest edition of the Caltrans Standard Specifications and Caltrans' Subgrade Enhancement Geosynthetic Design and Construction Guide (2013).

The selection of the appropriate type of geotextile or geogrid shall be based on subgrade R-value and gradation of the subgrade and aggregate base materials, evaluated by the geotechnical consultant during construction. The subgrade preparation requirements would remain unchanged if a subgrade enhancement geotextile or geogrid is used. Therefore, the thickness of the pavement section would vary based on subgrade enhancement used, as shown in Table 10.

5.10 Permanent Slopes and Related Evaluations

It is anticipated that the project grading will include the construction of number of permanent cut slopes in the Saugus Formation (cut slopes). There are also existing slopes in the Saugus Formation which are in the area of proposed project elements (existing slopes). It is also likely that slopes constructed of engineered fills will also be necessary to accommodate proposed grades (fill slopes).

Once site development plans have been formalized and an understanding of proposed permanent cut and fill slopes as well as existing slopes in the vicinity of proposed foundations has been developed slope stability evaluations should be conducted. Static and seismic slopes evaluations should be conducted by the geotechnical engineer of select representative slope configurations in each of these categories. The information presented in this report should be used to develop input parameters for these evaluations.

6. CONSTRUCTION CONSIDERATIONS

6.1 Excavations

Based on conditions encountered in exploratory borings and geophysical explorations the Saugus Formation materials are expected to be rippable with conventional excavation equipment. Sandstone bedrock like the Saugus Formation may be characterized as rippable using a Caterpillar D8R ripper to P-wave velocities of about 6,500 ft/s [Caterpillar, 2018]. P wave velocities measured in during the seismic refraction survey in the area of the compressor building (Appendix D-2) ranged from less than 2,500 ft/s near the ground surface to nearly 5,000 ft/s at an elevation of approximately 1,160 ft MSL. While direct measurements of P-wave velocity are not available below elevation 1,160 ft MSL, information from exploratory borings indicates that rippable of materials below this elevation are expected to be similar.

While not anticipated to be encountered based on available information rock with P-wave velocity of between about 6,500 and 8,300 ft/s is considered marginally rippable by a D8R although it may be more cost effective to blast rather than rip rock in this velocity range.

The project geotechnical consultant should assess the exposed bottom of excavation and determine the actual required removal depth, lateral excavation limits, and benching procedures during grading. Areas of loose or yielding soils, should be over-excavated and recompacted to the limits and depths determined by the geotechnical engineer. Consequently, actual removal depths may be larger than the depths indicated in the foundation recommendations section.

6.2 Temporary Slopes

The design and excavation of temporary slopes and their maintenance during construction are the responsibility of the contractor. Based on the materials observed in the borings, the design of temporary slopes for planning purposes may assume Type C conditions. The contractor shall have a geotechnical or geological professional evaluate the soil conditions encountered during excavation, for any variation in soil conditions, to determine the appropriate permissible temporary slope inclinations and other measures required by Cal OSHA. Existing infrastructure within a 2:1 (H:V) line projected up from the toe of temporary slopes should be monitored during construction.

6.3 Construction Observation and Testing

Soil deposits may vary in type, strength, and many other important properties between points of exploration, due to non-uniformity of the geologic formations or to man-made cut and fill operations, during construction at the site. To permit correlation between the investigation data, design, and the conditions encountered during construction, we recommend that the geotechnical engineer be retained to provide continuous observations of earthwork construction operations, foundation excavation and construction, and to provide quality control testing of fill placement and compaction.

7. LIMITATIONS

The geotechnical investigation for this project observed only a small portion of the pertinent subsurface conditions. The recommendations made herein are based on the assumption that soil conditions do not deviate appreciably from those found during the current field investigation. This geotechnical investigation report has been prepared in accordance with current practices and the standard of care exercised by scientists and engineers performing similar tasks in this area. The conclusions contained in this report are based solely on the analysis of the conditions observed by Geosyntec personnel. We cannot make any assurances concerning the completeness of the data presented to us.

No warranty, expressed or implied, is made regarding the professional opinions expressed in this report. Site grading and earthwork, subgrade preparation under concrete slabs and paved areas, utility trench backfill, and foundation excavations should be observed by a qualified engineer or geologist to verify that the site conditions are as anticipated. If actual conditions are found to differ from those described in the report, or if new information regarding the site conditions is obtained, Geosyntec should be notified and additional recommendations, if required, will be provided. Geosyntec is not liable for any use of the information contained in this report by persons other than SoCalGas, or their subconsultants, or the use of information in this report for any purposes other than referenced in this report without the expressed, written consent of Geosyntec.

California, including Los Angeles County, is an area of high seismic risk. It is generally considered economically unfeasible to design structures to resist earthquake loadings without damage. Proposed structures designed in accordance with the recommendations presented in this report could experience limited distress/damage if subjected to strong earthquake shaking.

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TABLES

Table 1. Summary of Exploratory Borings
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Exploration Name	Exploration Type	Surface Elevation (feet, MSL) (a,b)	Exploration Latitude (c)	Exploration Longitude (c)	Depth Advanced (feet b.g.s.) (d)	Date Advanced	Performed By
HSA-1 (e)	Hollow Stem Auger	1152.00	34.446158	-118.585703	25.5	01/04/2021	Geosyntec
HSA-2 (e)	Hollow Stem Auger	1146.00	34.445317	-118.586375	31.0	01/04/2021	Geosyntec
TPB-1	Hollow Stem Auger	1172.00	34.446133	-118.588286	15.9	01/04/2021	Geosyntec
TPB-2	Hollow Stem Auger	1171.31	34.446281	-118.588464	15.5	01/04/2021	Geosyntec
TPB-3	Hollow Stem Auger	1172.02	34.446300	-118.588300	6.0	01/04/2021	Geosyntec
CPT-1 (f)	Cone Penetration Test	1152.00	34.446186	-118.585683	23.1	01/11/2021	Geosyntec
CPT-2 (f)	Cone Penetration Test	1149.93	34.446219	-118.586042	38.9	01/11/2021	Geosyntec
CPT-3	Cone Penetration Test	1148.00	34.445864	-118.586369	29.4	01/11/2021	Geosyntec
CPT-4 (f)	Cone Penetration Test	1146.50	34.445656	-118.586325	15.6	01/11/2021	Geosyntec
CPT-5 (f)	Cone Penetration Test	1146.00	34.445344	-118.586256	23.3	01/11/2021	Geosyntec
CPT-6 (f)	Cone Penetration Test	1136.56	34.446219	-118.589303	34.6	01/11/2021	Geosyntec
B-1 (g)	Mud Rotary and HQ3 Rock Coring	1149.76	34.446186	-118.586069	56.0	01/15/2021	Geosyntec
B-2	HQ3 Rock Coring	1177.49	34.445311	-118.585669	40.0	01/13/2021-01/14/2021	Geosyntec
B-3	HQ3 Rock Coring	1145.28	34.446033	-118.589139	30.0	01/14/2021	Geosyntec
B-4	HQ3 Rock Coring	1172.00	34.446208	-118.588322	16.0	01/15/2021	Geosyntec

Notes:

a. MSL = Mean Sea Level.
b. The surface elevation of the borings were obtained from site topographic map provided by Southern California Gas Company.
c. The latitude and longitude of the borings were estimated using Google Earth™ and are considered approximate.
d. Feet below ground surface.
e. Hollow-stem borings were converted to temporary infiltration test wells.
f. Shear wave velocity tests were conducted in these CPTs.
g. OYO Suspension P-S logging was performed in this exploratory boring.

Table 2. Summary of Geotechnical Laboratory Test Results
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Sample Information				**USCS Classification** [c,d]	**USCS Name** [c,d]	**Sieve Analysis**			**Atterberg Limits**			**Moisture-Density Porosity Tests** [e]			**Collapse/Swell Potential** [f]	**Other Tests** [g,h]
						ASTM D6913 / D7928			**ASTM D4318**			**ASTM D2937**			**ASTM D4546**	
Boring ID	**Sample ID**	**Sample Type** [a]	**Depth (ft bgs)** [b]			**Gravel (%)**	**Sand (%)**	**Silt & Clay (#200) (%)**	**Liquid Limit LL**	**Plastic Limit PL**	**Plasticity Index PI**	**Dry Density (pcf)**	**Moisture Content (%)**	**Moist Unit Weight (pcf)**	**% vertical strain upon inundation @ vertical stress**	
HSA-1	HSA-1@1-5	Bulk	1-5	SC	Clayey Sand	3	61	36								Pro = 130.6 pcf @ 8.7%
HSA-1	HSA-1@5	Cal Mod	6-6.5	SC	Clayey Sand			40				111.4	8.3	120.6	0.24% @ 0.8 ksf	
												111.0	8.3	120.2	2.77% @ 3.2 ksf	
												113.1	8.3	122.5	2.63% @ 6.4 ksf	
HSA-1	HSA-1@10	SPT	10-11.5	SM	Silty Sand	3	70	27					5.6			
HSA-1	HSA-1@20	SPT	20-21.5	*SM*	*Silty Sand*			35					7.6			
HSA-2	HSA-2@0-5	Bulk	0-5	SC	Clayey Sand											R-V = 18
HSA-2	HSA-2@3	SPT	3-4.5	*SC*	*Clayey Sand*			38					6.9			
HSA-2	HSA-2@10	Cal Mod	11-11.5	SC	Clayey Sand			44				113.3	7.4	121.7	1.06% @ 1.6 ksf	DS = 300 psf, 32°
												114.1	7.4	122.5	2.31% @ 3.2 ksf	
												113.6	7.4	122.0	4.74% @ 6.4 ksf	
HSA-2	HSA-2@15	SPT	15-16.5	*SM*	*Silty Sand*			43					5.5			
HSA-2	HSA-2@25	SPT	25-26.5	SC	Clayey Sand	3	61	36					6.6			
TPB-1	TPB-1@5	SPT	5-6.5	CL	Claystone			72	39	15	24					
TPB-1	TPB-1@10	Cal Mod	10-10.75	SC	Clayey Sand	7	51	42				112.8	7.5	121.3		
TPB-2	TPB-2@0-5	Bulk	0-5	SC	Clayey Sand											Pro = 130.8 pcf @ 8.8%
TPB-2	TPB-2@5	SPT	5-6.5	CL	Claystone			67	36	12	24					
TPB-2	TPB-2@10	SPT	10-10.7	SM	Silty Sand		72	28					5.1			
B-1	B-1@1-5	Bulk	1-5	SC	Clayey Sand	1	64	35	26	18	8					
B-1	B-1@6-6.5	Cal Mod	6-6.5	SC	Clayey Sand			41				109.5	7.9	118.2	0.48% @ 0.8 ksf	
												110.2	7.9	118.9	2.35% @ 3.2 ksf	
												115.5	7.9	124.6	1.75% @ 6.4 ksf	
B-1	B-1@6.5-7	Cal Mod	6.5-7	SC	Clayey Sand			41				115.7	9.3	126.5		DS = 200 psf, 35°
B-1	B-1@10.5-11	Cal Mod	10.5-11	SC	Clayey Sand with Gravel			29	28	13	15	118.5	13.0	133.9	0.25% @ 1.6 ksf	
												121.3	13.0	137.1	0.15% @ 3.2 ksf	
												120.6	13.0	136.3	0.16% @ 6.4 ksf	
B-1	B-1@11-11.5	Cal Mod	11-11.5	SC	Clayey Sand			29	28	13	15	118.2	10.9	131.2		DS = 300 psf, 34°
B-1	B-1@20	SPT	20-21.5	SC	Clayey Sand	6	74	20					10.0			

Sample Information				USCS Classification (c,d)	USCS Name (c,d)	Sieve Analysis			Atterberg Limits			Moisture-Density Porosity Tests (e)			Collapse/Swell Potential (f)	Other Tests (g,h)
						ASTM D6913 / D7928			ASTM D4318			ASTM D2937			ASTM D4546	
Boring ID	Sample ID	Sample Type (a)	Depth (ft bgs) (b)			Gravel (%)	Sand (%)	Silt & Clay (#200) (%)	Liquid Limit LL	Plastic Limit PL	Plasticity Index PI	Dry Density (pcf)	Moisture Content (%)	Moist Unit Weight (pcf)	% vertical strain upon inundation @ vertical stress	
B-1	B-1@30	SPT	30-31.5	*SC*	*Clayey Sand*			30					9.8			
B-1	B-1@40-43	Rock Core	40.5-41	SM	Sandstone							129.6	8.4	140.5		UCS = 14.08 ksf
B-1	B-1@43-46	Rock Core	44.1-44.5	SM	Sandstone							130.6	7.8	140.8		UCS = 31.83 ksf
B-2	B-2@0.5-1	Bulk	0.5-1	SC	Clayey Sand				27	12	15					
B-2	B-2@7.5-10	Rock Core	9-9.5	SM	Sandstone							122.4	10.2	134.9		UCS = 2.32 ksf
B-2	B-2@15-17.5	Rock Core	15.5-16	CL	Claystone							119.6	11.7	133.6		UCS = 7.04 ksf
B-2	B-2@22.5-25	Rock Core	24-24.5	CL	Claystone							121.5	12.7	136.9		UCS = 6.14 ksf
B-2	B-2@27-30	Rock Core	27.5-28	SM	Sandstone							111.2	13.7	126.4		UCS = 0.89 ksf
B-3	B-3@6-11	Rock Core	7.5-8	SM	Sandstone							124.9	12.7	140.8		UCS = 5.33 ksf
B-4	B-4@1.5-6	Rock Core	5-5.5	SM	Sandstone							137.9	6.3	146.6		UCS = 47.60 ksf

Notes:

a. Cal Mod = California Modified ring sample; SPT = Standard Penetration Test Drive sample; Bulk = Bulk bag sample; Rock Core = Continuous rock core sample
b. bgs = Below Ground Surface
c. USCS = Unified Soil Classification System
d. Italicized UCSC Classification and Name based on field classification only. Not verified based on laboratory test results.
e. pcf = pounds per cubic foot
f. positive values indicate collapse, negative values indicate swell, ksf = kilopounds per square foot
g. DS = Direct Shear test (ASTM D3080); Pro = Modified Proctor Test (ASTM D1557), R-Value = R-Value test (ASTM D2844), UCS = Uniaxial Compressive Strength Test (ASTM D7012)
h. psf = pounds per square foot, ksf = kilopounds per square foot

Table 3. Nearby Faults
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Fault Name	**Fault Class**	**Distance and Direction from Site** [a]	**Maximum Moment Magnitude** [b]
San Gabriel Fault Zone Palomas Section	A	0.29 mi (0.47 km) to northeast	7.2
Holser Fault	A	0.27 mi (0.44 km) to south	6.7
Northridge Blind Thrust	A	3.9 mi (6.28 km) to southwest	6.8
Del Valle	A	5.0 mi (8.14 km) to southwest	6.2
Santa Felicia fault	A	5.1 mi (8.26 km) to northwest	*not available*
Sierra Madre Fault Zone Santa Susana Section	A	7.8 mi (12.5 km) to southwest	6.8
San Andreas Fault Mojave Section	A	17.7 mi (28.5 km) to northeast	7.9

Notes:

a. Distances from site noted are the closest distance to the surface trace or inferred projection of the fault as measured from mapped traces in the USGS Quaternary Fault and Fold Database of the United States [USGS, 2008].

b. Where available, maximum moment magnitude values were obtained from Caltrans Fault Database [Caltrans, 2013].

Table 4. Seismic Design Parameters
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Seismic Hazard Parameter	**Value**
Approximate Site Latitude	34.445794 N
Approximate Site Longitude	118.586475W
Average Shear Wave Velocity of the top 100 ft (30 m), V_{S30} (estimated from Suspension Logging)	1650 ft/s to 2300 ft/sec
Site Class	C
Mapped Short Period Spectral Response Acceleration, S_s	2.06 g
Mapped 1-second Spectral Response Acceleration, S_1	0.754 g
Short Period Site coefficient (at 0.2-s period), F_a	1.2
Long Period Site coefficient (at 1.0-s period), F_v	1.4
Site-modified Short Period Spectral Response Acceleration, S_{MS}	2.472 g
Site-modified 1-second Spectral Response Acceleration, S_{M1}	1.056 g
Design Short Period Spectral Response Acceleration, S_{DS}	1.648 g
Design 1-second Spectral Response Acceleration, S_{D1}	0.704 g
Mapped MCEG Peak Ground Acceleration, PGA	0.871 g
Site Coefficient, F_{PGA}	1.2
Site Class Adjusted MCEG Peak Ground Acceleration, PGA_M	1.045 g

Table 5. Damping Scaling Factors for 10% and 20% Damping Levels
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Period, T (sec)	Damping Scaling Factors (DSF)	
	10% Damping	20% Damping
0.01	1.00	1.00
0.02	0.99	0.99
0.03	0.98	0.96
0.05	0.94	0.89
0.075	0.89	0.80
0.1	0.86	0.74
0.15	0.82	0.66
0.2	0.80	0.62
0.25	0.79	0.61
0.3	0.79	0.60
0.4	0.78	0.59
0.5	0.78	0.59
0.75	0.78	0.58
1	0.79	0.59
1.5	0.79	0.60
2	0.80	0.61
3	0.81	0.63
4	0.82	0.64
5	0.82	0.65

Table 6. Pile Downdrag Forces and Axial Load Capacities
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

DOWNDRAG FORCES (ULTIMATE)			
2ft Diameter Drilled Shaft		**3ft Diameter Drilled Shaft**	
Pile Length in Fill/Alluvium (ft)	**Downdrag (kips)**	**Pile Length in Fill/Alluvium (ft)**	**Downdrag (kips)**
5	3	5	4
10	11	10	16
20	44	20	65
30	98	30	147
40	174	40	261
PILE CAPACITIES (ULTIMATE)			
2ft Diameter Drilled Shaft		**3ft Diameter Drilled Shaft**	
End bearing (kips)	63	End bearing (kips)	141
Skin friction per foot Socket (kips/ft)	9	Skin friction per foot Socket (kips/ft)	14

Assumptions:

a. Fill and alluvium layers were considered to have an internal friction angle of 30 degrees, and unit weight of 120 pcf.

b. Assumed unit base bearing (ultimate)= 20 ksf, unit skin friction (ultimate)=1.5ksf.

Table 7a. LPILE Design Parameters
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Material Type	Depth Below Existing Grades (feet)	Effective Unit Weight (pcf)	Friction Angle (degrees)	Undrained Shear Strength (psf)	Uniaxial Compression Strength (psf)	p-y Curve Type
Existing Undocumented Fills	0-15	120	30	-	-	Sand (Reese)
Engineered Fills[b]	N/A	120	32	-	-	Sand (Reese)
Alluvium	15-40	120	30	-	-	Sand (Reese)
Claystone	>40	135	-	3500	7000	Stiff Clay w/o Free Water (Reese)

Notes:

a. pcf = pounds per cubic foot, psf = pounds per square foot.

b. While not currently present at the site, potential future engineered fills derived from the Saugus formation or similar may use these properties.

Table 7b. Lateral Capacity of Deep Foundations
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Pile Head Deflection (inch)	24-inch Diameter Shaft				36-inch Diameter Shaft			
	Lateral Capacity (kips)		Maximum Moment (kips-in)		Lateral Capacity (kips)		Maximum Moment (kips-in)	
Non-cracked structural section								
	Fixed head	**Free head**	**Fixed head**	**Free head**	**Fixed head**	**Free head**	**Fixed head**	**Free head**
0.5	110	50	6,665	2,415	230	105	18,330	6,830
1	165	75	10,830	4,000	330	160	29,165	11,165
2	225	110	17,290	6,665	480	230	46,665	18,415
Cracked structural section (assumed $I_{cracked} = 0.5\ I_{intact}$)								
0.5	85	40	4,415	1,630	180	80	12,500	4,500
1	130	60	7,415	2,710	260	120	20,000	7,665
2	190	85	11,830	4,540	390	180	33,330	12,500

Notes:

a. Analysis assumed bottom of the pile cap 2 ft below ground surface for the fixed head option.
b. Analysis assumed top of the pile 2 ft below ground surface for the free head option.
c. Axial loading was considered with 100 kips. Structural engineer to assess and confirm.
d. Cracked structural sections approximated at 50% I of intact section. Structural engineer to assess and confirm if appropriate.
e. Pile was considered elastic with E modulus of 3,000,000 lbs/in^2.

Table 8. Summary of Soil Chemical Test Results
Honor Rancho Compressor Modernization Project
Moreno Valley, CA

Boring ID	Sample ID	Depth (ft bgs)[(a)]	USCS Classification[(b)]	CTM 417[(c)]	CTM 422[(c)]	CTM 643[(c)]	CTM 643[(c)]
				Sulfates	**Chlorides**	**Min. Resistivity**	**pH**
				(ppm)[(d)]	(ppm)[(d)]	(Ohm-cm)	
HSA-2	HSA-2@5	5-6.5	SC	55	90	2,085	7.3
TPB-1	TPB-1@15	15-15.9	ML	138	246	1,351	7.1
B-1	B-1@1-5	1-5	SC	124	144	1,898	8.2
B-1	B-1@40-43	41-41.3	SM	113	138	1,398	8.5
B-2	B-2@30-35	30-35	SM	70	102	2,415	8.6
B-3	B-3@3.5-4	3.5-4	SM	306	204	1,089	9.3
B-4	B-4@1.5-6	5-6.5	SM	145	174	1,336	8.9

Notes:

a. ft bgs = feet below ground surface
b. USCS = Unified Soil Classification System
c. CTM = California Test Method
d. ppm = parts per million

Table 9. Summary of Field-Measured Hydraulic Conductivity
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Borehole Nr.	Date Tested	Depth of Screened Interval	Soil Type in the Screened Interval	Estimated Hydraulic Conductivity using USBR method, cm/s (in/hr)	Estimated Hydraulic Conductivity using Hvorslev Method, cm/s (in/hr)
HSA-1	1/5/2021	15 ft to 25 ft	SM (Alluvium)	3.2×10^{-5} (0.05)	3.4×10^{-5} (0.05)
HSA-2	1/5/2021	5 ft to 15 ft	SC (Fill)	n/a (a)	4.5×10^{-5} (0.06)

Notes:

a. At HSA-2, a constant head infiltration test was initially attempted. However, water levels did not drop at a measurable rate due to low permeability of soils within the screen interval. Therefore, a falling head infiltration test was conducted, and results were evaluated with the Hvorslev method.

Table 10a. Flexible Pavement Structural Sections
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Traffic Index[(a)]	**Pavement Structural Section[(b,c,d)]**		
	Asphaltic Concrete (in)	**Class II Aggregate Base (in)**	**Class II Aggregate Base with Geogrid[(e)] (in)**
TI = 5.0	4	8	7
TI = 6.0	4	11	10
TI = 7.0	4	15	13
TI = 8.0	5	16	14

Notes:

a. These traffic index values should be confirmed by the project Traffic Engineer or SoCalGas prior to final design.

b. The pavement sections summarized are minimum thicknesses.

c. Structural section thicknesses were based on an R-value of 18 based on limited geotechnical sampling. The geotechnical consultant shall observe the prepared subgrade for the pavements to confirm the subgrade conditions are consistent with the design assumptions. Additional R-value testing may be required if varying soil conditions are encountered during construction.

d. These structural sections assume 12 inches of properly prepared subgrade compacted to a minimum 95 percent relative compaction (per Section 5.9).

e. Structural section for Class II Aggregate Base was based on an R-value of 25 per recommendations provided by Caltrans (2018) for a pavement section with a subgrade enhancement geogrid layer.

Table 10b. Rigid Pavement Structural Sections
Honor Rancho Compressor Modernization Project
Santa Clarita, CA

Traffic Index[(a)]	**Pavement Structural Section[(b,c,d)]**	
	Jointed Plain Concrete (in)	**Class II Aggregate Base (in)**
TI = 9.0	10	6
TI = 10.0	11	8
TI = 11.0	12	9

Notes:

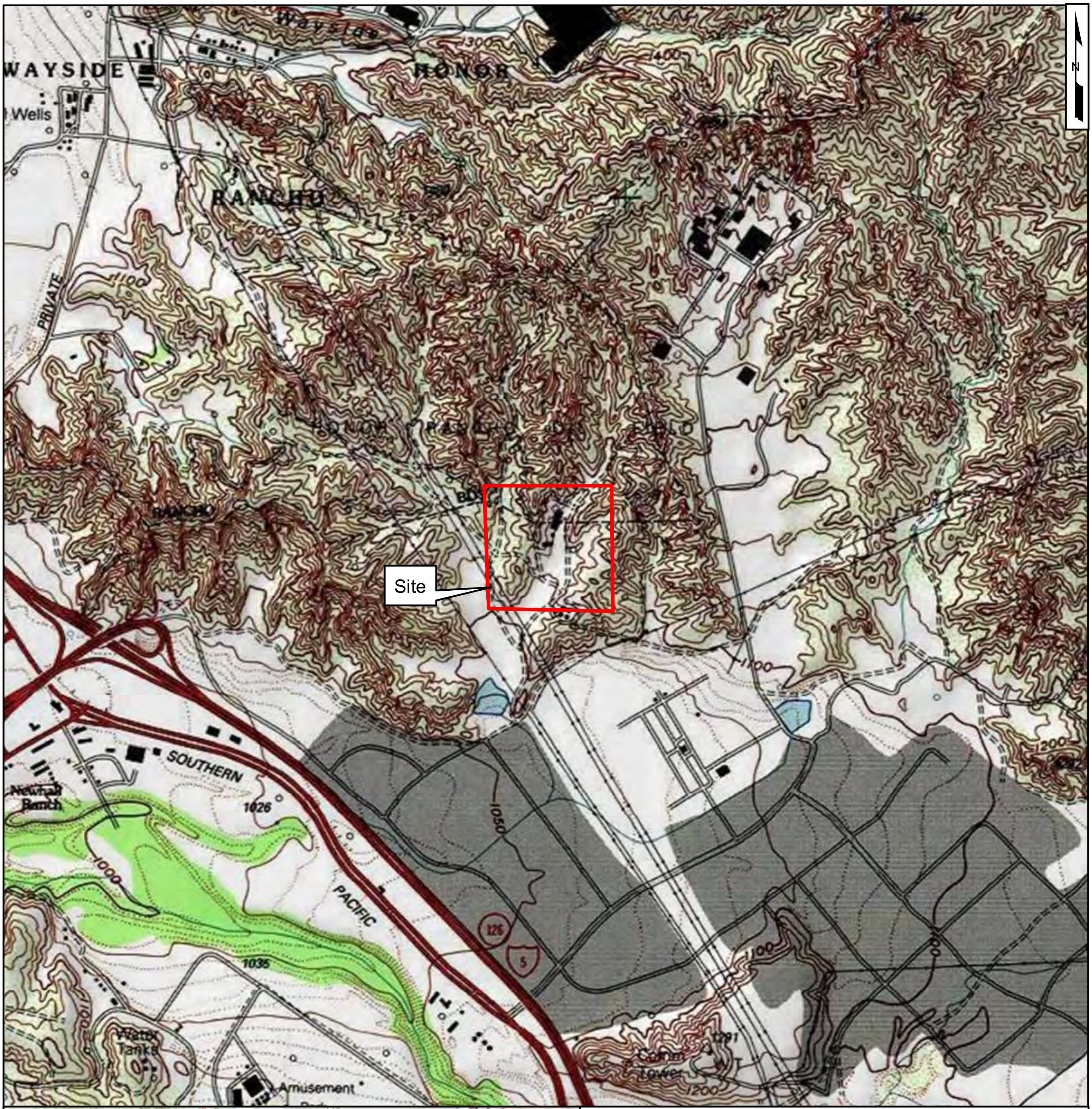
a. These traffic index values should be confirmed by the project Traffic Engineer or SoCalGas prior to final design. For traffic indices greater than 12, Class II Aggregate Base shall be replaced with Hot-Mix Asphalt Type A, to thickness recommended in table 623.1F provided by Caltrans (2020).

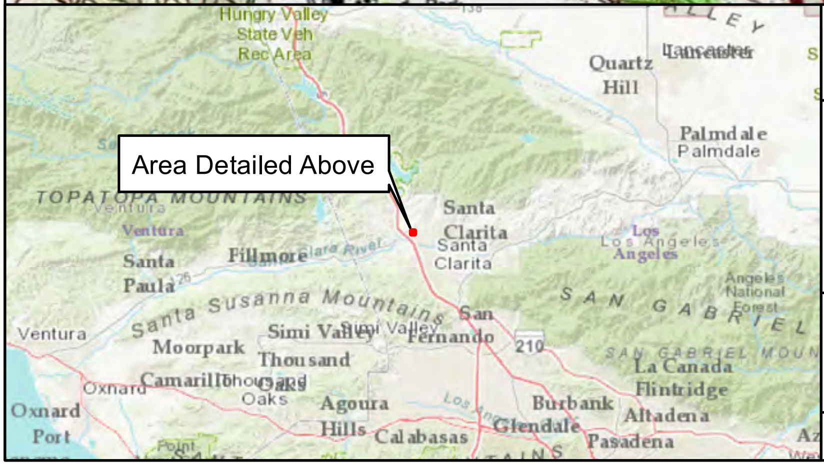
b. The pavement sections summarized are minimum thicknesses.

c. Structural section thicknesses were based on an R-value of 18 based on limited geotechnical sampling. The geotechnical consultant shall observe the prepared subgrade for the pavements to confirm the subgrade conditions are consistent with the design assumptions. Additional R-value testing may be required if varying soil conditions are encountered during construction.

d. These structural sections assume 12 inches of properly prepared subgrade compacted to a minimum 95 percent relative compaction (per Section 5.9).

FIGURES





2,000 1,000 0 2,000 Feet

Site Location

Honor Rancho Compressor Modernization (HRCM) Project
28300 Brady Parkway
Santa Clarita, CA 91355

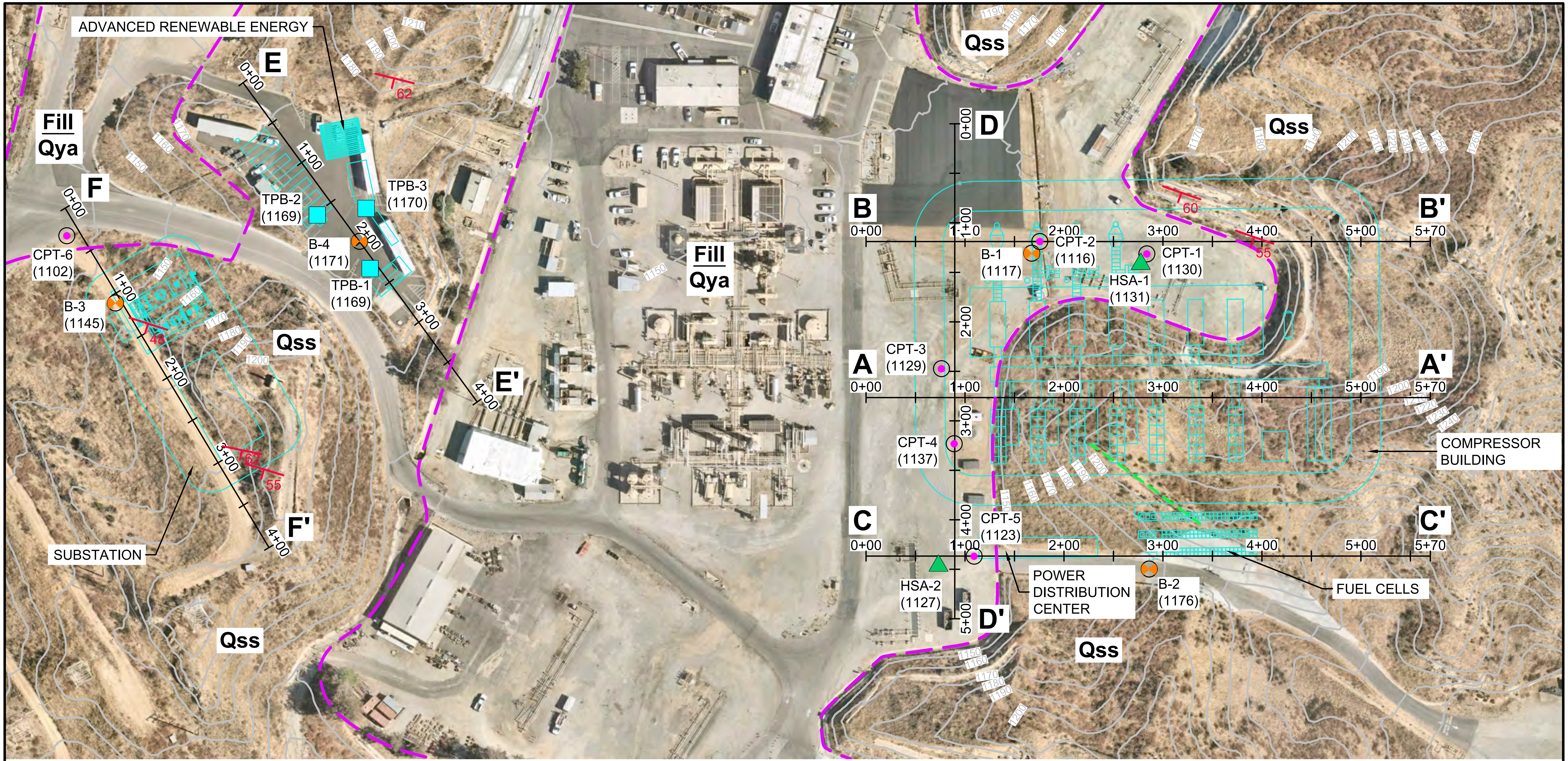
Geosyntec
consultants

SC0766U

APRIL 2021

Figure

1



LEGEND

—1150—	EXISTING GROUND MAJOR CONTOUR	**Fill** **Qya**	UNDOCUMENTED FILL OVERLYING QUATERNARY YOUNG ALLUVIAL DEPOSIT
▲	HOLLOW STEM AUGER BORING (HSA)	**Qss**	SAUGUS FORMATION
⊙	CONE PENETRATION TEST (CPT)	— — —	APPROXIMATE GEOLOGIC CONTACT
⊗	MUD ROTARY/ROCK CORE (B)	⊥ 50	APPROXIMATE STRIKE AND DIP OF BEDROCK
■	HOLLOW STEM AUGER BORING (TPB)		
- - - -	SEISMIC REFRACTION LINE (SREF)	A ├──┼──┤ A'	CROSS SECTION - REFER TO FIGURE 6A-6F
HSA-1 (1131)	APPROXIMATE ELEVATION OF TOP OF SAUGUS FORMATION IN PARENTHESES		

N

0 100
SCALE IN FEET

EXPLORATION LOCATION / GEOLOGIC MAP
HONOR RANCHO COMPRESSOR
MODERNIZATION
SANTA CLARITA, CALIFORNIA

Geosyntec
consultants

FIGURE
2

PROJECT NO: SC0766U
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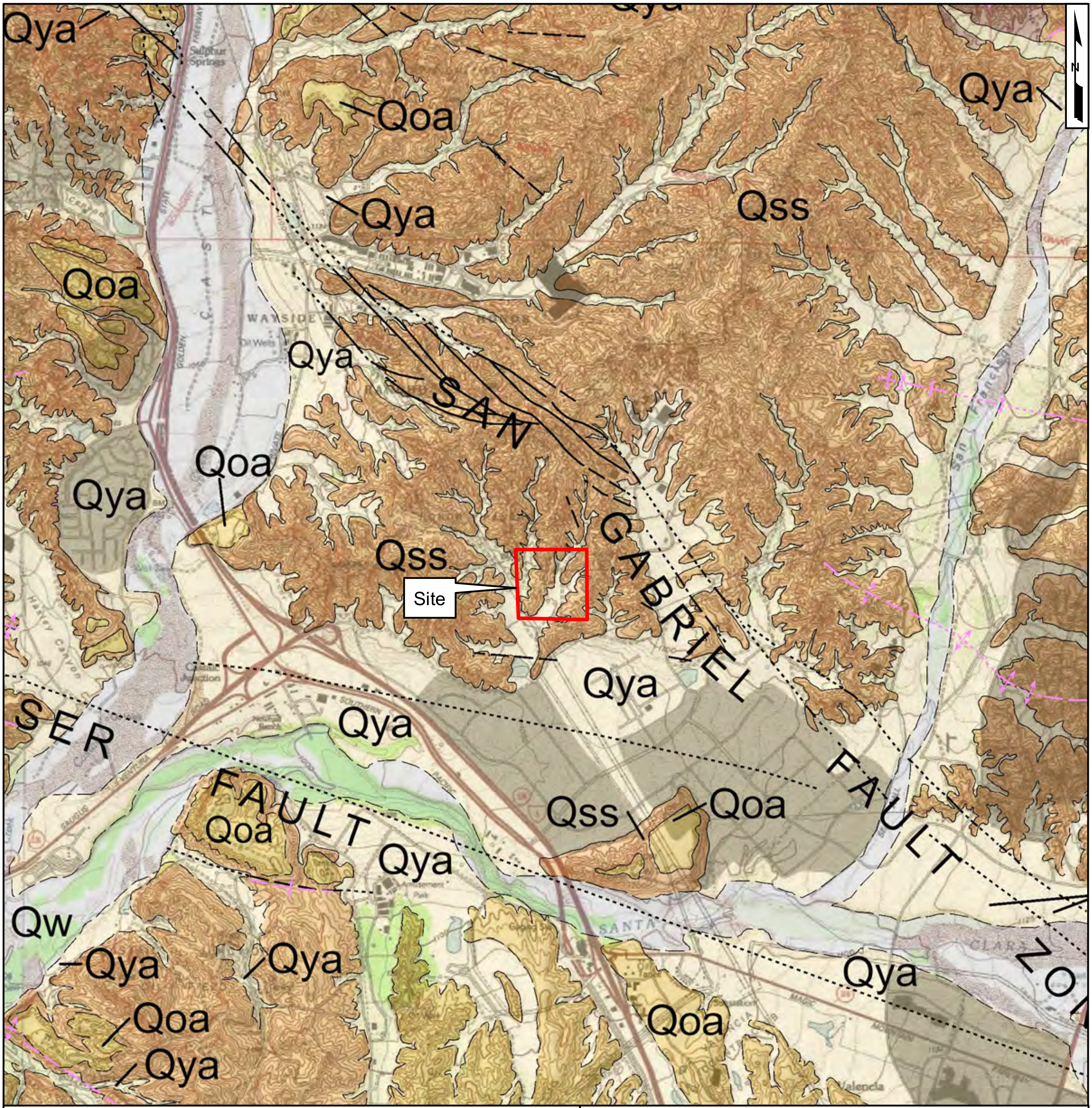
T:\CADD\SOCAL GAS\HONOR RANCH\COMPRESSOR MODERNIZATION\FIGURES\SC0766UF001 - Last Saved by: KViswanathan on 4/12/21



Legend

- ⬜ Qya – Young Alluvial Valley Deposit
- 🟨 Qoa – Older Alluvial Deposit
- 🟧 Qss – Sauqus Formation, Sandstone Unit
- ⬜ Qw – Active-wash Deposit

Service Layer Credits: This data was created and compiled by California Geological Survey. This project was funded by Department of Water Resources.
Copyright:© 2013 National Geographic Society, i-cubed

2,000 1,000 0 2,000 Feet

Geologic Map

Honor Rancho Compressor Modernization (HRCM) Project
28300 Brady Parkway
Santa Clarita, CA 91355

Geosyntec consultants

SC0766U

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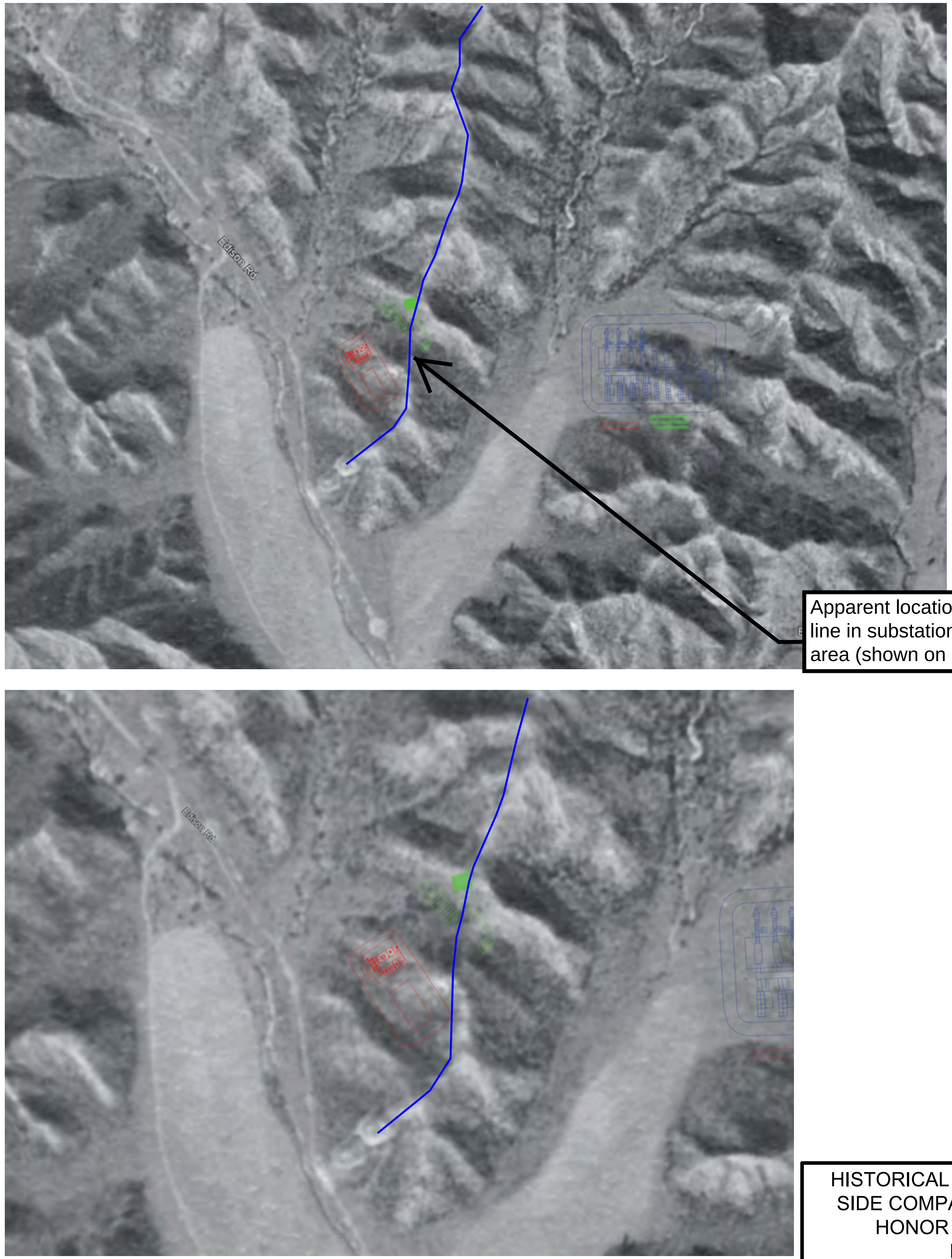
Figure

3

Image Credit: Google Earth, 2021

2020



Apparent location of pre-development ridge line in substation/alternative renewable energy area (shown on all images)

Image Credit: UC Santa Barbara Library, Flight C-197, Santa Clarita to Castaic and Val Verde, 1928, Fairchild Aerial Surveys

1928

HISTORICAL GEOMORPHOLOGY (SIDE BY SIDE COMPARISON OF AERIAL PHOTOS) HONOR RANCHO COMPRESSOR MODERNIZATION SANTA CLARITA, CALIFORNIA

Geosyntec consultants

FIGURE 4

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P:\CADD\SOCAL GAS\HONOR RANCH\COMPRESSOR MODERNIZATION\FIGURES\SC0766UF002 - Last Saved by: SBerdy on 2/8/21

Reported Earthquake Magnitudes 1932 - 2021

- 7.5
- 6.0 - 6.99
- 5.0 - 5.99
- 4.0 - 4.99

Quarternary Fault

Data Source: Southern California Earthquake Data Center and U.S. Geological Survey and California Geological Survey, 2006, Quaternary fault and fold database for the United States, 2019, from USGS web site: http//earthquake.usgs.gov/hazards/qfaults/.

10 5 0 10 Miles

Regional Fault and Historical Earthquake Epicenter Map

Honor Rancho Compressor Modernization (HRCM) Project
28300 Brady Parkway
Santa Clarita, CA 91355

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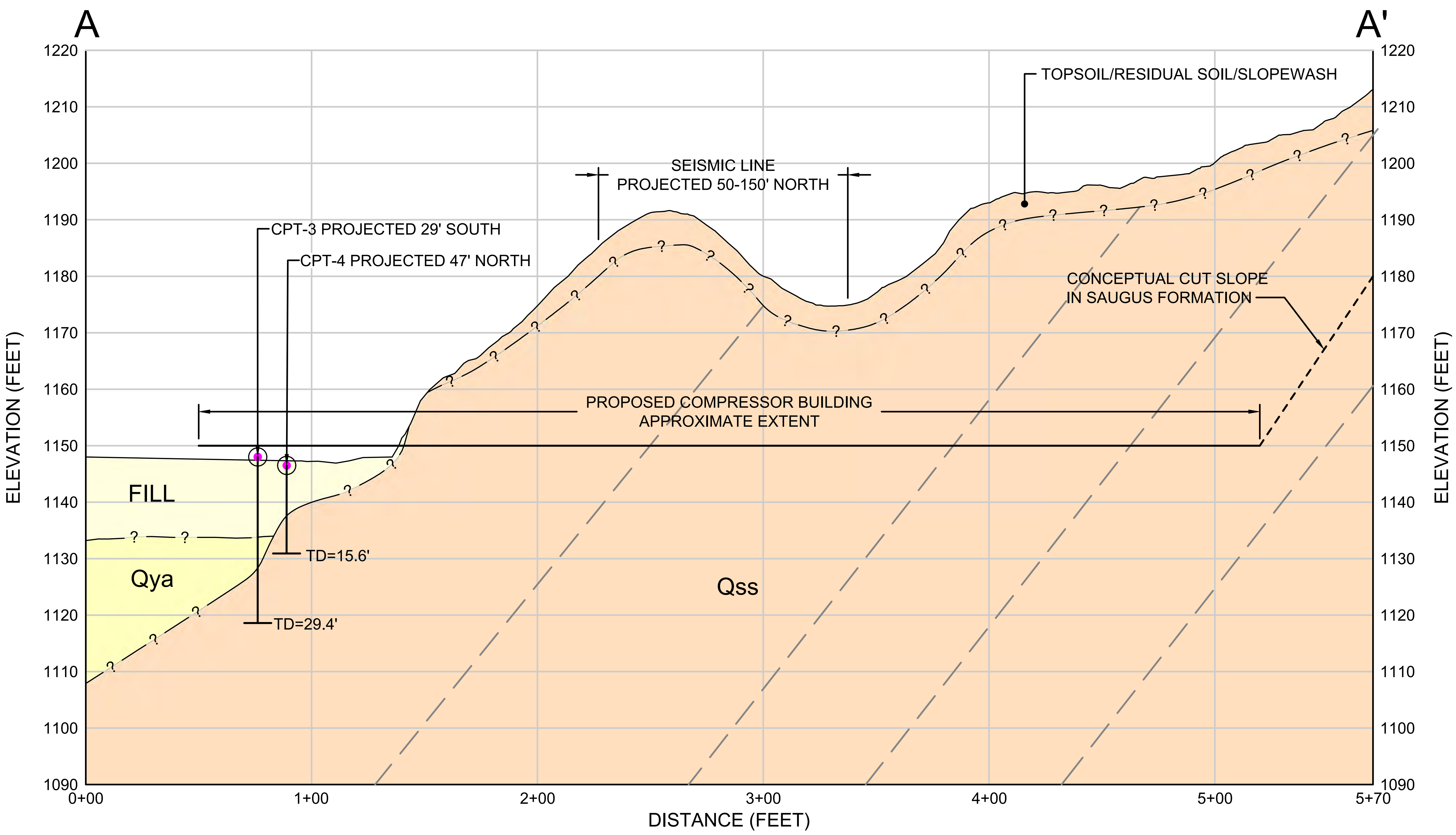
SC0766U | APRIL 2021

Figure

5



LEGEND

——————	EXISTING GROUND MAJOR CONTOUR	FILL	UNDOCUMENTED FILL
◉	CONE PENETRATION TEST (CPT)	Qya	QUATERNARY YOUNG ALLUVIAL DEPOSIT
— ? —— — — —	APPROXIMATE GEOLOGIC CONTACT (QUERIED WHERE UNCERTAIN)	Qss	SAUGUS FORMATION SANDSTONE WITH INTERBEDDED CLAYSTONE OF VARYING THICKNESS
— — — —	APPROXIMATE DIP OF BEDDING (APPARENT DIP)		

NOTE:

1. APPARENT DIP OF BEDDING APPEARS STEEPER THAN ACTUAL DUE TO VERTICAL EXAGGERATION.

CROSS SECTION A-A'
HONOR RANCHO COMPRESSOR
MODERNIZATION
SANTA CLARITA, CALIFORNIA

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FIGURE
6A

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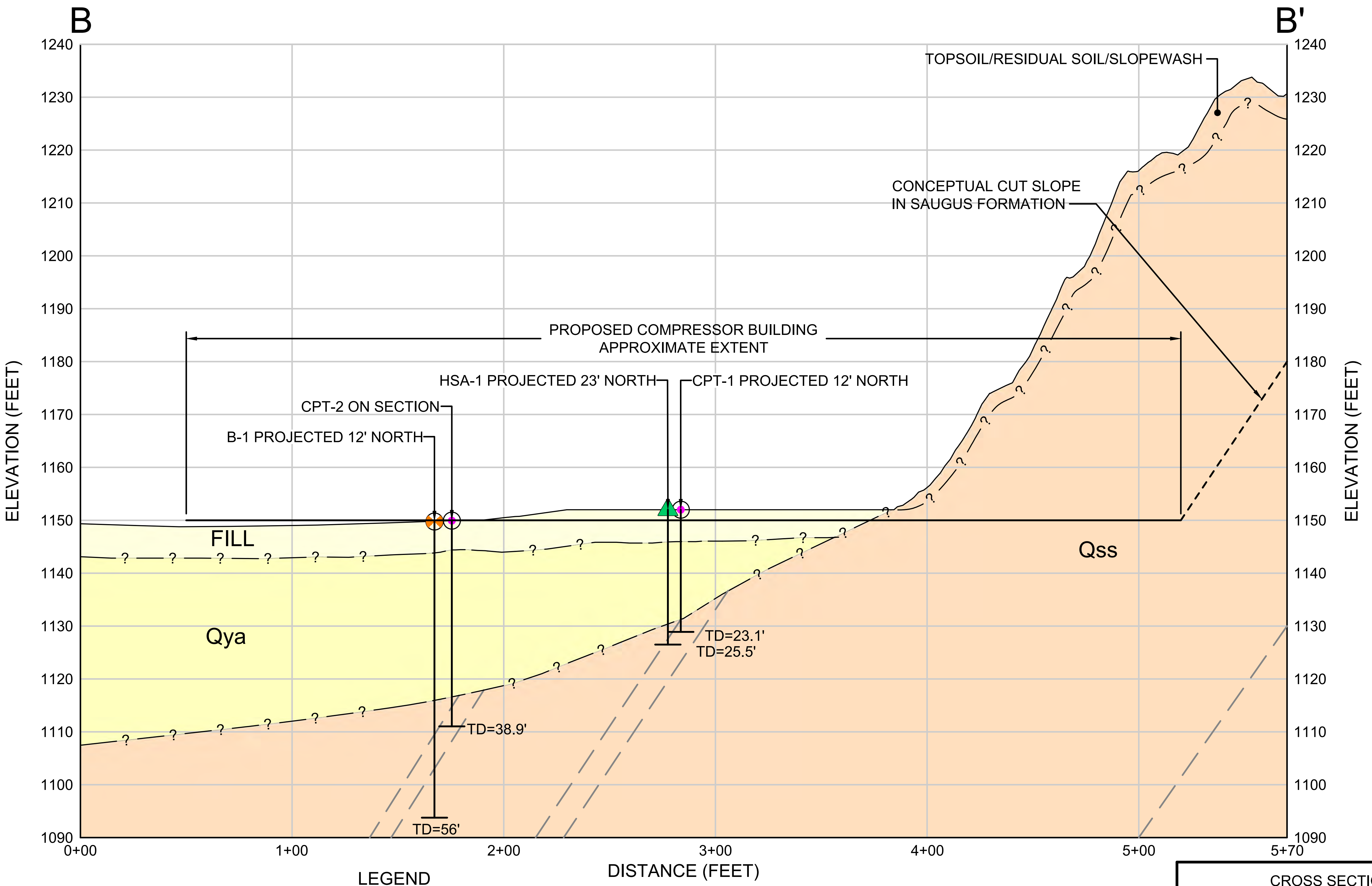

LEGEND

——	EXISTING GROUND MAJOR CONTOUR
▲	HOLLOW STEM AUGER BORING (HSA)
◉	CONE PENETRATION TEST (CPT)
⊗	MUD ROTARY/ROCK CORE (B)
— ? —— — —	APPROXIMATE GEOLOGIC CONTACT (QUERIED WHERE UNCERTAIN)
— — — —	APPROXIMATE DIP OF BEDDING (APPARENT DIP)
FILL	UNDOCUMENTED FILL
Qya	QUATERNARY YOUNG ALLUVIAL DEPOSIT
Qss	SAUGUS FORMATION SANDSTONE WITH INTERBEDDED CLAYSTONE OF VARYING THICKNESS

NOTE:

1. APPARENT DIP OF BEDDING APPEARS STEEPER THAN ACTUAL DUE TO VERTICAL EXAGGERATION.

CROSS SECTION B-B'
HONOR RANCHO COMPRESSOR
MODERNIZATION
SANTA CLARITA, CALIFORNIA

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APRIL 2021

FIGURE
6B

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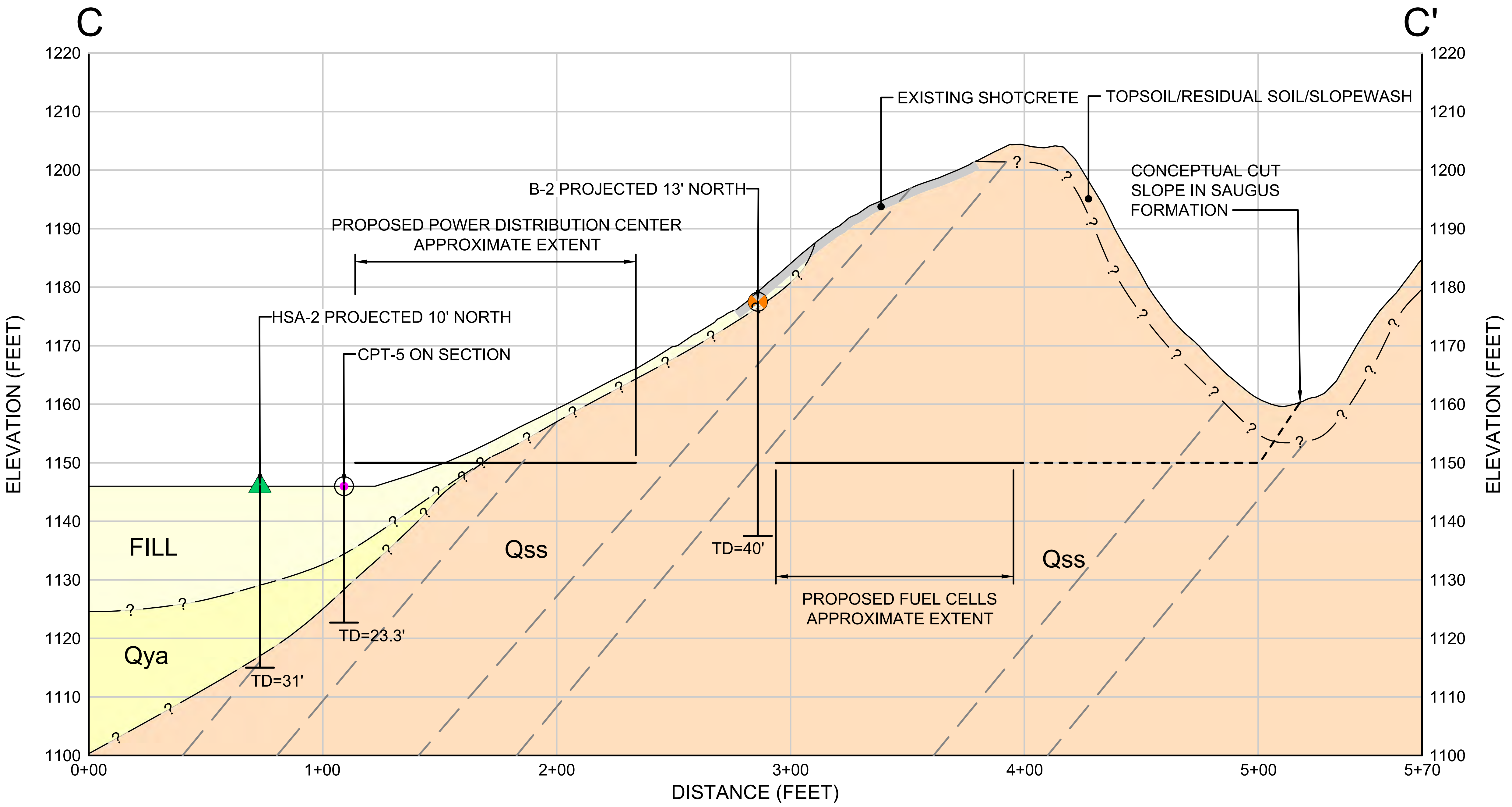

LEGEND

——	EXISTING GROUND MAJOR CONTOUR
▲	HOLLOW STEM AUGER BORING (HSA)
◉	CONE PENETRATION TEST (CPT)
⊗	MUD ROTARY/ROCK CORE (B)
— ? —— — —	APPROXIMATE GEOLOGIC CONTACT (QUERIED WHERE UNCERTAIN)
— — — —	APPROXIMATE DIP OF BEDDING (APPARENT DIP)

FILL	UNDOCUMENTED FILL
Qya	QUATERNARY YOUNG ALLUVIAL DEPOSIT
Qss	SAUGUS FORMATION SANDSTONE WITH INTERBEDDED CLAYSTONE OF VARYING THICKNESS

NOTE:

1. APPARENT DIP OF BEDDING APPEARS STEEPER THAN ACTUAL DUE TO VERTICAL EXAGGERATION.

CROSS SECTION C-C'
HONOR RANCHO COMPRESSOR
MODERNIZATION
SANTA CLARITA, CALIFORNIA

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FIGURE
6C

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APRIL 2021

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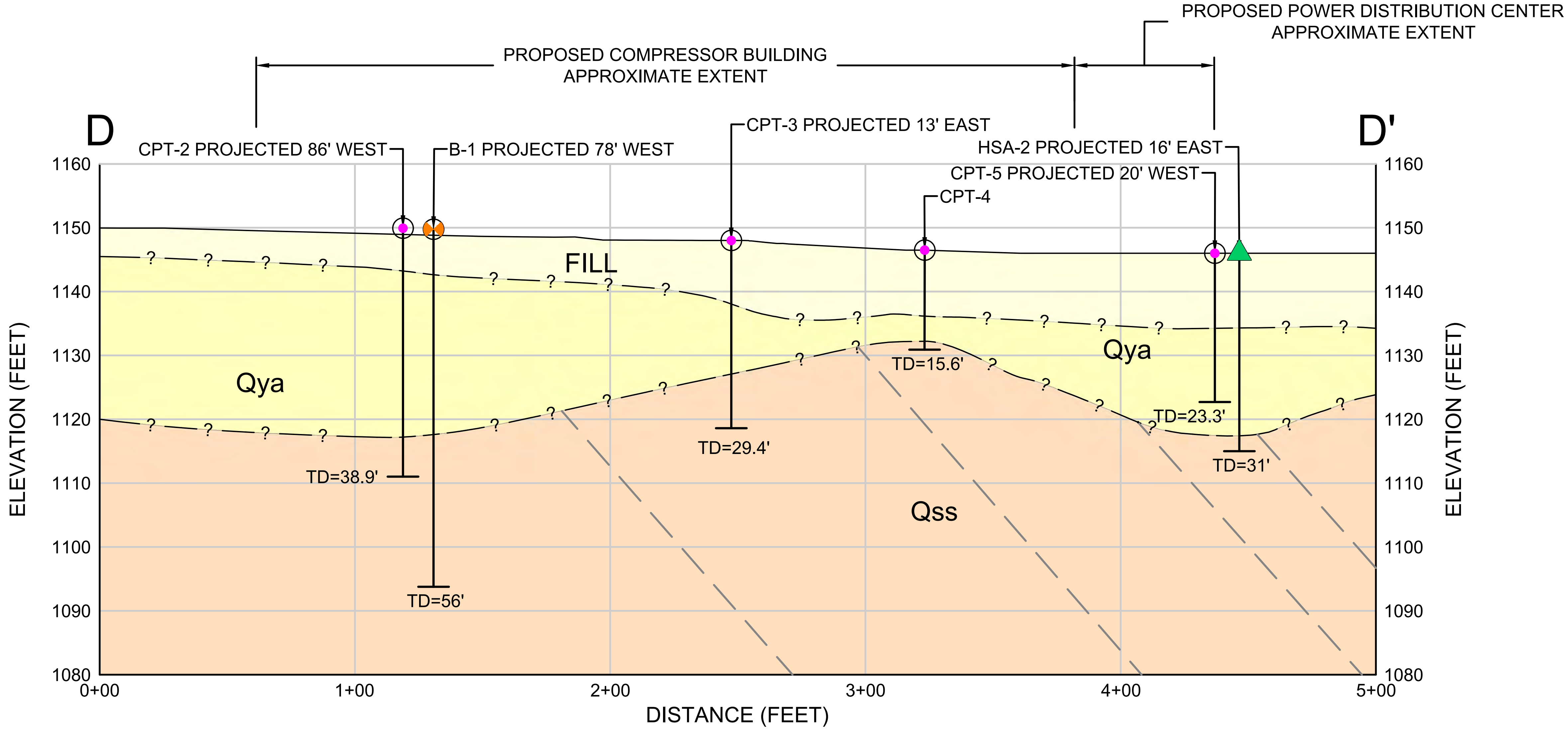

LEGEND

—— EXISTING GROUND MAJOR CONTOUR

▲ HOLLOW STEM AUGER BORING (HSA)

◉ CONE PENETRATION TEST (CPT)

⊗ MUD ROTARY/ROCK CORE (B)

— ? —— — — — APPROXIMATE GEOLOGIC CONTACT (QUERIED WHERE UNCERTAIN)

— — — — APPROXIMATE DIP OF BEDDING (APPARENT DIP)

FILL UNDOCUMENTED FILL

Qya QUATERNARY YOUNG ALLUVIAL DEPOSIT

Qss SAUGUS FORMATION SANDSTONE WITH INTERBEDDED CLAYSTONE OF VARYING THICKNESS

NOTE:

1. APPARENT DIP OF BEDDING APPEARS STEEPER THAN ACTUAL DUE TO VERTICAL EXAGGERATION.

CROSS SECTION D-D'
HONOR RANCHO COMPRESSOR
MODERNIZATION
SANTA CLARITA, CALIFORNIA

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FIGURE
6D

PROJECT NO: SC0766U
APRIL 2021

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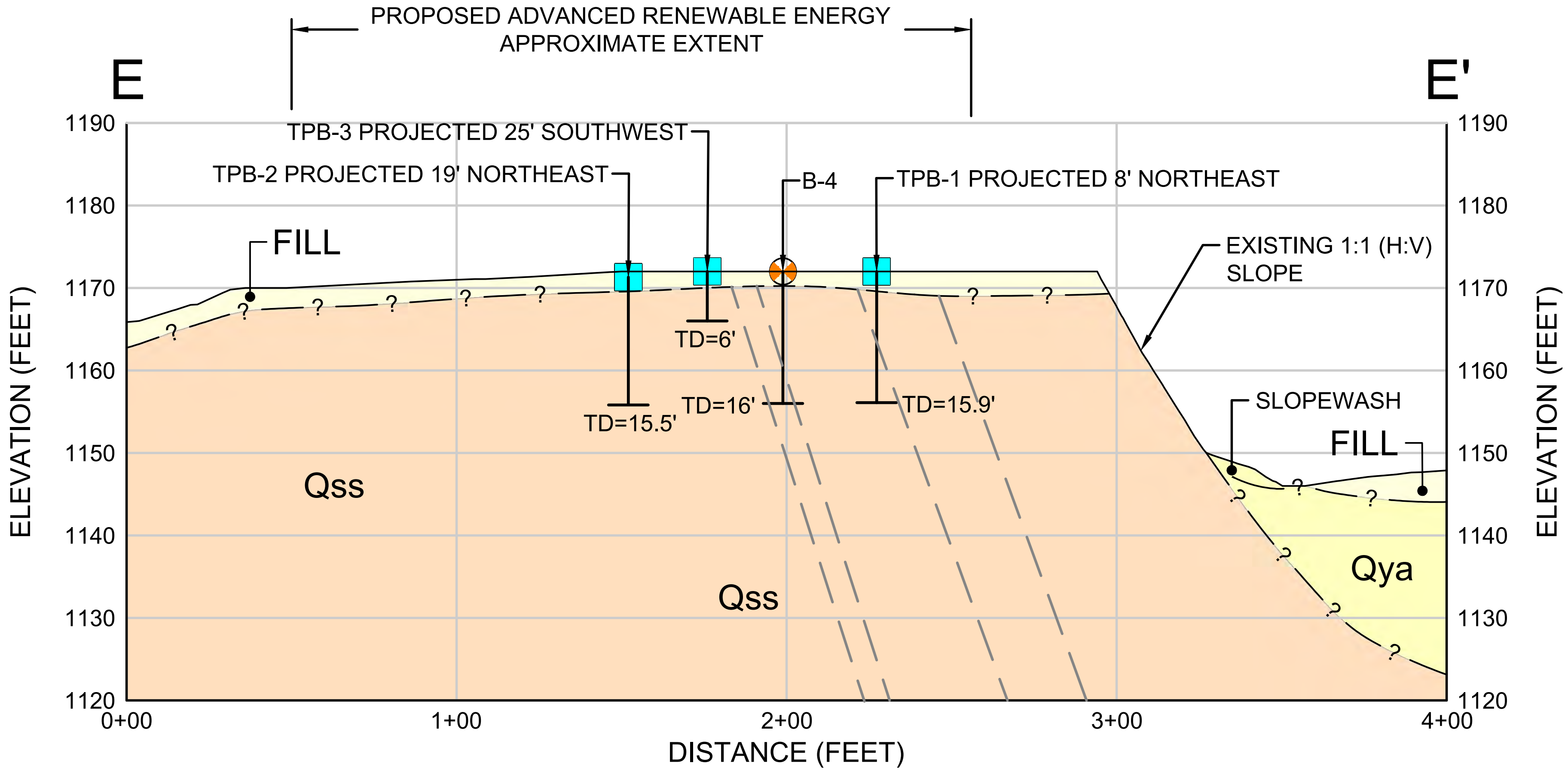

