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Description:	This report presents the findings of our subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.
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Potentia-Viridi BESS

Geotechnical Engineering Report

Tracy, Alameda County, California

August 16, 2024 | Terracon Project No. NA235087

Prepared for:

Levy Alameda LLC
115 Wellington St. West, Suite 2930
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August 16, 2024

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Attn: Patrick Leitch
P: (416) 649-1300
E: pleitch@capstoneinfra.com

Re: Geotechnical Engineering Report
Potentia-Viridi BESS
17257 Patterson Pass Road
Tracy, Alameda County, California
Terracon Project No. NA235087

Dear Mr. Leitch:

We have completed the scope of Geotechnical Engineering services for the referenced project in general accordance with Terracon Proposal No. PNA235087 dated April 29, 2024. This report presents the findings of our subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

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.

Sincerely,

Terracon

CHRISTOPHER CONGRAVE
NO. C92512

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Christopher B. Congrave, PE 92512
Geotechnical Group Manager

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Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Report Summary

Topic [1]	Overview Statement [2]
Project Description	The project includes a Battery Energy Storage System (BESS) facility, a substation east of the existing PG&E substation, and a Gen-Tie line.
Geotechnical Characterization	Subgrade soils encountered in our borings generally consisted of interbedded layers of sand, silt, and clay overlaying interbedded layers of sandstone, siltstone, and claystone. Groundwater was not encountered in our borings at the time of our exploration.
Earthwork	Specific site grading information was unavailable at the time this report was prepared. We anticipate grading may consist of cuts and fills on the order of 30 feet or less in order to develop final site elevations. Existing on site soils can be selectively used for structural fill. Clays are sensitive to moisture variation and should not be utilized beneath the foundation pads. General grading should be conducted in accordance with the **Earthwork** section of this report.
Mat Foundations	Shallow mat foundations are recommended for BESS and equipment support. Allowable bearing pressure = 1,500 psf to 4,000 psf depending on mat foundation width and subgrade support. Expected settlements: < 1-inch total, < ½-inch differential
Deep Foundations	Deep foundations are recommended for the substation elements and Gen-Tie line tower portion of the site. Drilled shafts are a common foundation type in this region and can be used to support the structure loads through a combination of end bearing in bedrock and skin friction in the overburden soils using parameters contained herein.
Access Roads	Gravel surfaced access roads are anticipated to be used for the project site.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics in the table can be used to access the appropriate section of the report by simply clicking on the topic itself.

2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed Battery Energy Storage System (BESS) to be located at 17257 Patterson Pass Road in Tracy, Alameda County, California. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil (and rock) conditions
- Groundwater conditions
- Seismic site classification per the 2022 California Building Code (CBC)
- Site preparation and earthwork
- Foundation design and construction
- Access road design and construction
- Liquefaction potential

The geotechnical engineering Scope of Services for this project included the advancement of test borings, a geophysical survey, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	An email request for the preliminary geotechnical services proposal was provided by Mathew Hanna on November 21, 2023. A follow up email on March 19, 2024, from Paul Miller included a revised site plan and a requested scope.
Project Description	The project includes a Battery Energy Storage System (BESS) facility, a substation east of the existing PG&E substation, and a Gen-Tie line. Development will include access roads.

Item	Description
Proposed Structures	Structures associated with the project include an approximately 13.2-acre BESS station, an approximately 5.2-acre substation, and a Gen-Tie monopole transmission line that will connect the BESS station to the existing PG&E substation. Proposed foundations for the BESS facility consist of mat foundations, drilled shafts, and/or driven steel piles and drilled shafts for the Gen-Tie monopole transmission line.
Maximum Loads	Anticipated structural loads for the battery containers were provided but the loads for the inverters and slabs were not provided. In the absence of information provided by the design team, we used the following loads in estimating settlement based on our experience with similar projects: ▪ Battery Containers: 48 tons (43,000 kg) ▪ Inverters: 20 tons ▪ Slabs: 500 pounds per square foot (psf)
Grading/Slopes	A preliminary grading plan was not available for review at the time this report was prepared. We anticipate approximately 30 feet of cut and 30 feet of fill may be required to develop final site grades, excluding remedial grading requirements if the project utilizes natural site features. Due to the extent of the potential grading at this site, this report provides **preliminary** design recommendations until site grading is known. Terracon must be afforded the opportunity to review the grading plans before final design recommendations can be provided. Additional borings may be necessary, pending review of the grading plans, in order to provide final design recommendations.
Free-Standing Retaining Walls	None anticipated

Item	Description
Access Roads	It is our understanding that access roads are planned within the proposed facility. It is our assumption that the majority of these roads will be unpaved and surfaced with aggregate base. The recommended access road construction was developed using the following information: ■ Traffic Loading: 250 ESALs for general roads; 500 ESALs for the substation road ■ Allowable Rut Depth: 2 inches ■ Design Serviceability Loss: 2.0 ■ Vehicle Tire Pressure: 80 psi Design life: 10 years (maintenance required)
Building Code	2022 California Building Code (CBC)

Terracon should be notified if any of this information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at 17257 Patterson Pass Road in Tracy, Alameda County, California. Assessor Parcel Numbers (APNs): 99B-7890-2-4 The site is approximately 43 acres in size. Latitude/Longitude (approximate): 37.7121°N, 121.5735°W See **Site Location**
Existing Improvements	The property is currently undeveloped. The site is bordered by an existing substation and Patterson Pass Road to the east and undeveloped land to the north, west, and south.
Current Ground Cover	Earthen with light to moderate vegetation consisting of grasses and weeds.

Item	Description
Existing Topography	The site consists of rolling hills with approximately 46 feet of topographic relief going from southwest to northeast based on a review of Google Earth. Actual elevations can be referenced if a site-specific topographic map is provided.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in **Exploration and Laboratory Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Sand**	Medium dense to very dense sand with various amounts of silt or clay
2	**Silt**	Stiff to hard silt with various amounts of sand
3	**Lean Clay**	Medium stiff to hard lean clay with various amounts of sand
4	**Fat Clay**	Stiff fat clay
5	**Sandstone**	Highly weathered sandstone
6	**Siltstone**	Highly weathered siltstone
7	**Claystone**	Highly weathered claystone

Practical auger refusal was encountered in Borings B5, B6, B7, B8, B9 and B11 at depths varying from 15½ feet to 28 feet bgs. Refusal is defined as the depth below the ground surface at which a boring can no longer be advanced with the soil drilling technique being used. Refusal is subjective and is based upon the type of drilling equipment used, the types of augers used, and the effort exerted by the driller. Refusal can occur on the upper surface of discontinuous bedrock, boulder, slabs of unweathered rock suspended in the residual soil matrix or "floaters", in widened joints that may extend well below the surrounding bedrock surface, on rock "pinnacles" rising above the surrounding bedrock surface, or on the upper surface of continuous bedrock.

Additional borings, auger probes, test pits, or geophysical testing could be performed to obtain more specific subgrade information.

Groundwater Conditions

Groundwater was not encountered in our borings during our field exploration. Nearby monitoring wells operated by the California Department of Water Resources do not provide sufficient information regarding the anticipated groundwater depth at the site. However, based on the elevation of the existing monitoring wells and the elevation of the project site, the groundwater depth at the site is anticipated to be deeper than 100 feet below ground surface (bgs).

Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structures may be higher or lower than the levels indicated on the boring logs. While not encountered at this site at the time of our exploration, perched groundwater may be encountered at soil and bedrock interfaces. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Geologic Hazards

Geologic maps indicate subsurface conditions at the site consist of Holocene age alluvial gravel, sand, and clay of valley areas underlain by Miocene aged Neroly Formation sandstone and mudstone[1]. The subgrade material encountered in our borings were generally consistent with mapped geology.

Faulting and Estimated Ground Motions

The site is located in the Altamont area of California, which is a relatively moderate seismicity region. The type and magnitude of seismic hazards affecting the site are dependent on the distance to causative faults, the intensity, and the magnitude of the seismic event. The following table indicates the distance of the fault zones and the

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[1] *Dibblee, T.W., and Minch, J.A., 2006, Geologic map of the Midway & Tracy quadrangles, Alameda & San Joaquin Counties, California, Dibblee Geological Foundation, Dibblee Foundation Map DF-243, 1:24,000*

associated maximum credible earthquake that can be produced by nearby seismic events, as calculated using the USGS Unified Hazard Tool. Segments of the Greenville Fault, which is located approximately 10 kilometers from the site, are considered to have the most significant effect on the site from a design standpoint.

Fault Name	Approximate Contribution (%)	Approximate Distance to Site (kilometers)	Maximum Credible Earthquake (MCE) Magnitude
UCERF3 Fault Model 3.2: Greenville (north) (2)	20.71	9.98	7.05
UCERF3 Fault Model 3.2: Great Valley 7 (Orestimba) (0)	13.94	8.32	6.33
UCERF3 Fault Model 3.1: Greenville (north) (2)	14.78	10.71	7.02
UCERF3 Fault Model 3.1: Great Valley 7 (Orestimba) (0)	14.01	8.32	6.34

Based on the ASCE 7-16 Standard, the peak ground acceleration (PGA_M) at the subject site is approximately 0.794g. Based on the USGS NSHM Conterminous U.S. 2018 interactive disaggregations, the PGA at the subject site for a 2% probability of exceedance in 50 years (return period of 2475 years) is expected to be about 0.747g. The site is not located within an Alquist-Priolo Earthquake Fault Zone based on our review of the State Fault Hazard Maps.[1]

Liquefaction

Liquefaction is a mode of ground failure that results from the generation of high pore water pressures during earthquake ground shaking, causing loss of shear strength. Liquefaction is typically a hazard where loose sandy soils or low plasticity fine grained soils exist below groundwater. The California Geological Survey (CGS) has designated certain areas within California as potential liquefaction hazard zones. These are areas considered at risk of liquefaction-related ground failure during a seismic event, based

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[1] California Geological Survey (CGS), *"California Earthquakes Hazards Zone Application (EQ Zapp)", September 23, 2021, https://maps.conservation.ca.gov/cgs/EQZApp/app/*.

upon mapped surficial deposits and the presence of a relatively shallow water table. The project site has not yet been mapped by the CGS for liquefaction hazards.

The Association of Bay Area Governments (ABAG) has mapped the eastern part of the property as having a high susceptibility to liquefaction while the western portion of the site is mapped as having a very low susceptibility to liquefaction. However, based on the density of the cohesionless soils, absence of groundwater, presence of interbedded layers of siltstone, sandstone, and claystone; and the age of the underlying site geology we believe the potential for liquefaction to occur at this site is low.

Landslides and Debris Flow

The improvements will be constructed on or near both natural slopes and proposed mass graded areas. A grading plan for the project was not yet available for review at the time this report was prepared. However, cut slopes and fill slopes up to 30 feet high are anticipated to help develop final grades across the site. Slope movement occurs on sloping sites when surficial soils are saturated, increasing the weight and decreasing the shear strength of the soils. Generally, movement of the slope due to such conditions occurs within the upper near surface unstable sandy, silty, and clayey soils. Soil movement also occurs when the upper portion of the slope is excessively loaded (such as by fills) and/or the bottom portion of the slope is undercut and not retained, causing the driving force to exceed the resisting force, and this type of slope instability can occur in deeper soils/rock. Slope movement can also be triggered by strong ground shaking from a seismic event due to the lack of lateral confinement. In addition, the clayey surficial soils at the site are susceptible to seasonal slope creep. Slope creep is the downward movement of plastic soils due to seasonal contraction and expansion as a result of variations in moisture content.

The California Geological Survey (CGS) has designated certain areas within California as potential seismically-induced landslide hazard zones. These are areas considered at a risk of slope failure during a seismic event, based upon mapped surficial deposits. The project site has not yet been mapped by the CGS for seismically-induced landslide hazards. The Association of Bay Area Governments (ABAG) has mapped the sloped areas within the property as being in an area with few landslides.

The geotechnical recommendations provided in this report are for the stated post grading conditions. The recommendations are not intended to provide global slope stability for debris flows or to resist deep seated movement associated with landslides. As indicated, it is impractical and not economically feasible to design and expect the limited improvements necessary for the proposed construction to also provide resistance against geologic conditions and/or global slope movement. Levy Alameda LLC should be aware that if global movement of the surrounding terrain were to occur, the proposed improvements could shift, settle, and/or crack. Depending on the type and extent of movement, the damage to the improvements could be substantial. Development of this site will involve regrading the existing slopes. The owner, architect, and engineer should be aware that regarding the slopes may affect the stability of the slopes. The stability is affected positively with properly designed and constructed grading and negatively with non-engineered grading.

Static and seismic slope stability analyses of the site and adjacent slopes were not requested or intended and were beyond the scope of this report. If the current global stability of the site is a concern, Terracon is qualified to perform a more detailed geologic hazard investigation and perform the subsequent slope stability analyses for the site.

Flooding

Based on a review of the Federal Emergency Management Agency (FEMA) National Flood Layer (NFHL), the project site is not located within a mapped flood zone.

Seismic Considerations

The 2022 California Building Code (CBC) Seismic Design Parameters have been generated using the SEAOC/OSHPD Seismic Design Maps Tool. This web-based software application calculates seismic design parameters in accordance with ASCE 7-16, and 2022 CBC.

Description	Value
2022 California Building Code (CBC) Site Classification[1]	C[2]
Risk Category	II
Site Latitude[3]	37.7121ºN
Site Longitude[3]	121.5735ºW
S_S, Spectral Acceleration for a Short Period[4]	1.573
S_1, Spectral Acceleration for a 1-Second Period[4]	0.539
Fa, Site Coefficient	1.200
Fv, Site Coefficient (1-Second Period)	1.461
S_{DS}, Spectral Acceleration for a Short Period	1.259
S_{D1}, Spectral Acceleration for a 1-Second Period	0.525

Description	Value
1. Seismic site soil classification in general accordance with the *2022 California Building Code*, which refers to ASCE 7-16. Site Classification is required to determine the Seismic Design Category for a structure. 2. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7-16 and the 2022 CBC. Terracon performed four Multichannel Analysis of Surface Waves (MASW) surveys in order to determine the shear wave velocity profile for the project site. 3. Provided coordinates represent a point located at the general center of the site. 4. These values were obtained using online seismic design maps and tools provided by ASCE Hazard Tool (**https://ascehazardtool.org/**).	

Typically, a site-specific ground motion study may reduce construction costs. We recommend consulting with a structural engineer to evaluate the need for such a study and its potential impact on construction costs. Terracon should be contacted if a site-specific ground motion study is desired.

Corrosivity

The following table lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary

Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (%)	Soluble Chloride (%)	Electrical Resistivity (Ω-cm)	pH
B4	5	Siltstone	0.003	0.001	1,750	8.10

Results of soluble sulfate testing can be classified in accordance with ACI 318 – Building Code Requirements for Structural Concrete. Numerous sources are available to characterize corrosion potential to buried metals using the parameters presented in the previous table. ANSI/AWWA is commonly used for ductile iron, while threshold values for evaluating the effect on steel can be specific to the buried feature (e.g., piling, culverts, welded wire reinforcement, etc.) or agency for which the work is performed. Imported fill materials may have significantly different properties than the site materials noted in the table and should be evaluated if expected to be in contact with metals used for construction. Consultation with a NACE certified corrosion professional is recommended for buried metals on the site.

Mapping by the Natural Resource Conservation Service (NRCS) includes qualitative severity of corrosion to concrete and steel. This source rates the near-surface materials as "Low" for corrosion to concrete and "Low to High" for corrosion of steel. A map of the project site showing areas that may exhibit higher levels of corrosion to steel is provided in the **Supporting Information** section of this report. Additional laboratory testing should be considered for more accurate results regarding the potential for corrosion at the project site.

Field Electrical Resistivity

In-situ electrical resistivity testing was performed during our field exploration in general accordance with ASTM G57, utilizing the Wenner Four-Electrode Method. The testing consisted of two arrays oriented NW-SE and SW-NE with a common midpoint. Within the test array, potential electrodes are created on a transverse line between the current electrodes. An equal "A" spacing between electrodes is maintained. Individual in-situ electrical resistivity values at various "A" spacings along each array are summarized in the Geophysical Report for this project, Terracon Job No. NS245114, dated July 18, 2024. The Geophysical Report for this project presenting the field test results and approximate test locations are presented in the **Supporting Information** section of this report.

Thermal Resistivity

We understand that new underground utilities will be installed as part of the proposed project. In accordance with IEEE Standard 442-2017, thermal resistivity testing was performed on bulk subgrade samples collected from Boring B4 at depths varying from 2 feet to 7 feet bgs. The samples were tested at 85 percent and 95 percent of the maximum dry density using ASTM D1557 (Modified Proctor). A dry-out curve was performed for each thermal resistivity test. Tests include a minimum of three points, including optimum moisture content or as-received moisture (whichever is higher), totally dry condition, and 1 intermediate moisture content. The test results are presented in the **Exploration and Laboratory Results** section of this report.

Geophysical Test Results

Due to the extent of the grading anticipated for the project site and the shallow rock encountered in the borings, a geophysical survey was performed that utilized Seismic

Refraction (SR) 2D profiles and Multichannel Analysis of Surface Waves (MASW) 1D soundings. The surveys were performed at four locations throughout the site. SR surveys measure subsurface variations in the compressional wave (p-wave) velocities which can be indicative of variations in the density and elastic properties of subsurface materials and can be used to help assess the rippability of the soil and bedrock. The MASW soundings assist in determining stiffness of the soil lithology (stiff/dense layers) and to check if any shear wave velocity inversions (less stiff soil underlying stiffer soil) exist. The geophysical test results and approximate test locations are summarized in the Geophysical Report for this project, Terracon Job No. NS245114, dated July 18, 2024. The Geophysical Report is presented in the **Supporting Information** section of this report.

Geotechnical Overview

The subject site has geotechnical considerations that will affect the construction and performance of the proposed improvements that are discussed in this report. The primary geotechnical considerations that have been identified at the subject site that will affect development are the following:

- Mass Grading Considerations
- Excavation Considerations
- Erosion Considerations
- Slope Stability Considerations
- Expansive soils

Mass Grading Considerations

As indicated in the **Project Description** section of this report, it is our understanding that the proposed site will be mass graded with up to 30 feet of cut and fill. The recommendations contained in this report are dependent on the final grading plans for the project. Terracon should be provided the final plans for review to determine if additional recommendations and further exploration, testing, and analysis are warranted.

Excavation Considerations

It is anticipated that excavations within the upper residual soil and weathered rock at the site can be accomplished with conventional large earthmoving equipment. Based on the results of our borings, competent bedrock (Sandstone, Siltstone, and Claystone with primary velocities, Vp, equal to or greater than 5,000 feet per second) which may require the use of specialized heavy-duty equipment and/or blasting was observed in the borings and geophysical surveys. It is recommended to get unit pricing for difficult excavation during the bidding process. An experienced contractor familiar with the local geology should anticipate such conditions and plan their work accordingly.

Erosion Considerations

The surface soils at the site consist of sand, silt, and clay which are typically subject to significant wind/water erosion or sedimentation. The project Civil Engineer while developing the plans should plan to limit wind/water erosion and sedimentation during and after construction to levels acceptable to the owner.

We understand the project will be a private closed project that will not provide access to the public. We have provided minimum recommendations to reduce the potential for surface erosion and potential undercutting of any slopes. We understand that it will be the owner's responsibility to maintain all drainages and manage surface run-off water for the life of the project. The owner shall determine what level of maintenance is acceptable. Some options have been provided herein. The owner, contractor, civil engineer, and our office shall work together to develop the best civil and grading plans to fit the owner's level of acceptable maintenance.

Natural drainages exist throughout the property and may impact the proposed development. Ultimately, Terracon recommends that the project Civil Engineer plan his work to account for any major drainage that may be altered as part of development (road crossing etc.). Typically, Terracon recommends protecting any bare soil from erosion by placing rip rap at the abutments of both sides of embankments or providing drainage swales, etc.

Slope Stability and Landslide Considerations

As discussed in the **Project Description** section of this report, the site is located within hilly topography and mass grading is anticipated to bring the sites to final design grades. A preliminary grading plan was not provided to Terracon as of the date of this report. Once grading plans have been made available, Terracon should be afforded the opportunity to review the plans and perform a slope stability analysis in cut areas to confirm the maximum allowable slope to maintain stability. Additionally, a detailed landslide study was not included as part of the scope covered under this report. A Certified Engineering Geologist should observe the cut slopes during construction to assess the bedding conditions and so that additional recommendations and considerations can be made.

Expansive Soils

Expansive soils are present on this site. This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement of the structures should be anticipated. The severity of damage such as uneven or cracked foundations will probably increase if modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. Some of these options are discussed in this report such as complete replacement of expansive soils.

The near surface, stiff to hard medium plasticity lean clay and high plasticity fat clay could become unstable with typical earthwork and construction traffic, especially after precipitation events. The effective drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier times of the year. If grading is performed during the winter months, an increased risk for possible undercutting and replacement of unstable subgrade will persist. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The soils which form the bearing stratum for shallow foundations are plastic and exhibit potential for shrink-swell movements with changes in moisture. Additional areas of localized highly plastic soils are likely present where borings were not performed. Maintaining above optimum moisture conditions in the bearing soils and a minimum dead load pressure on mat foundations should reduce the anticipated swell movements to tolerable levels. The **Mat Foundations** section addresses support of the BESS and substation foundations bearing on granular structural fill.

Earthwork

We anticipate grading may consist of cuts and fills on the order of 30 feet or less in order to develop final site elevations. Specific site grading information was unavailable at the time this report was prepared. Once grading plans become available, Terracon should be contacted to determine if additional earthwork recommendations are warranted.

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations.

Site Preparation

Prior to placing fill for roadways, substation equipment, or BESS battery containers and equipment; existing debris, vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed improvement areas. Stripping should extend laterally a minimum of 5 feet beyond the limits of proposed improvements.

Although no evidence of pre-existing fill or underground facilities (such as septic tanks, cesspools, and utilities) was observed during the exploration and site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Subgrade Preparation

After clearing, any required cuts and overexcavation should be made.

Due to the extensive site grading proposed for the project site, in areas where the cuts and fills will be less than 10 feet, we recommend that the soils within the footprint of the proposed structures be removed to a minimum depth of 24 inches below the bottom of mat foundations and replaced with granular structural fill. Granular structural fill placed beneath the entire footprint of the foundations should extend horizontally a minimum distance of 5 feet beyond the outside edge of the foundations. In areas where the cuts and fills will be greater than or equal to 10 feet, we recommend that the proposed structures bear on a minimum of 24 inches of granular structural fill overlaying a minimum of 8 feet of structural fill. Portions of the near-surface materials anticipated to be developed as excavation spoils are not considered suitable for use as structural fill.

Excavated material may be stockpiled for use as fill provided it is cleaned of organic material, debris, and any other deleterious material and meets the criteria for general or structural fill specified in the ***Fill Material Types*** section of this report.

Once cuts and overexcavation operations are complete, the resulting subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck. The proofrolling should be performed under the observation of the Geotechnical Engineer or their representative. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed or modified by stabilizing as noted in the ***Soil Stabilization*** section of this report. Excessively wet or dry material should either be removed, or moisture conditioned and recompacted.

Once proofrolling has been performed, and prior to placing any fill, the subgrade soil should be scarified, moisture conditioned, and compacted per the requirements provided in the **Fill Placement and Compaction Requirements** section of this report. The depth of scarification of subgrade soils and moisture conditioning of the subgrade is highly dependent upon the time of year of construction and the site conditions that exist immediately prior to construction. If construction occurs during the winter or spring, when the subgrade soils are typically already in a moist condition, scarification and compaction may only be 8 inches. If construction occurs during the summer or fall when the subgrade soils have been allowed to dry out deeper, the depth of scarification and moisture conditioning may be as much as 18 inches or more. A representative from Terracon should be present during earthwork to observe the exposed subgrade and confirm the depth of scarification and moisture conditioning required.

Following scarification, moisture conditioning, and compaction of the subgrade soils, any required fill soils should then be placed to the proposed design grade and compacted, and the moisture content and compaction of the subgrade soils should be maintained until foundation roadway construction.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable; however, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Slopes

Permanent cut slopes should preliminarily be no steeper than 3H:1V (Horiztontal:Vertical) for planning and budgeting purposes. Once grading plans have been made available, Terracon should be afforded the opportunity to review the plans and perform a slope stability analysis in cut areas to confirm the maximum allowable slope to maintain stability. For permanent slopes in compacted fill areas, recommended maximum configurations are as follows:

Maximum Embankment Fill Slope Configuration	
Inclination (Horizontal:Vertical)	**Slope Treatment**
5H:1V to less steep than 2H:1V	Vegetate
2H:1V to less steep than 1.5H:1V	Rip-rap over filter fabric
Steeper than 1.5H:1V	Stability analysis or structural retaining wall required

We expect slopes with these configurations to be resistant to erosion and stable against circular failure. If any slope in cuts or fill will exceed 25 feet in height, the grading design should include mid-height benches to intercept surface drainage and divert flow from the face of the embankment.

Where fill is placed on existing slopes steeper than 5H:1V, benches should be cut into the existing slopes prior to fill placement. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate the compaction equipment. This benching will help provide a positive bond between the fill and natural soils and reduce the possibility of failure along the fill/natural soil interface. A key should be installed at the toe of the slope. The depth of the key should be at least 1/3 the height of the planned fill. Furthermore, we recommend that fill slopes be over filled and then cut back to develop an adequately compacted slope face. No “cat tracking” of slope surfaces is allowed.

Topsoil and organic subsoil (subsoil with visible roots) should be removed prior to placing fill for slopes. Soil placed to create fill slopes should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

Cut and fill slopes should be covered with some type of erosion control measure immediately after construction. Erosion control measures can consist of a spray tacifyer with erosion resistant vegetation seed, jute netting, or geotextile erosion control mats. These should be installed per the manufacturer’s specifications. Some minor, relatively shallow erosion should be planned for. Routine maintenance will be required on all cut and fill slopes. Any detected problems should be repaired immediately. It is important that the bottom of all cuts and fills be protected from erosion or undercutting that could jeopardize the integrity of the slope. Substantial slope failure could occur if the bottoms of the slopes are not protected.

Terracon should be present during grading and when any cuts are being made to observe the soil/bedrock lithology and help identify any adverse conditions that may be present that would warrant our recommendations to be revised.

Excavation

We anticipate that shallow excavations for the proposed construction can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

However, for deeper excavations, based on the encountered subsurface conditions, we believe heavy-duty construction equipment, such as a hoe ram, a heavy dozer equipped with a ripper, a rock saw or jack hammer or with rock trenching equipment, is likely suitable for grading. Due to the presence of weathered rock, drilled shaft excavation will encounter very hard materials. A drilled-shaft drilling rig equipped with hard formation drilling bits (rock drill type bit) having high torque capacity may be required for installation of short shafts to achieve appropriate shaft depths.

Required excavation techniques will vary based on weathering of the materials to be excavated, and the fracturing, jointing and overall stratigraphy of the feature. Actual field conditions usually display a gradual weathering progression with poorly defined and uneven boundaries between layers of different materials. We recommend that earthwork operations be performed by those familiar with the local geology. As previously stated, seismic refraction profiles were performed in order to assist with estimating the rippability of the soil.

The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction. Onsite soils may consist of cohesionless sandy soils. Such soils have the tendency to cave and slough during excavations. Therefore, formwork may be needed for foundation excavations.

Individual contractors are responsible for designing and constructing stable, temporary excavations. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

Soil Stabilization

Methods of subgrade stabilization, as described in this section, could include scarification, moisture conditioning and recompaction, removal of unstable materials and replacement with granular fill (with or without geosynthetics), and chemical stabilization. The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size of area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs. Performing site grading operations during warm seasons and dry periods would help reduce the amount of subgrade stabilization required.

If the exposed subgrade is unstable during proofrolling operations, it could be stabilized using one of the following methods:

- **Scarification and Recompaction** - It may be feasible to scarify, dry, and recompact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.

