Geotechnical Investigation Report

Energy Research and Sustainability Center Project Alternative Site Cal Poly Humboldt

Prepared for:

California State Polytechnic University, Humboldt

July 2023

023098

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Reference: 023098

July 5, 2023

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California State Polytechnic University, Humboldt
1 Harpst Street
Arcata, CA 95521-8299

Subject: Geotechnical Investigation Report, Alternative Site for the Proposed Energy Research and Sustainability Center Project, Cal Poly Humboldt, Arcata, California

Dear Jason Baugh:

This report presents the results of our geotechnical investigation for the alternative site for the proposed Energy Research and Sustainability Center Project. As you know, we previously completed a geotechnical investigation for the originally selected site, which is located nearby. In this report, we discuss geotechnical site characteristics and provide specific recommendations for site preparation, and design and construction of foundations for the project.

We are available for additional periodic consultation during the ongoing design phase of the project. If you have any questions, please call our office at 707-441-8855.

Respectfully,

SHN

Gary D. Simpson, CEG
Sr. Engineering Geologist

John H. Dailey, GE 256 Sr.
Geotechnical Engineer

GDS:ame

Enclosure: Report

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Energy Research and Sustainability Center Project, Alternative Site

Prepared for:

California State Polytechnic University, Humboldt

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Abbreviations and Acronyms

Units of Measure

Term	Definition
B	width of foundation bearing area beneath column or bearing wall in feet
BGS	below ground surface
bpf	blows per foot
H:V	horizontal to vertical
ID	inside diameter
k_1	coefficient of subgrade reaction for 1-foot square plate = 150 pci
k_s	subgrade modulus
L	length of foundation bearing area beneath column or bearing wall in feet
mg/kg	milligrams per kilogram
mm	millimeters
OD	outside diameter
ohms-cm	ohms per centimeter
pcf	pounds per cubic foot
pci	pounds per cubic inch
ppm	parts per million
psf	pounds per square foot
psi	pounds per square inch
µm	micrometers

Additional Terms

Term	Definition
ACI	American Concrete Institute
ASCE	American Society of Civil Engineers
ASTM	ASTM-International
B-#	boring number
BSSB	Behavioral & Social Sciences Building
Cal Poly Humboldt	California State Polytechnic University, Humboldt
Caltrans	California Department of Transportation
CBC	California Building Code
ERSC	Energy Research and Sustainability Center
LID	low-impact development
MCE	Maximum Considered Earthquake
MCE_R	Maximum Considered Earthquake Spectral Acceleration
MCS	Modified California Sampler
OSHA	Occupational Safety and Health Administration
PGA_M	site modified peak ground acceleration
SE	sand equivalent
SPT	standard penetration test
USGS	United States Geological Survey

1.0 Introduction

This report presents the results of the geotechnical investigation and analyses conducted by SHN for the alternative site of the proposed Energy Research and Sustainability Center (ERSC) project on the California State Polytechnic University, Humboldt (Cal Poly Humboldt) campus (Figure 1). A previous geotechnical investigation was completed at a nearby site for the proposed development, but due to site constraints, this alternative site is being considered.

The project area is shown on Figure 2. As the location for the project is not finalized, there are no conceptual plans at the time of our reporting. Plans for the previously evaluated site are marginally relevant, as they applied to a sloping hillside site. The site under consideration in this evaluation occurs on a low gradient slope surrounded by a paved parking lot and 14th Street. A previous geotechnical investigation was completed for the adjacent parking lot in 2017 for a reconstruction project (SHN, 2017).

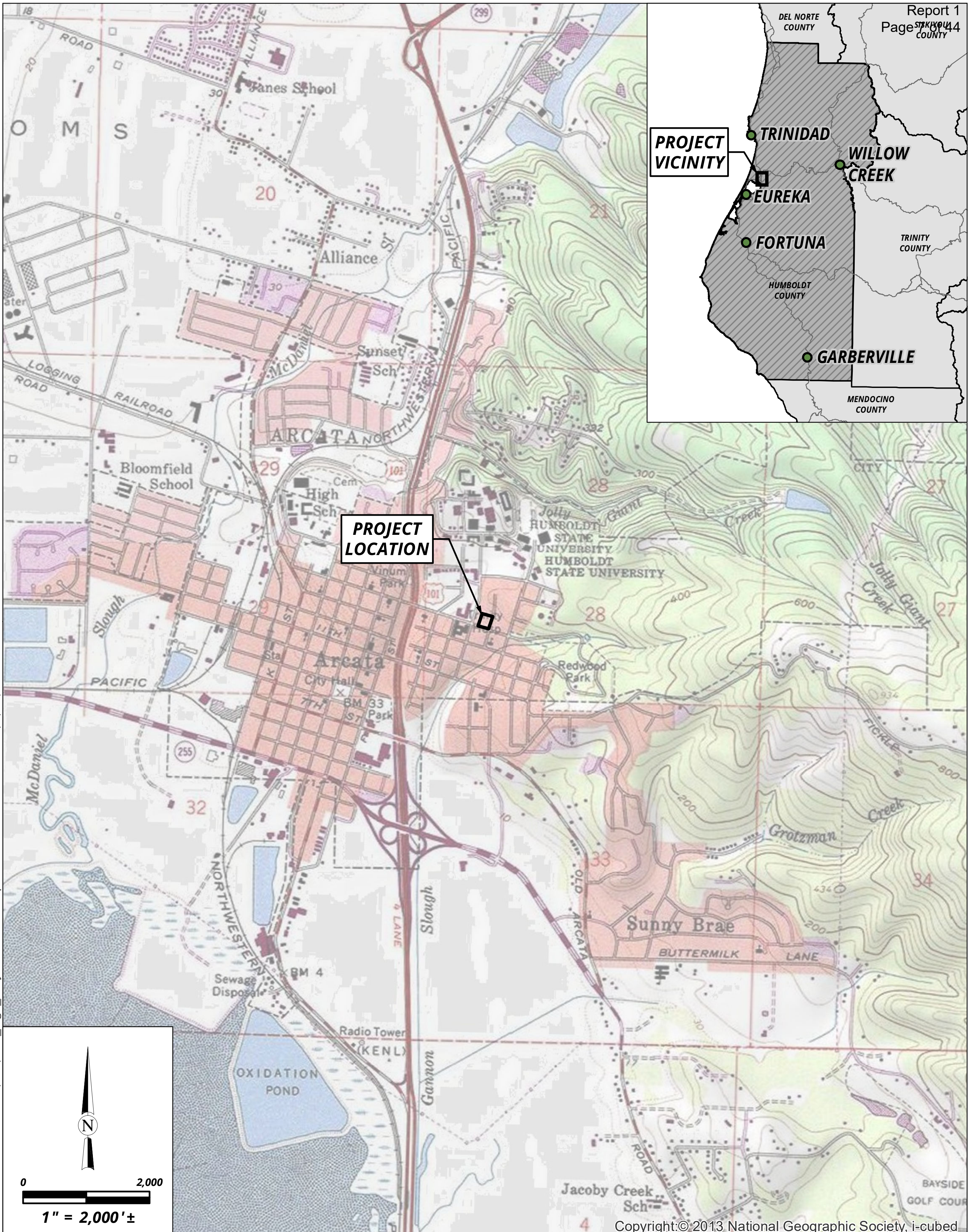
The purpose of our investigation was to evaluate the surface and subsurface conditions at the site in order to develop geotechnical criteria for design and construction of the project. Our scope of work included:

- monitoring the drilling, logging, and sampling of three subsurface machine soil borings;
- general assessment of the geologic setting in order to provide context for the subsurface materials at the site;
- laboratory testing of selected soil samples;
- geotechnical analyses, including assessment of seismic conditions and potential for secondary seismic effects; and
- preparation of this report.