LEGEND

────	EXISTING GROUND MAJOR CONTOUR
⊗	MUD ROTARY/ROCK CORE (B)
■	HOLLOW STEM AUGER BORING (TPB)
— ? —— — — —	APPROXIMATE GEOLOGIC CONTACT (QUERIED WHERE UNCERTAIN)
— — — —	APPROXIMATE DIP OF BEDDING (APPARENT DIP)
FILL	UNDOCUMENTED FILL
Qya	QUATERNARY YOUNG ALLUVIAL DEPOSIT
Qss	SAUGUS FORMATION SANDSTONE WITH INTERBEDDED CLAYSTONE OF VARYING THICKNESS

NOTE:

1. APPARENT DIP OF BEDDING APPEARS STEEPER THAN ACTUAL DUE TO VERTICAL EXAGGERATION.

CROSS SECTION E-E'
HONOR RANCHO COMPRESSOR
MODERNIZATION
SANTA CLARITA, CALIFORNIA

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FIGURE
6E

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APRIL 2021

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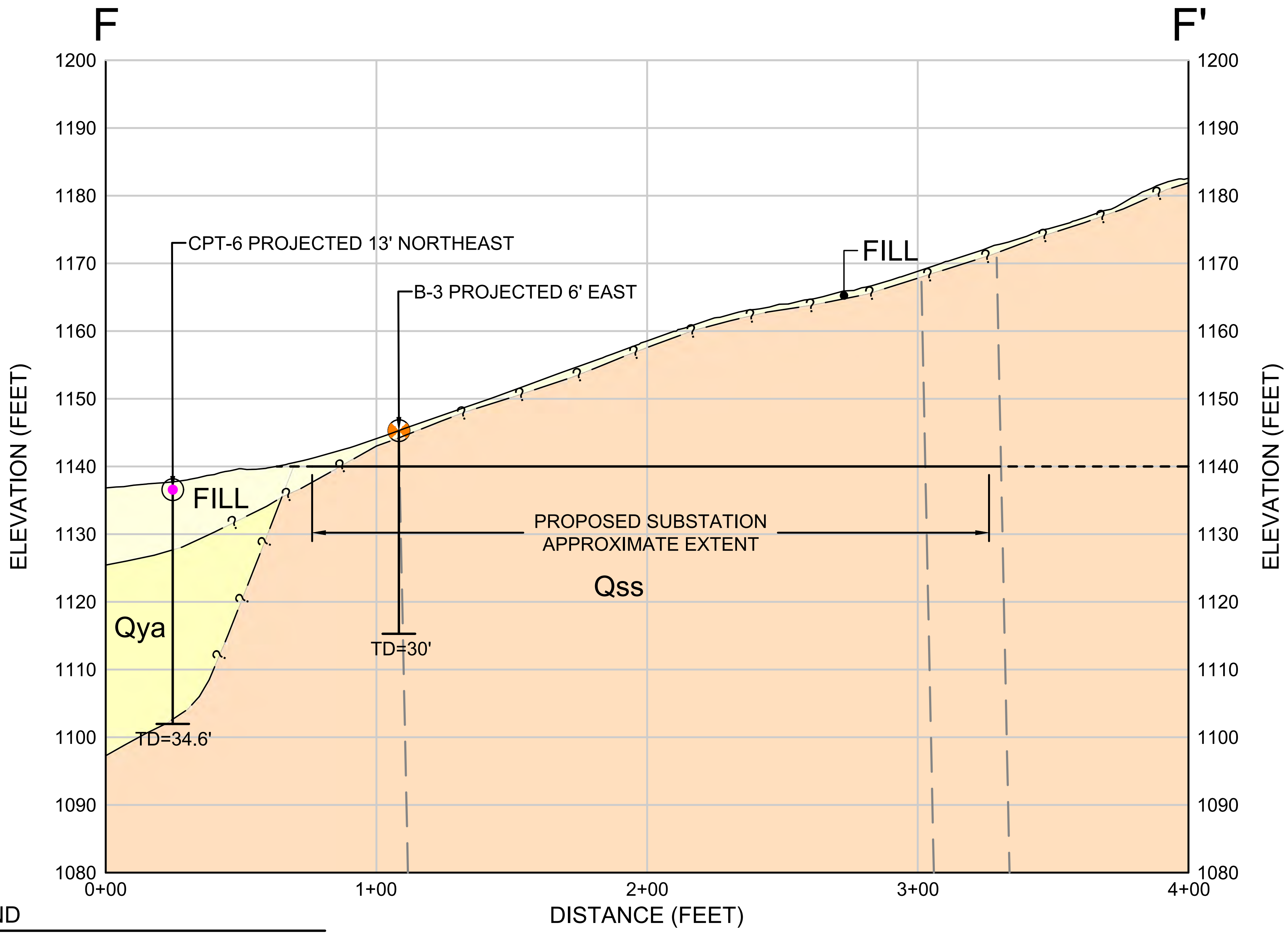

LEGEND

——	EXISTING GROUND MAJOR CONTOUR
◉	CONE PENETRATION TEST (CPT)
⊗	MUD ROTARY/ROCK CORE (B)
— ? —— — —	APPROXIMATE GEOLOGIC CONTACT (QUERIED WHERE UNCERTAIN)
— — — —	APPROXIMATE DIP OF BEDDING (APPARENT DIP)
FILL	UNDOCUMENTED FILL
Qya	QUATERNARY YOUNG ALLUVIAL DEPOSIT
Qss	SAUGUS FORMATION SANDSTONE WITH INTERBEDDED CLAYSTONE OF VARYING THICKNESS

NOTE:

1. APPARENT DIP OF BEDDING APPEARS STEEPER THAN ACTUAL DUE TO VERTICAL EXAGGERATION.

CROSS SECTION F-F'
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MODERNIZATION
SANTA CLARITA, CALIFORNIA

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FIGURE
6F

PROJECT NO: SC0766U
APRIL 2021

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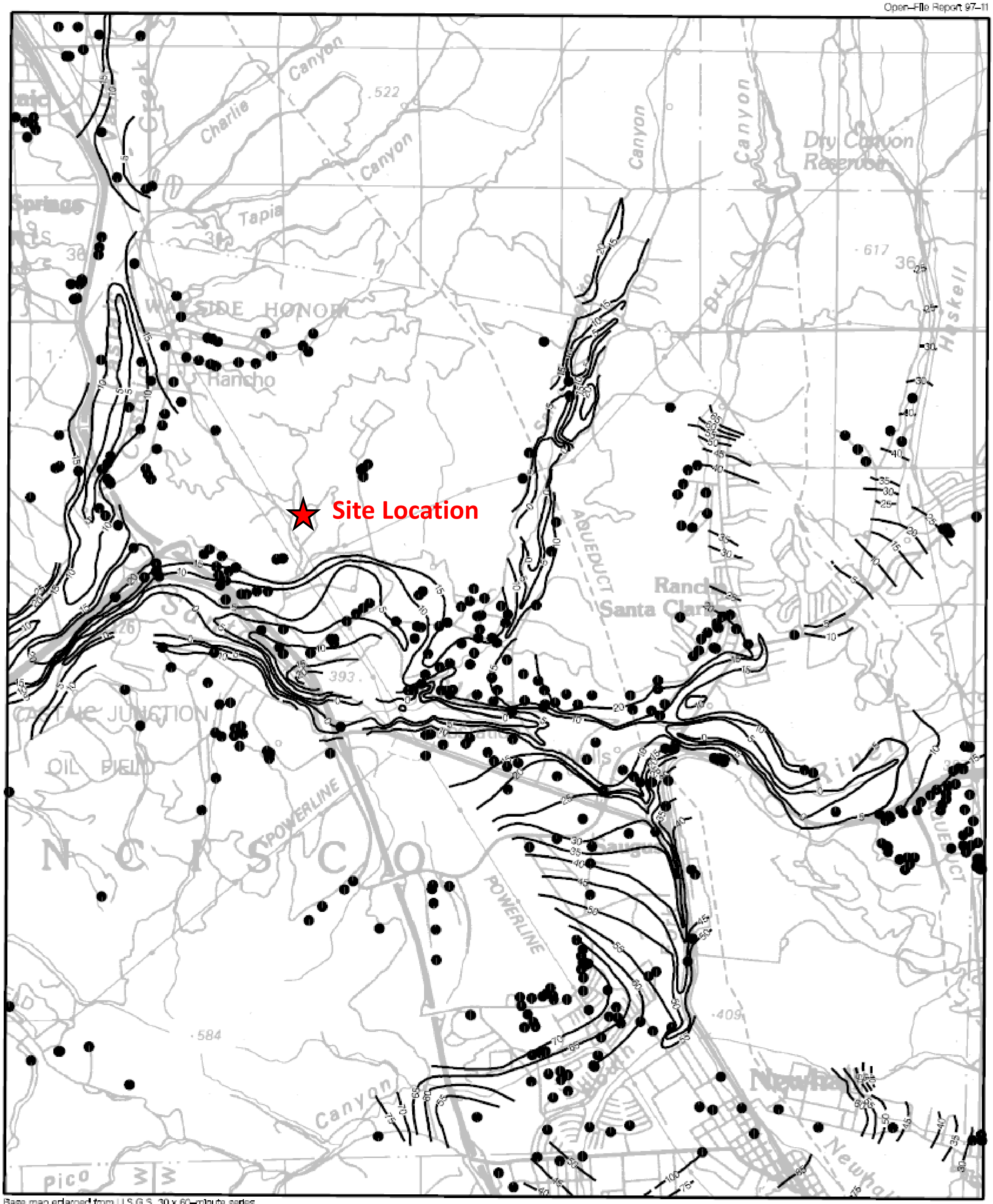
Open–File Report 97–11



Base map enlarged from U.S.G.S. 30 x 60–minute series

Plate 1.2 Historically Highest Ground Water Contours and Borehole Log Data Locations, Newhall Quadrangle.

● Borehole Site

30 Depth to ground water in feet

ONE MILE

HISTORIC HIGH GROUNDWATER CONTOURS, NEWHALL QUADRANGLE

HONOR RANCHO COMPRESSOR MODERNIZATION PROJECT, SANTA CLARITA, CALIFORNIA

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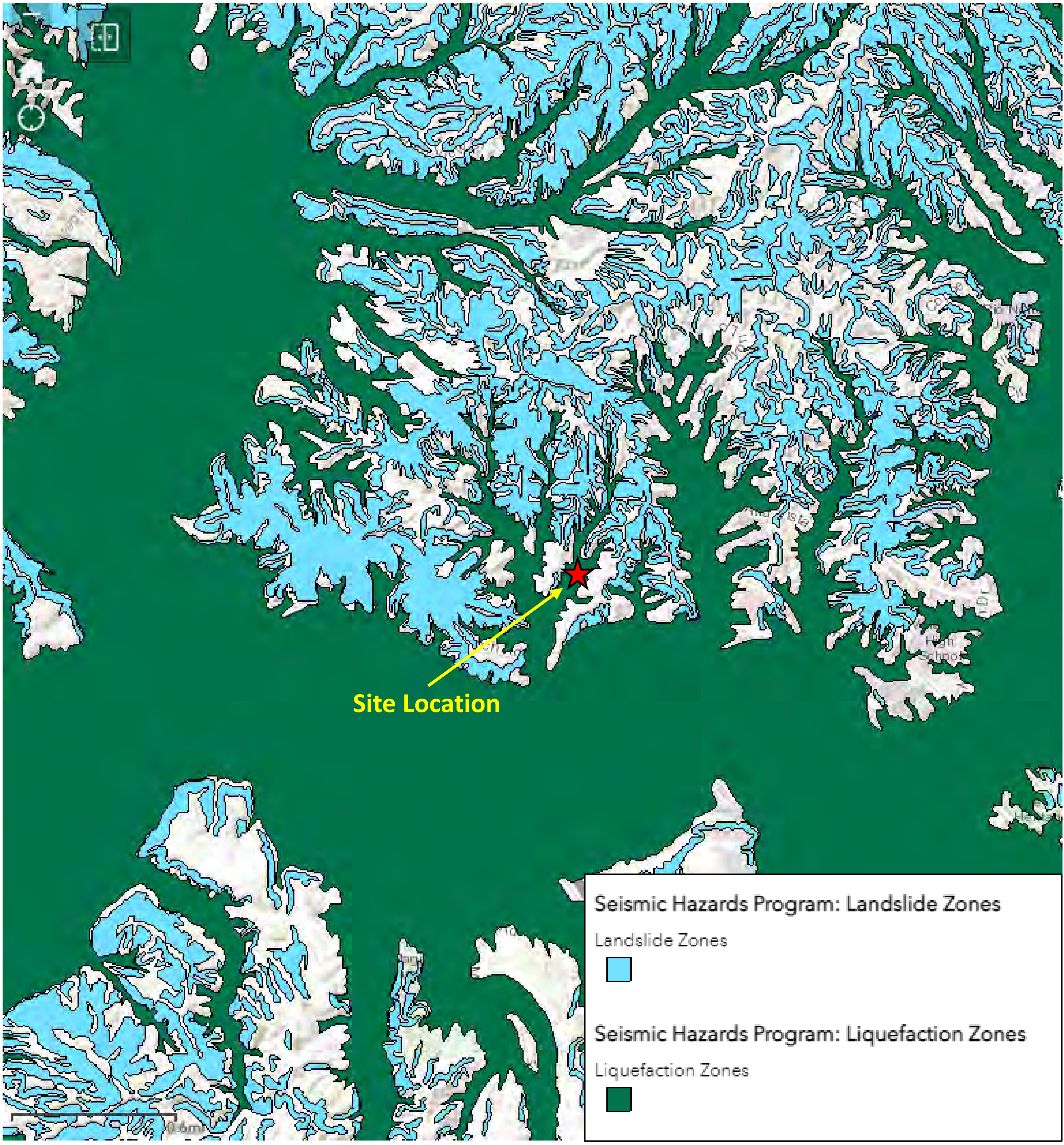
Figure 7

Project No: SC0766U

APRIL 2021



Excerpt from California Geological Survey, Webservice of Official Map of Seismic Hazard Zones (2018)
https://maps.conservation.ca.gov/geologichazards/

CGS LIQUEFACTION HAZARD ZONES
HONOR RANCHO COMPRESSOR MODERNIZATION PROJECT, SANTA CLARITA, CALIFORNIA

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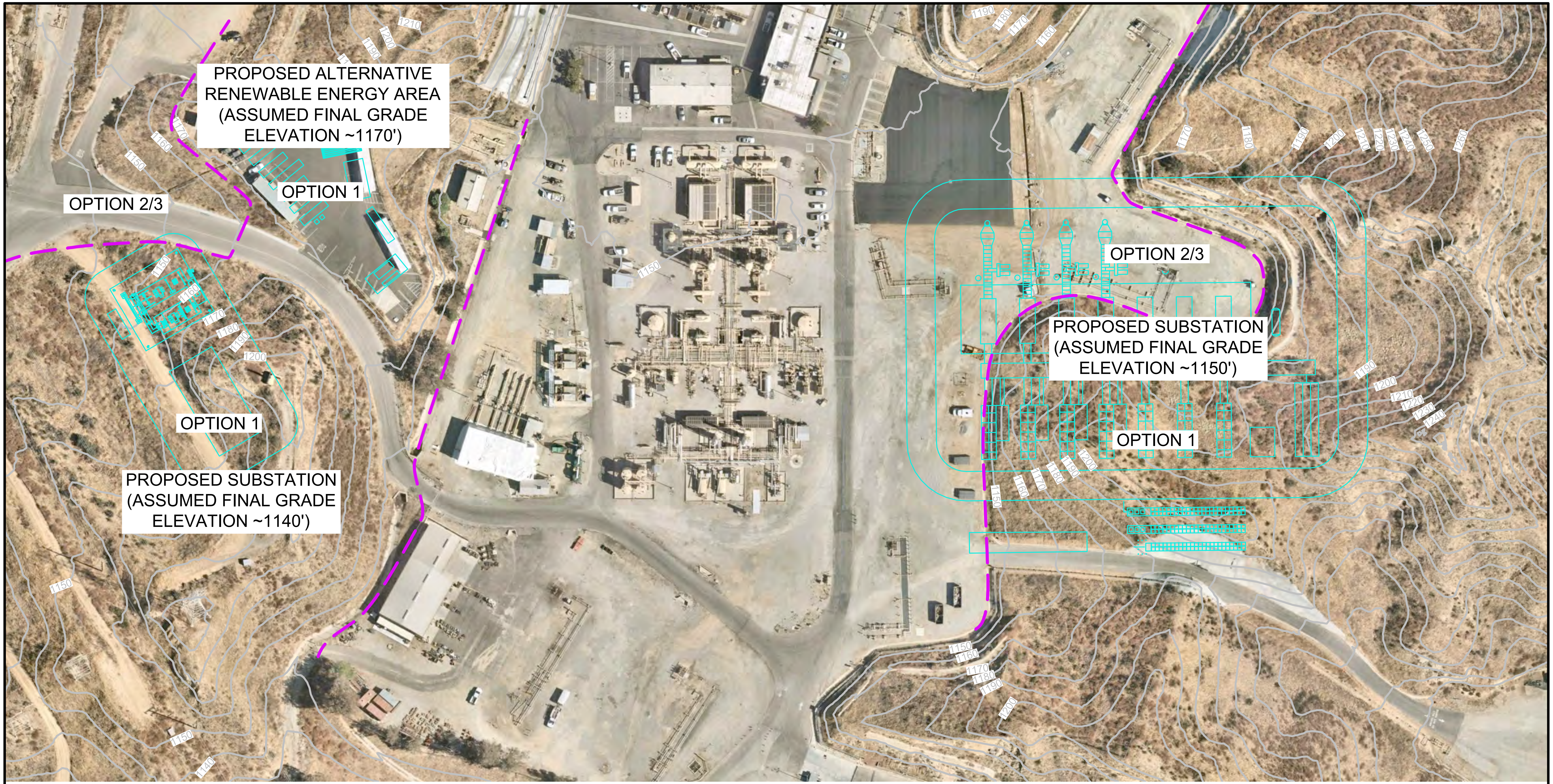
Figure 8

Project No: SC0766U

APRIL 2021



LEGEND

—1150—	EXISTING GROUND MAJOR CONTOUR
— — —	LIMIT OF INDICATED FOUNDATION RECOMMENDATION

N

0 100

SCALE IN FEET

APPLICABLE AREAS FOR FOUNDATION RECOMMENDATIONS
HONOR RANCHO COMPRESSOR MODERNIZATION
SANTA CLARITA, CALIFORNIA

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PROJECT NO: SC0766U

APRIL 2021

FIGURE 9

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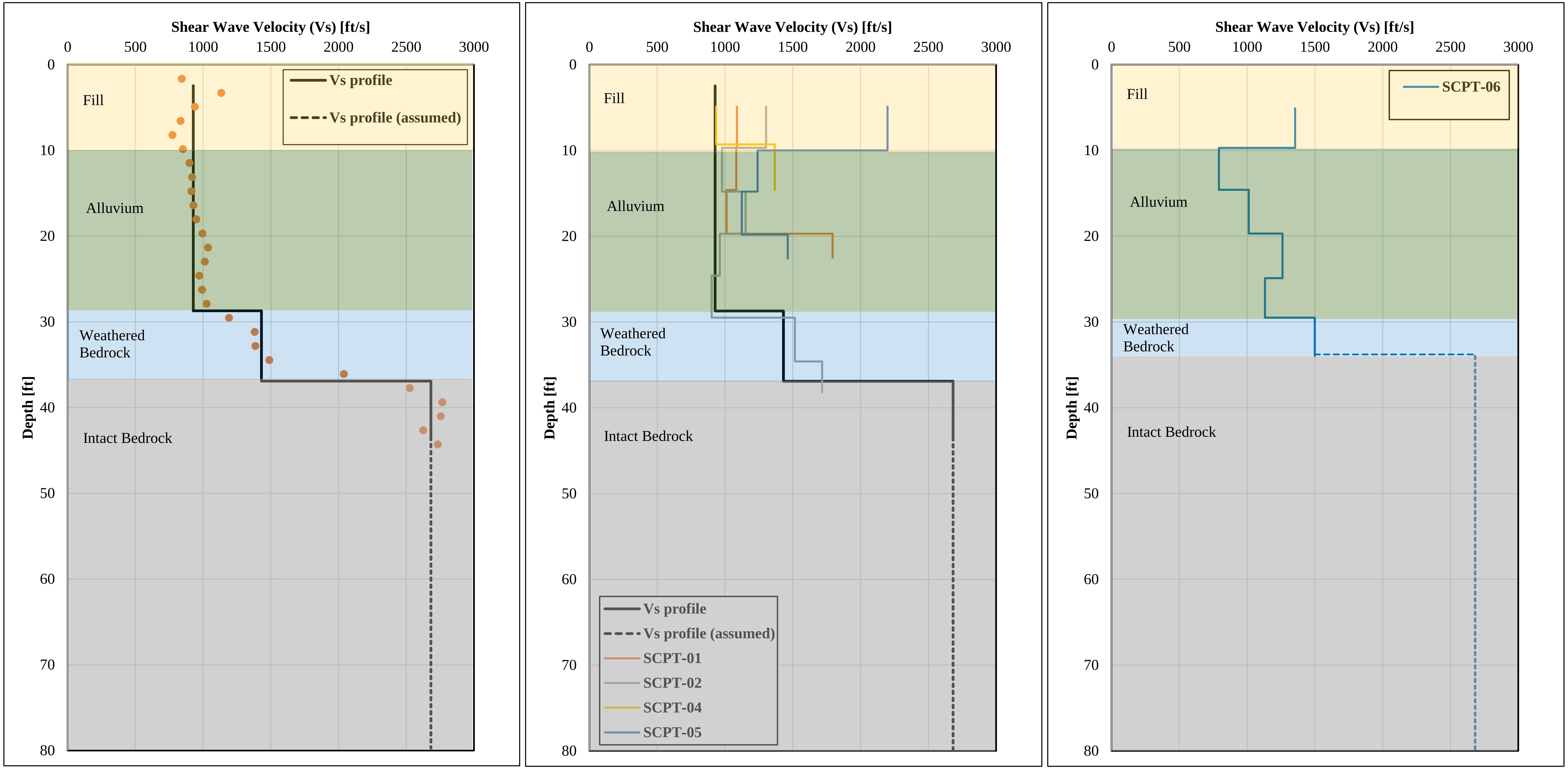

(a) Vs data and profile (OYO suspension logging)

(b) Vs profile (OYO suspension logging and SCPTs) – Compressor Building Area

(c) Vs profile (SCPT) – Substation Area

SHEAR WAVE VELOCITY PROFILES
HONOR RANCHO COMPRESSOR MODERNIZATION
SANTA CLARITA, CALIFORNIA

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Figure
10

Project No: SC0766U

APRIL 2021

APPENDIX A

Cone Penetration Test Results

GREGG DRILLING, LLC.
GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

January 12, 2021

Geosyntec
Attn: Chris Conkle

Subject: CPT Site Investigation
SoCal Gas Honor Rancho
Santa Clarita, California
GREGG Project Number: D1215003

Dear Mr. Conkle:

The following report presents the results of GREGG Drilling Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☒
4	UVOST Laser Induced Fluorescence	(UVOST)	☐
5	Groundwater Sampling	(GWS)	☐
6	Soil Sampling	(SS)	☐
7	Vapor Sampling	(VS)	☐
8	Pressuremeter Testing	(PMT)	☐
9	Vane Shear Testing	(VST)	☐
10	Dilatometer Testing	(DMT)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact me at 949-903-6873.

Sincerely,
Gregg Drilling, LLC.

CPT Reports Team
Gregg Drilling, LLC.

2726 Walnut Ave. • Signal Hill, California 90755 • (562) 427-6899 • FAX (562) 427-3314
950 Howe Road. • Martinez, California 94553 • (925) 313-5800 • FAX (925) 313-0302
www.greggdrilling.com

Cone Penetration Test Sounding Summary

-Table 1-

CPT Sounding Identification	Date	Termination Depth (feet)	Depth of Groundwater Samples (feet)	Depth of Soil Samples (feet)	Depth of Pore Pressure Dissipation Tests (feet)
CPT-03	1/11/2021	29.36	-	-	-
SCPT-01	1/11/2021	23.13	-	-	23.1
SCPT-02	1/11/2021	38.88	-	-	38.9
SCPT-04	1/11/2021	15.58	-	-	-
SCPT-05	1/11/2021	23.29	-	-	23.3
SCPT-06	1/11/2021	34.61	-	-	-

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Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, “Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers” BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

Cone Penetration Testing Procedure (CPT)

Gregg Drilling carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*.

The cone takes measurements of tip resistance (q_c), sleeve resistance (f_s), and penetration pore water pressure (u_2). Measurements are taken at either 2.5 or 5 cm intervals during penetration to provide a nearly continuous profile. CPT data reduction and basic interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored electronically for further analysis and reference. All CPT soundings are performed in accordance with revised ASTM standards (D 5778-12).

The 5mm thick porous plastic filter element is located directly behind the cone tip in the u_2 location. A new saturated filter element is used on each sounding to measure both penetration pore pressures as well as measurements during a dissipation test (*PPDT*). Prior to each test, the filter element is fully saturated with oil under vacuum pressure to improve accuracy.

When the sounding is completed, the test hole is backfilled according to client specifications. If grouting is used, the procedure generally consists of pushing a hollow tremie pipe with a "knock out" plug to the termination depth of the CPT hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

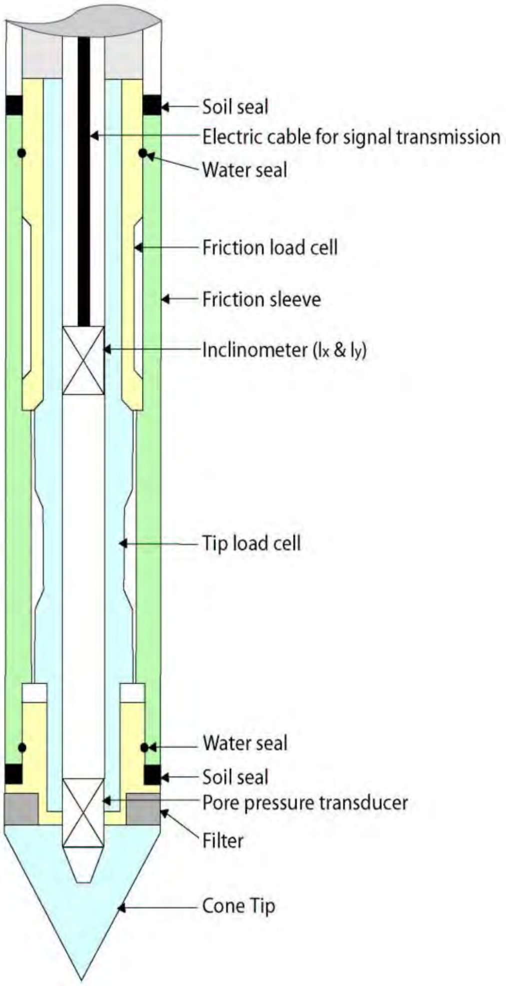


Figure CPT

Gregg 15cm^2 Standard Cone Specifications

Dimensions	
Cone base area	15 cm^2
Sleeve surface area	225 cm^2
Cone net area ratio	0.80
Specifications	
Cone load cell	
Full scale range	180 kN (20 tons)
Overload capacity	150%
Full scale tip stress	120 MPa (1,200 tsf)
Repeatability	120 kPa (1.2 tsf)
Sleeve load cell	
Full scale range	31 kN (3.5 tons)
Overload capacity	150%
Full scale sleeve stress	1,400 kPa (15 tsf)
Repeatability	1.4 kPa (0.015 tsf)
Pore pressure transducer	
Full scale range	7,000 kPa (1,000 psi)
Overload capacity	150%
Repeatability	7 kPa (1 psi)

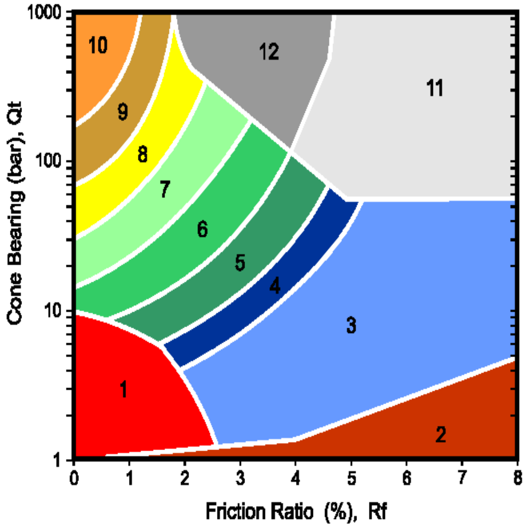
Note: The repeatability during field use will depend somewhat on ground conditions, abrasion, maintenance and zero load stability.

Cone Penetration Test Data & Interpretation

The Cone Penetration Test (CPT) data collected are presented in graphical and electronic form in the report. The plots include interpreted Soil Behavior Type (SBT) based on the charts described by Robertson (1990). Typical plots display SBT based on the non-normalized charts of Robertson et al (1986). For CPT soundings deeper than 30m, we recommend the use of the normalized charts of Robertson (1990) which can be displayed as SBTn, upon request. The report also includes spreadsheet output of computer calculations of basic interpretation in terms of SBT and SBTn and various geotechnical parameters using current published correlations based on the comprehensive review by Lunne, Robertson and Powell (1997), as well as recent updates by Professor Robertson (Guide to Cone Penetration Testing, 2015). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg Drilling & Testing Inc. does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software. Some interpretation methods require input of the groundwater level to calculate vertical effective stress. An estimate of the in-situ groundwater level has been made based on field observations and/or CPT results, but should be verified by the user.

A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Note that it is not always possible to clearly identify a soil type based solely on q_t, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the correct soil behavior type.



ZONE		SBT
1		🟥 Sensitive, fine grained
2		🟫 Organic materials
3		🟦 Clay
4		🟦 Silty clay to clay
5		🟩 Clayey silt to silty clay
6		🟩 Sandy silt to clayey silt
7		🟨 Silty sand to sandy silt
8		🟨 Sand to silty sand
9		🟫 Sand
10		🟧 Gravely sand to sand
11		⬜ Very stiff fine grained*
12		⬛ Sand to clayey sand*

*over consolidated or cemented

Figure SBT (After Robertson et al., 1986) – Note: Colors may vary slightly compared to plots

Cone Penetration Test (CPT) Interpretation

Gregg uses a proprietary CPT interpretation and plotting software. The software takes the CPT data and performs basic interpretation in terms of soil behavior type (SBT) and various geotechnical parameters using current published empirical correlations based on the comprehensive review by Lunne, Robertson and Powell (1997). The interpretation is presented in tabular format using MS Excel. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software.

The following provides a summary of the methods used for the interpretation. Many of the empirical correlations to estimate geotechnical parameters have constants that have a range of values depending on soil type, geologic origin and other factors. The software uses 'default' values that have been selected to provide, in general, conservatively low estimates of the various geotechnical parameters.

Input:

1. Units for display (Imperial or metric) (atm. pressure, p_a = 0.96 tsf or 0.1 MPa)
2. Depth interval to average results (ft or m). Data are collected at either 0.02 or 0.05m and can be averaged every 1, 3 or 5 intervals.
3. Elevation of ground surface (ft or m)
4. Depth to water table, z_w (ft or m) – input required
5. Net area ratio for cone, a (default to 0.80)
6. Relative Density constant, C_{Dr} (default to 350)
7. Young's modulus number for sands, α (default to 5)
8. Small strain shear modulus number
    a. for sands, S_G (default to 180 for SBT_n 5, 6, 7)
    b. for clays, C_G (default to 50 for SBT_n 1, 2, 3 & 4)
9. Undrained shear strength cone factor for clays, N_{kt} (default to 15)
10. Over Consolidation ratio number, k_{ocr} (default to 0.3)
11. Unit weight of water, (default to γ_w = 62.4 lb/ft^3 or 9.81 kN/m^3)

Column

1. Depth, z, (m) – CPT data is collected in meters
2. Depth (ft)
3. Cone resistance, q_c (tsf or MPa)
4. Sleeve resistance, f_s (tsf or MPa)
5. Penetration pore pressure, u (psi or MPa), measured behind the cone (i.e. u_2)
6. Other – any additional data
7. Total cone resistance, q_t (tsf or MPa) $q_t = q_c + u\,(1\text{-}a)$

8	Friction Ratio, R_f (%)	$R_f = (f_s/q_t) \times 100\%$
9	Soil Behavior Type (non-normalized), SBT	see note
10	Unit weight, γ (pcf or kN/m^3)	based on SBT, see note
11	Total overburden stress, σ_v (tsf)	$\sigma_{vo} = \sigma\ z$
12	In-situ pore pressure, u_o (tsf)	$u_o = \gamma_w\ (z - z_w)$
13	Effective overburden stress, σ'_{vo} (tsf)	$\sigma'_{vo} = \sigma_{vo} - u_o$
14	Normalized cone resistance, Q_{t1}	$Q_{t1}= (q_t - \sigma_{vo}) / \sigma'_{vo}$
15	Normalized friction ratio, F_r (%)	$F_r = f_s / (q_t - \sigma_{vo}) \times 100\%$
16	Normalized Pore Pressure ratio, B_q	$B_q = u - u_o / (q_t - \sigma_{vo})$
17	Soil Behavior Type (normalized), SBT_n	see note
18	SBT_n Index, I_c	see note
19	Normalized Cone resistance, Q_{tn} (n varies with I_c)	see note
20	Estimated permeability, k_{SBT} (cm/sec or ft/sec)	see note
21	Equivalent SPT N_{60}, blows/ft	see note
22	Equivalent SPT $(N_1)_{60}$ blows/ft	see note
23	Estimated Relative Density, D_r, (%)	see note
24	Estimated Friction Angle, ϕ', (degrees)	see note
25	Estimated Young's modulus, E_s (tsf)	see note
26	Estimated small strain Shear modulus, Go (tsf)	see note
27	Estimated Undrained shear strength, s_u (tsf)	see note
28	Estimated Undrained strength ratio	s_u/σ_v'
29	Estimated Over Consolidation ratio, OCR	see note

Notes:

1 Soil Behavior Type (non-normalized), SBT (Lunne et al., 1997 and table below)

2 Unit weight, γ either constant at 119 pcf or based on Non-normalized SBT (Lunne et al., 1997 and table below)

3 Soil Behavior Type (Normalized), SBT_n Lunne et al. (1997)

4 SBT_n Index, I_c $I_c = ((3.47 - \log Q_{t1})^2 + (\log F_r + 1.22)^2)^{0.5}$

5 Normalized Cone resistance, Q_{tn} (n varies with Ic)

$Q_{tn} = ((q_t - \sigma_{vo})/pa)\ (pa/(\sigma'_{vo})^n$ and recalculate I_c, then iterate:

When $I_c < 1.64$, $n = 0.5$ (clean sand)
When $I_c > 3.30$, $n = 1.0$ (clays)
When $1.64 < I_c < 3.30$, $n = (I_c - 1.64)0.3 + 0.5$
Iterate until the change in n, $\Delta n < 0.01$

6 Estimated permeability, k_{SBT} based on Normalized SBT_n (Lunne et al., 1997 and table below)

7 Equivalent SPT N_{60}, blows/ft Lunne et al. (1997)

$$\frac{(q_t/p_a)}{N_{60}} = 8.5 \left(1 - \frac{I_c}{4.6}\right)$$

8 Equivalent SPT $(N_1)_{60}$ blows/ft $(N_1)_{60} = N_{60}\,C_N,$

where $C_N = (pa/\sigma'_{vo})^{0.5}$

9 Relative Density, D_r, (%) $D_r^2 = Q_{tn} / C_{Dr}$

Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

10 Friction Angle, ϕ', (degrees) $\tan \phi' = \frac{1}{2.68}\left[\log\left(\frac{q_c}{\sigma'_{vo}}\right) + 0.29\right]$

Only SBT_n 5, 6, 7 & 8 *Show'N/A' in zones 1, 2, 3, 4 & 9*

11 Young's modulus, E_s $E_s = \alpha\, q_t$

Only SBT_n 5, 6, 7 & 8 *Show 'N/A' in zones 1, 2, 3, 4 & 9*

12 Small strain shear modulus, Go

a. $G_o = S_G (q_t \;\; \sigma'_{vo}\; pa)^{1/3}$ *For SBT_n 5, 6, 7*

b. $G_o = C_G\, q_t$ *For SBT_n 1, 2, 3& 4*

Show 'N/A' in zones 8 & 9

13 Undrained shear strength, s_u $s_u = (q_t - \sigma_{vo}) / N_{kt}$

Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

14 Over Consolidation ratio, OCR $OCR = k_{ocr}\, Q_{t1}$

Only SBT_n 1, 2, 3, 4 & 9 *Show 'N/A' in zones 5, 6, 7 & 8*

The following updated and simplified SBT descriptions have been used in the software:

SBT Zones		**SBT_n Zones**	
1	sensitive fine grained	1	sensitive fine grained
2	organic soil	2	organic soil
3	clay	3	clay
4	clay & silty clay	4	clay & silty clay
5	clay & silty clay		
6	sandy silt & clayey silt		

7	silty sand & sandy silt	5	silty sand & sandy silt
8	sand & silty sand	6	sand & silty sand
9	sand		
10	sand	7	sand
11	very dense/stiff soil*	8	very dense/stiff soil*
12	very dense/stiff soil*	9	very dense/stiff soil*

*heavily overconsolidated and/or cemented

Track when soils fall with zones of same description and print that description (i.e. if soils fall only within SBT zones 4 & 5, print 'clays & silty clays')

Estimated Permeability (see Lunne et al., 1997)

SBT_n	Permeability (ft/sec)	(m/sec)
1	$3x\ 10^{-8}$	$1x\ 10^{-8}$
2	$3x\ 10^{-7}$	$1x\ 10^{-7}$
3	$1x\ 10^{-9}$	$3x\ 10^{-10}$
4	$3x\ 10^{-8}$	$1x\ 10^{-8}$
5	$3x\ 10^{-6}$	$1x\ 10^{-6}$
6	$3x\ 10^{-4}$	$1x\ 10^{-4}$
7	$3x\ 10^{-2}$	$1x\ 10^{-2}$
8	$3x\ 10^{-6}$	$1x\ 10^{-6}$
9	$1x\ 10^{-8}$	$3x\ 10^{-9}$

Estimated Unit Weight (see Lunne et al., 1997)

SBT	Approximate Unit Weight (lb/ft^3)	(kN/m^3)
1	111.4	17.5
2	79.6	12.5
3	111.4	17.5
4	114.6	18.0
5	114.6	18.0
6	114.6	18.0
7	117.8	18.5
8	120.9	19.0
9	124.1	19.5
10	127.3	20.0
11	130.5	20.5
12	120.9	19.0

Pore Pressure Dissipation Tests (PPDT)

Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals can be used to measure equilibrium water pressure (at the time of the CPT). If conditions are hydrostatic, the equilibrium water pressure can be used to determine the approximate depth of the ground water table. A PPDT is conducted when penetration is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (*u*) with time is measured behind the tip of the cone and recorded.

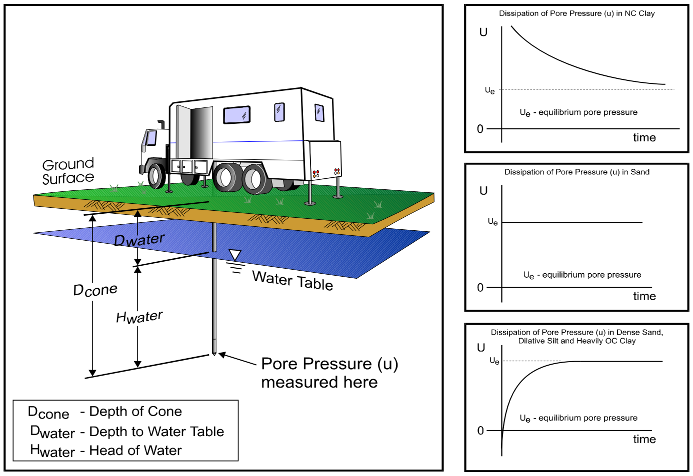
Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permeability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until it reaches equilibrium, *Figure PPDT*. This time is commonly referred to as t_{100}, the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1992 and Lunne et al. 1997.

A summary of the pore pressure dissipation tests are summarized in Table 1.



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors:
1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

Figure PPDT

Seismic Cone Penetration Testing (SCPT)

Seismic Cone Penetration Testing (SCPT) can be conducted at various intervals during the Cone Penetration Test. Shear wave velocity (Vs) can then be calculated over a specified interval with depth. A small interval for seismic testing, such as 1-1.5m (3-5ft) allows for a detailed look at the shear wave profile with depth. Conversely, a larger interval such as 3-6m (10-20ft) allows for a more average shear wave velocity to be calculated. Gregg's cones have a horizontally active geophone located 0.2m (0.66ft) behind the tip.

To conduct the seismic shear wave test, the penetration of the cone is stopped and the rods are decoupled from the rig. An automatic hammer is triggered to send a shear wave into the soil. The distance from the source to the cone is calculated knowing the total depth of the cone and the horizontal offset distance between the source and the cone. To calculate an interval velocity, a minimum of two tests must be performed at two different depths. The arrival times between the two wave traces are compared to obtain the difference in time (Δt). The difference in depth is calculated (Δd) and velocity can be determined using the simple equation: $v = \Delta d/\Delta t$

Multiple wave traces can be recorded at the same depth to improve quality of the data.

A complete reference on seismic cone penetration tests is presented by Robertson et al. 1986 and Lunne et al. 1997.

A summary the shear wave velocities, arrival times and wave traces are provided with the report.

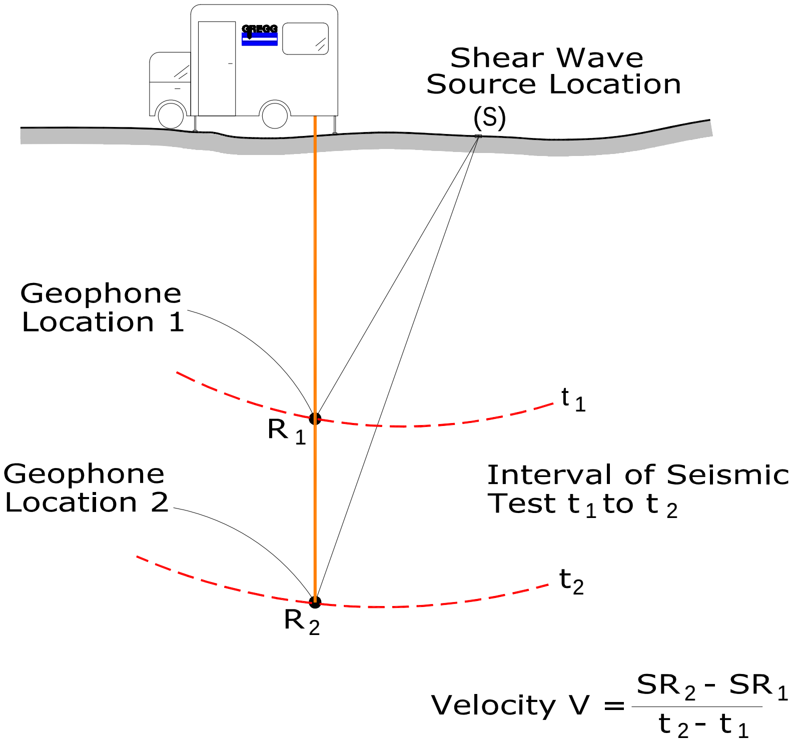


Figure SCPT

Groundwater Sampling

Gregg Drilling & Testing, Inc. conducts groundwater sampling using a sampler as shown in *Figure GWS*. The groundwater sampler has a retrievable stainless steel or disposable PVC screen with steel drop off tip. This allows for samples to be taken at multiple depth intervals within the same sounding location. In areas of slower water recharge, provisions may be made to set temporary PVC well screens during sampling to allow the pushing equipment to advance to the next sample location while the groundwater is allowed to infiltrate.

The groundwater sampler operates by advancing 44.5mm (1¾ inch) hollow push rods with the filter tip in a closed configuration to the base of the desired sampling interval. Once at the desired sample depth, the push rods are retracted; exposing the encased filter screen and allowing groundwater to infiltrate hydrostatically from the formation into the inlet screen. A small diameter bailer (approximately ½ or ¾ inch) is lowered through the push rods into the screen section for sample collection. The number of downhole trips with the bailer and time necessary to complete the sample collection at each depth interval is a function of sampling protocols, volume requirements, and the yield characteristics and storage capacity of the formation. Upon completion of sample collection, the push rods and sampler, with the exception of the PVC screen and steel drop off tip are retrieved to the ground surface, decontaminated and prepared for the next sampling event.

For a detailed reference on direct push groundwater sampling, refer to Zemo et. al., 1992.

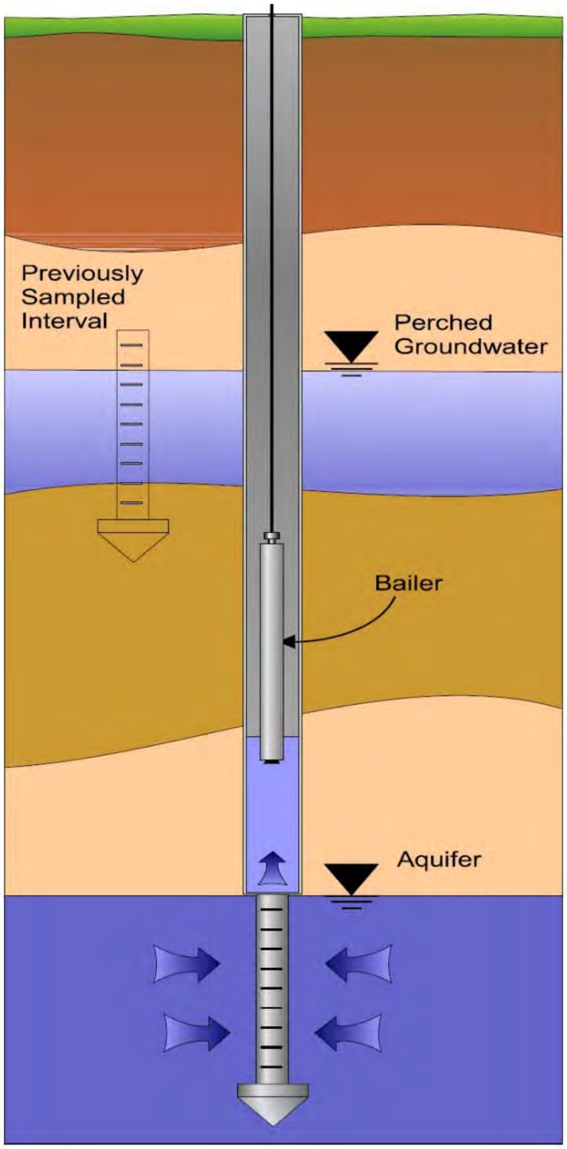


Figure GWS

Soil Sampling

Gregg Drilling & Testing, Inc. uses a piston-type push-in sampler to obtain small soil samples without generating any soil cuttings, *Figure SS*. Two different types of samplers (12 and 18 inch) are used depending on the soil type and density. The soil sampler is initially pushed in a "closed" position to the desired sampling interval using the CPT pushing equipment. Keeping the sampler closed minimizes the potential of cross contamination. The inner tip of the sampler is then retracted leaving a hollow soil sampler with inner 1¼" diameter sample tubes. The hollow sampler is then pushed in a locked "open" position to collect a soil sample. The filled sampler and push rods are then retrieved to the ground surface. Because the soil enters the sampler at a constant rate, the opportunity for 100% recovery is increased. For environmental analysis, the soil sample tube ends are sealed with Teflon and plastic caps. Often, a longer "split tube" can be used for geotechnical sampling.

For a detailed reference on direct push soil sampling, refer to Robertson et al, 1998.

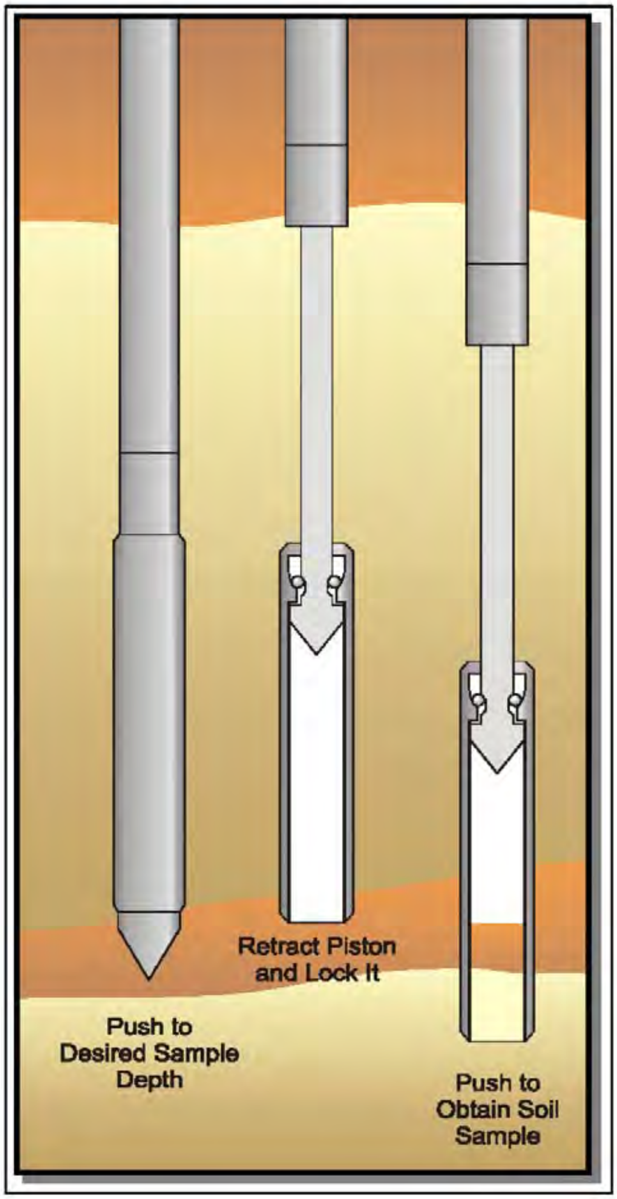


Figure SS

GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

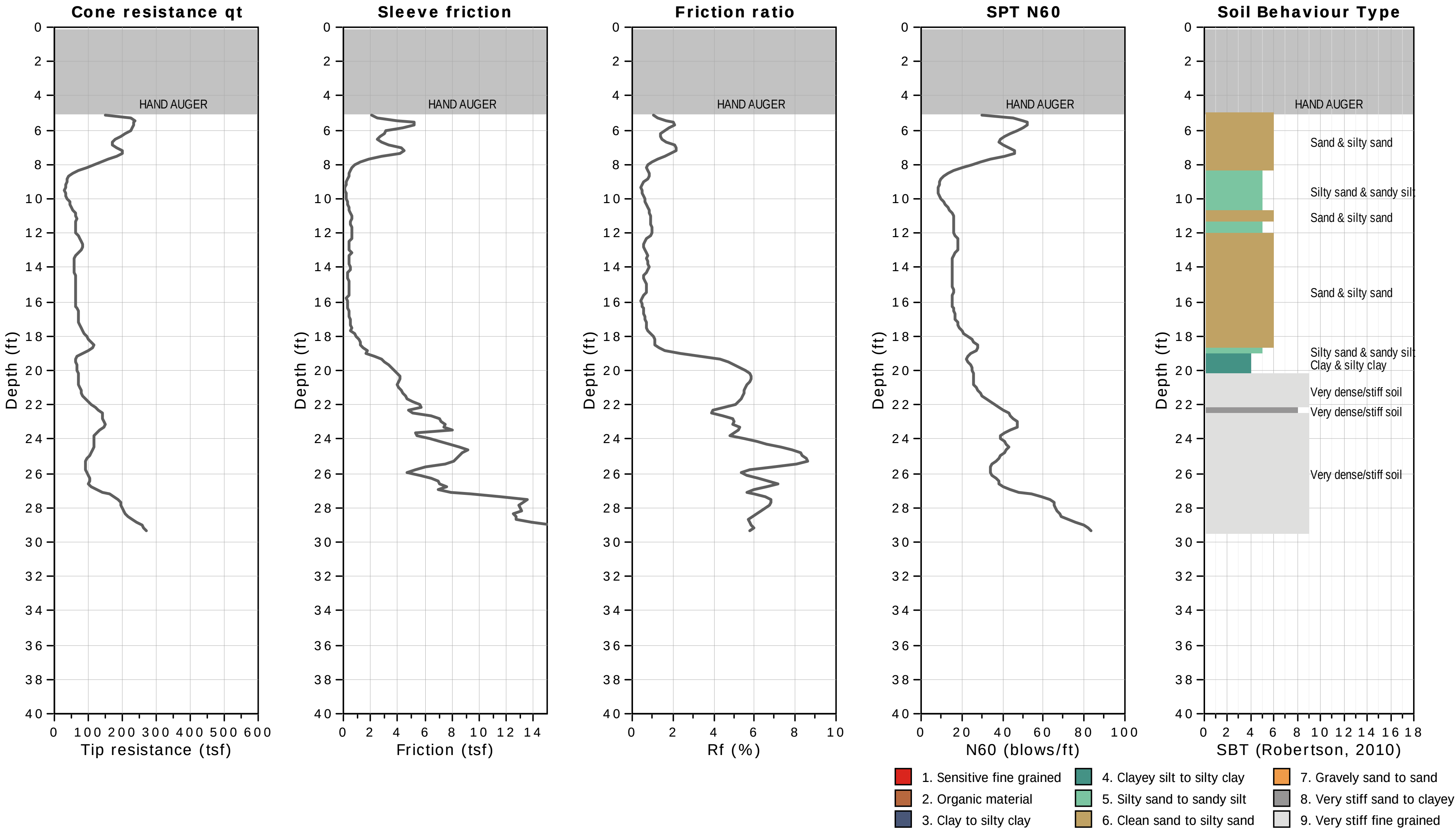
CPT: CPT-03

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

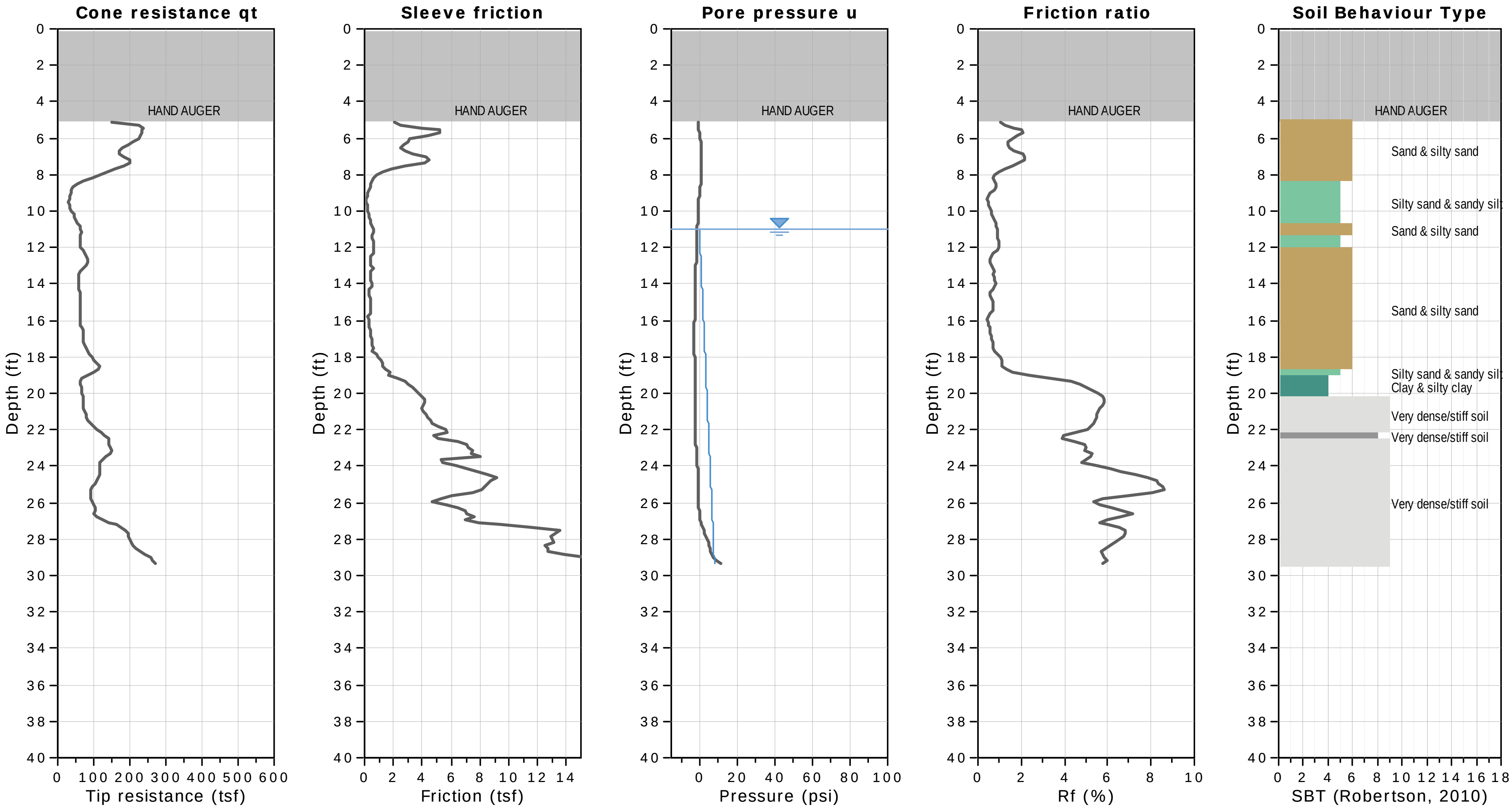
Total depth: 29.36 ft, Date: 1/11/2021



CPT: CPT-03

CLIENT: GEOSYNTEC
SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.
Total depth: 29.36 ft, Date: 1/11/2021



🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟫 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey
⬜ 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
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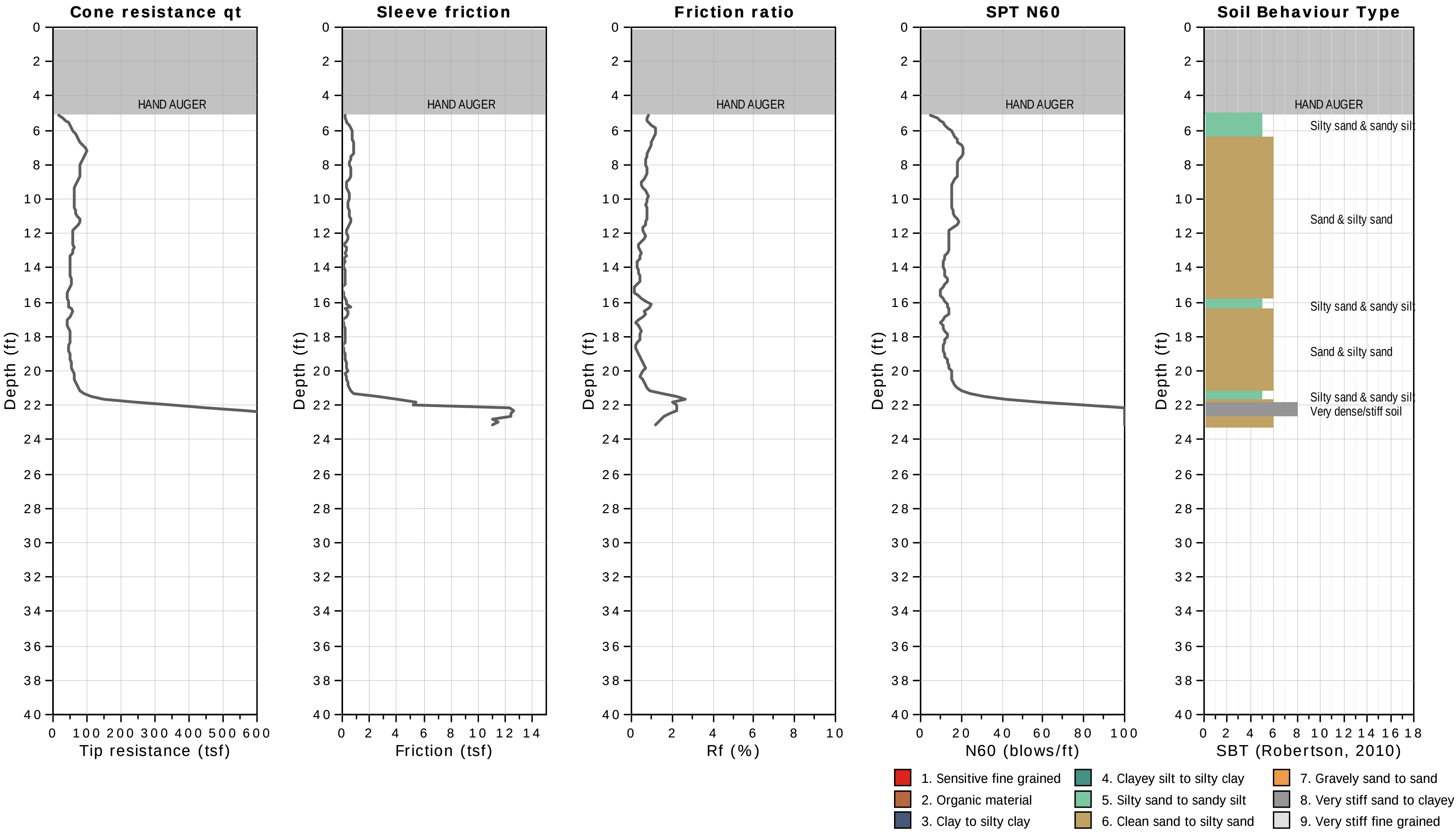
CPT: SCPT-01

CLIENT: **GEOSYNTEC**

SITE: **SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA**

FIELD REP: ERIK J.