- **Aggregate Base** - The use of Caltrans Class II aggregate base is a common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 6 inches to 18 inches below finished subgrade elevation. The use of high modulus geosynthetics (i.e., engineering fabric or geogrid) could also be considered after underground work such as utility construction is completed. Prior to placing the fabric or geogrid, we recommend that all below grade construction, such as utility line installation, be completed to avoid damaging the fabric or geogrid. Equipment should not be operated above the fabric or geogrid until one full lift of aggregate base is placed above it. The maximum particle size of granular material placed over geotextile fabric or geogrid should meet the manufacturer's specifications.
- **Chemical Stabilization** - Improvement of subgrades with Portland cement or quicklime could be considered for improving unstable soils. Chemical stabilization should be performed by a pre-qualified contractor having experience with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions. The hazards of chemicals blowing across the site or onto adjacent property should also be considered. Additional testing would be needed to develop specific recommendations to improve subgrade stability by blending chemicals with the site soils. Additional testing could include, but not be limited to, determining the most suitable stabilizing agent, the optimum amounts required, and the presence of sulfates in the soil. If this method is chosen to stabilize subgrade soils the actual amount of high calcium quicklime/Portland cement to be used should be determined by Terracon and by laboratory testing **at least three weeks prior** to the start of grading operations.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below or within 5 feet of structures or constructed slopes and within 3 feet of roadways. General fill is material used to achieve grade outside of these areas.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as fill. However, some of the excavated on-site soil is not suitable for reuse as Structural Fill based on their expansive properties and should not be placed within foundation bearing zones. Portions of the on-site soil have an elevated fines content and will be sensitive to moisture conditions (particularly during seasonally wet periods) and may not be suitable for reuse when above optimum moisture content.

Material property requirements for on-site soil for use as general fill and structural fill are noted in the following table:

Property	Structural Fill	General Fill
Composition	Free of deleterious material	Free of deleterious material
Maximum particle size	3 inches	6 inches (or 2/3 of the lift thickness)
Fines content	Less than 60% Passing No. 200 sieve	Not limited
Plasticity	Maximum liquid limit of 30 Maximum plasticity index of 10 Expansion Index less than 20	Not limited
GeoModel Layer Expected to be Suitable[1]	1, 5, 6	1, 2, 3, 4, 5, 6, 7

1. Based on subsurface exploration. Actual material suitability should be determined in the field at time of construction.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. For all import material, the contractor shall submit current verified reports from a recognized analytical laboratory indicating that the import has a “not applicable” (Class S0) potential for sulfate attack based upon current ACI criteria and is “mildly corrosive” to ferrous metal and copper. The reports shall be accompanied by a written statement from the contractor that the laboratory test results are representative of all import material that will be brought to the project.

Soil Type [1]	USCS Classification	Acceptable Parameters (for Structural Fill)
Low Plasticity	CL, SC	Liquid Limit less than 30 Plasticity index less than 12 Expansion index less than 20 Less than 70% passing No. 200 sieve
Granular[2]	GW, GM, SW, SM	Less than 40% passing No. 200 sieve

Soil Type [1]	USCS Classification	Acceptable Parameters (for Structural Fill)

1. Structural and general fill should consist of approved materials free of organic matter and debris and should contain no material larger than 3 inches and 6 inches in greatest dimension, respectively. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation at least two weeks prior to use on this site. Additional geotechnical consultation should be provided prior to use of uniformly graded gravel on the site.
2. Caltrans Class II aggregate base may be used for this material. Recycled aggregate base should not be used without prior approval by the Geotechnical Engineer.

Fill Placement and Compaction Requirements

Compacted native soil and structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as structural fill
Minimum Compaction Requirements [1,2]	95% of max. for structural fill below foundations and slabs, within 1 foot of finished pavement subgrade, for aggregate base and chemically treated soil, and for fills deeper than 5 feet 90% of max. for all other locations	90% of max.
Water Content Range [1]	Low plasticity cohesive: +1% to +3% above optimum High plasticity cohesive: +2% to +4% above optimum Granular: -2% to +2% of optimum	As required to achieve min. compaction requirements

Item	Structural Fill	General Fill

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D 1557).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed full time by the Geotechnical Engineer or representative.

The compaction requirements for buried power cable should be verified and confirmed by the project electrical engineer as thermal resistivity properties of soil can vary significantly with changes in density.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility to be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and Atterberg limit requirements for structural fill discussed in this report.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Flooding or jetting for placement and compaction of backfill is not recommended.

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cementitious flowable fill or cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill. Attempts should also be made to limit the amount of fines migration into the clean granular material. Fines migration into clean granular fill may result in unanticipated localized settlements over a period of time. To help limit the amount of fines migration, Terracon recommends the use of a geotextile fabric that is designed to prevent fines migration in areas of contact between clean granular material and fine-grained soils. Terracon also recommends that clean granular fill be tracked or tamped in place where possible to limit the amount of future densification which may cause localized settlements over time.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the structures should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the structures. The trench should provide an effective trench plug that extends at least 5 feet from the face of the improvement. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the construction area during and after construction and should be maintained throughout the life of the structures. Water retained next to the structures can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential foundation movements and cracked slabs.

Exposed ground should be sloped and maintained at a minimum of 5 percent away from the foundation areas for at least 10 feet beyond the perimeter of the foundations area. After construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure’s maintenance program.

Implementation of adequate drainage for this project can affect the surrounding developments. Consequently, in addition to designing and constructing drainage for this project, the effects of site drainage should be taken into consideration for the planned structures on this property, the undeveloped portions of this property, and surrounding sites. Extra care should be taken to ensure irrigation and drainage from adjacent areas do not drain onto the project site or saturate the construction area.

Earthwork Construction Considerations

Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of foundation slabs. Construction traffic over the completed subgrades should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to construction.

We recommend that the earthwork portion of this project be completed during extended periods of dry weather if possible. If earthwork is completed during the wet season (typically November through April) it may be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork operations may require additional mitigation measures beyond that which would be expected during the drier summer and fall months. This could include ground stabilization utilizing chemical treatment of the subgrade, diversion of surface runoff around exposed soils, and draining of ponded water on the site. Once subgrades are established, it may be necessary to protect the exposed subgrade soils from construction traffic.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations. Stockpiles of soil, construction materials, and construction equipment should not be placed near trenches or excavations. ***The Contractor is responsible for maintaining the stability of adjacent structures during construction.***

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and debris), evaluation and remediation of existing fill materials, if encountered, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 1,000 square feet of compacted fill in the equipment pad areas and at least one test for every 2,500 square feet of compacted fill in unpaved road areas. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill and a minimum of one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer’s evaluation of subsurface conditions, including assessing variations and associated design changes.

Preliminary Mat Foundations

The proposed substation elements and battery storage pads may be supported by mat foundations. Due to the degree of the proposed grading and the lack of preliminary grading plans as of the date of this report, the recommendations provided in this section are preliminary and contingent upon Terracon’s review of the grading plans before final recommendations can be provided. If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

It is recognized that in some areas of the project site, surficial soils are softer than underlying soils. However, some of these areas may receive sufficient fills and/or cuts that would effectively remove the potential for softer soil conditions and allow for an increased bearing capacity. Option 1 below is provided the area has minimal fills and/or cuts while Option 2 below is provided the area has a minimum of 10 feet of fills and/or cuts.

Preliminary Mat Foundation Design Parameters – Compressive Loads

Item	Description
Required Bearing Stratum [3]	Option 1 - 2 feet minimum of granular structural fill Option 2 - 2 feet minimum of granular structural fill over a minimum of 8 feet of structural fill after removal of the upper 10 feet of overburden soil
Maximum Net Allowable Bearing Pressure [1, 2, 9] **(Option 1)**	4,000 psf for foundation max. width up to 3½ feet 2,000 psf for foundation max. width up to 7 feet 1,500 psf for foundation max. width up to 11 feet
Maximum Net Allowable Bearing Pressure [1, 2, 9] **(Option 2)**	4,000 psf for foundation max. width up to 9 feet 2,500 psf for foundation max. width up to 15 feet 1,500 psf for foundation max. width up to 35 feet
Minimum Foundation Dimensions	Per CBC 1809.7
Passive Resistance[4, 8] **(equivalent fluid pressures)**	250 pcf
Sliding Resistance [5, 8]	0.35 allowable coefficient of friction
Minimum Embedment below Finished Subgrade [6]	12 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About ½of total settlement
Design Modulus of Subgrade Reaction, k	For 4,000 psf bearing pressure: 28 psi/in For 2,500 psf bearing pressure: 17 psi/in For 2,000 psf bearing pressure: 14 psi/in For 1,500 psf bearing pressure: 10 psi/in

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. This bearing pressure can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Values assume that exterior grades are no steeper than 20% within 10 feet of structure. The bearing pressures provided assumes a rigid mat foundation design that applies a uniform pressure across the footprint of the foundation. If the mat foundation will be flexible resulting in variable pressures across the foundation, Terracon should be contacted to collaborate with the structural engineer to determine the anticipated settlement due to the variable pressures across the slab.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.

Item	Description

3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the foundation forms be removed and compacted structural fill be placed against the vertical foundation face. Assumes no hydrostatic pressure.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. Should be neglected for foundations subject to uplift conditions.
6. Embedment necessary to minimize the effects of seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior subgrade within 10 horizontal feet of the structure.
7. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.
8. Passive Resistance and Sliding Resistance may be combined to resist sliding provided the Passive Resistance is reduced by 50 percent.
9. The dimensions assume width as the shortest plan view dimension of the foundation and the length is assumed to be less than or equal to 2 times this value.

Settlement calculations were performed utilizing Westergaard and Hough's methods[5] to estimate the static settlement and allowable bearing pressure for various foundation widths.

Since several factors will control the design of mat foundations besides vertical load, Terracon should be consulted when the final foundation depth and width are determined to assist the structural designer in the evaluation of anticipated settlement. Other details including treatment of loose foundation soils, superstructure reinforcement, and observation of foundation excavations as outlined in the **Earthwork** section of this report are applicable for the design and construction of a mat foundation at the site.

Foundation Construction Considerations

As noted in **Earthwork**, the foundation excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent

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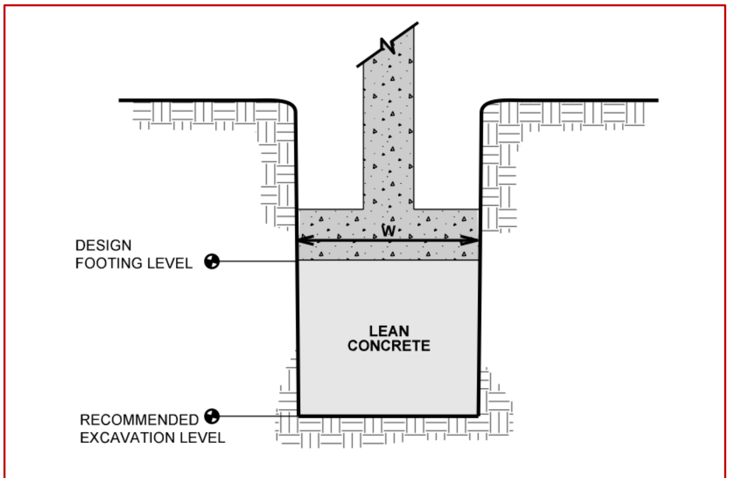
[5] FHWA Geotechnical Engineering Circular No. 6 – Shallow Foundations, FHWA-SA-02-054.

wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the foundation excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are observed at the base of the planned foundation excavation, the excavation should be extended deeper to suitable soils, and the foundations could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated in the following sketch.



LEAN CONCRETE BACKFILL

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

To ensure foundations have adequate support, special care should be taken when foundations are located adjacent to trenches. The bottom of such foundations should be at least 1 foot below an imaginary plane with an inclination of 1.5 horizontal to 1.0 vertical extending upward from the nearest edge of the adjacent trench.

Deep Foundations

Preliminary Drilled Shaft Design Parameters

The proposed substation elements and Gen-Tie line tower may be supported by a deep foundation system consisting of drilled shafts. Due to the degree of the proposed grading and the lack of preliminary grading plans as of the date of this report, the recommendations provided in this section are preliminary and contingent upon Terracon's review of the grading plans before final recommendations can be provided. Final design shaft lengths should be determined by the Geotechnical and Structural

Engineers during final design based on structural loading and final design parameters developed upon review of the project grading plans.

Preliminary Allowable Skin Friction versus Depth and Allowable Total Capacity versus Depth charts are provided in the **Figures** section of this report for shaft diameters ranging from 1.5 feet to 4 feet for project planning. The preliminary recommendations are provided from existing grades. Therefore, significant cuts or fills will affect the recommended soil profiles. A factor of safety of 2.5 was used for skin friction and a factor of safety of 3 was used for end bearing. Terracon should be consulted if additional shaft diameters are required.

We recommend that the deep foundation system be designed to develop axial compression through skin friction, and that end-bearing should only be used when shafts extend at least one shaft diameter into rock. Shaft uplift capacity should also be derived from skin friction only. Shaft uplift capacity should be considered as 2/3 of the compressive capacity due to skin friction. The effective weight of the shaft can be added to the uplift load resistance to the extent permitted by the 2022 CBC. Preliminary design parameters for a drilled shaft foundation system are presented in the following table.

Drilled Shaft Design Summary

Description	Recommendations
Foundation Type	Drilled shaft
Shaft Dimension (minimum)	18-inch diameter
Minimum Shaft Embedment for Axial Design	8 feet below the existing ground surface or 5 feet into rock

1. Design capacity is dependent upon the method of installation, and quality control parameters, and should be evaluated further during final design.
2. Drilled shaft embedment depths should be evaluated further with the design team when structural loading information and final grading plans are available. The upper 3 feet of soil has been neglected in providing support to drilled shaft.
3. Our current scope of work included extending test borings to a maximum depth of 51½ feet bgs. Deeper borings shall be utilized for confirmation of subgrade conditions if drilled shafts deeper than 51½ feet bgs are required.
4. The drilled shafts may be subject to uplift as a result of wind and seismic loading. The shafts must contain sufficient continuous vertical reinforcing and embedment depth to resist the net tensile load.

Shafts should be adequately reinforced as designed by the Structural Engineer for both tension and shear to sufficient depths.

The shaft foundations shall be designed to distribute the weight of structures solely on the shafts. All shafts should be connected with a reinforced slab or continuous grade beams which rely on the shafts for full support where multiple shafts are supporting a structure. Slab or grade beam reinforcement should be designed by the structural engineer so as to distribute the structural loads to the shafts. Grade beams should extend a minimum of 18 inches below the lowest surrounding grade.

Drilled shafts should have a minimum (center-to-center) spacing of three diameters. Closer spacing may require a reduction in axial load capacity. Axial capacity reduction can be determined by comparing the allowable axial capacity determined from the sum of individual shafts in a group versus the capacity calculated using the perimeter and base of the shaft group acting as a unit. The lesser of the two capacities should be used in design.

Post-construction settlements of drilled shafts designed and constructed as described in this report are estimated to range from about ½ to ¾ inch. Differential settlement between individual shafts is expected to be ½ to ⅔ of the total settlement.

Preliminary Drilled Shaft Lateral Loading

The following table lists preliminary input values for use in preliminary LPILE analyses. The preliminary values are provided based on existing grades. Therefore, significant cuts or fills will affect the recommended values. Final design input values can be developed once the project grading plans have been developed and reviewed. Modern versions of LPILE provide estimated default values of k_h and E_{50} based on strength and are recommended for the project. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Drilled Shaft Lateral Design Parameters at Boring B1

Stratigraphy[1]		**L-Pile Soil Model**	**S_u (psf)**[2]	**ϕ**[2]	**γ' (pcf)**[2]	**ε_{50}**	**K (pci)**	
Depth	**Material**						**Static**	**Cyclic**
3-18[3]	Silty Sand	Sand (Reese)	---	38°	115	Use Default Value		
18-34	Silt	Stiff Clay w/o Free Water	4,000	---	120	Use Default Value		
34-37	Silty Sand	Sand (Reese)	---	42°	120	Use Default Value		

Stratigraphy[1]		L-Pile Soil Model	S_u (psf)[2]	ϕ[2]	γ′ (pcf)[2]	ε_{50}	K (pci)	
Depth	**Material**						**Static**	**Cyclic**
37-51½	Lean Clay	Stiff Clay w/o Free Water	3,500	---	115	Use Default Value		

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   ϕ: Internal friction angle
   γ′: Effective unit weight
3. The upper 3 feet of the drilled shaft should be neglected from design.
4. Our current scope of work included extending test borings to a maximum depth of 51½ feet bgs. Deeper borings shall be utilized for confirmation of subgrade conditions if drilled shafts deeper than 51½ feet bgs are required.

Drilled Shaft Lateral Design Parameters at Borings B2 & B3

Stratigraphy[1]		L-Pile Soil Model	S_u (psf)[2]	ϕ[2]	γ′ (pcf)[2]	ε_{50}	K (pci)	
Depth	**Material**						**Static**	**Cyclic**
3-9[3]	Silty Sand	Sand (Reese)	---	40°	100	Use Default Value		
9-41	Weathered Sandstone	Sand (Reese)	---	45°	115	Use Default Value		

1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   ϕ: Internal friction angle
   γ′: Effective unit weight
3. The upper 3 feet of the drilled shaft should be neglected from design.
4. Our current scope of work included extending test borings to a maximum depth of 41 feet bgs. Deeper borings shall be utilized for confirmation of subgrade conditions if drilled shafts deeper than 41 feet bgs are required.

Drilled Shaft Lateral Design Parameters at Borings B4 & B5

Stratigraphy[1]		L-Pile Soil Model	S_u (psf)[2]	ϕ[2]	γ' (pcf)[2]	ε_{50}	K (pci)	
Depth	Material						Static	Cyclic
3-4[3]	Fat Clay	Stiff Clay w/o Free Water	3,500	---	105	Use Default Value		
4-13	Sand/ Siltstone	Sand (Reese)	---	36°	110	Use Default Value		
13-19	Lean Clay/Sandy Silt	Stiff Clay w/o Free Water	1,220	---	105	Use Default Value		
19-41	Weathered Siltstone	Sand (Reese)	---	40°	115	Use Default Value		

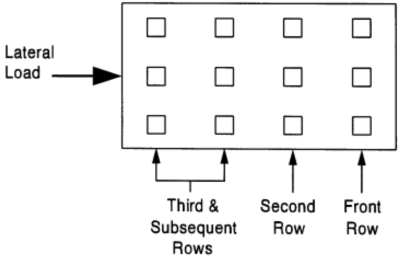
1. See Subsurface Profile in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   ϕ: Internal friction angle
   γ': Effective unit weight
3. The upper 3 feet of the drilled shaft should be neglected from design.
4. Our current scope of work included extending test borings to a maximum depth of 41 feet bgs. Deeper borings shall be utilized for confirmation of subgrade conditions if drilled shafts deeper than 41 feet bgs are required.

When shafts are used in groups, the lateral capacities of the shafts in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent shaft. Guidance for applying p-multiplier factors to the p values in the p-y curves for each row of shaft foundations within a shaft group are as follows:

Center to Center Shaft Spacing[1,2]	P-Multiplier, P_m[3]		
	Front Row	Second Row	Third and Subsequent Rows
3B	0.8	0.4	0.3
4B	0.9	0.65	0.5
5B	1.0	0.85	0.7
6B	1.0	1.0	1.0

Center to Center Shaft Spacing [1,2]	P-Multiplier, P_m [3]		
	Front Row	Second Row	Third and Subsequent Rows

1. Spacing in the direction of loading. B = shaft diameter
2. For the case of a single row of shafts supporting a laterally loaded grade beam, group action for lateral resistance of shafts would need be considered when spacing is less than three shaft diameters (measured center-to-center).
3. See adjacent figure for definition of front, second and third rows.



Spacing closer than 3D (where D is the diameter of the shaft) is allowed without applying a reduction factor provided the drilled shaft is embedded into a minimum of 5 feet of rock. Embedment is to be verified by a representative of the Geotechnical Engineer of Record at the time of installation.

The load capacities provided herein are based on the stresses induced in the supporting soil strata. The structural capacity of the shafts should be checked to assure they can safely accommodate the combined stresses induced by axial and lateral forces. Lateral deflections of shafts should be evaluated using an appropriate analysis method, and will depend upon the shaft's diameter, length, configuration, stiffness and "fixed head" or "free head" condition. We can provide additional analyses and estimates of lateral deflections for specific loading conditions upon request. The load-carrying capacity of shafts may be improved by increasing the diameter and possibly the length.

Drilled Shaft Construction Considerations

Drilling of foundations to design depths should be possible with conventional drilling equipment using single-flight power augers. However, difficult drilling conditions should be expected where weathered to intact sandstone, siltstone and/or claystone rocks, or very dense and cemented soils will be encountered. The drilling contractor should be experienced in the subsurface conditions observed at the site, and the excavations should be performed with equipment capable of providing a clean bearing surface. Specialized drilling equipment will likely be required to advance drilled shaft excavations in areas of cemented soils and rock drilling techniques will be required where rock is encountered on the project. Construction of drilled shaft foundations may or may not necessitate the use of temporary casing and/or wet drilling methods particularly if groundwater is encountered.

The drilled straight-shaft foundation system should be installed in general accordance with the procedures presented in "Standard Specification for the Construction of Drilled Piers", ACI Publication No. 336.1-01.

The contractor is generally expected to use conventional “dry” techniques for installation of the drilled shaft. Subsurface water was not encountered in our borings during the drilling activities. Subsurface water levels are influenced by seasonal and climatic conditions, which result in fluctuations in subsurface water elevations. Additionally, it is common for water to be present after periods of significant rainfall. Casing or slurry drilling procedures could be required in soils zones of higher sand content (such as was observed in Model Layer 1 of the borings) to reduce the potential for excavation sidewall collapse.

The drilling contractor should remove all soft and disturbed soils from the base of the drilled shafts prior to placing concrete.

Formation of mushrooms or enlargements at the tops of shafts should be avoided during shaft drilling. If mushrooms develop at the tops of the shafts during drilling, sono-tubes should be placed at the shaft tops to help isolate the shafts.

The drilled shaft installation process should be performed under the observation of the Geotechnical Engineer. The Geotechnical Engineer should document the shaft installation process including soil/rock and groundwater conditions observed, consistency with expected conditions, and details of the installed shaft.

Access Roads (Gravel-Surfaced Drives)

We understand that paved roads will not be constructed for the access roads. An all-gravel road will be constructed to provide periodic maintenance access to the BESS equipment and substation locations. It should be understood that the unpaved roads will require occasional maintenance. The access roads shall be crowned or sloped to drain surface water readily.

Subgrade Preparation

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are typically placed and compacted in a uniform manner. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, or rainfall. As a result, the aggregate-surfaced roadway or parking area subgrade may not be suitable for construction and corrective action will be required. The subgrade should be carefully evaluated at the time of construction for signs of disturbance or instability. We recommend the subgrade be thoroughly proofrolled with a loaded tandem-axle dump truck prior to final grading.

The top 12 inches of the exposed subgrade should be scarified, moisture conditioned, and recompacted to at least 95 percent of the maximum dry unit weight as determined by ASTM D1557 before any new fill or aggregate is placed.

Design Recommendations

Design of aggregate-surfaced roadways for the project has been based in general accordance with the Caltrans Highway Design Manual, latest edition and based on subsurface conditions observed at the site and laboratory test results. During the field investigation at the site, bulk samples of the near surface soils were collected. Two representative samples from borings B7 and B10 were tested in a Terracon laboratory to determine their Hveem Stabilometer Value (R-value). The test from boring B7 produced an R-Value of 35 and the test from boring B10 produced an R-value of less than 5. A design R-Value of 35 was utilized for silts and sands and a design R-Value of 5 was used for clayey soils to calculate the thickness of gravel section. Additional testing will be required during final grading to verify site conditions with respect to the tested R-Values.

Our analysis has assumed a "low" traffic volume, which is appropriate for 10,000 to 30,000 equivalent single axle loads (ESALs), and traffic indexes of 5.5 and 6.0 over the life of the gravel surfacing. This traffic volume should be confirmed by the design team; additional geotechnical consultation and revision of recommendations could be necessary with higher traffic volumes.

Recommended minimum aggregate surfacing thickness is provided in the following table.

Gravel Roadway Design

R-Value	Gravel Thickness (inches)	
	TI=5.5[1]	TI=6.0[1]
35	13.0	14.0
5	19.0	20.0

1. All materials should meet the current Caltrans Highway Design Manual specifications.
    - Base – Caltrans Class 2 aggregate base

The following table provides options for AC pavement sections reinforced with geogrid. The sections were calculated based on the Tensar Technical Note from June 2023. Tensar allows pavements to be designed using a R-Value of 50 when placing Tensar InterAx NX850 Geogrid on compacted subgrade. The geogrid shall be placed directly on the subgrade below the aggregate base layer. Adjacent rolls of geogrid shall be overlapped a minimum of 1 foot. Soft subgrade conditions should be evaluated by the geotechnical engineer. The development of wrinkles in the geogrid shall be avoided. A minimum loose fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph).

Reinforced pavement design procedures developed by grid producers rely on product specific field and laboratory research. In some cases, this research has tested pavement sections within a limited range of subgrade conditions and pavement thicknesses. Extrapolations are typically used for thicker pavement sections outside those parameters based on computer modeling. These methods represent the state of the practice but have not always been specifically verified by performance testing.

Gravel Roadway Design with Geogrid Reinforcement

R-Value	Gravel Thickness (inches)	
	TI=5.5[1]	TI=6.0[1]
50[2]	10.0	11.0

1. All materials should meet the current Caltrans Highway Design Manual specifications.
    - Base – Caltrans Class 2 aggregate base
2. An R-Value of 50 may be utilized when placing Tensar InterAx NX850 Geogrid or equivalent, as approved by the Geotechnical Engineer of Record, on compacted subgrade.

Quality roadway surfacing materials should consist of a blend of gravel, sand, and fines (clay and silt). We believe the maximum size particle should not exceed 1 inch in diameter and the gravel should be crushed with angular edges (not rounded). The blend of materials should be selected to allow for easy compaction resulting in a firm, low permeable surface promoting surface drainage off the roadway surface. Materials meeting Caltrans Class 2 specifications can be used for aggregate surfacing material. Aggregate surfacing material should be placed in lifts not exceeding 6 inches and compacted to a minimum of 95 percent of the maximum dry unit weight as determined by ASTM D1557. The width of the roadway should extend a minimum distance of 2 feet on each side of the desired surface width.

A quality roadway surfacing material should also contain approximately 10 to 25 percent fines (silt and clay-sized particles passing the No. 200 sieve). The fines should exhibit low to moderate plasticity (plastic index less than 12) and will act as a binder to help reduce risk for wash boarding. If the fines content of a roadway surfacing material is comprised mostly of silt, the fines will be non-plastic and the surfacing materials will not have the benefit of the binder or cohesive aspects.

If it is desired to reduce maintenance of the access road, we recommend that the surface of the aggregate be sealed with asphalt oil as soon as possible after final grading. This is to reduce the potential for moisture to migrate into the gravel and to reduce dust from the gravel in the dry months. The gravel should be sealed every year for the first few years until the gravel appears relatively stable and impermeable.

Additionally, as another method to help reduce dust, reclaimed asphalt pavement (RAP) may be used as the upper 2 to 4 inches of the aggregate-surfacing. The RAP should be graded to the specified limits for Caltrans Class 2 aggregate base course but modified to contain 10 to 25 percent fines and properly compacted. Periodic spraying (1 to 2 times a year following maintenance grading) of the surface with magnesium chloride or another dust suppressant may also be considered to reduce dust and wash boarding.

Studies have indicated that a major factor in extending roadway life is to provide adequate drainage for the roadway surface. Care should be made during development of the grading plans to provide for good drainage.

The use of underground drains lines and catch basins are recommended to reduce the length runoff water needs to travel to be removed from the roadway surface. However, we understand this may not be feasible or economic for this facility.

Aggregate-surfaced roadways performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of aggregate-surfaced roadways:

- Site grades should slope a minimum of 10 percent away from the roadways;
- The subgrade and the aggregate-surfaced roadways have a minimum 10 percent slope to promote proper surface drainage;
- Consider appropriate edge drainage; and
- Install pavement drainage in surrounding areas anticipated for frequent wetting.