A detailed geologic hazards evaluation is not specifically addressed in this report, as the site is surrounded by a variety of other campus structures that have been the subject of previous investigations, such that the potential for geohazards is well understood to be low. In preparation of this investigation, we reviewed a series of geotechnical and geologic investigations from this and adjacent sites, including the two phases of investigation for the Schatz Energy Research Center development, the Behavioral & Social Sciences Building, and the College Creek Complex. A summary of the available geohazard information is presented below in Section 3.3.

This report provides Cal Poly Humboldt with findings, conclusions, and recommendations related to geologic and geotechnical aspects of project design and construction. Specifically, the following information is presented in this report:

- location map and aerial image of the site showing the location of the geotechnical borings;
- descriptions of soil and groundwater conditions interpreted based on our field exploration, laboratory testing, and review of existing geotechnical and geologic information;
- seismic design parameters in accordance with the applicable portions of the 2022 California Building Code (CBC) and American Society of Civil Engineers (ASCE) 7-16 Standard, including the soil classification, seismic design category, and spectral response accelerations;



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SHN	Cal Poly Humboldt Geotechnical Investigation for ERSC Arcata, California	**Project Location Map** July 2023 - 023098	**Figure** **1**

SHN	Cal Poly Humboldt Geotechnical Investigation for ERSC Arcata, California	**Geotechnical Boring Locations** July 2023 - 023098	**Figure** **2**

- recommendations for site grading and subgrade preparation, fill material placement and compaction requirements, and building foundation support;
- assessment of foundation load-bearing soil conditions, including allowable bearing capacities; and
- recommendations for observation of foundation installation, materials testing and inspection, and other construction considerations.

2.0 Field Investigation and Laboratory Testing

SHN conducted geotechnical field investigations to document and evaluate subsurface soil conditions, to provide foundation design and site development criteria for the proposed buildings, and to identify construction considerations related to development of the site.

2.1 Field Investigation

In order to characterize site conditions, three exploratory machine borings were advanced at the site, in the locations shown on Figure 2. In the absence of design plans, the borings were distributed evenly over the site, considering the limited access through much of the site due to existing structures. The borings were advanced to depths ranging from 31.5 feet (borings B-02-23 and B-03-23) to 51.5 feet (boring B-01-23) below ground surface (BGS) using solid flight augers. The drilling was completed utilizing a DR10K1 truck-mounted drill rig provided and operated by Clear Heart Drilling of Santa Rosa, California, equipped with an automatic sampling hammer for standard penetration testing (SPT).

Visual classifications of the earth materials encountered in the borings were made in general accordance with the Manual-Visual Classification Method (ASTM-International [ASTM] D 2488). Final geotechnical boring logs were prepared based on conditions encountered in the field, examination of samples in the laboratory, and the results of laboratory testing. Boring logs are included as Appendix 1.

Soil samples were obtained by driving a 2.5-inch inside diameter (ID), 3.0-inch outside diameter (OD), Modified California Sampler (MCS) containing steel liners and a 1.5-inch ID, 2.0-inch OD SPT sampler without liners in accordance with ASTM D1586 standards. The samplers were advanced using a 140-pound auto-hammer falling 30 inches per blow. The number of blows required to drive the samplers the last 12 inches of an 18-inch drive is provided on the boring logs as penetration resistance (blows per foot [bpf]). The penetration resistance values (bpf) recorded for SPT sampler drives and provided on the boring logs are actual penetration resistance (N-values) that are uncorrected for depth and the energy transfer ratio of the automatic hammers used. The penetration resistance values provided on boring logs for the MCS sampler drives are field blow counts and should not be construed as SPT N-values. Approximate equivalent SPT N-values for the MCS sampler should be multiplied by a factor of 0.64.

2.2 Laboratory Testing

Selected soil samples were tested in SHN's soils testing laboratory in Eureka, California, to determine index properties and strength characteristics of the subsurface materials. Samples were tested for in-place moisture content, dry density, percent fines, liquid limit, plasticity index, and unconfined compressive strength. Testing also included a corrosivity test performed by CERCO Analytical Labs in Concord, California, on a bulk composite sample collected from the borings. Results of the tests are provided at the corresponding sample locations on the boring logs (Appendix 1) and included as Appendix 2.

3.0 Site Conditions

The following sections describe the project site and current surface and subsurface conditions at the time of our investigation.

3.1 Existing Site Conditions

The alternate ERSC site is located along the north side of 14th Street, along the southern edge of the Cal Poly Humboldt campus (Figure 2). The study area is currently occupied by a series of older one-story structures that maintain the campus Children's and Toddler Centers (the interior of the existing site consists of play areas), and the Mary Warren House. The northern and eastern margins of the site are bordered by Parking Lots G14 and G15. The ground surface at the site is generally planar and slopes gently toward the southwest. Elevations at the site range from about 90 feet at the southwest corner to about 100 feet at the northeast corner.

3.2 Subsurface Soil and Groundwater Conditions

Subsurface conditions encountered at the site during this investigation are consistent with those encountered during the previous geotechnical investigation for Parking Lots G14 and G15, during which 12 shallow borings were completed (SHN, 2017).

The site appears to be entirely underlain by Pleistocene age sediments of the Falor Formation. The Falor Formation consists of medium stiff to very stiff lean clays, loose to medium dense clayey sands, and medium dense to very dense sands with clay. As is typical, Falor Formation sediments appear laterally and vertically discontinuous, and we observe significant variability in texture and consistency between boreholes. SPT values ranged from 7 to 38 (soft/loose to very stiff) although most were in the medium dense/stiff range.

Based on the results of subsurface investigations north of the site (along the northern edge of Parking Lots G14 and G15, at the initial ERSC site and the adjacent Schatz Energy Research Center), as well as geologic mapping, the Falor Formation sediments overlie Franciscan Complex bedrock at relatively shallow depth beneath the site. However, Franciscan bedrock was not encountered in the borings for this project.

Groundwater was not encountered during our subsurface investigation.

3.3 Summary of Potential Geologic Hazards

3.3.1 Seismic Ground Shaking

Coastal northern California is a seismically active region that is susceptible to strong earthquake shaking from a variety of seismic sources. The site is in near proximity to several known active faults that are known to be capable of generating surface rupture. The Cascadia subduction zone is the most significant potential seismic source in the region, capable of producing very large earthquakes in excess of magnitude 9. Such earthquakes could affect the entire Pacific Northwest, from Cape Mendocino to British Columbia. Several feet of uplift or subsidence may occur in coastal areas as a result of very strong, long duration seismic events. Earthquakes with a magnitude of 8 to 9 are expected to occur about every 300 to 500 years, with the last subduction event occurring in 1700. Based on the proximity to active faults, the project site is likely to experience strong seismic ground shaking during the design life of the building.

3.3.2 Surface Fault Rupture

The site is just south of a mapped trace of the Fickle Hill fault zone (Carver, Stephens, and Young, 1985), although the trace is not zoned as an active fault by the State of California within an Alquist-Priolo Earthquake fault zone. Fault hazard associated with the mapped trace was evaluated during the development of the Behavioral & Social Sciences Building and the College Creek student housing complex. Fault hazard investigations for the College Creek complex, in particular, involved comprehensive assessment of rupture potential along the mapped fault trace, just northwest of the subject site (Geomatrix, 2008). That study concluded a very low slip rate and a very low to negligible potential for surface fault rupture along the fault.

3.3.3 Liquefaction, Co-seismic Settlement, Lateral Spreading

The presence of loose or soft horizons within the Falor Formations sediments suggests a potential for liquefaction, and previous investigations have evaluated liquefaction potential at several nearby sites. As the materials most susceptible to liquefaction potential are geologically recent (late Holocene age) sand- and silt-rich deposits, the early to middle Pleistocene age Falor Formation sediments are unlikely to liquefy due to their geologic age. Note descriptive terms on the borings logs regarding cementation, toughness, and manganese concretions, all of which define older sediments with low liquefaction potential. Liquefaction risk is also not indicated by the cohesive nature of sediments encountered at the site.