Total depth: 23.13 ft, Date: 1/11/2021



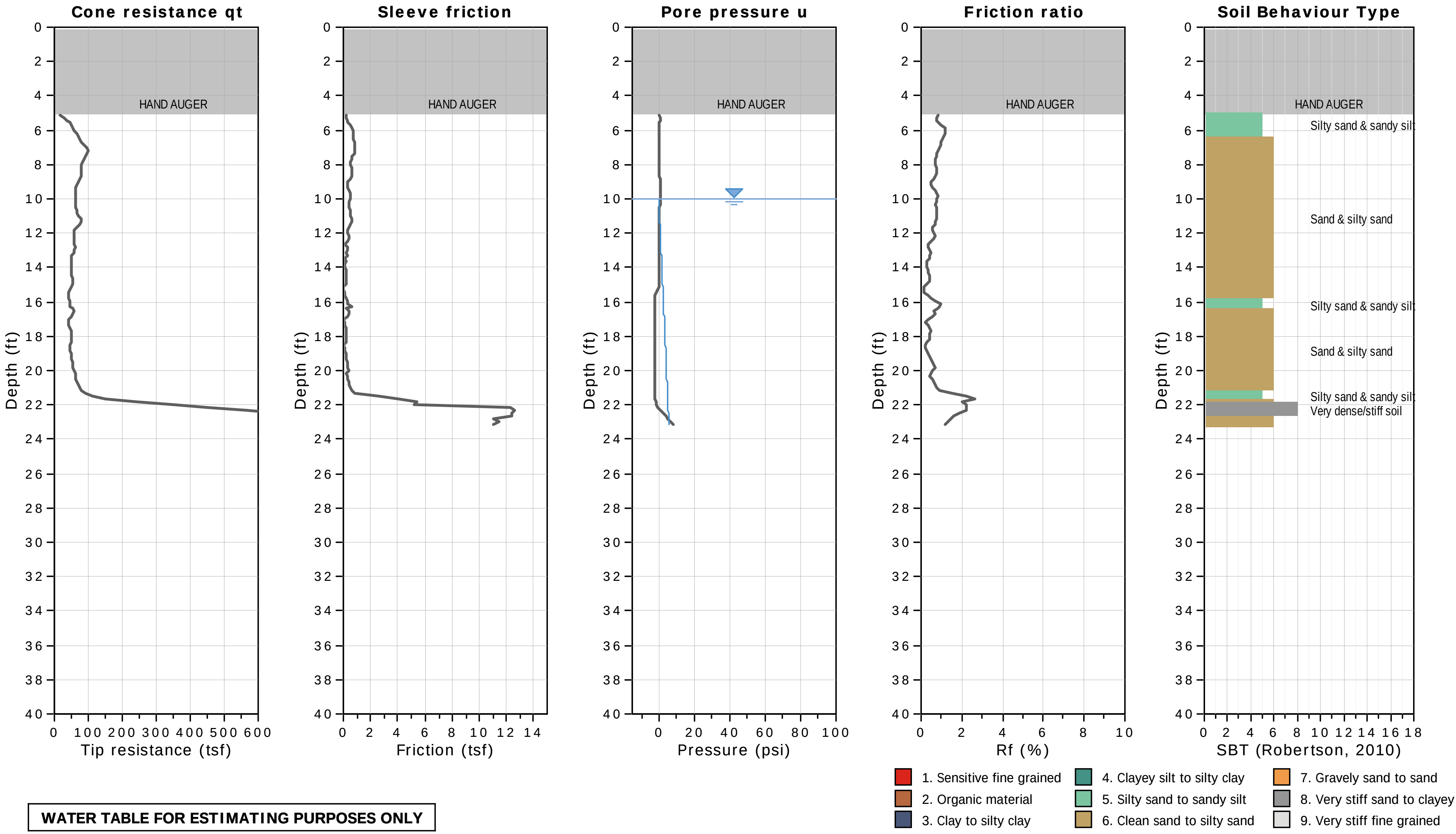
CPT: SCPT-01

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 23.13 ft, Date: 1/11/2021



WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
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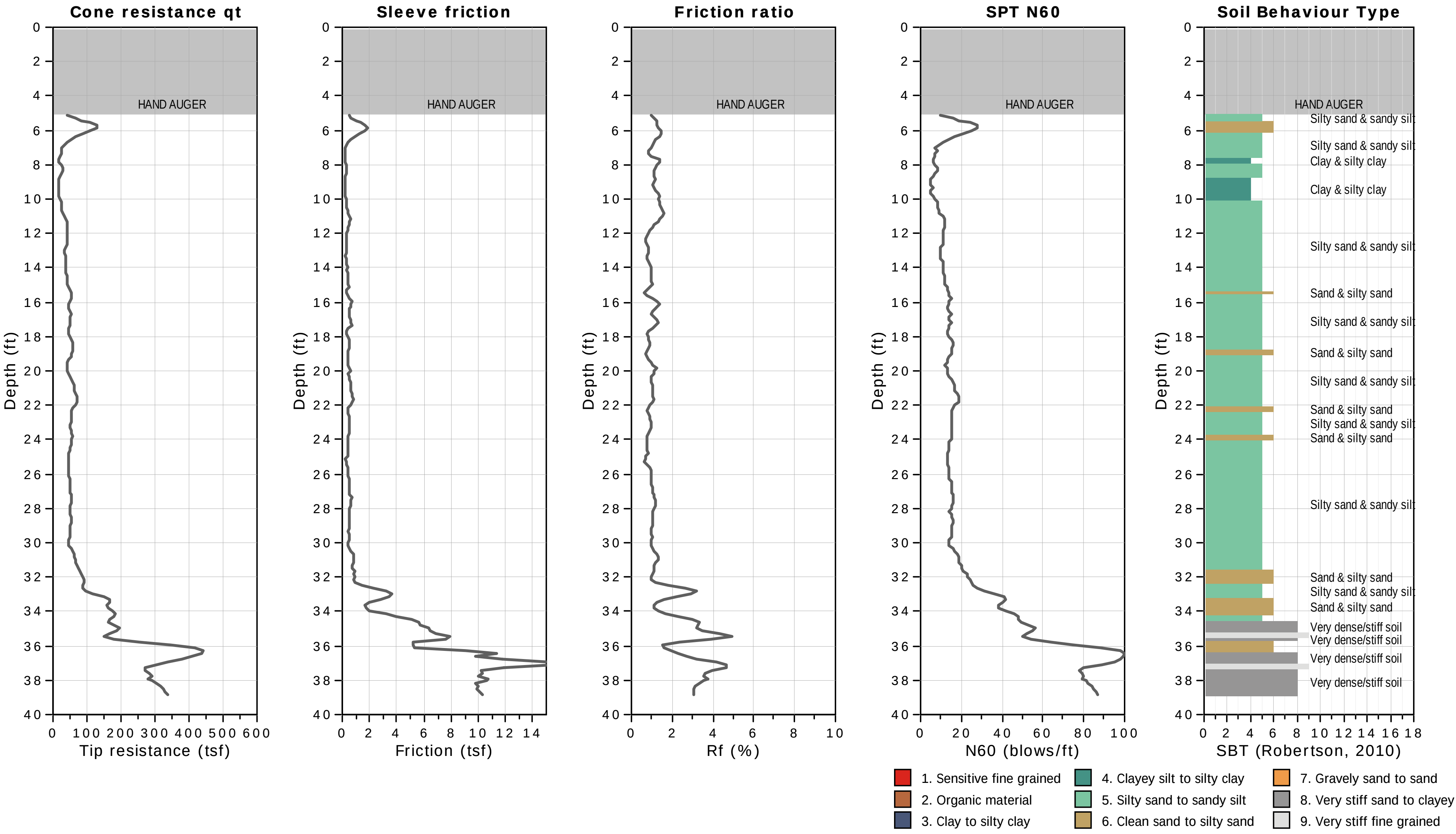
CPT: SCPT-02

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 38.88 ft, Date: 1/11/2021



GREGG DRILLING, LLC
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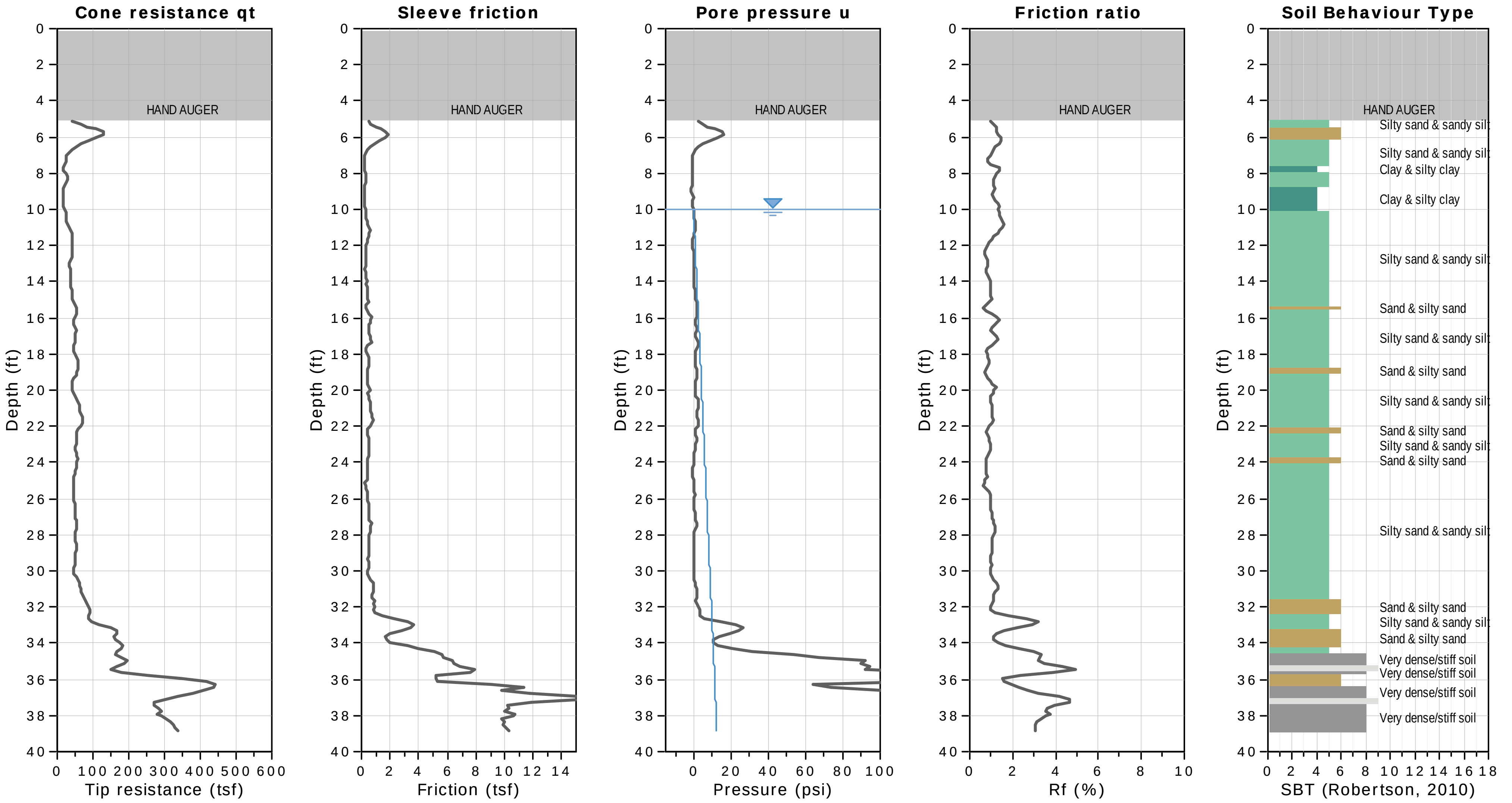
CPT: SCPT-02

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 38.88 ft, Date: 1/11/2021



🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty clay	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to clayey
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

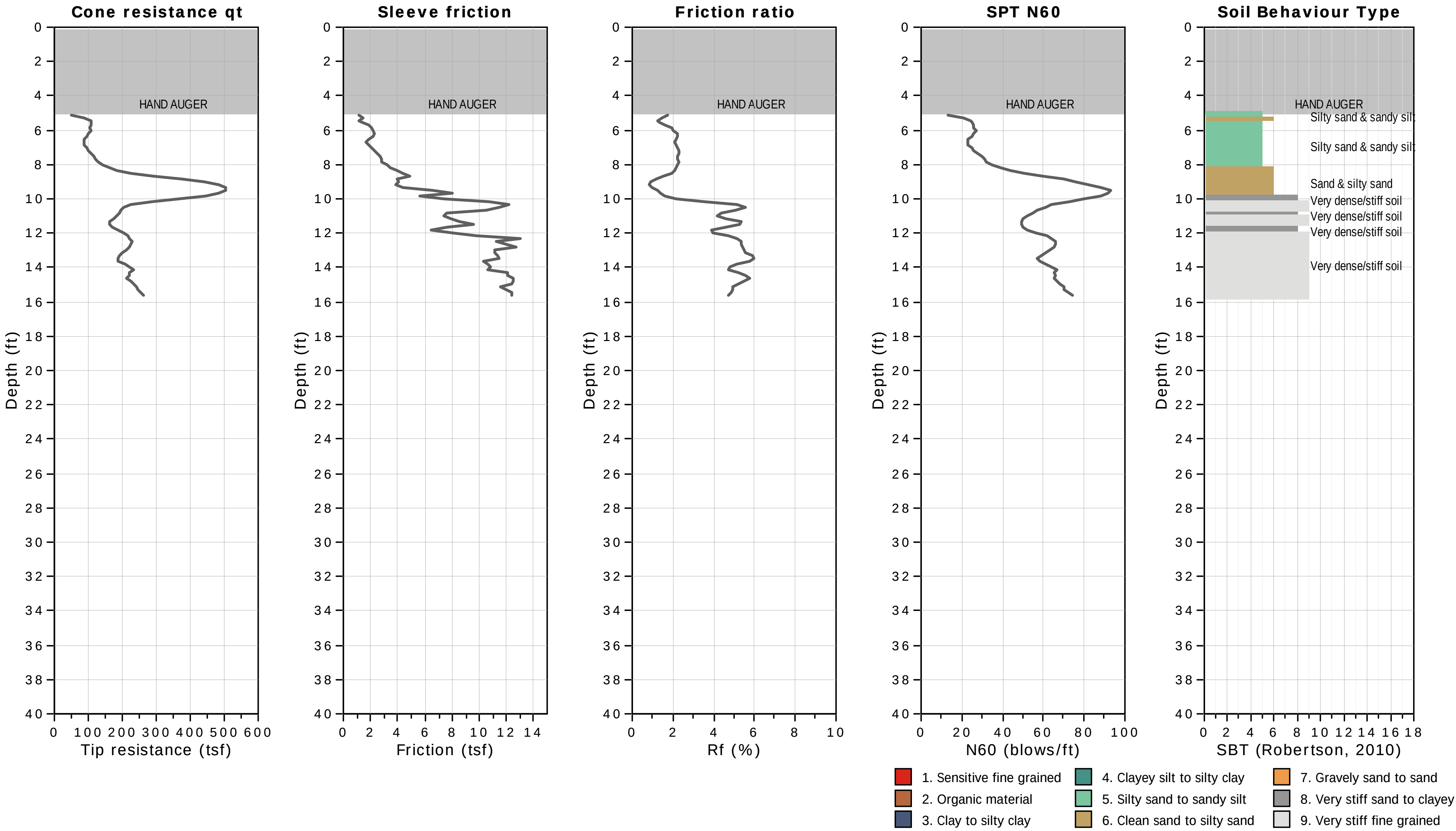
CPT: SCPT-04

CLIENT: **GEOSYNTEC**

SITE: **SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA**

FIELD REP: ERIK J.

Total depth: 15.58 ft, Date: 1/11/2021



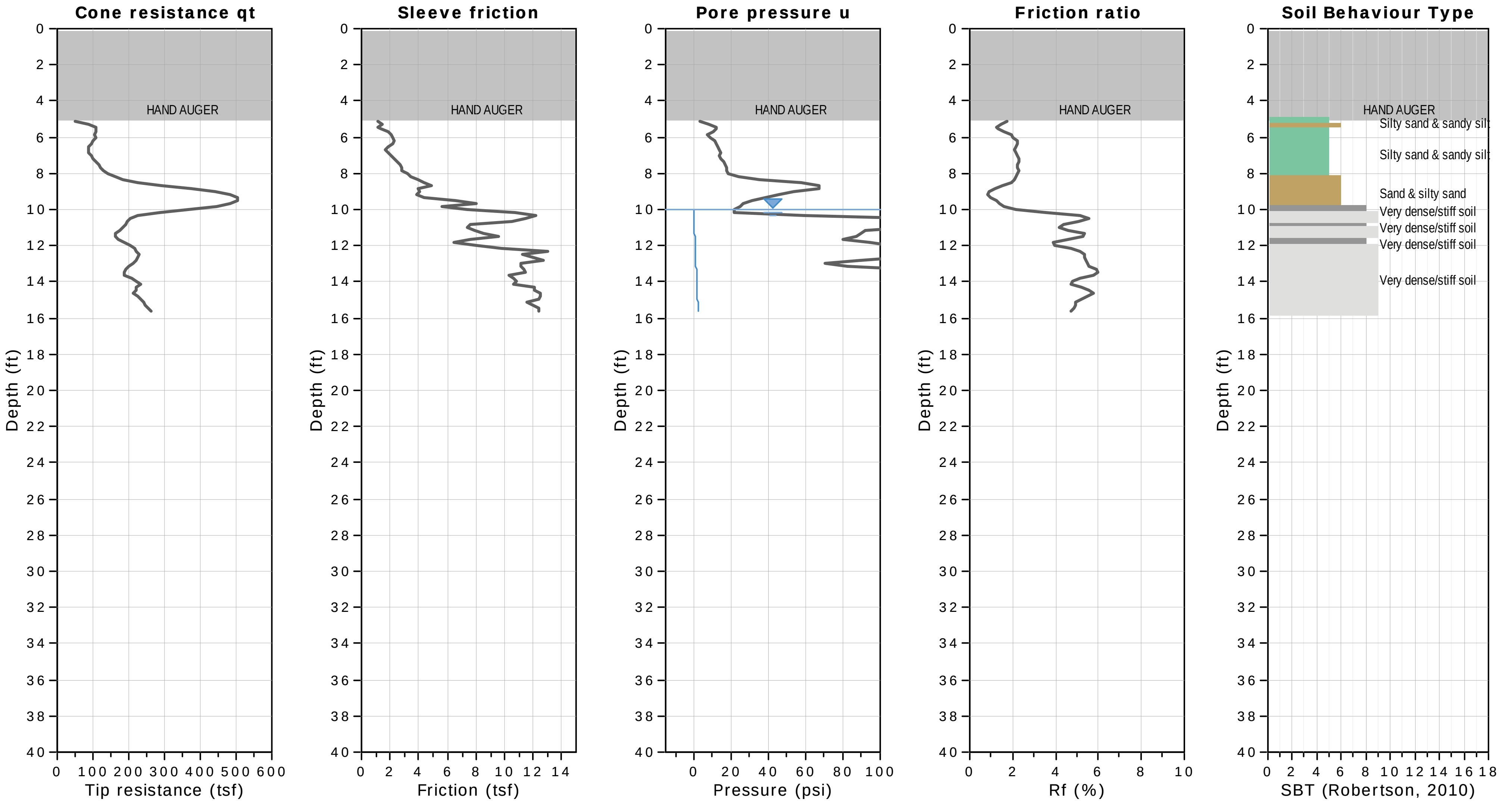
CPT: SCPT-04

CLIENT: **GEOSYNTEC**

SITE: **SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA**

FIELD REP: ERIK J.

Total depth: 15.58 ft, Date: 1/11/2021



🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey
⬜ 9. Very stiff fine grained

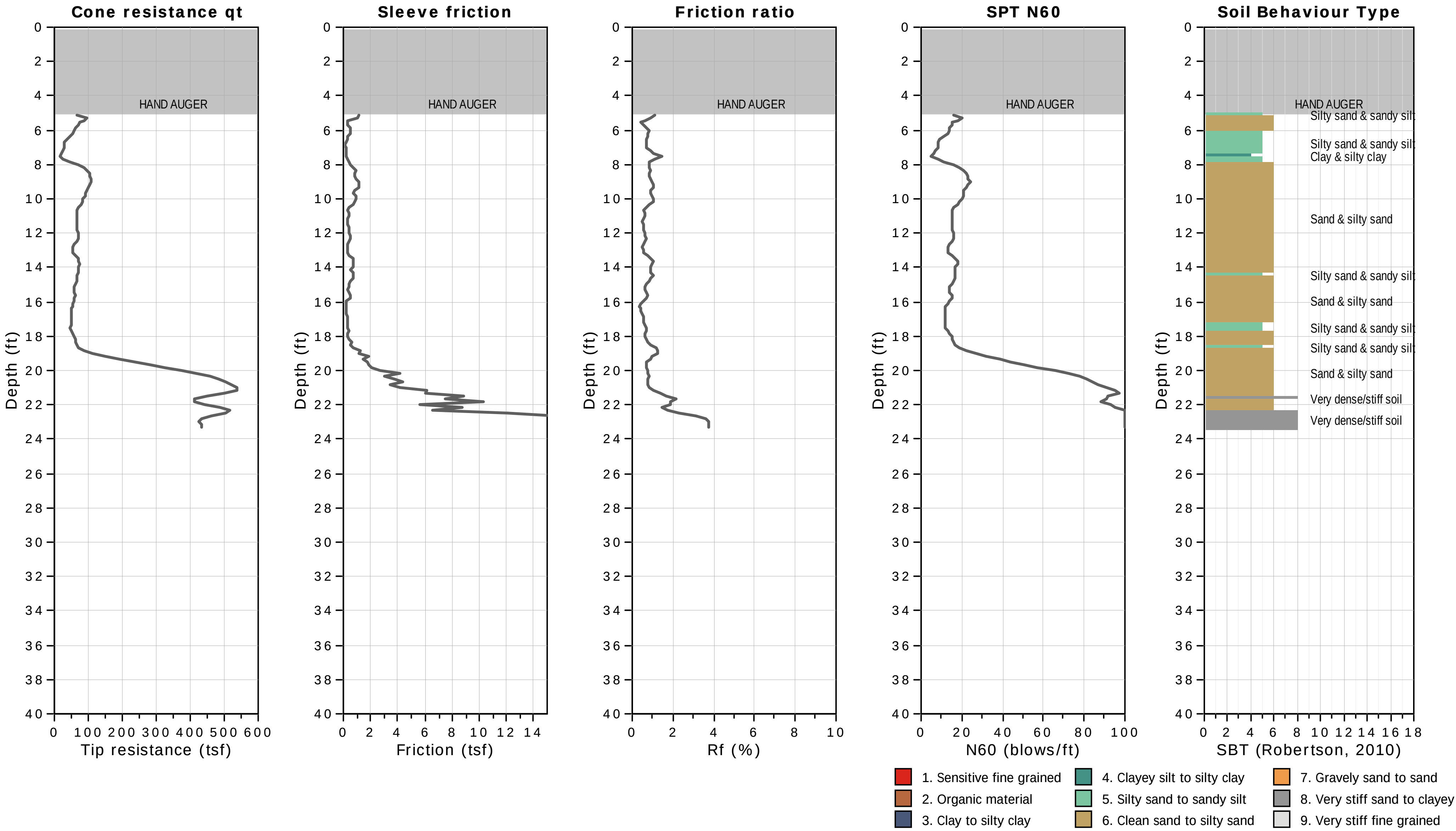
WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

CPT: SCPT-05

CLIENT: GEOSYNTEC
SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.
Total depth: 23.29 ft, Date: 1/11/2021



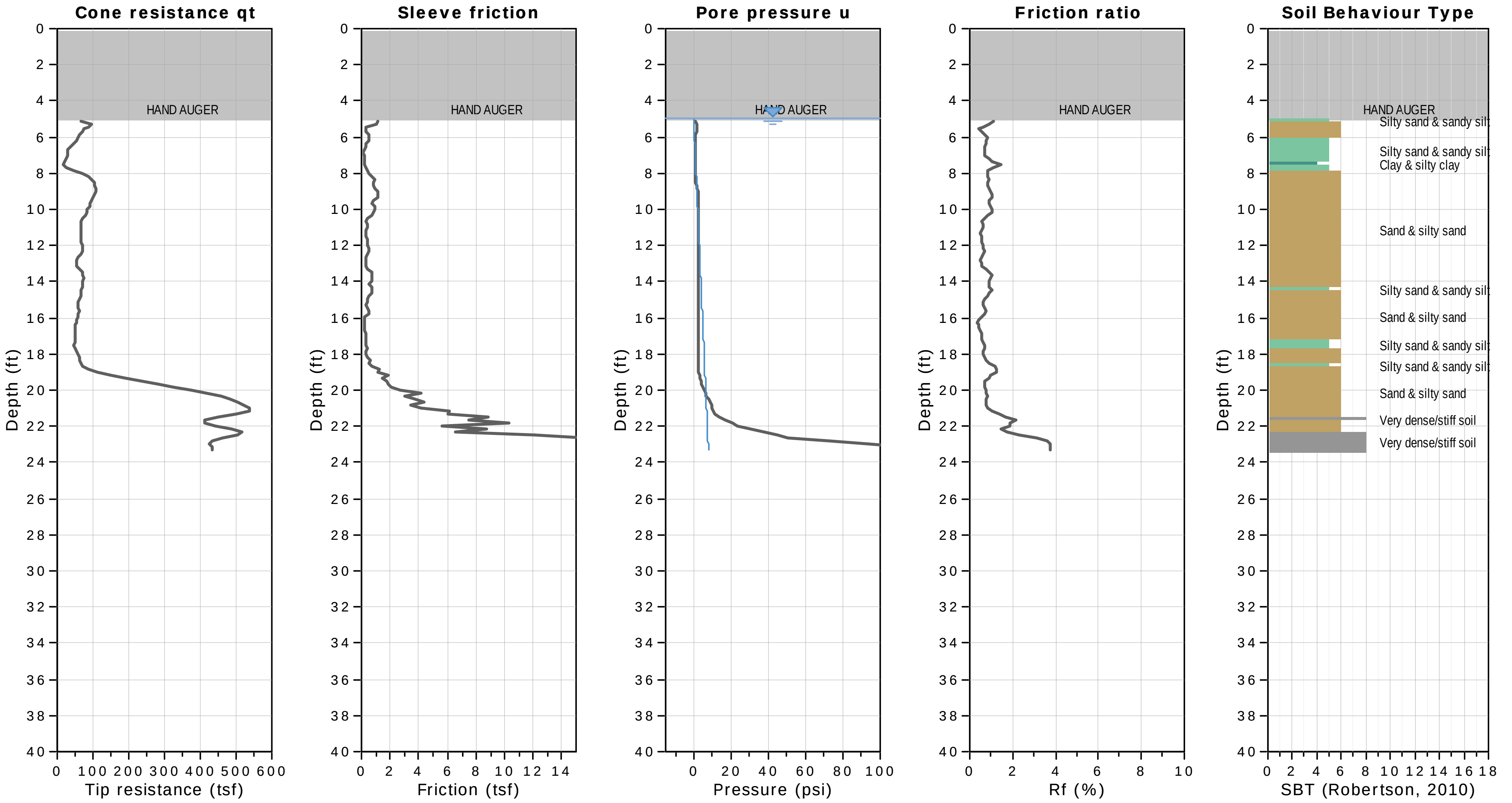
CPT: SCPT-05

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 23.29 ft, Date: 1/11/2021



🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty clay	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to clayey
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

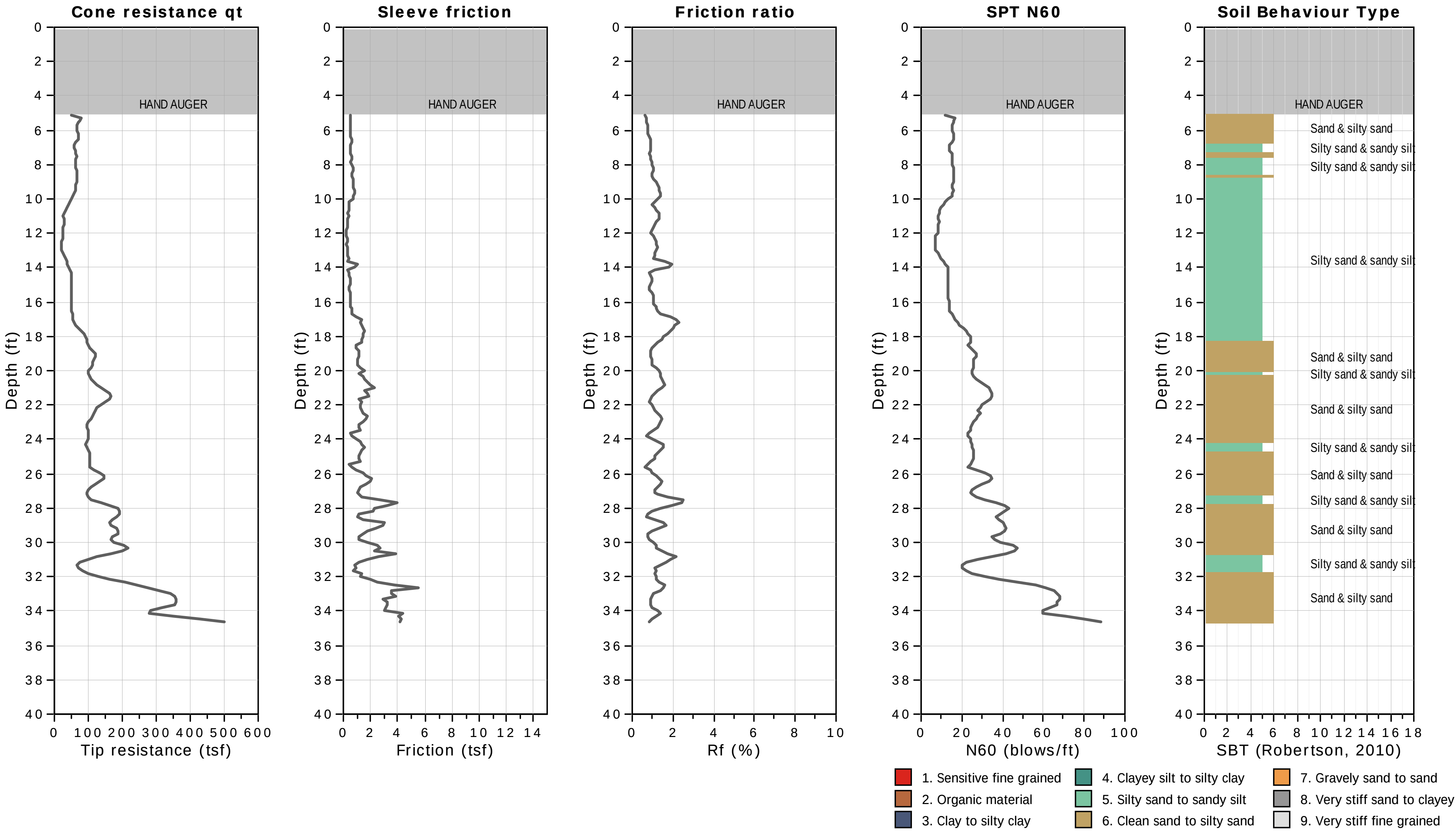
WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

CPT: SCPT-06

CLIENT: GEOSYNTEC
SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.
Total depth: 34.61 ft, Date: 1/11/2021



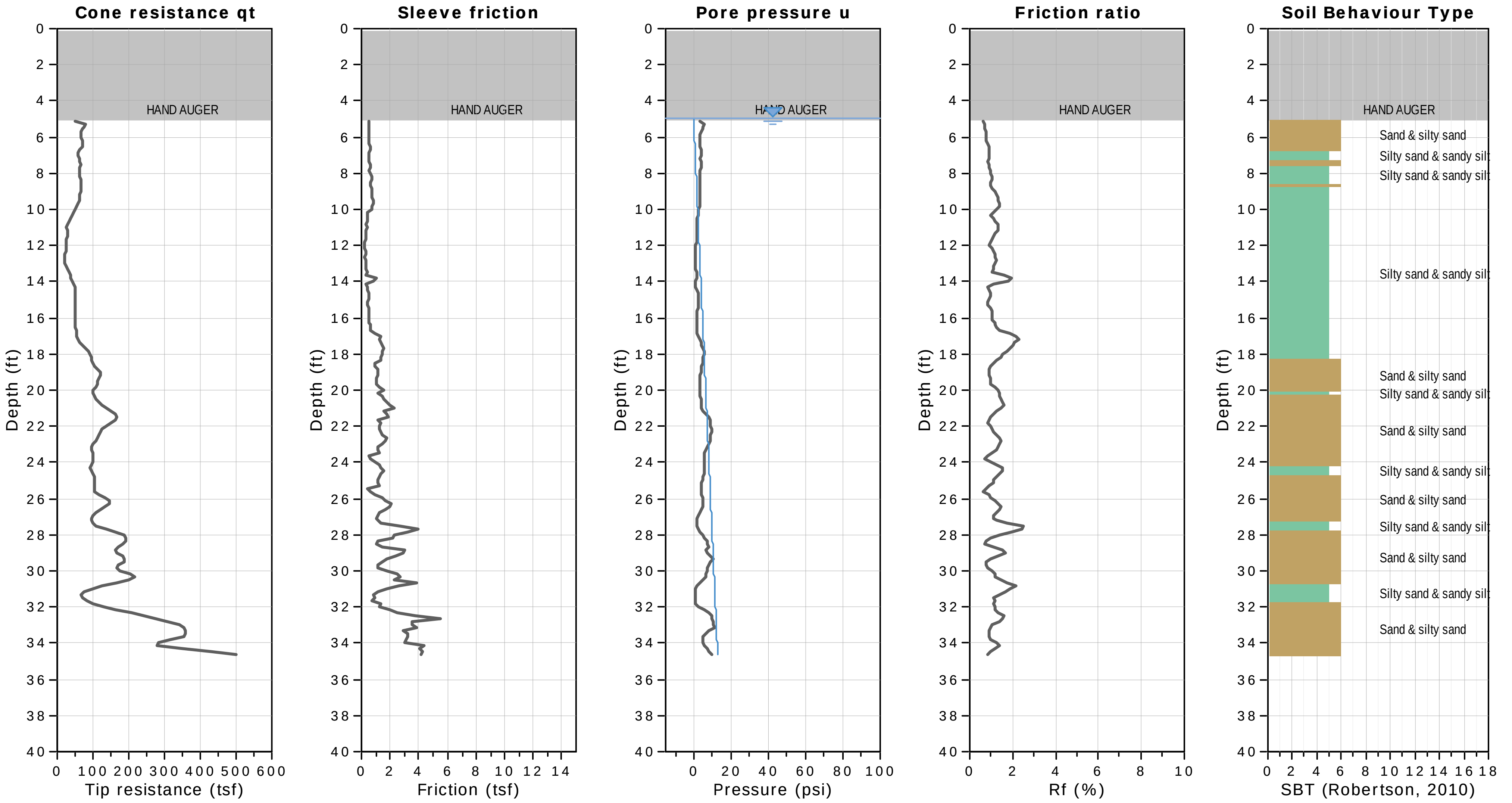
CPT: SCPT-06

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 34.61 ft, Date: 1/11/2021



- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty clay
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to clayey
- ⬜ 9. Very stiff fine grained

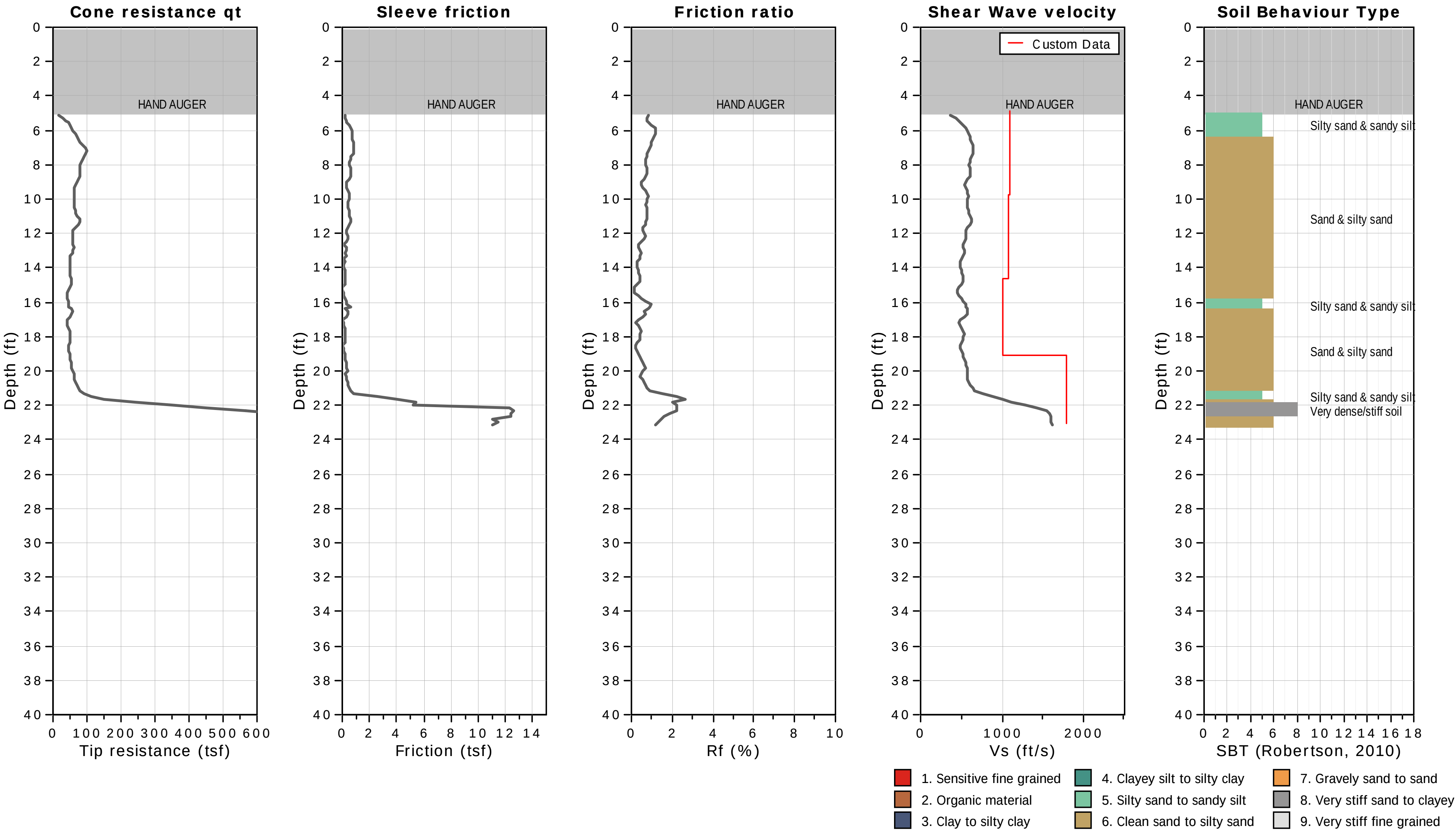
WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

CPT: SCPT-01

CLIENT: GEOSYNTEC
SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.
Total depth: 23.13 ft, Date: 1/11/2021

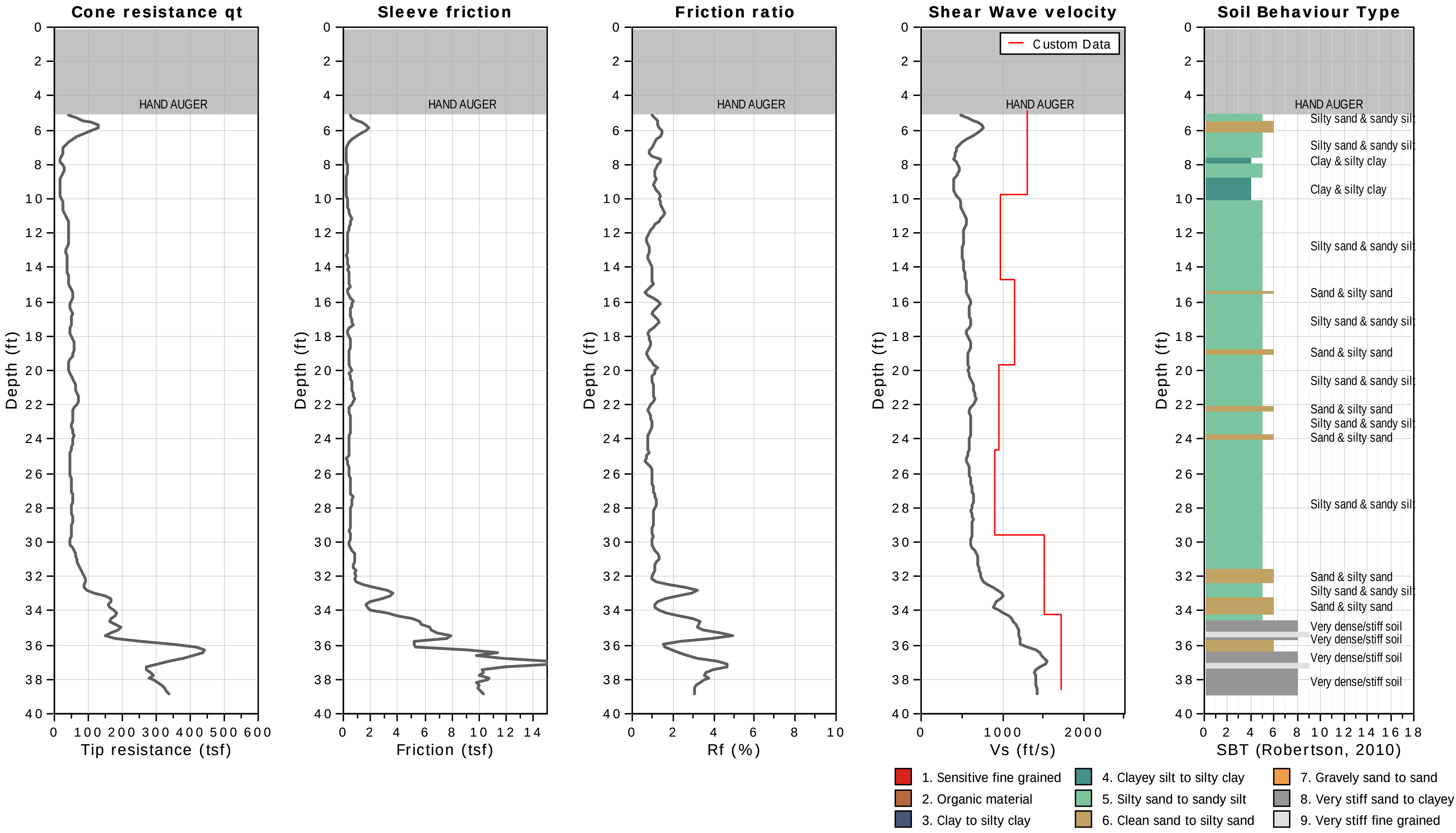


GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

CPT: SCPT-02

CLIENT: GEOSYNTEC
SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.
Total depth: 38.88 ft, Date: 1/11/2021



GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

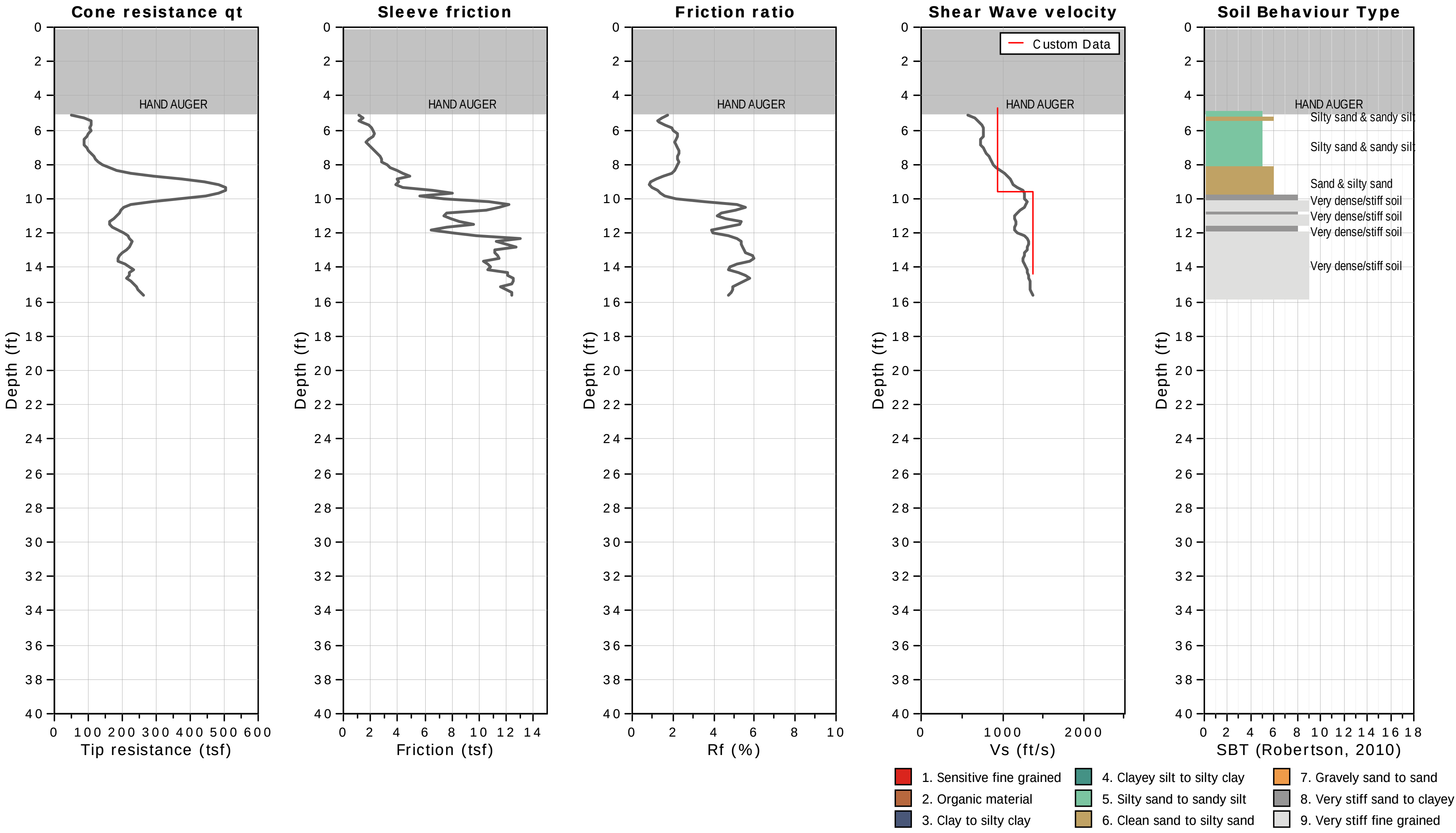
CPT: SCPT-04

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 15.58 ft, Date: 1/11/2021



GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

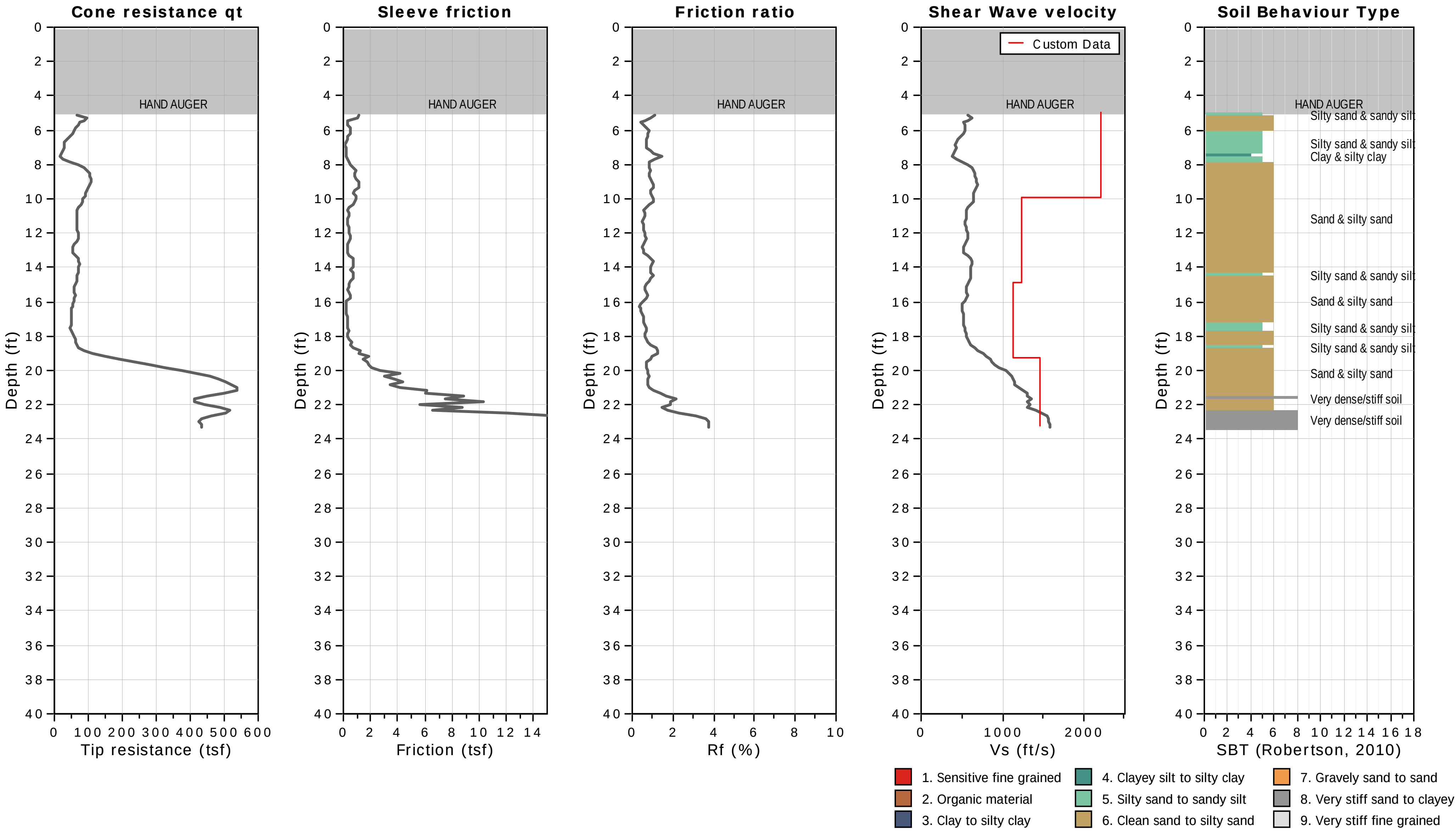
CPT: SCPT-05

CLIENT: GEOSYNTEC

SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 23.29 ft, Date: 1/11/2021



GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

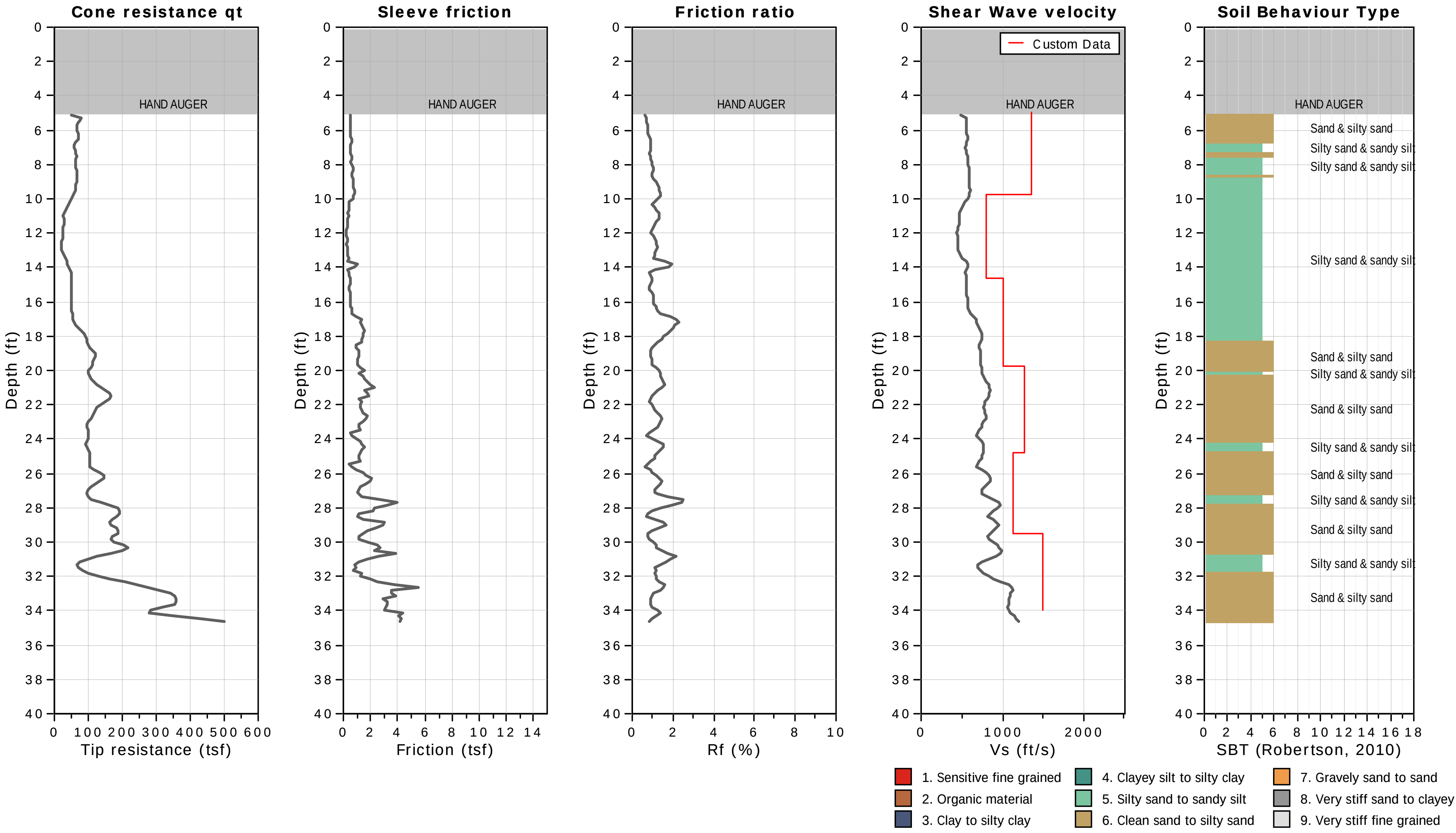
CPT: SCPT-06

CLIENT: GEOSYNTEC

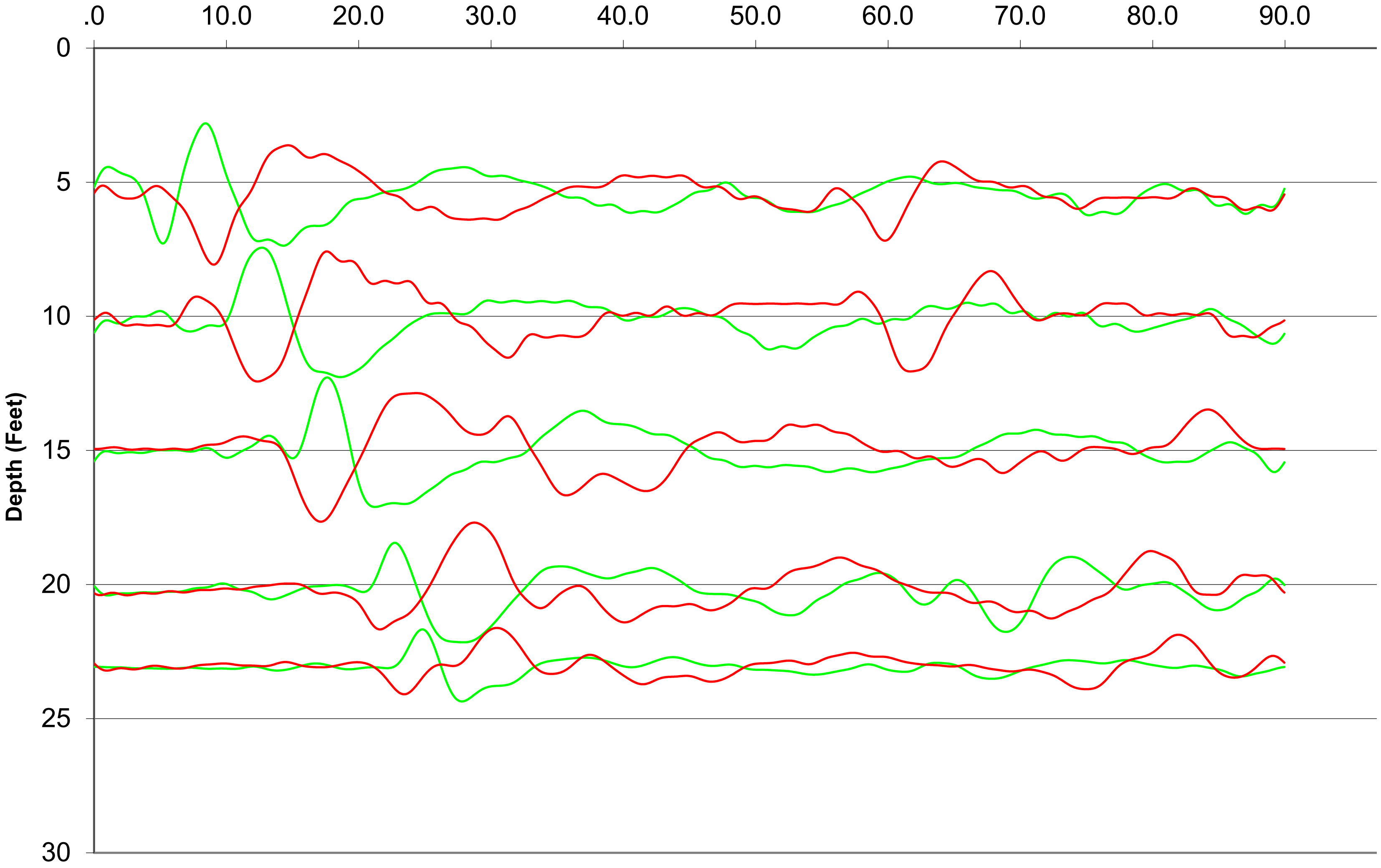
SITE: SOCAL GAS HONOR RANCHO, SANTA CLARITA, CA

FIELD REP: ERIK J.