Maintenance

The roadway section recommended above assumes that periodic maintenance of the roadway will be performed on a routine basis. This includes repair of failing areas prior to the start of the rainy season, re-sealing the surface as necessary, and re-grading of depressions and rutted areas. Re-grading of the surface to reduce or remove depressions and ruts is extremely important. If ruts or depressions develop, they will allow water to pond and saturate the aggregate and subgrade. This will lead to a reduction in shear strength of the roadway section and premature failure of the roadway. The owner may want to consider having a stockpile of Class 2 aggregate base on site to fill in depressions or rutted areas as they develop rather than wait until failure occurs.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

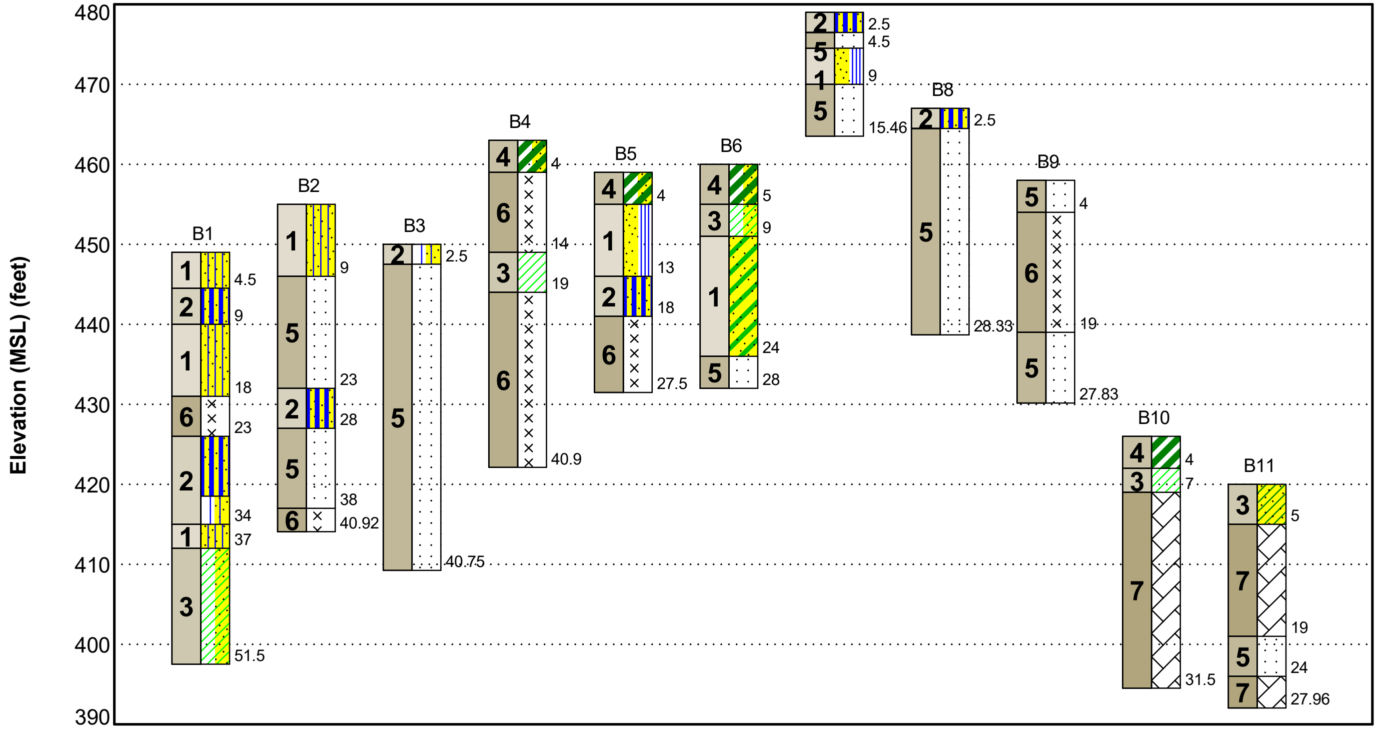
Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing. This report should not be used after 3 years without written authorization from Terracon.

Figures

Contents:

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

LEGEND

▨ Silty Sand
▨ Siltstone
▨ Lean Clay with Sand
▨ Fat Clay with Sand
▨ Poorly-graded Sand with Silt
▨ Fat Clay
▨ Sandy Lean Clay

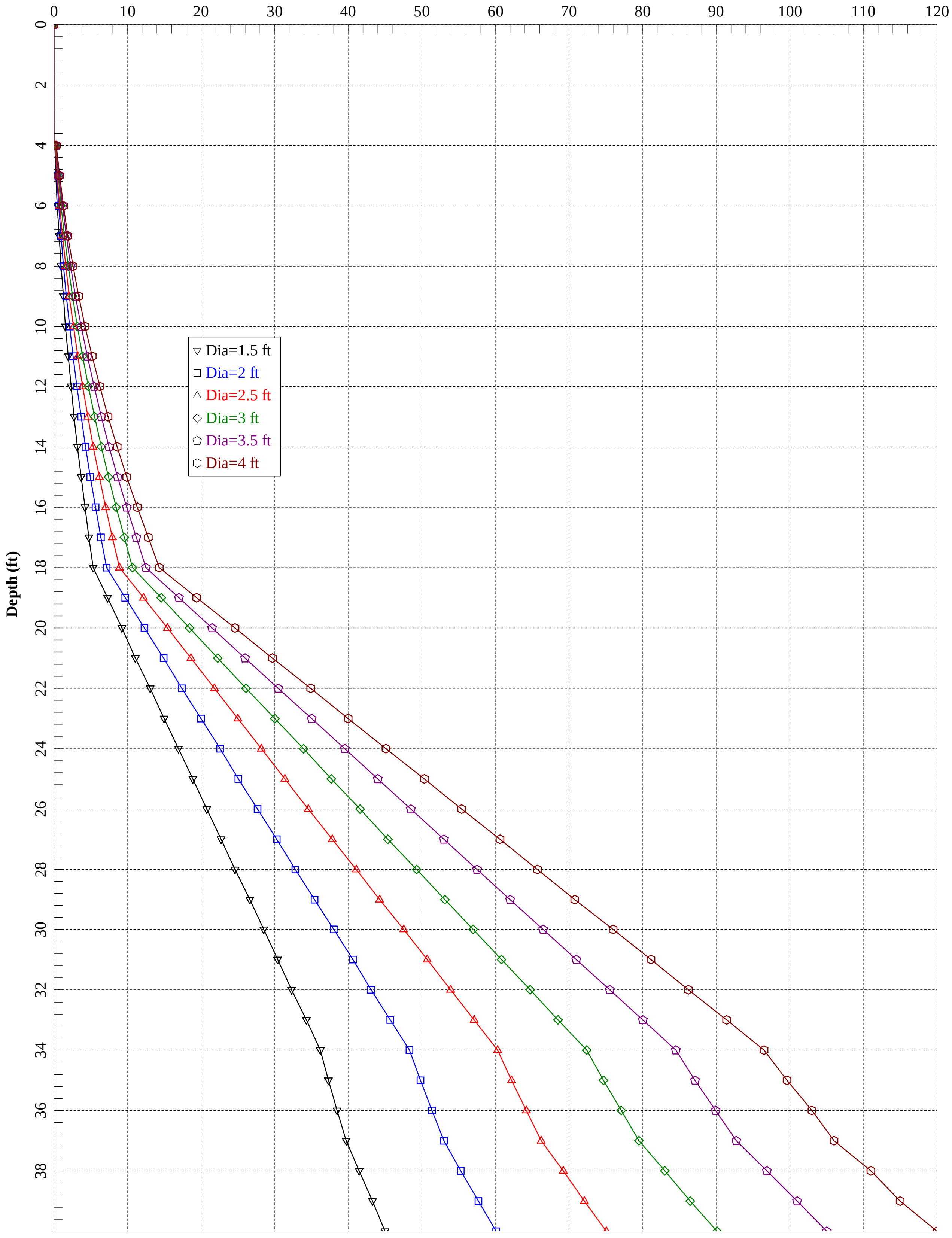
▨ Sandy Silt
▨ Silt with Sand
▨ Sandstone
▨ Lean Clay
▨ Clayey Sand
▨ Claystone

Model Layer	Layer Name	General Description
1	Sand	Medium dense to very dense sand with various amounts of silt or clay
2	Silt	Stiff to hard silt with various amounts of sand
3	Lean Clay	Medium stiff to hard lean clay with various amounts of sand
4	Fat Clay	Stiff fat clay
5	Sandstone	Highly weathered sandstone
6	Siltstone	Highly weathered siltstone
7	Claystone	Highly weathered claystone

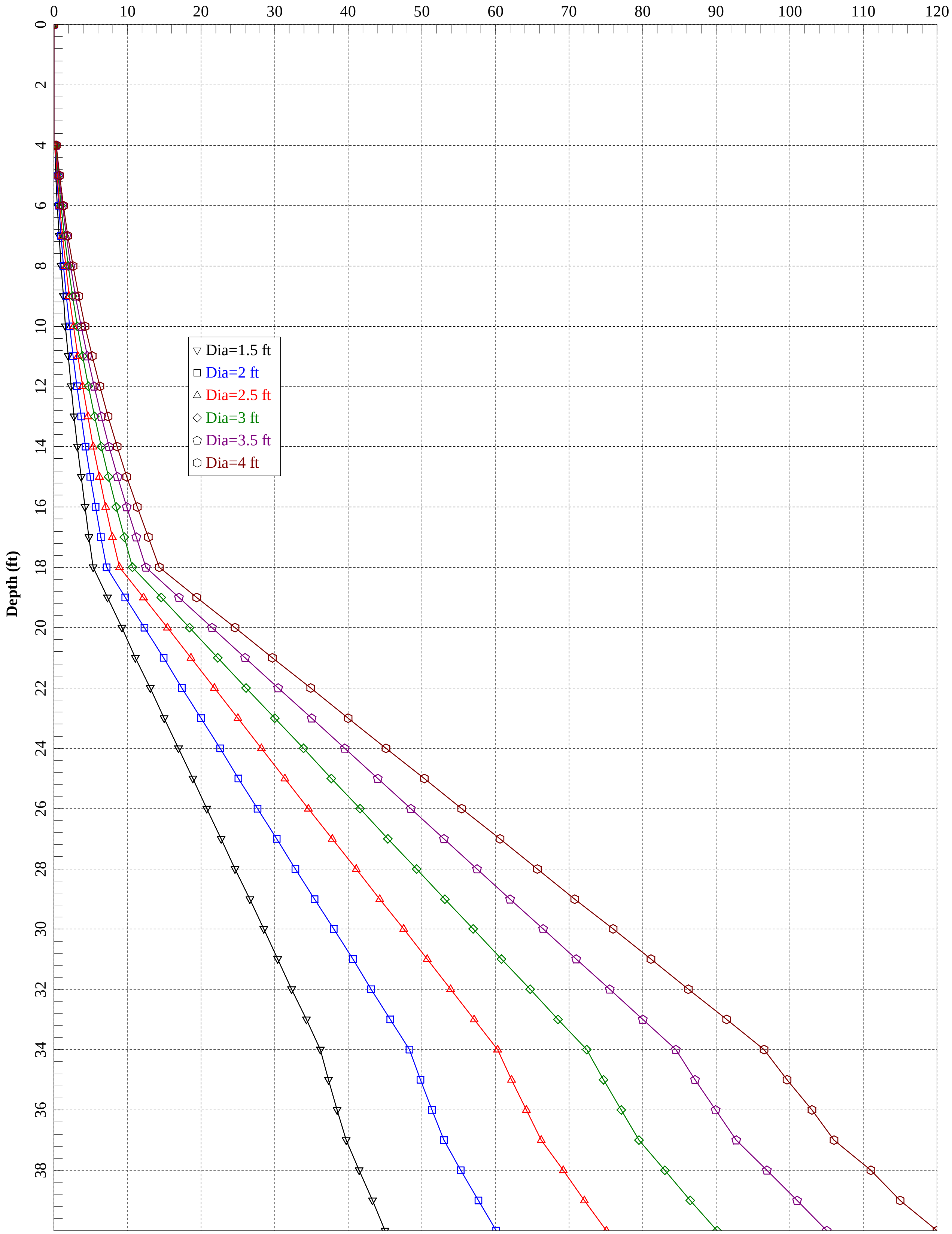
NOTES:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.

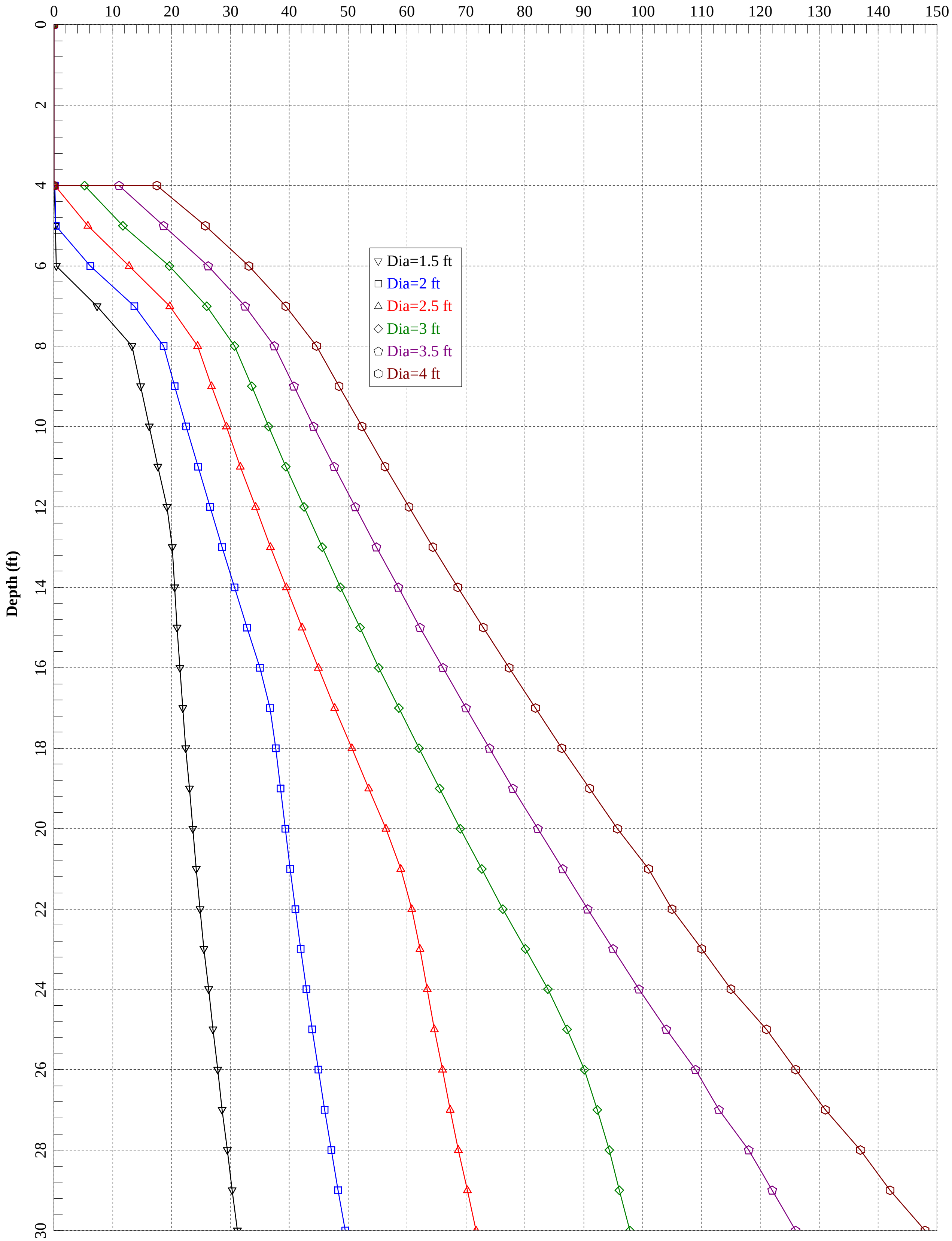
Allowable Total Capacity versus Depth Chart for B1
Total Resistance/F.S. (tons)



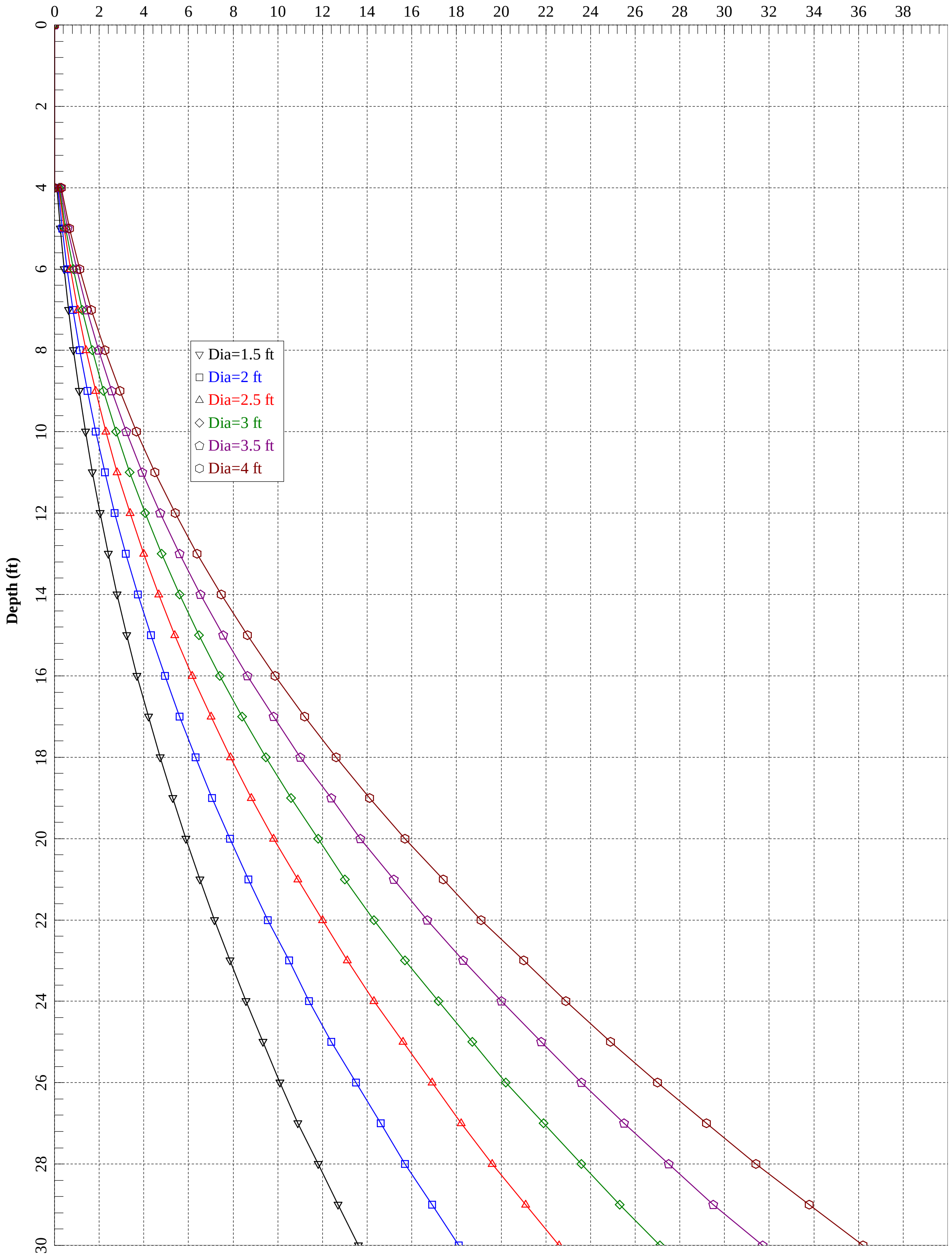
Allowable Skin Friction versus Depth Chart for B1
Side Resistance/F.S. (tons)



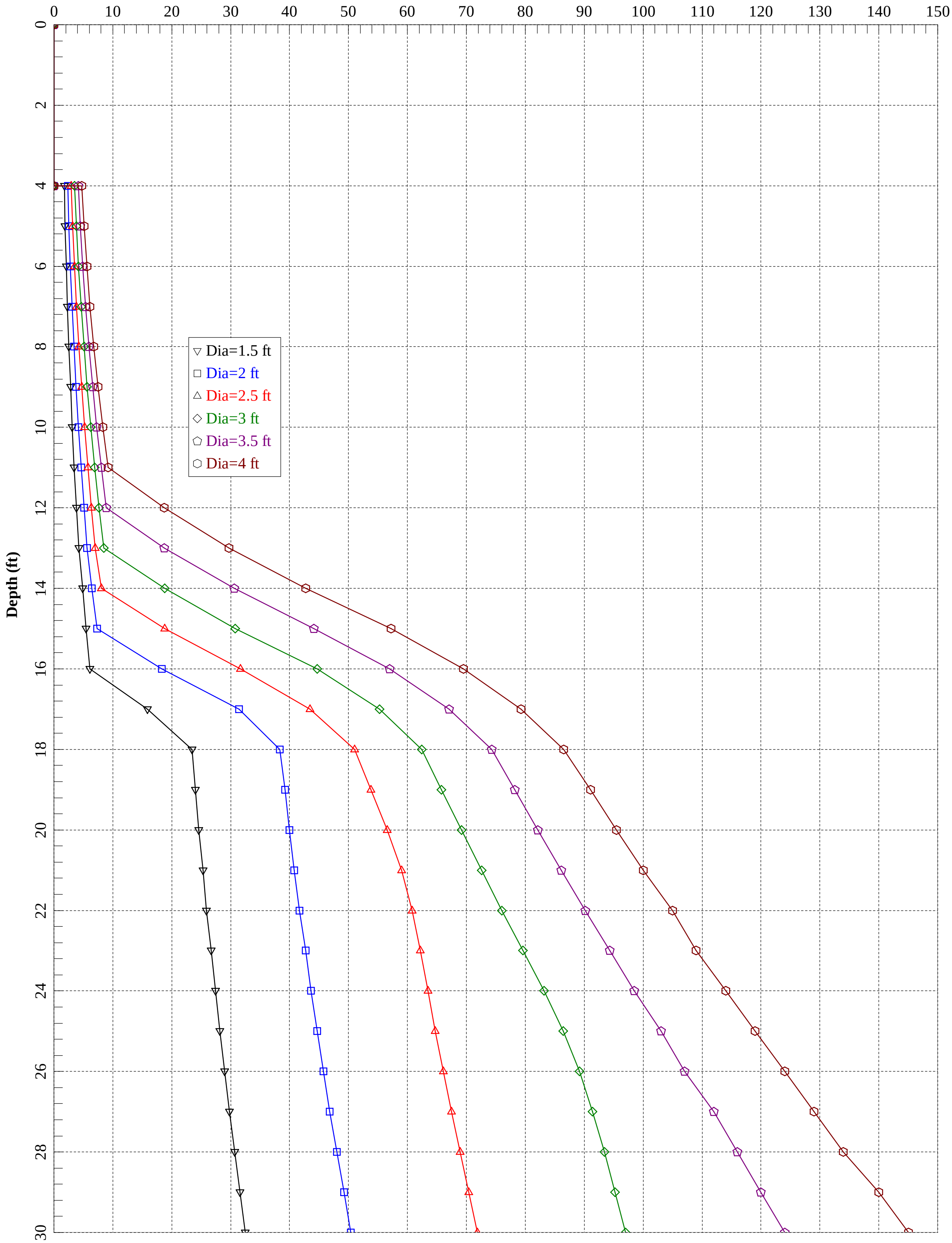
Allowable Total Capacity versus Depth Chart for B2 and B3
Total Resistance/F.S. (tons)



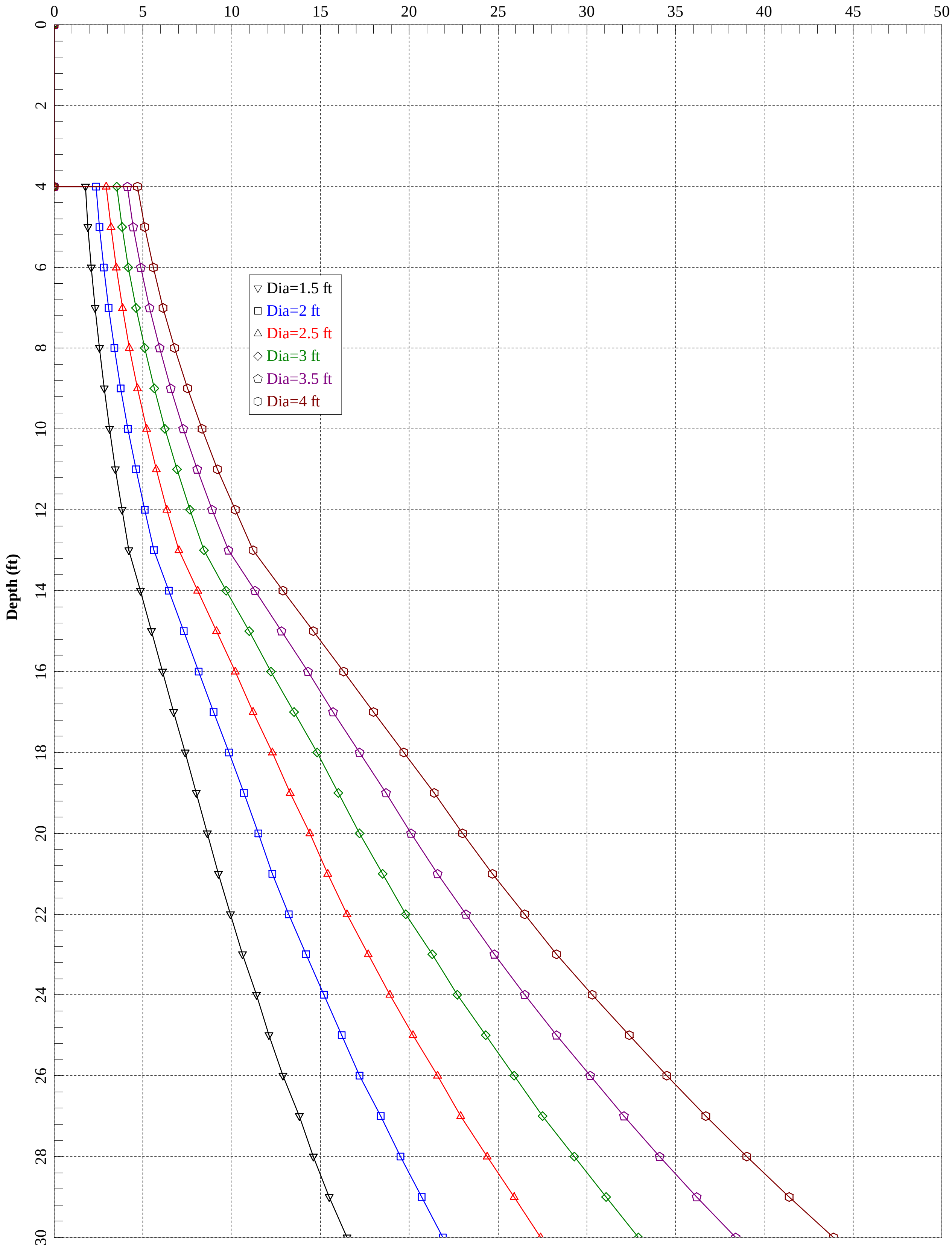
Allowable Skin Friction versus Depth Chart for B2 and B3



Allowable Total Capacity versus Depth Chart for B4 and B5
Total Resistance/F.S. (tons)



Allowable Skin Friction versus Depth Chart for B4 and B5
Side Resistance/F.S. (tons)



Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
6	15½ to 31½	BESS area
4	27½ to 41½	BESS Substation area
1	51½	Gen-Tie Line alignment

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend the exploration locations be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight hollow stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. A 2½-inch O.D. split-barrel sampling spoon with 2-inch I.D. ring lined sampler was used for sampling. Ring-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. For safety purposes, all borings were backfilled with cement-grout after their completion.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. Groundwater was not observed at these times in the boreholes.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Dry Unit Weight
- Unconfined Compression
- Atterberg Limits
- Direct Shear
- Hveem Stabilometer (R-Value)

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Site Location and Exploration Plans

Contents:

Note: All attachments are one page unless otherwise noted.