Groundwater was not encountered in the upper 51.5 feet at the time of our investigation.

Due to the geologic age of the Falor Formation materials and the presence of abundant cohesive zones, their typically medium dense consistency, and the absence of shallow groundwater levels, adverse effects from liquefaction, co-seismic settlement, and lateral spreading are considered very low risks. Previous investigations have also concluded an absence of liquefaction potential at nearby sites with similar conditions. Co-seismic settlement can occur in essentially non-cohesive, loose sands, which are not indicated at the study area. Lateral spreading is typically associated with liquefaction, which is a negligible hazard.

3.3.4 Slope Stability

The site slopes gently to the southwest, and it is separated from modest slopes north of the site by a broad paved parking area. There are no slope stability hazards associated with the site.

3.3.5 Soil Corrosion Potential

As part of this investigation, laboratory corrosivity tests were performed on composited soil samples collected from each borings B-02-23 at 4 to 4.5 feet BGS and B-03-23 at 3.5 to 4 feet BGS. Tests were performed to evaluate the reduction and oxidation potential (redox), pH, resistivity, and concentrations of chloride and sulfate, of/in the soil that would be in contact with shallow foundation elements and underground piping. The results of the soil corrosivity tests are included in Appendix 2 and are summarized in Table 1.

Table 1. Soil Corrosivity Test Results

Parameter	Composite 1-3.5'
Redox (mV)[a,b]	360
pH	6.01
Resistivity (100% Saturation) (ohms-cm)[c]	11,000
Chloride (mg/kg)[d]	<15
Sulfate (mg/kg)	23

[a] Redox: oxidation-reduction potential
[b] mV: millivolts
[c] ohms-cm: ohms-centimeter
[d] mg/kg: milligrams per kilogram

- The redox potential is indicative of potentially slightly corrosive soils resulting from anaerobic soil conditions.
- The pH of the soil reportedly does not present corrosion problems for buried iron, steel, mortar-coated steel, and reinforced concrete structures.
- Based upon the resistivity measurement, the soil samples are classified as mildly corrosive. All buried iron, steel, cast iron, ductile iron, galvanized steel, and dielectric-coated steel or iron should be properly protected against corrosion. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.
- The chloride ion concentrations are below the detection limits of 15 milligrams per kilogram (mg/kg).
- The sulfate ion concentration is 23 mg/kg and is determined to be insufficient to damage reinforced concrete structures and cement-coated steel.

3.4 Seismic Design Parameters

Based on the subsurface conditions encountered at our exploration locations, laboratory test results, and our interpretation of soil/geologic conditions, we classify the site of the proposed Energy Research and Sustainability Center Project as a Site Class C consisting of "Very Dense Soil and Soft Rock" in accordance with Chapter 20 of ASCE 7-16. On this basis, the mapped and design spectral response accelerations were determined using the United States Geological Survey (USGS) Seismic Design Maps based on ASCE/SEI 7-16 (Accessed June 20, 2023) in conjunction with the site class and the site coordinates near the proposed buildings (40.871835° N, -124.078283 ° W). Calculated values for ASCE/SEI 7-16 are presented in Table 2.

Table 2. ASCE/SEI 7-16 Spectral Acceleration Parameters

Parameter	0.2 Second	1 Second
Maximum Considered Earthquake Spectral Acceleration (MCE_R)	S_S = 2.464	S_1 = 1.073
Site Class	C	
Site Amplification factor	F_a = 1.2	F_v = 1.4
Site-modified spectral acceleration	S_{MS} = 2.957	S_{M1} = 1.502
Numeric seismic design value	S_{DS} = 1.971	S_{D1} = 1.002
MCE_G peak ground acceleration (PGA)	0.995	
Site amplification factor at PGA (F_{PGA})	1.2	
Site modified peak ground acceleration (PGA_M)	1.194	

4.0 Geotechnical Discussion and Conclusions

Based on the results of our investigation, SHN concludes the site can be developed as planned for the proposed building construction, provided the recommendations presented in this report are followed. The main geotechnical considerations relative to development of the site are:

- the unengineered fill that was encountered to a depth up to 3 feet;
- the disturbed soils that will occur following the removal of trees and demolition of the existing buildings and improvements; and
- the need to provide uniform foundation support under the proposed structures.

The presence of the soft topsoil and unengineered fill, along with disturbed soils following demolition of existing structures could result in undesirable amounts of total and/or differential settlement with the potential to have an adverse effect on the building foundations, especially following strong ground shaking during a major earthquake. Development of criteria for foundation design and support of concrete flatwork will require consideration of these near-surface soils. The supporting capacity of the soils can be improved by over-excavation and replacement with structural fill within and adjacent to building and exterior slab areas.

Based on the current site grades, removal of about 2.5 feet of soil below planned subgrade elevation across the entirety of the proposed building footprint is recommended to reach suitably firm native soil and allow for the placement of 12 inches of compacted engineered fill beneath footings.

In areas where deep excavations are created from the removal of old foundations, utilities, and loose disturbed soils, the resulting excavation may be backfilled with compacted engineered fill up to the planned subgrade depth.

The site is in a seismically active area and is likely to experience strong seismic ground shaking during the design life of the proposed structures. The intensity of ground shaking from earthquakes will depend on several factors, including the distance from the site to the earthquake focus, the magnitude and duration of the earthquake, and the response of the underlying soil. At a minimum, it will be necessary to design and construct the proposed structures in accordance with the earthquake-resistant provisions of the most recent building codes.

All geotechnical-related work should be performed in accordance with the recommendations of the Geotechnical Engineer-of-Record during construction. Where the recommendations of this report and the cited sections of Title 24 are in conflict, the Owner and Architect should request clarification from the Geotechnical Engineer-of-Record. The recommendations in this report should not be waived without the consent of the Geotechnical Engineer-of-Record for the project. The following subsections present recommendations for the geotechnical-related work.

5.0 Recommendations

5.1 Site Preparation and Grading

Site preparation operations should extend at least 5 feet beyond the limits of the proposed building footprints and all site improvements. Site preparation should include the complete demolition and removal of existing surface and subsurface improvements, including building foundations, utilities, hardscapes, and removal of debris, tree roots, and loose soil caused by demolition. Deeper stripping may be locally required to remove concentrations of vegetation, such as large root wads. Where the removal of large trees is required, it will be necessary to remove all major root systems, then fill the excavations with properly placed engineered fill compacted to at least 90 percent relative compaction[1]. Any undocumented fills that are encountered within the limits of grading should be excavated to expose firm natural ground. All active or inactive utility lines within the construction areas should be relocated or abandoned. Pipelines to be abandoned in place should be filled with sand-cement slurry. Where existing utilities or foundations are removed, the resulting excavations should be backfilled using properly compacted engineered fill. All cleared vegetation and debris should be removed from the site.

We expect that the site soils will be excavatable with conventional grading and trenching equipment. If grading commences in the winter or spring, or after a period of excessive rainfall, it is likely that the surficial soils will become saturated due to the presence of fine-grained material. Wet or saturated soil may cause difficulties in access with grading and trenching equipment and difficulties in loading, spreading, and compaction of fill material. Moisture conditioning and/or aerating of the site soils may be required. The time required for drying can be reduced by disking, ripping, or otherwise aerating the soil.