Total depth: 34.61 ft, Date: 1/11/2021



Waveforms for Sounding SCPT-01



Shear Wave Velocity Calculations

SO CAL GAS H.R

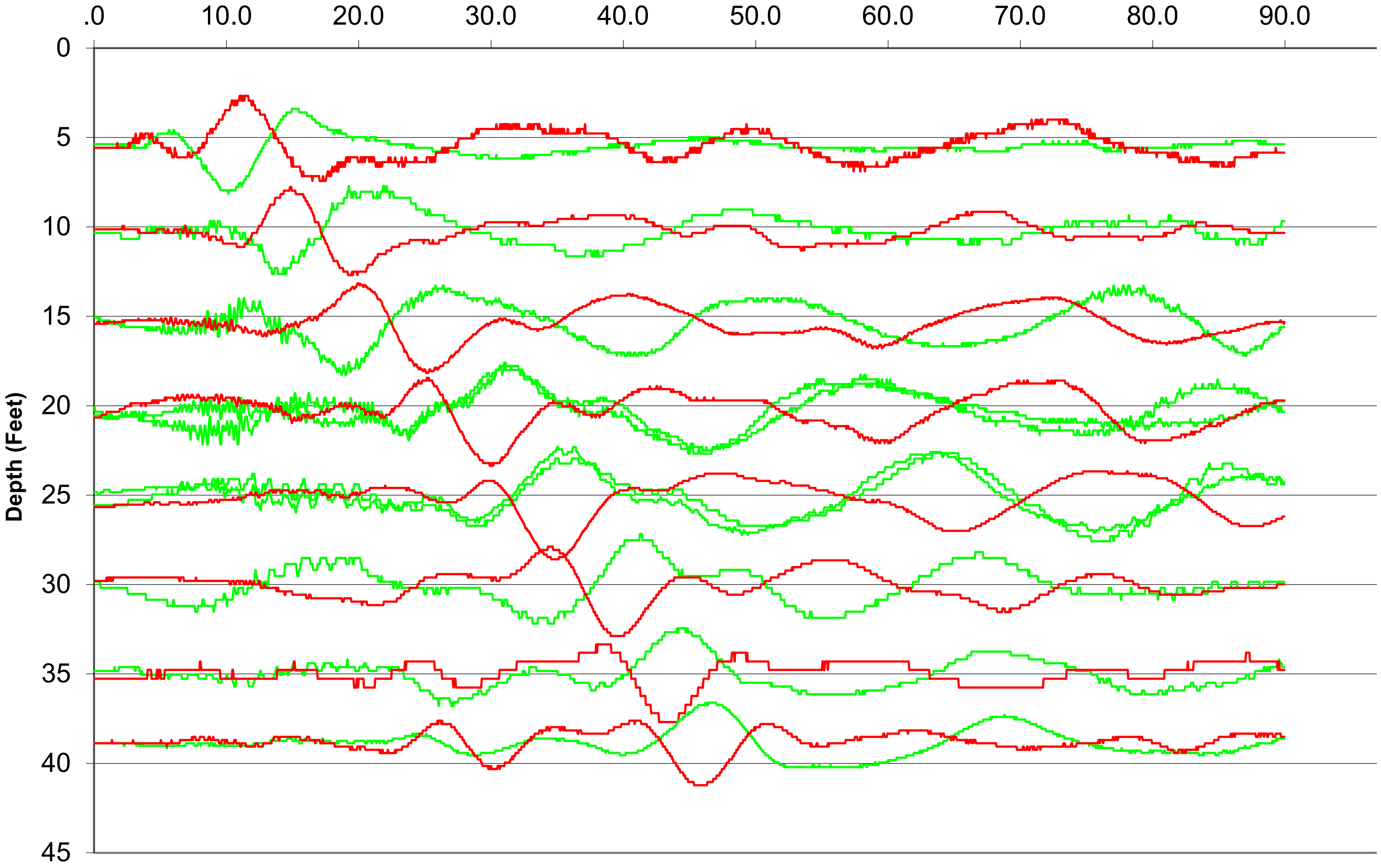
SCPT-01

Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

01/11/21

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.58	4.92	5.19	5.19	10.9000			
10.33	9.67	9.82	4.62	15.1500	4.2500	1088.1	7.30
15.26	14.60	14.69	4.87	19.6500	4.5000	1083.0	12.14
20.34	19.68	19.75	5.06	24.6500	5.0000	1012.2	17.14
23.13	22.47	22.53	2.78	26.2000	1.5500	1793.5	21.08

Waveforms for Sounding SCPT-02



Shear Wave Velocity Calculations

SO CAL GAS H.R

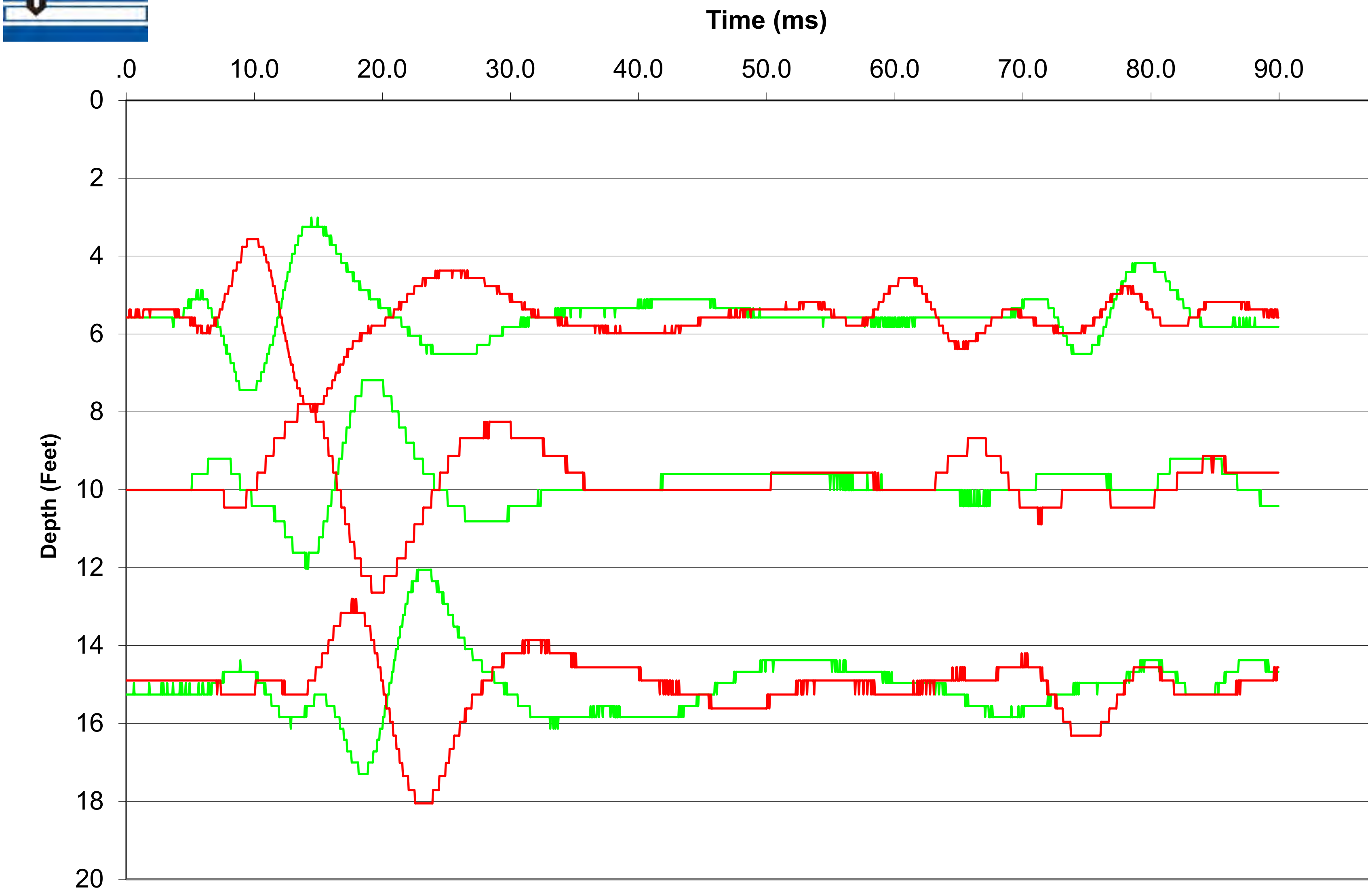
SCPT-02

Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

01/11/21

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.58	4.92	5.19	5.19	13.6000			
10.33	9.67	9.82	4.62	17.1500	3.5500	1302.7	7.30
15.42	14.76	14.85	5.04	22.3000	5.1500	977.9	12.22
20.34	19.68	19.75	4.90	26.5500	4.2500	1152.4	17.22
25.26	24.60	24.66	4.91	31.6500	5.1000	962.2	22.14
30.18	29.52	29.57	4.91	37.1000	5.4500	901.3	27.06
35.27	34.61	34.65	5.08	40.4500	3.3500	1515.9	32.07
38.88	38.22	38.25	3.61	42.5500	2.1000	1716.7	36.41

Waveforms for Sounding SCPT-04



Shear Wave Velocity Calculations

SO CAL GAS H.R

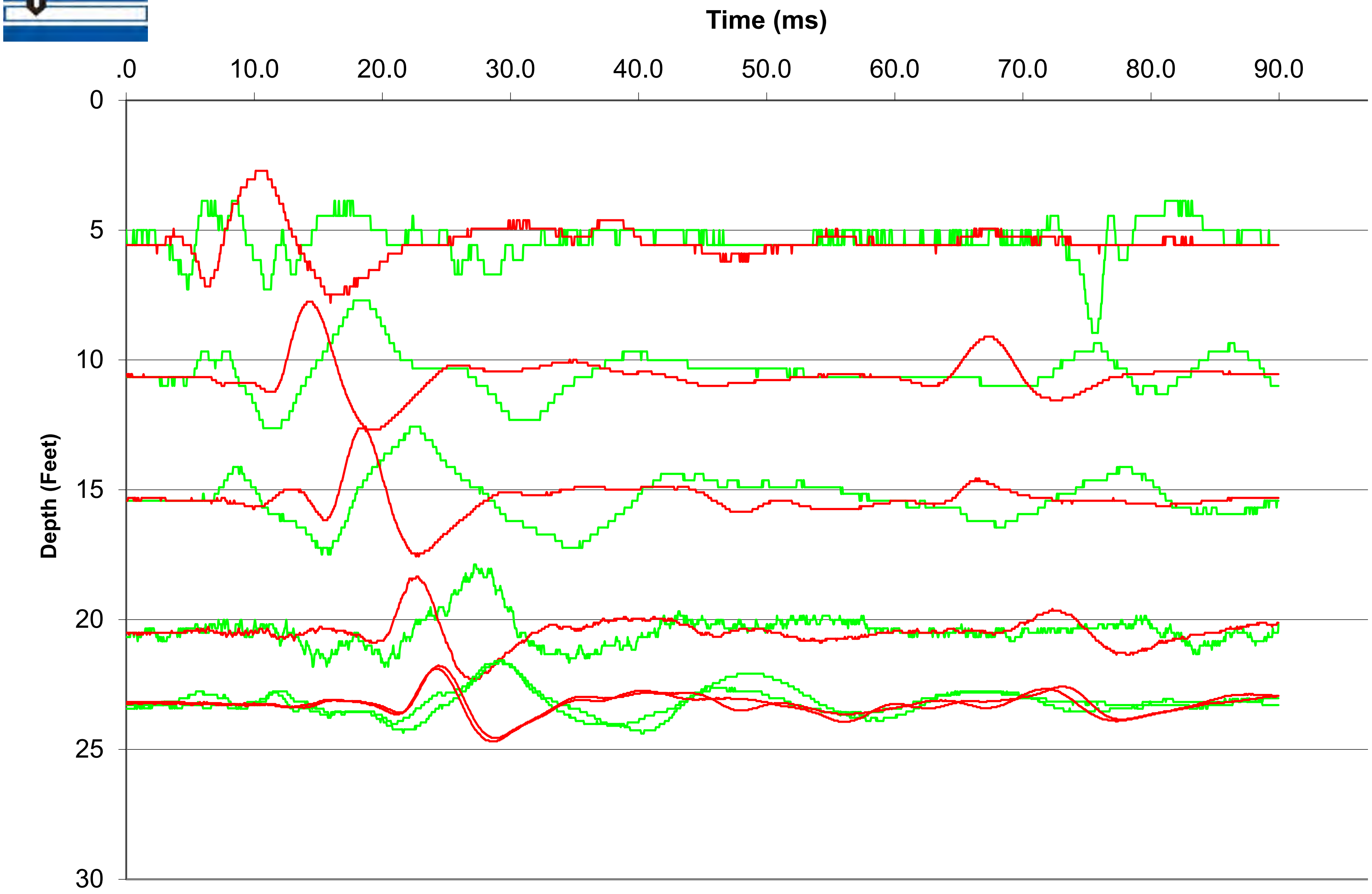
SCPT-04

Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

01/11/21

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.58	4.92	5.19	5.19	11.8500			
10.01	9.35	9.49	4.30	16.4500	4.6000	935.1	7.13
15.26	14.60	14.69	5.20	20.2500	3.8000	1367.5	11.97

Waveforms for Sounding SCPT-05



Shear Wave Velocity Calculations

SO CAL GAS H.R

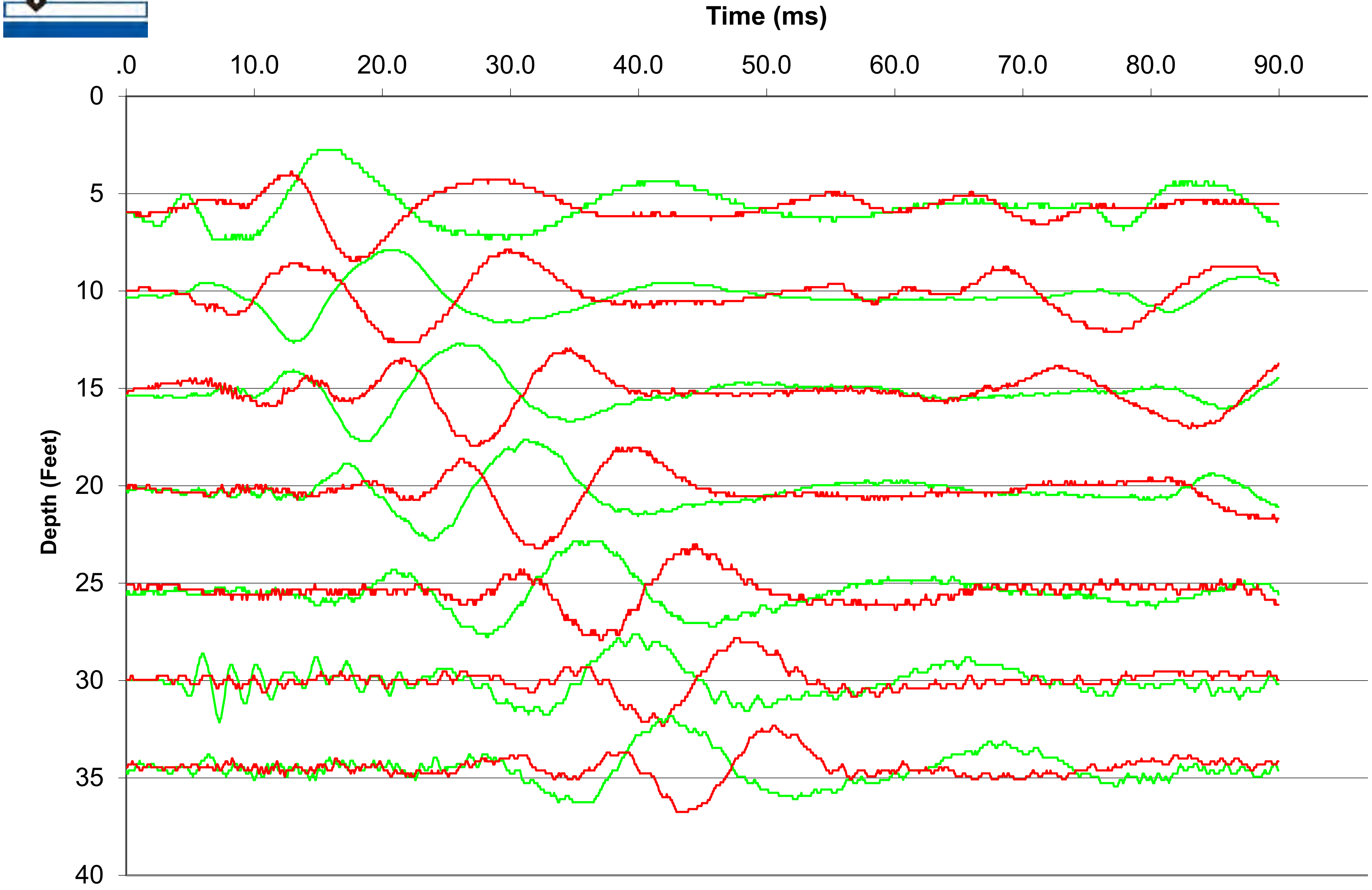
SCPT-05

Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

01/11/21

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.58	4.92	5.19	5.19	13.6000			
10.66	10.00	10.14	4.95	15.8500	2.2500	2199.1	7.46
15.42	14.76	14.85	4.71	19.6500	3.8000	1240.2	12.38
20.51	19.85	19.92	5.06	24.1500	4.5000	1124.7	17.30
23.29	22.63	22.70	2.78	26.0500	1.9000	1463.2	21.24

Waveforms for Sounding SCPT-06



Shear Wave Velocity Calculations

SO CAL GAS H.R

SCPT-06

Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

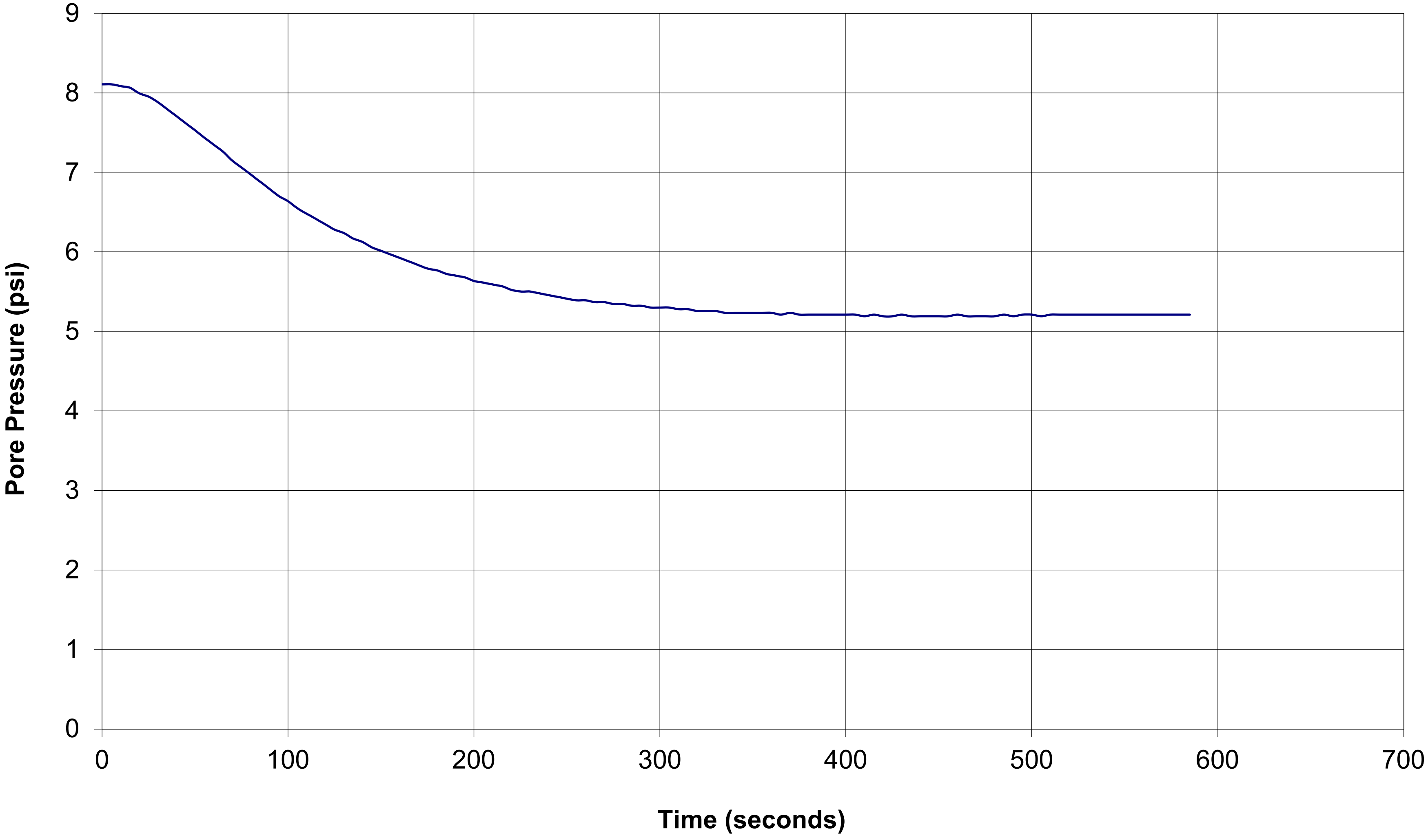
01/12/21

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.74	5.08	5.35	5.35	13.4000			
10.33	9.67	9.82	4.47	16.7000	3.3000	1354.2	7.38
15.26	14.60	14.69	4.87	22.8500	6.1500	792.4	12.14
20.34	19.68	19.75	5.06	27.8500	5.0000	1012.2	17.14
25.59	24.93	24.99	5.23	32.0000	4.1500	1261.3	22.31
30.18	29.52	29.57	4.58	36.0500	4.0500	1132.0	27.23
34.61	33.95	33.99	4.42	39.0000	2.9500	1499.3	31.74

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

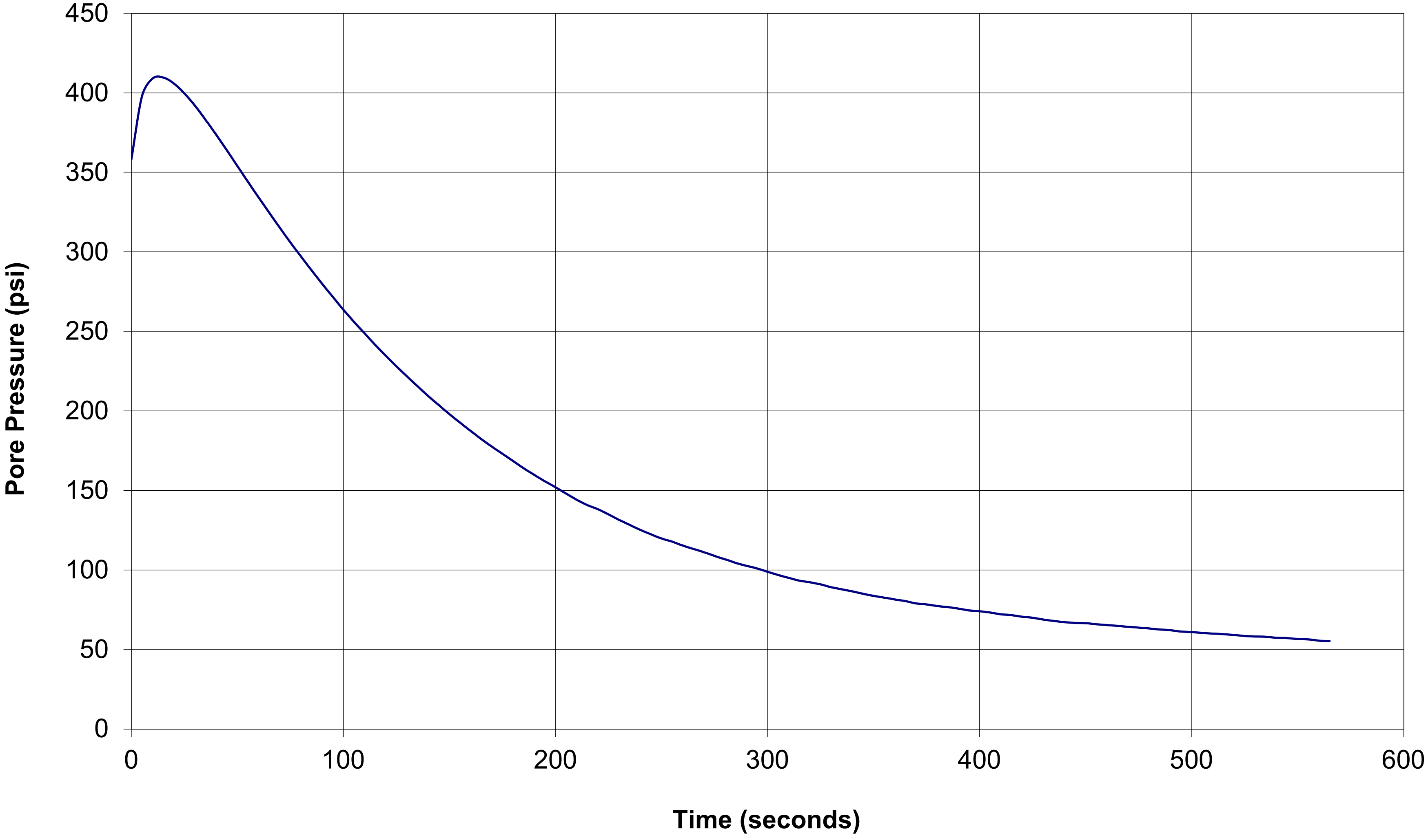
Sounding: SCPT-01
Depth (ft): 23.13
Site: SO CAL GAS H.R
Engineer: ERIK J.



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

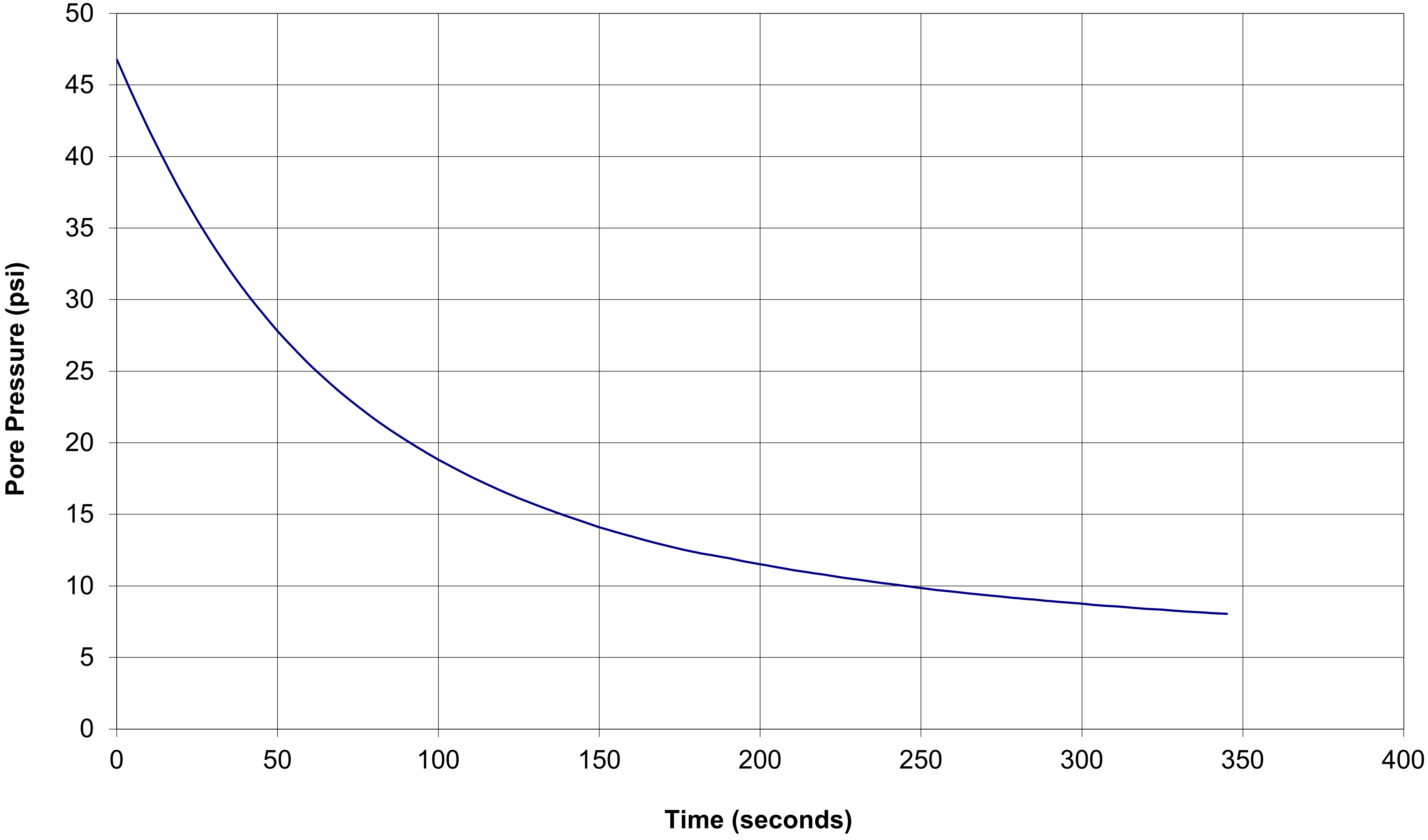
Sounding: SCPT-02
Depth (ft): 38.88
Site: SO CAL GAS H.R
Engineer: ERIK J.



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: SCPT-05
Depth (ft): 23.29
Site: SO CAL GAS H.R
Engineer: ERIK J.



APPENDIX B

Hammer Calibration Certification

SPT HAMMER ENERGY MEASUREMENTS

Prepared by;

SPT CAL
5512 Belem Dr
Chino Hills, CA 91709

909-730-2161
bc@sptcal.com

Martini Drilling Corp
15571 Chemical Ln.
Huntington Beach, CA 92649
714.715.2715

Project Title: HSA 2

Project Description: I-10 Ontario

Martini HSA 2 - Gene

Energy Transfer Ratio = 78.7% @ 56 blows per minute

Testing was performed on July 15, 2019 in Ontario, California

Hammer Energy Measurements performed in accordance to ASTM D4633 using an approved and calibrated SPT Analyzer from Pile Dynamics, Inc.

Depth	ETR%	BPM
5	78.2	52.7
10	75.4	54.7
15	79.0	55.3
20	77.0	55.8
25	79.7	56.7
30	76.5	57.0
35	80.9	56.9
40	79.9	57.2
45	81.9	57.5
Average	**78.7**	**56.0**

Thank you very much. It was a pleasure to work with you and your drill crews.Sincerely yours,

Brian Serl
Calibration Engineer
SPTCAL.COM

PRESENTATION OF SPT ANALYZER TEST DATA

1. Introduction

This report presents the results of SPT Hammer Energy Measurements recorded with an SPT Analyzer from Pile Dynamics carried out on July 15, 2019 in Ontario, California

52. Field Equipment and Procedures

The drill used was Martini Drilling's HSA 2. It has an attached SPT Automatic Hammer manufactured by Central Mine Equipment Company.

The CME Auto Hammer uses a 140 lb. weight dropped 30" on to an anvil above the bore hole. AWJ drill rod connects the anvil to a split spoon type soil sampler inside an 8" o.d. hollow stem auger at the designated sample depth. After a seeding blow the sampler is driven 18". The number of blows required to penetrate the last 12" is referred to as the "N value", which is related to soil strength.

The first recording was taken at 5' below ground surface and then every 5' to final recording at 45'.

3. Instrumentation

An SPT Analyzer from Pile Dynamics was used to record and the process the data. The raw data was stored directly in the SPT Analyzer computer with subsequent analysis in the office with PDA-W and PDIPlot software. The measurements and analysis were conducted in general accordance with ASTM D4945 and ASTM D6066 test standards.

The SPT Analyzer is fully compliant with the minimum digital sampling frequency requirements of ASTM D4633-05 (50 kHz) and EN ISO 22476-3:2005 (100 kHz), as well as with the low pass filter, (cutoff frequency of 5000 Hz instead of 3000 Hz) requirements of ASTM D4633-05. All equipment and analysis also conform to ASTM D6066.

A 2' instrumented section of AWJ rod, with two sets of accelerometers and strain transducers mounted on opposite sides of the drill rod, was placed below the anvil. It measured strain and acceleration of every hammer blow. The SPT Analyzer then calculates the amount of energy transferred to the rod by force and velocity measurements.

4. Observations

The drill rig motor is diesel fueled. The throttle was manually controlled. The blows per minute average was consistent at every sample interval.

5. Results

Results from the SPT Hammer Energy Measurements are summarized below. It shows the Energy Transfer Ratio (ETR) at each sampling depth. ETR is the ratio of the measured maximum transferred energy to rated energy of the hammer which is the product of the weight of the hammer times the height of the fall. 140 lb x 30” = 4200 lb-in = 0.350 kip-ft.

Energy Transfer Ratio = 78.7% @ 56 blows per minute

Depth	ETR%	BPM
5	78.2	52.7
10	75.4	54.7
15	79.0	55.3
20	77.0	55.8
25	79.7	56.7
30	76.5	57.0
35	80.9	56.9
40	79.9	57.2
45	81.9	57.5
Average	**78.7**	**56.0**

If you have any questions please do not hesitate to call or email.

Thank you,

Brian Serl
Calibration Engineer
SPT CAL
909-730-2161
bc@sptcal.com

GREGG DRILLING, LLC
ENVIRONMENTAL AND GEOTECHNICAL INVESTIGATION SERVICES

November 5, 2020

Kleinfelder
Attn: Kimberly Brown

Re: Standard Penetration Energy Measurements
Automatic Hammer on Hollow-stem Auger Drill Rig, D-76
Jibboom Bridge & 1st St. Project Area, Sacramento, CA

Dear Ms. Brown,

This report offers results of energy measurements and related calculations made on November 3, 2020 during Standard Penetration Testing (SPT) on Gregg Drilling's hollow stem auger drill rig. Dynamic tests were performed on an instrumented section of NWJ drill rod attached to the sampler rod string. All dynamic measurements were obtained and recorded using a SPT Analyzer®.

Average Energy: 90%
Sample Depths tested (in feet): 5, 7.5, 10, 12.5, 15, 17.5, 20, 25, 27.5, 30

***Note:** If the SPT Analyzer did not measure all blows for a sample depth, the reported blow count and therefore calculated N60 value in the following tables will be incorrect. Often blows are excluded from calculations if the sensors are loose or have drifted from the baseline. Field records of actual blow count values should be used in place of the blow counts shown in the following tables.

Equipment:

SPT energy measurements were made on SPT and Modified California samplers driven by the hammer/anvil system on the Gregg Drilling drill rig on November 3, 2020. The rig was tested on Jibboom Bridge& 1st St. Project area. In total, 10 energy measurements were collected corresponding to 10 different samples at increasing depth.

Gregg used a SPT Analyzer (SPTA) to acquire and process measurements of force and velocity with every impact of the automatic hammer on the sample rods. Gregg follows the procedure outlined in ASTM D4633. Two strain gauges mounted on a 2-foot section of NWJ rod measured force, while two piezoresistive accelerometers bolted on the same rod measured acceleration. The gauges were mounted approximately 6" from the top of the rod.
Analog signals from the gauges and accelerometers were collected, digitized, displayed in real-time, and stored by the SPTA. Selected output from the SPTA for each recorded impact of the hammer included:

- Maximum force in the rod (FMX)
- Maximum velocity in the rod (VMX)
- Maximum calculated transferred energy (EFV)
- Blows per minute (BPM)
- Energy transferred to the rods (ETR)

Data and Calculations:

The purpose of testing was to measure the energy transferred from the hammer to the drill rod and to calculate the energy efficiency of the hammer. The SPTA measurements of force and velocity were reviewed after field testing and analyzed to calculate the transferred energy (EFV).

The maximum energy transferred past the gauge location, EFV, is computed by the SPTA using force (F) and velocity (V) records as follows:

$$EMX = \int_a^b F(t)\, V(t)\, dt$$

The time “a” corresponds to the start of the record when the energy transfer begins and “b” is the time at which energy transferred to the rod reaches a maximum value. The energy transferred is defined as ETR, and is usually used to define the efficiency of the hammer/anvil system.

Results:

Tables for each sample depth summarize the average calculated energies for each sample tested as well as the details for each sample. It is shown that the overall average (ETR) energy for this system is 90%. The Summary of SPT Test Results table at the end provides a summary of all the samples tested at each sampling depth. The plots and tables present selected measured and calculated results as a function of blow number. The results include:

- the blow number
- BC (blow count in feet) *NOTE: This is calculated by dividing the number of blows for each 6” of penetration by the 6” depth interval and is therefore only approximate. If some blows were deleted due to erroneous or poor data, the penetration depths are not correct.
- FMX (maximum rod force)
- VMX (maximum rod velocity)
- BPM (blows per minute)
- EFV (energy using the Force Velocity method in ft-lbs)
- ETR (energy transferred as a percentage of maximum)

At the end of each table is a statistical evaluation of the results for each variable including the average, standard deviation, maximum, minimum and what blow number these maximums and minimums occurred.

If you have any questions or comments on this report, please do not hesitate to call or e-mail me: kcabal@greggdrilling.com.

Sincerely,

Kelly Cabal

Kelly Cabal
Data Management & Communications
Gregg Drilling, LLC

Appendix A

SPT Analyzer Results
PDA-S Ver. 2018.30 - Printed: 11/5/2020

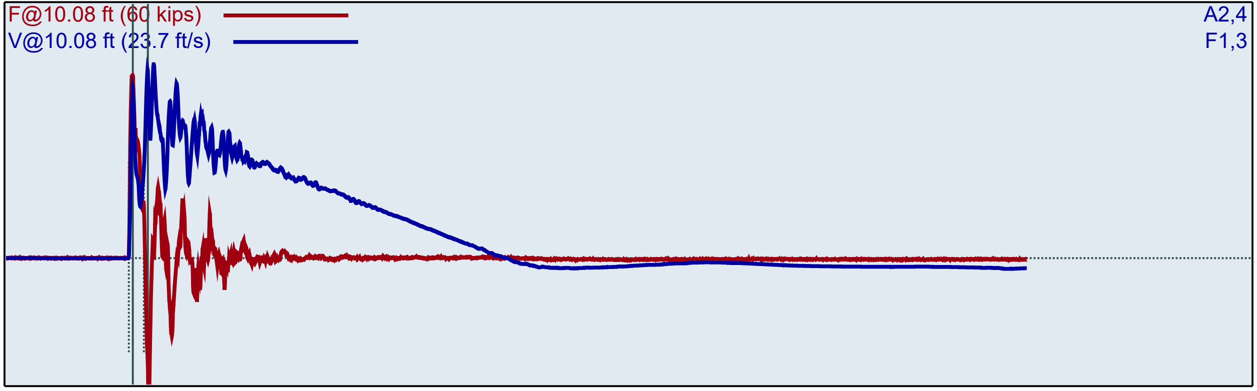
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 10.08 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (5.00 - 6.50 ft], displaying BN: 6



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
1	2	42	19.4	1.9	279	79.7
2	2	42	18.7	18.0	286	81.8
3	3	40	17.0	57.1	265	75.8
4	3	39	16.1	57.6	240	68.6
6	3	43	17.9	27.5	299	85.4
7	3	43	18.6	58.5	287	82.1
8	3	42	17.7	57.1	288	82.2
	Average	41	17.5	51.5	276	78.8
	Std Dev	2	0.8	12.0	21	6.0
	Maximum	43	18.6	58.5	299	85.4
	Minimum	39	16.1	27.5	240	68.6

N-value: 5

Sample Interval Time: 11.47 seconds.

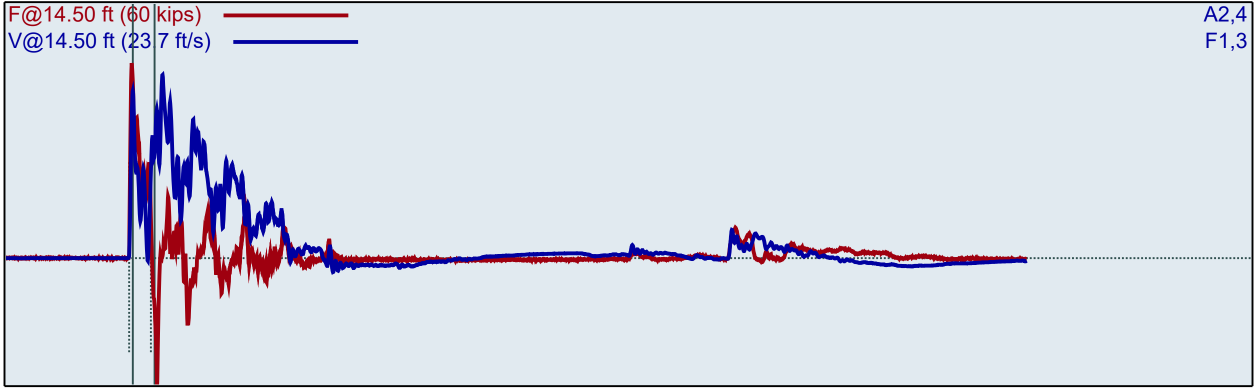
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 14.50 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (7.50 - 9.00 ft], displaying BN: 19



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
9	3	42	15.9	1.9	299	85.3
10	3	43	16.0	22.6	321	91.8
11	3	43	16.3	58.4	313	89.5
12	4	43	16.3	58.4	314	89.8
13	4	42	16.5	58.3	314	89.8
14	4	43	17.1	57.9	318	90.9
15	4	43	16.5	58.4	321	91.8
16	6	43	16.4	57.7	322	92.0
17	6	44	16.4	58.0	322	91.9
18	6	43	16.2	58.0	318	90.9
19	6	46	16.9	58.1	334	95.4
20	6	44	15.2	58.0	320	91.5
21	6	44	15.1	58.3	322	92.0
	Average	43	16.3	58.1	321	91.6
	Std Dev	1	0.6	0.2	5	1.5
	Maximum	46	17.1	58.4	334	95.4
	Minimum	42	15.1	57.7	314	89.8

N-value: 10

Sample Interval Time: 14.01 seconds.

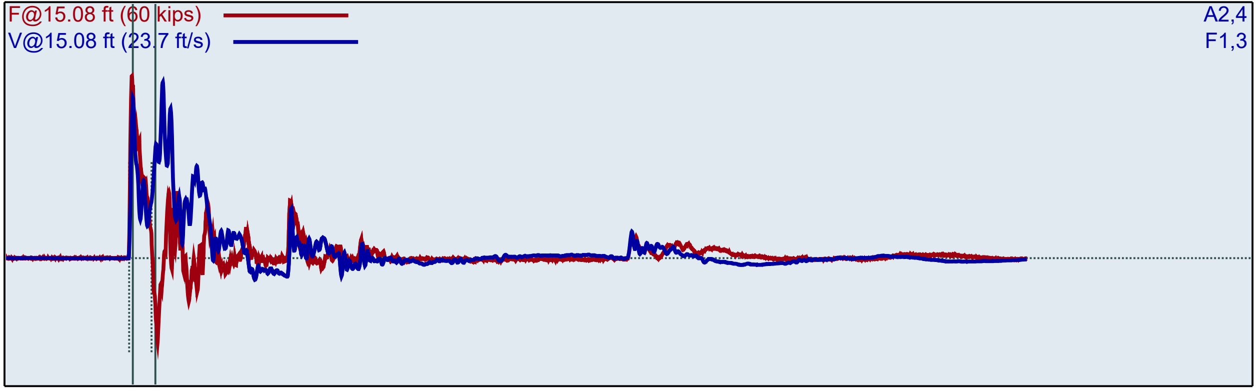
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 15.08 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (10.00 - 11.50 ft], displaying BN: 41



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
22	3	40	19.0	1.9	313	89.4
23	3	41	18.9	23.2	322	92.0
24	3	41	18.3	57.2	315	90.0
25	8	42	17.5	57.7	316	90.2
26	8	43	17.8	58.2	318	90.9
27	8	43	16.8	58.1	321	91.7
28	8	42	15.2	58.4	315	89.9
29	8	42	15.2	58.2	316	90.2
30	8	42	14.9	58.2	313	89.5
31	8	42	15.6	57.9	322	92.1
32	8	42	16.0	58.1	318	90.8
33	11	41	16.0	58.3	312	89.2
34	11	41	16.4	58.2	309	88.2
35	11	42	16.8	58.0	319	91.1
36	11	41	15.9	57.9	305	87.2
37	11	42	17.0	58.6	306	87.4
38	11	42	16.1	58.3	315	90.1
39	11	43	16.5	58.2	320	91.5
40	11	43	15.4	58.2	319	91.1
41	11	43	16.3	58.3	322	92.1
42	11	43	16.7	58.2	322	92.1
43	11	45	16.1	31.0	337	96.3
	Average	42	16.2	56.7	317	90.6
	Std Dev	1	0.7	6.1	7	2.0
	Maximum	45	17.8	58.6	337	96.3
	Minimum	41	14.9	31.0	305	87.2

N-value: 19

Sample Interval Time: 24.12 seconds.

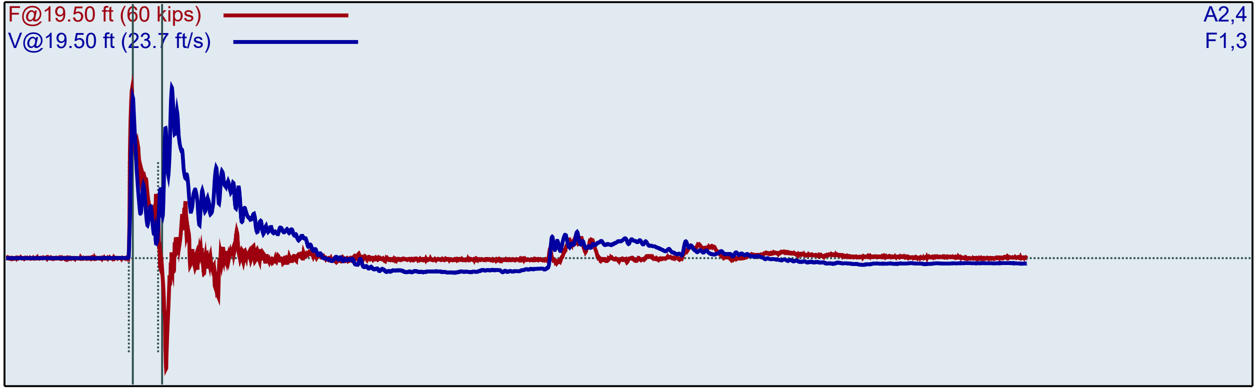
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 19.50 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (12.50 - 14.00 ft], displaying BN: 79



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
44	15	40	17.3	1.9	331	94.5
45	15	40	17.3	28.8	333	95.1
46	15	41	17.8	59.2	338	96.5
47	15	40	17.1	59.4	331	94.5
48	15	39	16.7	59.5	333	95.2
49	15	40	17.0	59.6	332	94.8
50	15	37	16.5	59.3	335	95.6
51	15	37	16.3	59.3	333	95.1
52	15	36	15.8	59.2	322	92.1
53	15	38	16.2	59.2	327	93.3
54	15	39	16.6	59.2	332	94.8
55	15	35	16.8	59.0	319	91.1
56	15	37	15.9	59.1	329	94.1
57	16	37	16.6	59.2	327	93.3
58	16	40	16.2	59.0	323	92.3
59	16	39	16.5	59.2	333	95.2
60	16	40	15.7	59.1	325	92.9
61	16	36	16.2	59.1	328	93.8
62	16	37	15.9	59.1	327	93.3
63	16	35	17.1	59.2	324	92.6
64	16	38	16.1	59.2	326	93.3
65	16	37	16.4	59.1	333	95.0
66	16	35	15.7	59.2	326	93.1
67	16	34	17.4	59.0	321	91.8
68	16	39	16.4	59.1	329	93.9
69	16	40	15.8	59.1	329	94.0
70	16	40	16.0	59.0	333	95.2
71	16	36	15.8	59.0	331	94.6
72	16	39	15.4	58.9	330	94.3
73	9	42	15.6	58.9	342	97.6
74	9	41	15.4	59.0	335	95.6

75	9	40	16.0	58.9	326	93.1
76	9	39	15.6	58.9	332	94.9
77	9	40	15.6	58.9	333	95.0
78	9	39	15.8	58.8	332	94.8
79	9	39	15.8	58.4	324	92.6
80	9	40	15.4	58.6	331	94.5
81	9	41	15.6	58.6	330	94.2
	Average	39	16.0	59.0	329	94.0
	Std Dev	2	0.5	0.2	4	1.2
	Maximum	42	17.4	59.2	342	97.6
	Minimum	34	15.4	58.4	321	91.8

N-value: 25

Sample Interval Time: 38.66 seconds.

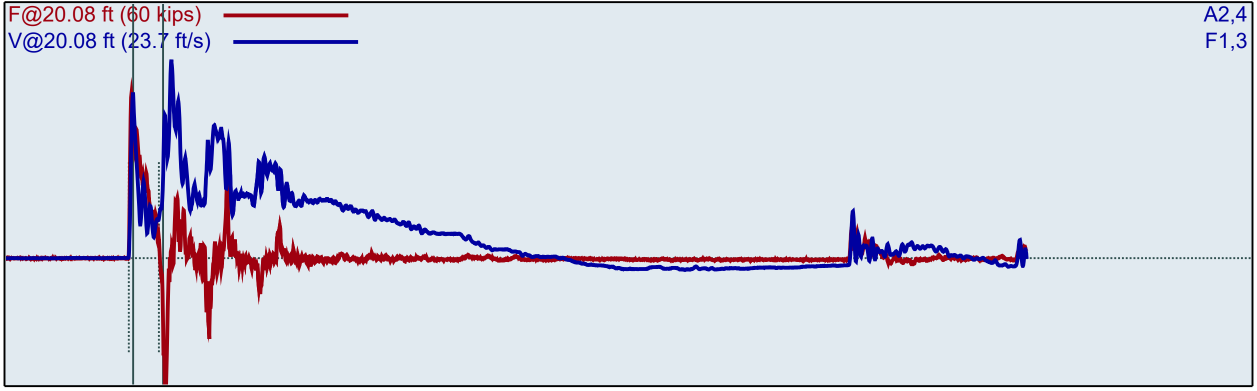
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 20.08 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (15.00 - 16.50 ft], displaying BN: 92



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
84	3	41	17.4	47.5	330	94.4
85	3	40	17.0	52.1	330	94.4
86	3	39	17.4	51.2	328	93.7
87	4	41	17.4	51.3	334	95.5
88	4	39	17.0	51.5	324	92.5
89	4	38	18.2	51.4	327	93.4
90	4	40	18.1	51.3	331	94.4
91	4	40	18.0	51.5	328	93.9
92	4	38	18.4	51.5	329	94.0
93	4	39	18.0	51.0	323	92.2
94	4	40	18.3	51.0	327	93.5
	Average	39	17.9	51.3	328	93.7
	Std Dev	1	0.5	0.2	3	1.0
	Maximum	41	18.4	51.5	334	95.5
	Minimum	38	17.0	51.0	323	92.2

N-value: 8

Sample Interval Time: 11.68 seconds.

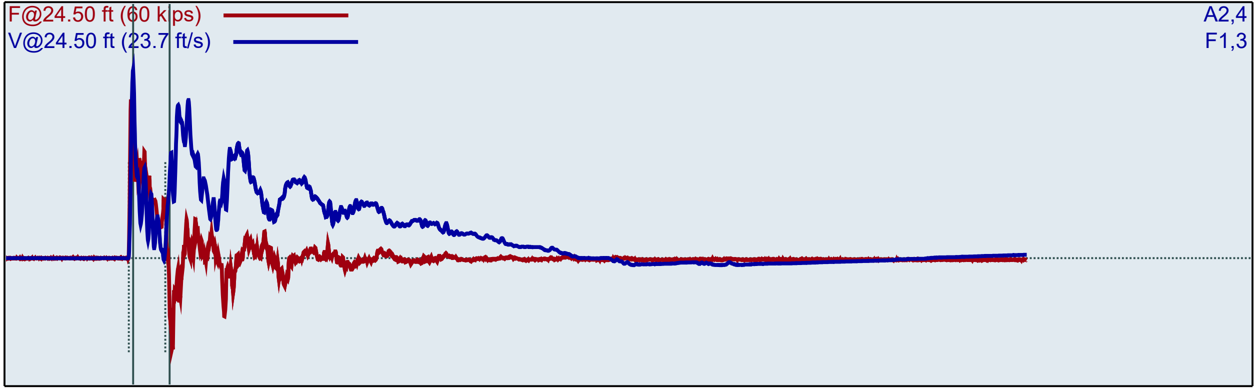
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 24.50 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (17.50 - 19.00 ft], displaying BN: 101



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
97	2	38	17.8	37.3	337	96.2
98	3	37	17.0	50.9	327	93.3
99	3	41	17.6	50.0	328	93.7
100	3	40	17.3	49.2	325	92.9
101	3	37	17.4	49.4	326	93.1
102	3	37	17.1	49.6	324	92.6
103	3	39	17.1	49.4	318	90.7
	Average	39	17.2	49.8	325	92.7
	Std Dev	2	0.2	0.6	3	0.9
	Maximum	41	17.6	50.9	328	93.7
	Minimum	37	17.0	49.2	318	90.7

N-value: 6

Sample Interval Time: 7.22 seconds.

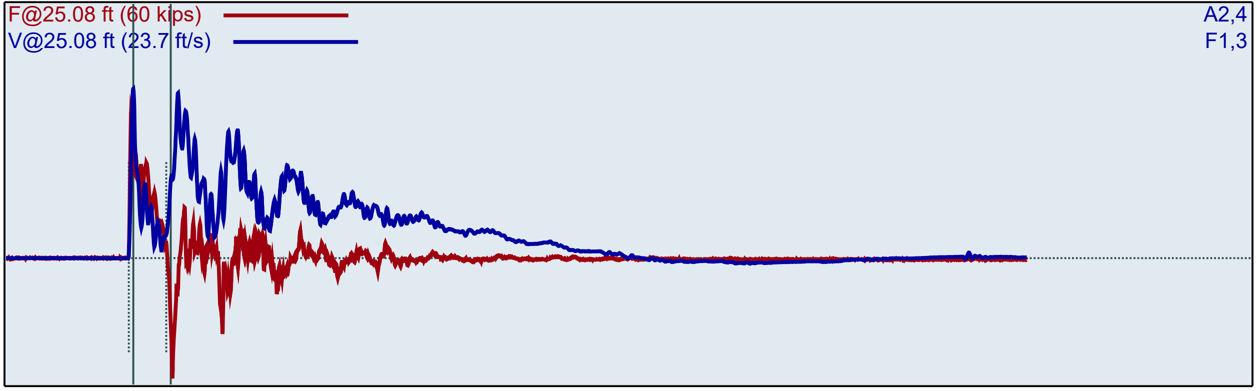
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 25.08 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (20.00 - 21.50 ft], displaying BN: 108



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC	FMX	VMX	BPM	EFV	ETR
	/6"	kips	ft/s	bpm	ft-lb	%
104	2	35	16.0	1.9	307	87.7
105	2	36	16.4	18.2	308	87.9
106	2	35	16.2	35.2	306	87.6
107	2	35	16.3	35.4	313	89.3
108	3	35	15.7	36.5	303	86.6
109	3	35	16.1	36.5	306	87.5
110	3	38	16.4	36.5	307	87.8
	Average	35	16.1	36.0	307	87.7
	Std Dev	1	0.3	0.6	3	0.9
	Maximum	38	16.4	36.5	313	89.3
	Minimum	35	15.7	35.2	303	86.6

N-value: 5

Sample Interval Time: 11.64 seconds.

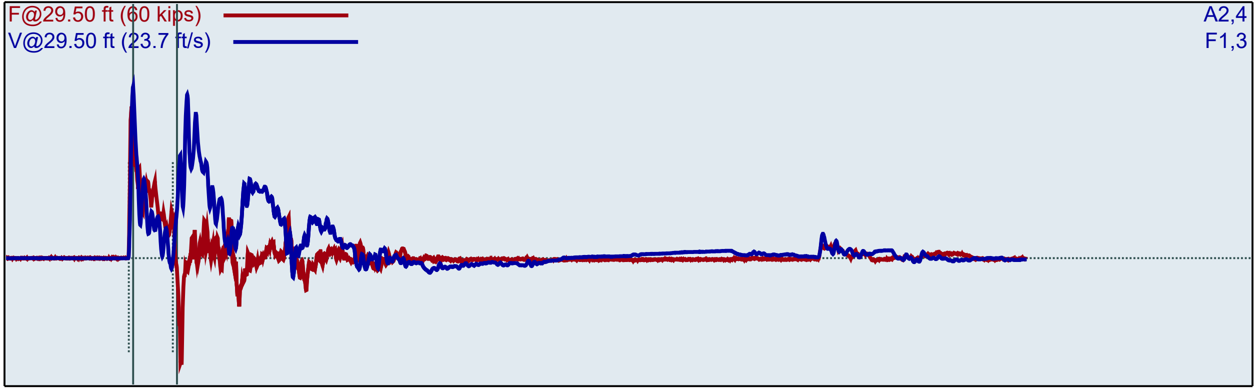
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 29.50 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (25.00 - 26.50 ft], displaying BN: 124



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
111	5	38	16.3	1.9	327	93.5
112	5	38	16.1	22.4	315	90.1
113	5	37	15.7	41.1	296	84.4
114	5	39	16.6	37.5	314	89.7
115	5	39	16.3	39.1	313	89.5
116	5	38	15.5	39.1	308	87.9
117	5	39	16.1	39.2	309	88.2
118	5	38	15.5	39.2	304	86.8
119	5	43	17.0	39.2	312	89.1
120	5	40	16.7	39.4	316	90.4
121	6	38	15.4	39.4	303	86.7
122	6	38	15.8	39.5	310	88.5
123	6	37	15.8	40.5	314	89.8
124	6	36	15.9	42.6	314	89.8
125	6	37	16.0	44.7	313	89.3
126	6	40	16.6	47.6	322	91.9
	Average	38	16.0	41.0	311	89.0
	Std Dev	2	0.5	2.7	5	1.5
	Maximum	43	17.0	47.6	322	91.9
	Minimum	36	15.4	39.1	303	86.7

N-value: 11

Sample Interval Time: 23.43 seconds.

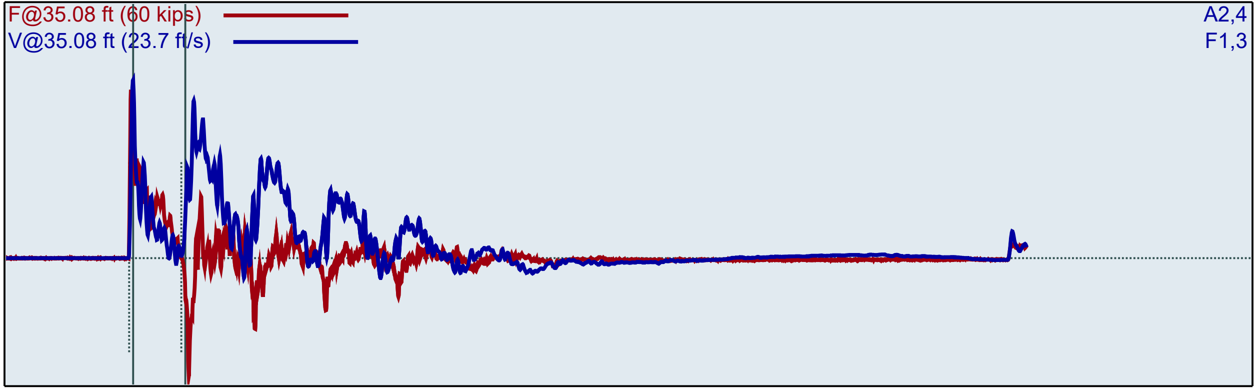
D-76
Wessam Zanaty
2f-20-002

5
Test date: 11/3/2020

AR: 1.42 in^2
LE: 35.08 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (27.50 - 29.00 ft], displaying BN: 135



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC	FMX	VMX	BPM	EFV	ETR
	/6"	kips	ft/s	bpm	ft-lb	%
127	2	36	16.0	1.9	301	86.1
128	2	38	16.8	22.4	327	93.4
129	4	37	16.1	38.5	304	86.9
130	4	35	16.3	39.9	303	86.5
131	4	38	16.4	41.9	302	86.4
132	4	40	16.9	41.8	308	88.1
133	5	40	17.3	36.5	312	89.3
134	5	37	16.2	38.3	307	87.7
135	5	39	16.5	39.7	306	87.4
136	5	37	16.7	40.0	315	90.1
137	5	37	15.9	40.8	308	88.0
	Average	38	16.5	39.7	307	87.8
	Std Dev	2	0.4	1.6	4	1.2
	Maximum	40	17.3	41.9	315	90.1
	Minimum	35	15.9	36.5	302	86.4

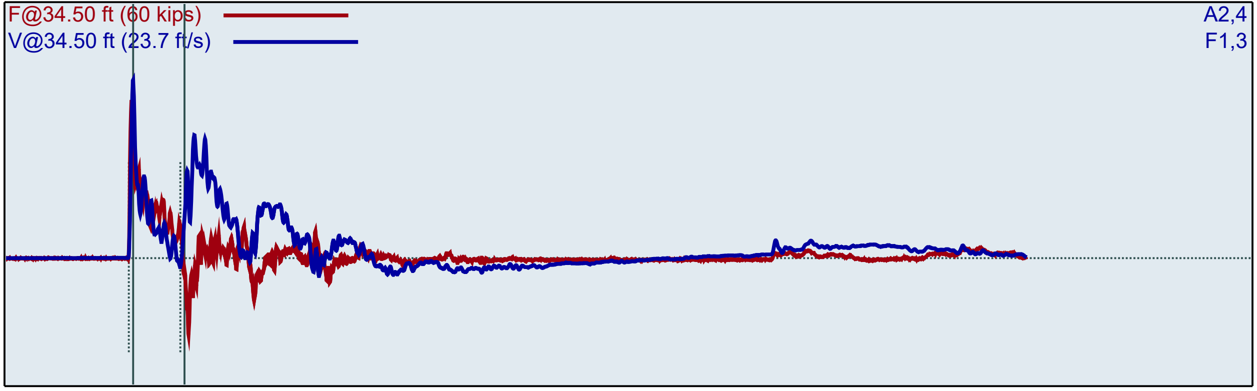
N-value: 9

Sample Interval Time: 16.32 seconds.

D-76 5
Wessam Zanaty Test date: 11/3/2020
2f-20-002

AR: 1.42 in^2 SP: 0.492 k/ft3
LE: 34.50 ft EM: 30000 ksi
WS: 16807.9 ft/s

Depth: (30.00 - 31.50 ft], displaying BN: 151



F1 : [150NWJ1] 210.83 PDICAL (1) FF1
F3 : [150NWJ2] 212.78 PDICAL (1) FF1

A2 (PR): [K3719] 368 mv/6.4v/5000g (1) VF1
A4 (PR): [K5674] 345 mv/6.4v/5000g (1) VF1

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
138	3	37	15.7	1.9	302	86.4
139	3	36	15.7	21.2	301	86.0
140	3	38	15.9	35.5	300	85.7
141	5	38	16.6	35.5	303	86.7
142	5	37	16.4	35.5	300	85.7
143	5	38	16.6	35.7	310	88.5
144	5	38	16.5	35.8	303	86.7
145	5	38	16.5	35.8	306	87.3
146	8	37	16.3	35.9	300	85.8
147	8	38	16.6	35.9	306	87.3
148	8	38	16.6	36.0	303	86.7
149	8	38	16.6	36.0	304	86.9
150	8	39	16.4	36.4	307	87.6
151	8	37	16.5	38.1	308	87.9
152	8	38	16.5	37.6	304	86.9
153	8	37	16.3	36.2	307	87.7
	Average	38	16.5	36.2	305	87.1
	Std Dev	1	0.1	0.7	3	0.8
	Maximum	39	16.6	38.1	310	88.5
	Minimum	37	16.3	35.5	300	85.7

N-value: 13

Sample Interval Time: 26.08 seconds.

Summary of SPT Test Results

Project: D-76, Test Date: 11/3/2020

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

Instr. Length ft	Blows Applied /6"	**N Value**	**N60 Value**	Average FMX kips	Average VMX ft/s	Average BPM bpm	Average EFV ft-lb	Average ETR %
10.08	**2-3-3**	**6**	**9**	41	17.5	51.5	276	78.8
14.50	**3-4-6**	**10**	**15**	43	16.3	58.1	321	91.6
15.08	**3-8-11**	**19**	**28**	42	16.2	56.7	317	90.6
19.50	**15-16-9**	**25**	**37**	39	16.0	59.0	329	94.0
20.08	**3-4-4**	**8**	**12**	39	17.9	51.3	328	93.7
24.50	**2-3-3**	**6**	**9**	39	17.2	49.8	325	92.7
25.08	**2-2-3**	**5**	**7**	35	16.1	36.0	307	87.7
29.50	**5-5-6**	**11**	**16**	38	16.0	41.0	311	89.0
35.08	**2-4-5**	**9**	**13**	38	16.5	39.7	307	87.8
34.50	**3-5-8**	**13**	**19**	38	16.5	36.2	305	87.1
			Overall Average Values:	39	16.4	50.1	316	90.3
			Standard Deviation:	3	0.8	9.7	14	4.0
			Overall Maximum Value:	46	18.6	59.2	342	97.6
			Overall Minimum Value:	34	14.9	27.5	240	68.6

APPENDIX C

Exploratory Boring Logs

KEY SHEET - CLASSIFICATIONS AND SYMBOLS

GS FORM:
KEY/SYMBOLS 01/04

EMPIRICAL CORRELATIONS WITH STANDARD PENETRATION RESISTANCE N60 VALUES *

	N60 VALUE * (BLOWS/FT)	CONSISTENCY	UNCONFINED COMPRESSIVE STRENGTH (TONS/SQ FT)		N60 VALUE * (BLOWS/FT)	RELATIVE DENSITY
FINE GRAINED SOILS	0 - 2	VERY SOFT	<0.25	COARSE GRAINED SOILS	0 - 4	VERY LOOSE
	3 - 4	SOFT	0.25 - 0.50		5 - 10	LOOSE
	5 - 8	FIRM	0.50 - 1.00		11 - 30	MEDIUM DENSE
	9 - 15	STIFF	1.00 - 2.00		31 - 50	DENSE
	16 - 30	VERY STIFF	2.00 - 4.00		>50	VERY DENSE
	31 - 50	HARD	>4.00			
	>50	VERY HARD				

* ASTM D 1586; NUMBER OF BLOWS OF 140 POUND HAMMER FALLING 30 INCHES TO DRIVE A 2 IN. O.D., 1.4 IN. I.D. SAMPLER ONE FOOT, CORRECTED FOR HAMMER EFFICIENCY.

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

MAJOR DIVISIONS			SYMBOLS	DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL COARSER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO.4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES APPRECIABLE AMOUNT OF FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL -SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO.4 SIEVE	CLEAN SANDS LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES APPRECIABLE AMOUNT OF FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL FINER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

NOTE: DUAL SYMBOLS USED FOR BORDERLINE CLASSIFICATIONS

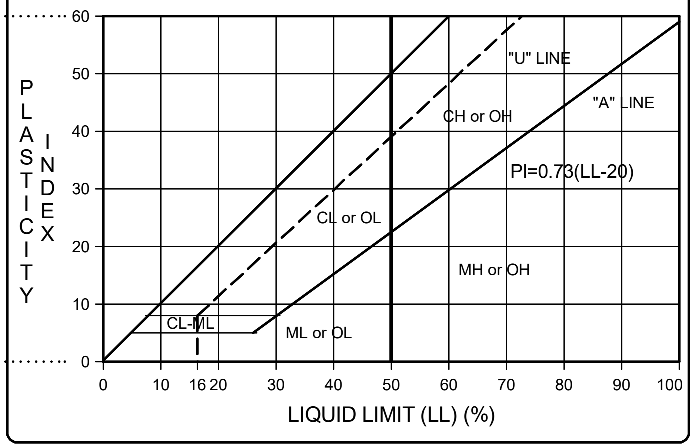
PARTICLE SIZE IDENTIFICATION

USCS (SOILS ONLY) *		SEDIMENTARY (ROCK ONLY)	
BOULDER	>300 mm	BOULDER	>256 mm
COBBLE	75 - 300 mm	COBBLE	64 - 256 mm
GRAVEL: COARSE	20 - 75 mm	PEBBLE	4 - 64 mm
GRAVEL: FINE	4.75 - 20 mm	GRANULE	2 - 4 mm
		SAND: V. COARSE	1 - 2 mm
SAND: COARSE	2 - 4.75 mm	SAND: COARSE	0.5 - 1 mm
SAND: MEDIUM	0.42 - 2 mm	SAND: MEDIUM	0.25 - 0.5 mm
SAND: FINE	0.074 - 0.42 mm	SAND: FINE	0.125 - 0.25 mm
		SAND: V. FINE	0.063 - 0.125 mm
SILT/CLAY	<0.074 mm	SILT	0.004 - 0.063 mm
		CLAY	<0.004 mm

* WELL GRADED - HAVING WIDE RANGE OF GRAIN SIZES AND APPRECIABLE AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES
* POORLY GRADED - PREDOMINANTLY ONE GRAIN SIZE, OR HAVING A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING

PERCENTAGE OF PARTICLE TYPE IN DECREASING ORDER OF PARTICLE SIZE (GRAVEL,SAND,FINES), BASED ON VISUAL OBSERVATION

PLASTICITY CHART



OTHER MATERIAL SYMBOLS

Conglomerate
Sandstone
Silty Sandstone
Clayey Sandstone
Sandy Siltstone
Siltstone
Claystone
Clayey Siltstone/ Silty Claystone

Sandy Claystone
Granitic/Intrusive
Volcanic/Extrusive
Metamorphic
Limestone
Dolomite
Glacial Till
Landslide Debris

Marker Bed
Artificial Fill
Refuse
Concrete/Asphalt

WELL SYMBOLS

CONCRETE
GROUT
BENTONITE SEAL
TRANSITION SAND
SAND PACK
GRAVEL PACK
NATIVE/SLUFF
CENTRALIZER

SAMPLE TYPE AND OTHER SYMBOLS

BULK SAMPLE
STANDARD PENETRATION TEST
MODIFIED CALIFORNIA SAMPLE
CORE SAMPLE
SHELBY TUBE
DRIVE SAMPLE

▽ Water Level at Time Drilling, or as Shown
▼ Static Water Level
Pump Inlet
◀ Loss of Drilling Fluid
MSL: Mean Sea Level
AGS: Above Ground Surface
BGS: Below Ground Surface
BTOC: Below Top of Casing
HSA: Hollow Stem Auger

WEATHERING

FRESH (W1): Body of rock is not oxidized or discolored; fracture surfaces are not oxidized or discolored*; no separation of grain boundaries; no change of texture and no solutioning. Hammer rings when crystalline rocks are struck.

SLIGHTLY WEATHERED TO FRESH (W2):**

SLIGHTLY WEATHERED (W3): Discoloration or oxidation is limited to surface of, or short distance from fractures; some feldspar crystals are dull; fracture surfaces have minor to complete discoloration or oxidation; no visible separation of grain boundaries; texture preserved and minor leaching of soluble minerals may be present. Hammer rings when crystalline rocks are struck, body of rock is not weakened by weathering.

MODERATELY TO SLIGHTLY WEATHERED (W4):**

MODERATELY WEATHERED (W5): Discoloration or oxidation extends from fractures, usually throughout body of rock; ferromagnesian minerals are "rusty," feldspar crystals are "cloudy;" all fracture surfaces are discolored or oxidized; partial opening of grain boundaries visible; texture generally preserved but soluble minerals may be mostly leached. Hammer does not ring when rock is struck, body of rock is slightly weakened.

INTENSLEY TO MODERATELY WEATHERED (W6):**

INTENSELY WEATHERED (W7): Body of rock is discolored or oxidized throughout; all feldspars and ferromagnesian minerals are altered to clay to some extent. All fracture surfaces are discolored or oxidized, surfaces friable; partial separation of grain boundaries, rock is friable; in situ disaggregation of granitics common in semi-arid regions; texture altered and leaching of soluble minerals may be complete. Rock has dull sound when struck with hammer; rock is weakened, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness.

VERY INTENSELY WEATHERED (W8):**

DECOMPOSED (W9): Body of rock is discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and ferromagnesian minerals are completely altered to clay; complete separation of grain boundaries (disaggregated), partial or complete remnant rock structure may be preserved, but resembles a soil.

NOTE: Weathering categories are established primarily for crystalline rocks and those with ferromagnesian minerals, weathering in various sedimentary rocks will not always fit the categories established - weathering categories may be modified for particular site conditions or alteration such as hydrothermal alteration. Where modified criteria are established, they are identified and described.

* Characteristics of fracture surfaces do not include directional weathering along shears or faults and their associated fracture zones; for example a shear that carries weathering to great depths in a fresh rock mass would not require the whole rock mass to be classified as weathered.

** Combination descriptors are used where equal distribution of both weathering characteristics are present over significant intervals or where characteristics noted are "in between" the diagnostic characteristics.

DURABILITY INDEX

DURABILITY DESCRIPTOR	DESCRIPTIVE CRITERIA
DI0	Rock specimen or exposure remains intact with no deleterious cracking after exposure longer than 1 year.
DI1	Rock specimen or exposure develops hairline cracking on surfaces within 1 month, but no disaggregation within 1 year of exposure.
DI2	Rock specimen or exposure develops hairline cracking on surfaces within 1 week, and/or disaggregation within 1 month of exposure.
DI3	Specimen or exposure may develop hairline cracks in 1 day and displays pronounced separation of bedding and/or disaggregation within 1 week of exposure.
DI4	Specimen or exposure displays pronounced cracking and disaggregation within 1 day (24 hours) of exposure. Generally ravels and degrades to small fragments.