Site Location

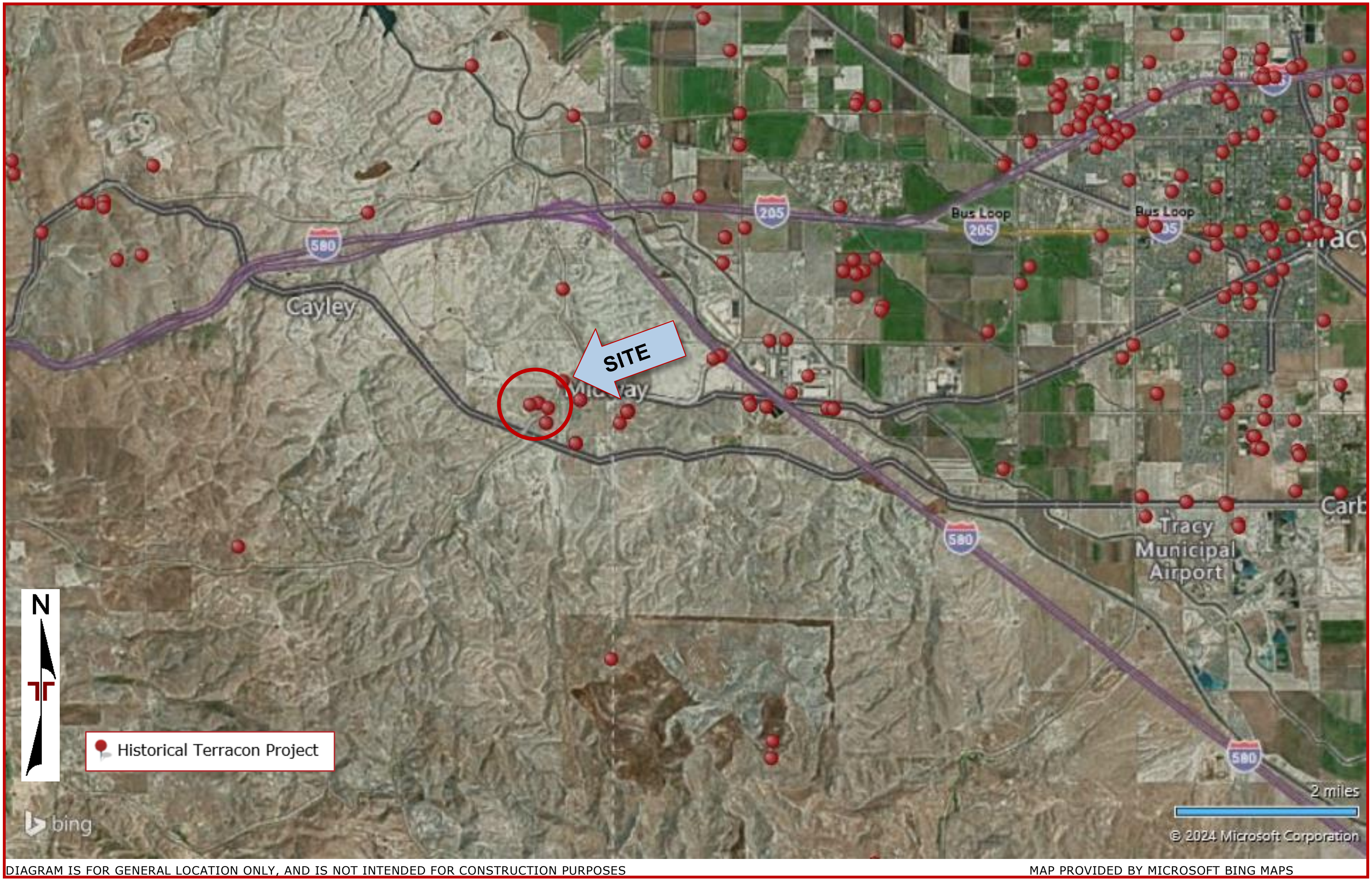


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless otherwise noted.

Potentia-Virdi BESS
17257 Patterson Pass Road | Tracy, CA
Terracon Project No. NA235087

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7088° Longitude: -121.5690° Depth (Ft.) Elevation: 449 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		**SILTY SAND (SM)**, fine to medium grained, light gray, medium dense			⧗	5-10-15			15.2	87		
		dense 4.5 444.5			⧗	13-19-23			14.8	85		36
2		**SANDY SILT (ML)**, light brown, very stiff, weak cementation 9.0 440	5		⧗	9-13-18			5.0	111		
1		**SILTY SAND (SM)**, brown, dense, weak cementation	10		⧗	14-23-38			26.8	91		
		18.0 431	15		⧗	12-23-33			12.4	111		49
6		**SILTSTONE**, brown, weak cementation, highly weathered 23.0 426	20		⧗	13-10-18						
2		**SANDY SILT (ML)**, brown, hard 30.5 418.5	25		⊠	10-12-44 N=56	4.5+ (HP)		23.7		49-31-18	60
		SILT WITH SAND (ML), light brown, hard	30		⊠	7-12-33 N=45	4.5+ (HP)		24.3			

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Logged by
J. Neilsen

Boring Started
06-04-2024

Boring Completed
06-04-2024

Boring Log No. B1

Location: See Exploration Plan

Latitude: 37.7088° Longitude: -121.5690°

Depth (Ft.) Elevation: 449 (Ft.) +/-

Model Layer	Depth (Ft.) / Description	Elevation	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2	**SILT WITH SAND (ML)**, light brown, hard *(continued)*											
	34.0	415										
1	**SILTY SAND (SM)**, fine to medium grained, brown, very dense, weak cementation		35		☒	12-34-48 N=82			21.5			
	37.0	412										
3	**LEAN CLAY WITH SAND (CL)**, gray, hard		40		☒	10-19-22 N=41	4.0 (HP)					
	very stiff		45		⧗	5-7-13	4.0 (HP)		24.4	88		
	hard		50		⧗	10-23-38			16.5	101		
	51.5	397.5										
	Boring Terminated at 51.5 Feet											

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-04-2024

Boring Completed
06-04-2024

Boring Log No. B2

Location: See Exploration Plan

Latitude: 37.7121° Longitude: -121.5747°

Model Layer	Graphic Log	Depth (Ft.) / Elevation: 455 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		**SILTY SAND (SM)**, fine to medium grained, gray, medium dense, weak cementation										
					⧗	3-7-14			16.1	83		
		very dense			⧗	16-33-50/5"			16.0	97		26
			5		⧗	24-50/6"			21.4	78		
		9.0 446										
5		**SANDSTONE**, brown gray, moderate cementation, highly weathered										
			10		⧗	30-30-49			18.0	102		
			15		⧗	16-27-50/5"			26.3	90		
			20		⧗	47-44-50/3"			24.2	90		
		23.0 432										
2		**SANDY SILT (ML)**, brown, hard, weak cementation										
			25		⧗	24-46-50/3"			17.0	91		
		28.0 427										
5		**SANDSTONE**, brown, moderate cementation, highly weathered										
			30		⧗	26-40-50/4"			26.7	94		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-06-2024

Boring Completed
06-06-2024

Notes

Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Boring Log No. B2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7121° Longitude: -121.5747° Depth (Ft.) Elevation: 455 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
5		**SANDSTONE**, brown, moderate cementation, highly weathered *(continued)*	35		⧗	17-39-50/4"			28.1	89		
		38.0 417										
6		**SILTSTONE**, brown, moderate cementation, highly weathered	40		⧗	21-50/5"			36.4	87		
		40.9 414.08										
		Boring Terminated at 40.92 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevation Estimated Using Google Earth

Water Level Observations

Groundwater not encountered

Advancement Method

6 inch Hollow Stem Auger

Abandonment Method

Boring backfilled with cement grout upon completion.

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-06-2024

Boring Completed
06-06-2024

Boring Log No. B3

Location: See Exploration Plan

Latitude: 37.7125° Longitude: -121.5735°

Model Layer	Graphic Log	Depth (Ft.) / Elevation: 450 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		**SILT WITH SAND (ML)**, dark brown, stiff			⋈	6-6-10			17.4	74		
		2.5 447.5										
6		**SILTSTONE**, grayish brown, moderate cementation, highly weathered			⋈	21-24-18			21.6	76		
			5		⋈	25-50/5"			19.1	100		
			10		⋈	31-50/6"			32.1	73		
		grayish brown and red, weak cementation										
			15		⋈	7-50/3"			9.8	91		
		brown, moderate cementation										
			20		⋈	10-47-50/3"			31.4	88		
			25		⋈	26-50/4"			15.5	85		
			30		⋈	28-27-50/5"			30.7	89		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-07-2024

Boring Completed
06-07-2024

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7125° Longitude: -121.5735° Depth (Ft.) Elevation: 450 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
6	× × ×	**SILTSTONE**, grayish brown, moderate cementation, highly weathered *(continued)*	35		⋈	17-50/6"			31.8	101		
	× × ×	40.8 409.25	40		⋈	28-50/3"			34.8	82		
		Boring Terminated at 40.75 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes

Elevation Reference: Elevation Estimated Using Google Earth

Water Level Observations
Groundwater not encountered

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-07-2024

Boring Completed
06-07-2024

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B4

Location: See Exploration Plan

Latitude: 37.7111° Longitude: -121.5740°

Depth (Ft.) Elevation: 463 (Ft.) +/-

Model Layer	Graphic Log	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
4	▨	**FAT CLAY WITH SAND (CH)**, dark brown, stiff			⧓	5-7-12			20.1	82		
					⧓	4-6-7			13.1	84	55-21-34	81
		4.0 459										
6	▨	**SILTSTONE**, light brown, weak cementation, highly weathered	5		⧓	16-50/3"			29.9	66		
			10		⧓	32-47-47			25.3	95	49-42-7	69
		14.0 449										
3	▨	**LEAN CLAY (CL)**, light brown, hard	15		⧓	28-25-50/5"	4.5+ (HP)		40.7	61		
		19.0 444										
7	▨	**CLAYSTONE**, brown, weak cementation, highly weathered	20		⧓	13-31-50/5"			34.5	84		
			25		⧓	13-26-46			34.2	86		
			30		⧓	10-30-50			26.9	96		

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
D-90 track

Hammer Type
Automatic

Driller
Terracon

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Logged by
J. Neilsen

Boring Started
06-10-2024

Boring Completed
06-10-2024

Boring Log No. B4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7111° Longitude: -121.5740° Depth (Ft.) Elevation: 463 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
7		**CLAYSTONE**, brown, weak cementation, highly weathered *(continued)*										
			35		⧓	23-39-50/4"			25.8	97		
			40		⧓	34-50/5"			28.5	88		
		40.9 422.1										
		Boring Terminated at 40.9 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Water Level Observations
Groundwater not encountered

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-90 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-10-2024

Boring Completed
06-10-2024

Potentia-Virdi BESS
17257 Patterson Pass Road | Tracy, CA
Terracon Project No. NA235087

902 Industrial Way
Lodi, CA

Boring Log No. B5

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7114° Longitude: -121.5729° Depth (Ft.) Elevation: 459 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
4		**FAT CLAY WITH SAND (CH)**, brown, stiff				5-6-9			18.7	95	54-22-32	80
						5-7-10			16.8	85		
		4.0 455										
1		**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, dark gray, medium dense	5			6-9-14			6.3	89		6
		fine to coarse grained										
		very dense	10			33-50/5"			6.4	111		
		13.0 446										
2		**SANDY SILT (ML)**, brown, stiff to hard	15			5-21-47		1.22	31.3	81	49-35-14	51
		18.0 441										
6		**SILTSTONE**, greenish brown, moderate cementation, highly weathered	20			15-42-50			17.7	99	NP	67
			25			15-23-50/4"			33.7	87		
						9-17-50/2"						
		27.5 431.5										
		Practical Auger Refusal at 27.5 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-90 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-10-2024

Boring Completed
06-10-2024

Boring Log No. B6

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7121° Longitude: -121.5765° Depth (Ft.) Elevation: 460 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
4	▨	**FAT CLAY WITH SAND (CH)**, dark brown, stiff			⧗	5-7-8			19.4	92		
		brown, very stiff			⧗	8-12-20	4.5+ (HP)		21.3	100	54-20-34	75
		5.0 455										
3	▨	**LEAN CLAY WITH SAND (CL)**, stiff	5		⧗	3-5-8			17.1	87		
		9.0 451										
1	▨	**CLAYEY SAND (SC)**, fine to coarse grained, greenish gray, very dense, weak cementation	10		⧗	19-50/4"			19.9	95		
		reddish brown	15		⧗	9-50/4"			19.2	99		20
			20		⧗	10-50/2"			26.2	107		
		24.0 436										
5	▨	**SANDSTONE**, brown, moderate cementation, highly weathered	25		⧗	12-39-50/4"			18.4	104		
		28.0 432										
		Practical Auger Refusal at 28 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
D-90 track

Hammer Type
Automatic

Driller
Terracon

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Logged by
J. Neilsen

Boring Started
06-07-2024

Boring Completed
06-07-2024

Potentia-Virdi BESS
17257 Patterson Pass Road | Tracy, CA
Terracon Project No. NA235087

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B7

Location: See Exploration Plan

Latitude: 37.7117° Longitude: -121.5754°

Depth (Ft.) Elevation: 479 (Ft.) +/-

Model Layer	Graphic Log	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		**SANDY SILT (ML)**, tan and gray, very stiff				9-8-16			19.4	84	NP	53
		2.5 476.5										
5		**SANDSTONE**, brown, moderate cementation, highly weathered				30-50/5"			15.5	88		
		4.5 474.5										
1		**POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, brown, dense	5			10-22-34			29.3	76		
		9.0 470										
6		**SILTSTONE**, brown, weak cementation, highly weathered	10			12-18-43			33.6	67	NP	36
		moderate cementation				19-50/5"						
		15.5 463.54	15			50/6"			26.9	77		

Practical Auger Refusal at 15.46 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-90 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-07-2024

Boring Completed
06-07-2024

Potentia-Virdi BESS
17257 Patterson Pass Road | Tracy, CA
Terracon Project No. NA235087

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B8

Location: See Exploration Plan

Latitude: 37.7105° Longitude: -121.5756°

Model Layer	Graphic Log	Depth (Ft.) / Elevation: 467 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		**SANDY SILT (ML)**, brown, very stiff			⧗	4-12-10			22.7	75		66
		2.5 464.5										
5		**SANDSTONE**, dark brown, moderate cementation, highly weathered			⧗	4-17-44			16.4	98		
			5		⧗	33-50/3"			19.9	87		
			10		⧗	26-27-50/4"			24.3	104		
			15		⧗	14-20-46			18.5	98		
		brown	20		⧗	25-27-50/4"			18.1	102		
			25		⧗	17-26-50/1"			34.4	81		
					⧗	5-15-50/4"			30.4	81		
		28.3 438.67										
		Practical Auger Refusal at 28.33 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
D-90 track

Hammer Type
Automatic

Driller
Terracon

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Logged by
J. Neilsen

Abandonment Method
Boring backfilled with cement grout upon completion.

Boring Started
06-07-2024

Boring Completed
06-07-2024

Potentia-Virdi BESS
17257 Patterson Pass Road | Tracy, CA
Terracon Project No. NA235087

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B9

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7132° Longitude: -121.5735° Depth (Ft.) Elevation: 458 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
6	× × ×	**SILTSTONE**, brown, weak cementation, highly weathered										
					⧗	19-49-50/2"			31.7	80		
					⧗	22-50/5"			31.7	73		
			5		⧗	18-12-14						
			10		⧗	18-18-21					68-44-24	81
			15		⧗	9-12-26			29.1	93		
			20		⧗	20-18-30			33.5	82		
		dark brown, moderate cementation, highly weathered	25		⧗	26-40-50/6"						
		27.8 430.17			☒	28-50/4"			30.5	80		
		Practical Auger Refusal at 27.83 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-06-2024

Boring Completed
06-06-2024

Potentia-Virdi BESS
17257 Patterson Pass Road | Tracy, CA
Terracon Project No. NA235087

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B10

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 37.7121° Longitude: -121.5713° Depth (Ft.) Elevation: 426 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
4	▨	**FAT CLAY (CH)**, dark gray, stiff			⧗	6-6-8			18.9	88	63-31-32	88
	▨				⧗	6-8-9			19.4	89		
		4.0 422										
3	▨	**LEAN CLAY (CL)**, dark gray, stiff	5		⧗	4-7-7			23.6	86		
		7.0 419										
7	▨	**CLAYSTONE**, grey, weak cementation, highly weathered										
	▨		10		⧗	7-14-24			27.5	96	59-29-30	88
	▨		15		⧗	20-23-25			34.0	78		
	▨	brown	20		⧗	25-28-50			34.5	91		
	▨		25		⧗	25-28-50			24.6	102		
	▨		30		⧗	18-25-35			29.8	102		
		31.5 394.5										
		Boring Terminated at 31.5 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Notes
Elevation Reference: Elevation Estimated Using Google Earth

Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Drill Rig
D-90 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-10-2024

Boring Completed
06-10-2024

Potentia-Virdi BESS
17257 Patterson Pass Road | Tracy, CA
Terracon Project No. NA235087

Terracon
902 Industrial Way
Lodi, CA

Boring Log No. B11

Location: See Exploration Plan

Latitude: 37.7140° Longitude: -121.5718°

Model Layer	Graphic Log	Depth (Ft.) / Elevation: 420 (Ft.) +/-	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	HP (tsf)	Unconfined Compressive Strength (tsf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
3		**SANDY LEAN CLAY (CL)**, brown, medium stiff			⋈	3-2-4			18.7			
		soft			⋈	1-2-3			18.7	82	34-19-15	60
		5.0 415										
7		**CLAYSTONE**, brown, weak cementation, highly weathered	5		⋈	7-12-15			22.3	93		
			10		⋈	10-15-20			24.4	93	109-30-79	95
			15		⋈	14-22-30			26.0	98		
		19.0 401										
5		**SANDSTONE**, greenish gray, weak cementation, highly weathered	20		⋈	9-43-50/5"			15.8	98		
		24.0 396										
7		**CLAYSTONE**, brown, moderate cementation, highly weathered	25		⋈	23-25-46			36.8	82		
					⋈	19-20-50/5"			26.7	93		
		28.0 392.04										
		Practical Auger Refusal at 27.96 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Water Level Observations
Groundwater not encountered

Drill Rig
D-50 track

Hammer Type
Automatic

Driller
Terracon

Logged by
J. Neilsen

Boring Started
06-05-2024

Boring Completed
06-05-2024

Notes

Elevation Reference: Elevation Estimated Using Google Earth

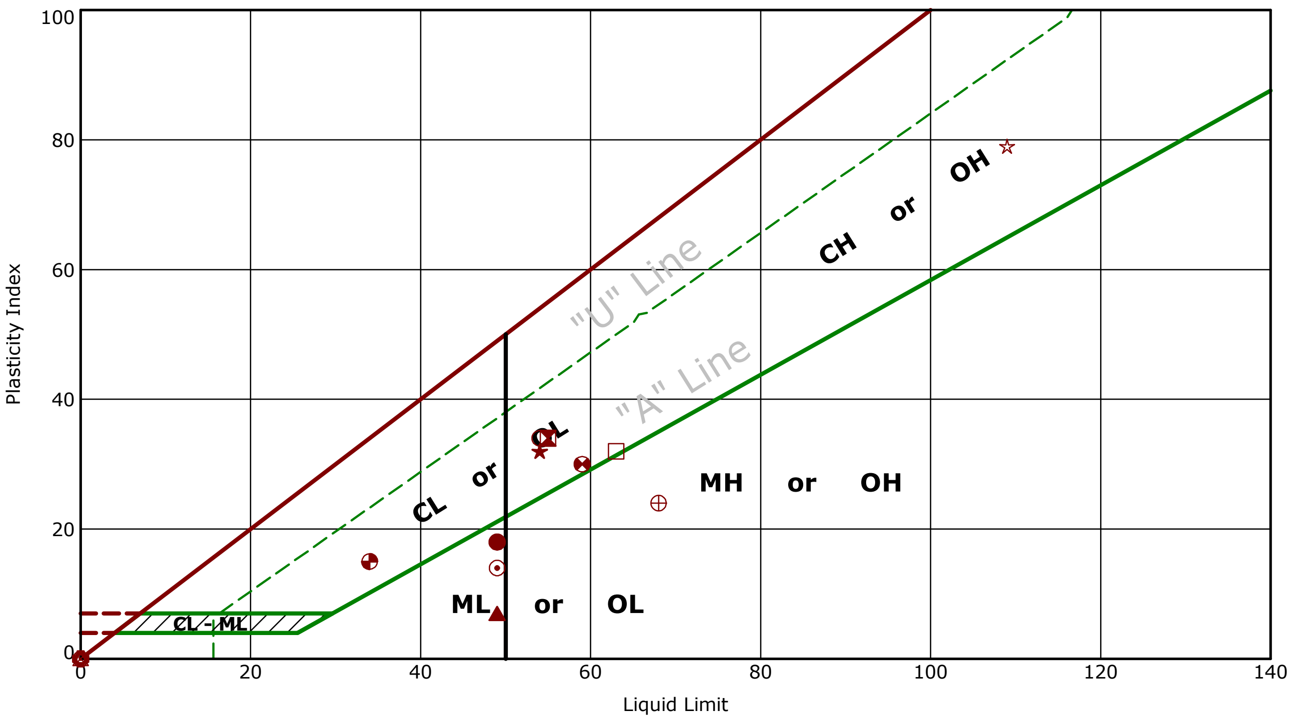
Advancement Method
6 inch Hollow Stem Auger

Abandonment Method
Boring backfilled with cement grout upon completion.

Terracon
902 Industrial Way
Lodi, CA

Atterberg Limit Results

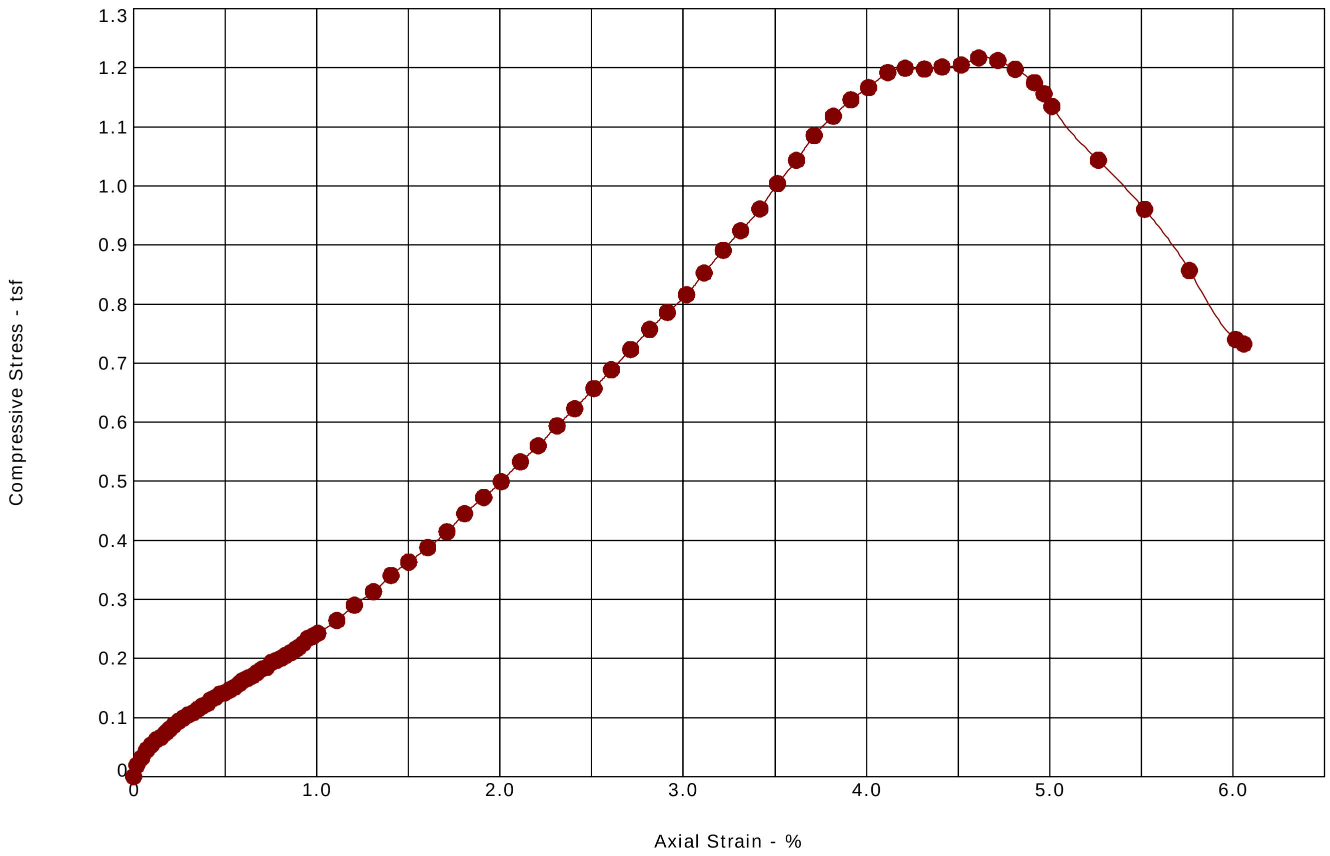
ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B1	25 - 26.5	49	31	18	60.4	ML	SANDY SILT
⊠	B4	2.5 - 4	55	21	34	81.4	CH	FAT CLAY with SAND
▲	B4	10 - 11.5	49	42	7	68.5	ML	SILTSTONE
★	B5	1 - 2.5	54	22	32	80.0	CH	FAT CLAY with SAND
⊙	B5	15 - 16.5	49	35	14	50.8	ML	SANDY SILT
✚	B5	20 - 21.5	NP	NP	NP	66.5	ML	SILTSTONE
○	B6	2.5 - 4	54	20	34	75.2	CH	FAT CLAY with SAND
△	B7	1 - 2.5	NP	NP	NP	53.1	ML	SANDY SILT
⊗	B7	10 - 11.5	NP	NP	NP	36.3	SM	SANDSTONE
⊕	B9	10 - 11.5	68	44	24	81.4	MH	SILTSTONE
□	B10	1 - 2.5	63	31	32	88.2	CH	FAT CLAY
⨂	B10	10 - 11.5	59	29	30	88.4	CH	CLAYSTONE
◕	B11	2.5 - 4	34	19	15	60.4	CL	SANDY LEAN CLAY
☆	B11	10 - 11.5	109	30	79	95.2	CH	CLAYSTONE

Unconfined Compression Test

ASTM D2166

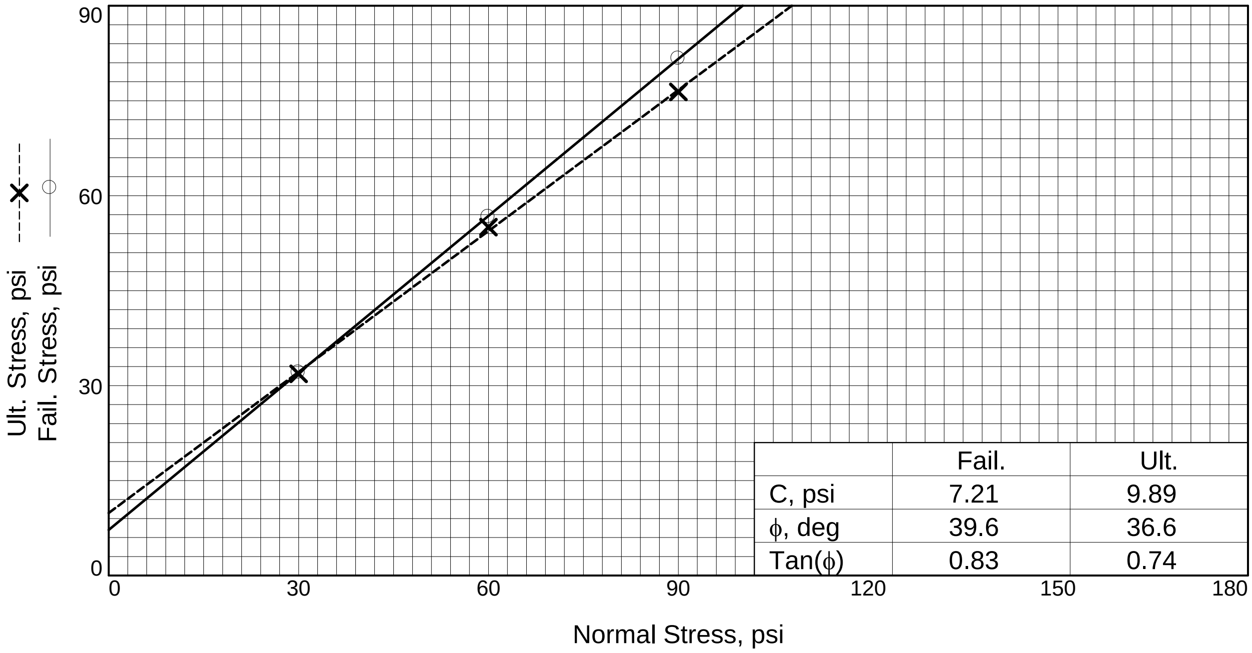


Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B5	15 - 16.5	CARS	49	35	14	51	Sandy Silt

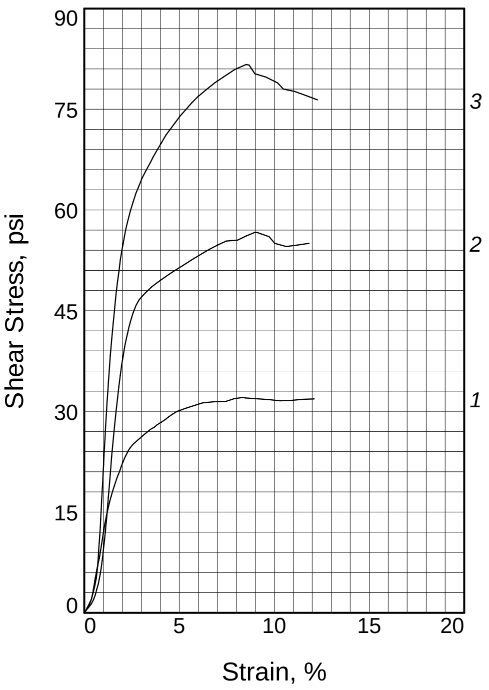
Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	30.8
Dry Density (pcf):	78
Diameter (in.):	1.90
Height (in.):	4.28
Height / Diameter Ratio:	2.25
Calculated Saturation (%):	79.05
Calculated Void Ratio:	1.07
Assumed Specific Gravity:	2.7
Failure Strain (%):	4.61
Unconfined Compressive Strength (tsf):	1.22
Undrained Shear Strength (tsf):	0.61
Strain Rate (in/min):	0.0428
Remarks:	