Following site preparation, the areas to contain the new buildings and for a horizontal distance of at least 5 feet beyond, should be over-excavated to a minimum depth of 30 inches, or more if necessary, such that a minimum of 12 inches of new engineered fill is present beneath the “base of footing” depth. The exposed subgrade should be level and should be scarified to a minimum depth of 6 inches, moisture conditioned, and compacted to a minimum of 90 percent relative compaction. The approved surface may then be brought to pad grade with the placement of properly compacted engineered fill. Any vegetation and organic topsoil with more than 2 percent organic material by dry weight should be removed. The Geotechnical Engineer or qualified representative should observe and approve the prepared site prior to any excavation, subgrade preparation, and placement of fill or improvements.

The contractor shall be responsible for the stability of all temporary excavations and should comply with applicable Occupational Safety and Health Administration (OSHA) regulations (California Construction

1 Relative compaction refers to the in-place dry density of a soil expressed as a percentage of the maximum dry density of the same soil, as determined by the ASTM D1557 compaction test procedure. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Safety Orders, Title 8). The contractor should periodically monitor all open cuts for evidence of incipient stability failures.

5.2 Select Engineered Fills

Fill placed in areas to support proposed foundations should meet the requirements for select engineered fill. Select engineered fill should have less than 2 percent by dry weight of vegetation and deleterious material and should meet the gradation requirements presented in Table 3.

Table 3. Fill Gradation Criteria

Sieve Designation	Percent Passing by Dry Weight
3-inch (50 mm)[a]	100
2½-inch (37.5 mm)	85 minimum
¾-inch (19 mm)	70 minimum
No. 4 (4.75 mm)	60 minimum
No. 200 (75 μm)[b]	5 minimum, 40 maximum

[a] mm: millimeters
[b] μm: micrometers

We anticipate that not all of the onsite soils will meet the gradation or subsequent plasticity requirements and be suitable for reuse as select engineered fill following removal of debris, organics, and any other unsuitable material. Fine-grained soil with a liquid limit greater than 35 and a plasticity index greater than 12 should not be used as select engineered fill. If clayey soils do not meet the plasticity requirements, mixing of the clayey soils with sandier soils may be required. Crushing and/or removal of rock particles greater than 3 inches in size will be required. Select engineered fill should have a low corrosion potential, which is defined as a minimum resistivity of 2,000 ohms-centimeter (ohms-cm) and maximum sulfate and chloride concentrations of 250 parts per million (ppm). In addition, we do not recommend using river-run material as select engineered fill; crushed, angular material is preferred with at least 50 percent of the material (as determined by the material's dry weight) containing a minimum of two fractured faces.

Engineered fill should be placed in loose lifts not exceeding 8 inches in thickness and compacted to a minimum of 90 percent relative compaction. The Geotechnical Engineer or qualified representative should approve all fill prior to placement.

A qualified field technician should be present to observe fill placement and perform field density tests in accordance with ASTM D 6938 at random locations throughout each lift to verify that the specified compaction is being achieved.

Samples of proposed import fill materials should be submitted to SHN for approval at least three business days prior to use at the site.

5.3 Wet Weather Subgrade Protection

The near-surface soils consist of loose, non-cohesive, fine-grained granular materials and/or soft fine-grained clays. We expect that both light and heavy construction equipment will have difficulty operating on the near-surface soils if grading commences during and/or immediately following the wet season.

Contractors should expect high soil moisture conditions in the near-surface soils throughout the wet season and into the late spring months following a typical winter wet season. The wet season in coastal northern California generally begins in the month of November and continues through May. Heavy rains are also not uncommon during the months of October and June. Beginning construction activities and earthwork immediately prior to the onset of the wet season is not advised and will likely lead to delays if measures are not taken to stabilize and protect the exposed subgrade.

Soils that have been disturbed during site preparation activities, or unsuitable areas identified during proof-rolling or probing, should be removed to firm ground and replaced with stabilization material and compacted engineered fill.

Protection of the subgrade is the responsibility of the contractor. Track-mounted excavating equipment may be required during and following wet weather. The contractor will be responsible for constructing an all-weather access road and staging area. The thickness of the haul road to access the currently undeveloped portions of the site for construction and staging areas will depend on the amount and type of construction traffic. The materials used for haul roads or site access drives should be stabilization material consisting of pit or quarry run rock that is well-graded, angular, crushed rock consisting of 4- to 6-inch minus material with less than 5 percent passing the U.S. Standard No. 4 Sieve. The material should be free of organic matter and other deleterious material. A minimum 6- to 12-inch-thick mat of stabilization material should be used for light staging areas. The stabilization material for haul roads and areas with repeated heavy construction traffic will likely need to be increased to between 12 to 18 inches. The actual thickness of haul roads and staging areas should be based on the contractor’s approach to site work and the amount and type of construction traffic and is the contractor’s responsibility. The stabilization material should be placed in one lift over the prepared, undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. Additionally, a geotextile fabric should be placed as a barrier between the subgrade and stabilization material. The geotextile should meet specifications for soil separation and stabilization, such as Mirafi 600X or equivalent.

5.4 Surface Drainage Control

Surface drainage should be planned to prevent ponding and enable water to drain away from foundations, slabs-on-grade, and edges of pavements, and towards suitable collection or discharge facilities. Surface drainage should be designed to capture runoff from upslope of proposed structures. A positive surface drainage of at least 4 percent is recommended within 10 feet of all building foundations in unpaved areas. In paved areas, a positive surface drainage of at least 2 percent is recommended to allow for rapid removal of surface water. Roof drainage systems should be planned to direct rainwater away from building foundations and retaining walls.

The use of water-intensive landscaping around the perimeter of structures should be avoided to reduce the amount of water introduced to the subgrade. Irrigation of landscaping around structures should be limited to drip or bubbler-type systems. Trees with large roots should also be avoided since they can dry out the soil beneath foundations and cause settlement. The purpose of these recommendations is to avoid large differential moisture changes adjacent to foundations, which have been known to cause large differential movement over short horizontal distances in expansive soils, resulting in cracking of slabs and architectural damage.

In addition, surface drainage should adhere to the setbacks for low-impact development (LID) features, if required, as shown in Table 4.

Table 4. Recommended Setbacks for LID[a] Features

Type of LID Feature	Setback from Building Foundations	Setback from Pavement Sections and Exterior Slabs-on-Grade
Designed to infiltrate collected and concentrated stormwater (that is, dry wells, vegetated swales, bioretention facilities)	10 feet	3 feet[b]
Alternative engineered hardscaping (that is, porous asphalt, permeable pavers) subject only to incidental rainfall (*not* subject to re-routed, concentrated stormwater)	5 feet	3 feet[b]

[a] LID: low-impact development
[b] Setback is not required *only if* an effective barrier is installed (such as a concrete-filled cutoff trench that prevents moisture from traveling from the LID feature to below the pavement section/slab-on-grade).

5.5 Utility Trench Backfill

New utility trenches excavated parallel to spread footing foundations should be set back from the footings such that the trench bottoms lie outside a projected hypothetical 1.5H:1V (horizontal:vertical) line extending downward from the footing bottom.

Unless concrete bedding is required around utilities, bedding should consist of sand having a sand equivalent (SE) of at least 30. The bedding should extend from 6 inches below to 1 foot above the conduit or pipe. Sand bedding should not be jetted or ponded into place and should be mechanically compacted to a minimum of 90 percent relative compaction.

In areas to support improvements such as slabs and pavements and adjacent to structure foundations, backfill placed above the bedding in utility trenches (including culvert and sprinkler lines) should be properly placed and adequately compacted to minimize settlement and provide a stable subgrade.

If possible, the trench backfill should be compacted following rough grading but prior to final grading and compaction. Onsite inorganic soils meeting the requirements for engineered fill may be used as trench backfill. Backfill consisting of onsite soils should be placed in layers not exceeding 8 inches in loose thickness, water-conditioned, and compacted to at least 90 percent relative compaction as described for engineered fill. Trench backfill need only be compacted to 85 percent relative compaction in landscape areas or in areas more than 5 feet beyond the limits of buildings, pavements, concrete slabs-on-grade, sidewalks, or other flatwork. The upper 6 inches of trench backfill under pavements should be surface compacted to at least 95 percent relative compaction.