COLOR

The Munsell color system (Geologic Society of America Rock Color Chart) was used. This system defines wet color by its hue, value, and chroma. Color symbols (i.e., 5 YR 5/6 may be included).

SEDIMENTARY AND PYROCLASTIC ROCK PARTICLE SIZES

Size in mm	Sedimentary Rounded, subrounded, subangular		Pyroclastic	
	Particle or fragment	Lithified product	Fragment	Lithified product
256	Boulder	Boulder conglomerate	Block* or Bomb**	Volcanic breccia* or Volcanic agglomerate**
64	Cobble	Cobble conglomerate		
4	Pebble	Pebble conglomerate	Lapilli	Lapillistone and Lapilli tuff
2	Granule	Granule conglomerate		
1	Very coarse sand	Sandstone	Coarse ash	Coarse tuff
0.5	Coarse sand			
0.25	Medium sand	(Very coarse, coarse, medium, fine, or very fine)		
0.125	Fine sand			
0.0625	Very fine sand			
0.00391	Silt	Siltstone/ Shale	Fine ash	Fine tuff
	Clay	Claystone/ Shale		

* Broken from previous igneous rock, block shaped (angular to subangular).
** Solidified from plastic material while in flight, rounded clasts.

IGNEOUS AND METAMORPHIC ROCK TEXTURE

TEXTURE DESCRIPTOR	AVERAGE GRAIN DIAMETER
VERY COARSE GRAINED OR PEGMATITIC	>10 mm [>3/8 in]
COARSE GRAINED	5-10 mm [3/16 - 3/8 in]
MEDIUM GRAINED	1-5 mm [1/32 - 3/16 in]
FINE GRAINED	0.1-1 mm [0.004 - 1/32 in]
APHANITIC (Cannot be seen with the unaided eye)	<0.1 mm [<0.004 in]

ADDITIONAL TEXTURAL ADJECTIVES

PIT (pitted) - Pinhole to 0.03 ft [3/8 in] (<1 to 10 mm) openings.

VUG (vuggy) - Small openings (usually lined with crystals) ranging in diameter from 0.03 ft [3/8 in] to 0.33 ft [4 in] (10 to 100 mm).

CAVITY - An opening larger than 0.33 ft [4 in] (100 mm), size descriptions are required, and adjectives such as small, large, etc., may be used.

HONEYCOMBED - If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form.

VESICLE (vesicular) - Small openings in volcanic rocks of variable shape and size formed by entrapped gas bubbles during solidification.

BEDDING FOLIATION OR FLOW TEXTURE

DESCRIPTORS	THICKNESS/SPACING
MASSIVE	Greater than 10 ft (>3 m)
VERY THICKLY (bedded, foliated, or banded)	3 to 10 ft (1 to 3 m)
THICKLY	1 to 3 ft (300 mm to 1 m)
MODERATELY	0.3 to 1 ft (100 to 300 mm)
THINLY	0.1 to 0.3 ft (30 to 100 mm)
VERY THINLY	0.03 [3/8 in] to 0.1 ft (10 to 30 mm)
LAMINATED (Intensely foliated or banded)	Less than 0.03 ft [3/8 in] (<10 mm)

BEDROCK HARDNESS / STRENGTH

EXTREMELY HARD (H1): Core, fragment or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.

VERY HARD (H2): Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.

HARD (H3): Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.

MODERATELY HARD (H4): Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow.

MODERATELY SOFT (H5): Can be grooved 1/16 inch (2 mm) deep by knife or sharp pick with (moderate or heavy) pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.

SOFT (H6): Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.

VERY SOFT (H7): Can be readily indented, groved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

Note: Bedrock units softer than H7, Very Soft, are described using USCS (soils) consistency descriptors.

Source: U.S. Department of the Interior Bureau of Reclamation, Engineering Geology Field Manual, 2nd Edition, 1988

Geosyntec consultants

Standard Descriptors and Descriptive Criteria for Rock

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consultants

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PROJECT: HRCM
PROJECT LOCATION: Santa Clarita, CA
PROJECT NUMBER: SC0766U

KEY TO ROCK DESCRIPTIVE TERMS USED ON CORE LOGS

DISCONTINUITY DESCRIPTORS

a

TYPE:
F – Fault
JT – Joint
Sh – Shear
Fo – Foliation
V – Vein
Bd – Bedding

b

FRACTURE DENSITY (feet):
EW – Extremely Wide (>6)
W – Wide (2-6)
M – Moderate (0.7-2)
C – Close (0.2-0.7)
VC – Very Close (<0.2)

c

APERTURE (inches):
W – Wide (0.5-2.0)
MW – Moderately Wide (0.1-0.5)
N – Narrow (0.05-0.1)
VN – Very Narrow (<0.05)
T – Tight (0)

d

FRACTURE INFILLING:
Su – Surface Stain
Sp – Spotty
Pa – Partially Filled
Fi – Filled
No – None

e

MINERAL TYPE:
Cl – Clay
Ca – Calcite
Ch – Chlorite
Fe – Iron Oxide
Gy – Gypsum/Talc
H – Healed
No – None
Py – Pyrite
Qz – Quartz
Sd – Sand

f

PLANARITY:
Wa – Wavy
Pl – Planar
St – Stepped
Ir – Irregular

g

DIP: – Dip of planar feature measured relative to horizontal

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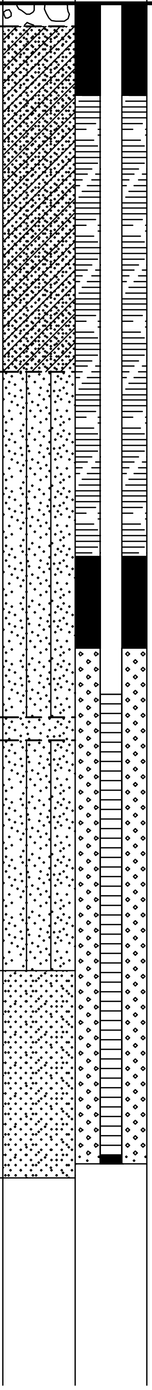
GS FORM:
WELL BORE 01/04

BOREHOLE LOG

BORING HSA-1
SHEET 1 **OF** 1
START DRILL DATE Jan 4, 21
FINISH DRILL DATE Jan 4, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1152
TOP OF CASING
DATUM ft +MSL



DEPTH (ft-bgs)	DESCRIPTION 1) Unit/Formation, Mem. 2) USCS Name 3) Color 4) Moisture 5) Percent Grain Size 6) Plasticity 7) Density/Consistency 8) Structure 9) Other (Mineralization, Discoloration, Odor, etc.)	GROUNDWATER OR STRUCTURE	ELEVATION (ft)	SAMPLE SAMPLE NO.	TYPE	BLOWS PER 6"	RECOVERY (%)	PID READING (ppm)	TIME (00:00)	COMMENTS 1) Rig Behavior 2) Air Monitoring
	GRAVEL/SUB-BASE	Bentonite Plug (0'-2')							08:30	
	FILL: Clayey SAND (SC): brown; slightly moist; fine sand with clay; medium dense; trace gravels and mica.		1151	HSA-1 @1-5						Hand-augered to 5-ft. bgs.
		Native Backfill (2'-12')	1150							
			1149							
			1148							
5			1147	HSA-1 @5		4 6 8	100		08:39	
			1146							
			1145							
	Quaternary Young Alluvium (Qya): Silty SAND (SM): brown to reddish brown; slightly moist; predominantly fine-grained with trace medium to coarse sand; medium dense.		1144							
			1143							
10			1142	HSA-1 @10		4 7 5	100			
			1141							
		Bentonite Plug (12'14')	1140							
			1139							
		Sand Pack (14'-25')	1138							
15			1137	HSA-1 @15		4 5 5	100			
	Interbedded Poorly-graded SAND (SP). Silty SAND (SM): brown to reddish brown; slightly moist; predominantly fine-grained with trace medium to coarse sand.		1136							
			1135							
			1134							
			1133							
20			1132	HSA-1 @20		2 11 38	100			
	Saugus Formation (Qss): SANDSTONE (SM): light brown; slightly moist; silty fine sand; very dense; trace clay.		1131							Saugus Formation observed: appeares relatively impermeable due to cementation and fines content.
			1130							
			1129							
			1128							
25			1127	HSA-1 @25		50	100			
	Terminated Boring at 25.5 ft. below ground surface. After completion of drilling, borehole was converted to infiltration test well.		1126							
			1125							
			1124							
			1123							
30			1122							

CONTRACTOR Martini Drilling Corp
EQUIPMENT CME-75
DRILL MTHD Hollow Stem Auger
DIAMETER 8-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE

NORTHING 34.446158
EASTING -118.585700
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Hammer energy transfer ratio was 78.7%. Logging of soils completed in general accordance with ASTM D2488 and ASTM D1586. Location is approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM:
WELL BORE 01/04

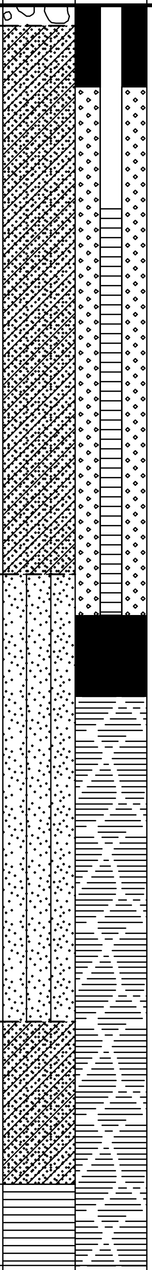
BOREHOLE LOG

BORING	**HSA-2**	**SHEET**	**1 OF 1**
START DRILL DATE	Jan 4, 21	**ELEVATION DATA:**	
FINISH DRILL DATE	Jan 4, 21	**GROUND SURF.**	1146
LOCATION	Santa Clarita, CA	**TOP OF CASING**	
PROJECT	HRCM	**DATUM**	ft +MSL
NUMBER	SC0766U		

DESCRIPTION: 1) Unit/Formation, Mem. 2) USCS Name 3) Color 4) Moisture 5) Percent Grain Size 6) Plasticity 7) Density/Consistency 8) Structure 9) Other (Mineralization, Discoloration, Odor, etc.)

COMMENTS: 1) Rig Behavior 2) Air Monitoring

DEPTH (ft-bgs)	DESCRIPTION
0	GRAVEL/SUB-BASE
	FILL: Clayey SAND (SC): brown to reddish brown; slightly moist; predominantly fine-grained with medium to coarse sand; medium dense; trace silt and gravels.
14	**Quaternary Young Alluvium (Qya):** Silty SAND (SM): light brown to brown; slightly moist; predominantly fine-grained with trace medium to coarse sand; medium dense; trace gravel.
20	becomes loose to medium desne.
25	Clayey SAND (SC): mottled brown, reddish brown and grayish brown; slightly moist; predominantly fine-grained with medium to coarse sand; medium dense.
29	**Saugus Formation (Qss):** CLAYSTONE (CL): reddish brown; slightly moist; hard; trace sand.
31	Terminated Boring at 31 ft. below ground surface. After completion of drilling, borehole was converted to infiltration test well.



GROUNDWATER OR STRUCTURE
Bentonite Plug (0'-2')
Sand Pack (2'-15')
Bentonite Plug (15'-17')
Native Backfill (17'-31')

ELEVATION (ft): 1145, 1144, 1143, 1142, 1141, 1140, 1139, 1138, 1137, 1136, 1135, 1134, 1133, 1132, 1131, 1130, 1129, 1128, 1127, 1126, 1125, 1124, 1123, 1122, 1121, 1120, 1119, 1118, 1117, 1116, 1115, 1114, 1113, 1112

SAMPLE NO.	TYPE	BLOWS PER 6"	RECOVERY (%)	PID READING (ppm)	TIME (00:00)
HSA-2 @0-5	▨				
HSA-2 @3	▨	4 12 14	100		10:00
HSA-2 @5	◺	11 9 4	100		
HSA-2 @10	▯	11 13 12	100		
HSA-2 @15	◺	7 10 8	100		
HSA-2 @20	◺	4 6 6	100		
HSA-2 @25	◺	9 7 7	100		10:25
HSA-2 @	◺	19 50	100		

DEPTH (ft-bgs)	COMMENTS
0-1	Hand-augered to 5-ft. bgs.
14	Driller indicated tighter drilling.
23-24	Driller indicated harder drilling.

CONTRACTOR	Martini Drilling Corp	**NORTHING**	34.445317
EQUIPMENT	CME-75	**EASTING**	-118.586380
DRILL MTHD	Hollow Stem Auger	**COORDINATE SYSTEM:**	
DIAMETER	8-inch		
LOGGER	D. Kilian, PG, CEG	**REVIEWER**	C. Conkle, PE, GE

NOTES: No groundwater encountered. Hammer energy transfer ratio was 78.7%. Logging of soils completed in general accordance with ASTM D2488 and ASTM D1586. Location is approximate and obtained from Google Earth.

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GS FORM:
GEOTECH2 01/04

BOREHOLE LOG

BORING TPB-1
SHEET 1 **OF** 1
START DRILL DATE Jan 4, 21
FINISH DRILL DATE Jan 4, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1172
TOP OF CASING
DATUM ft +MSL

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

COMMENTS: 1) Rig Behavior 2) Air Monitoring 3) Pocket Pen 4) Tor Vane

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	SAMPLE NO.	TYPE	BLOWS PER 6"	N VALUE	RECOVERY (%)	PID READING (ppm)	TIME (00:00)	COMMENTS	DRY DENSITY (pcf)	MAX. DRY DENSITY (pcf)	PERCENT FINES (%)	PERCENT GRAVEL (%)	MOIST. CONTENT (%)	OPT. MOIST. CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
		ASPHALT							12:00										
	1171	AGGREGATE BASE																	
	1170	**FILL:** Clayey SAND (SC): mottled brown and reddish brown; moist; fine sand; medium dense; trace gravels and cobbles.								Hand-augered to 5-ft. bgs.									
	1169																		
	1168	**Saugus Formation (Qss):** Sandy CLAYSTONE (CL): reddish brown with gray mottling; slightly moist; clayey fine sand to hard sandy claystone; dense to very dense.																	
5	1167		TPB-1 @5		10 20 30	50	100						72				39	15	24
	1166																		
	1165																		
	1164																		
	1163																		
10	1162	Silty SANDSTONE (SM): pale brown; slightly moist; predominantly fine-grained with trace medium to coarse sand; very dense.	TPB-1 @10		17 50/3		100				112.8		42		7.5				
	1161																		
	1160																		
	1159																		
	1158																		
15	1157		TBP-1 @15		26 50/5	50/5	100												
	1156	Terminated Boring at 15.9 ft. below ground surface. After completion of drilling, borehole was backfilled with high-solids cement-bentonite grout.							13:00										
	1155																		
	1154																		
	1153																		
20	1152																		
	1151																		
	1150																		
	1149																		
	1148																		
25	1147																		
	1146																		
	1145																		
	1144																		
	1143																		
30	1142																		

CONTRACTOR Martini Drilling Corp
EQUIPMENT CME-75
DRILL MTHD Hollow Stem Auger
DIAMETER 8-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE
NORTHING 34.446133
EASTING -118.588290
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Hammer energy transfer ratio was 78.7%. Logging of soils completed in general accordance with ASTM D2488 and ASTM D1586. Location is approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM:
GEOTECH2 01/04

BOREHOLE LOG

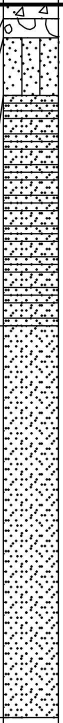
BORING TPB-2
SHEET 1 **OF** 1
START DRILL DATE Jan 4, 21
FINISH DRILL DATE Jan 4, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1171
TOP OF CASING
DATUM ft +MSL

DESCRIPTION
1) Soil Name (USCS)
2) Color
3) Moisture
4) Grain Size
5) Percentage
6) Plasticity
7) Density/Consistency
8) Other (Mineral Content, Discoloration, Odor, etc.)

COMMENTS
1) Rig Behavior
2) Air Monitoring
3) Pocket Pen
4) Tor Vane

GRAPHIC LOG



			SAMPLE								LABORATORY RESULTS						ATTERBERG LIMITS		
DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	SAMPLE NO.	TYPE	BLOWS PER 6"	N VALUE	RECOVERY (%)	PID READING (ppm)	TIME (00:00)	COMMENTS	DRY DENSITY (pcf)	MAX. DRY DENSITY (pcf)	PERCENT FINES (%)	PERCENT GRAVEL (%)	MOIST. CONTENT (%)	OPT. MOIST. CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
		ASPHALT							13:00										
	1170	AGGREGATE BASE	TPB-2 @0-5							Hand-augered to 5-ft. bgs.		130.8				8.8			
	1169	**FILL:** Silty to Clayey SAND (SM/SC): reddish brown; slightly moist; fine sand; medium dense.																	
	1168	**Saugus Formation (Qss):** Sandy CLAYSTONE (CL): reddish brown; slightly moist; fine sandy clay to dense clayey sand with trace coarse sand; hard.																	
	1167																		
5	1166		TPB-2 @5		12 14 20	34	100						67				36	12	24
	1165																		
	1164	SANDSTONE (SM): pale to olive brown; slightly moist; fine sand; very dense.																	
	1163																		
	1162																		
10	1161		TPB-2 @10		40 50/2	50/2	100						28	0	5.1				
	1160																		
	1159																		
	1158																		
	1157																		
15	1156		TBP-2 @15		50/5	REF	100												
	1155	Terminated Boring at 15.5 ft. below ground surface. After completion of drilling, borehole was backfilled with high-solids cement-bentonite grout.							14:00										
	1154																		
	1153																		
	1152																		
20	1151																		
	1150																		
	1149																		
	1148																		
	1147																		
25	1146																		
	1145																		
	1144																		
	1143																		
	1142																		
30	1141																		

CONTRACTOR Martini Drilling Corp
EQUIPMENT CME-75
DRILL MTHD Hollow Stem Auger
DIAMETER 8-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE
NORTHING 34.446281
EASTING -118.588460
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Hammer energy transfer ratio was 78.7%. Logging of soils completed in general accordance with ASTM D2488 and ASTM D1586. Location is approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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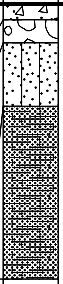
GS FORM:
GEOTECH2 01/04

BOREHOLE LOG

BORING	TPB-3	**SHEET**	1 **OF** 1
START DRILL DATE	Jan 4, 21	**ELEVATION DATA:**	
FINISH DRILL DATE	Jan 4, 21	**GROUND SURF.**	1172
LOCATION	Santa Clarita, CA	**TOP OF CASING**	
PROJECT	HRCM	**DATUM**	ft +MSL
NUMBER	SC0766U		



DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	SAMPLE: SAMPLE NO.	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: N VALUE	SAMPLE: RECOVERY (%)	SAMPLE: PID READING (ppm)	SAMPLE: TIME (00:00)	COMMENTS 1) Rig Behavior 2) Air Monitoring 3) Pocket Pen 4) Tor Vane	DRY DENSITY (pcf)	MAX. DRY DENSITY (pcf)	PERCENT FINES (%)	PERCENT GRAVEL (%)	MOIST. CONTENT (%)	OPT. MOIST. CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX
		ASPHALT							14:00										
	1171	AGGREGATE BASE								Hand-augered to 5-ft. bgs.									
	1170	**FILL:** Silty to Clayey SAND (SM/SC): mottled brown and reddish brown; slightly moist; fine sand; medium dense.																	
	1169																		
	1168	**Saugus Formation (Residual) (Qss):** Silty SANDSTONE (SM): light brown; slightly moist; predominantly fine-grained with trace medium to coarse sand; very dense.																	
5	1167		TPB-3 @5	⧄	19 50/6	50/6	100												
	1166	Terminated Boring at 6.0 ft. below ground surface. After completion of drilling, borehole was backfilled with high-solids cement-bentonite grout.							14:45										
	1165																		
	1164																		
	1163																		
10	1162																		
	1161																		
	1160																		
	1159																		
	1158																		
15	1157																		
	1156																		
	1155																		
	1154																		
	1153																		
20	1152																		
	1151																		
	1150																		
	1149																		
	1148																		
25	1147																		
	1146																		
	1145																		
	1144																		
	1143																		
30	1142																		

CONTRACTOR	Martini Drilling Corp	**NORTHING**	34.446300
EQUIPMENT	CME-75	**EASTING**	-118.588300
DRILL MTHD	Hollow Stem Auger	**COORDINATE SYSTEM:**	
DIAMETER	8-inch		
LOGGER	D. Kilian, PG, CEG	**REVIEWER**	C. Conkle, PE, GE

NOTES: No groundwater encountered. Hammer energy transfer ratio was 78.7%. Logging of soils completed in general accordance with ASTM D2488 and ASTM D1586. Location is approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants
2100 Main St
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GS FORM:
GEOTECH2 01/04

BOREHOLE LOG

BORING B-1
SHEET 1 **OF** 3
START DRILL DATE Jan 15, 21
FINISH DRILL DATE Jan 15, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U
ELEVATION DATA:
GROUND SURF. 1150
TOP OF CASING
DATUM ft +MSL

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)	SAMPLE: SAMPLE NO.	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"	SAMPLE: N VALUE	SAMPLE: RECOVERY (%)	SAMPLE: PID READING (ppm)	SAMPLE: TIME (00:00)	COMMENTS 1) Rig Behavior 2) Air Monitoring 3) Pocket Pen 4) Tor Vane	LABORATORY RESULTS: DRY DENSITY (pcf)	MAX. DRY DENSITY (pcf)	PERCENT FINES (%)	PERCENT GRAVEL (%)	MOIST. CONTENT (%)	OPT. MOIST. CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
		GRAVEL/SUB-BASE																	
	1149		B-1 @1-5							Hand-augered to 5-ft. bgs.			35	1			26	18	8
	1148	**FILL:** Clayey SAND (SC): brown; slightly moist; fine sand; medium dense; trace gravels.																	
	1147																		
	1146	becomes Silty SAND (SM): light brown; slightly moist; fine sand; medium dense; trace gravels.																	
5	1145				7 10		100		07:27										
	1144	**Quaternary Young Alluvium (Qya):** Clayey SAND (SC): brown; slightly moist; fine sand; loose; trace silt and gravels.	B-1 @6-6.5		6 7						110.2		41		7.9				
	1143		B-1 @6.5-7										41						
	1142																		
	1141																		
10	1140	increase in gravel content.			5		100												
	1139		B-1 @10.5-11		7 6						120.6		29		13.0		28	13	15
	1138		B-1 @11-11.5								118.2		29		10.9		28	13	15
	1137																		
	1136																		
15	1135																		
	1134																		
	1133																		
	1132																		
	1131																		
20	1130	becomes medium dense; trace medium and coarse sand.	B-1 @20		6 10 10	20	100						20		10.0				
	1129																		
	1128																		
	1127																		
	1126																		
25	1125	becomes loose.	B-1 @25		5 5 5	10	100												
	1124																		
	1123																		
	1122																		
	1121																		
30	1120																		

CONTRACTOR Gregg Drilling, LLC
EQUIPMENT Fraste XL 140T
DRILL MTHD Mud Rotary
DIAMETER 8-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE
NORTHING 34.446186
EASTING -118.586070
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Hammer energy transfer ratio was 90.3%. Logging of soils completed in general accordance with ASTM D2488 and ASTM D1586. Location is approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

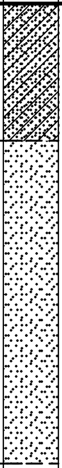
BOREHOLE LOG

BORING B-1 **SHEET** 2 **OF** 3
START DRILL DATE Jan 15, 21
FINISH DRILL DATE Jan 15, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1150
TOP OF CASING
DATUM ft +MSL

DESCRIPTION: 1) Soil Name (USCS) 2) Color 3) Moisture 4) Grain Size 5) Percentage 6) Plasticity 7) Density/Consistency 8) Other (Mineral Content, Discoloration, Odor, etc.)

COMMENTS: 1) Rig Behavior 2) Air Monitoring 3) Pocket Pen 4) Tor Vane



DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	SAMPLE NO.	TYPE	BLOWS PER 6"	N VALUE	RECOVERY (%)	PID READING (ppm)	TIME (00:00)	COMMENTS	DRY DENSITY (pcf)	MAX. DRY DENSITY (pcf)	PERCENT FINES (%)	PERCENT GRAVEL (%)	MOIST. CONTENT (%)	OPT. MOIST. CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
		trace carbonates and oxidized reddish brown mottling.	B-1 @30		4 7 7	14	100		10:25				30		9.8				
	1119	Terminated Boring at 31 ft. below ground surface. After completion of drilling, borehole was converted to infiltration test well.																	
	1118																		
	1117																		
	1116	**Saugus Formation (Qss):** SANDSTONE (SM): mottled brown, reddish brown and grayish brown; dry to slightly moist; fine to coarse sand; very dense; locally cemented; trace gravels.																	
35	1115		B-1 @35		19 50 50/3	100/9	100												
	1114																		
	1113																		
	1112																		
	1111																		
40	1110																		
	1109																		
	1108																		
	1107	Refer to B-1 Page 3																	
	1106																		
45	1105																		
	1104																		
	1103																		
	1102																		
	1101																		
50	1100																		
	1099																		
	1098																		
	1097																		
	1096																		
55	1095																		
	1094																		
	1093																		
	1092																		
	1091																		
60	1090																		

CONTRACTOR Gregg Drilling, LLC
EQUIPMENT Fraste XL 140T
DRILL MTHD Mud Rotary
DIAMETER 8-inch
LOGGER D. Kilian, PG, CEG **REVIEWER** C. Conkle, PE, GE

NORTHING 34.446186
EASTING -118.586070
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Hammer energy transfer ratio was 90.3%. Logging of soils completed in general accordance with ASTM D2488 and ASTM D1586. Location is approximate and obtained from Google Earth.

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GS FORM:
CONT. CORE 01/04

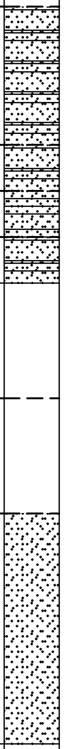
COREHOLE LOG

BORING B-1
SHEET 3 **OF** 3
START DRILL DATE Jan 15, 21
FINISH DRILL DATE Jan 15, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1150
TOP OF CASING
DATUM ft +MSL

DESCRIPTION: 1) Formation, Member 2) Rock Name 3) Color 4) Grain Size/Percentage 5) Bedding 6) Weathering 7) Hardness 8) Cementation 9) Moisture 10) Other (Mineralization, Discoloration, Odor, etc.)

COMMENTS: 1) Rig Behavior 2) Air Monitoring



DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	RUN NUMBER	LENGTH (ft)	RECOVERY (ft)	RECOVERY (%)	RQD	RUN TIME (min.)	COMMENTS	TYPE	FRACTURE DENSITY	APERTURE	FRACTURE FILLING	MINERAL TYPE	PLANARITY	DIP (degrees)
	1119	Refer to B-1 Page 2.														
	1118															
	1117															
	1116															
35	1115															
	1114															
	1113															
	1112															
	1111															
40	1110	**Saugus Formation (Qss):** Clayey SANDSTONE (SC): light brown; slightly moist; clayey fine sand with silt; moderately to highly weathered; moderately hard; some reddish brown clayey sand, thin to medium bedding @ 40' to 41'.	1	3	2.75	92	92	09:36								
	1109															
	1108															
	1107	becomes moderately weathered; hard; cemented @ 43'-44'.	2	3	3	100	100	09:59 10:15								
	1106	becomes moderately to highly weathered; moderately hard. becomes clayey @44.45'.								J		MW	Fi	CL	PL	60
45	1105	becomes sandy; soft. fine to coarse gravel @45.45'.														
	1104	No Recovery - Friable Sands.	3	2.5	0	0	0	10:16 10:20	Friable - Low Recovery Anticipated.							
	1103															
	1102															
	1101	No Recovery	4	2.5	0	0	0	10:32 10:36								
50	1100															
	1099	6" of Sandstone in core; fine to coarse sand; moderately to highly weathered; cemented.	5	5	0.5	10	10	10:44 10:50								
	1098															
	1097															
	1096															
55	1095															
	1094	Terminated Coring at 56.0 ft. below ground surface. After completion of coring and suspension logging, corehole was backfilled with high-solids cement-bentonite grout.						11:01								
	1093															
	1092															
	1091															
60	1090															

CONTRACTOR Gregg Drilling, LLC
EQUIPMENT Fraste XL 140T
DRILL MTHD HQ3 Rock Coring
DIAMETER 4-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE
NORTHING 34.446186
EASTING -118.586070
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Corehole drilled using potable water and polymer for circulation. Location and elevation are approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM:
CONT. CORE 01/04

COREHOLE LOG

BORING B-2 **SHEET** 1 **OF** 2
START DRILL DATE Jan 13, 21
FINISH DRILL DATE Jan 14, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1177
TOP OF CASING
DATUM ft +MSL

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Formation, Member 2) Rock Name 3) Color 4) Grain Size/Percentage 5) Bedding 6) Weathering 7) Hardness 8) Cementation 9) Moisture 10) Other (Mineralization, Discoloration, Odor, etc.)	GRAPHIC LOG	WELL LOG	SAMPLE: RUN NUMBER	SAMPLE: LENGTH (ft)	SAMPLE: RECOVERY (ft)	SAMPLE: RECOVERY (%)	SAMPLE: RQD	SAMPLE: RUN TIME (min.)	COMMENTS 1) Rig Behavior 2) Air Monitoring	DISCONTINUITY DATA: TYPE	FRACTURE DENSITY	APERTURE	FRACTURE FILLING	MINERAL TYPE	PLANARITY	DIP (degrees)
		ASPHALT								09:10								
	1176	AGGREGATE BASE			B-2 @0.5-1													
	1175	**FILL:** Clayey SAND (SC): reddish brown; slightly moist; fine sand; medium dense.			B-2 @1						Hand-augered to 3-ft. bgs (refusal).							
	1174	**Saugus Formation (Qss):** Silty SAND (SM): light brown to brown; slightly moist; predominantly fine-grained with medium to coarse sand and gravel; moderately weathered; dense to very dense.			1	1	0.5	50	0	10:45	Switch to coring. Add casing - leak at edge of asphalt.		0					
	1173				2	1	0	0		10:48 11:28	Sand washed out.							
5	1172	CLAYSTONE (CL): moderately weathered with sand; soft. No recovery - some sand; fine to coarse gravel and cobbles in bit.			3	2.5	0	0		11:32 11:50								
	1171	No recovery.																
	1170																	
	1169	Silty SANDSTONE (SM): brown to olive and reddish brown; slightly moist; silty fine sand; mechanical fracturing, all segments 3"-3.5"; moderately to highly weathered.			4	2.5	1.6	64	0	11:57 12:58			1					
	1168																	
10	1167	Silty SANDSTONE (SM): grayish brown; silty fine sand; two 3" sections, moderately to highly weathered.			5	2.5	2.5	100	0	13:08 13:19			2					
	1166	Silty CLAYSTONE (CL): reddish brown; slightly moist; silty claystone with fine sand; moderately to highly weathered; soft to moderately hard; mechanical fracturing.							89				0					
	1165																	
	1164	moderately to highly weathered; moderately hard; mechanical fracturing.			6	2.5	2.25	90	5	13:27 13:53			1					
	1163	~1' recovered in run 7 - no fracturing.																
15	1162	moderately to highly weathered; soft to moderately hard; mechanical fractures.			7	2.5	3.5	140	94	14:00 14:14	Extra 1' stub in sample from Run 6.		1					
	1161																	
	1160	@16.5' - some gray mottling.																
	1159	CLAYSTONE (CL): reddish brown; slightly moist; fine sands; moderately to highly weathered; soft to moderately hard.			8	2.5	2.4	96	70	14:21 14:28	1' recovery. Stub remaining hole.		1.7					
	1158	slightly weathered; soft. cemented nodule in tip; moderately hard.																
20	1157	Upper 6" - reddish brown claystone.			9	2.5	2.5	100	90	14:35 15:55			0.8					
	1156	Silty SANDSTONE to Sandy SILTSTONE (SM/ML): grayish brown and orangish brown mottling; slightly moist;moderately to highly weathered; moderately hard.																
	1155																	
	1154	becomes gray silt; moist; highly weathered; soft. CLAYSTONE (CL): reddish brown; highly fractured from 23'-24'; non-filled; tight, mechanical?; moderately to highly weathered; moderately hard.			10	2.5	2.75	110	61	16:00 16:08	3" additional in sampler, stub from Run 9.		2.8					
	1153																	
25	1152	Mottled clay; moderately to highly weathered; moderately hard.			11	5	4.5	90	90	16:16 16:38			2					
	1151																	
	1150	Silty SANDSTONE (SM): olive brown; slightly moist; silty fine sand; moderately hard.																
	1149																	
	1148	becomes brown; moist; highly weathered; friable; soft.																
30	1147																	

CONTRACTOR Gregg Drilling, LLC
EQUIPMENT Fraste XL 140T
DRILL MTHD HQ3 Rock Coring
DIAMETER 4-inch
LOGGER D. Kilian, PG, CEG **REVIEWER** C. Conkle, PE, GE

NORTHING 34.445311
EASTING -118.585670
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Corehole drilled using potable water and polymer for circulation. Location and elevation are approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

Geosyntec consultants

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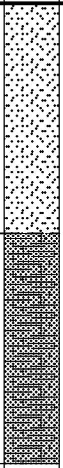
GS FORM:
CONT. CORE 01/04

COREHOLE LOG

BORING B-2 **SHEET** 2 **OF** 2
START DRILL DATE Jan 13, 21
FINISH DRILL DATE Jan 14, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1177
TOP OF CASING
DATUM ft +MSL

DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION 1) Formation, Member 2) Rock Name 3) Color 4) Grain Size/Percentage 5) Bedding 6) Weathering 7) Hardness 8) Cementation 9) Moisture 10) Other (Mineralization, Discoloration, Odor, etc.)	GRAPHIC LOG	WELL LOG	SAMPLE: RUN NUMBER	SAMPLE: LENGTH (ft)	SAMPLE: RECOVERY (ft)	SAMPLE: RECOVERY (%)	SAMPLE: RQD	SAMPLE: RUN TIME (min.)	COMMENTS 1) Rig Behavior 2) Air Monitoring	DISCONTINUITY DATA: TYPE	FRACTURE DENSITY	APERTURE	FRACTURE FILLING	MINERAL TYPE	PLANARITY	DIP (degrees)
		SANDSTONE (SM): mottled reddish and grayish brown; slightly moist; moderately to highly weathered; soft to moderately hard.			12	5	2.66	53	81	16:48 16:55			0.6					
	1146																	
	1145																	
	1144																	
	1143																	
35	1142	SANDSTONE (SM): mottled brown and grayish brown; trace gravel; moderately to highly weathered; soft to moderately hard.			13	5	4.5	90	86	17:05 07:45	Resume coring on 1/14/21.		0.7		CL			
	1141																	
	1140																	
	1139																	
	1138																	
40	1137	Terminated Coring at 40.0 ft. below ground surface. After completion of coring, corehole was backfilled with high-solids cement-bentonite grout.								08:01 09:16	Core barrel tip remains in hole. Decision to stop and backfill. Driller noted potentially hard rock @ 40' while drilling Run 12. Tip of sampler/bit sheared off.							
	1136																	
	1135																	
	1134																	
	1133																	
45	1132																	
	1131																	
	1130																	
	1129																	
	1128																	
50	1127																	
	1126																	
	1125																	
	1124																	
	1123																	
55	1122																	
	1121																	
	1120																	
	1119																	
	1118																	
60	1117																	



CONTRACTOR Gregg Drilling, LLC
EQUIPMENT Fraste XL 140T
DRILL MTHD HQ3 Rock Coring
DIAMETER 4-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE

NORTHING 34.445311
EASTING -118.585670
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Corehole drilled using potable water and polymer for circulation. Location and elevation are approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

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GS FORM:
CONT. CORE 01/04

COREHOLE LOG

BORING B-3
SHEET 1 **OF** 1
START DRILL DATE Jan 14, 21
FINISH DRILL DATE Jan 14, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1145
TOP OF CASING
DATUM ft +MSL

DESCRIPTION:
1) Formation, Member
2) Rock Name
3) Color
4) Grain Size/Percentage
5) Bedding
6) Weathering
7) Hardness
8) Cementation
9) Moisture
10) Other (Mineralization, Discoloration, Odor, etc.)

COMMENTS:
1) Rig Behavior
2) Air Monitoring

			SAMPLE							DISCONTINUITY DATA						
DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	RUN NUMBER	LENGTH (ft)	RECOVERY (ft)	RECOVERY (%)	RQD	RUN TIME (min.)	COMMENTS	TYPE	FRACTURE DENSITY	APERTURE	FRACTURE FILLING	MINERAL TYPE	PLANARITY	DIP (degrees)
	1144 1143 1142	**Saugus Formation (Qss):** Clayey SANDSTONE (SC): reddish brown; slightly moist; clayey fractured sandstone with trace medium to coarse sand; dense; highly weathered; moderately hard; mechanical fractures below 0.5'. Residual Soil @ upper 1'. @2.25' - becomes gray; with gravel.	1	3	3	100	67	13:09			1					
5	1141 1140 1139	becomes moderately to highly weathered. @4.0' - gray with 2" band of red clay.	2	3	3	100	100	13:15 13:20			0					
	1138 1137 1136	Sandy CLAYSTONE (CL): Reddish brown; moderately to highly weathered.	3	5	4.75	95	95	13:25 13:30			0.20					
										J						80
10	1135	@10' - becomes Saugus Sandstone; gray.														
15	1134 1133 1132 1131 1130	Clayey SANDSTONE (SC): grayish brown; slightly moist; clayey sandstone with fine to coarse sand and gravels; dense to very dense; moderately to highly weathered; soft to moderately hard. Poor Recovery.	4	5	0.75	15	15	13:43 13:48								
	1129 1128 1127	No recovery.	5	2.5	0	0		14:00 14:07	Switched rods to drive SPT sampler. Driller stated Soft and Sandy, leading to no recovery. Drove SPT sampler to try to sample.							
	1126	SANDSTONE (SM): brown; dry to slightly moist; fine to coarse sand with silt; very dense; friable.	B-3 @18.5	0.5	0.5	100			SPT driven with blow counts 32,50/1.							
20	1125	No recovery - sands in coring fluid. Material is friable with low fines content.	6	2	0	0		15:06								
	1124 1123	No recovery - sands in coring fluid. Material is friable with low fines content.	7	2	0	0		15:14 15:17								
	1122 1121	SANDSTONE (SM): brown; fine sand with gravel; very dense; recovery ~3".	8	2	0.25	13	0	15:22 15:26								
25	1120 1119 1118 1117 1116	No recovery - friable sands.	9	5	0	0		15:35 15:42	Low pump, high pressure - still no recovery.							
30	1115 1114 1113	Terminated Coring at 30.0 ft. below ground surface. After completion of coring, corehole was backfilled with high-solids cement-bentonite grout.						15:54								

CONTRACTOR Gregg Drilling, LLC
EQUIPMENT Fraste XL 140T
DRILL MTHD HQ3 Rock Coring
DIAMETER 4-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE

NORTHING 34.446033
EASTING -118.589140
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Corehole drilled using potable water and polymer for circulation. Location and elevation are approximate and obtained from Google Earth.

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GS FORM:
CONT. CORE 01/04

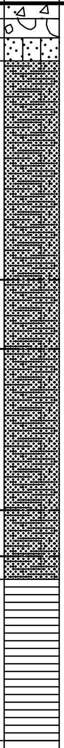
COREHOLE LOG

BORING B-4
SHEET 1 **OF** 1
START DRILL DATE Jan 15, 21
FINISH DRILL DATE Jan 15, 21
LOCATION Santa Clarita, CA
PROJECT HRCM
NUMBER SC0766U

ELEVATION DATA:
GROUND SURF. 1172
TOP OF CASING
DATUM ft +MSL

DESCRIPTION
1) Formation, Member
2) Rock Name
3) Color
4) Grain Size/Percentage
5) Bedding
6) Weathering
7) Hardness
8) Cementation
9) Moisture
10) Other (Mineralization, Discoloration, Odor, etc.)

COMMENTS
1) Rig Behavior
2) Air Monitoring



DEPTH (ft-bgs)	ELEVATION (ft)	DESCRIPTION	GRAPHIC LOG	WELL LOG	SAMPLE RUN NUMBER	LENGTH (ft)	RECOVERY (ft)	RECOVERY (%)	RQD	RUN TIME (min.)	COMMENTS	DISCONTINUITY DATA TYPE	FRACTURE DENSITY	APERTURE	FRACTURE FILLING	MINERAL TYPE	PLANARITY	DIP (degrees)
		ASPHALT																
	1171	AGGREGATE BASE																
	1170	**FILL:** Silty SAND (SM): brown; slightly moist; fine sand; medium dense.			1	4.5	4.5	100	100	14:43								
	1169	**Saugus Formation (Qss):** Silty SANDSTONE (SM): olive to grayish brown; slightly moist; fine sand; moderately to highly weathered; dense to very dense.																
	1168																	
5	1167																	
	1166	becomes moderately weathered; soft; poor recovery.			2	5	1.25	25	25	14:52 14:56	Poor Recovery.							
	1165																	
	1164	mottled gray and reddish brown; fine-grained with coarse sand and gravel.																
	1163																	
10	1162																	
	1161	becomes moderately weathered; soft to medium hard; poor recovery.			3	2.5	1	40		15:06 15:10	Poor Recovery.		0.67					
	1160	fine-grained with coarse sand and gravel.																
	1159	CLAYSTONE (CL): mottled brown and reddish brown; slightly moist; moderately weathered; soft to medium hard.																
	1158				4	2.5	2	80	75	15:19 15:22			0.67					55
15	1157																	
	1156	Terminated Coring at 16.0 ft. below ground surface. After completion of coring, corehole was backfilled with high-solids cement-bentonite grout.								15:36								
	1155																	
	1154																	
	1153																	
20	1152																	
	1151																	
	1150																	
	1149																	
	1148																	
25	1147																	
	1146																	
	1145																	
	1144																	
	1143																	
30	1142																	

CONTRACTOR Gregg Drilling, LLC
EQUIPMENT Fraste XL 140T
DRILL MTHD HQ3 Rock Coring
DIAMETER 4-inch
LOGGER D. Kilian, PG, CEG
REVIEWER C. Conkle, PE, GE
NORTHING 34.446208
EASTING -118.588320
COORDINATE SYSTEM:

NOTES: No groundwater encountered. Corehole drilled using potable water and polymer for circulation. Location and elevation are approximate and obtained from Google Earth.

SEE KEY SHEET FOR SYMBOLS AND ABBREVIATIONS

APPENDIX D-1

OYO Suspension Logging Results

BOREHOLE VELOCITY GEOPHYSICS
HONOR RANCHO
SANTA CLARITA, CALIFORNIA

Prepared for

Geosyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, California 92548
(714) 969 - 0800

Prepared by

GEO*Vision* Geophysical Services
1124 Olympic Drive
Corona, California 92881
(951) 549-1234

February 8, 2021
Report 21004-02 rev 0

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APPENDICES

INTRODUCTION

Borehole geophysical measurements were collected in one borehole at a So Cal Gas facility (Brady Parkway in Santa Clarita, California. This work is part of an investigation by Geosyntec. Data acquisition was performed on January 15th, 2021. Data analysis and report were reviewed by a **GEO***Vision* Professional Geophysicist or Engineer.

SCOPE OF WORK

This report presents the results of borehole geophysical measurements collected in one borehole as detailed in Table 1.

The OYO Suspension PS Logging System (Suspension System) was used to obtain in-situ horizontal shear (S_H) and compressional (P) wave velocity measurements in one uncased borehole at 1.6 foot intervals. Measurements followed **GEO***Vision* Procedure for PS Suspension Seismic Velocity Logging, revision 1.5. Acquired data were analyzed and a profile of velocity versus depth was produced for both S_H and P waves.

A detailed reference for the suspension PS velocity measurement techniques used in this study is:

> Guidelines for Determining Design Basis Ground Motions, Report TR-102293, Electric Power Research Institute, Palo Alto, California, November 1993, Sections 7 and 8.

INSTRUMENTATION

Suspension Velocity Instrumentation

Suspension velocity measurements were performed using the suspension PS logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geo (RG). This system directly determines the average velocity of a 3.3-foot high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave source (S_H) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder, as shown in Figure 1. The separation of the two receivers is 3.3 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is approximately 22 feet, with the center point of the receiver pair 12.5 feet above the bottom end of the probe.

The probe receives control signals from, and sends the digitized receiver signals to, instrumentation on the surface via an armored conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data using a sheave of known circumference fitted with a digital rotary encoder.

The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the source. This pressure wave is converted to P and S_H-waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate through the soil and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid surrounding the receivers as the soil waves pass their location. Separation of the P and S_H-waves at the receivers is performed using the following steps:

1. Orientation of the horizontal receivers is maintained parallel to the axis of the source, maximizing the amplitude of the recorded S_H -wave signals.
2. At each depth, S_H-wave signals are recorded with the source actuated in opposite directions, producing S_H-wave signals of opposite polarity, providing a characteristic S_H-wave signature distinct from the P-wave signal.
3. The 6.3 foot separation of source and receiver 1 permits the P-wave signal to pass and damp significantly before the slower S_H-wave signal arrives at the receiver.
4. In saturated soils, the received P-wave signal is typically of much higher frequency than the received S_H-wave signal, permitting additional separation of the two signals by low pass filtering.
5. Direct arrival of the original pressure pulse in the fluid is not detected at the receivers because the wavelength of the pressure pulse in fluid is significantly greater than the dimension of the fluid annulus surrounding the probe (feet versus inches scale), preventing significant energy transmission through the fluid medium.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and S_H-wave arrivals; reversal of the source changes the polarity of the S_H-wave pattern but not the P-wave pattern.

The data from each receiver during each source activation is recorded as a different channel on the recording system. The Suspension PS system has six channels (two simultaneous recording channels), each with a 1024 sample record. The recorded data are displayed as six channels with a common time scale. Data are stored on disk for further processing.

Review of the displayed data on the recorder or computer screen allows the operator to set the gains, filters, delay time, pulse length (energy), and sample rate to optimize the quality of the data before recording. Verification of the calibration of the Suspension PS digital recorder is performed every twelve months using a NIST traceable frequency source and counter, as presented in Appendix B.

MEASUREMENT PROCEDURES

Suspension Velocity

One borehole was logged with the PS Suspension tool. Measurements followed the **GEO***Vision* Procedure for PS Suspension Seismic Velocity Logging, revision 1.5. Prior to logging, the probe was positioned with the top of the probe even with a stationary reference point. The electronic depth counter was set to the distance between the mid-point of the receiver and the top of the probe, minus the height of the stationary reference point, if any, verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the boring, stopping at 1.6 foot intervals to collect data, as summarized in Table 2.

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth were viewed on the computer display, checked, and recorded to disk before moving to the next depth.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

DATA ANALYSIS

Suspension Velocity

Using the proprietary OYO program PSLOG.EXE version 1.0, the recorded digital waveforms were analyzed to locate the most prominent first minima, first maxima, or first break on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 1.0 meter segment of the soil column. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data. The time picks were then transferred into a Microsoft Excel® template to complete the velocity calculations based on the arrival time picks made in PSLOG. The Microsoft Excel® analysis files were previously delivered. Due to the longevity of this project, results were delivered at intervals as requested.

The P-wave velocity over the 6.3-foot interval from source to receiver 1 (S-R1) was also picked using PSLOG, and calculated and plotted in Microsoft Excel®, for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 4.8 feet to correspond to the mid-point of the 6.3-foot S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at receiver 1 and subtracting 0.35 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

As with the P-wave records, the recorded digital waveforms were analyzed to locate clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital Fast Fourier Transform – Inverse Fast Fourier Transform (FFT – IFFT) lowpass filtering was used to remove the higher frequency P-wave signal from the S_H-wave signal. Different filter cutoffs were used to separate P- and S_H-waves at different depths, ranging from 600 Hz in the slowest zones to 4000 Hz in the regions of highest velocity. At each depth, the filter frequency was selected to be at least twice the fundamental frequency of the S_H-wave signal being filtered.

Generally, the first maxima were picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by +/- 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by boring inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H-wave velocity calculated from the travel time over the 6.3-foot interval from source to receiver 1 was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 4.8 feet to correspond to the mid-point of the 6.3-foot S-R1 interval. Travel times were obtained by picking the first break of the S_H-wave signal at the near receiver and subtracting 0.35 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

Figure 2 shows an example of R1 - R2 measurements on a sample filtered suspension record. In Figure 2, the time difference over the 3.3 foot interval of 1.88 milliseconds for the horizontal signals is equivalent to an S_H-wave velocity of 1745 feet/second. Whenever possible, time differences were determined from several phase points on the S_H-waveform records to verify the data obtained from the first arrival of the S_H-wave pulse. Figure 3 displays the same record before filtering of the S_H-waveform record with a 1400 Hz FFT - IFFT digital lowpass filter, illustrating the presence of higher frequency P-wave energy at the beginning of the record, and distortion of the lower frequency S_H-wave by residual P-wave signal.

RESULTS

Suspension Velocity

Suspension R1-R2 P- and S_H-wave velocities for borehole B-1 are presented in Figure 4. The suspension velocity data presented in this figure are also presented in Table 3. The Microsoft Excel® analysis file was delivered separately.

P- and S_H-wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figure A-1 to aid in visual comparison. It should be noted that R1-R2 data are an average velocity over a 3.3-foot segment of the soil column; S-R1 data are an average over 6.3 feet, creating a significant smoothing relative to the R1-R2 plots. The S-R1 velocity data displayed in this figure is also presented in Table A-1 and included in the Microsoft Excel® analysis file delivered separately. The Microsoft Excel® analysis file includes Poisson's Ratio calculations, tabulated data and plots.

SUMMARY

Discussion of Suspension Velocity Results

Suspension PS velocity data are ideally collected in an uncased fluid filled boreholes, drilled with rotary mud (rotary wash) methods, as was the case for this borehole.

Suspension PS velocity data quality is judged based upon 5 criteria.

	Criteria	HONOR RANCHO B-1
1	Consistent data between receiver to receiver (R1 – R2) and source to receiver (S – R1) data.	Yes.
2	Consistency between data from adjacent depth intervals.	Yes
3	Consistent relationship between P-wave and S_H -wave (excluding transition to saturated soils)	Yes
4	Clarity of P-wave and S_H-wave onset, as well as damping of later oscillations.	This is excellent data.
5	Consistency of profile between adjacent borings, if available.	Not applicable

These data indicate good consistency between R1-R2 and S-R1 velocities, and consistency between adjacent depths in the intervals tested.

Suspension Velocity Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.3-foot interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable with estimated precision of +/- 5%. Standardized field procedures and quality assurance checks contribute to the reliability of these data.

Quality Assurance

These borehole geophysical measurements were performed using industry-standard or better methods for measurements and analyses. All work was performed under **GEO***Vision* quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation
- Use of standard field data logs
- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

CERTIFICATION

All geophysical data, analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a **GEO***Vision* California Professional Geophysicist or Engineer.

Reviewed by:

J. G. DIEHL
No. 30362

2/8/2021

John Diehl
California Professional Engineer
GEO*Vision* Geophysical Services

Date

∗ This geophysical investigation was conducted under the supervision of a California Professional Geophysicist or Engineer using industry standard methods and equipment. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing, interpretation and reporting. All original field data files, field notes and observations, and other pertinent information are maintained in the project files and are available for the client to review for a period of at least one year.

A professional geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations or ordinances.

Table 1. Borehole Logging Dates and Locations

BOREHOLE NUMBER	DATE LOGGED	COORDINATES(1)		
		NORTHING	EASTING	ELEVATION (FEET MSL)
B-1	1/15/2021	34.446186	-118.586069	1149.76

(1) Coordinates via Geosyntec email 2-9-21

Table 2. Logging Tools, Depth Ranges and Sample Intervals

BOREHOLE NUMBER	TOOL AND RUN NUMBER	DEPTH RANGE (FEET)	SAMPLE INTERVAL (FEET)	LOGGING DATE(S)
B-1	SUSPENSION DOWN01	1.64 – 44.29	1.6	1/15/2021

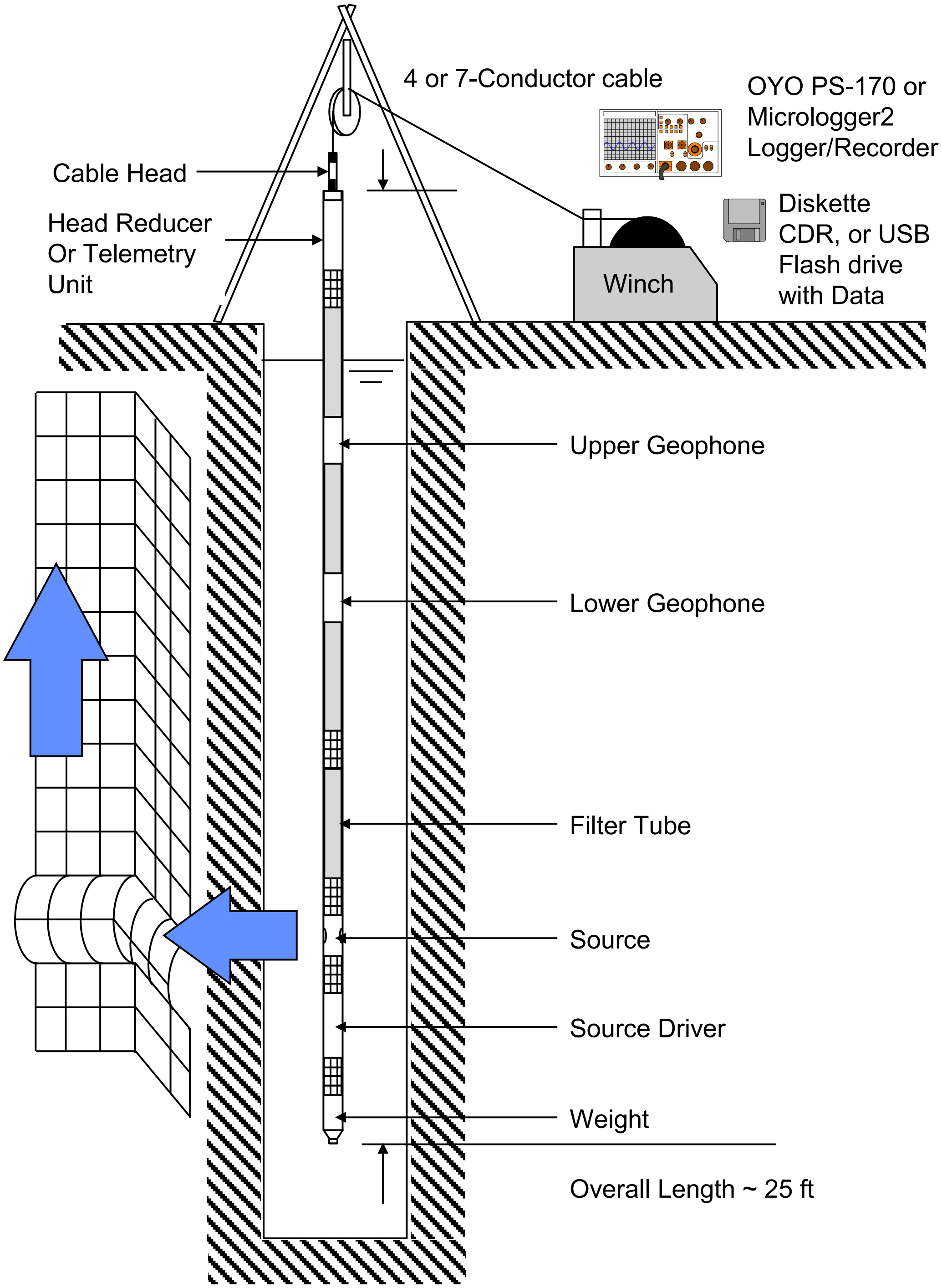

Figure 1: Concept illustration of P-S logging system

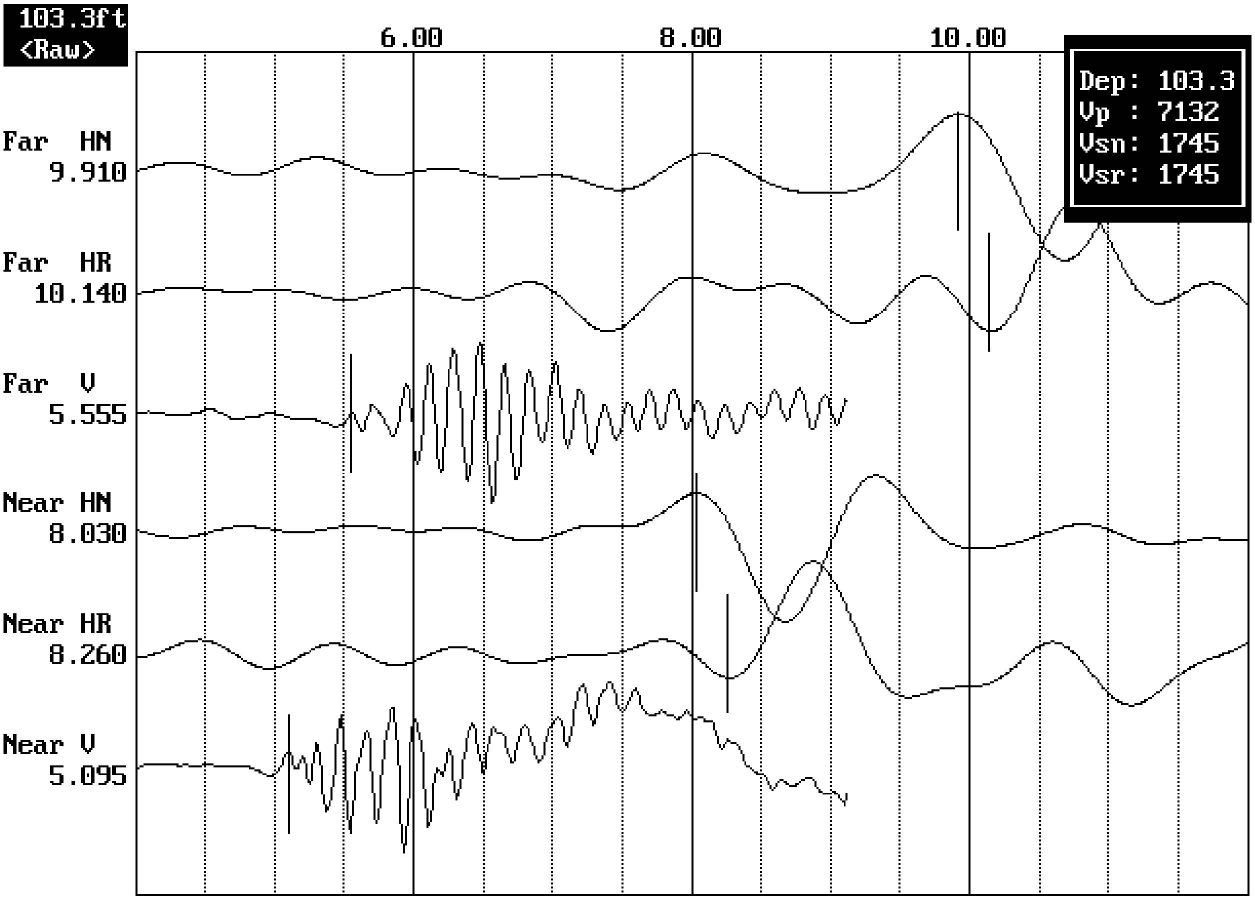

Figure 2: Example of filtered (1400 Hz lowpass) suspension record

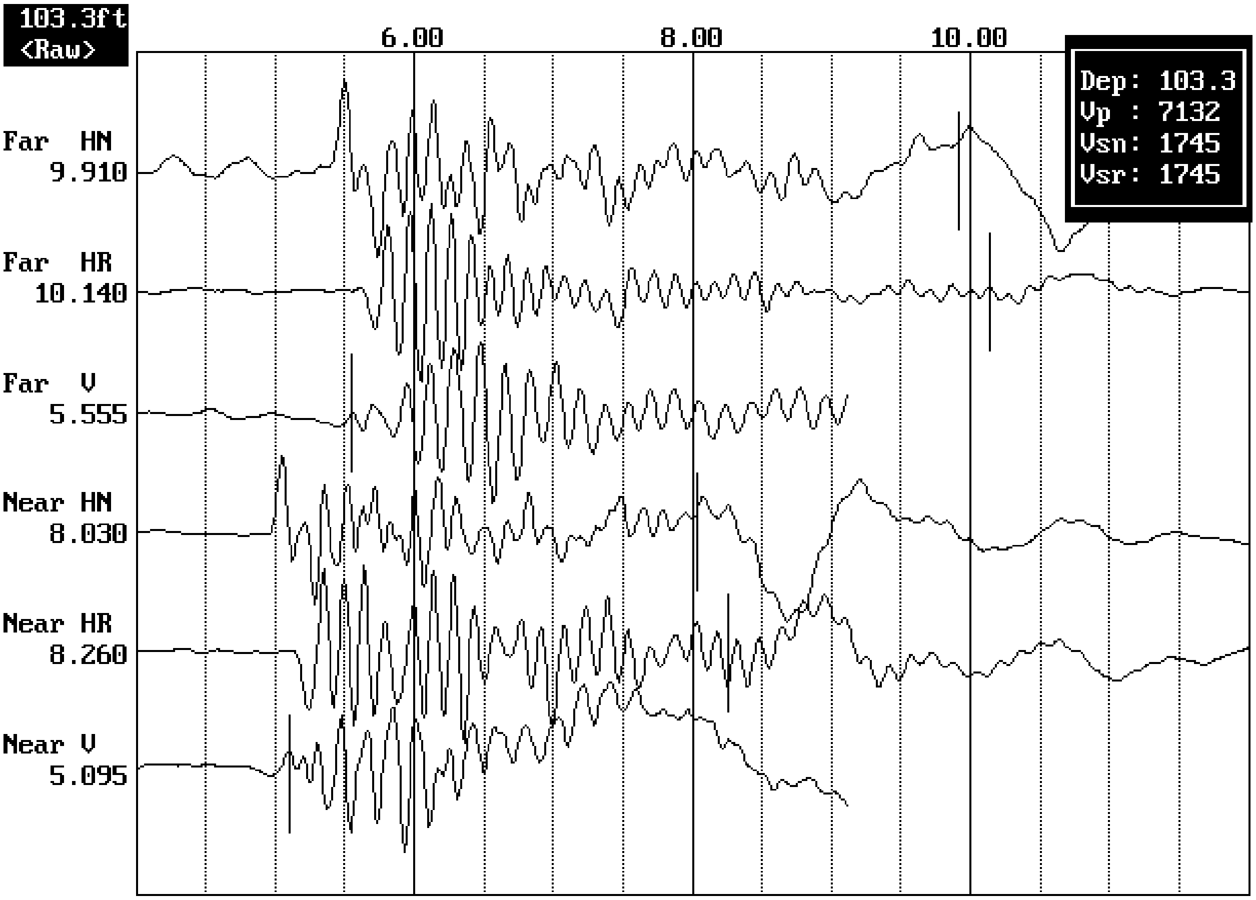

Figure 3. Example of unfiltered suspension record

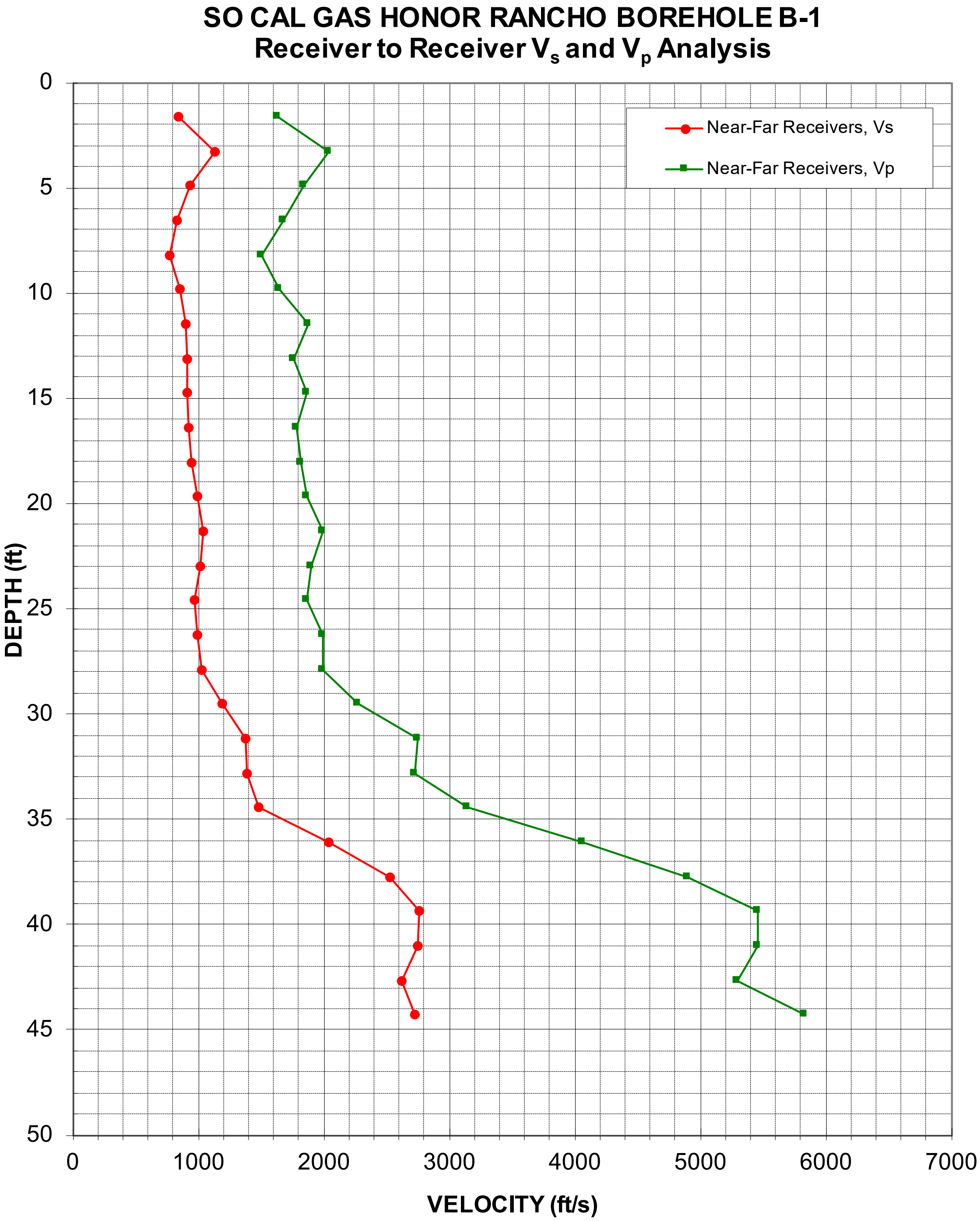

Figure 4: Borehole B-1, Suspension R1-R2 P- and S_H-wave velocities

Table 3. Borehole B-1, Suspension R1-R2 depths and P- and S_H-wave velocities

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole B-1

American Units			
Depth at Midpoint Between Receivers	**Velocity**		**Poisson's Ratio**
	V_s	**V_p**	
(ft)	(ft/s)	(ft/s)	
1.6	840	1630	0.32
3.3	1130	2040	0.28
4.9	940	1840	0.32
6.6	830	1680	0.34
8.2	770	1510	0.32
9.8	850	1650	0.32
11.5	900	1880	0.35
13.1	920	1760	0.31
14.8	910	1860	0.34
16.4	930	1780	0.31
18.0	950	1820	0.31
19.7	1000	1860	0.30
21.3	1040	2000	0.32
23.0	1010	1900	0.30
24.6	970	1860	0.31
26.3	990	2000	0.34
27.9	1030	2000	0.32
29.5	1190	2270	0.31
31.2	1380	2750	0.33
32.8	1390	2730	0.33
34.5	1490	3140	0.36
36.1	2040	4070	0.33
37.7	2530	4900	0.32
39.4	2770	5460	0.33
41.0	2750	5460	0.33
42.7	2620	5290	0.34
44.3	2730	5830	0.36