	Fail.	Ult.
C, psi	7.21	9.89
ϕ, deg	39.6	36.6
Tan(ϕ)	0.83	0.74



Sample No.		1	2	3
Initial	Water Content, %	16.3	16.2	16.3
	Dry Density, pcf	99.8	99.9	99.9
	Saturation, %	63.9	63.8	63.9
	Void Ratio	0.6882	0.6869	0.6880
	Diameter, in.	2.00	2.00	2.00
	Height, in.	1.00	1.00	1.00
At Test	Water Content, %	22.5	22.4	21.6
	Dry Density, pcf	104.7	104.9	106.6
	Saturation, %	99.8	99.5	100.0
	Void Ratio	0.6094	0.6071	0.5817
	Diameter, in.	2.00	2.00	2.00
	Height, in.	0.95	0.95	0.94
Normal Stress, psi		30.00	60.00	90.00
Fail. Stress, psi		32.08	56.66	81.67
Strain, %		8.4	9.0	8.5
Ult. Stress, psi		31.85	55.03	76.39
Strain, %		12.1	11.8	12.3
Strain rate, in./min.		0.004	0.004	0.004

Sample Type: CARS
Description: Sandstone

Specific Gravity= 2.7
Remarks:

Figure _______

Client: Levy Alameda LLC

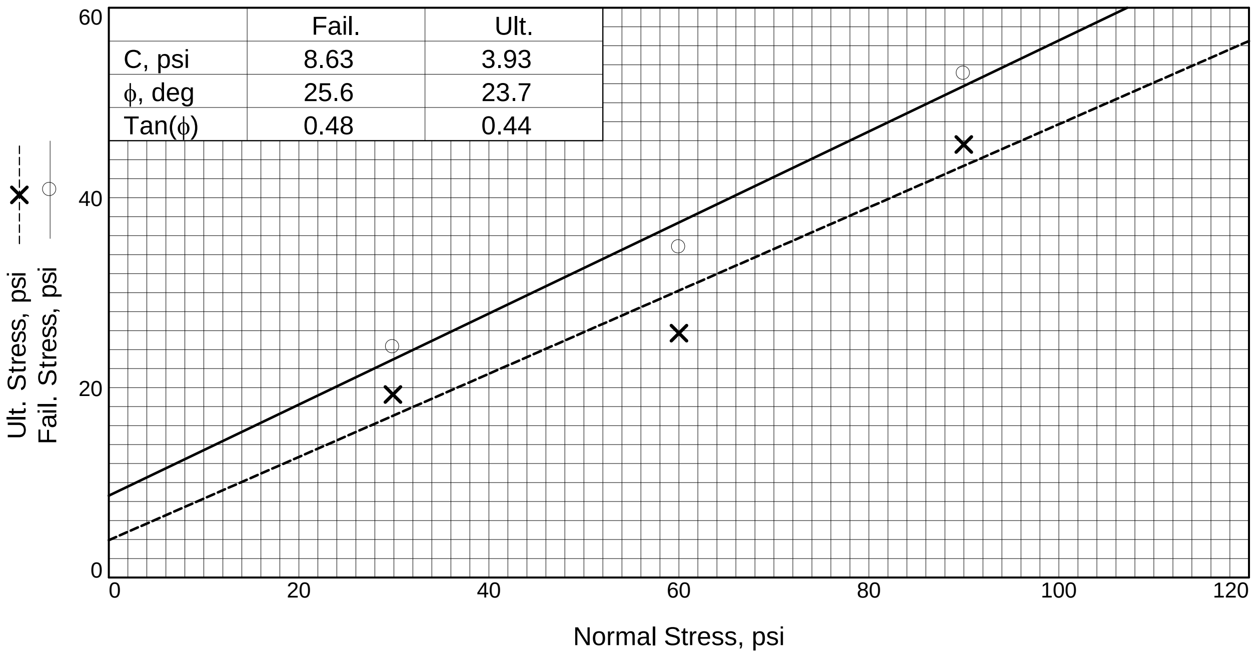
Project: Potentia-Viridi BESS

Location: B-8
Sample Number: 5 **Depth:** 15ft
Proj. No.: NA235087 **Date Sampled:** 6/7/2024

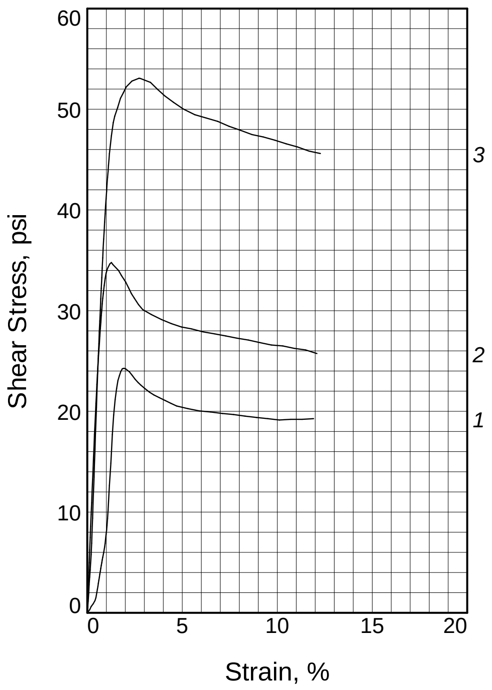
DIRECT SHEAR TEST REPORT

Terracon
Lodi, CA

Tested By: Stella Oliveira **Checked By:** Paula Arends



	Fail.	Ult.
C, psi	8.63	3.93
ϕ, deg	25.6	23.7
Tan(ϕ)	0.48	0.44



	Sample No.	1	2	3
Initial	Water Content, %	24.0	24.4	24.1
	Dry Density, pcf	96.9	97.4	96.6
	Saturation, %	87.4	90.2	87.4
	Void Ratio	0.7403	0.7313	0.7440
	Diameter, in.	2.00	2.00	2.00
	Height, in.	1.00	0.99	1.00
At Test	Water Content, %	25.3	23.4	23.6
	Dry Density, pcf	100.1	103.0	103.0
	Saturation, %	99.8	99.4	100.0
	Void Ratio	0.6839	0.6360	0.6366
	Diameter, in.	2.00	2.00	2.00
	Height, in.	0.97	0.94	0.94
	Normal Stress, psi	29.90	60.01	89.99
	Fail. Stress, psi	24.27	34.78	53.07
	Strain, %	1.9	1.3	2.7
	Ult. Stress, psi	19.27	25.74	45.60
	Strain, %	11.9	12.1	12.3
	Strain rate, in./min.	0.003	0.003	0.003

Sample Type: CARS
Description: Siltstone

Specific Gravity= 2.7
Remarks:

Figure _______

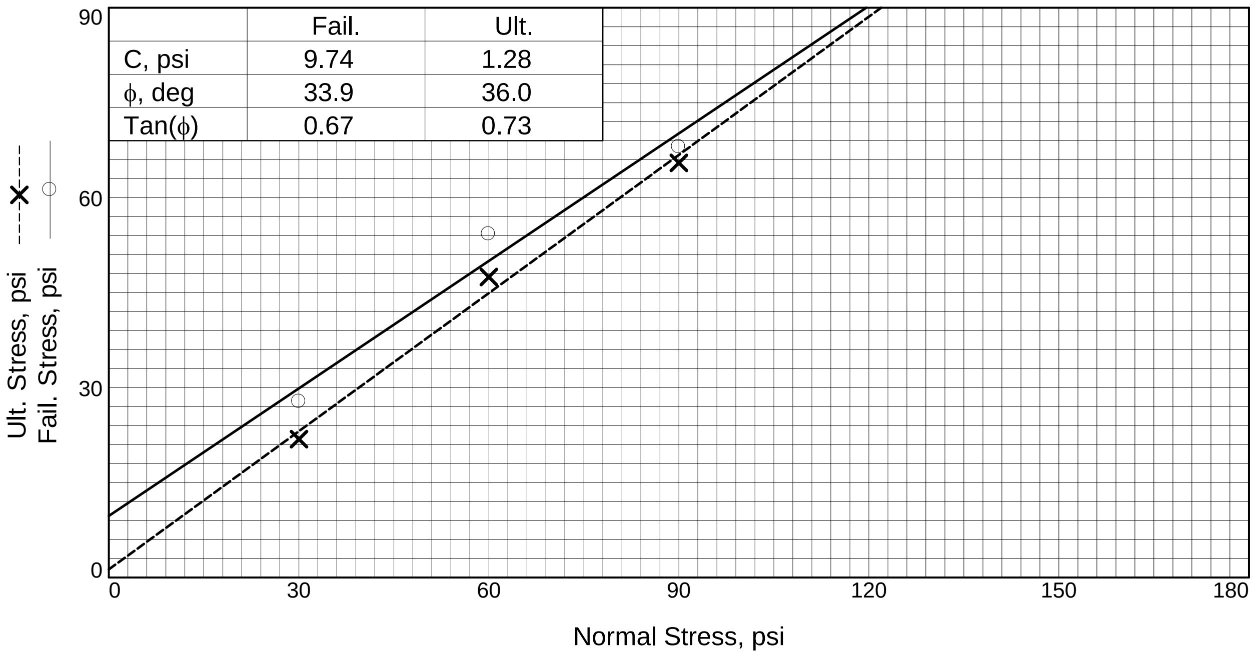
Client: Levy Alameda LLC

Project: Potentia-Viridi BESS

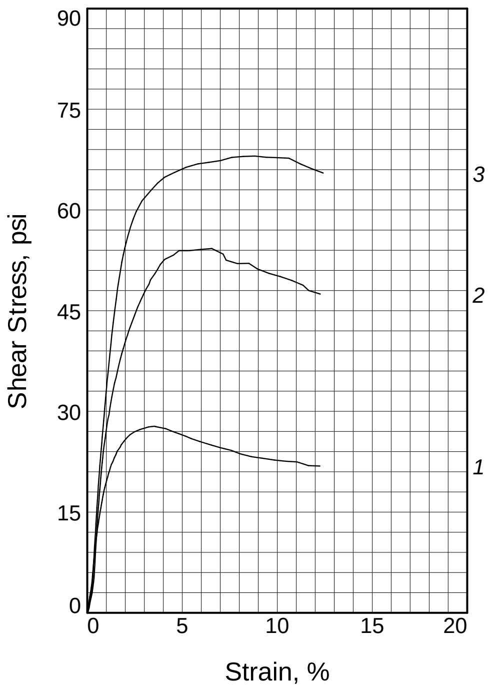
Source of Sample: B-9 **Depth:** 15 ft
Sample Number: 5-1
Proj. No.: NA235087 **Date Sampled:** 6/6/2024

DIRECT SHEAR TEST REPORT
Terracon
Lodi, CA

Tested By: Stella Oliveira **Checked By:** Paula Arends



	Fail.	Ult.
C, psi	9.74	1.28
ϕ, deg	33.9	36.0
Tan(ϕ)	0.67	0.73



	Sample No.	1	2	3
Initial	Water Content, %	36.8	36.8	36.1
	Dry Density, pcf	80.0	79.9	80.3
	Saturation, %	89.6	89.7	88.8
	Void Ratio	1.1077	1.1092	1.0986
	Diameter, in.	2.00	2.00	2.00
	Height, in.	1.00	1.00	1.00
At Test	Water Content, %	37.5	35.6	34.7
	Dry Density, pcf	83.7	85.8	87.0
	Saturation, %	99.8	99.8	99.9
	Void Ratio	1.0145	0.9635	0.9364
	Diameter, in.	2.00	2.00	2.00
	Height, in.	0.96	0.93	0.92
	Normal Stress, psi	30.02	60.00	90.00
	Fail. Stress, psi	27.77	54.25	68.03
	Strain, %	3.5	6.6	8.8
	Ult. Stress, psi	21.86	47.47	65.50
	Strain, %	12.2	12.3	12.4
	Strain rate, in./min.	0.003	0.003	0.003

Sample Type: CARS
Description: Siltstone

Specific Gravity= 2.7
Remarks:

Figure _______

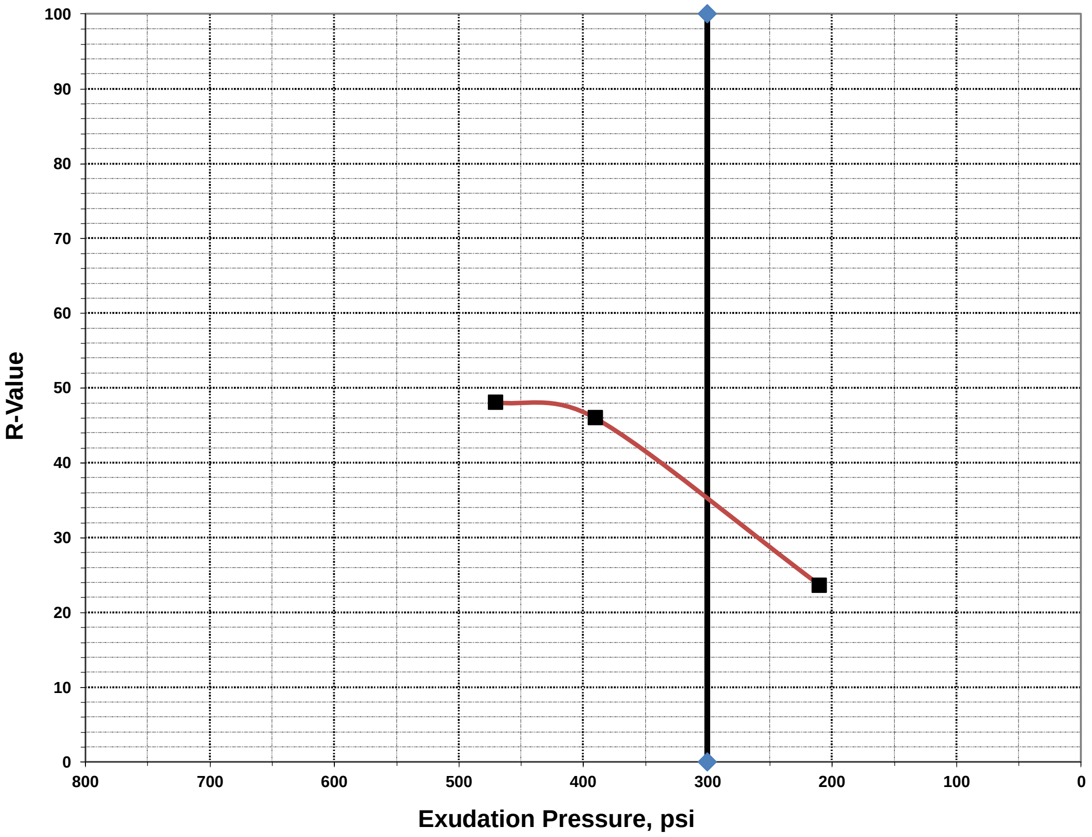
Client: Levy Alameda LLC

Project: Potentia-Viridi BESS

Source of Sample: B-9 **Depth:** 20 ft
Sample Number: 6-1
Proj. No.: NA235087 **Date Sampled:** 6/6/2024

DIRECT SHEAR TEST REPORT
Terracon
Lodi, CA

Tested By: Stella Oliveira **Checked By:** Paula Arends



Specimen Identification	Compaction Pressure (psi)	R-Value at 300 psi
B-7	**190.0**	**35**

R-Value Test

Client: Obra Maestra Renewables, LLC
Project: Potentia-Viridi BESS
Site: 17257 Patterson Pass Rd
Project No.: NA235087

902 Industrial Way
Lodi, California 95240
(209) 367-3701

Client

Levy Alameda LLC

Project

Potentia-Viridi BESS

Sample Submitted By: Terracon (NA) **Date Received:** 7/30/2024 **Project Number:** NA235087

Results of Corrosion Analysis

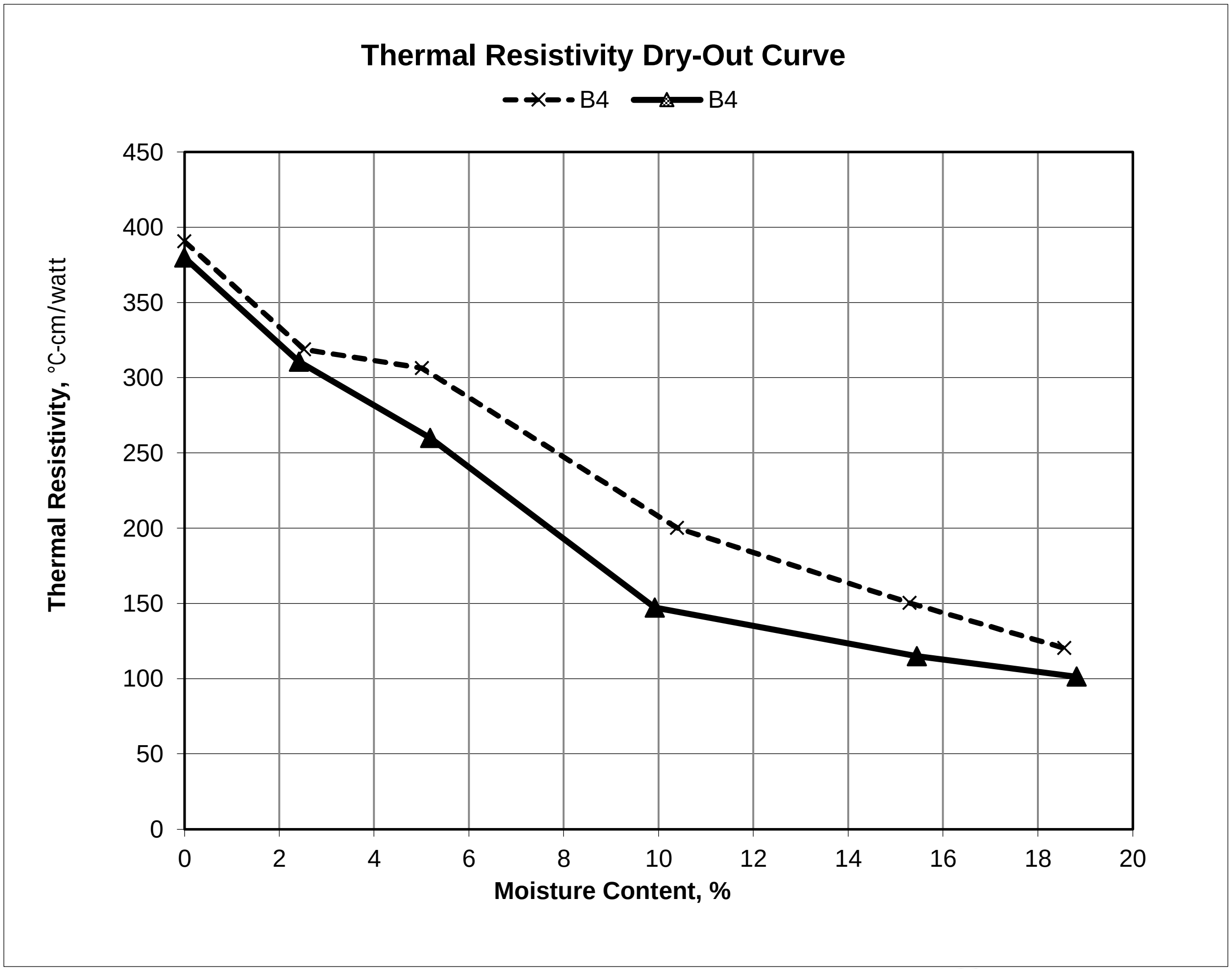
Sample Type	CARS
Sample Location	B4 - 3
Sample Depth (ft.)	5.0
pH Analysis, ASTM G 51	8.10
Water Soluble Sulfate (SO4), ASTM D516 (%)	0.003
Sulfides, AWWA 4500-S^{2-} D, (ppm)	<0.001
Chlorides, AWWA 4500-CL^{-} E, (%)	0.001
Red-Ox, ASTM G 200, (mV)	+317
Total Salts, AWWA 2520 B, (mg/kg)	171.0
Saturated Minimum Resistivity, ASTM G 57, (ohm-cm)	1,750

Reviewed By: Paula Arends

Paula Arends
Laboratory Manager

Project Name: Potentia-Virdi BESS
Project Number: NA235087

						Thermal Resistivity Test Results		
Sample ID	**Soil Type**	**Proctor Method**	**Max. Dry Density (pcf)**	**Optimum Moisture Content (%)**	**Sample Comp. (%)**	**Moisture Content (%)**	**Thermal Resistivity (°C-cm/watt)**	**Temperature (°C)**
B4	Fat Clay	ASTM D 1557-A	101.8	19	85	0.0	391	24.2
						2.5	319	24.1
						5.0	306	24.9
						10.4	200	23.8
						15.3	150	23.3
						18.6	120	23.5
B4	Fat Clay	ASTM D 1557-A	101.8	19	95	0.0	380	24.4
						2.4	311	24.5
						5.2	260	24.5
						9.9	147	23.7
						15.4	115	24.0
						18.8	101	24.3



Date: 7/5/2024 | Run By: CM | Reviewed By: MTR

Supporting Information

Contents:

Note: All attachments are one page unless otherwise noted.

General Notes

Sampling

⧗ Modified California Ring Sampler

☒ Standard Penetration Test

Water Level

▽ Water Initially Encountered

▽ Water Level After a Specified Period of Time

▼ Water Level After a Specified Period of Time

▨ Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				**Soil Classification**	
				Group Symbol	**Group Name** [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

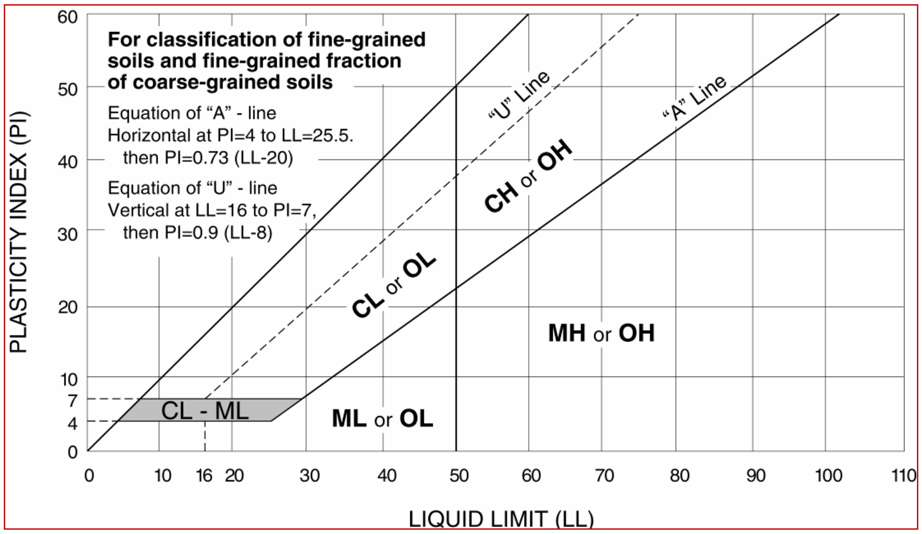
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Rock Classification Notes

WEATHERING

Term	Description
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or no staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS

Description	Field Identification	Uniaxial Compressive Strength, psi
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION

Fracture Spacing (Joints, Faults, Other Fractures)		Bedding Spacing (May Include Foliation or Banding)	
Description	**Spacing**	**Description**	**Spacing**
Intensely fractured	< 2.5 inches	**Laminated**	< ½-inch
Highly fractured	2.5 – 8 inches	**Very thin**	½ – 2 inches
Moderately fractured	8 inches to 2 feet	**Thin**	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	**Medium**	1 – 3 feet
Very slightly fractured	> 6.5 feet	**Thick**	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) [1]

Description	RQD Value (%)
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

[1] The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Corrosion of Steel

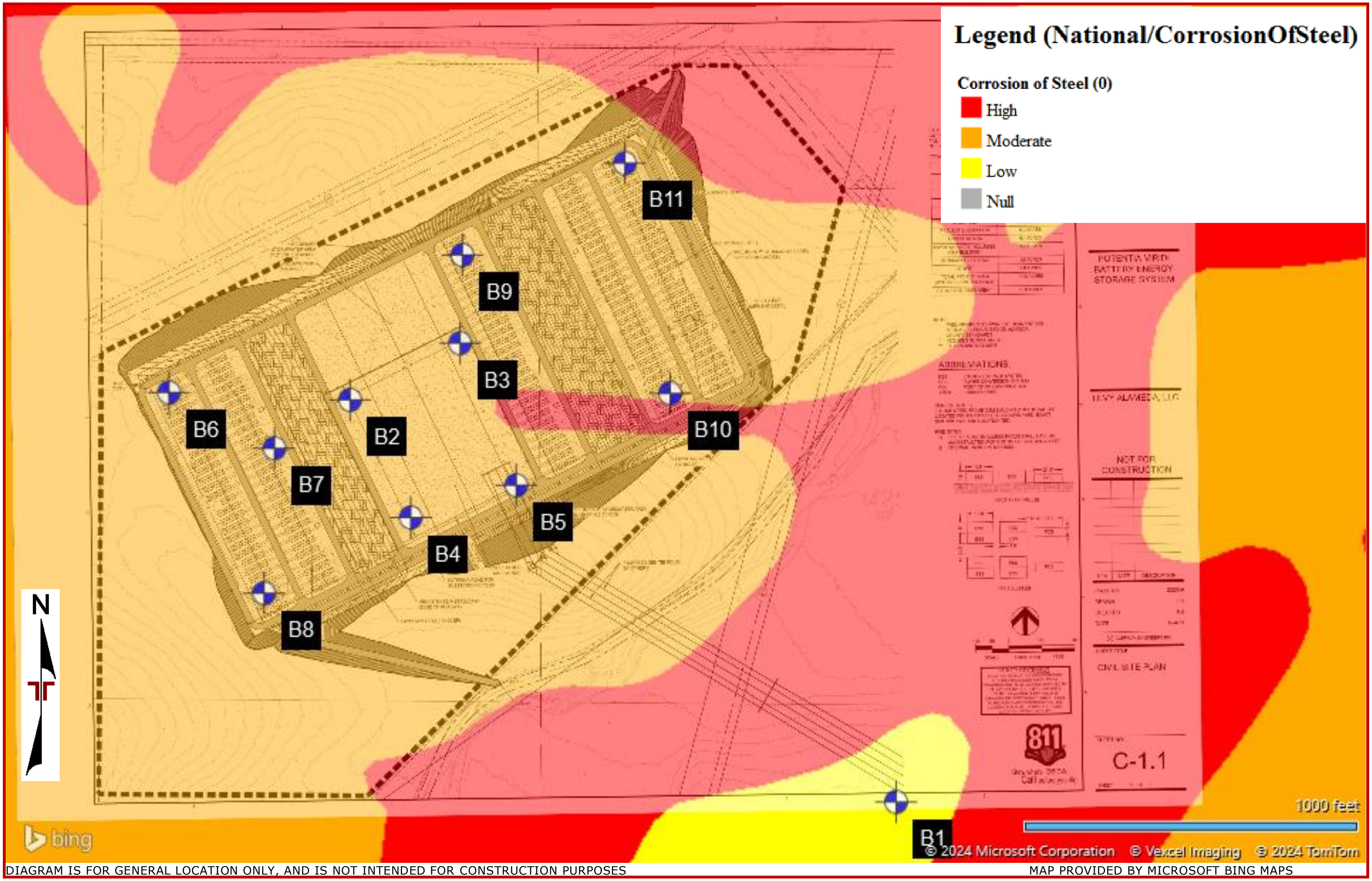


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Geophysical Report

Potentia Viridi Substation & BESS
17257 Patterson Pass Road
Tracy, California

July 18, 2024
Terracon Job No. NS245114

Prepared for:

Levy Alameda

Prepared by:

Terracon
Geophysical Services

Terracon
Geophysical Services

July 18, 2024

Levy Alameda, LLC
115 Wellington Street, West
Toronto, Ontario, Canada M5V3H1

Attention: Mr. Paul Miller

Subject: Potentia Viridi Substation & BESS
17257 Patterson Pass Road
Tracy, California
Terracon Project No. NS245114

Dear Mr. Miller,

This report presents the findings of a geophysical investigation performed by the Sonoma County office of Terracon Consultants, Inc. (Terracon), formerly NORCAL Geophysical Consultants. The survey was performed for Levy Alameda, LLC (Levy Alameda) in coordination with the Terracon Lodi office. The investigation was performed using seismic refraction (SR), multichannel analysis of surface waves (MASW) and electrical resistivity sounding (ERS) geophysical survey methods.