Where utility trenches cross underneath buildings, we recommend that a plug be placed within the trench backfill to minimize the normally granular backfill from acting as a conduit for water to enter beneath the building. The plug should be constructed using a sand cement slurry (minimum 28-day compressive strength of 500 pounds per square inch [psi]) or relatively impermeable native soil for pipe bedding or backfill. We recommend that the plug extend a distance of at least 3 feet in each direction from the point where the utility enters the building perimeter.

5.6 Foundations

The proposed structures can be supported by spread footings bottomed a minimum of 18 inches below adjacent soil subgrade on a minimum of 12 inches of properly compacted engineered fill in order to provide uniform support for the entire foundation. Such foundations may be designed for an allowable bearing capacity of 2,500 pounds per square foot (psf) for dead plus long-term live loads. This value may be increased by one-third to account for short-term effects of wind and seismic loading.

A horizontal friction coefficient of 0.30 times the net vertical dead load may be used for the footing/soil contact. Frictional resistance may be calculated in conjunction with an allowable lateral passive pressure represented by an equivalent fluid weighing 300 pounds per cubic foot (pcf) for short-term loading, such as lateral foundation response to wind or earthquake loadings. Passive pressure should be neglected in the upper 12 inches unless confined by concrete slabs or asphalt pavement.

Provided any new foundations are constructed in accordance with these recommendations, we estimate that total post-construction settlement will be 0.5 inch or less under static conditions; the differential settlement will be about half of the total settlement.

All foundation excavations should be observed and approved by the Geotechnical Engineer prior to placement of forms and reinforcing steel. The excavations should be trimmed neat, level, and square. All loose, sloughed, and moisture-softened materials should be removed prior to setting reinforcing steel and placement of concrete.

5.7 Slabs-on-Grade

Concrete slabs-on-grade should be supported by engineered fill prepared in accordance with our recommendations for earthwork.

To reduce water vapor transmission upward through floor slabs, concrete slabs-on-grade should be constructed on a minimum 4-inch-thick layer of capillary break material covered with a vapor retarder. The capillary break material should be free-draining, clean gravel or rock, such as No. 4 by ¾-inch pea gravel or permeable aggregate complying with California Department of Transportation (Caltrans) Standard Specification, Section 68, Class 1, Type B Permeable Material. The vapor retarder should be at least 10 mils in thickness and meet the material requirements for Class C vapor retarders presented in ASTM E1745 and should be installed according to ASTM E1643. These installation requirements include overlapping seams by 6 inches, taping seams, and sealing penetrations in the vapor retarder.

The field of moisture vapor transmission is a specialty field, and we suggest that qualified experts be contacted to assist in the design and construction of measures related to moisture transmission through slabs-on-grade.

The American Concrete Institute (ACI) Committee document “Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials” (ACI 302.2R-06) provides guidelines for reducing moisture migration through slabs-on-grade. This document advises that concrete slabs be cast directly on the vapor retarder (ACI 302.2R-06, Section 9.3) and provides guidelines for selecting vapor permeance, tensile strength, and puncture resistance. When casting the slab directly on the vapor retarder, a reduced joint spacing, low shrinkage mix design, or other appropriate measures should be used to control slab curl. The ACI guide also notes that a maximum water-cement ratio of 0.5 has yielded satisfactory performance on many slab-on-grade projects. Water-reducing admixtures may be useful in achieving workability at low water-cement ratios. Control joints should be provided at appropriate intervals to control the location of shrinkage cracks. After proper curing, the slab should be allowed to dry and then should be tested to check that the moisture transmission rate is appropriate for the intended floor covering.

For exterior flatwork, such as sidewalks, and other slabs-on-grade where water vapor transmission through slabs is not a concern, the vapor barrier and capillary break material described in this section may be omitted. However, a minimum of 4 inches of Class 2 Aggregate Base rock, compacted to a minimum of 90 percent relative compaction, should be provided beneath exterior flatwork and other slabs-on-grade where vapor transmission is not a concern.

It is important that the subgrade be moist and free of desiccation cracks at the time the slab is cast. Recommendations for slab reinforcement, strength, thickness, control, and construction joints, and so on, should be provided by others. Although cracks in concrete slabs are common and should be expected, the following measures may help to reduce cracking of slabs. Slabs should be cast using concrete with a maximum slump of 4 inches or less. Add a water reducing agent or plasticizer to the concrete to increase slump while maintaining a low water-cement ratio to reduce concrete shrinkage; concrete having a high water-cement ratio is a major cause of concrete cracking. Control joints should be provided at appropriate intervals to control the location of shrinkage cracks.

6.0 Closure

The analyses, conclusions, and recommendations contained in this report are based on site conditions that we observed at the time of our investigation, data from our subsurface explorations, our current understanding of proposed project elements, and on our experience with similar projects in similar geotechnical environments. We have assumed that the information obtained from our limited subsurface explorations is representative of subsurface conditions throughout the areas of proposed development addressed in this report.

We have assumed, in preparing our recommendations, that SHN will be retained to review those portions of the plans and specifications that pertain to earthwork. The purpose of this review is to confirm that our earthwork recommendations have been properly interpreted and implemented during design. If we are not provided with this opportunity for review of the plans and specifications, our recommendations could be misinterpreted.

We recommend a representative of our firm confirm site conditions during the construction phase. If subsurface conditions differ significantly from those disclosed by our investigation, we should be given the opportunity to re-evaluate the applicability of our conclusions and recommendations. Some alteration of recommendations may be appropriate. If the scope of the proposed construction changes from that described in this report, our recommendations should also be reviewed.

If there is a substantial lapse of time between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we should review our report to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse. This report is applicable only to the project and site studied.

The recommendations provided in this report are based on the assumption that we will be retained to provide the construction monitoring described above in order to evaluate compliance with our recommendations. If we are not retained for these services, SHN cannot assume any responsibility for any potential claims that may arise during or after construction as a result of misuse or misinterpretation of this report by others. Furthermore, if another geotechnical consultant is retained for follow-up service to this report, SHN will at that time cease to be the Geotechnical Engineer-of-Record.

The opinions presented in this report are valid as of the present date for the property evaluated. Changes in the condition of a property can occur with the passage of time, whether due to natural processes or the works of man, on this or adjacent properties. In addition, changes in applicable standards of practice can occur, whether from legislation or the broadening of knowledge. Accordingly, the opinions presented in this report may be invalidated, wholly or partially, by changes outside of our control. Therefore, this report is subject to review and should not be relied upon after a period of 3 years. In addition, this report should not be used and is not applicable for any property other than that evaluated.

7.0 References

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Boring Logs

1

BORING NUMBER B-01-2023

CLIENT Cal Poly Humboldt
PROJECT NAME Energy Research Sustainability Center (alternate site)
PROJECT NUMBER 023098
PROJECT LOCATION Arcata, Humboldt County, CA
DATE STARTED 6/1/23 **COMPLETED** 6/1/23
GROUND ELEVATION 94 ft (approx.) **HOLE SIZE** 8"
DRILLING CONTRACTOR 14
GROUNDWATER DEPTH
DRILLING METHOD Solid Flight Augers/ Hollow Stem Augers
AT TIME OF DRILLING --- No free groundwater encountered.
LOGGED BY A. Troia **CHECKED BY**
NOTES Borehole backfilled with Portland cement.