Metric Units			
Depth at Midpoint Between Receivers	**Velocity**		**Poisson's Ratio**
	V_s	**V_p**	
(m)	(m/s)	(m/s)	
0.5	260	500	0.32
1.0	350	620	0.28
1.5	290	560	0.32
2.0	250	510	0.34
2.5	240	460	0.32
3.0	260	500	0.32
3.5	270	570	0.35
4.0	280	540	0.31
4.5	280	570	0.34
5.0	280	540	0.31
5.5	290	560	0.31
6.0	300	570	0.30
6.5	320	610	0.32
7.0	310	580	0.30
7.5	300	570	0.31
8.0	300	610	0.34
8.5	310	610	0.32
9.0	360	690	0.31
9.5	420	840	0.33
10.0	420	830	0.33
10.5	450	960	0.36
11.0	620	1240	0.33
11.5	770	1490	0.32
12.0	840	1670	0.33
12.5	840	1670	0.33
13.0	800	1610	0.34
13.5	830	1780	0.36

APPENDIX A

SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

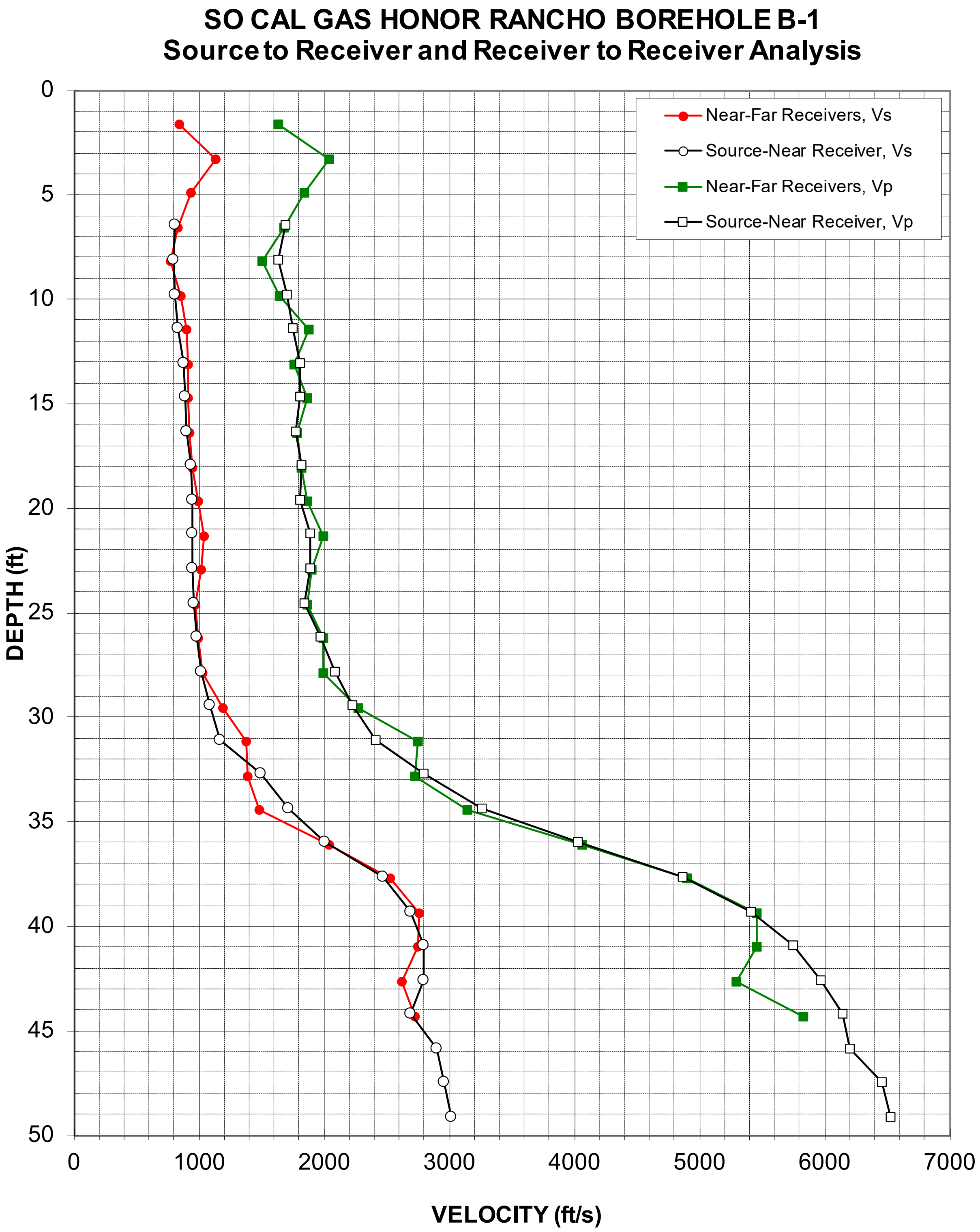

Figure A-1: Borehole B-1, Suspension S-R1 P- and SH-wave velocities

Table A-1. Borehole B-1, S - R1 quality assurance analysis P- and S_H-wave data

Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole B-1

American Units			
Depth at Midpoint Between Source and Near Receiver	**Velocity**		**Poisson's Ratio**
	V_s	**V_p**	
(ft)	(ft/s)	(ft/s)	
6.5	810	1690	0.35
8.1	800	1630	0.34
9.8	800	1700	0.36
11.4	840	1750	0.35
13.0	880	1810	0.35
14.7	900	1810	0.34
16.3	910	1770	0.32
18.0	940	1820	0.32
19.6	950	1810	0.31
21.2	950	1880	0.33
22.9	950	1880	0.33
24.5	960	1850	0.31
26.2	980	1970	0.34
27.8	1020	2080	0.34
29.4	1080	2230	0.35
31.1	1160	2420	0.35
32.7	1490	2800	0.30
34.4	1720	3260	0.31
36.0	2010	4030	0.33
37.6	2470	4870	0.33
39.3	2690	5410	0.34
40.9	2800	5750	0.34
42.6	2800	5970	0.36
44.2	2690	6150	0.38
45.8	2900	6210	0.36
47.5	2960	6460	0.37
49.1	3010	6530	0.36

Metric Units			
Depth at Midpoint Between Source and Near Receiver	**Velocity**		**Poisson's Ratio**
	V_s	**V_p**	
(m)	(m/s)	(m/s)	
2.0	250	510	0.35
2.5	240	500	0.34
3.0	250	520	0.36
3.5	250	530	0.35
4.0	270	550	0.35
4.5	270	550	0.34
5.0	280	540	0.32
5.5	290	550	0.32
6.0	290	550	0.31
6.5	290	570	0.33
7.0	290	570	0.33
7.5	290	560	0.31
8.0	300	600	0.34
8.5	310	630	0.34
9.0	330	680	0.35
9.5	350	740	0.35
10.0	460	850	0.30
10.5	520	990	0.31
11.0	610	1230	0.33
11.5	750	1480	0.33
12.0	820	1650	0.34
12.5	850	1750	0.34
13.0	850	1820	0.36
13.5	820	1870	0.38
14.0	890	1890	0.36
14.5	900	1970	0.37
15.0	920	1990	0.36

APPENDIX B

BORING GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION RECORDS

MICRO PRECISION CALIBRATION, INC
2165 N. Glassell St.,
Orange, CA 92865
714-901-5659

Certificate of Calibration

Date: Sep 25, 2020 **Cert No. 551220083842967**

Customer:

GEOVISION

1124 OLYMPIC DRIVE
CORONA CA 92881

Work Order #: LA-90048091
Purchase Order #: OH-200925-01

MPC Control #: BG9698
Asset ID: 15014
Gage Type: LOGGER
Manufacturer: OYO
Model Number: 03331-0000
Size: N/A
Temp/RH: 26.7°C / 41.2%
Location: Calibration performed at MPC facility

Serial Number: 15014
Department: N/A
Performed By: TYLER MCKEEN
Received Condition: IN TOLERANCE
Returned Condition: IN TOLERANCE
Cal. Date: September 18, 2020
Cal. Interval: 12 MONTHS
Cal. Due Date: September 18, 2021

Calibration Notes:

See Attached Data Sheet For Calculations (1 Page)

This Certificate Supersedes Cert No. 551220083842711, Corrected Serial Number.

Calibrated IAW customer supplied data form Rev 2.1
Frequency measurement uncertainty = 0.0005 Hz
Unit calibrated with Panasonic Toughbook CF-31 Ser#: 2ITYA90009

Calibrated to 4:1 accuracy ratio.

Standards Used to Calibrate Equipment

I.D.	Description.	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
DB8748	GPS TIME AND FREQUENCY RECEIVER	58503A	3625A01225	HEWLETT PACKARD	Apr 30, 2021	551220083021224
LAS0052	ARB / FUNC GENERATOR	33250A	MY40029031	AGILENT	Oct 31, 2020	551220083302616
BD7715	UNIVERSAL COUNTER	53131A	3416A05377	HEWLETT PACKARD	Apr 30, 2021	551220082934517

Calibrating Technician:

TYLER MCKEEN

QC Approval:

NIKOLAS GROHMAN

STATEMENTS OF PASS OR FAIL CONFORMANCE: The uncertainty of measurement has been taken into account when determining compliance with specification. All measurements and test results guard banded to ensure the probability of false-accept does not exceed 2% in compliance with ANSI/NCSL Z540.3-2006 and in case without guard banded the probability of false-accept depending on test uncertainty ratio.

THE CALIBRATION REPORT STATUS:
PASS- Term used when compliance statement is given, and the measurement result is PASS.
PASS^{Z}- Term used when compliance statement is given, and the measurement result is conditional passed or PASS^{Z}.
FAIL- Term used when compliance statement is given, and the measurement result is FAIL.
FAIL^{Z}- Term used when compliance statement is given, and the measurement result is conditional failed or FAIL^{Z}.
REPORT OF VALUE - Term used when reported measurement is not requiring compliance statement in report.
ADJUSTED- When adjustments are made to an instrument which changes the value of measurement from what was measured as found to new value as left.
LIMITED - When an instrument fails calibration but is still functional in a limited manner.

The expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%, unless otherwise stated. This calibration report complies with ISO/IEC 17025:2017 and ANSI/NCSL Z540.3. Calibration cycles and resulting due dates were submitted/approved by the customer. Any number of factors may cause an instrument to drift out of tolerance before the next scheduled calibration. Recalibration cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. All standards are traceable to SI through the National Institute of Standards and Technology (NIST) and/or recognized national or international standards laboratories. Services rendered include proper manufacturer's service instruction and are warranted for no less than thirty (30) days. The information on this report pertains only to the instrument identified, this may not be reproduced in part or in a whole without the prior written approval of the issuing MP Calibration Laboratory.

Certificate of Calibration

Date: Sep 25, 2020 **Cert No. 551220083842967**

Procedures Used in this Event

Procedure Name	Description
GEOVISION SEISMIC Rev. 2.1	Seismic Logger/Recorder Calibration Procedure, Rev. 2.1

Calibrating Technician:

TYLER MCKEEN

QC Approval:

NIKOLAS GROHMAN

STATEMENTS OF PASS OR FAIL CONFORMANCE: The uncertainty of measurement has been taken into account when determining compliance with specification. All measurements and test results guard banded to ensure the probability of false-accept does not exceed 2% in compliance with ANSI/NCSL Z540.3-2006 and in case without guard banded the probability of false-accept depending on test uncertainty ratio.

THE CALIBRATION REPORT STATUS:
PASS- Term used when compliance statement is given, and the measurement result is PASS.
PASS^Z- Term used when compliance statement is given, and the measurement result is conditional passed or PASS^Z.
FAIL- Term used when compliance statement is given, and the measurement result is FAIL.
FAIL^Z- Term used when compliance statement is given, and the measurement result is conditional failed or FAIL^Z.
REPORT OF VALUE - Term used when reported measurement is not requiring compliance statement in report.
ADJUSTED- When adjustments are made to an instrument which changes the value of measurement from what was measured as found to new value as left.
LIMITED - When an instrument fails calibration but is still functional in a limited manner.

The expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%, unless otherwise stated. This calibration report complies with ISO/IEC 17025:2017 and ANSI/NCSL Z540.3. Calibration cycles and resulting due dates were submitted/approved by the customer. Any number of factors may cause an instrument to drift out of tolerance before the next scheduled calibration. Recalibration cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. All standards are traceable to SI through the National Institute of Standards and Technology (NIST) and/or recognized national or international standards laboratories. Services rendered include proper manufacturer's service instruction and are warranted for no less than thirty (30) days. The information on this report pertains only to the instrument identified, this may not be reproduced in part or in a whole without the prior written approval of the issuing MP Calibration Laboratory.

BG9698

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SUSPENSION PS SEISMIC LOGGER/RECORDER CALIBRATION DATA FORM

INSTRUMENT DATA

System mfg.: OYO
Model no.: 3331
Serial no.: 15014
Calibration date: 9/18/2020
By: MICROPRECISION
Due date: 9/18/2021

Counter mfg.: HEWLETT PACKARD
Model no.: 53131A
Serial no.: 3416A05377
Calibration date: 4/23/2020
By: MICROPRECISION
Due date: 4/30/2021

Signal generator mfg.: AGILENT
Model no.: 33250A
Serial no.: MY40029031
Calibration date: 10/31/2019
By: MICROPRECISION
Due date: 10/31/2020

Laptop controller mfg.: PANASONIC
Model no.: CF-31
Serial no.: 21TYA90009
Calibration date: N/A

SYSTEM SETTINGS:

Gain: 10
Filter: 5 Hz Low Cut, 20 KHz Hi Cut
Range: 5-200 µs
Delay: 0
Stack (1 std): 1
System date = correct date and time: ✓ 8:20 Am 9/18/2020

PROCEDURE:

Set sine wave frequency to target frequency with amplitude of approximately 0.25 volt peak
Note actual frequency on data form.
Set sample period and record data file to disk. Note file name on data form.
Pick duration of 9 cycles using PSLOG.EXE program, note duration on data form, and save as .sps file. Calculate average frequency for each channel pair and note on data form.

Average frequency must be within +/- 1% of actual frequency at all data points.

Maximum error ((AVG-ACT)/ACT*100)% As found 0.13% As left 0.13%

Target Frequency (Hz)	Actual Frequency (Hz)	Sample Period (microS)	File Name	Time for 9 cycles Hn (msec)	Average Frequency Hn (Hz)	Time for 9 cycles Hr (msec)	Average Frequency Hr (Hz)	Time for 9 cycles V (msec)	Average Frequency V (Hz)
50.00	50.00	200	001	180.0	50.00	180.0	50.00	180.0	50.00
100.0	100.0	100	002	90.00	100.0	90.00	100.0	90.00	100.0
200.0	200.0	50	003	44.90	200.4	44.90	200.4	45.00	200.0
500.0	500.0	20	004	18.00	500.0	18.00	500.0	18.00	500.0
1000	1000	10	005	8.990	1001	9.010	998.9	8.990	1001
2000	2000	5	006	4.500	2000	4.500	2000	4.500	2000

Calibrated by: Tyler McLean — Name; 9/18/20 — Date; Signature

Witnessed by: ROBERT STELLER — Name; 9/18/2020 — Date; Signature

Suspension PS Seismic Recorder/Logger Calibration Data Form Rev 2.1 February 7, 2012

APPENDIX D-2

Seismic Refraction Survey Results

REPORT
SEISMIC REFRACTION SURVEY

28300 Brady Parkway
Santa Clarita, California

GEO*Vision* Project No. 21004

Prepared for

Geosyntec, Inc.
2100 Main Street, Suite 150
Huntington Beach, CA 92648
(714) 465-1250

Prepared by

GEO*Vision* Geophysical Services, Inc.
1124 Olympic Drive
Corona, CA 92881
(951) 549-1234

January 22, 2021

Report 21004-01 Rev 0

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APPENDICES

1 INTRODUCTION

A P-wave seismic refraction survey was conducted at the property located at 28300 Brady Parkway, Santa Clarita, California on January 5, 2021. The purpose of this investigation was to determine the rippability of the sedimentary rock of the Saugus Formation. P-wave seismic refraction data was acquired along a single profile, designated as Line 1 (Figure 1).

The expected geology in this area consists of soil overlying the Saugus Formation, expected to be primarily comprised of sandstone. Depending on the bedding, degree of weathering, jointing, etc., sandstone rock may broadly be characterized as rippable using a Caterpillar D8R ripper to P-wave velocities of about 6,500 feet per second (ft/s), marginally-rippable to 8,300 ft/s, and non-rippable at P-wave velocity greater than 8,300 ft/s (Caterpillar, 2018). Using a Caterpillar D9R, rock is considered rippable to P-wave velocities of 7,300 ft/s, marginally-rippable to 9,600 ft/s, and non-rippable at P-wave velocity greater than 9,600 ft/s.

The following sections include a discussion of equipment and field procedures, methodology, data processing, and results of the geophysical survey.

— P-wave Seismic Refraction Line

NOTES:
1. Coordinate System: California State Plane, NAD83, Zone V (0405), US Survey Feet
2. Base map source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

GEOVision
geophysical services

Date:	1/7/2021
GV Project:	21004
Developed by:	C Martinez
Drawn by:	T Rodriguez
Approved by:	V Gonzalez
File Name:	21004-1.MXD

FIGURE 1
SITE MAP

SITE LOCATED AT
28300 BRADY PKWY
SANTA CLARITA, CALIFORNIA

PREPARED FOR
GEOSYNTEC, INC.

2 METHODOLOGY

Detailed discussions of the seismic refraction method can be found in Telford et al. (1990), Dobrin and Savit (1988), and Redpath (1973).

When conducting a seismic survey, acoustic energy is input to the subsurface by an energy source such as a sledgehammer impacting a metallic plate, weight drop, vibratory source, or explosive charge. The acoustic waves propagate into the subsurface at a velocity dependent upon the elastic properties of the material through which they travel. When the waves reach an interface where the density or velocity changes significantly, a portion of the energy is reflected to the surface and the remainder is transmitted into the lower layer. Where the velocity of the lower layer is higher than that of the upper layer, a portion of the energy is also critically refracted along the interface. Critically refracted waves travel along the interface at the velocity of the lower layer and continually refract energy back to the surface. Receivers (geophones) laid out in linear array on the surface record the incoming refracted and reflected waves. The seismic refraction method involves analysis of the travel times of the first energy to arrive at the geophones. These seismic first arrivals are from either the direct wave (at geophones close to the source) or critically refracted waves (at geophones further from the source).

Analysis of seismic refraction data depends upon the complexity of the subsurface velocity structure. If the subsurface target is planar in nature then the slope intercept method (Telford et al., 1990) can be used to model multiple horizontal or dipping planar layers. A minimum of one end shot is required to model horizontal layers and reverse end shots are required to model dipping planar layers. If the subsurface target is undulating (i.e. bedrock valley) then layer based analysis routines such as the generalized reciprocal method (Palmer, 1980 and 1981, Lankston and Lankston, 1986 and Lankston, 1990); reciprocal method (Hawkins, 1961) also referred to as the ABC method; Hales' method (Hales, 1958); delay time method (Wyrobek, 1956 and Gardner, 1967); time-term inversion (Scheidegger and Willmore, 1959); plus-minus method (Hagedoorn, 1959); and wavefront method (Rockwell, 1967) are preferred to model subsurface velocity structure. These methods generally require a minimum of 5 shot points per spread (end shots, off end shots and a center shot). If subsurface velocity structure is complex and cannot be adequately modeled using layer-based modeling techniques (e.g., complex weathering profile in bedrock, numerous lateral velocity variations), then Monte Carlo or tomographic inversion techniques (Zhang and Toksoz, 1998; Schuster and Quintus-Bosz, 1993) are required to model the seismic refraction data. These techniques require a high shot density; typically, every 1 to 6 stations/geophones. Generally, these techniques cannot effectively take advantage of off-end shots to extend depth of investigation, so longer profiles are required.

Errors in seismic refraction models can be caused by velocity inversions, hidden layers, or lateral velocity variations. At sites with steeply dipping or highly irregular bedrock surfaces, refractions from structures to the side of the line rather than from beneath the line may severely complicate modeling. A velocity inversion is a geologic layer with a lower seismic velocity than an overlying layer. Critical refraction does not occur along such a layer because velocity has to increase with depth for critical refraction to occur. This type of layer, therefore, cannot be recognized or modeled and depths to underlying layers would be overestimated.

A hidden layer is a layer with a velocity increase, but of sufficiently small thickness relative to the velocities of overlying and underlying layers, that refracted arrivals do not arrive at the geophones before those from the deeper, higher velocity layer. Because the seismic refraction method generally only involves the interpretation of first arrivals, a hidden layer cannot be recognized or modeled and depths to underlying layers would be underestimated. Saturated sediments overlying high velocity bedrock can be a hidden layer under many field conditions. Generally, saturated sediments generally have a much higher velocity than unsaturated sediments, typically in the 5,000 to 7,000 ft/s range and can occasionally be interpreted as a second arrival when the layer does not give rise to a first arrival.

A subsurface velocity structure that increases as a function of depth rather than as discrete layers will cause depths to subsurface refractors to be underestimated in a manner very similar to that of the hidden layer problem. Lateral velocity variations that are not adequately addressed in the seismic models also lead to depth errors. Tomographic imaging techniques can often resolve the complex velocity structures associated with hidden layers, velocity gradients, and lateral velocity variations. However, in the event of an abrupt increase in velocity at a geologic horizon, the velocity model generated using tomographic inversion routines will smooth the horizon with velocity possibly being underestimated at the interface and overestimated at depth.

3 EQUIPMENT AND FIELD PROCEDURES

Seismic refraction equipment used during this investigation consisted of a Geometrics Geode 24-channel signal enhancement seismograph, 10 Hz vertical geophones, seismic cables with 10-foot spaced connectors, piezo hammer switches, and a 20-lb sledgehammer and aluminum strike plate.

The seismic line consisted of 24 geophones spaced 6 feet apart for a total line length of 138 feet. Elevations along the refraction lines were surveyed using a Spectra SP60 GPS system with CenterPoint RTX real-time differential corrections. The location of the seismic line is presented in Table 1.

Sample photographs of seismic equipment is provided in Appendix A. Source locations included end shots at the end geophone, multiple off-end shot locations, and interior shot locations at every 4th geophone for a total of 11 shot points. A 20-lb sledgehammer was used as the energy source for all source locations. A hammer switch mounted on the aluminum plate was used to trigger the seismograph upon impact. The final seismic record at each shot point was the result of stacking 5 to 10 shots to increase the signal to noise ratio. All seismic records were stored on a laptop computer. Data acquisition parameters, file names, and other observations were recorded on a digital observers' log, which is retained in project files.

Table 1 Location of Seismic Line 1

Position (ft)	Northing (US ft)	Easting (US ft)	Elevation (ft)
0	1984999.6	6385146.3	1210.3
6	1985003.2	6385141.5	1210.3
12	1985006.3	6385136.4	1210.5
18	1985010.4	6385132.2	1210.2
24	1985013.7	6385127.2	1209.7
30	1985017.0	6385122.5	1209.0
36	1985020.4	6385117.8	1208.3
42	1985023.9	6385113.0	1206.8
48	1985027.5	6385108.5	1205.6
54	1985031.1	6385103.8	1205.0
60	1985034.7	6385098.9	1204.4
66	1985038.2	6385093.8	1204.8
72	1985041.5	6385089.1	1205.1
78	1985045.1	6385084.1	1205.7
84	1985048.4	6385079.3	1205.6
90	1985052.0	6385074.4	1205.9
96	1985055.6	6385069.7	1206.3
102	1985059.1	6385065.0	1206.7
108	1985062.7	6385060.2	1206.3
114	1985066.0	6385055.3	1205.7
120	1985069.3	6385050.3	1205.3
126	1985073.0	6385045.5	1204.8
132	1985076.2	6385040.5	1204.1
138	1985079.6	6385035.9	1202.5

Note: Coordinates in California State Plane Coordinate System, Zone 5, NAD83, US feet.

4 DATA REDUCTION AND MODELING

The first step in data processing consisted of picking the arrival time of the first energy (first-arrival) received at each geophone for each shot point. The first-arrivals on each seismic record are either a direct arrival from a compressional (P) wave traveling in the uppermost layer or a refracted arrival from a subsurface interface where there is a velocity increase. First-arrival times were selected using the manual picking routines in the SeisImager™ software suite (Geometrics, Inc.). These first-arrival times were saved in an ASCII file containing shot location, geophone locations, and associated first-arrival time. Errors in the first-arrival times were variable with error generally increasing with distance from the shot point.

Analysis of seismic refraction data depends upon the complexity of the subsurface velocity structure. Layer-based and tomographic inversion routines can be used to model the seismic data. Layer-based methods are better suited when subsurface units are arranged along distinct geologic boundaries, whereas tomographic methods may be better applied when gradational changes across geologic contacts. These different modeling schemes have their own strengths and weaknesses. Refraction tomography techniques are often able to resolve complex velocity structure (e.g. velocity gradients) that can be observed in bedrock weathering profiles. Layer-based modeling techniques such as GRM are not able to accurately model the velocity gradients that can be observed in weathered or transitional zones. However, tomographic modeling methods force a velocity gradient across apparent geologic units or vertical cross-section, smoothing the velocity ranges presented in the model.

Seismic refraction data were first modeled using a two or three-layer modeling algorithm to fit the major trends in the travel time data. This layer-based model was used as a starting model for preliminary analysis using the tomographic inversion routine in the SeisImager Plotrefa software package. Analysis was also conducted using the tomographic inversion routine with a smooth velocity gradient starting model, which was selected for site characterization.

The final tomographic velocity models for the seismic line were exported as ASCII files and imported into the Golden Software Surfer mapping system where the velocity model was gridded, contoured, and annotated for presentation.

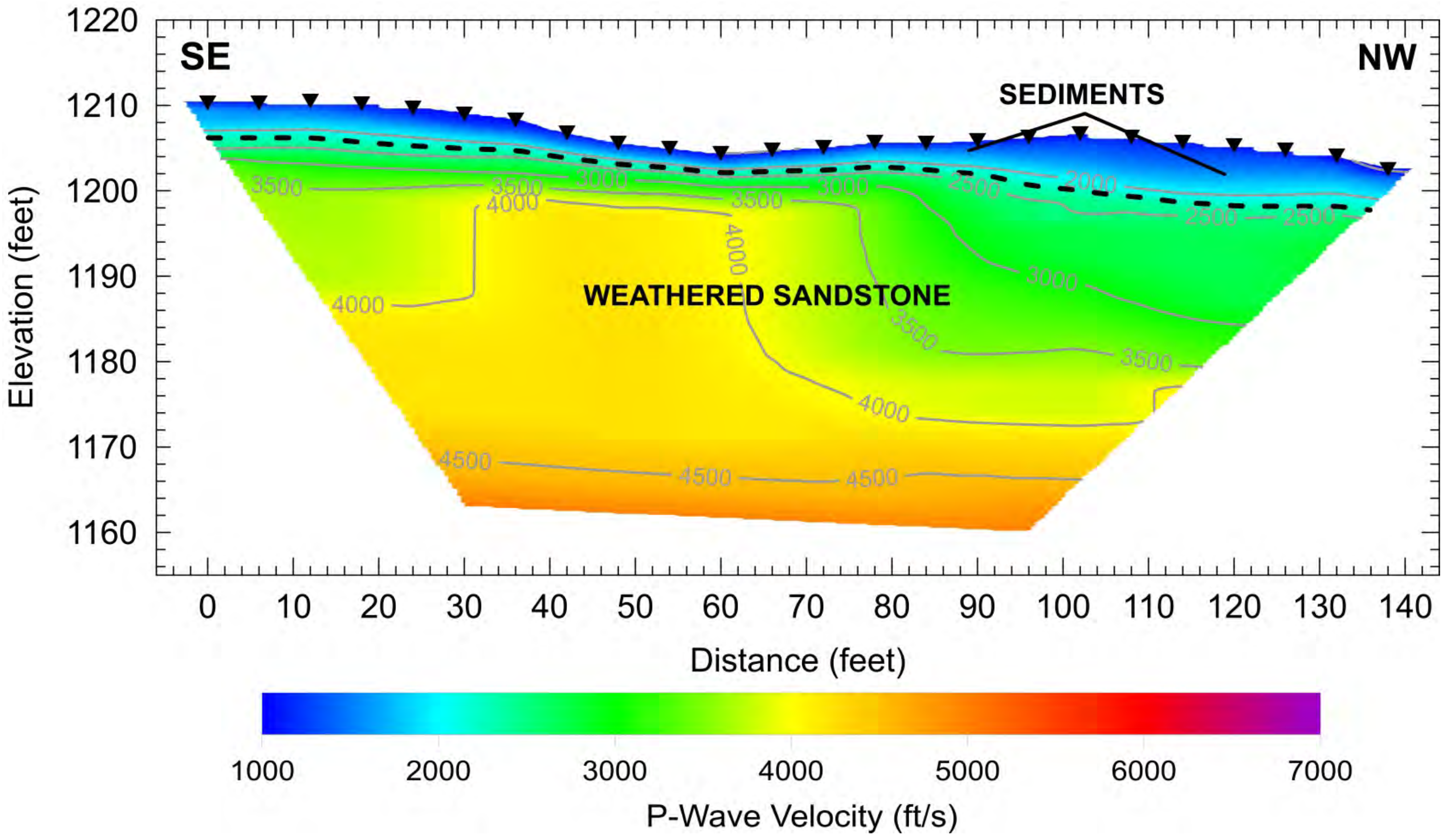
5 DISCUSSION OF RESULTS

The P-wave seismic refraction model for Line 1 is presented as Figure 2. In tomographic models, sharp layer contacts are not clearly defined and thus ranges of velocities are used to interpret possible rock conditions and competency. A color scheme with blue-cyan, green-orange, and red-purple indicating low, intermediate, and high P-wave velocities, respectively, and velocity contours at 500 ft/s intervals are used to display the seismic velocity model.

Tomographic inversion techniques will typically model a gradual increase in velocity with depth even if an abrupt velocity contact is present. Velocity gradients can, however, be very common in geologic environments comprised on weathered rock, such as the project site. In tomographic images, layer contacts are not clearly defined and thus, ranges of velocities are used to interpret possible rock conditions and competency.

For purpose of discussion, we assume that a Caterpillar D8R Ripper, or equivalent, will be used on site. Rock with P-wave velocity of less than approximately 6,500 ft/s should be rippable by a D8R assuming that the rock is sufficiently fractured. Rock with P-wave velocity of between about 6,500 and 8,300 ft/s should be marginally rippable by a D8R although it may be more cost effective to blast rather than rip rock in this velocity range. Rock with P-wave velocity greater than 8,300 ft/s is assumed to be non-rippable by a D8R.

Line 1 (Figure 2) has between about 2 and 8 ft of sediments or residual soil overlying weathered rock with P-wave velocity in the 2,500 to 4,500 ft/s range. Depth of investigation is about 40 ft and the sedimentary rock appears to be rippable to this depth



GEOVision
geophysical services

Project No: 21004

Date: JAN 22, 2021

Drawn By: A MARTIN

Approved By: Antony J Martin

R:\GVProjects\2021\21004 Geosyntec\Report\Figure 2.cdr

FIGURE 2
LINE 1 P-WAVE SEISMIC REFRACTION MODEL

28300 BRADY PARKWAY
SANTA CLARITA, CALIFORNIA

PREPARED FOR
GEOSYNTEC, INC.

6 REFERENCES

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7 CERTIFICATION

All geophysical data, analysis, interpretations, conclusions, and recommendations in this document have been prepared under the supervision of and reviewed by a **GEO***Vision* California Professional Geophysicist.

Reviewed and approved by,

Antony J Martin

ANTONY JEFFREY MARTIN
GP 989

01/22/2021

Antony J. Martin
Date

California Professional Geophysicist, P. Gp. 989
GEO*Vision* Geophysical Services

* This geophysical investigation was conducted under the supervision of a California Professional Geophysicist using industry standard methods and equipment. A high degree of professionalism was maintained during all aspects of the project from the field investigation and data acquisition, through data processing, interpretation, and reporting. All original field data files, field notes, observations, and other pertinent information are maintained in the project files and are available for the client to review for a period of at least one year.

A professional geophysicist's certification of interpreted geophysical conditions comprises a declaration of his/her professional judgment. It does not constitute a warranty or guarantee, expressed or implied, nor does it relieve any other party of its responsibility to abide by contract documents, applicable codes, standards, regulations, or ordinances

APPENDIX E

Geotechnical Laboratory Results

PERCENT PASSING NO. 200 SIEVE

ASTM D1140

Client: Geosyntec Consultants, Inc.

AP Lab No.: 21-0143

Project Name: SCG Honor Rancho

Test Date: 01/29/21

Project Number: SC0766U-04

Boring No.	Sample No.	Depth (ft)	Percent Fines (%)
HSA-1	HSA-1@5	6-6.5	40.3
HSA-1	HSA-1@20	20-21.5	35.4

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

COMPACTION TEST

Client: Geosyntec Consultants, Inc.
AP Number: 21-0143
Project Name: SCG Honor Rancho
Tested By: JT
Date: 01/27/21
Project No. : SC0766U-04
Calculated By: NR
Date: 01/29/21
Boring No.: HSA-1
Checked By: AP
Date: 02/02/21
Sample No.: HSA-1@1-5
Depth (ft.): 1-5
Visual Sample Description: Clayey Sand

Compaction Method
☒ ASTM D1557
☐ ASTM D698

METHOD: A
MOLD VOLUME (CU.FT): 0.0333

Preparation Method
☐ Moist
☒ Dry

Wt. Comp. Soil + Mold (gm.)	3981	4011	3834	3955		
Wt. of Mold (gm.)	1863	1863	1863	1863		
Net Wt. of Soil (gm.)	2118	2148	1971	2092		
Container No.						
Wt. of Container (gm.)	149.25	150.97	149.74	150.48		
Wet Wt. of Soil + Cont. (gm.)	487.84	518.06	468.81	472.54		
Dry Wt. of Soil + Cont. (gm.)	463.47	484.37	453.81	436.55		
Moisture Content (%)	7.76	10.10	4.93	12.58		
Wet Density (pcf)	140.08	142.06	130.36	138.36		
Dry Density (pcf)	130.00	129.03	124.23	122.90		

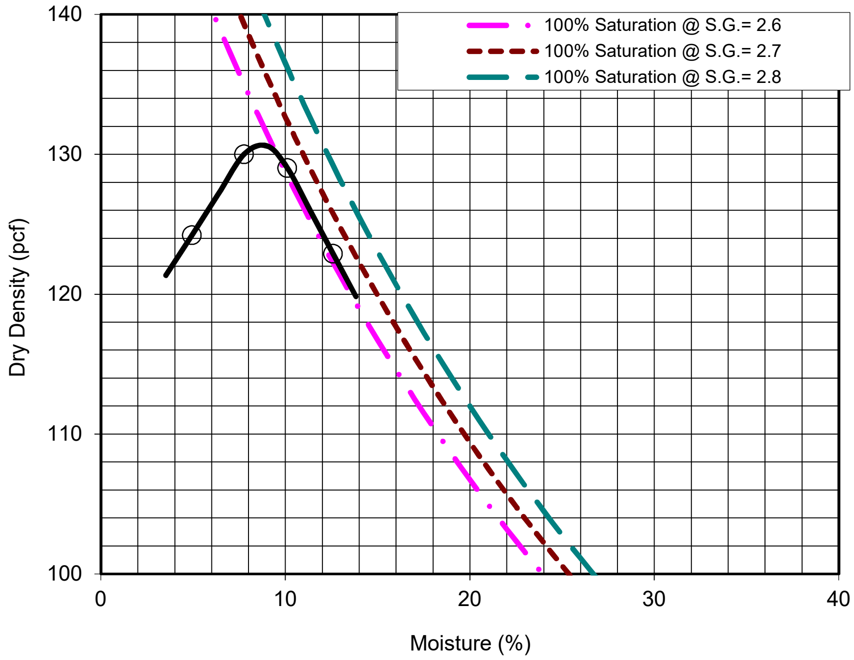
Maximum Dry Density (pcf): **130.6**
Maximum Dry Density w/ Rock Correction (pcf): **N/A**
Optimum Moisture Content (%): **8.7**
Optimum Moisture Content w/ Rock Correction (%): **N/A**

PROCEDURE USED

☒ *METHOD A: Percent of Oversize:* *3.6%*
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)

☐ *METHOD B: Percent of Oversize:* *N/A*
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)

☐ *METHOD C: Percent of Oversize:* *N/A*
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)



MOISTURE AND DENSITY TEST RESULTS

ASTM D2216 and ASTM D7263 (Method B)

Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

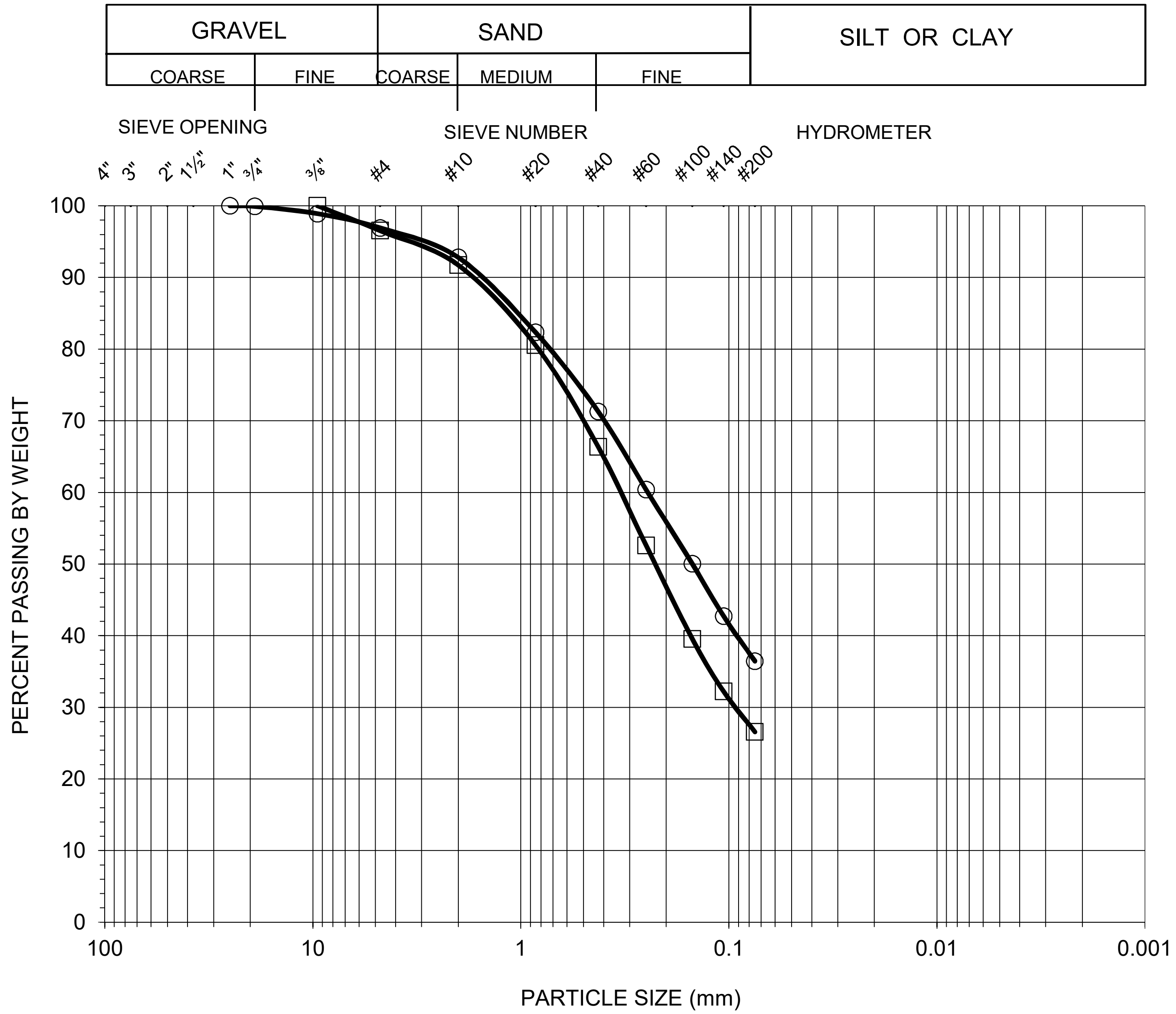
AP Lab No.: 21-0143
Test Date: 01/27/21

Boring No.	Sample No.	Sample Depth (ft.)	Moisture Content (%)	Dry Density (pcf)
HSA-1	HSA-1@10	10-11.5	5.6	NA
HSA-1	HSA-1@20	20-21.5	7.6	NA

GRAIN SIZE DISTRIBUTION CURVE
ASTM D 6913

Client Name: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

Tested by: SM Date: 01/29/21
Computed by: NR Date: 02/01/21
Checked by: AP Date: 02/02/21



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Type U.S.C.S
				Gravel	Sand	Silt & Clay		
○	HSA-1	HSA-1@ 1-5	1-5	3	61	36	N/A	SC*
□	HSA-1	HSA-1@10	10-11.5	3	70	27	N/A	SM

Note: Based on visual classification of sample

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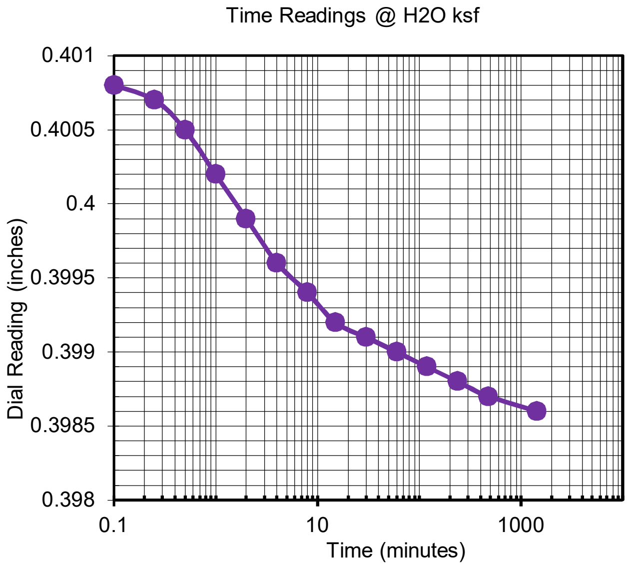

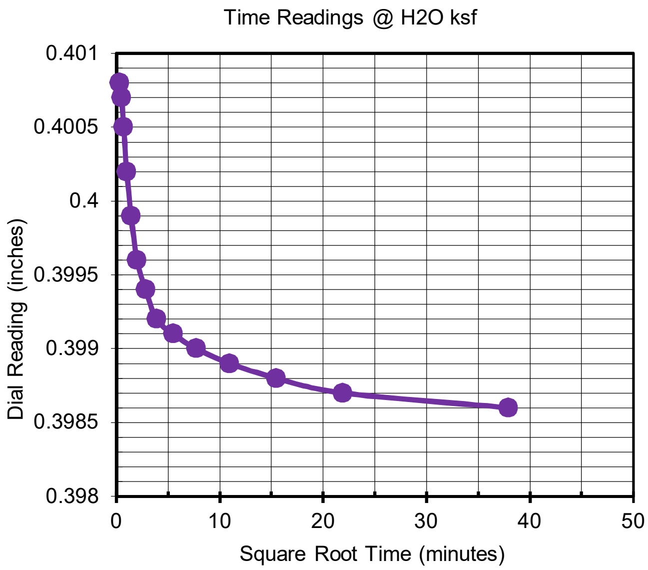

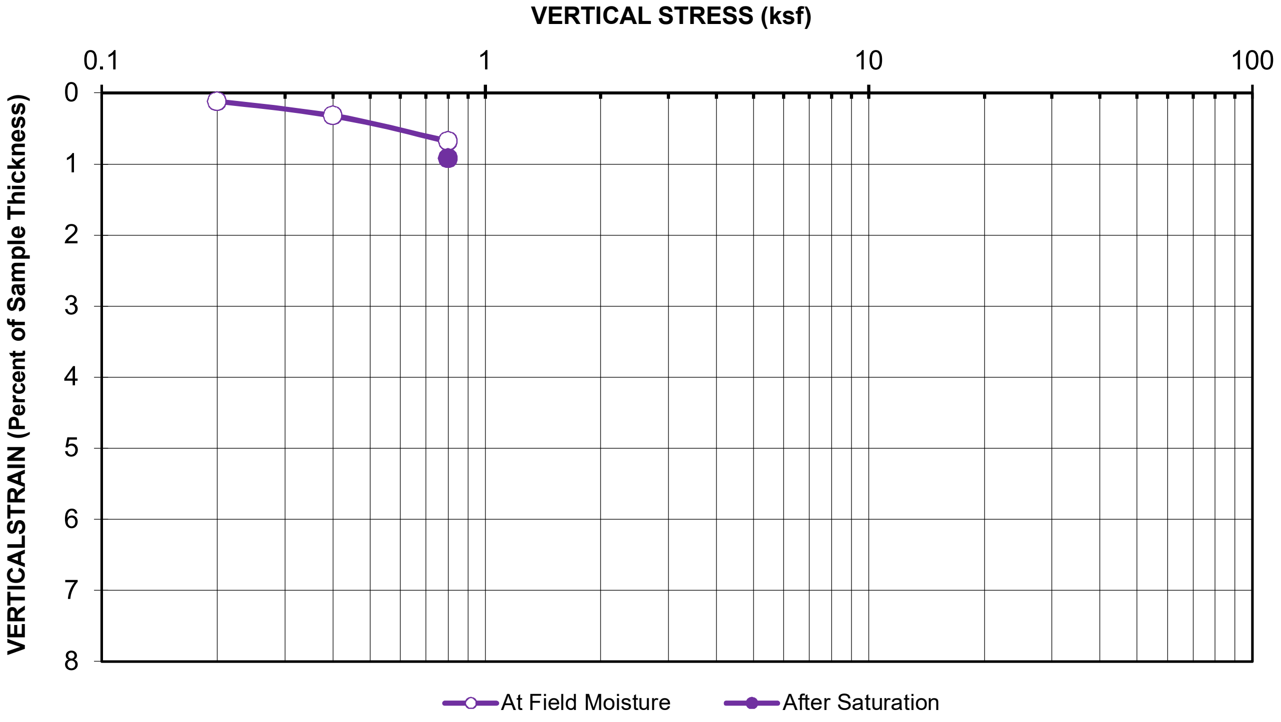

Boring No. : HSA-1
Sample No.: HSA-1@5
Depth (feet): 6-6.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 0.24% upon inundation

Initial Dry Unit Weight (pcf): 111.4
Initial Moisture Content (%): 8.3
Final Moisture Content (%): 18.4
Initial Void Ratio: 0.51

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

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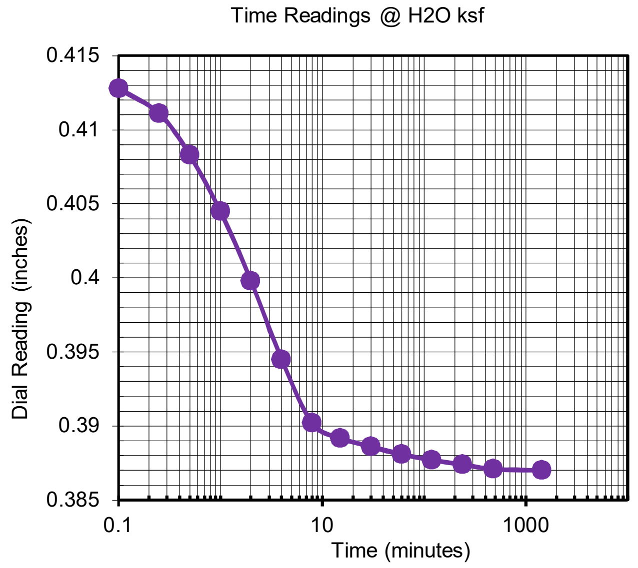
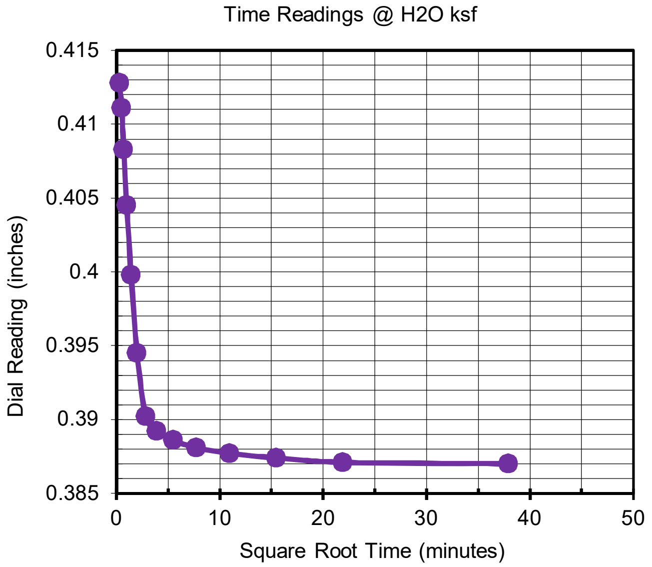
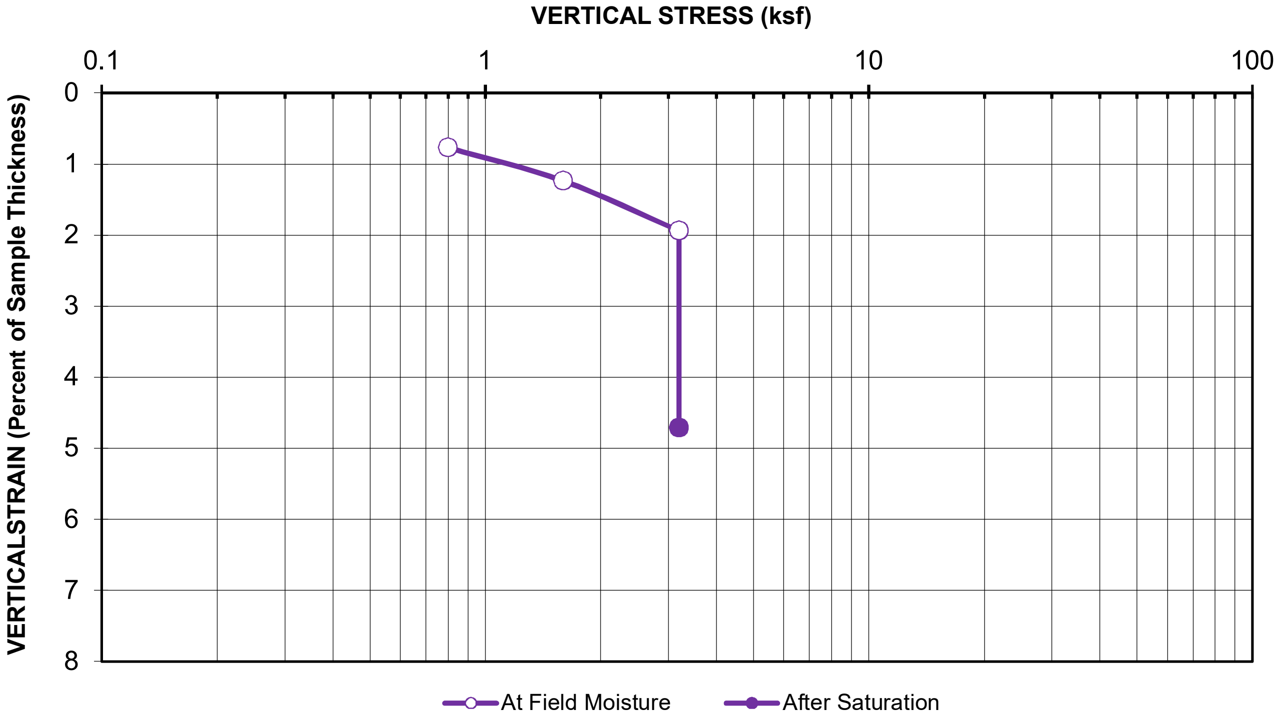




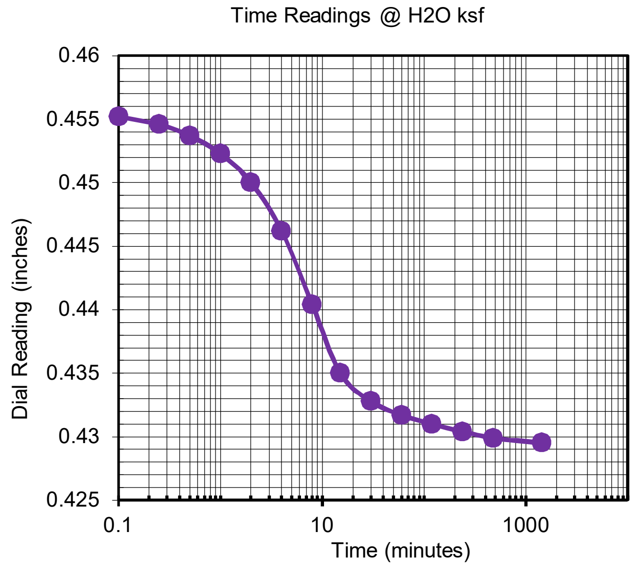


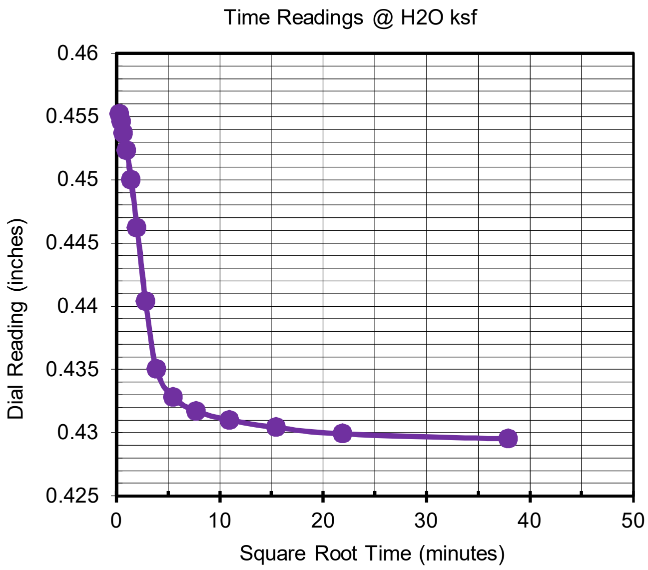
Boring No. : HSA-1
Sample No.: HSA-1@5
Depth (feet): 6-6.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 2.77% upon inundation

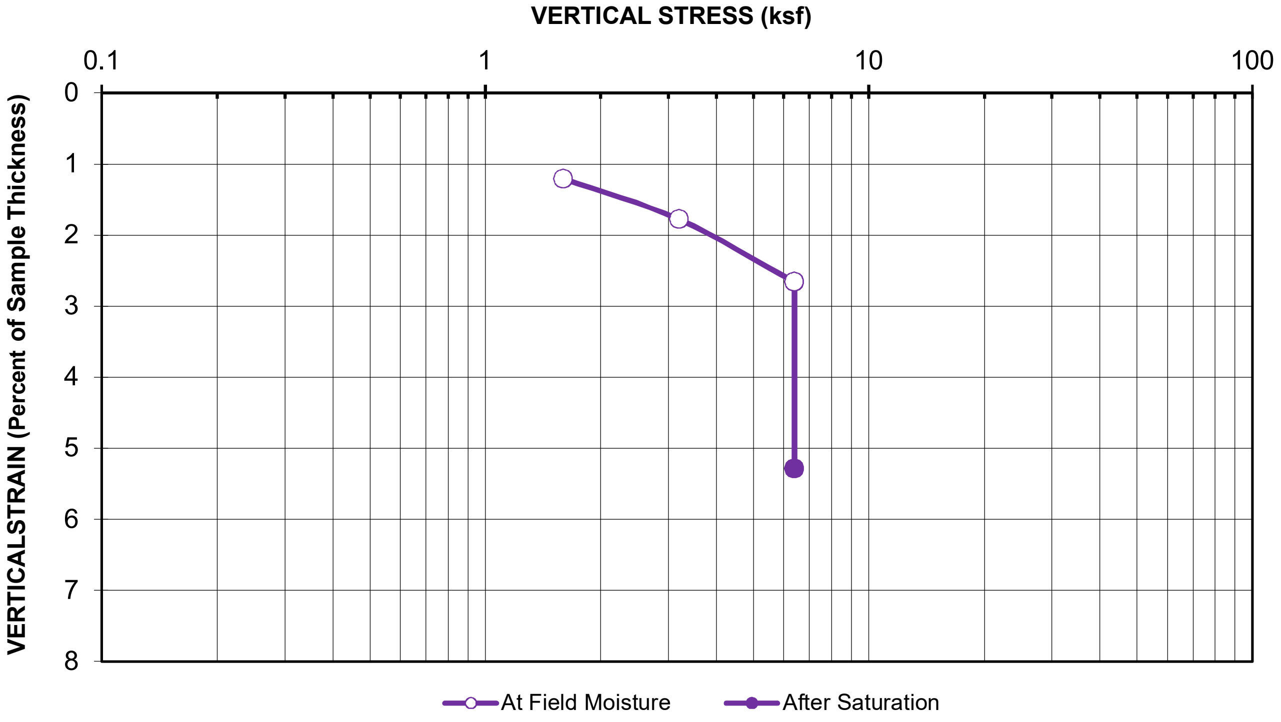
Initial Dry Unit Weight (pcf): 111.0
Initial Moisture Content (%): 8.3
Final Moisture Content (%): 17.3
Initial Void Ratio: 0.52

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143







Boring No. : HSA-1
Sample No.: HSA-1@5
Depth (feet): 6-6.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 2.63% upon inundation

Initial Dry Unit Weight (pcf): 113.1
Initial Moisture Content (%): 8.3
Final Moisture Content (%): 16.7
Initial Void Ratio: 0.49

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

PERCENT PASSING NO. 200 SIEVE

ASTM D1140

Client:	Geosyntec Consultants, Inc.	AP Lab No.:	21-0143
Project Name:	SCG Honor Rancho	Test Date:	01/29/21
Project Number:	SC0766U-04		

Boring No.	Sample No.	Depth (ft)	Percent Fines (%)
HSA-2	HSA-2@3	3-4.5	38.4
HSA-2	HSA-2@10	11-11.5	44.1
HSA-2	HSA-2@15	15-16.5	42.8

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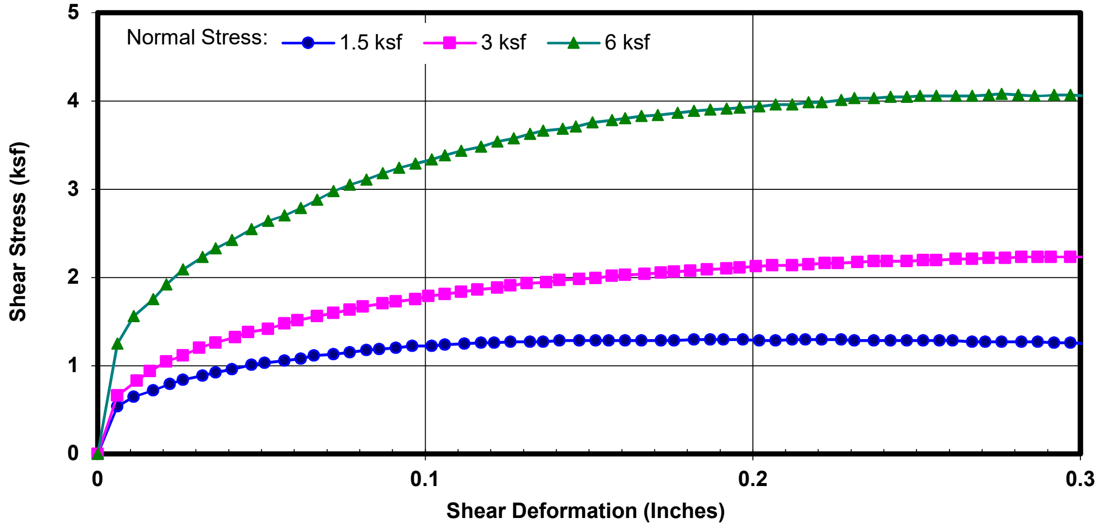
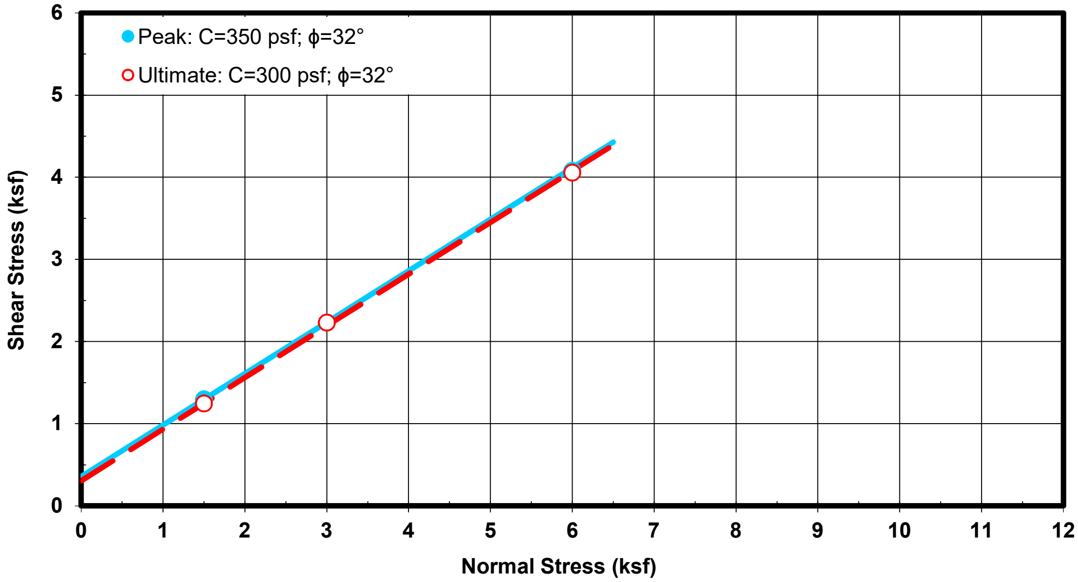
DIRECT SHEAR TEST RESULTS
ASTM D 3080

Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Boring No.: HSA-2
Sample No.: HSA-2@10 **Depth (ft):** 11-11.5
Sample Type: Mod. Cal.
Soil Description: Clayey Sand
Test Condition: Unsaturated **Shear Type:** Regular

Tested By: ST **Date:** 01/28/21
Computed By: NR **Date:** 02/01/21
Checked by: AP **Date:** 02/02/21

Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)	Initial Degree Saturation (%)	Final Degree Saturation (%)	Normal Stress (ksf)	Peak Shear Stress (ksf)	Ultimate Shear Stress (ksf)
119.7	111.4	7.4	7.8	39	41	1.5	1.296	1.248
						3	2.232	2.232
						6	4.080	4.056





MOISTURE AND DENSITY TEST RESULTS

ASTM D2216 and ASTM D7263 (Method B)

Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

AP Lab No.: 21-0143
Test Date: 01/27/21

Boring No.	Sample No.	Sample Depth (ft.)	Moisture Content (%)	Dry Density (pcf)
HSA-2	HSA-2@3	3-4.5	6.9	NA
HSA-2	HSA-2@15	15-16.5	5.5	NA
HSA-2	HSA-2@25	25-26.5	6.6	NA

R-VALUE TEST DATA

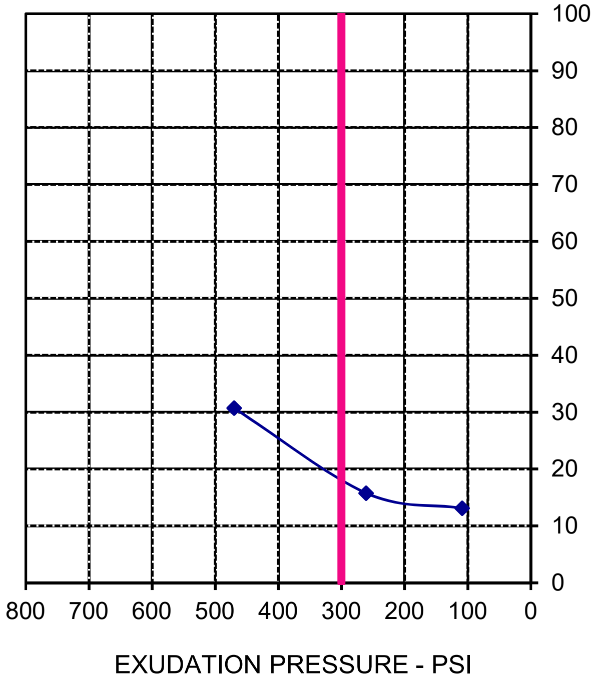
ASTM D2844

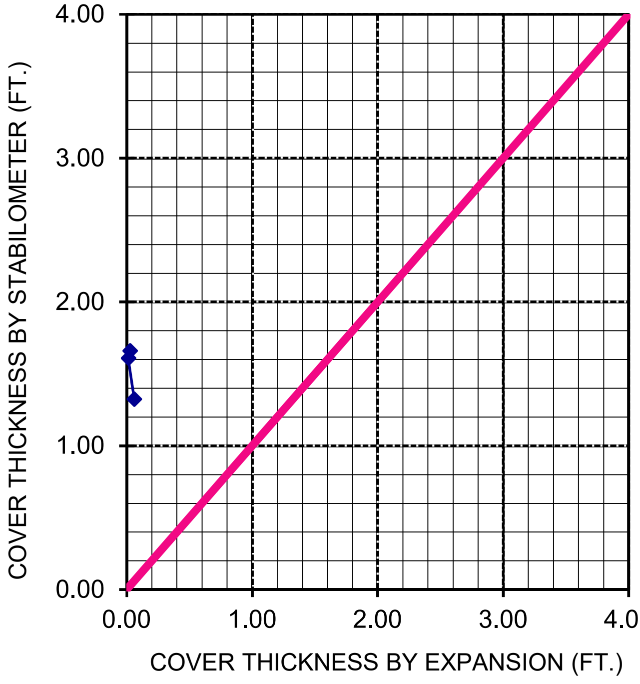
Project Name: SCG Honor Rancho
Project Number: SC0766U-04
Boring No.: HSA-2
Sample No.: HSA-2@0-5 Depth (ft.): 0-5
Location: N/A
Soil Description: Clayey Sand

Tested By: ST Date: 01/26/21
Computed By: KM Date: 01/28/21
Checked By: AP Date: 02/02/21

Mold Number	A	B	C	
Water Added, g	45	59	65	
Compact Moisture(%)	10.0	11.5	12.1	
Compaction Gage Pressure, psi	250	100	50	
Exudation Pressure, psi	470	261	109	
Sample Height, Inches	2.4	2.5	2.5	
Gross Weight Mold, g	3054	3067	3076	
Tare Weight Mold, g	1967	1967	1969	
Net Sample Weight, g	1086	1100	1107	
Expansion, inchesx10^{-4}	18	4	8	
Stability 2,000 (160 psi)	38/90	53/120	53/123	
Turns Displacement	4.00	4.45	4.98	
R-Value Uncorrected	33	16	13	
R-Value Corrected	31	16	13	
Dry Density, pcf	124.7	119.6	119.7	
Traffic Index	8.0	8.0	8.0	
G.E. by Stability	1.32	1.61	1.66	
G.E. by Expansion	0.06	0.01	0.03	

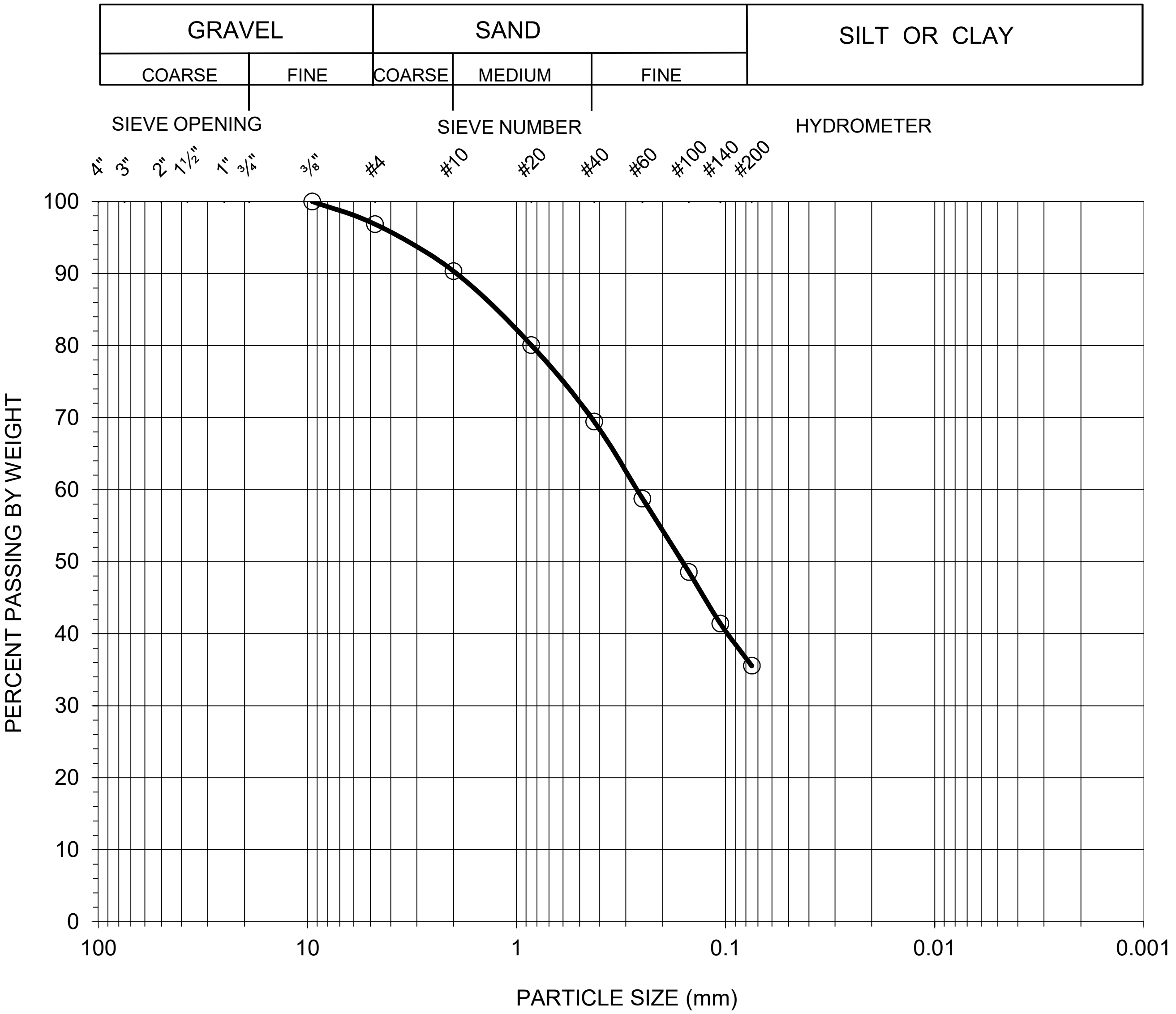
R-VALUE	By Exudation:	18
	By Expansion:	*N/A
	At Equilibrium: (by Exudation)	18
Remarks	Gf = 1.34, and 1.3 % Retained on the ¾" *Not Applicable	





GRAIN SIZE DISTRIBUTION CURVE
ASTM D 6913

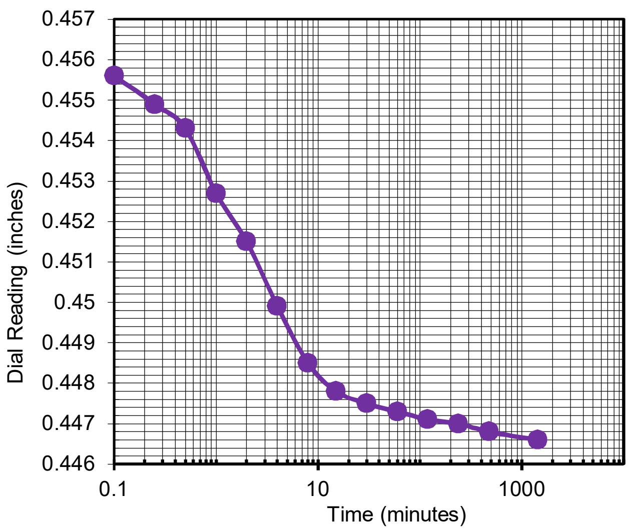
Client Name:	Geosyntec Consultants, Inc.	Tested by:	SM	Date:	01/29/21
Project Name:	SCG Honor Rancho	Computed by:	NR	Date:	02/01/21
Project No.:	SC0766U-04	Checked by:	AP	Date:	02/02/21



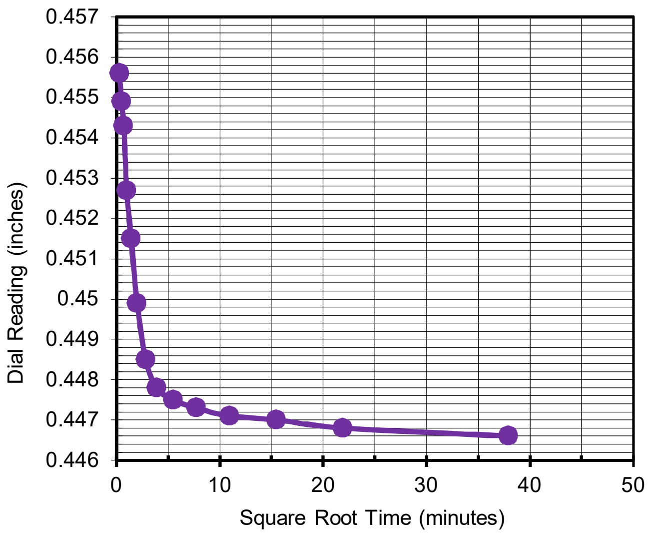
Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Type U.S.C.S
				Gravel	Sand	Silt & Clay		
○	HSA-2	HSA-2@25	25-26.5	3	61	36	N/A	SC*

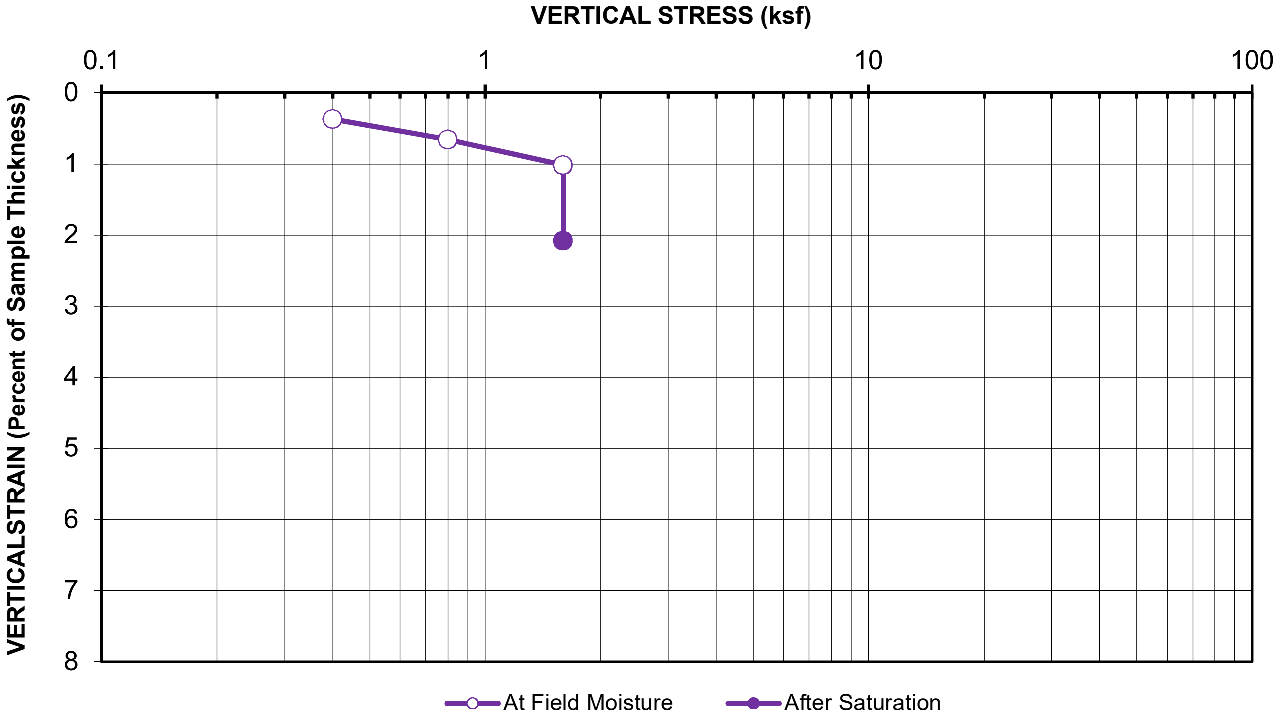
**Note: Based on visual classification of sample*

Time Readings @ H2O ksf



Time Readings @ H2O ksf





Boring No. : HSA-2
Sample No.: HSA-2@10
Depth (feet): 11-11.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 1.06% upon inundation

Initial Dry Unit Weight (pcf): 113.3
Initial Moisture Content (%): 7.4
Final Moisture Content (%): 16.1
Initial Void Ratio: 0.49

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

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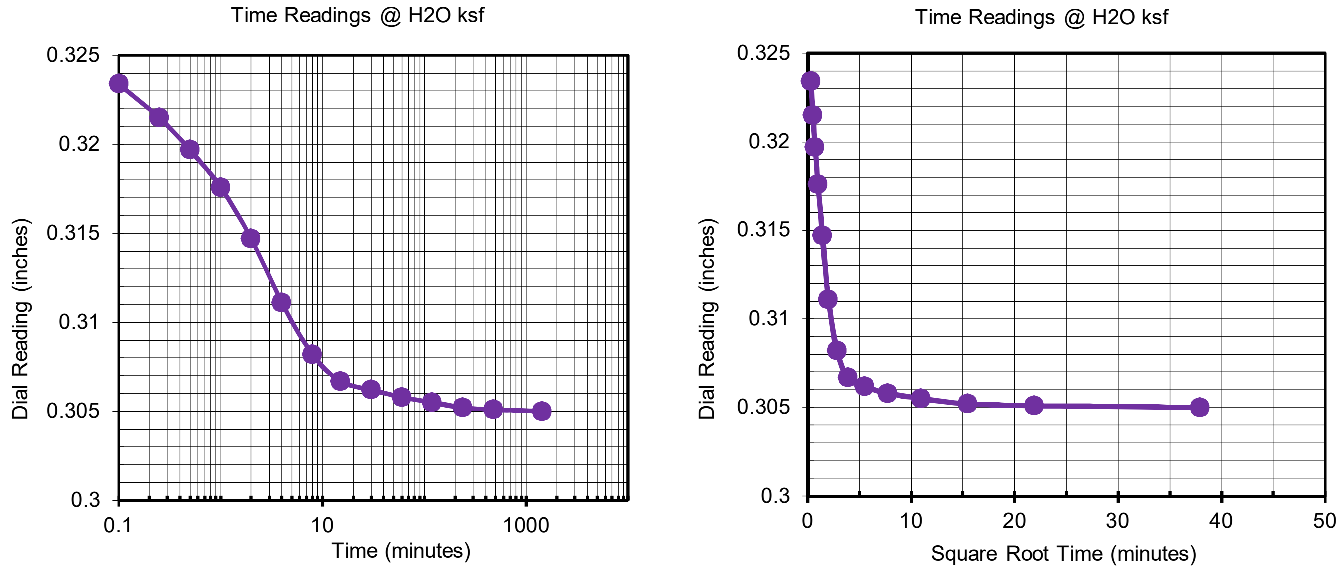

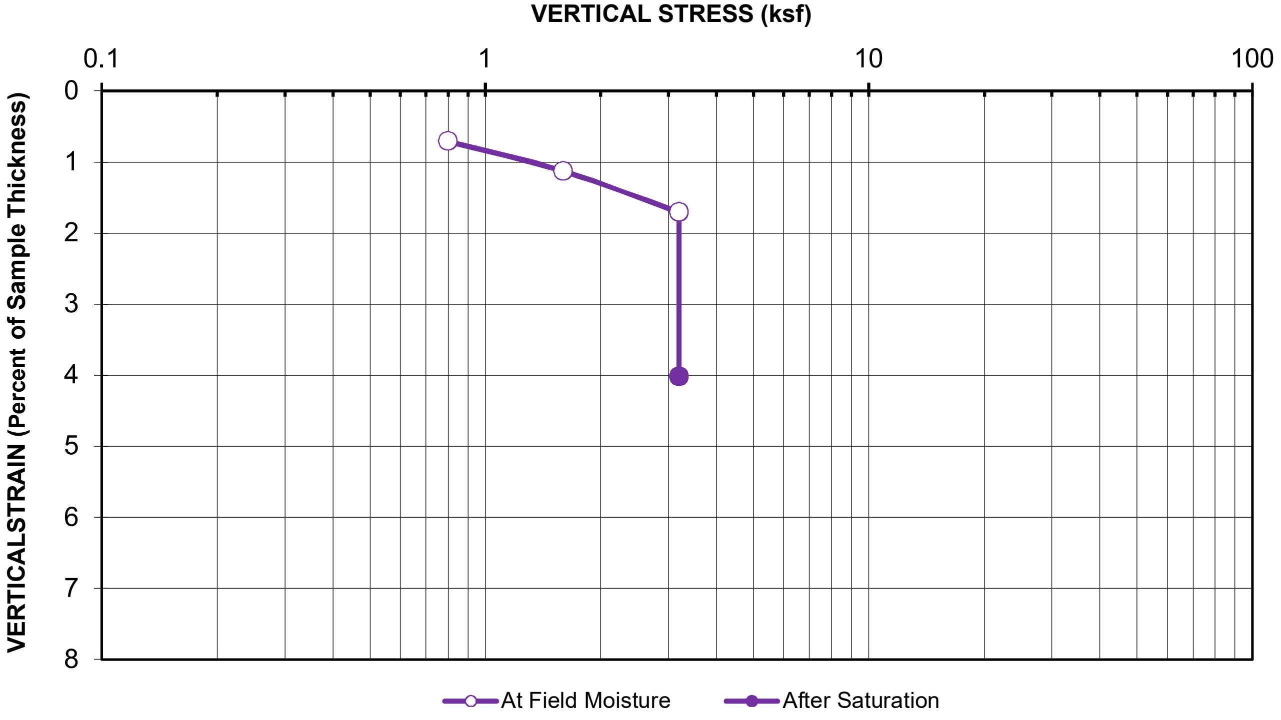

Boring No. : HSA-2
Sample No.: HSA-2@10
Depth (feet): 11-11.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 2.31% upon inundation

Initial Dry Unit Weight (pcf): 114.1
Initial Moisture Content (%): 7.4
Final Moisture Content (%): 15.1
Initial Void Ratio: 0.48

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

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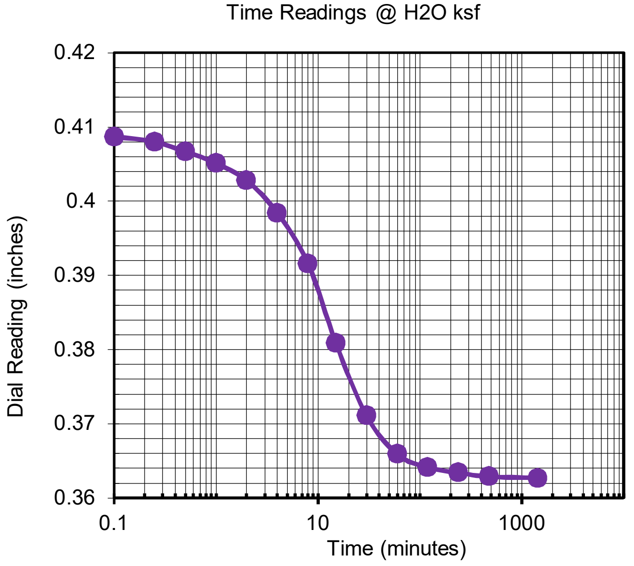

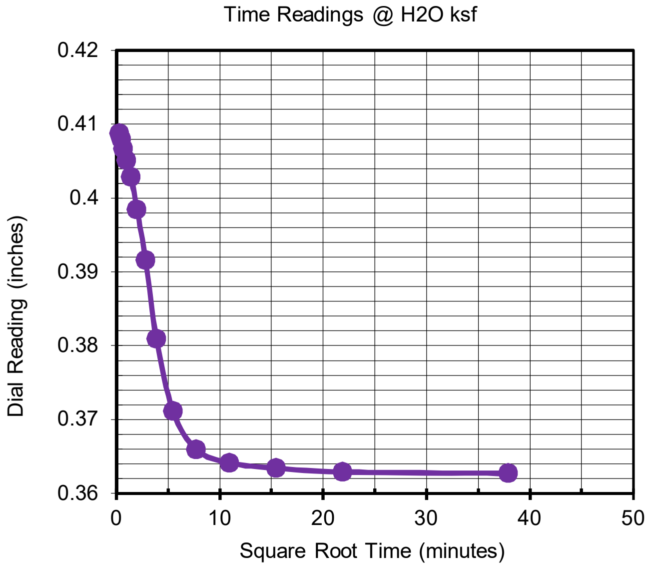

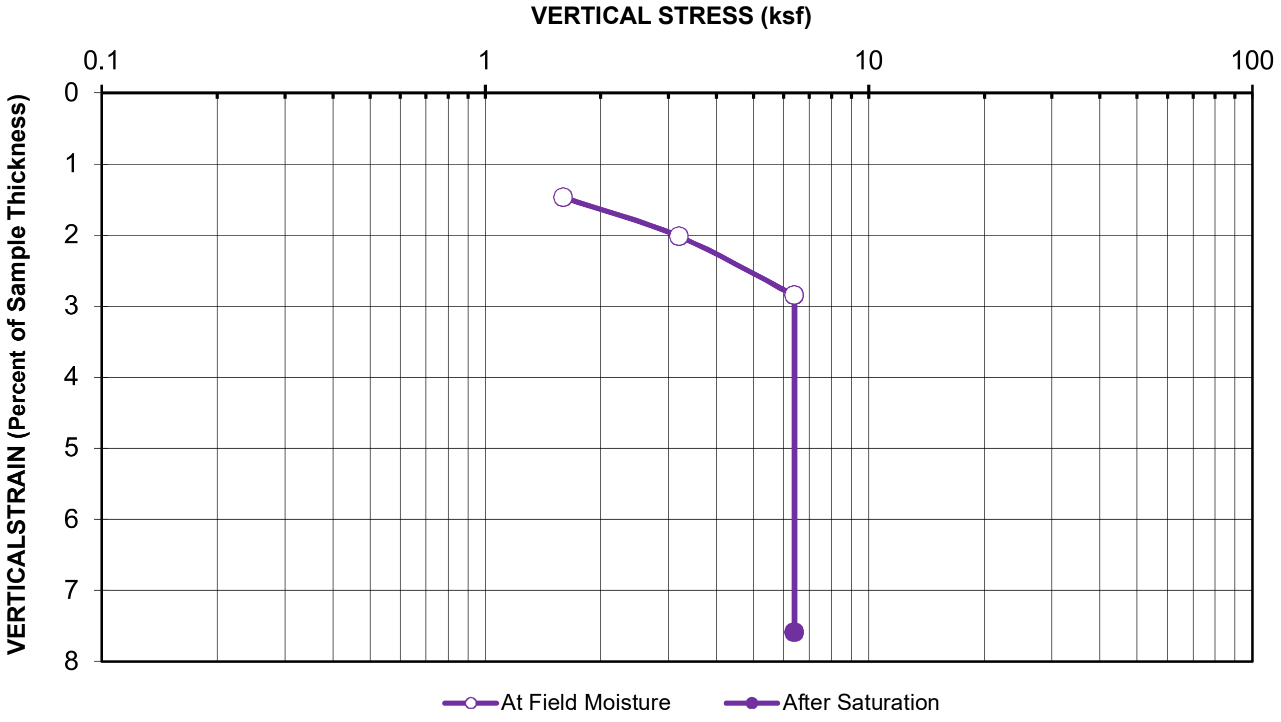

Boring No. : HSA-2
Sample No.: HSA-2@10
Depth (feet): 11-11.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 4.74% upon inundation

Initial Dry Unit Weight (pcf): 113.6
Initial Moisture Content (%): 7.4
Final Moisture Content (%): 15.1
Initial Void Ratio: 0.48

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

PERCENT PASSING NO. 200 SIEVE

ASTM D1140

Client:	Geosyntec Consultants, Inc.	AP Lab No.:	21-0143
Project Name:	SCG Honor Rancho	Test Date:	01/27/21
Project Number:	SC0766U-04		

Boring No.	Sample No.	Depth (ft)	Percent Fines (%)
TPB-1	TPB-1@5	5-6.5	71.5

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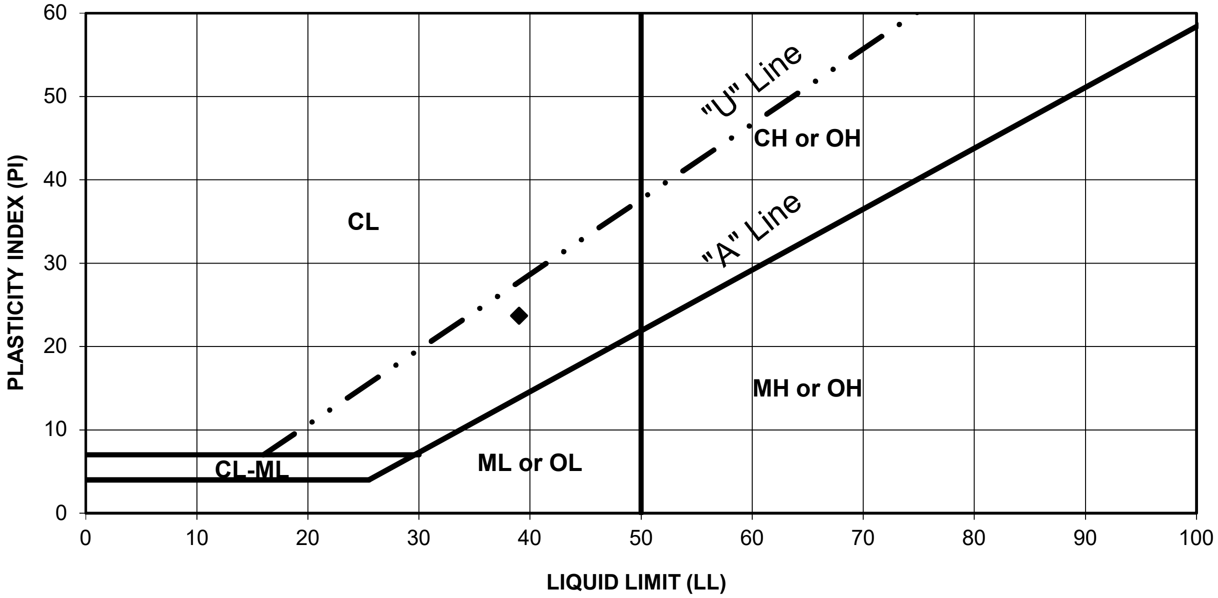
ATTERBERG LIMITS
ASTM D 4318

Client Name: Geosyntec Consultants, Inc. Tested By: DK Date: 01/27/21
Project Name: SCG Honor Rancho Computed By: NR Date: 01/29/21
Project No.: SC0766U-04 Checked By: AP Date: 02/02/21



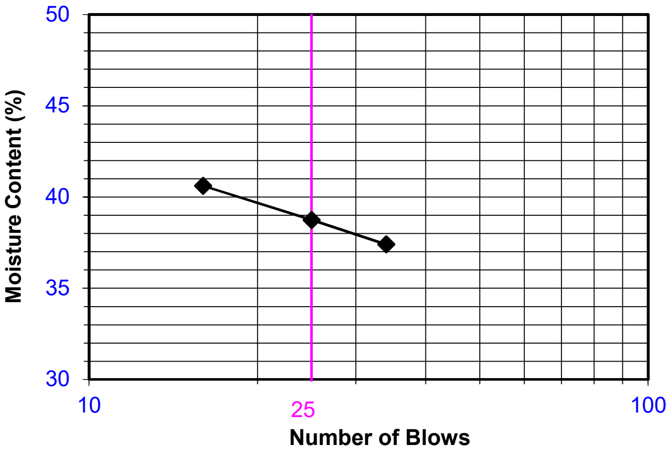
PROCEDURE USED

☐ Wet Preparation

☒ Dry Preparation

☒ Procedure A
Multipoint Test

☐ Procedure B
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
◆	TPB-1	TPB-1@5	5-6.5	39	15	24	CL

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MOISTURE AND DENSITY TEST RESULTS

ASTM D2216 and ASTM D7263 (Method B)

Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

AP Lab No.: 21-0143
Test Date: 01/27/21

Boring No.	Sample No.	Sample Depth (ft.)	Moisture Content (%)	Dry Density (pcf)
TPB-1	TPB-1@10	10-10.75	7.5	112.8

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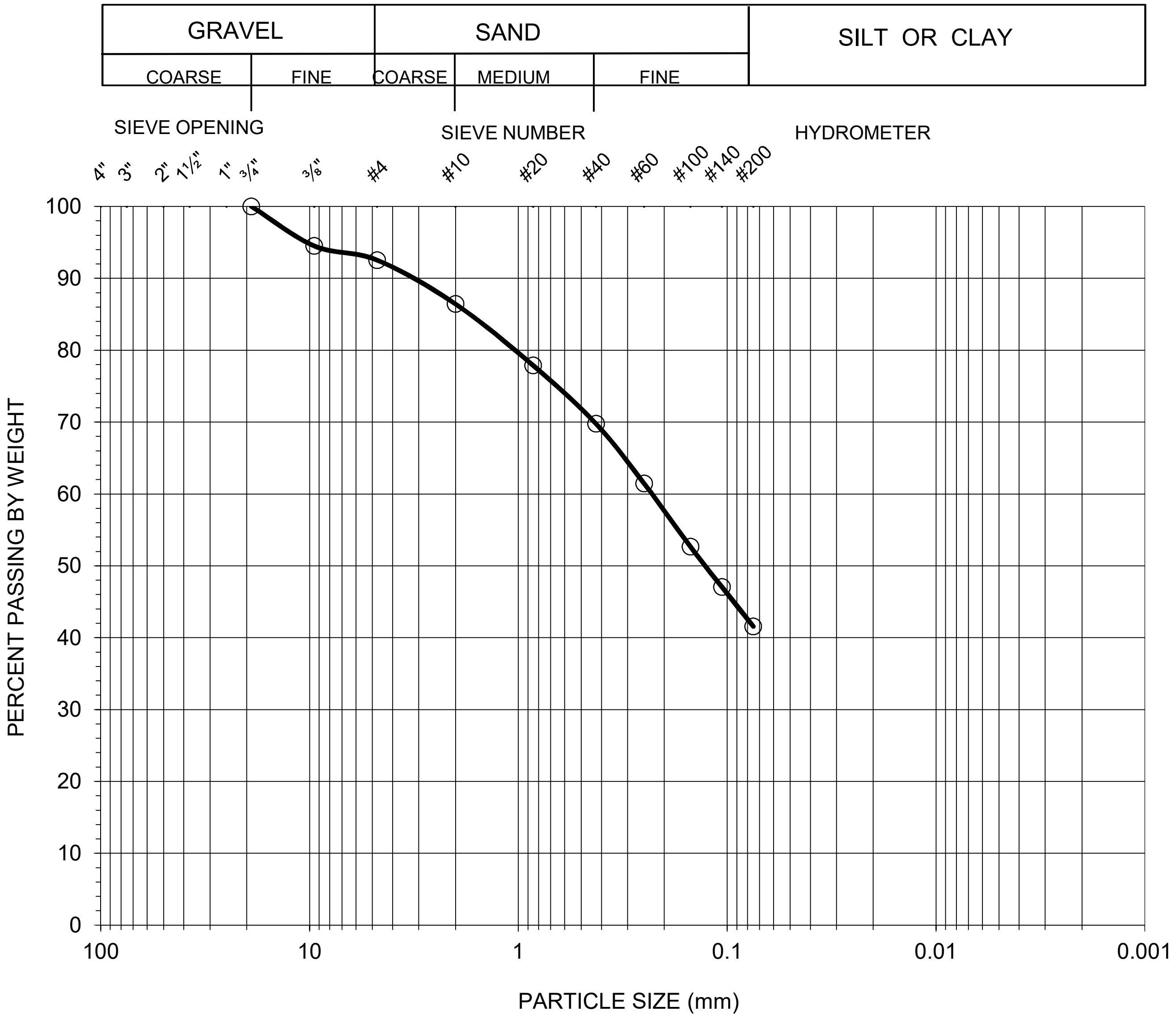
GRAIN SIZE DISTRIBUTION CURVE
ASTM D 6913

Client Name:	Geosyntec Consultants, Inc.	Tested by:	DK	Date:	02/01/21
Project Name:	SCG Honor Rancho	Computed by:	NR	Date:	02/02/21
Project No.:	SC0766U-04	Checked by:	AP	Date:	02/02/21



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Type U.S.C.S
				Gravel	Sand	Silt & Clay		
○	TPB-1	TPB-1@10	10-10.75	7	51	42	N/A	SC*

**Note: Based on visual classification of sample*

PERCENT PASSING NO. 200 SIEVE

ASTM D1140

Client:	Geosyntec Consultants, Inc.	AP Lab No.:	21-0143
Project Name:	SCG Honor Rancho	Test Date:	01/27/21
Project Number:	SC0766U-04		

Boring No.	Sample No.	Depth (ft)	Percent Fines (%)
TPB-2	TPB-2@5	5-6.5	66.9

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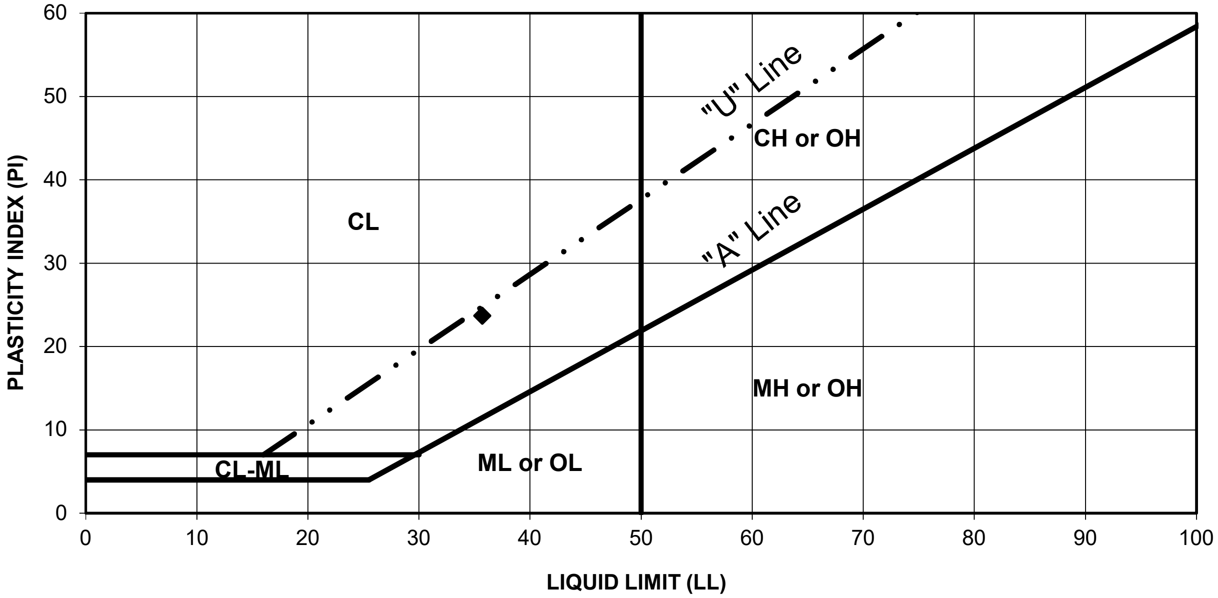
ATTERBERG LIMITS
ASTM D 4318

Client Name: Geosyntec Consultants, Inc. Tested By: DK Date: 01/27/21
Project Name: SCG Honor Rancho Computed By: NR Date: 01/29/21
Project No.: SC0766U-04 Checked By: AP Date: 02/02/21



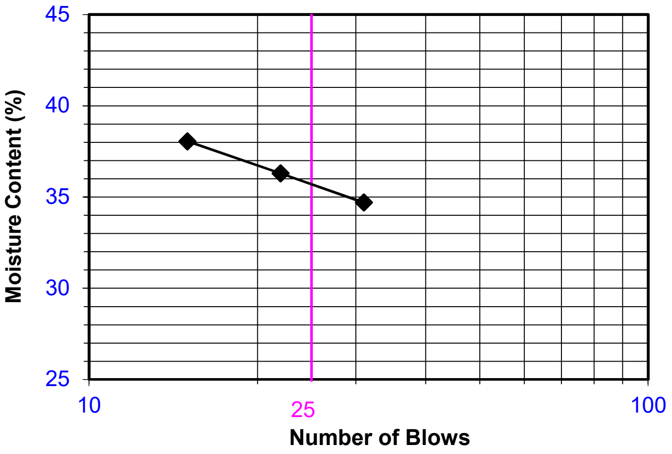
PROCEDURE USED

☐ Wet Preparation

☒ Dry Preparation

☒ Procedure A
Multipoint Test

☐ Procedure B
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
◆	TPB-2	TPB-2@5	5-6.5	36	12	24	CL

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COMPACTION TEST

Client: Geosyntec Consultants, Inc.
AP Number: 21-0143
Project Name: SCG Honor Rancho
Tested By: SM
Date: 01/29/21
Project No. : SC0766U-04
Calculated By: NR
Date: 02/01/21
Boring No.: TPB-2
Checked By: AP
Date: 02/02/21
Sample No.: TPB-2@0-5
Depth (ft.): 0-5
Visual Sample Description: Clayey Sand

Compaction Method
☒ ASTM D1557
☐ ASTM D698

Preparation Method
☐ Moist
☒ Dry

METHOD: A
MOLD VOLUME (CU.FT): 0.0333

Wt. Comp. Soil + Mold (gm.)	3840	3998	4008	3946		
Wt. of Mold (gm.)	1863	1863	1863	1863		
Net Wt. of Soil (gm.)	1977	2135	2145	2083		
Container No.						
Wt. of Container (gm.)	139.28	136.01	145.73	146.79		
Wet Wt. of Soil + Cont. (gm.)	564.78	517.17	493.98	454.51		
Dry Wt. of Soil + Cont. (gm.)	542.31	488.34	461.35	420.37		
Moisture Content (%)	5.58	8.18	10.34	12.48		
Wet Density (pcf)	130.75	141.17	141.83	137.76		
Dry Density (pcf)	123.85	130.49	128.54	122.48		

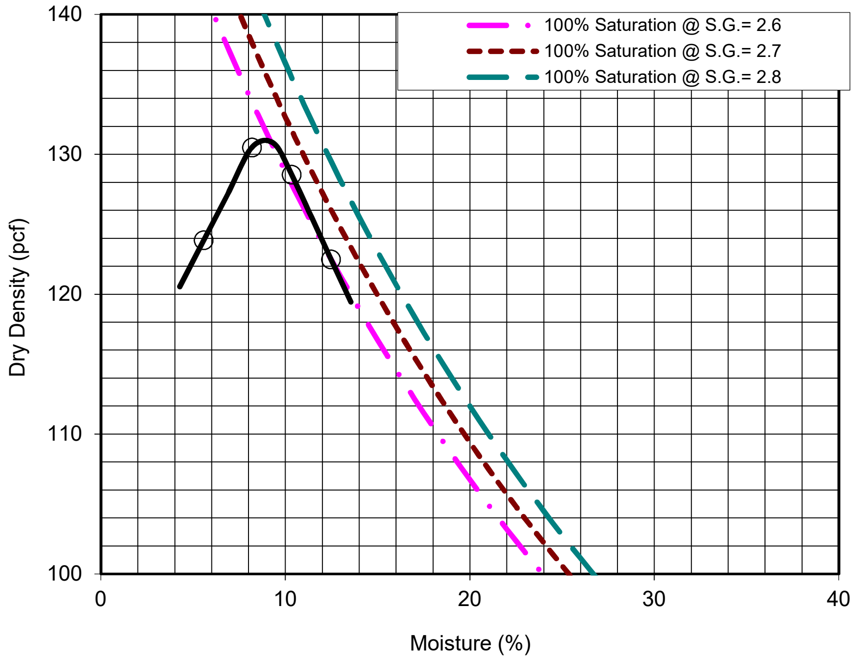
Maximum Dry Density (pcf): **130.8**
Maximum Dry Density w/ Rock Correction (pcf): **132.7**
Optimum Moisture Content (%): **8.8**
Optimum Moisture Content w/ Rock Correction (%): **8.2**

PROCEDURE USED

☒ *METHOD A: Percent of Oversize:* *6.3%*
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)

☐ *METHOD B: Percent of Oversize:* *N/A*
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)

☐ *METHOD C: Percent of Oversize:* *N/A*
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)



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MOISTURE AND DENSITY TEST RESULTS

ASTM D2216 and ASTM D7263 (Method B)

Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

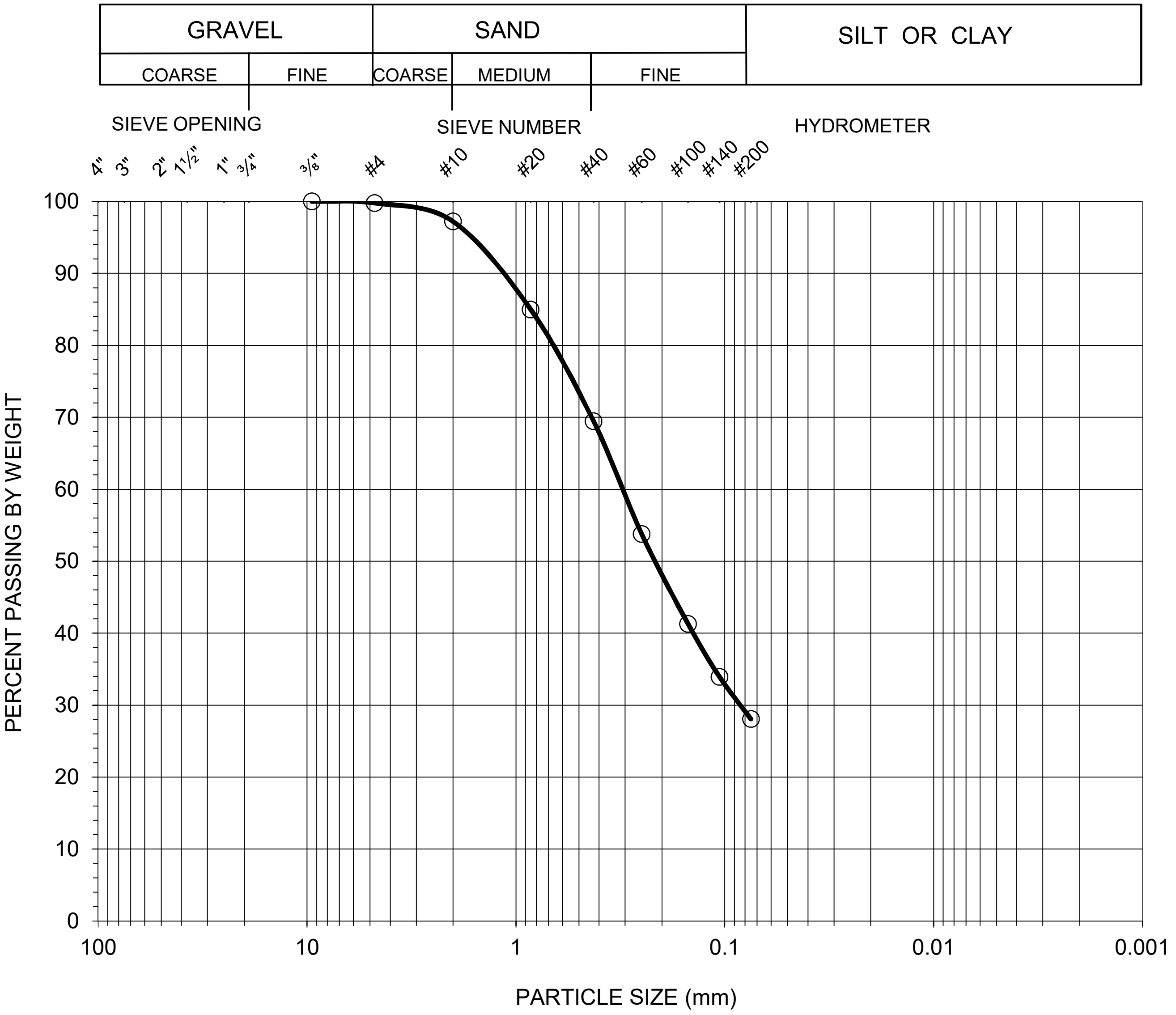
AP Lab No.: 21-0143
Test Date: 01/27/21

Boring No.	Sample No.	Sample Depth (ft.)	Moisture Content (%)	Dry Density (pcf)
TPB-2	TPB-2@10	10-10.7	5.1	NA

GRAIN SIZE DISTRIBUTION CURVE
ASTM D 6913

Client Name: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

Tested by: DK Date: 02/01/21
Computed by: NR Date: 02/02/21
Checked by: AP Date: 02/02/21



Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Type U.S.C.S
				Gravel	Sand	Silt & Clay		
○	TPB-2	TPB-2@10	10-10.7	0	72	28	N/A	SM

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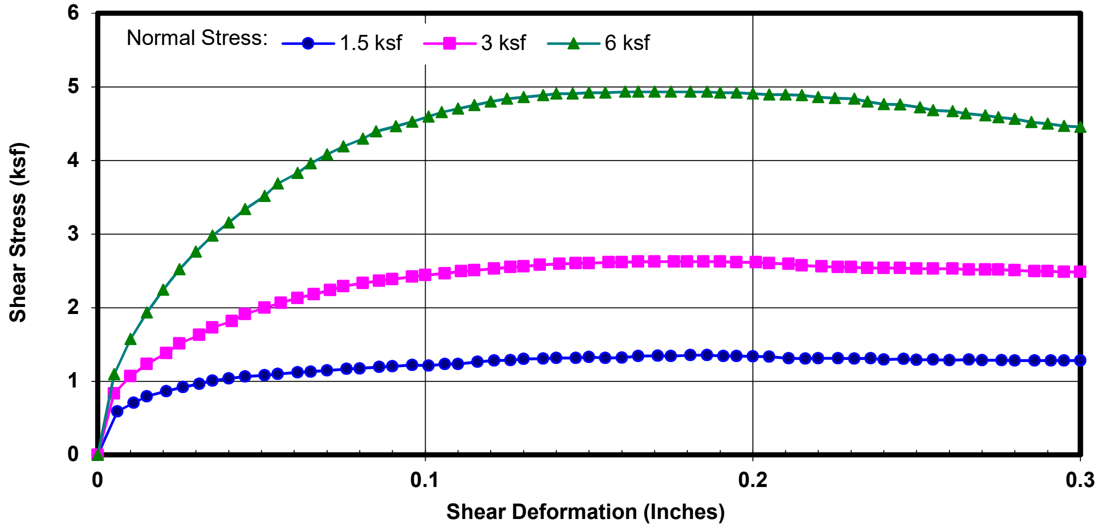
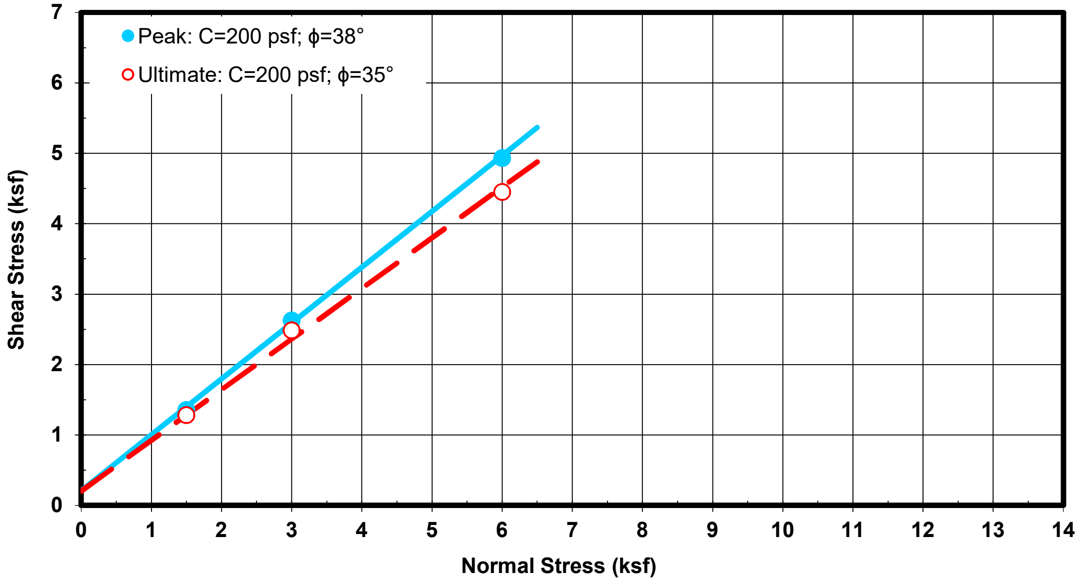
DIRECT SHEAR TEST RESULTS
ASTM D 3080

Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Boring No.: B-1
Sample No.: B-1@6.5-7 **Depth (ft):** 6.5-7
Sample Type: Mod. Cal.
Soil Description: Clayey Sand
Test Condition: Unsaturated **Shear Type:** Regular

Tested By: ST **Date:** 01/28/21
Computed By: NR **Date:** 02/01/21
Checked by: AP **Date:** 02/02/21

Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)	Initial Degree Saturation (%)	Final Degree Saturation (%)	Normal Stress (ksf)	Peak Shear Stress (ksf)	Ultimate Shear Stress (ksf)
126.5	115.7	9.3	9.5	55	56	1.5	1.354	1.282
						3	2.624	2.484
						6	4.932	4.453



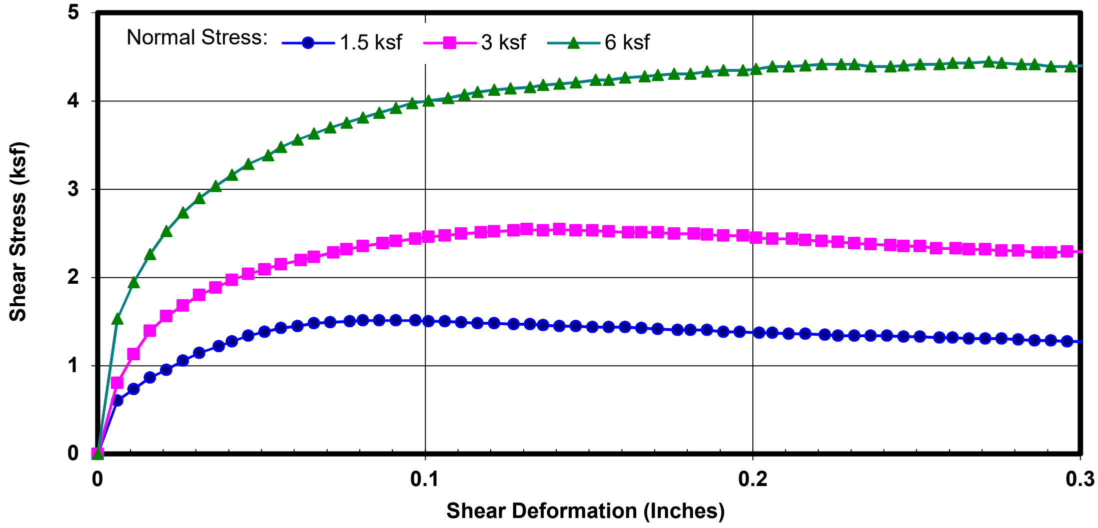


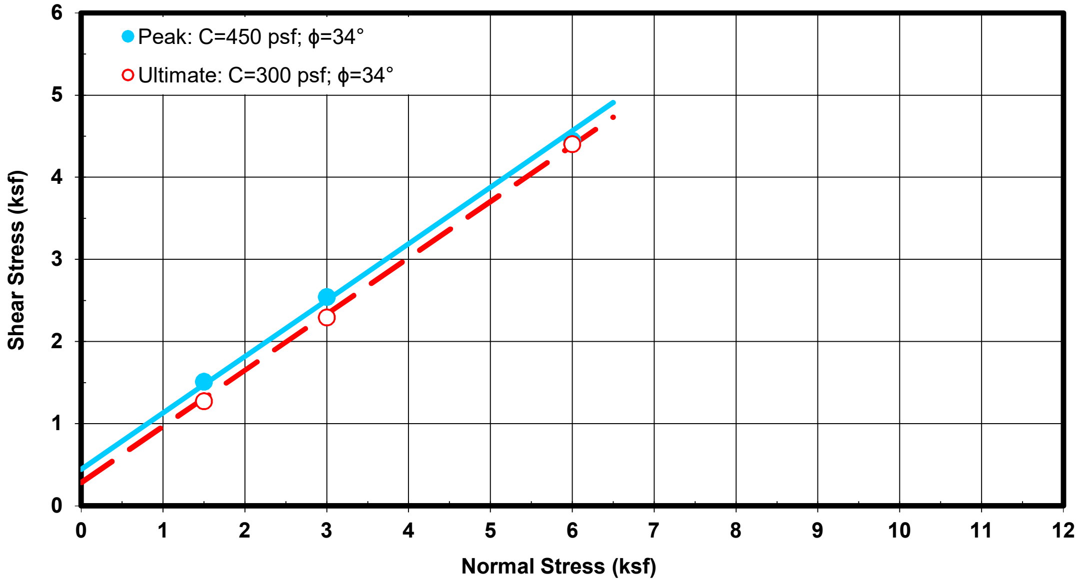
DIRECT SHEAR TEST RESULTS
ASTM D 3080

Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Boring No.: B-1
Sample No.: B-1@11-11.5 **Depth (ft):** 11-11.5
Sample Type: Mod. Cal.
Soil Description: Clayey Sand
Test Condition: Unsaturated **Shear Type:** Regular

Tested By: LS **Date:** 01/29/21
Computed By: NR **Date:** 02/01/21
Checked by: AP **Date:** 02/02/21

Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)	Initial Degree Saturation (%)	Final Degree Saturation (%)	Normal Stress (ksf)	Peak Shear Stress (ksf)	Ultimate Shear Stress (ksf)
131.2	118.2	10.9	10.4	69	66	1.5	1.512	1.274
						3	2.544	2.292
						6	4.444	4.402





PERCENT PASSING NO. 200 SIEVE

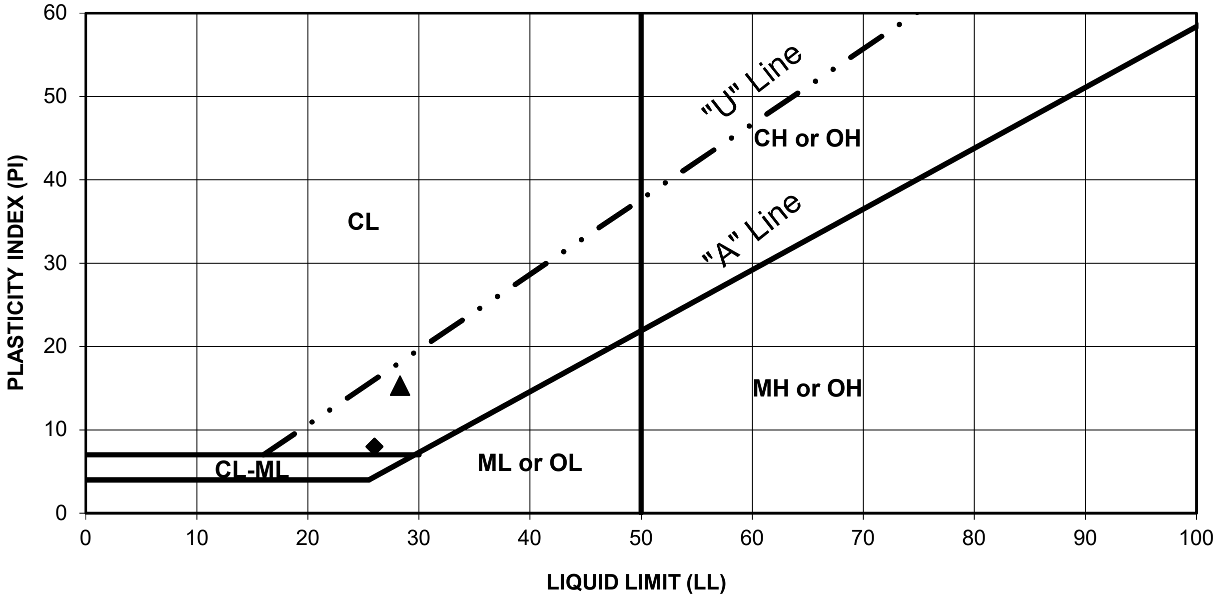
ASTM D1140

Client: Geosyntec Consultants, Inc.
AP Lab No.: 21-0143
Project Name: SCG Honor Rancho
Test Date: 01/27/21
Project Number: SC0766U-04

Boring No.	Sample No.	Depth (ft)	Percent Fines (%)
B-1	B-1@6-7	6-7	40.7
B-1	B-1@10.5-11.5	10.5-11.5	29.4
B-1	B-1@30	30-31.5	29.5

ATTERBERG LIMITS
ASTM D 4318

Client Name: Geosyntec Consultants, Inc. Tested By: DK Date: 01/27/21
Project Name: SCG Honor Rancho Computed By: NR Date: 01/29/21
Project No.: SC0766U-04 Checked By: AP Date: 02/02/21



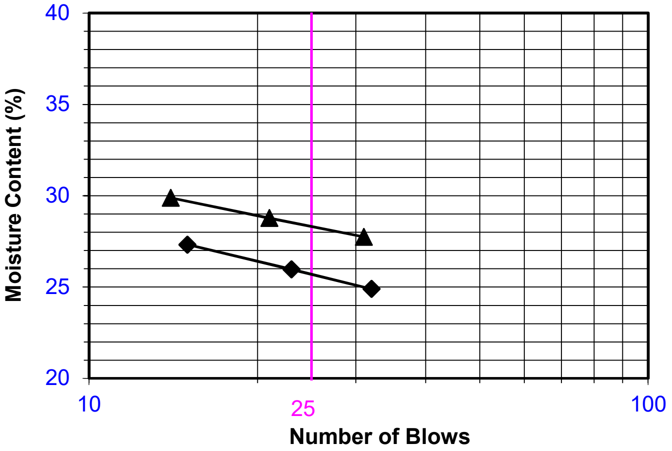
PROCEDURE USED

☐ Wet Preparation

☒ Dry Preparation

☒ Procedure A
Multipoint Test

☐ Procedure B
One-point Test



Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
◆	B-1	B-1@1-5	1-5	26	18	8	CL
▲	B-1	B-1@ 10.5-11.5	10.5-11.5	28	13	15	CL

MOISTURE AND DENSITY TEST RESULTS

ASTM D2216 and ASTM D7263 (Method B)

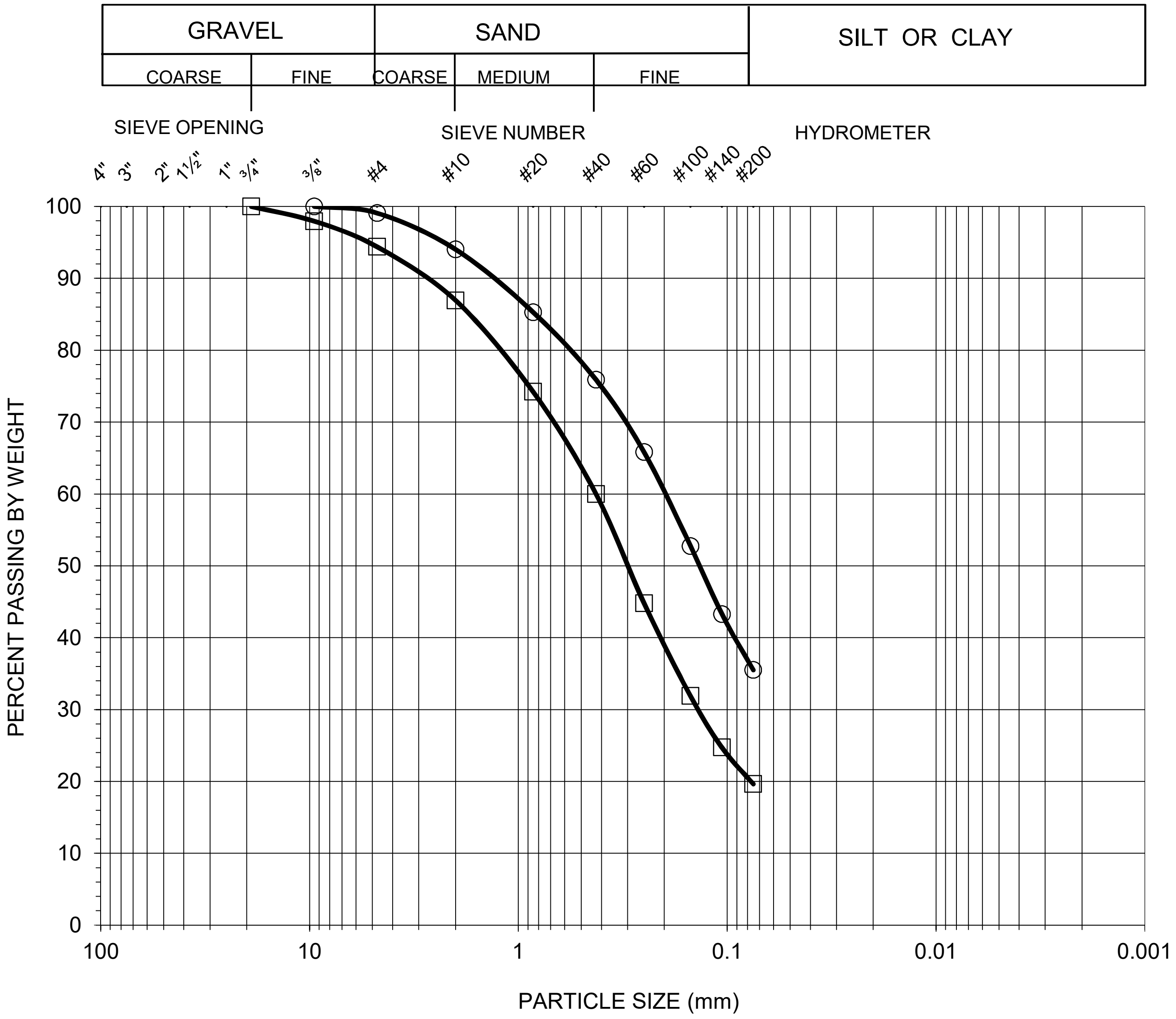
Client: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

AP Lab No.: 21-0143
Test Date: 01/27/21

Boring No.	Sample No.	Sample Depth (ft.)	Moisture Content (%)	Dry Density (pcf)
B-1	B-1@20	20-21.5	10.0	NA
B-1	B-1@30	30-31.5	9.8	NA