The work was supplemental to a geotechnical investigation currently underway by Terracon Lodi for the Potentia Viridi Substation and Battery Energy Storage System (BESS) at 17257 Patterson Pass Road, Tracy, California. The work was authorized through an Inter-Office Services Agreement with the Terracon Lodi office. Terracon Professional Geophysicist David T. Hagin (CA PGp No. 1033) and Geophysical Field Supervisor Travis W. Black conducted the survey on June 12 and 13, 2024. Field geophysical technicians Ireln King and Jon Neilson completed the survey on July 16, 2024.

The scope of Terracon's services for this project consisted of using geophysical methods to characterize the subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the standard of care ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the performance of services delivered under this agreement, express or implied, is made by Terracon.

We appreciate having the opportunity to provide our services for this project. If you have any questions or require additional geophysical services, please do not hesitate to call on us.

Sincerely,
Terracon Consultants, Inc.

David Hagin
David T. Hagin
California Professional Geophysicist
PGp 1033

DAVID T HAGIN
No. 1033

7-18-2024

Donald J. Kirker
Donald J. Kirker, Reviewer
California Professional Geophysicist
PGp No. 997

DONALD KIRKER
No. 997

7-18-2024

1.0 INTRODUCTION

The Potentia Viridi Substation and Battery Energy Storage System (BESS) are planned for a parcel of rangeland west of the existing Altamont Pass Wind Farm Substation. A geotechnical investigation for the project is currently underway by Terracon Lodi. This geophysical survey will aid in the planning and design of various elements associated with the project.

The investigation consisted of the seismic refraction (SR), multichannel analysis of surface waves (MASW), and electrical resistivity sounding (ERS) geophysical methods.

- The SR method provides compressional-wave (p-wave) velocity values that may aid in determining the consolidation, cementation, or hardness of the underlying lithologic materials.
- The MASW method produces shear-wave (s-wave) velocity values that can provide information regarding the relative strength of the underlying geology and can be used to assess the seismic site class (Vs30).
- The ERS method provides measurements of the volumetric (bulk) apparent electrical resistivity, in this instance for grounding grid design.

2.0 SITE CONDITIONS

The following description of site conditions is derived from our observations during the survey and a review of publicly available aerial photographs, geologic and topographic maps.

Item	Description
Site Information	The site currently consists of grass covered hills utilized for cattle grazing. The approximate geographic coordinates of the center of the site are: (37°42'43.2"N 121°34'25.1"W).
Survey Sites	The geophysical surveys were performed on soil-covered areas to the northwest of Patterson Pass Road.
Existing Topography	Based on our Trimble Geo7X GPS, Google Earth and site observations, the site consists of gently rolling hills that slope generally toward the west. Surface elevations range from about 370- to 470-ft (NAVD88).
Site Geology	Available geologic maps (CGS 2015) indicate that the surficial site geology consists of Pleistocene and/or Pliocene age sandstone, shale, and gravel deposits. Deeper formations may consist of Miocene nonmarine sedimentary rocks and/or Upper Cretaceous sedimentary and/or metasedimentary rocks.

3.0 SCOPE OF WORK

The various survey methods were placed based on the planned site use and the existing site conditions. Aerial photographic imagery showing the site vicinity and the locations of the various survey areas is provided on **Plate 1 – Site Location Map**, as detailed in the legend. Our scope of work included:

- The SR data (2D profiles) were acquired to measure p-wave values at locations SR-1 through SR-4. The SR lines were placed along selected ridgelines to evaluate areas likely to require more extensive cuts. The SR lines are shown as red lines on Plate 1.

- The MASW measurements (1D soundings) were collected to quantify s-wave values at MASW-1 through MASW-4. The locations are centered on the respective SR locations. The MASW locations are shown as red diamonds on Plate 1.

- The ERS readings consist of two 1D soundings with a common center in a cross formation to measure apparent resistivity values at locations ER-1 and ER-2. The ERS locations are shown as blue diamonds, and the electrode arrays are indicated by the blue lines on Plate 1.

To provide documentation of our investigation, this geophysical report includes the site location map, details of our data acquisition and processing, as well as the resulting SR profiles, MASW shear-wave models presented in both tabular and graphic form, and two ERS data sheets.

4.0 SEISMIC REFRACTION SURVEY

4.1 SR SURVEY METHOD

The SR method is designed to measure subsurface variations in the compressional-wave (p-wave) velocities, which will be denoted herein as “Vp.” Variations in Vp can be indicative of variations in the density and elastic properties of subsurface materials. The Vp values can typically be interpreted to differentiate between bedrock and overburden, as well as to evaluate the underlying bedrock. The SR method provides both vertical and lateral variations in the Vp of subsurface materials. These measurements can then be used to produce a two-dimensional (2D) cross-section (profile) illustrating variations in Vp versus depth and distance beneath the seismic line.

Typically, Vp is dependent on physical properties such as density, hardness, compaction, and induration. However, other factors such as bedding, fracturing and saturation also affect Vp. In general, the Vp of weathered rock and consolidated or cemented sedimentary deposits are higher than those of unconsolidated sediments or fill material. Within rock, higher Vp values typically correspond with harder, less weathered and/or fractured rock. Therefore, the configuration of Vp values may aid in determining the thickness of sedimentary and soil layers (overburden), and the character of the underlying bedrock.

Detailed descriptions of the SR methodology, the instrumentation we used, our data acquisition, analysis, and interpretation procedures as well as the general limitations of the method are provided in **Appendix A – Seismic Refraction Survey**.

4.2 SR PROFILES

The results of the SR survey are illustrated by the color contoured seismic velocity cross-sections (profiles) shown on **Plates 2 through 5 – Seismic Refraction Profiles**. On each plate, the vertical axis represents elevation (NAVD88), and the horizontal axis represents the survey stationing established for each SR line with the zero-value at the westernmost end of each line. The unit of measure for all axes is the US Survey Foot. The solid black line along the top of the contoured portion of the profiles represents the ground surface. The length of each line is 216-ft and the maximum depth of investigation, as determined by the greatest shot-to-receiver distance, is estimated to be 40-ft for all lines.

4.3 SEISMIC P-WAVE VELOCITY VALUES

Seismic p-wave velocity (Vp) is represented by the labeled contours and the color shading between contours and is presented in feet per second (ft/sec). The relationship between color and Vp is specified by the color scale shown below each profile. The color scales are identical (normalized) for ease of comparison.

Based on our experience, and without borehole information or some other form of “ground truth” for correlation to Vp, we typically differentiate the range of measured values into three sub-ranges which we define herein as low, moderate, and high.

- *Low Vp* ranges from approximately 1,000 to 4,000 ft/sec and is represented by brown to yellow shading. Vp in this range typically represents unsaturated surficial soils, poorly consolidated sedimentary deposits, or fill.

- *Moderate Vp* varies from 4,000 to 6,000 ft/sec and is shown in shades of green to blue. Vp in this range typically represents more consolidated, cemented, or saturated sediments and/or weathered rock.

- *High Vp* ranges from 6,000 to over 9,000 ft/sec and is indicated by varying shades of maroon, typically representing rock with varying degrees of weathering. As Vp increases, weathering and/or fracturing typically decrease.

4.4 OBSERVATIONS

The distribution of Vp values allows for a general interpretation of thickness of soils and sediments and depth-to-rock, drawn from the Vp interpretations presented in Section 4.3.

- Lines SR-1 and SR-2 show low (brown, tan, yellow) to moderate Vp values (green), likely indicating soils over poorly consolidated sediments. The brown to tan surficial layers likely represent soils within the upper 10-ft on SR-1 and 20-ft for SR-2. Areas with yellow color likely represent poorly consolidated sedimentary deposits. Deeper in the profiles, somewhat higher velocity values are indicated by darker green, and may include consolidated or cemented sedimentary deposits or intensely to highly weathered rock. The contours are mostly horizontal, indicating flat-lying layers; however, Line SR-1 shows lateral variation within the lower portion of the profile that may reflect a small paleochannel or similar feature.

- Lines SR-3 and SR-4 are characterized by a flat-lying surficial low Vp layer (brown to yellow) generally less than 10-ft thick that we interpret as likely soil horizons. Below this, both profiles show a thick moderate Vp layer (green, blue) approximately 20- to 25-ft thick that may represent mainly weathered rock. At depths of 25- to 35-ft on Line SR-3 and 30- to 35-ft on SR-4, we note high Vp values (maroon) that likely indicate more competent rock. These values are especially high on Line SR-4 (>9,000 ft/sec), suggesting harder rock.

5.0 MASW SURVEY

5.1 MASW SURVEY METHOD

The Seismic Multichannel Analysis of Surface Waves (MASW) sounding survey measures the s-wave velocities (Vs) of the subsurface as a function of depth. The method used for this survey is referred to as a sounding, producing one-dimensional (1D) data that are presented in both tabular and graphic form as a layered shear wave model. The location of each sounding is the center of the geophone array. Descriptions of the MASW methodology, our data acquisition and analysis procedures, and the instrumentation we employed are provided in **Appendix B – MASW Sounding Survey**.

The standard method of reporting MASW data is to consider the location of the 1D velocity vs. depth model as the center point of the MASW array. However, this does not mean that the measured velocity values represent materials solely beneath that location. In fact, the subsurface conditions underlying the entire length of the array, and for several tens of feet to either side, contribute to the measured velocity values.

5.2 MASW TABLES AND STEP-CHART GRAPHS

The results of the MASW survey are listed in the tables presented in Section 5.3. The left columns of each table contain the depth ranges for each layer (feet below ground surface) and the right columns comprise the associated Vs values in feet per second (ft/sec). The results are also presented graphically in ft/sec by the step charts shown on **Plates 6 and 7 – MASW Soundings**.

The minimum and maximum depths of investigation are determined by the highest and lowest frequencies measured by the survey, respectively. This frequency distribution is a function of the site geology, the source characteristics, the geophone spacing and the array length. The minimum depth of exploration for each sounding is approximated at 5-ft below ground surface and the maximum depth at 100-ft. Note that although Vs generally increases with depth, some velocity inversions (lower Vs beneath higher Vs) are present.

5.3 SEISMIC S-WAVE VELOCITY VALUES

The layered s-wave models for MASW-1 through MASW-4 are presented by the following tables:

MASW-1: Seismic S-Wave Velocity vs Depth

DEPTH RANGE (FT)	S-WAVE VELOCITY (FT/SEC)
5 - 9	560
9 - 15	690
15 - 32	1,580
32 - 44	1,710
44 - 59	2,060
59 - 78	2,210
78 - 100	2,270

MASW-2: Seismic S-Wave Velocity vs Depth

DEPTH RANGE (FT)	S-WAVE VELOCITY (FT/SEC)
5 - 9	820
9 - 14	1,420
14 - 19	1,650
19 - 27	1,230
27 - 36	1,460
36 - 47	1,980
47 - 60	1,460
60 - 100	2,940

MASW-3: Seismic S-Wave Velocity vs Depth

DEPTH RANGE (FT)	S-WAVE VELOCITY (FT/SEC)
5 - 6	750
6 - 10	870
10 - 16	1,040
16 - 23	1,110
23 - 31	1,520
31 - 42	1,630
42 - 55	1,510
55 - 71	1,840
71 - 100	1,860

MASW-4: Seismic S-Wave Velocity vs Depth

DEPTH RANGE (FT)	S-WAVE VELOCITY (FT/SEC)
5 - 8	1,030
8 - 13	950
13 - 18	1,060
18 - 25	1,570
25 - 34	2,050
34 - 44	2,170
44 - 57	1,460
57 - 100	2,810

The measured Vs values for the MASW soundings range from a minimum of 560 ft/sec to a maximum of 2,940 ft/sec. These values are low to moderate within the upper 40-ft and moderate to high at greater depth.

6.0 SEISMIC SITE CLASS

Caltrans and NEHRP (National Earthquake Hazard Reduction Program) have published soil profile types based on Vs values to determine seismic site class as shown by the Table below.

Caltrans/NEHRP Profile Types

SEISMIC SITE CLASS	SHEAR WAVE VELOCITY (FT/SEC)	SOIL PROFILE NAME
A	Vs > 5,000	Hard Rock
B	2,500 < Vs ≤5,000	Rock
C	1,200 < Vs ≤2,500	Very Dense Soil and Soft Rock
D	600 ≤ Vs ≤1,200	Stiff Soil
E	Vs < 600	Soft Soil

The site classes are used to evaluate risk to structures from shaking and are based on the weighted average of Vs values in the upper ~100-ft (Vs30).

7.0 ERS SURVEY

7.1 METHODOLOGY

We completed the ERS survey using the Wenner 4-Pin method, which measures the Electrical Resistivity (ER) of the shallow sub-surface. The four “pins” (electrodes) are arranged in a collinear array. Current is transmitted between the outer two electrodes and the resulting voltage is measured across the inner two electrodes. Readings were taken with electrode separations (a-spacings) of 0.5-, 1-, 1.5-, 2-, 5-, 10-, 15-, 20-, 30-, 50-, 75-, 125-, 200-, 300-, 400- and 500-ft. More detailed descriptions of the ERS methodology, our data acquisition and analysis procedures, and the instrumentation we used are provided in **Appendix C – ERS Survey**.

7.2 RESULTS

The data for each ER sounding were acquired along two perpendicular arrays with a common center point, oriented approximately N-S and E-W. The ERS survey results for ERS-1 and ERS-2 are presented by the Field Electrical Resistivity Data Sheets, presented below. The data sheets include a graphical depiction of the ER data, utilizing a log-log graph of apparent resistivity versus a-spacing. The apparent resistivity values are provided in units of ohm-centimeters.

FIELD ELECTRICAL RESISTIVITY DATA SHEET

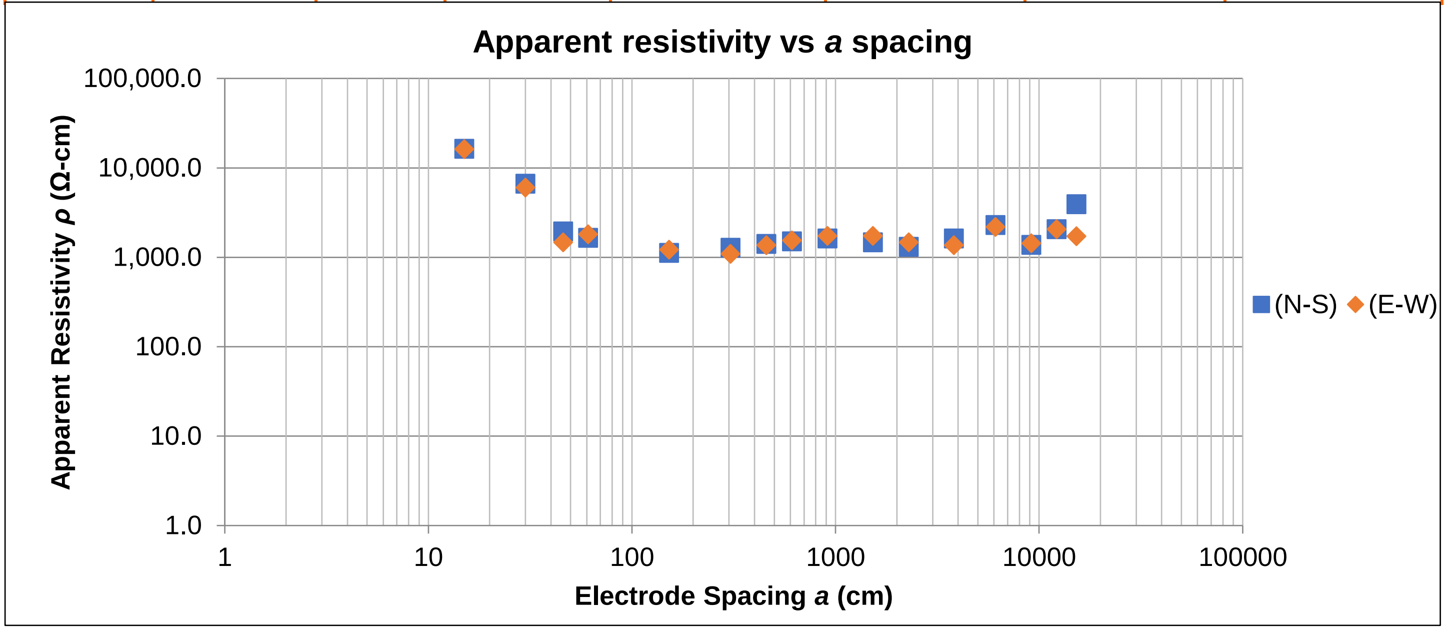
Levy Alameda - Potentia Viridi Substation BESS ■ Tracy, California
July 2024 ■ Terracon Project No. NS245114

Array Loc. 37°42'42.6"N 121°34'25.7"W
Instrument Ultra MiniRes
Weather Fair
Serial # 201
Ground Cond. Soil
Cal. Check 7/16/2024
Tested By IK/JN
Test Date July 16, 2024
Method Wenner 4-pin ASTM G57-06 (2012); IEEE 81-2012
Notes & Conflicts **ERS-1**

Apparent resistivity ρ is calculated as :

$$\rho = \frac{4\pi a R}{1 + \frac{2a}{\sqrt{a^2 + 4b^2}} - \frac{a}{\sqrt{a^2 + b^2}}}$$

Electrode Spacing *a*		**Electrode Depth *b***		**(N-S)**		**(E-W)**	
(feet)	(centimeters)	(inches)	(centimeters)	Measured Resistance *R*	Apparent Resistivity *ρ*	Measured Resistance *R*	Apparent Resistivity *ρ*
				Ω	(Ω-cm)	Ω	(Ω-cm)
0.5	15	6	15	102.900000	16340	102.200000	16220
1	30	6	15	26.800000	6650	24.300000	6030
1.5	46	6	15	5.800000	1940	4.400000	1470
2	61	12	30	3.300000	1650	3.600000	1810
5	152	12	30	1.100000	1120	1.200000	1220
10	305	12	30	0.658000	1280	0.562000	1090
15	457	12	30	0.488000	1410	0.471000	1360
20	610	12	30	0.393000	1510	0.399000	1540
30	914	12	30	0.282000	1620	0.300000	1730
50	1524	12	30	0.153000	1470	0.181000	1730
75	2286	12	30	0.091000	1310	0.102000	1470
125	3810	12	30	0.068000	1630	0.057000	1360
200	6096	12	30	0.060000	2300	0.057000	2180
300	9144	12	30	0.024000	1380	0.025000	1440
400	12192	12	30	0.027000	2070	0.027000	2070
500	15240	12	30	0.041000	3930	0.018000	1720



FIELD ELECTRICAL RESISTIVITY DATA SHEET

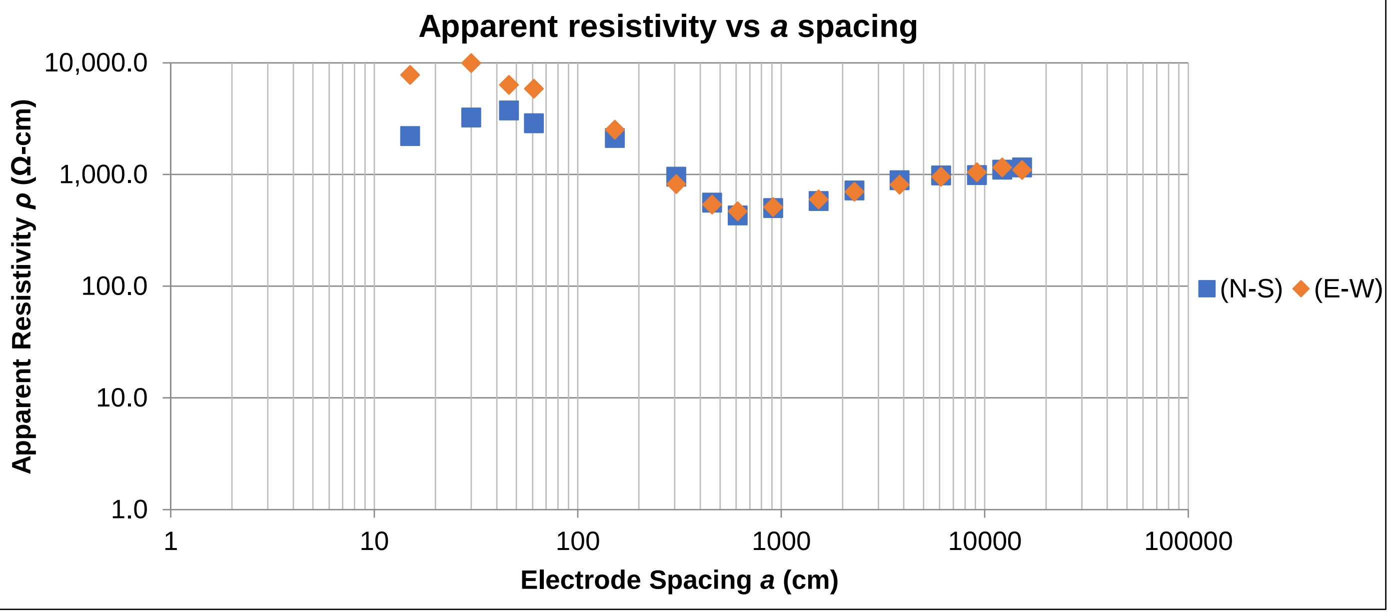
Levy Alameda - Potentia Viridi Substation BESS ■ Tracy, California
June 2024 ■ Terracon Project No. NS245114

Array Loc. 37°42'45.6"N 121°34'19.6"W
Instrument AGI Sting R1
Weather Fair & Windy
Serial # SP0303161
Ground Cond. Soil
Cal. Check 6/8/2023
Tested By DTH
Test Date June 13, 2024
Method Wenner 4-pin ASTM G57-06 (2012); IEEE 81-2012
Notes & Conflicts **ERS-2**

Apparent resistivity ρ is calculated as :

$$\rho = \frac{4\pi a R}{1+\frac{2a}{\sqrt{a^2+4b^2}}-\frac{a}{\sqrt{a^2+b^2}}}$$

Electrode Spacing *a*		**Electrode Depth *b***		**(N-S)**		**(E-W)**	
(feet)	(centimeters)	(inches)	(centimeters)	Measured Resistance *R* Ω	Apparent Resistivity *ρ* (Ω-cm)	Measured Resistance *R* Ω	Apparent Resistivity *ρ* (Ω-cm)
0.5	15	6	15	13.950000	2210	48.990000	7780
1	30	6	15	13.070000	3240	40.270000	9990
1.5	46	6	15	11.190000	3750	18.950000	6350
2	61	12	30	5.742000	2880	11.750000	5890
5	152	12	30	2.094000	2130	2.475000	2520
10	305	12	30	0.490600	960	0.421600	820
15	457	12	30	0.195300	560	0.185000	540
20	610	12	30	0.113000	430	0.123300	470
30	914	12	30	0.086470	500	0.089040	510
50	1524	12	30	0.060590	580	0.062950	600
75	2286	12	30	0.050050	720	0.048560	700
125	3810	12	30	0.037110	890	0.033960	810
200	6096	12	30	0.025520	980	0.025040	960
300	9144	12	30	0.017300	990	0.018320	1050
400	12192	12	30	0.014440	1110	0.015170	1160
500	15240	12	30	0.012150	1160	0.011450	1100

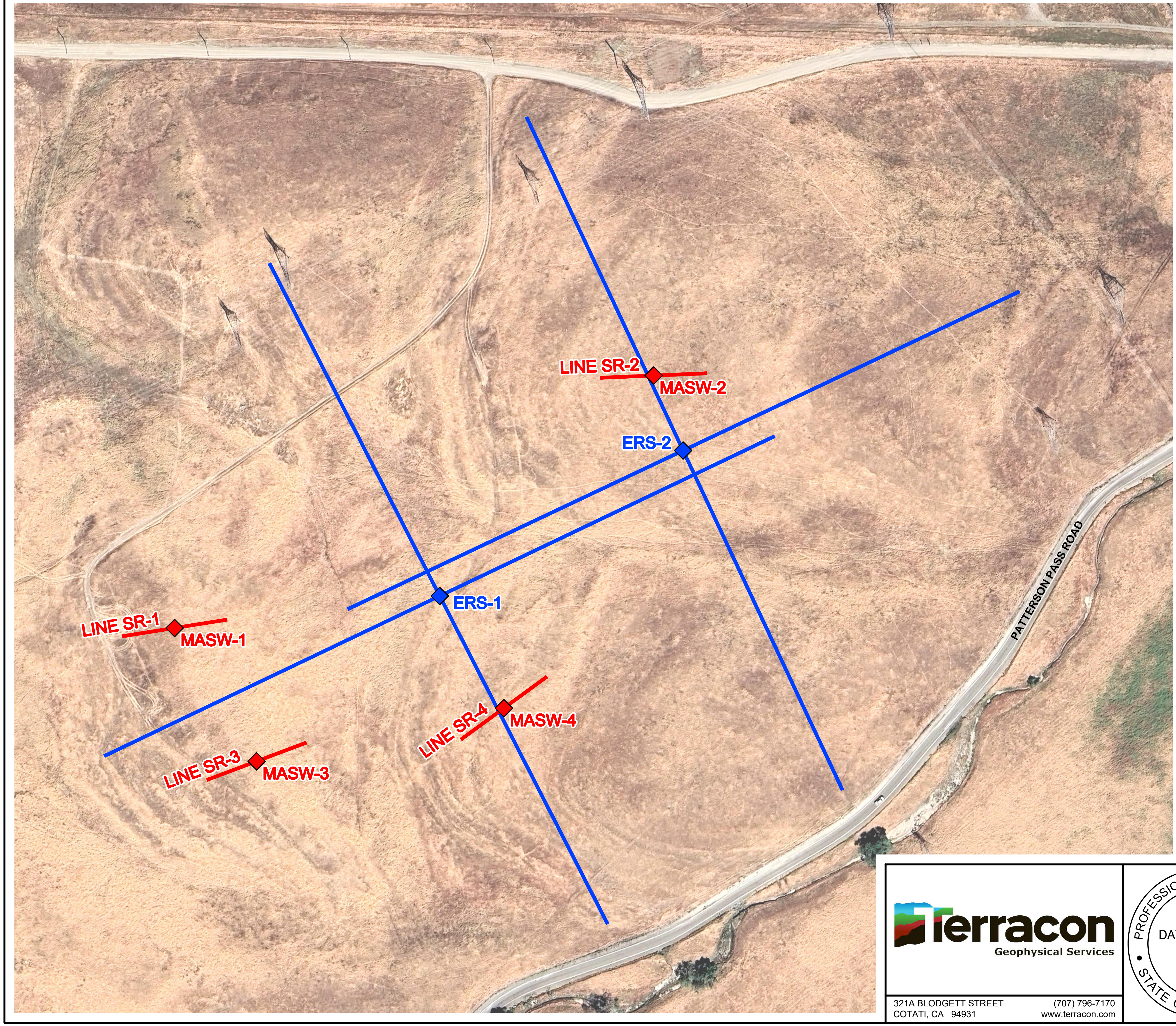


8.0 SUMMARY

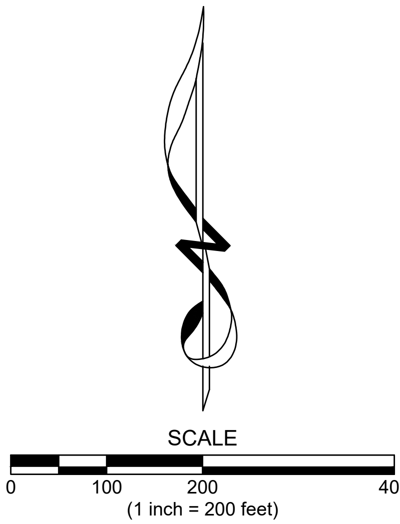
Based on the data acquired, we offer these observations:

- Both seismic survey methods indicate a relatively thick mantle of surficial soils, poorly consolidated sedimentary deposits and/or weathered rock. Harder rock is indicated by SR-3 and SR-4 at depths of 25- to 35-ft; however, typical rock velocities were not detected by SR-1 or SR-2.

- The ERS surveys indicate low to moderate ER values that are typical of mixed soils, sediments and/or sedimentary rock.