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0	Began drilling with solid flight augers. Approximately 2" of ASPHALT. Switched to hollow stem rotary at 1'.										
	(GW) SANDY GRAVEL, dry, medium sand, well-graded subrounded gravels, (FILL/BASE ROCK).	MCS S1, S2	100	4-4-4 (8)	1.75	79	40				
	(CL-ML) SILTY LEAN CLAY with SAND, moist, very dark brown, low plasticity, low toughness, slightly mottled, (FILL).										
	(CL) GRAVELLY LEAN CLAY, medium stiff, dark brown, moist, low plasticity with low toughness; weak cementation; rounded gravels, max. size 1", (FILL/NATIVE TOPSOIL?).	MCS S3, S4	100	2-4-10 (14)	4.5	98	26	32	21	11	
5	(CL) LEAN CLAY with SAND, stiff, moist, yellowish brown with gray mottling, medium plasticity with moderate toughness; fine sand, (FALOR FM.) **UC Test** Undrained Shear Strength = 2947 psf Becomes very stiff, dry to moist; increase cementation, difficult to break samples; very fine roots (?).	MCS S5, S6	100	9-11-18 (29)	4.0	105	23				
	(CL) LEAN CLAY, very stiff, dry to moist, yellowish brown with gray mottling, medium plasticity with high toughness; strong cementation; manganese flecks and small nodules.	MCS S7, S8	100	8-13-17 (30)	>4.5	107	27				
10	(SC) Grades to CLAYEY SAND, medium dense, moist, yellowish brown and gray; medium plasticity fines; strong cementation, fine sand. Interbedded fine gravels at 11.5'.	MCS S9, S10, S11	100	7-10-18 (28)							82
	Grades to olive. Grades to yellowish brown at 13'.	MCS S12, S13, S14	100	6-12-15 (27)							
15	(CL) SANDY LEAN CLAY to LEAN CLAY with SAND, medium stiff, moist to wet, light bluish gray; fine sand; low plasticity with low toughness, moderate cementation; interbedded medium angular sand, occasional very coarse angular sand; occasional fine organic (root or wood fiber).	SPT S15	100	4-3-4 (7)							
20											

(Continued Next Page)

BORING NUMBER B-01-2023

CLIENT Cal Poly Humboldt
PROJECT NAME Energy Research Sustainability Center (alternate site)
PROJECT NUMBER 023098
PROJECT LOCATION Arcata, Humboldt County, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTIC LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	FINES CONTENT (%)
20		(SC) CLAYEY SAND, loose, wet, bluish gray; mostly fine sand, some medium to coarse quartz-rich sand; strong cohesion, moderate cementation; occasional wood fibers.	SPT S16	100	3-4-5 (9)							48
25		(SC-SM) POORLY GRADED SAND with CLAY, medium dense, wet, gray; fine sand with minor medium to coarse sand, occasional fine subrounded gravels; moderate cementation.	SPT S17	100	10-12-8 (20)							
30		(CL-ML) SILTY LEAN CLAY, stiff, moist, dark gray, medium plasticity with low toughness, moderate cementation; minor very fine sand; upright wood fibers from 30-30.5'.	MCS S18, S19	100	4-6-11 (17)							
35												
40		Becomes dry to moist, low plasticity.	SPT S20	100	2-3-8 (11)							

(Continued Next Page)

BORING NUMBER B-01-2023

CLIENT Cal Poly Humboldt **PROJECT NAME** Energy Research Sustainability Center (alternate site)

PROJECT NUMBER 023098 **PROJECT LOCATION** Arcata, Humboldt County, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
45		(CL-ML) SILTY LEAN CLAY, stiff, moist, dark gray, medium plasticity with low toughness, moderate cementation; minor very fine sand; upright wood fibers from 30-30.5'. *(continued)*										
		(CL) SANDY LEAN CLAY, stiff, dry, gray, mostly fine sand with coarse, angular quartz-rich sand; low to medium plasticity with moderate toughness, moderate cementation.	SPT S21	100	5-6-10 (16)							
50		(CL) LEAN CLAY, very stiff, dry, very dark grayish brown, medium plastiity, grades to gray at 51.5', strong cementation, high toughness; wood fragments at bottom.	MCS S23, S24	100	6-13-25 (38)							

Bottom of borehole at 51.5 feet.

BORING NUMBER B-02-2023

CLIENT Cal Poly Humboldt
PROJECT NAME Energy Research Sustainability Center (alternate site)
PROJECT NUMBER 023098
PROJECT LOCATION Arcata, Humboldt County, CA
DATE STARTED 6/1/23 **COMPLETED** 6/1/23
GROUND ELEVATION 91 ft (approx.) **HOLE SIZE** 8"
DRILLING CONTRACTOR 14
GROUNDWATER DEPTH
DRILLING METHOD Solid Flight Augers/ Hollow Stem Augers
AT TIME OF DRILLING --- No free groundwater encountered.
LOGGED BY A. Troia **CHECKED BY**
NOTES Borehole backfilled with Portland cement.

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0	Began drilling with solid flight augers to 0.75'. Approximately 3" of ASPHALT.										
	Hand augered from 0.75 to 1.5', switched to hollow stem rotary at 1.5'.										
	GRAVELLY SAND, dry, medium sand, well-graded subrounded gravel, (FILL/BASE ROCK).	MCS S1, S2	100	6-7-12 (19)		94	29				
	(CL-ML) SILTY LEAN CLAY with SAND, moist, very dark brown, low plasticity, low toughness, slightly mottled, (FILL).				4.25						
	(CL) LEAN CLAY, stiff, dry, yellowish brown with gray mottling, medium plasticity with high toughness, moderate to strong cementation; very fine roots, (FALOR FM.)										
	UC Test Undrained Shear Strength = 2615 psf	MCS S3, S4	100	5-8-12 (20)	3.0						
5	**UC Test** Undrained Shear Strength = 3722 psf				4.0	92	29				
	Becomes very stiff, strong cementation; trace fine sand.	MCS S5, S6	100	7-12-17 (29)	3.75	96	28				
10	Becomes stiff; dry to moist.	MCS S7, S8	100	5-7-10 (17)	2.5	92	33				
15	Becomes moist, bluish gray to olive with yellowish-brown patches; medium plasticity with high toughness, strong cementation, trace fine sand; plant fibers.	SPT S9	100	3-4-5 (9)							
20											

(Continued Next Page)

BORING NUMBER B-02-2023

CLIENT Cal Poly Humboldt

PROJECT NAME Energy Research Sustainability Center (alternate site)

PROJECT NUMBER 023098

PROJECT LOCATION Arcata, Humboldt County, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20		(CL) SANDY LEAN CLAY, stiff, moist, bluish gray to greenish gray, medium plasticity with low to moderate toughness, moderate to strong cementation; fine sand; fine upright plant fibers.	MCS S10, S11	100	4-6-9 (15)	1.0						
25		(SC) CLAYEY SAND, medium dense, moist, bluish gray and olive; medium plasticity fines, strong cohesion, moderate to strong cementation.	SPT S12	100	3-5-10 (15)	2.25						
30		(CL) SANDY LEAN CLAY, stiff, moist to wet, bluish gray, low plasticity; fine sand.	MCS S13, S14	100	4-6-9 (15)	1.0 2.0						

Bottom of borehole at 31.5 feet.

BORING NUMBER B-03-2023

CLIENT Cal Poly Humboldt
PROJECT NAME Energy Research Sustainability Center (alternate site)
PROJECT NUMBER 023098
PROJECT LOCATION Arcata, Humboldt County, CA
DATE STARTED 6/2/23 **COMPLETED** 6/2/23
GROUND ELEVATION 99 ft (approx.) **HOLE SIZE** 8"
DRILLING CONTRACTOR 14
GROUNDWATER DEPTH
DRILLING METHOD Solid Flight Augers/ Hollow Stem Augers
AT TIME OF DRILLING --- No free groundwater encountered.
LOGGED BY A. Troia **CHECKED BY**
NOTES Borehole backfilled with Portland cement.