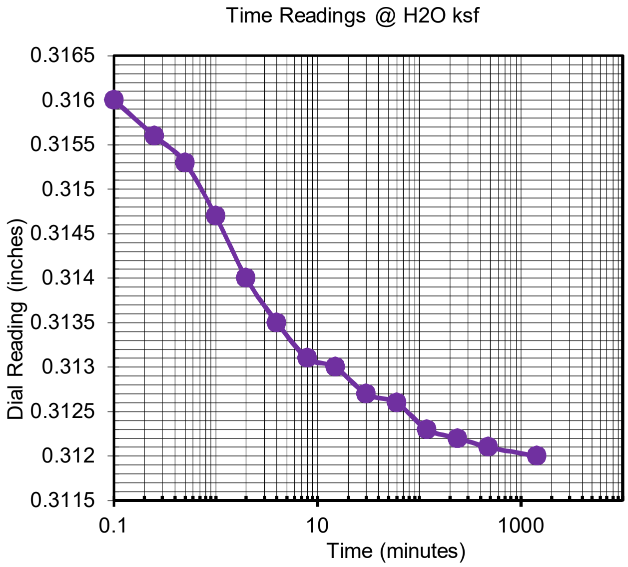
GRAIN SIZE DISTRIBUTION CURVE
ASTM D 6913

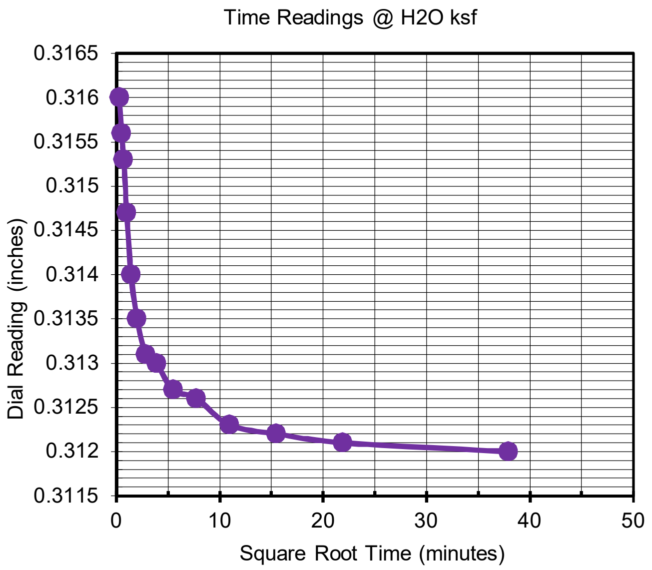
Client Name: Geosyntec Consultants, Inc. Tested by: DK Date: 02/01/21
Project Name: SCG Honor Rancho Computed by: NR Date: 02/02/21
Project No.: SC0766U-04 Checked by: AP Date: 02/02/21

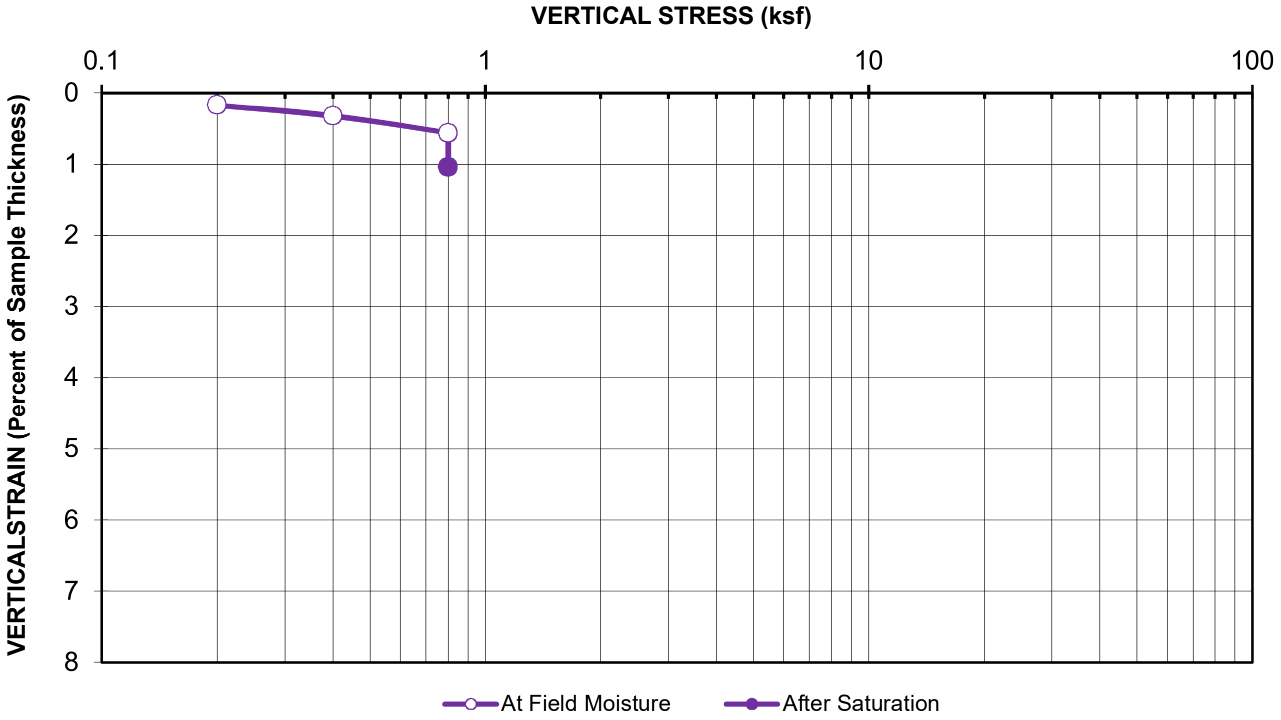


Symbol	Boring No.	Sample No.	Sample Depth (feet)	Percent			Atterberg Limits LL:PL:PI	Soil Type U.S.C.S
				Gravel	Sand	Silt & Clay		
○	B-1	B-1@1-5	1-5	1	64	35	26:18:8	SC
□	B-1	B-1@20	20-21.5	6	74	20	N/A	SC*

**Note: Based on visual classification of sample*







Boring No. : B-1
Sample No.: B-1@6-6.5
Depth (feet): 6-6.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 0.48% upon inundation

Initial Dry Unit Weight (pcf): 109.5
Initial Moisture Content (%): 7.9
Final Moisture Content (%): 19.4
Initial Void Ratio: 0.54

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

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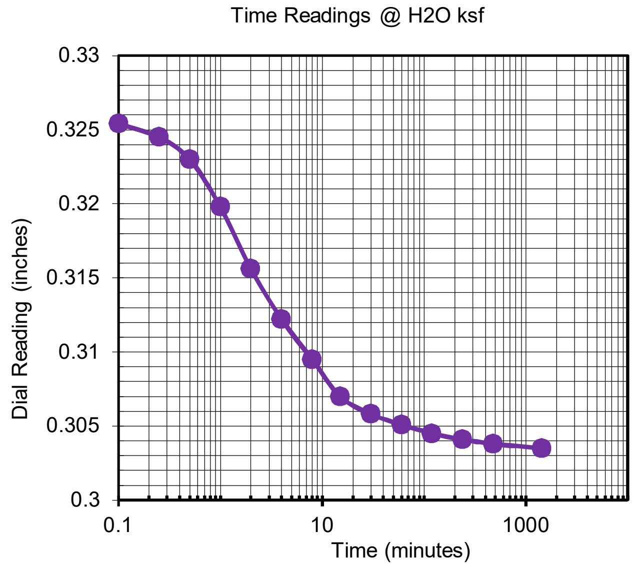

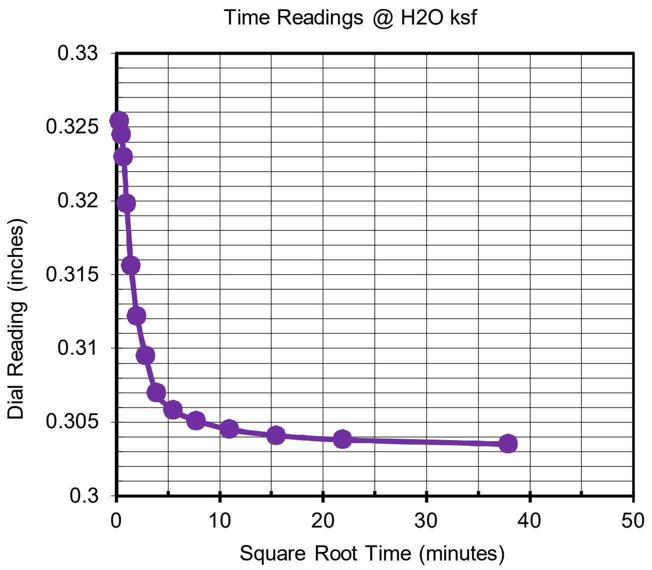

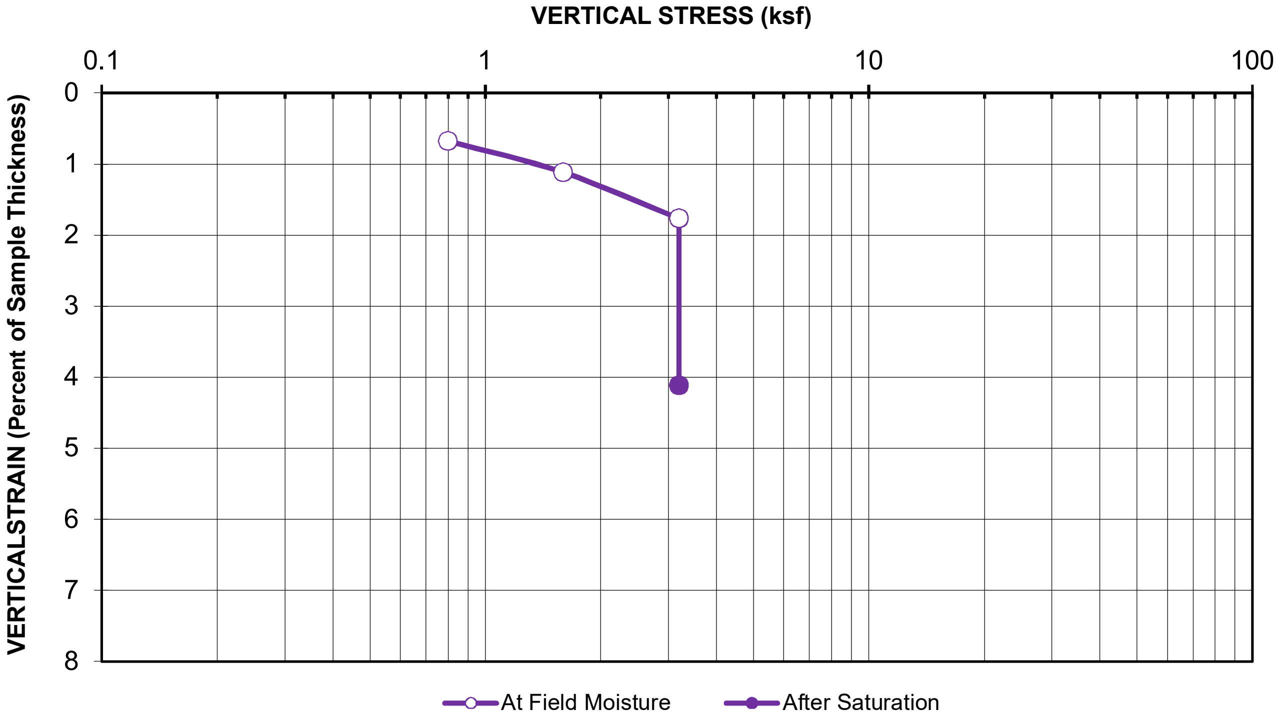

Boring No. : B-1
Sample No.: B-1@6-6.5
Depth (feet): 6-6.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 2.35% upon inundation

Initial Dry Unit Weight (pcf): 110.2
Initial Moisture Content (%): 7.9
Final Moisture Content (%): 18.1
Initial Void Ratio: 0.53

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

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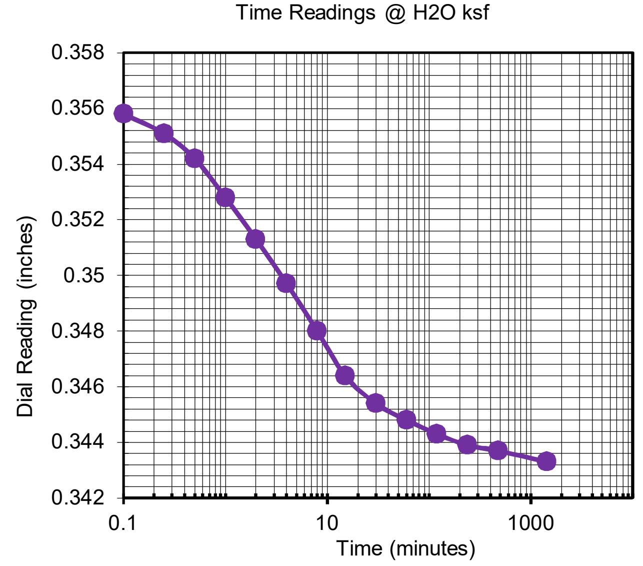

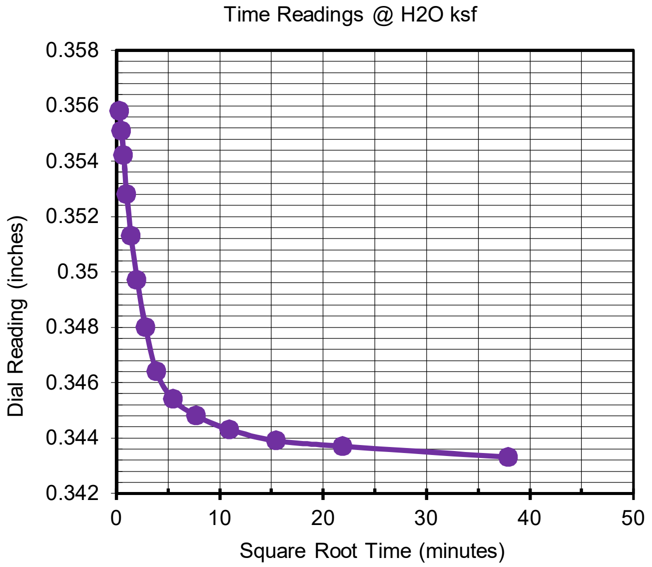

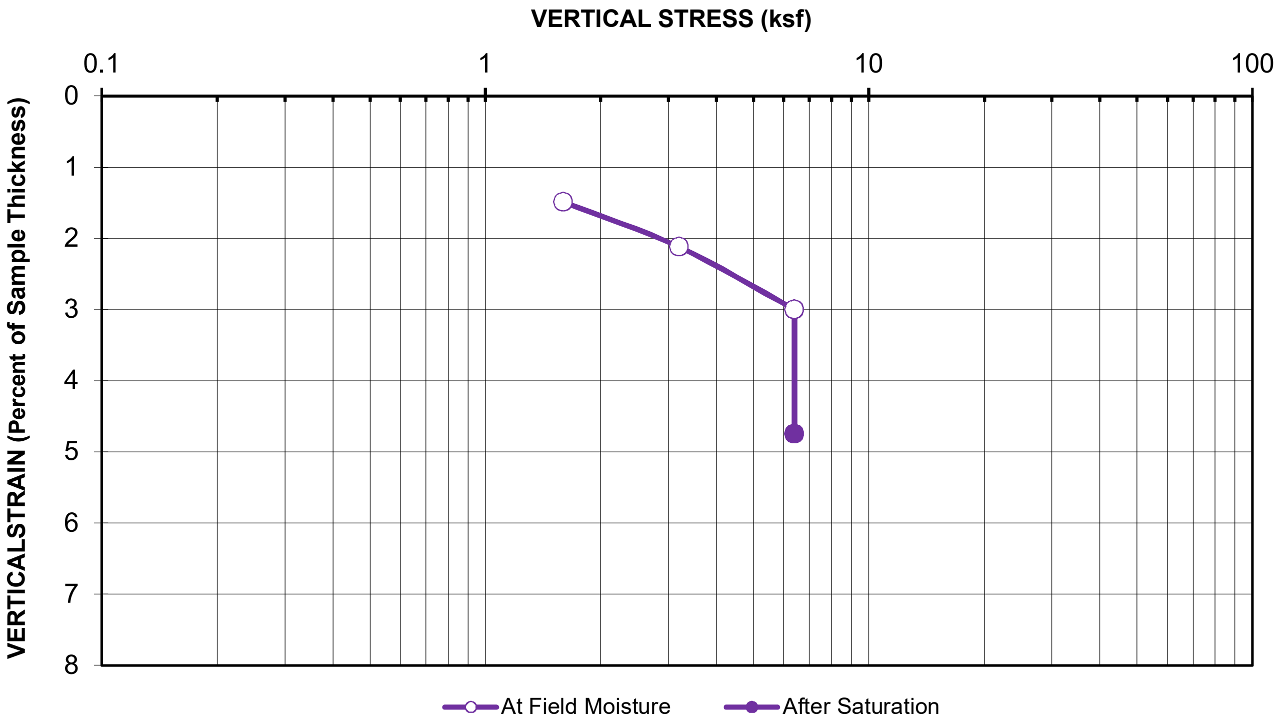

Boring No. : B-1
Sample No.: B-1@6-6.5
Depth (feet): 6-6.5
Sample Type: Mod Cal
Soil Description: Clayey Sand
Remarks: Collapse = 1.75% upon inundation

Initial Dry Unit Weight (pcf): 115.5
Initial Moisture Content (%): 7.9
Final Moisture Content (%): 16.1
Initial Void Ratio: 0.46

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143

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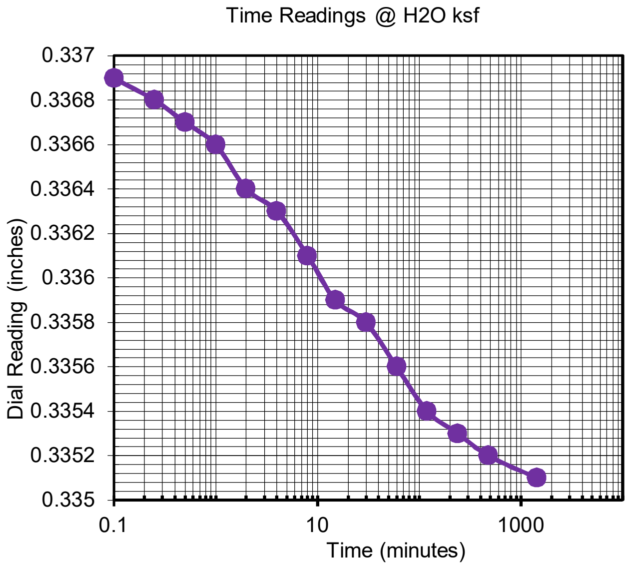
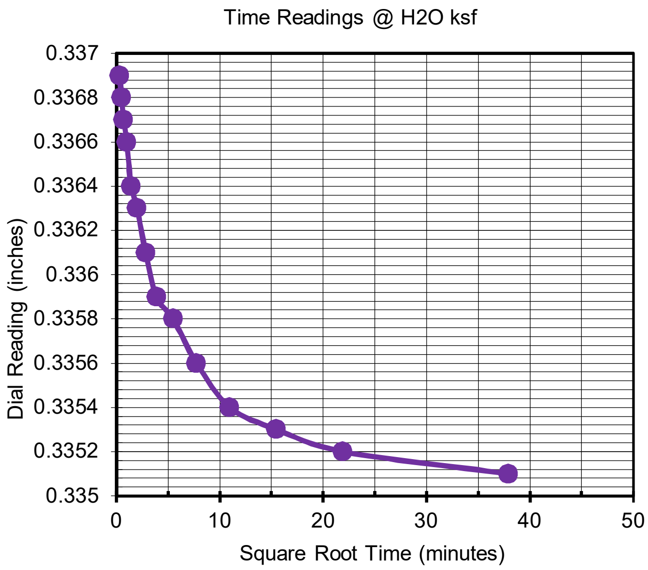
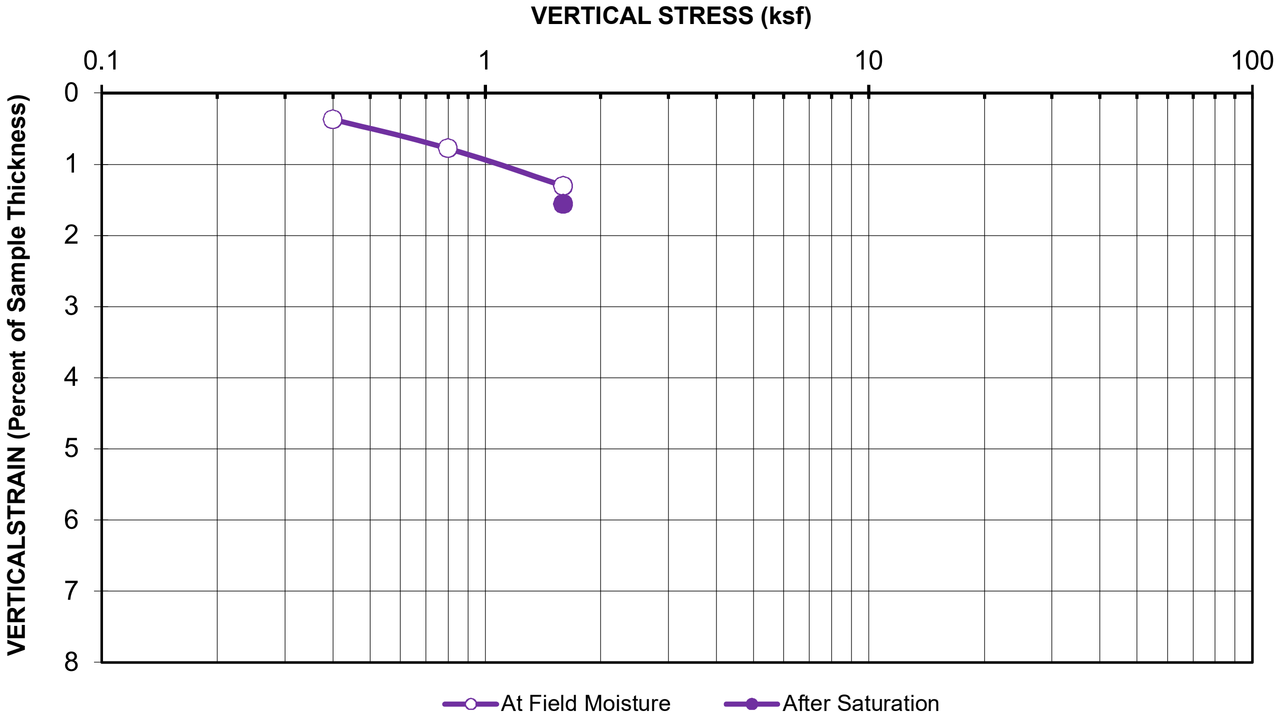


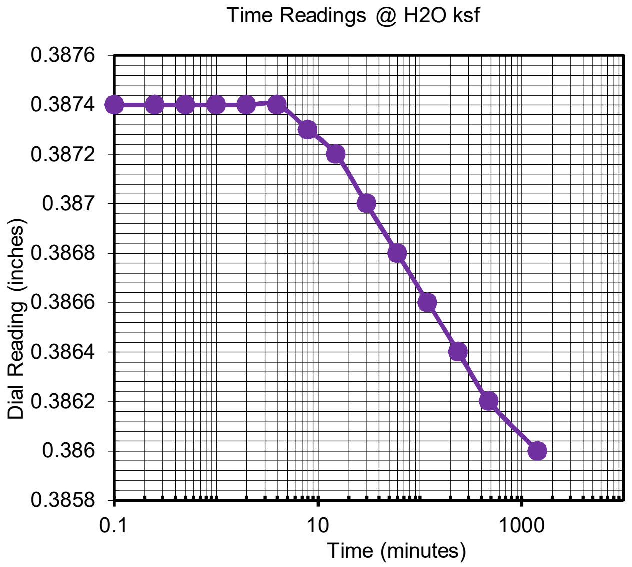


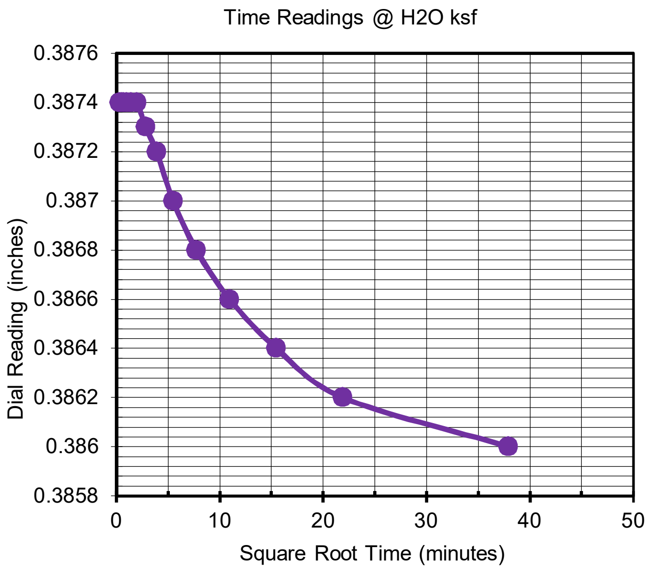


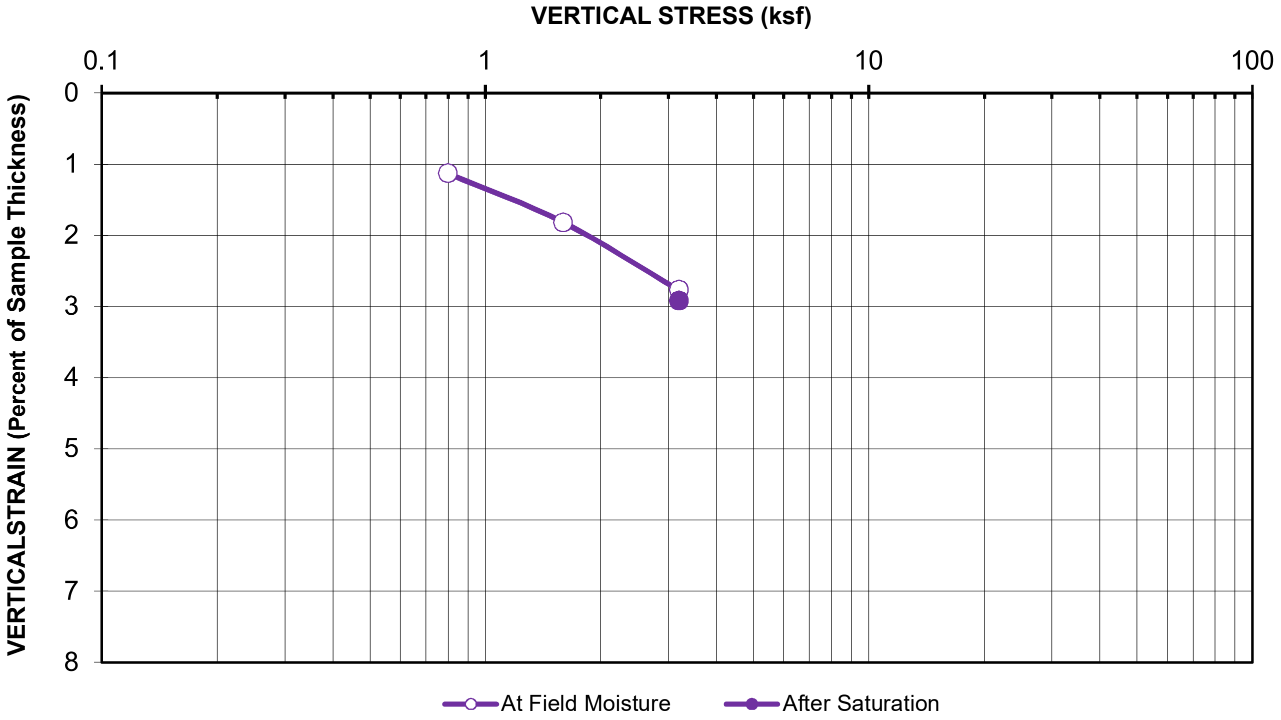
Boring No. :	B-1	Initial Dry Unit Weight (pcf):	118.5
Sample No.:	B-1@10.5-11	Initial Moisture Content (%):	13.0
Depth (feet):	10.5-11	Final Moisture Content (%):	14.6
Sample Type:	Mod Cal	Initial Void Ratio:	0.42
Soil Description:	Clayey Sand		
Remarks:	Collapse = 0.25% upon inundation		

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/29/21
AP No: 21-0143







Boring No. : B-1
Sample No.: B-1@10.5-11
Depth (feet): 10.5-11
Sample Type: Mod Cal
Soil Description: Clayey Sand w/gravel
Remarks: Collapse = 0.15% upon inundation

Initial Dry Unit Weight (pcf): 121.3
Initial Moisture Content (%): 13.0
Final Moisture Content (%): 14.2
Initial Void Ratio: 0.39

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/28/21
AP No: 21-0143

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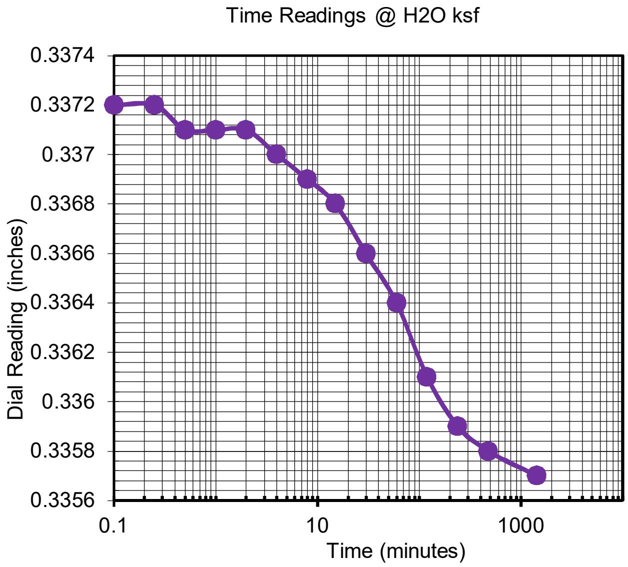
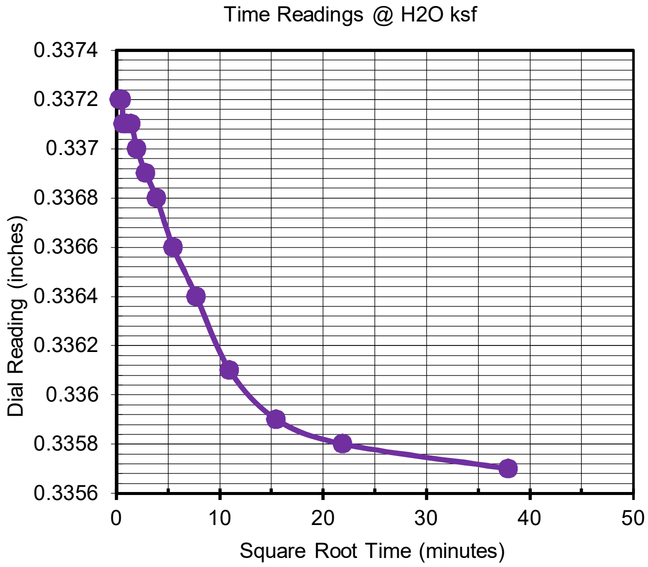
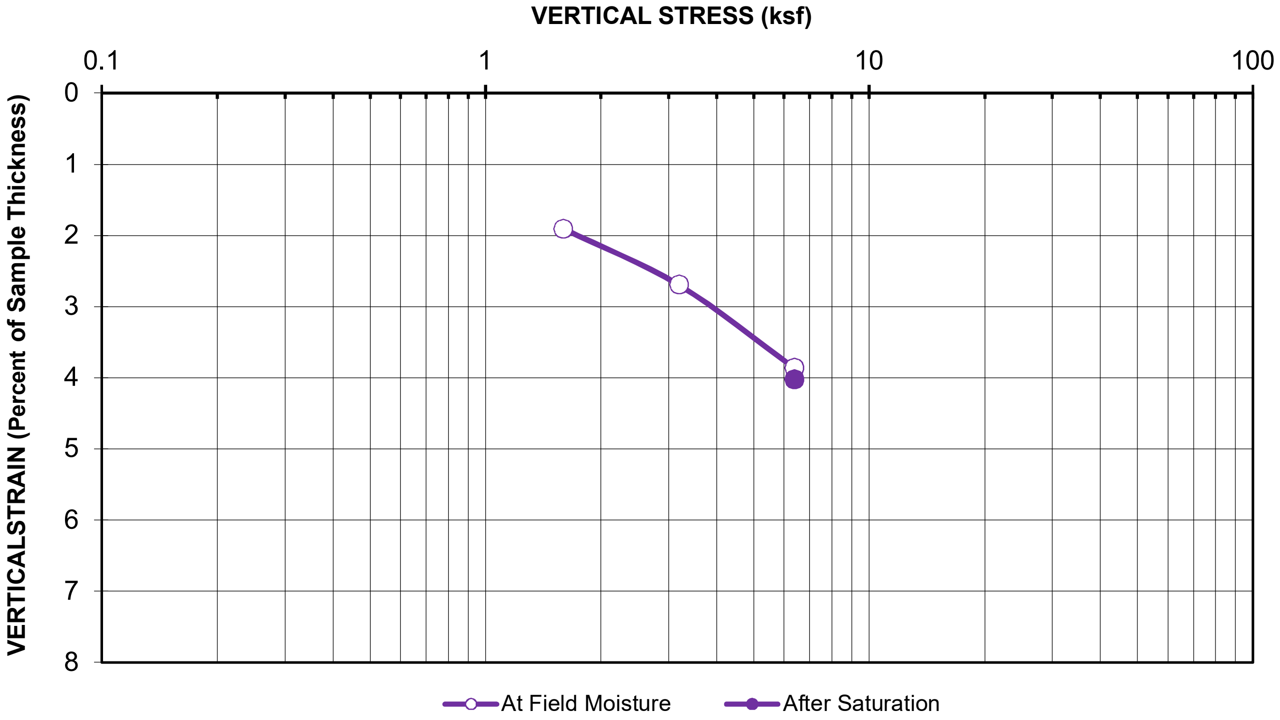






Boring No. : B-1
Sample No.: B-1@10.5-11
Depth (feet): 10.5-11
Sample Type: Mod Cal
Soil Description: Clayey Sand w/gravel
Remarks: Collapse = 0.16% upon inundation

Initial Dry Unit Weight (pcf): 120.6
Initial Moisture Content (%): 13.0
Final Moisture Content (%): 14.3
Initial Void Ratio: 0.40

1-D SWELL/COLLAPSE
ASTM D 4546-14, Method B

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Date: 1/28/21
AP No: 21-0143

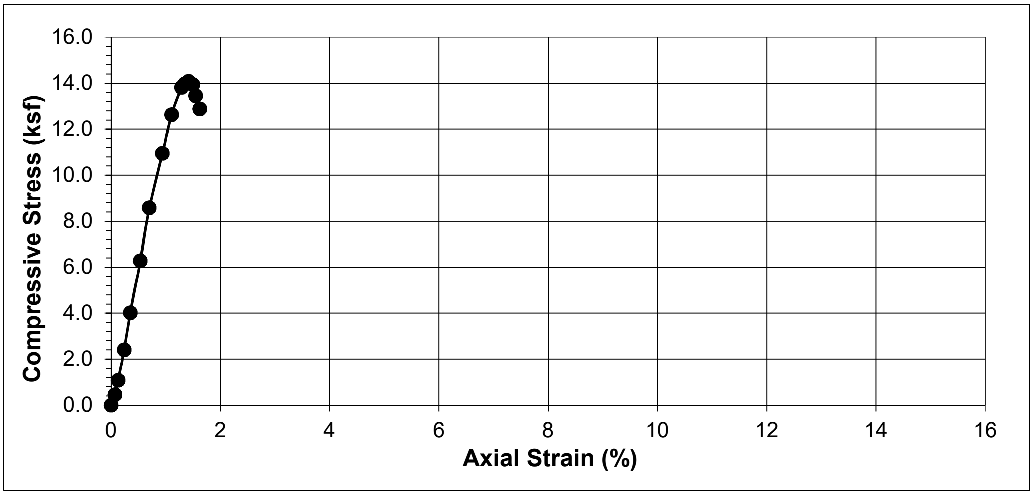
UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Boring No.: B-1
Sample No.: B-1@40-43
Depth (feet): 40.5-41

Sample Type: Core
Soil Description Sandstone
Dry Density (pcf): 129.6
Moisture Content (%) 8.4
Test Date: 01/28/21

Sample Diameter (inch): 2.357
Sample Height (inch): 5.421
Sample Weight (gms): 872.99

Wt. Wet Soil+Container(gms) 1015.1
Wt. Dry Soil+Container(gms) 947.23
Wt. Container (gms) 143.48



After Test

Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.36	0.00	0.00
14	0.004	4.37	0.46	0.07
33	0.007	4.37	1.09	0.13
73	0.013	4.37	2.40	0.24
122	0.019	4.38	4.01	0.35
191	0.029	4.39	6.27	0.53
262	0.038	4.40	8.58	0.70
335	0.051	4.41	10.95	0.94
387	0.060	4.41	12.63	1.11
424	0.070	4.42	13.81	1.29
429	0.073	4.42	13.96	1.35
433	0.077	4.43	14.08	1.42
429	0.081	4.43	13.94	1.49
414	0.084	4.43	13.45	1.55
397	0.088	4.44	12.89	1.62

Unconfined Compressive Strength (ksf) = **14.08**

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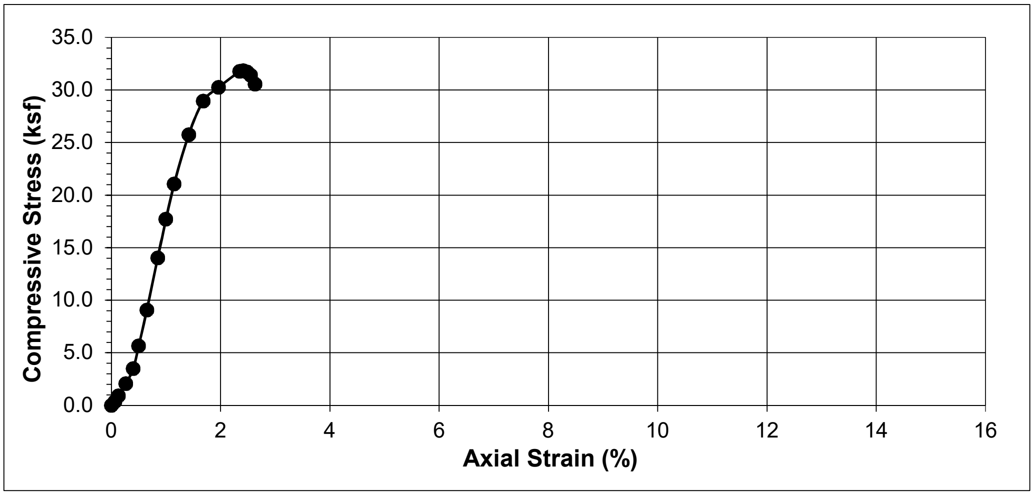
UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name:	SCG Honor Rancho	Sample Type:	Core
Project No.:	SC0766U-04	Soil Description	Sandstone
Boring No.:	B-1	Dry Density (pcf):	130.6
Sample No.:	B-1@43-46	Moisture Content (%)	7.8
Depth (feet):	44.1-44.5	Test Date:	01/28/21

Sample Diameter (inch):	2.420	Wt. Wet Soil+Container(gms)	1169.12
Sample Height (inch):	6.002	Wt. Dry Soil+Container(gms)	1095.15
Sample Weight (gms):	1020.64	Wt. Container (gms)	150.00



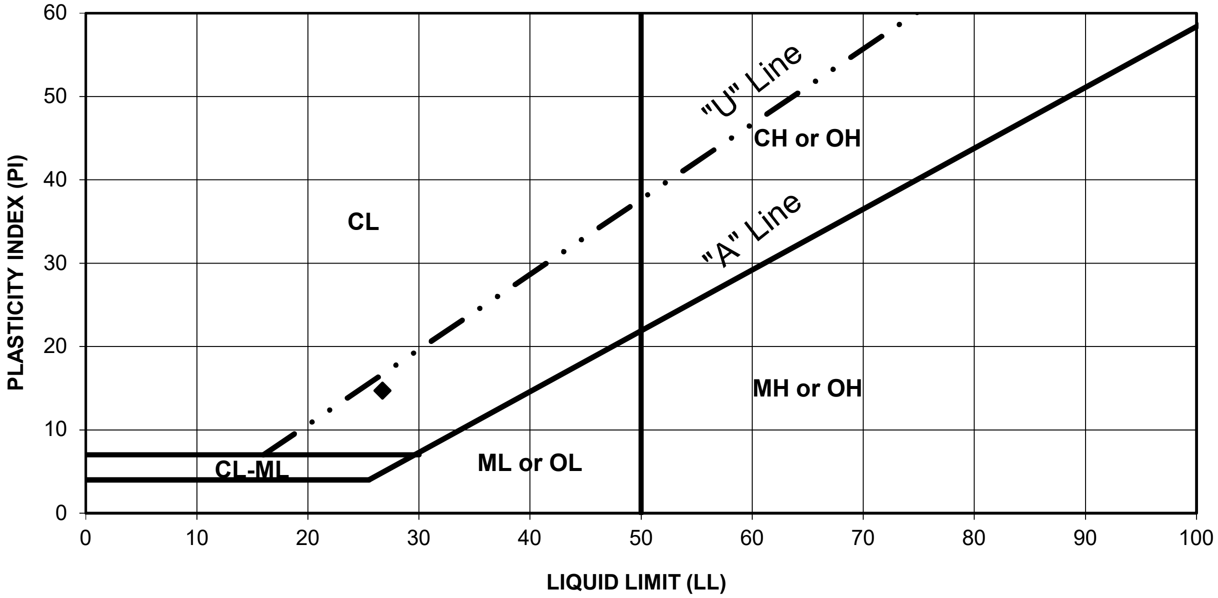
After Test

Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.60	0.00	0.00
11	0.004	4.60	0.34	0.07
29	0.008	4.61	0.91	0.13
66	0.016	4.61	2.06	0.27
112	0.024	4.62	3.49	0.40
181	0.030	4.62	5.64	0.50
291	0.039	4.63	9.05	0.65
452	0.051	4.64	14.03	0.85
571	0.060	4.65	17.70	1.00
680	0.069	4.65	21.04	1.15
834	0.085	4.67	25.74	1.42
940	0.101	4.68	28.93	1.68
986	0.118	4.69	30.26	1.97
1039	0.141	4.71	31.76	2.35
1042	0.145	4.71	31.83	2.42
1039	0.149	4.72	31.72	2.48
1029	0.153	4.72	31.39	2.55
1002	0.158	4.72	30.54	2.63

Unconfined Compressive Strength (ksf) = **31.83**

ATTERBERG LIMITS
ASTM D 4318

Client Name: Geosyntec Consultants, Inc. Tested By: DK Date: 01/27/21
Project Name: SCG Honor Rancho Computed By: NR Date: 01/29/21
Project No.: SC0766U-04 Checked By: AP Date: 02/02/21



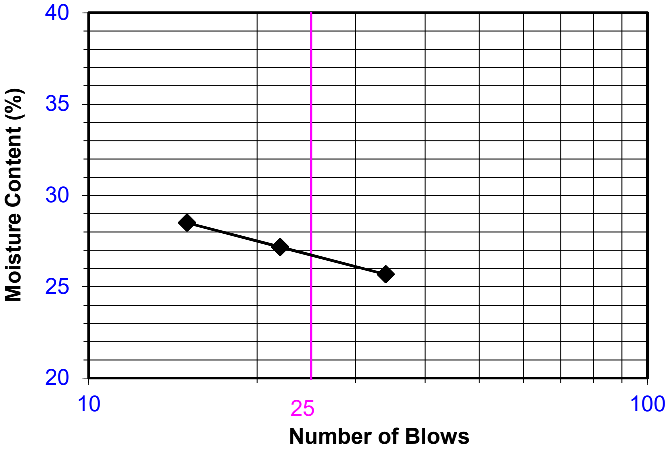
PROCEDURE USED

☐ Wet Preparation

☒ Dry Preparation

☒ Procedure A
Multipoint Test

☐ Procedure B
One-point Test

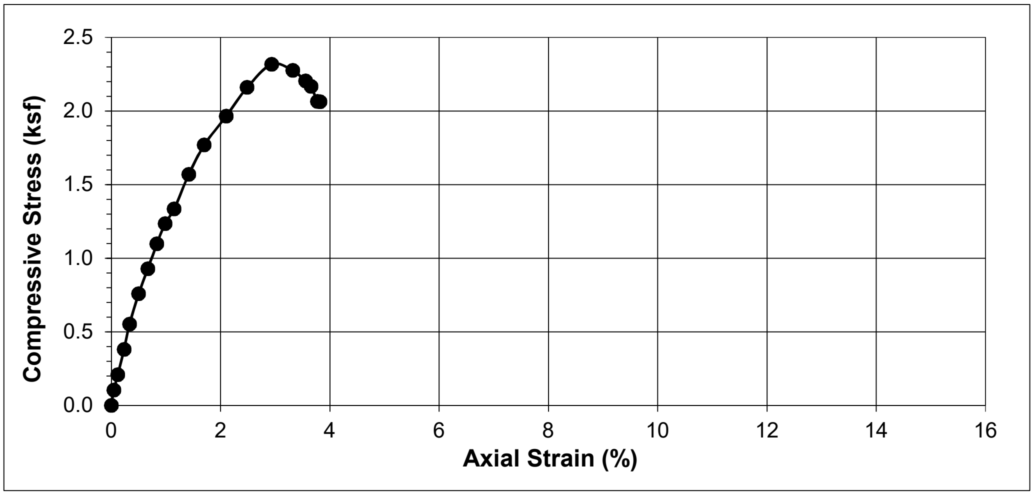


Symbol	Boring Number	Sample Number	Depth (feet)	LL	PL	PI	Plasticity Chart Symbol
♦	B-2	B-2@0.5-5	0.5-5	27	12	15	CL

UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name:	SCG Honor Rancho	Sample Type:	Core
Project No.:	SC0766U-04	Soil Description	Sandstone, wk cementation
Boring No.:	B-2	Dry Density (pcf):	122.4
Sample No.:	B-2@7.5-10	Moisture Content (%)	10.2
Depth (feet):	9.0-9.5	Test Date:	01/28/21

Sample Diameter (inch):	2.302	Wt. Wet Soil+Container(gms)	1020.5
Sample Height (inch):	5.994	Wt. Dry Soil+Container(gms)	938.54
Sample Weight (gms):	883.62	Wt. Container (gms)	137.46



After Test

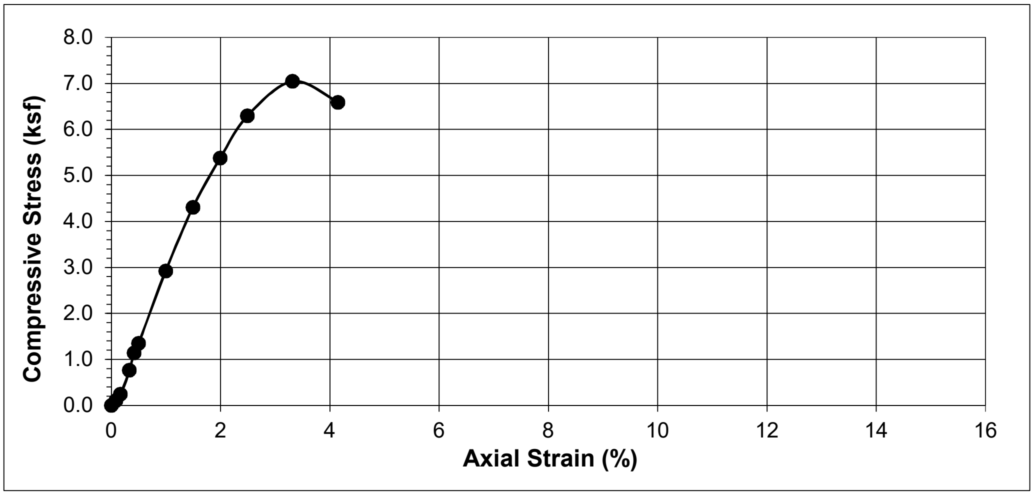
Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.16	0.00	0.00
3	0.003	4.16	0.10	0.05
6	0.007	4.17	0.21	0.12
11	0.014	4.17	0.38	0.23
16	0.020	4.17	0.55	0.33
22	0.030	4.18	0.76	0.50
27	0.040	4.19	0.93	0.67
32	0.050	4.20	1.10	0.83
36	0.059	4.20	1.23	0.98
39	0.069	4.21	1.33	1.15
46	0.085	4.22	1.57	1.42
52	0.102	4.23	1.77	1.70
58	0.126	4.25	1.97	2.10
64	0.149	4.27	2.16	2.49
69	0.176	4.29	2.32	2.94
68	0.199	4.30	2.28	3.32
66	0.213	4.31	2.20	3.55
65	0.219	4.32	2.17	3.65
62	0.226	4.32	2.06	3.77
62	0.229	4.33	2.06	3.82

Unconfined Compressive Strength (ksf) = **2.32**

UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name:	SCG Honor Rancho	Sample Type:	Core
Project No.:	SC0766U-04	Soil Description	Claystone
Boring No.:	B-2	Dry Density (pcf):	119.6
Sample No.:	B-2@15-17	Moisture Content (%)	11.7
Depth (feet):	15.5-16	Test Date:	01/28/21

Sample Diameter (inch):	2.299	Wt. Wet Soil+Container(gms)	1020.38
Sample Height (inch):	6.026	Wt. Dry Soil+Container(gms)	928.48
Sample Weight (gms):	877.07	Wt. Container (gms)	145.04



After Test

Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.15	0.00	0.00
3	0.005	4.15	0.10	0.08
7	0.010	4.16	0.24	0.17
22	0.020	4.16	0.76	0.33
33	0.025	4.17	1.14	0.41
39	0.030	4.17	1.35	0.50
85	0.060	4.19	2.92	1.00
126	0.090	4.21	4.31	1.49
158	0.120	4.23	5.37	1.99
186	0.150	4.26	6.29	2.49
210	0.200	4.29	7.04	3.32
198	0.250	4.33	6.59	4.15

Unconfined Compressive Strength (ksf) = **7.04**

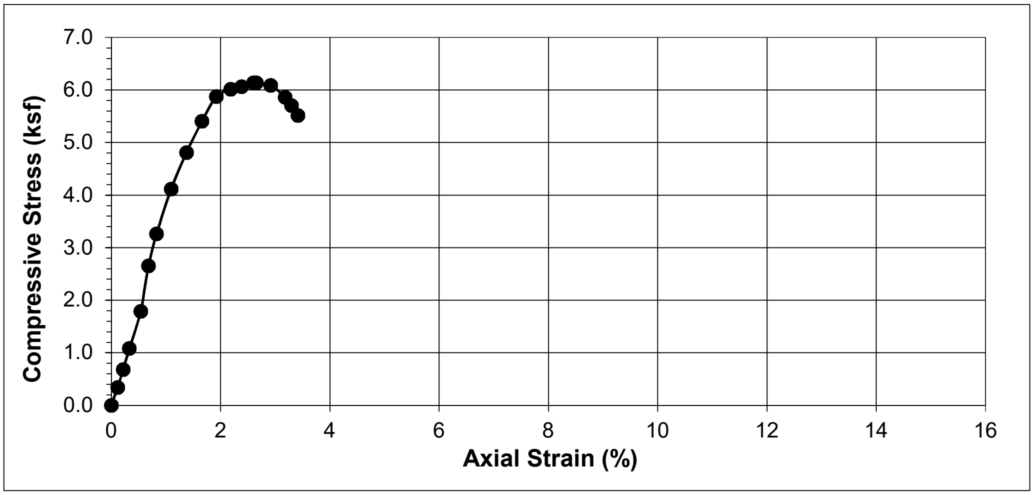
UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Boring No.: B-2
Sample No.: B-2@22.5-25
Depth (feet): 24-24.5

Sample Type: Core
Soil Description: Claystone
Dry Density (pcf): 121.5
Moisture Content (%): 12.7
Test Date: 01/28/21

Sample Diameter (inch): 2.430
Sample Height (inch): 6.033
Sample Weight (gms): 1005.91

Wt. Wet Soil+Container(gms): 1153.9
Wt. Dry Soil+Container(gms): 1041.07
Wt. Container (gms): 149.62



After Test

Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.64	0.00	0.00
11	0.007	4.64	0.34	0.12
22	0.013	4.65	0.68	0.22
35	0.020	4.65	1.08	0.33
58	0.033	4.66	1.79	0.54
86	0.041	4.67	2.65	0.68
106	0.050	4.68	3.26	0.83
134	0.066	4.69	4.11	1.09
157	0.083	4.70	4.81	1.38
177	0.100	4.72	5.40	1.66
193	0.116	4.73	5.88	1.92
198	0.132	4.74	6.01	2.19
200	0.144	4.75	6.06	2.39
203	0.157	4.76	6.14	2.60
203	0.160	4.77	6.13	2.65
202	0.176	4.78	6.09	2.92
195	0.192	4.79	5.86	3.18
190	0.199	4.80	5.70	3.30
184	0.206	4.80	5.52	3.41

Unconfined Compressive Strength (ksf) = **6.14**

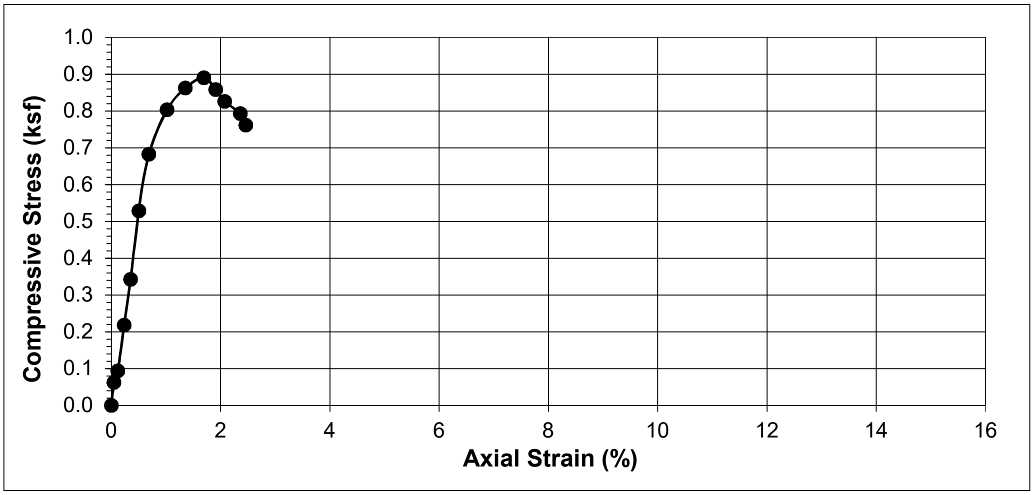
UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Boring No.: B-2
Sample No.: B-2@27-30
Depth (feet): 27.5-28

Sample Type: Core
Soil Description: Sandstone, v.wk Cementation
Dry Density (pcf): 111.2
Moisture Content (%) 13.7
Test Date: 01/28/21

Sample Diameter (inch): 2.423
Sample Height (inch): 5.970
Sample Weight (gms): 913.46

Wt. Wet Soil+Container(gms) 1057.96
Wt. Dry Soil+Container(gms) 947.89
Wt. Container (gms) 144.53



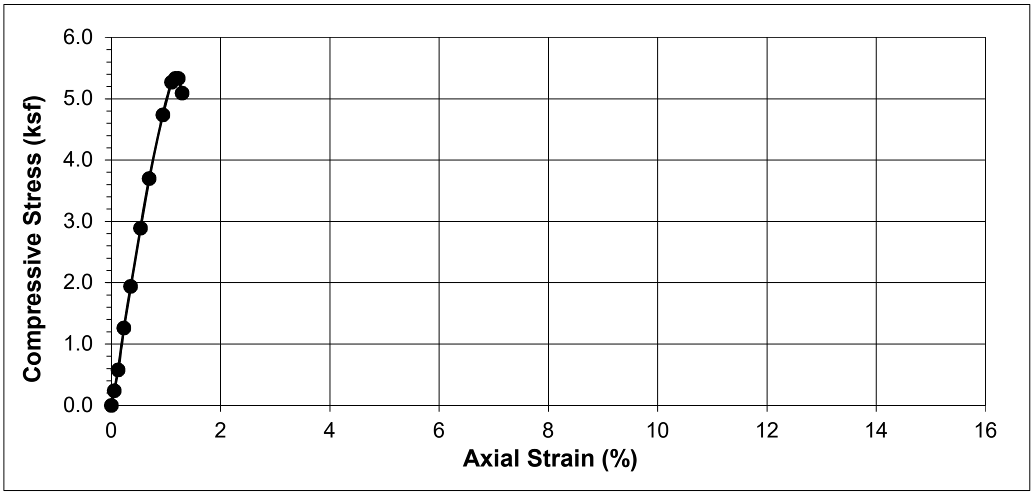
After Test

Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.61	0.00	0.00
2	0.003	4.61	0.06	0.05
3	0.007	4.62	0.09	0.12
7	0.014	4.62	0.22	0.23
11	0.021	4.63	0.34	0.35
17	0.030	4.63	0.53	0.50
22	0.041	4.64	0.68	0.69
26	0.061	4.66	0.80	1.02
28	0.081	4.67	0.86	1.36
29	0.101	4.69	0.89	1.69
28	0.114	4.70	0.86	1.91
27	0.124	4.71	0.83	2.08
26	0.141	4.72	0.79	2.36
25	0.147	4.73	0.76	2.46

Unconfined Compressive Strength (ksf) = **0.89**

UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name:	SCG Honor Rancho	Sample Type:	Core
Project No.:	SC0766U-04	Soil Description	Sandstone
Boring No.:	B-3	Dry Density (pcf):	124.9
Sample No.:	B-3@6-11	Moisture Content (%)	12.7
Depth (feet):	7.5-8	Test Date:	01/28/21
Sample Diameter (inch):	2.317	Wt. Wet Soil+Container(gms)	1009.9
Sample Height (inch):	5.624	Wt. Dry Soil+Container(gms)	910.96
Sample Weight (gms):	876.39	Wt. Container (gms)	134.89



After Test

Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.22	0.00	0.00
7	0.003	4.22	0.24	0.05
17	0.007	4.22	0.58	0.12
37	0.013	4.23	1.26	0.23
57	0.020	4.23	1.94	0.36
85	0.030	4.24	2.89	0.53
109	0.039	4.25	3.70	0.69
140	0.053	4.26	4.74	0.94
156	0.062	4.26	5.27	1.10
158	0.066	4.27	5.33	1.17
158	0.069	4.27	5.33	1.23
151	0.073	4.27	5.09	1.30

Unconfined Compressive Strength (ksf) = **5.33**

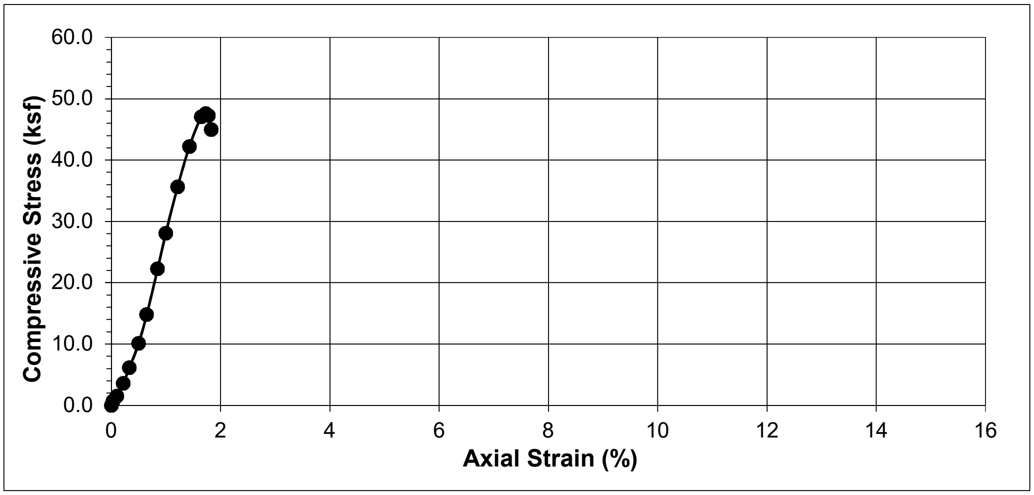
UNCONFINED COMPRESSION TEST RESULTS
ASTM D 2166

Project Name: SCG Honor Rancho
Project No.: SC0766U-04
Boring No.: B-4
Sample No.: B-4@1.5-6
Depth (feet): 5-5.5

Sample Type: Core
Soil Description Sandstone
Dry Density (pcf): 137.9
Moisture Content (%) 6.3
Test Date: 01/28/21

Sample Diameter (inch): 2.407
Sample Height (inch): 6.020
Sample Weight (gms): 1053.51

Wt. Wet Soil+Container(gms) 1232.02
Wt. Dry Soil+Container(gms) 1169.97
Wt. Container (gms) 179.72



After Test

Load (lbs)	Deformation (inch)	Area (sq.in)	Compressive Stress (ksf)	Axial Strain (%)
0	0.000	4.55	0.00	0.00
22	0.002	4.55	0.70	0.03
48	0.006	4.55	1.52	0.10
113	0.013	4.56	3.57	0.22
194	0.020	4.56	6.12	0.33
321	0.030	4.57	10.11	0.50
470	0.039	4.58	14.78	0.65
709	0.051	4.59	22.25	0.85
895	0.060	4.59	28.05	1.00
1139	0.073	4.60	35.62	1.21
1352	0.086	4.62	42.19	1.43
1512	0.099	4.63	47.07	1.64
1530	0.104	4.63	47.60	1.73
1520	0.107	4.63	47.26	1.78
1447	0.110	4.63	44.97	1.83

Unconfined Compressive Strength (ksf) = **47.60**

APPENDIX F

SEAOC/OSHPD Online Design Maps Tool Output

HCRM

Latitude, Longitude: 34.445794, -118.586475

Date	1/19/2021, 3:52:32 PM
Design Code Reference Document	ASCE7-16
Risk Category	IV
Site Class	C - Very Dense Soil and Soft Rock

Type	Value	Description
S_S	2.06	MCE_R ground motion. (for 0.2 second period)
S_1	0.754	MCE_R ground motion. (for 1.0s period)
S_{MS}	2.472	Site-modified spectral acceleration value
S_{M1}	1.056	Site-modified spectral acceleration value
S_{DS}	1.648	Numeric seismic design value at 0.2 second SA
S_{D1}	0.704	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	F	Seismic design category
F_a	1.2	Site amplification factor at 0.2 second
F_v	1.4	Site amplification factor at 1.0 second
PGA	0.871	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	1.045	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	2.06	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	2.245	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.518	Factored deterministic acceleration value. (0.2 second)
S1RT	0.754	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.835	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.797	Factored deterministic acceleration value. (1.0 second)
PGAd	1.002	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.917	Mapped value of the risk coefficient at short periods
C_{R1}	0.903	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

APPENDIX G

Soil Chemical Laboratory Results

AP Engineering and Testing, Inc.
DBE|MBE|SBE
2607 Pomona Boulevard | Pomona, CA 91768
t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

CORROSION TEST RESULTS

Client Name: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

AP Job No.: 21-0143
Date: 02/01/21

Boring No.	Sample No.	Depth (feet)	Soil Description	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-1	B-1@40-43	41-41.3	Sandstone	1,398	8.5	113	138
B-2	B-2@30-35	30-35	Silty Sandstone	2,415	8.6	70	102
B-3	B-3@3-6	3.5-4	Silty Sandstone	1,089	9.3	306	204
B-4	B-4@1.5-6	5-6.5	Sandstone	1,336	8.9	145	174

NOTES:
Resistivity Test and pH: California Test Method 643
Sulfate Content : California Test Method 417
Chloride Content : California Test Method 422
ND = Not Detectable
NA = Not Sufficient Sample
NR = Not Requested

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CORROSION TEST RESULTS

Client Name: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

AP Job No.: 21-0143
Date: 01/29/21

Boring No.	Sample No.	Depth (feet)	Soil Description	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-1	B-1@1-5	1-5	Clayey Sand	1,898	8.2	124	144

NOTES:

Resistivity Test and pH: California Test Method 643
Sulfate Content : California Test Method 417
Chloride Content : California Test Method 422
ND = Not Detectable
NA = Not Sufficient Sample
NR = Not Requested

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CORROSION TEST RESULTS

Client Name: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

AP Job No.: 21-0143
Date: 01/29/21

Boring No.	Sample No.	Depth (feet)	Soil Description	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
HSA-2	HSA-2@5	5-6.5	Clayey Sand	2,085	7.3	55	90

NOTES:
Resistivity Test and pH: California Test Method 643
Sulfate Content : California Test Method 417
Chloride Content : California Test Method 422
ND = Not Detectable
NA = Not Sufficient Sample
NR = Not Requested

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t. 909.869.6316 | f. 909.869.6318 | www.aplaboratory.com

CORROSION TEST RESULTS

Client Name: Geosyntec Consultants, Inc.
Project Name: SCG Honor Rancho
Project No.: SC0766U-04

AP Job No.: 21-0143
Date: 01/29/21

Boring No.	Sample No.	Depth (feet)	Soil Description	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
TPB-1	TPB-1@15	15-15.9	Sandy Silt	1,351	7.1	138	246

NOTES:
Resistivity Test and pH: California Test Method 643
Sulfate Content : California Test Method 417
Chloride Content : California Test Method 422
ND = Not Detectable
NA = Not Sufficient Sample
NR = Not Requested