VICINITY MAP



LEGEND

━	SEISMIC REFRACTION LINE (PLATES 2-5)
◆	MASW SOUNDING LOCATION (PLATES 6-7)
◆	ELECTRICAL RESISTIVITY SOUNDING (ERS) LOCATION
━	ELECTRICAL RESISTIVITY SOUNDING (ERS) ARRAY

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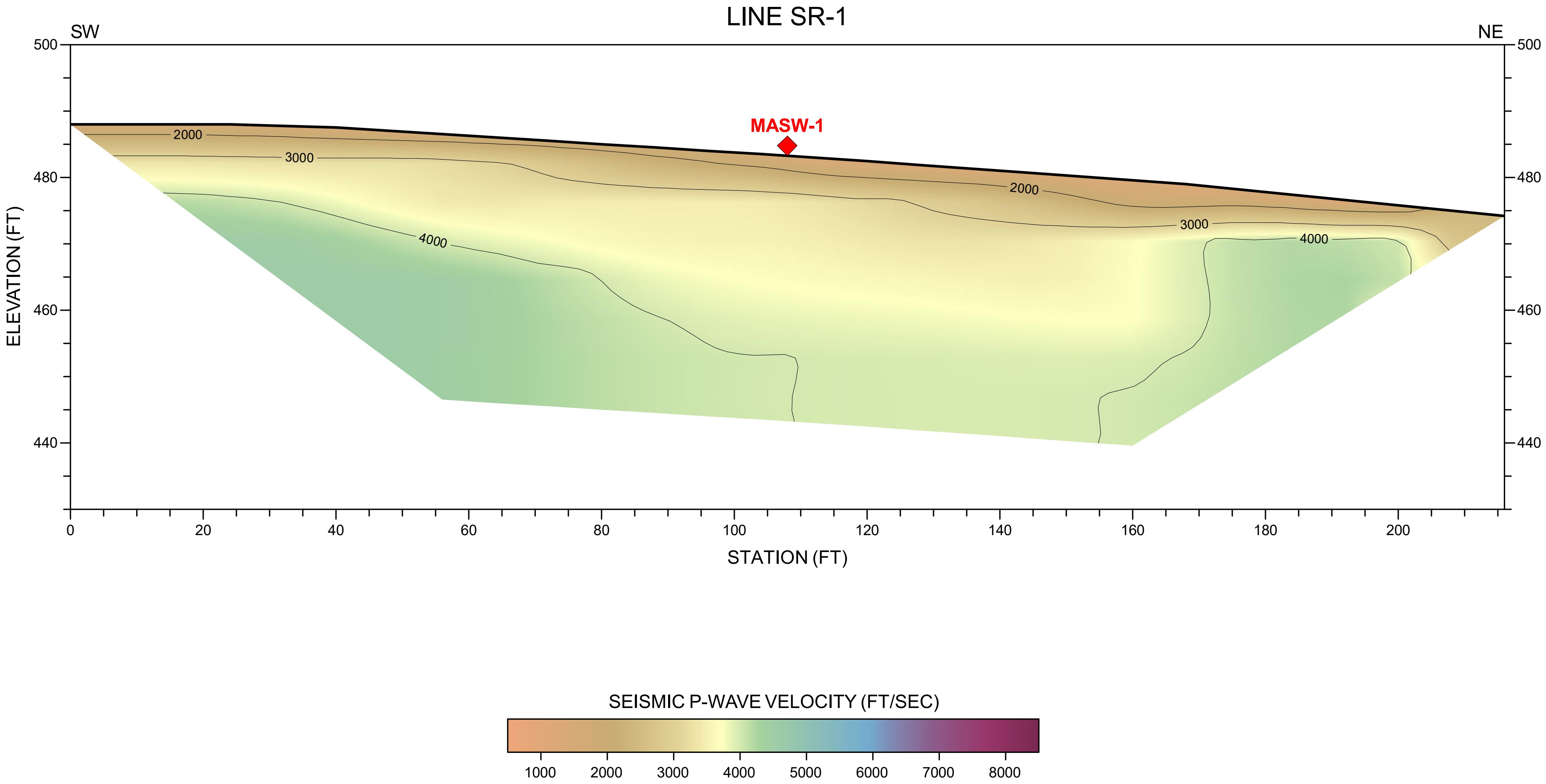
SITE LOCATION MAP
GEOPHYSICAL INVESTIGATION
POTENTIA VIRIDI SUBSTATION & BESS

LOCATION: 17257 PATTERSON PASS ROAD, TRACY, CALIFORNIA

CLIENT: LEVY ALAMEDA, LLC

JOB #. NS245114	DATE: JULY 2024	PLATE
DRAWN BY: H.PHILSON	APPROVED BY: DTH	1

David Hagin 7/17/2024



LEGEND

◆	MASW SOUNDING LOCATION

SCALE
0 10 20 40
(1 inch = 20 feet)

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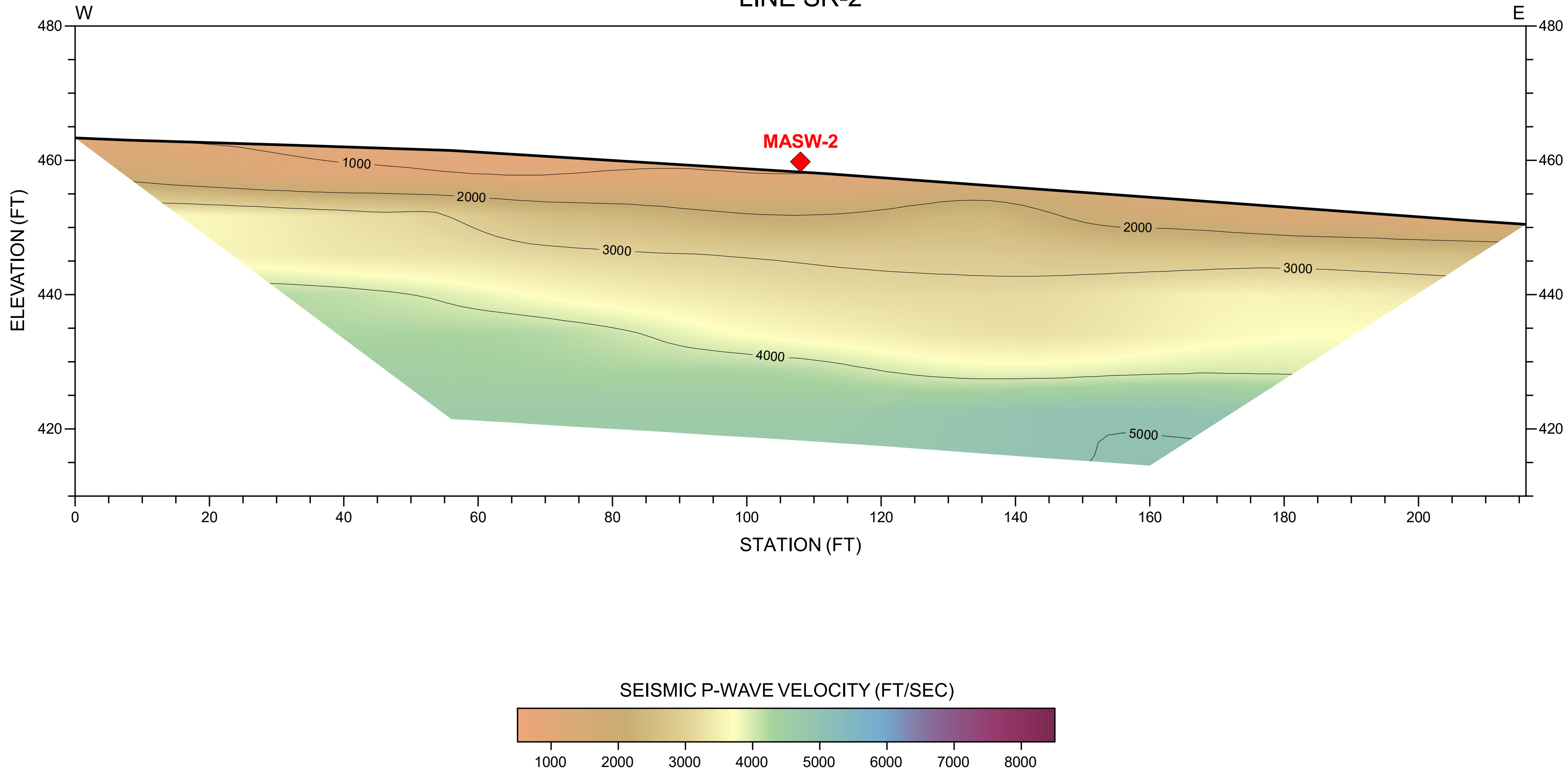
SEISMIC REFRACTION PROFILE
LINE SR-1
POTENTIA VIRIDI SUBSTATION & BESS

LOCATION: 17257 PATTERSON PASS ROAD, TRACY, CALIFORNIA
CLIENT: LEVY ALAMEDA, LLC
JOB #: NS245114
DATE: JULY 2024
DRAWN BY: H.PHILSON
APPROVED BY: DTH
David Hagin 7/17/2024
PLATE
2

LINE SR-2



LEGEND	
◆	MASW SOUNDING LOCATION

SCALE
0 10 20 40
(1 inch = 20 feet)

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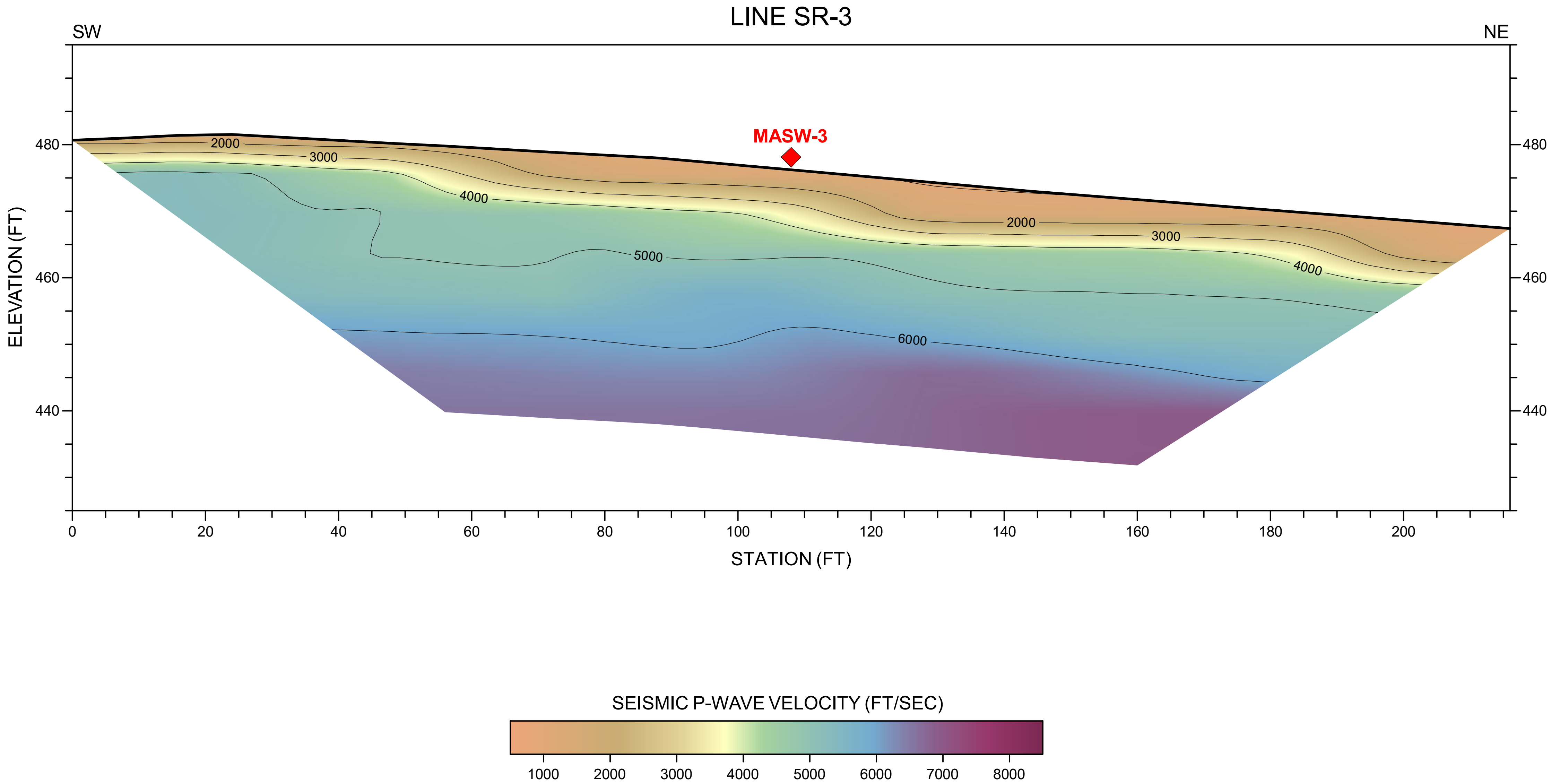
SEISMIC REFRACTION PROFILE
LINE SR-2
POTENTIA VIRIDI SUBSTATION & BESS

LOCATION: 17257 PATTERSON PASS ROAD, TRACY, CALIFORNIA

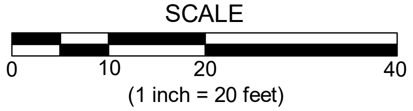
CLIENT: LEVY ALAMEDA, LLC

JOB #: NS245114	DATE: JULY 2024	PLATE
DRAWN BY: H.PHILSON	APPROVED BY: DTH	3
David Hagin	7/17/2024	



LEGEND

◆	MASW SOUNDING LOCATION



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SEISMIC REFRACTION PROFILE
LINE SR-3
POTENTIA VIRIDI SUBSTATION & BESS

LOCATION: 17257 PATTERSON PASS ROAD, TRACY, CALIFORNIA

CLIENT: LEVY ALAMEDA, LLC

JOB #: NS245114
DATE: JULY 2024
DRAWN BY: H.PHILSON
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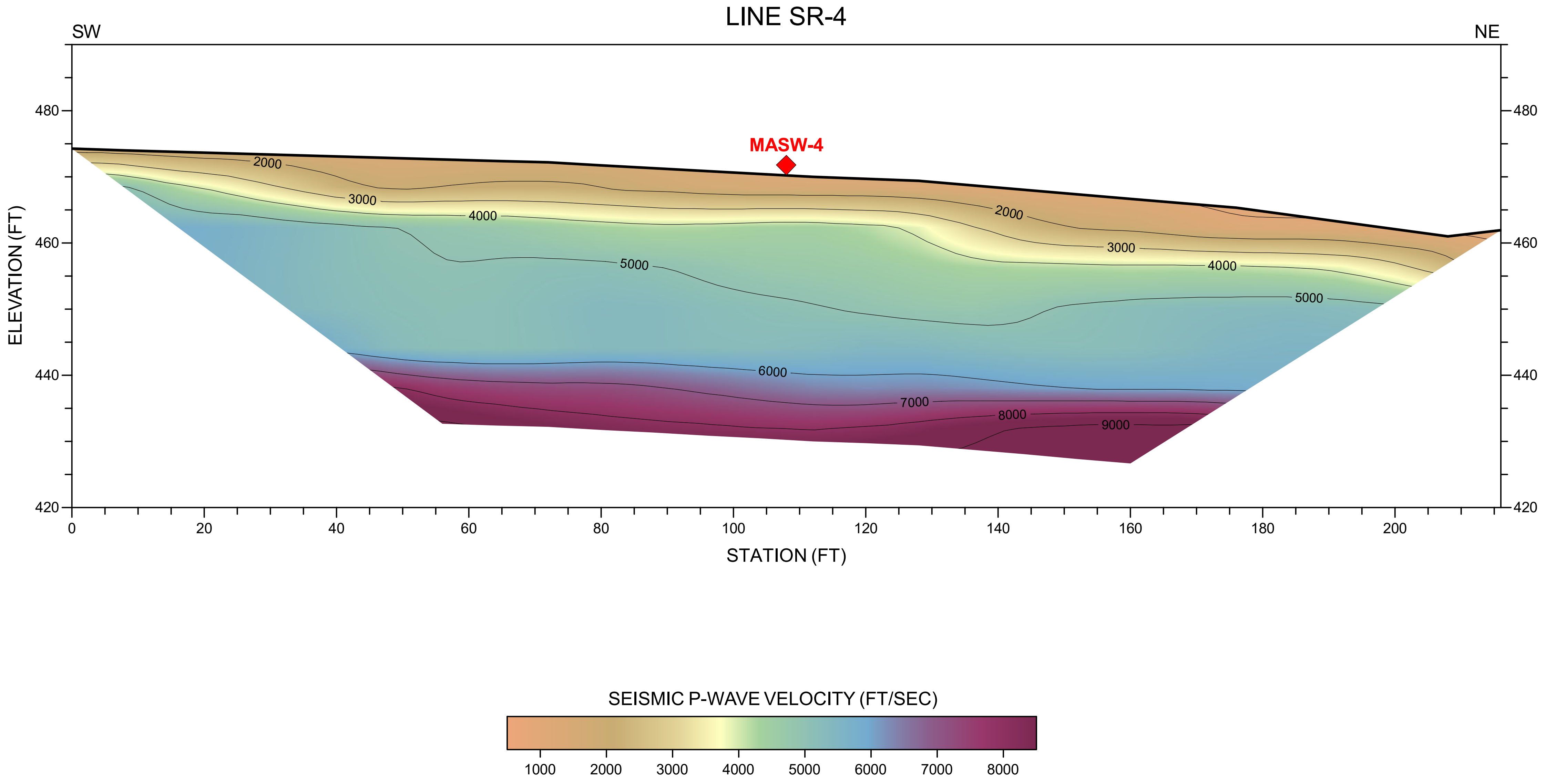
PLATE
4



LEGEND

◆	MASW SOUNDING LOCATION

SCALE
0 10 20 40
(1 inch = 20 feet)

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SEISMIC REFRACTION PROFILE
LINE SR-4
POTENTIA VIRIDI SUBSTATION & BESS

LOCATION: 17257 PATTERSON PASS ROAD, TRACY, CALIFORNIA
CLIENT: LEVY ALAMEDA, LLC

JOB #: NS245114	DATE: JULY 2024	PLATE
DRAWN BY: H.PHILSON	APPROVED BY: DTH	5

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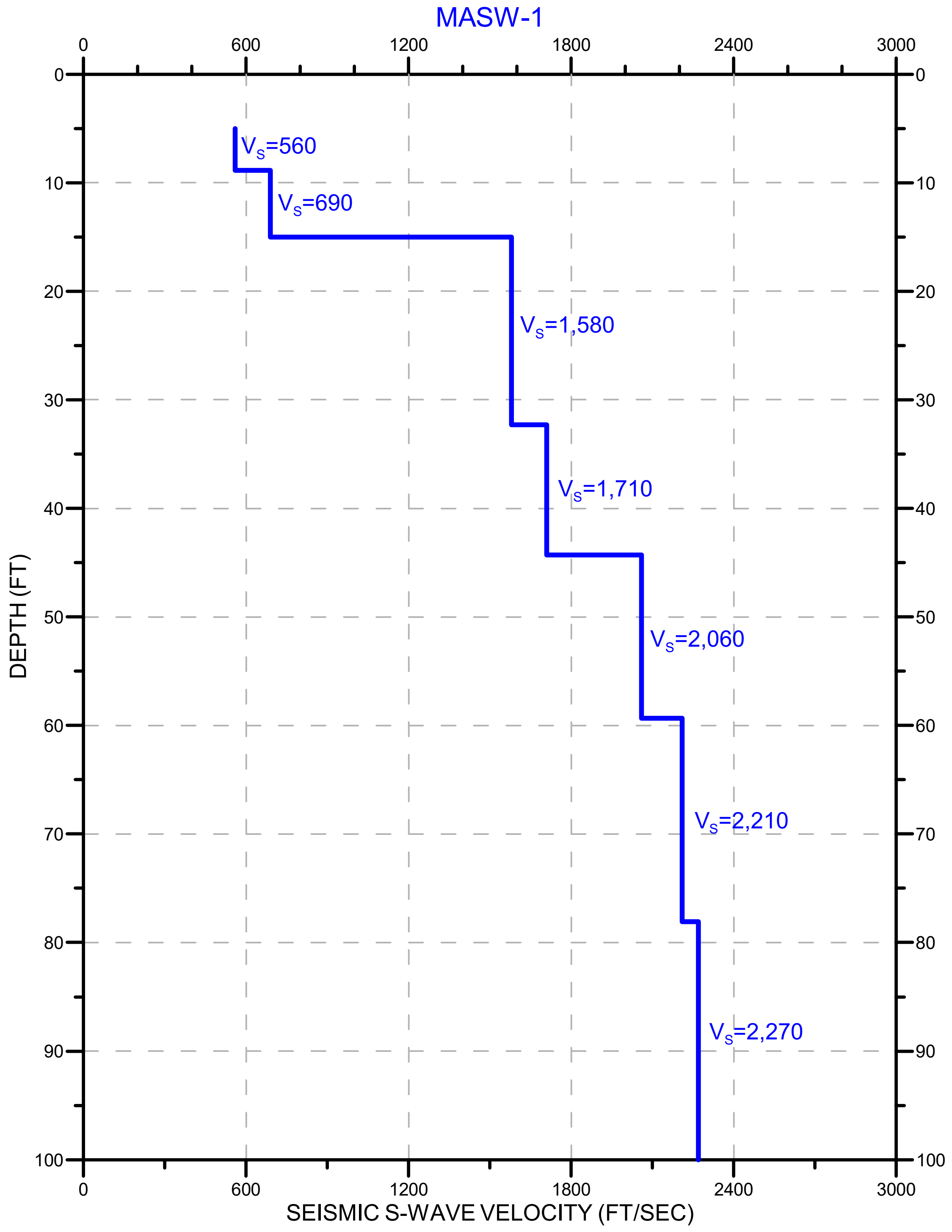