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		Began drilling with solid flight augers. Approximately 2" of ASPHALT										
		Switched to hollow stem rotary at 1'.										
		(GW) SANDY GRAVEL, dry, medium sand, subrounded medium gravel, (FILL/BASE ROCK).	MCS S1, S2	100	3-5-9 (14)	2.5	104	23	34	22	12	
		(CL) SANDY LEAN CLAY with SILT, moist, very dark brown, low to medium plasticity with low toughness, well-graded sand, (FILL/NATIVE TOPSOIL?).										
		(CL) LEAN CLAY, stiff, dry to moist, yellowish Brown, medium plasticity with moderate toughness, moderate cementation; trace very fine sand, slightly mottled, (FALOR FM.) Layer of fine sand at 2.5'	MCS S3, S4	100	6-6-7 (13)	3.25	102	23				
5		(CL) LEAN CLAY, stiff, dry to moist, yellowish brown; medium plasticity with high toughness and moderate to strong cementation. Grades to olive, medium stiff, moist; iron-oxide staining.	MCS S5, S6	100	4-5-7 (12)	3.0	95	29				
		Interbeds of fine sand; gray and yellowish brown mottling, iron-oxide staining.	MCS S7, S8	100	4-7-8 (15)	3.25						
10		Becomes stiff; manganese flecks; occasional fine rounded quartz-rich gravel; trace very fine sand.	SPT S9	100	8-10-12 (22)	4.0						
15		(CL) LEAN CLAY with SAND, very stiff, dry to moist, dark yellowish brown; mostly very fine to fine sand wtih trace coarse, angular sand; some fine organics (roots?), manganese flecks.	MCS S10, S11	100	8-10-15 (25)	>4.5						
20												

(Continued Next Page)

BORING NUMBER B-03-2023

CLIENT Cal Poly Humboldt

PROJECT NAME Energy Research Sustainability Center (alternate site)

PROJECT NUMBER 023098

PROJECT LOCATION Arcata, Humboldt County, CA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20		(SC) CLAYEY SAND, medium dense, moist, yellowish brown; laminated beds of fine, quartz-rich sand.	SPT S12	100	5-7-7 (14)							48
25			MCS S13	33	6-9-14 (23)							
30		Becomes bluish gray, slight increase in moisture, moderate cementation.	SPT S14	100	4-5-6 (11)							

Bottom of borehole at 31.5 feet.

Laboratory Test Results

2

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

13 June 2023

Job No. 2306011
Cust. No. 11258

Ms. Alyssa Troia
SHN Consulting Engineers and Geologists
812 W. Wabash Avenue
Eureka, CA 95501

Subject: Project No.: 023098
Project Name: Cal Poly Humboldt Serc Alt. (CPH Serc Alt)
Corrosivity Analysis – ASTM Test Methods with Brief Evaluation

Dear Ms. Troia:

Pursuant to your request, CERCO Analytical has analyzed the soil sample submitted on June 07, 2023. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurement, this sample is classified as "mildly corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentration reflects none detected with a reporting limit of 15 mg/kg.

The sulfate ion concentration is 23 mg/kg and is determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at this location.

The pH of the soil is 6.01, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

The redox potential is 360-mV and is indicative of potentially "slightly corrosive" soils resulting from anaerobic soil conditions.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc. at (925) 927-6630.*

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.

J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Client: SHN Consulting Engineers & Geologists
Client's Project No.: 023098
Client's Project Name: Cal Poly Humboldt Serc Alt (CPH Serc Alt)
Date Sampled: 2-Jun-23
Date Received: 7-Jun-23
Matrix: Soil
Authorization: Signed Chain of Custody

Date of Report: 13-Jun-2023

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)*	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
2306011-001AB	Composite B-02-23 @ 4-4.5' and B-03-23 @ 3.5-4'	360	6.01	-	11,000	-	N.D.	23

Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Reporting Limit:	-	-	10	-	50	15	15
Date Analyzed:	9-Jun-2023	9-Jun-2023	-	8-Jun-2023	-	12-Jun-2023	12-Jun-2023

Cheri McMillen
Chemist

* Results Reported on "As Received" Basis
N.D. - None Detected

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

CAL POLY HUMBOLDT SERC ALT.
(CPH SERC ALT.)

Chain of Custody

Page 1 of 1

1100 Willow Pass Court
Concord, CA 94520-1006
925 462 2771
Fax: 925 462 2775
CERCO analytical

Job No.	CU#	Client Project I.D.	Schedule / Analyte	Date Sampled	Date Due
2306011	11258	023098			

Full Name SHN ENGINEERS & GEOLOGISTS
Phone X
Fax
Cell 530-613-4819 ☒
Company and/or Mailing Address 812 W. WABASH AVE, EUREKA 95501
Sample Source SOIL

ANALYSIS — ASTM

Lab No.	Sample I.D.	Date	Time	Matrix	Contain.	Size	Preserv.	Qty.	Redox Potential	pH	Sulfate	Chloride	Resistivity-100% Saturated			Brief Evaluation						
001A	COMPOSITE B-02-23 4-4.5' B-03-23 3.5-4'	6/2/23		S	PL				X	X	X	X	X			X						

MATRIX	ABBREVIATIONS	SAMPLE RECEIPT	
DW - Drinking Water	HB - Hosebib	Total No. of Containers	
GW - Ground Water	PV - Petcock Valve	Rec'd Good Cond/Cold	
SW - Surface Water	PT - Pressure Tank	Conforms to Record	
WW - Waste Water	PH - Pump House	Temp. a t Lab -°C	
SL - Sludge	RR - Restroom	Sampler	
S - Soil	GL - Glass		
Product	PL - Plastic		
	ST - Sterile		

	Date	Time
Relinquished By: Alyssa Troia	6/5/2023	18:00
Received By: [signature]	6/7/23	0900
Relinquished By:		
Received By:		
Relinquished By:		
Received By:		

Comments:

THERE IS AN ADDITIONAL CHARGE FOR EXTRUDING SOIL FROM METAL TUBES

Email Address: atroia@SHN-ENGR.COM

Phone: (707) 441-8855 Email: info@shn-engr.com Web: shn-engr.com
812 W. Wabash Avenue, Eureka, CA 95501-2138

DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	**CPH ERSC**	**Project Number:**	**023098**
Performed By:	**KEW**	**Date:**	**6/16/2023**
Checked By:	**KEW**	**Date:**	**6/16/2023**
Project Manager:	**G. Simpson**		

Lab Sample Number	23-504	23-508	23-510	23-532	23-534
Boring Label	B-1 S2	B1 S6	B-1 S8	B2 S6	B2 S8
Sample Depth (ft)	2-2.5	6-6.5	8-8.5	7-7.5	11-11.5
Diameter of Cylinder, in	2.40	2.40	2.40	2.40	2.40
Total Length of Cylinder, in.	6.00	6.00	6.00	6.00	6.00
Length of Empty Cylinder A, in.	0.00	0.00	0.00	0.00	0.00
Length of Empty Cylinder B, in.	1.80	0.91	1.50	1.01	1.49
Length of Cylinder Filled, in	4.20	5.09	4.50	4.99	4.51
Volume of Sample, in^3	19.00	23.03	20.36	22.57	20.40
Volume of Sample, cc.	311.36	377.34	333.60	369.92	334.34

Pan #	P12	A7	A5	S8	SS11
Weight of Wet Soil and Pan	636.9	866.4	810.2	887.4	843.4
Weight of Dry Soil and Pan	479.4	719.3	656.8	730.4	683.9
Weight of Water	157.5	147.1	153.4	157.0	159.5
Weight of Pan	87.4	86.7	87.1	158.9	192.9
Weight of Dry Soil	392.0	632.6	569.7	571.5	491.0
Percent Moisture	40.2	23.3	26.9	27.5	32.5
Dry Density, g/cc	1.26	1.68	1.71	1.54	1.47
Dry Density, lb/ft^3	78.6	104.7	106.6	96.4	91.7