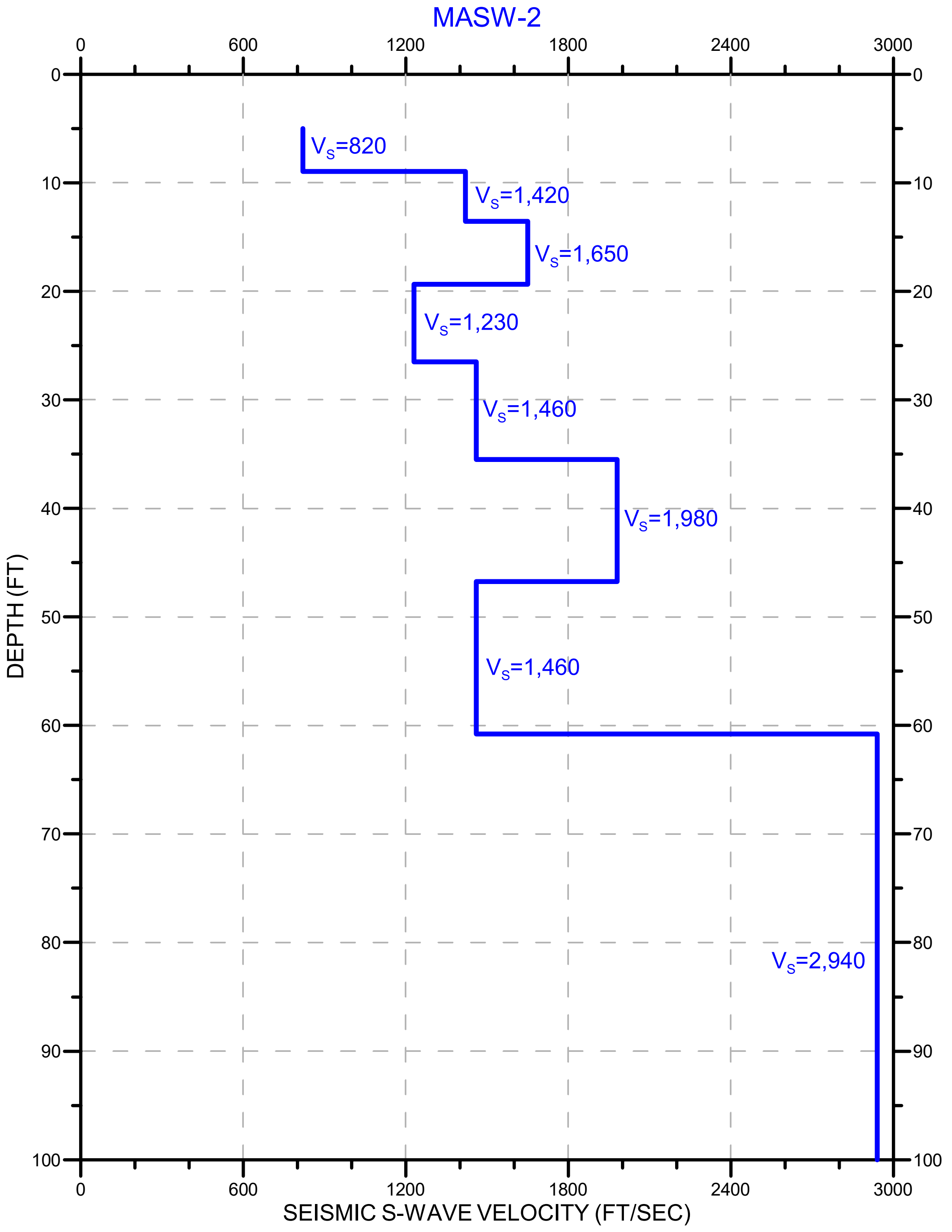

LEGEND

—	SEISMIC S-WAVE VELOCITY

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MASW SOUNDINGS
MASW-1 & MASW-2
POTENTIA VIRIDI SUBSTATION & BESS

LOCATION: 17257 PATTERSON PASS ROAD, TRACY, CALIFORNIA
CLIENT: LEVY ALAMEDA, LLC
JOB #: NS245114
DATE: JULY 2024
DRAWN BY: H.PHILSON
APPROVED BY: DTH
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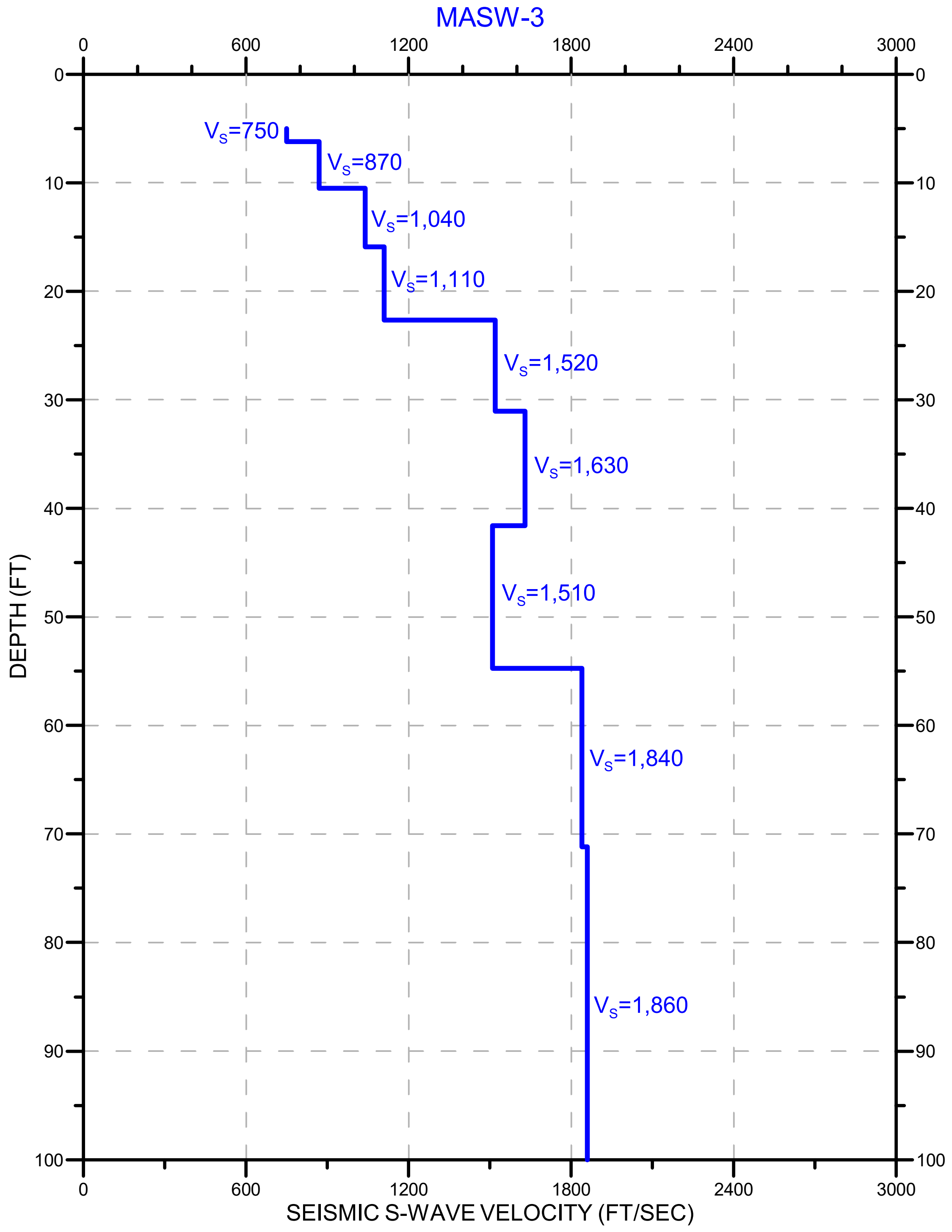
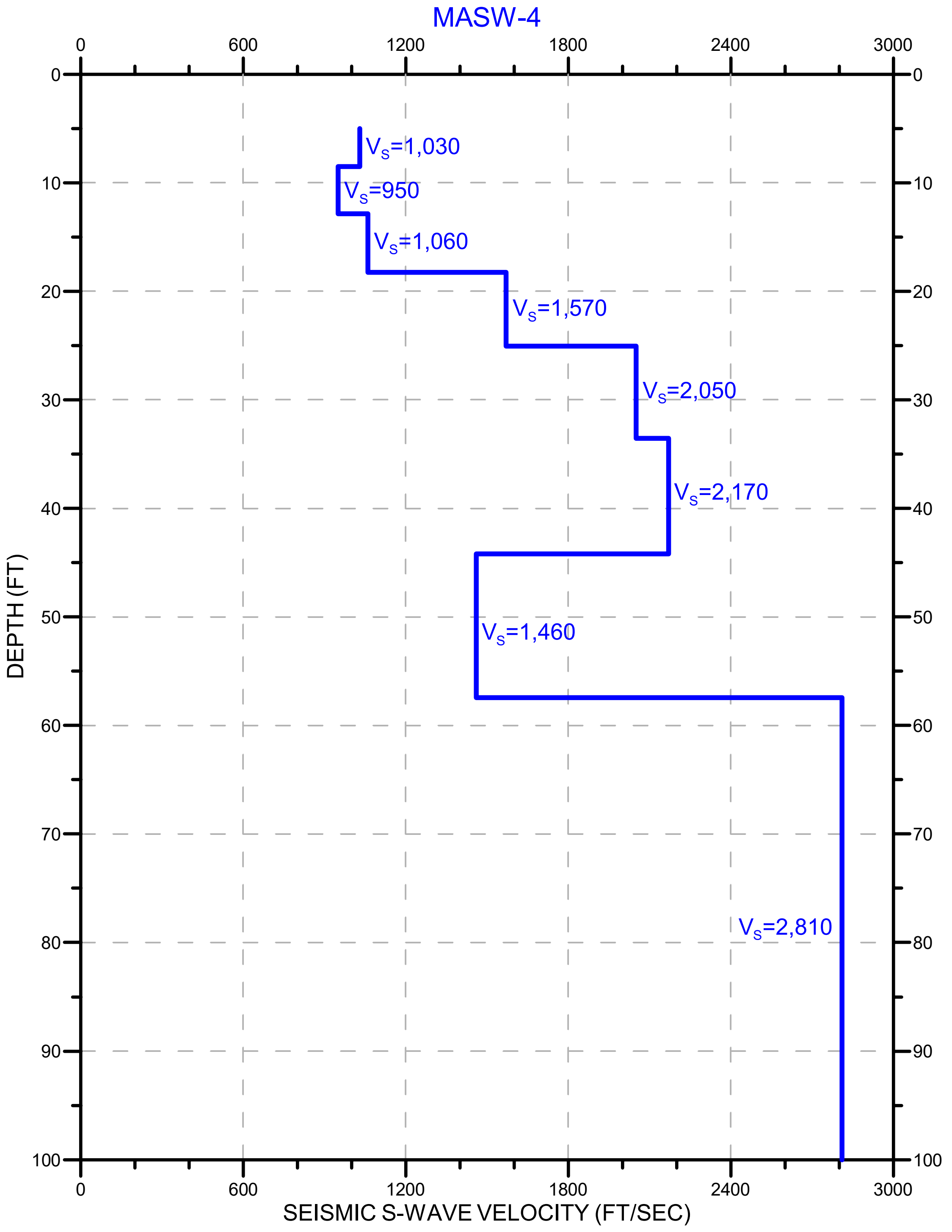
PLATE
6





LEGEND

━━	SEISMIC S-WAVE VELOCITY

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MASW SOUNDINGS
MASW-3 & MASW-4
POTENTIA VIRIDI SUBSTATION & BESS

LOCATION: 17257 PATTERSON PASS ROAD, TRACY, CALIFORNIA

CLIENT: LEVY ALAMEDA, LLC

JOB #: NS245114
DATE: JULY 2024
DRAWN BY: H.PHILSON
APPROVED BY: DTH

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PLATE
7

APPENDIX A:

Seismic Refraction Survey

APPENDIX A:

Seismic Refraction Survey

1.0 METHODOLOGY

The seismic refraction method provides information regarding the seismic velocity structure of the subsurface. An impulsive (mechanical or explosive) energy source is used to produce compressional (p-) wave seismic energy at the surface. The p-waves propagate into the earth and are refracted along interfaces caused by an increase in velocity. A portion of the p-wave energy is typically refracted back to the surface where it is detected by sensors (geophones) that are coupled to the ground surface in a collinear array (spread). The detected signals are recorded on a multi-channel seismograph and are analyzed to determine the shot point-to-geophone travel times. These data can be used along with the corresponding shot point-to-geophone distances and elevation data to determine the depth, thickness, and velocity of subsurface seismic layers.

2.0 INSTRUMENTATION

The seismic waveforms produced at each shot point were recorded using a Geometrics ***Geode*** 24-channel engineering distributed array seismograph, as pictured in Figure 1, and ***RT Clark*** geophones with a natural frequency of 4.5 Hz. The geophones were coupled to the ground surface by a metal spike affixed to the bottom of each geophone case. Seismic energy was produced at each shot point by multiple impacts with a 16-pound sledgehammer against a metal strike plate placed on the ground surface. The seismic waveforms were digitized, processed, and amplified by the Geode, transmitted via a ruggedized Ethernet cable to a field computer and algebraically summed (stacked) until sufficient signal to noise ratio was achieved. The data were displayed on the computer's LCD screen in the form of seismograms, analyzed for quality assurance and archived for subsequent processing. These images were subsequently used to determine the time required for P-waves to travel from each shot point to each geophone in the array (spread).

Figure 1: *Geometrics Geode 24-channel engineering distributed array seismograph.*

3.0 DATA ACQUISITION

We collected SR data along four lines, designated as Lines SR-1 through SR-4, as described in the main body of the report. The line locations are shown by the red lines on the site location map (Plate 1). Terracon Lodi and Sonoma County personnel jointly determined the locations and orientations of the SR lines. Data were acquired using arrays of 24 geophones with 8-ft spacing and 5 shot-points. The shot-points were placed off each end of the geophone arrays as well as distributed equally within the arrays. Each seismic line comprised a single spread, yielding a 216-ft length for each line. The maximum depth of investigation is determined by the greatest shot-to-receiver distance and is estimated to be 40-ft for each line.

4.0 DATA ANALYSIS

The seismic refraction data were processed using the software package ***SeisImager,*** written by Oyo Corporation (Japan) and distributed by Geometrics Inc. This package consists of two programs titled ***Pickwin,*** Version 5.1.1.2 (2013) and ***Plotrefa*****,** Version 3.0.0.6 (2014). For each seismic line we used ***Pickwin*** to view the seismic records and identify first arriving P-wave energy at each geophone and to determine the shot point to geophone travel time associated with each arrival. We then used ***Plotrefa*** to assign elevations to each geophone and to plot the shot point to geophone travel times versus their distance (Station) along the line. A sample Time versus Depth (T-D) graph is shown in Figure 2.

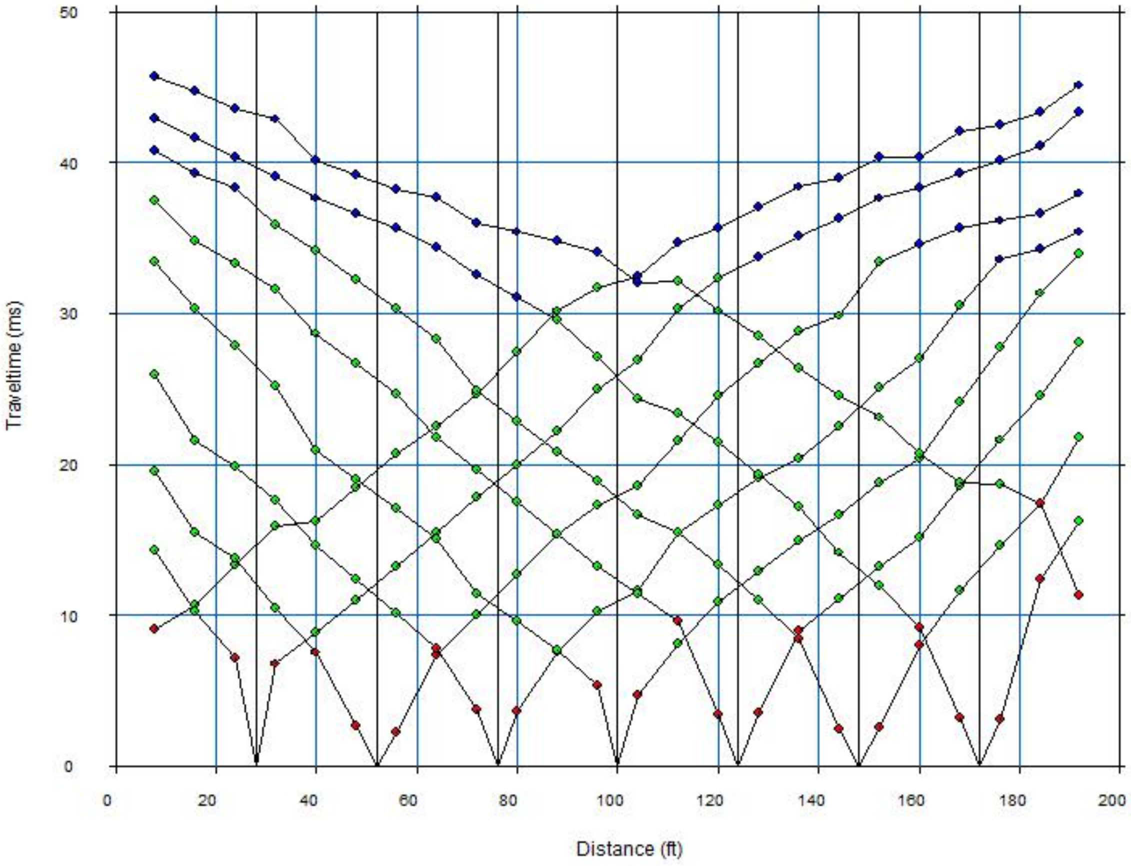

Figure 2: *Sample SR Time-Distance Graph. Red circles represent layer 1 (V1), green circles represent V2 and blue circles represent V3.*

After examining the T-D graph we assigned velocity layers (1-3) to each travel time and then computed a 2D model using ***Plotrefa's*** time-term routine. This resulted in a 2D layered cross-section (profile) illustrating seismic velocity versus depth. A sample 2D time-term model is shown in Figure 3.

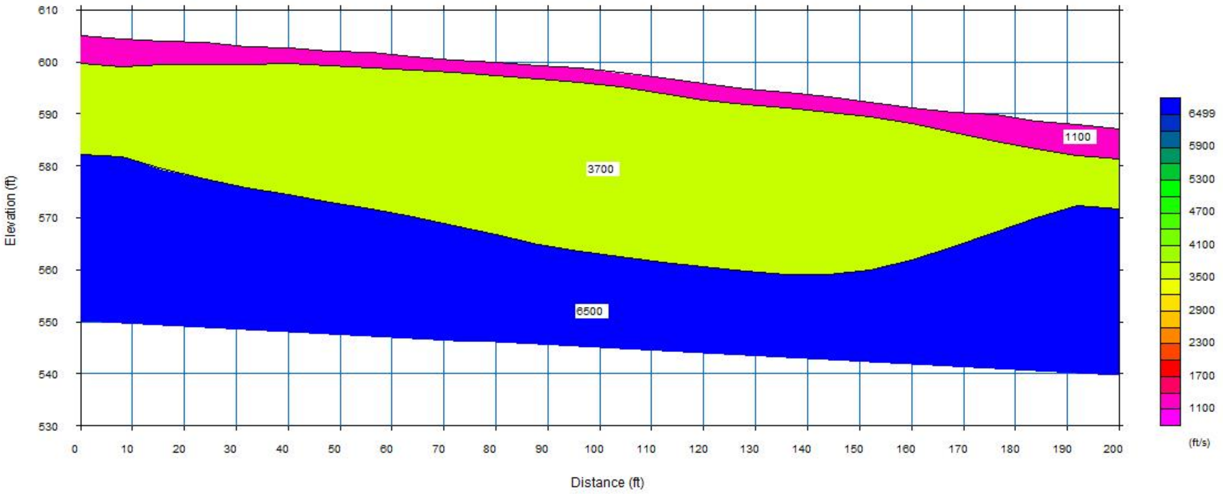

Figure 3: *Sample Time-Term Seismic Velocity Model. Velocities are labeled and indicated by the color bar on the right.*

Finally, we used the time term model as input to ***Plotrefa's*** tomographic routine. This routine divided the input model into cells according to the geophone spacing and depth range and assigned a velocity to each cell. It then used a ray-tracing routine to compute synthetic travel times through the model from each shot point to every geophone. The synthetic travel times were compared with the observed travel times to determine the goodness of fit. If the fit was not within certain assigned parameters, the program then adjusted the velocity in each cell and reran the ray tracing. This procedure was repeated through as many as 20 iterations in order to achieve the optimum fit between observed and synthetic travel times. A sample tomographic model is shown in Figure 4.

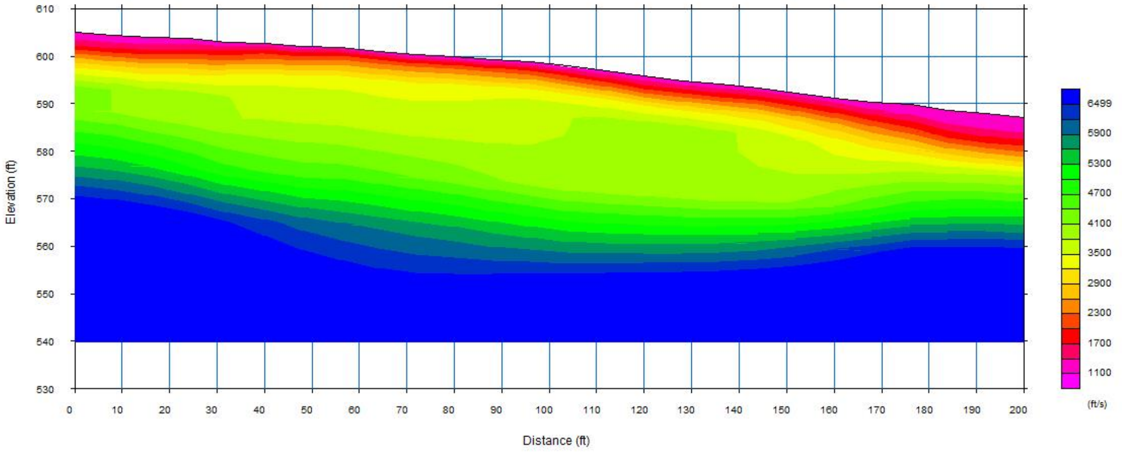

Figure 4: *Sample tomographic Inverted Seismic Velocity Model. Velocities indicated by color bar on right.*

Once the tomographic processing was complete, we used the computer program ***Surfer 21.2*** by Golden Software to construct a color contoured 2D cross-section (profile) illustrating the results for each seismic line.

5.0 INTERPRETATION

The SR profiles described above are models of the subsurface based on P-wave velocities. How these velocities and their subsurface distribution relate to geology is a matter of interpretation. This interpretation can be based on experience and a general knowledge of the local geology. However, the best results are achieved when the models can be correlated with subsurface information provided by other means such as onsite observations, borehole geological and/or geophysical logs, trench logs or projections based on mapped surface geology. This type of information is referred to as “ground truth”.

In any case, the resulting seismic velocity profile represents a model of the subsurface that must be interpreted by the best means available. Thus, the interpreted profile is conceptual in nature, and is not expected to represent an exact depiction of the subsurface.

6.0 LIMITATIONS

Based on the physical properties of refraction (Snell’s Law), in order for a seismic wave to be refracted back toward the surface, the seismic velocity of the upper layer must be less than the velocity of the lower layer. When higher velocities overlie lower velocities, often referred to as a velocity inversion, the seismic energy will be refracted downward, and the lower layer will not be detected at the surface. As a result, the calculated depths of any deeper higher velocity layers may be overestimated. Furthermore, some layers may be truncated or too thin to detect. These are referred to as “hidden layers”.

If the seismic source used for the survey does not produce sufficient energy to propagate through the entire spread at detectable levels, the first arriving P-waves at each geophone may not be visible on the seismic records. Additionally, extraneous seismic energy sources such as wind, traffic or nearby machinery may create “noise” on the recorded waveforms that may mask the first arrivals.

Another common external noise source is overhead power lines. If the cable is laid out parallel to the lines electrical noise may be induced in the cable. Possible internal noise sources may be faulty geophone connections due to dirt or moisture or use of an unsuppressed power supply.

In noisy conditions many “stacks” (multiple shots) may be necessary to achieve an acceptable signal-to-noise ratio. Stacking consists of superposition of waveforms such that the stacked shot energy builds with successive shots, whereas the noise tends to cancel itself out due to its random nature. In extremely noisy conditions it may not be possible to achieve an acceptable signal-to-noise ratio for the greatest shot-to-receiver distance, possibly reducing the maximum depth of investigation.

Finally, seismic refraction processing algorithms are based on the assumption that the seismic velocity layers are isotropic. That is, that the velocity is uniform within the length and breadth of each layer. Another assumption is that the velocity distribution does not change in a direction transverse to the seismic line. In other words, that there is true 2D symmetry. If these conditions are not met, the actual subsurface conditions will vary from those represented by the seismic model.

APPENDIX B:

MASW Sounding Survey

APPENDIX B:

MASW Sounding Survey

1.0 METHODOLOGY

When seismic energy is generated at or near the ground surface, both body and surface waves are produced. Body waves expand omni-directionally throughout the subsurface. They consist of both compressional (P) and shear (S) waves. Surface waves (e.g., Rayleigh, Love, etc.) radiate along the ground surface at velocities that are proportional to shear wave velocity (Vs). Rayleigh waves are characterized by retrograde elliptical particle motion, and travel at approximately 0.9 times the velocity of S-waves.

If a vertical impact source is used, approximately two-thirds of the seismic energy that is produced is in the form of ground roll. As a result, surface waves are typically the most prominent signal on multi-channel seismic records. In addition, surface waves have dispersion properties that body waves lack. That is, different wavelengths have different penetration depths and, therefore, propagate at different velocities. By analyzing the dispersion of surface waves, it is possible to obtain an S-wave versus depth velocity profile. Since s-wave velocity is directly proportional to shear modulus, this provides a direct indication in the variation of stiffness (or rigidity) of subsurface materials.

Surface waves can be recorded and analyzed using a method referred to as Multichannel Analysis of Surface Waves (MASW). This method is used to collect surface wave data using a fixed array of geophones and shot points. This is referred to as a sounding, and results in a one-dimensional (1D) model depicting variation in S-wave velocity versus depth beneath the center of the array. However, the subsurface conditions underlying the entire length of the array, and for several tens of feet to either side, contribute to the measured velocity values. The method requires an energy source that is capable of producing ground roll and geophones that are capable of detecting low frequencies (<10 Hz) signals.

2.0 INSTRUMENTATION

The seismic waveforms produced at each shot point were recorded using a Geometrics ***Geode*** 24-channel engineering distributed array seismograph, as pictured in Figure 1, and ***RT Clark*** geophones with a natural frequency of 4.5 Hz. The geophones were coupled to the ground surface by a metal spike affixed to the bottom of each geophone case. Seismic energy was produced at each shot point by multiple impacts with a 16-pound sledgehammer against a metal strike plate placed on the ground surface. The seismic waveforms were digitized, processed, and amplified by the Geode, transmitted via a ruggedized Ethernet cable to a field computer and algebraically summed (stacked) until sufficient signal to noise ratio was achieved. The data were displayed on the computer’s LCD screen in the form of seismograms, analyzed for quality assurance and archived for subsequent processing.

Figure 1: *Geometrics Geode 24-channel engineering distributed array seismograph.*

3.0 DATA ACQUISITION

We acquired four MASW soundings, designated as MASW-1 through MASW-4, as described in the main body of the report. Terracon Lodi and Sonoma County personnel jointly determined the locations and orientations of the MASW soundings. The sounding locations are centered on the SR lines and are shown by the red diamonds on Plate 1. For each sounding, the seismic equipment was set out in a collinear array consisting of 24-geophones and six shot-points. The geophone stationing interval was 8-ft and shot-points were placed 2-, 4- and 6-stations off each end of the arrays, for total array lengths of 280-ft.

The minimum and maximum depths of investigation are determined by the highest and lowest frequencies measured by the survey, respectively. This frequency distribution is a function of the site geology, the source characteristics, the geophone spacing and the array length. The minimum depth of exploration for each sounding is approximated at 5-ft below ground surface and the maximum depth at 100-ft.

4.0 DATA ANALYSIS

The seismic wave-traces (shot gathers) recorded at each shot point were analyzed using the computer program ***SURFSEIS*** developed by the Kansas Geological Survey (Version 5.0, 2016). This interactive program converts the data acquired from all four shot points in a given sounding into a dispersion curve representing phase velocity versus frequency. This curve is then inverted to produce a 1D model indicating S-wave velocity versus depth. The steps involved in this procedure are as follows:

1) The shot gathers are converted to KGS format.
2) Stations are assigned to the geophone and shot point locations.
3) The resulting records are viewed to determine their overall quality. If necessary, portions of the records are muted to remove interference from refractions, reflections, and higher mode events.
4) For each formatted (and/or muted) record, the program produces what is referred to as an “overtone plot”. This is a colored cross-section indicating phase velocity versus frequency and amplitude. The vertical axis represents phase velocity (increasing upward); the horizontal axis represents frequency (increasing to the right); and signal amplitude is indicated by various colors, with the hottest colors (orange to red to dark brown) representing the greatest signal to noise ratio. Typically, the strongest signals align in a curved pattern with a symmetry with the shape of a “hockey stick” where the blade is pointing upward at the lower end of the frequency spectrum (higher velocity at greater depth) and the handle projects to the right in the direction of increasing frequencies indicating lower velocities.
5) The overtone plots compiled from the four shot points are reviewed to determine their overall quality and the best among them (possibly all) are merged to form a single overtone. This enhances the overall signal to noise ratio of the survey and incorporates data from both ends of the spread (if feasible).
6) The resulting overtone plot is used as a guide in deriving a dispersion curve representing phase velocity versus frequency. This is done by fitting the curve along the center of the hockey stick where the signal to noise ratio is highest.
7) The resulting dispersion curve is inverted through an iterative process to compute a 1D model representing S-wave velocity versus depth.

The shear-wave velocities in each depth range for the four soundings are tabulated in the tables presented in Section 5.3, in the main body of the report. The results are also presented graphically by the step-chart graphs on Plates 6 and 7.

5.0 LIMITATIONS

Extraneous seismic energy sources such as wind, traffic or nearby machinery may create “noise” on the recorded waveforms. Also, live electric lines may induce unwanted electrical current into the seismic cable, also creating noise. If the seismic source used for the survey does not produce sufficient energy to propagate through the entire spread at detectable levels, the wave forms created by the surface waves may be overly contaminated by noise and reduce the signal-to-noise ratio and thus the data quality.

In noisy conditions many “stacks” may be necessary to achieve an acceptable signal-to-noise ratio. Stacking consists of superposition of waveforms such that the stacked shot energy builds with successive shots whereas the noise tends to cancel itself out due to its random nature. In some cases, however, noise is not sufficiently random to be reduced to acceptable levels.

APPENDIX C:

ERS Survey

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1.0 METHODOLOGY

1.1 ELECTRICAL RESISTIVITY: DEFINITION AND APPLICATIONS

Electrical resistivity (ER) is the resistance of a volume of earth material to the flow of electrical current. The ER of sedimentary earth materials is directly affected by factors such as grain size, porosity, mineralogy, moisture content and groundwater salinity. However, it has been our experience through numerous ER surveys conducted throughout the Bay Area that, in unconsolidated materials, grain size seems to have the largest effect on ER of all these parameters. Specifically, fine grained materials such as clays and silts typically have relatively low ER whereas coarse grained materials such as sands and gravels have relatively high ER.

The ER of rock is affected primarily by mineralogy and the degree of weathering and fracturing. Rock formations that are deeply buried and not exposed to chemical weathering are generally impermeable, contain little water, and have a relatively high electrical resistivity. Conversely, highly weathered and fractured rock that contains moisture typically has lower resistivity values. Alternatively, some rocks contain conductive minerals that can result in the rock having relatively low ER.

Given the relationships described above, geophysical methods that measure subsurface ER can be used to determine the depth, thickness and lateral extent of groundwater aquifers, the depth to groundwater, the depth to rock, the depth, thickness and lateral extent of clay layers and the depth, thickness and lateral extent of sand/gravel deposits. ER measurements can also be used to evaluate soil corrosion potential and to provide parameters for the design of electrical grounding systems.

1.2 ELECTRICAL RESISTIVITY SOUNDING

Measuring the variation in ER versus depth beneath a fixed point is referred to as an electrical resistivity sounding (ERS). This involves transmitting electrical current *(I)* into the ground between two electrodes, and measuring the resulting electrical potential or voltage drop (*V*) between two other electrodes. There are many different electrode configurations that can be used. The most common are the Wenner and Schlumberger arrays. With both techniques, the four electrodes are arranged in a collinear array. Current is transmitted between the outer two electrodes (referred to as A and B) and the resulting voltage is measured across the inner two electrodes (referred to as M and N). Readings are typically taken with many different electrode separations, ranging from less than one foot to several hundreds of feet. The larger the separation, the deeper the current is forced to flow to complete a circuit. The actual current flow occurs within a generally hemispherical volume of earth between the current electrodes. The readings obtained with each electrode separation are used to compute a value referred to as apparent resistivity *(ρ_a)*. The term “apparent” is used because the value represents the resistivity of a volume of earth with varying resistivity values rather than a discrete layer with consistent resistivity. The location of the sounding is defined as the center of the electrode array.

For ER surveys involving the design of grounding systems, such as this survey, the Four Pin Wenner Array is typically used. With this array the electrode separation (a) is uniform between all four electrodes and increases from one reading to the next. The depth of the electrode (b) is also increased at greater a-spacings. The equation that is used to compute apparent resistivity values is presented on the Field Electrical Resistivity Data Sheets included in Appendix A.

2.0 INSTRUMENTATION

We collected ERS data using a ***SuperSting R1*** Resistivity Meter, manufactured by Advanced Geosciences Incorporated (AGI) and an ***Ultra Mini Res***, manufactured by L and R Instruments. The SuperSting is a self-contained unit that transmits current outputs ranging from 1 to 1,000 milliamps (mA). The instrument measures the electrical potential drop (voltage) caused by the current influx and converts the data to values of resistance and apparent resistivity. The data are stored in internal memory and can be downloaded to a computer for subsequent processing and archiving.

3.0 DATA ACQUISITION

The ERS survey consisted of two bi-directional electrode arrays denoted as ERS-1 and ERS-2, as shown on Plate 1. For each survey, either the SuperSting R1 (ERS-2) or the Ultra MiniRes (ERS-1) was connected to the four electrodes in the array using 14-gauge insulated copper conductor wires. Once programmed with the a-spacing for a given measurement, the instrument transmitted electrical current through the outer electrodes (A and B) and measured the voltage drop across the inner pair (M and N). Each measurement was made twice, and the results compared to make sure that there was no more than 2% deviation between the measurements. The averaged readings were then saved for subsequent processing. This procedure was repeated for every prescribed a-spacing starting with small values and expanding with each subsequent measurement to the largest spacing. Measurements were acquired using a-spacings of 0.5-, 1-, 1.5-, 2-, 5-, 10-, 15-, 20-, 30-, 50-, 75-, 125-, 200-, 300-, 400- and 500-ft. as specified by Terracon Lodi.