Phone: (707) 441-8855 Email: info@shn-engr.com Web: shn-engr.com
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DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	**CPH ERSC**	**Project Number:**	**023098**
Performed By:	**KEW**	**Date:**	**6/16/2023**
Checked By:	**KEW**	**Date:**	**6/16/2023**
Project Manager:	**G. Simpson**		

Lab Sample Number	23-542	23-544	23-546		
Boring Label	B3 S2	B3 S4	B3 S6		
Sample Depth (ft)	2-2.5	4-4.5	6-6.5		
Diameter of Cylinder, in	2.40	2.40	2.40		
Total Length of Cylinder, in.	6.00	6.00	6.00		
Length of Empty Cylinder A, in.	0.00	0.00	0.00		
Length of Empty Cylinder B, in.	0.65	0.85	0.83		
Length of Cylinder Filled, in	5.35	5.15	5.17		
Volume of Sample, in^3	24.20	23.30	23.39		
Volume of Sample, cc.	396.61	381.79	383.27		

Pan #	SS2	SS9	SS1		
Weight of Wet Soil and Pan	1006.4	970.1	949.0		
Weight of Dry Soil and Pan	854.3	823.2	778.1		
Weight of Water	152.1	146.9	170.9		
Weight of Pan	193.5	196.7	195.0		
Weight of Dry Soil	660.8	626.5	583.1		
Percent Moisture	23.0	23.4	29.3		
Dry Density, g/cc	1.67	1.64	1.52		
Dry Density, lb/ft^3	104.0	102.4	95.0		

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PERCENT PASSING # 200 SIEVE (ASTM - D1140)

Project Name:	**CPH-ERSC**	**Project Number:**	**023098**
Performed By:	**KEW**	**Date:**	**6/25/2023**
Checked By:	**KEW**	**Date:**	**6/25/2023**
Project Manager:	**G. Simpson**		

Lab Sample Number	23-511	23-518	23-552		
Boring Label	B-1 S9	B-1 S16	B-3 S12		
Sample Depth	10-10.5	20-21.5	20-21.5		
Pan Number	S31	SS15	SS10		
Dry Weight of Soil & Pan	236.9	360.0	364.2		
Pan Weight	76.8	194.5	195.7		
Weight of Dry Soil	160.1	165.5	168.5		
Soil Weight Retained on #200&Pan	106.1	281.3	282.7		
Soil Weight Passing #200	130.8	78.7	81.5		
Percent Passing #200	**82**	**48**	**48**		

Lab Sample Number					
Boring Label					
Sample Depth					
Pan Number					
Dry Weight of Soil & Pan					
Pan Weight					
Weight of Dry Soil					
Soil Weight Retained on #200&Pan					
Soil Weight Passing #200					
Percent Passing #200					

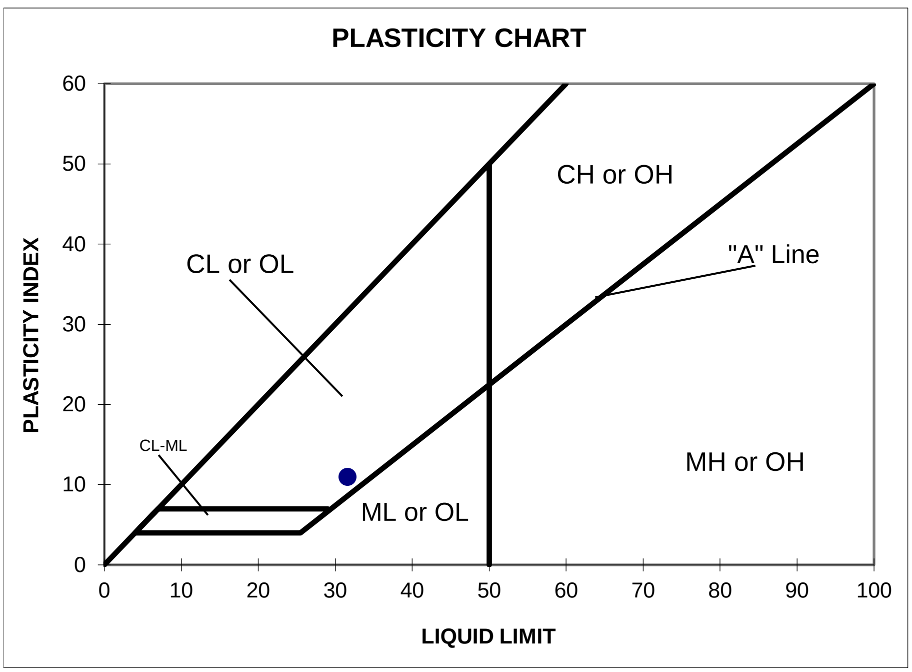
ENGINEERS & GEOLOGISTS, INC.
812 W. Wabash Eureka, CA 95501-2138 Tel: 707/441-8855 FAX: 707/441-8877 E-mail: shninfo@shn-engr.com

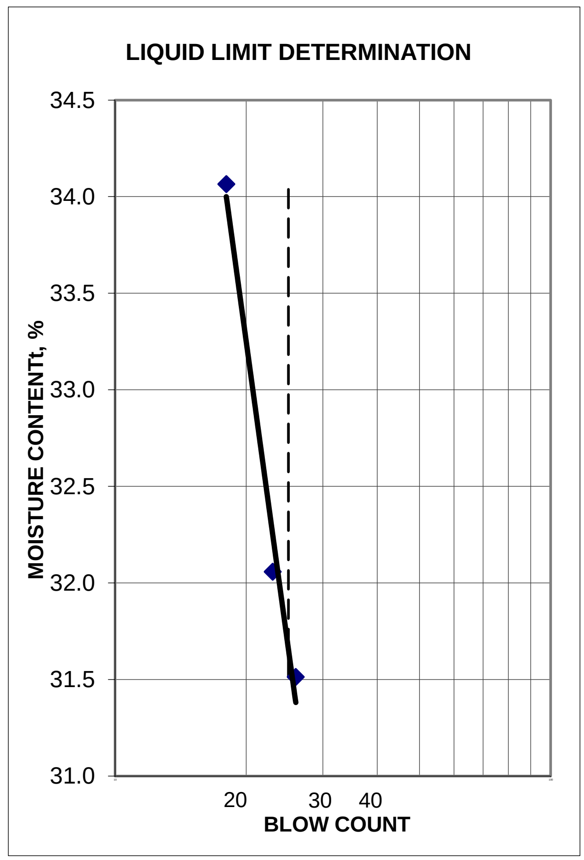
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	CPH ERSC	JOB #:	023098	LAB SAMPLE #:	23-505
SAMPLE ID:	B-01 3.5-4	PERFORMED BY:	KEW	DATE:	6/25/2023
PROJECT MANAGER:	G. Simpson	CHECKED BY:	KEW	DATE:	6/25/2023

LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	13	14	1	2	3
B	PAN WT. (g)	21.950	20.120	29.580	28.930	28.960
C	WT. WET SOIL & PAN (g)	30.140	28.200	35.840	34.450	35.060
D	WT. DRY SOIL & PAN (g)	28.750	26.810	34.340	33.110	33.510
E	WT. WATER (C-D)	1.390	1.390	1.500	1.340	1.550
F	WT. DRY SOIL (D-B)	6.800	6.690	4.760	4.180	4.550
G	BLOW COUNT	--	--	26	23	18
H	MOISTURE CONTENT (E/F*100)	20.4	20.8	31.5	32.1	34.1

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
32	**11**	21





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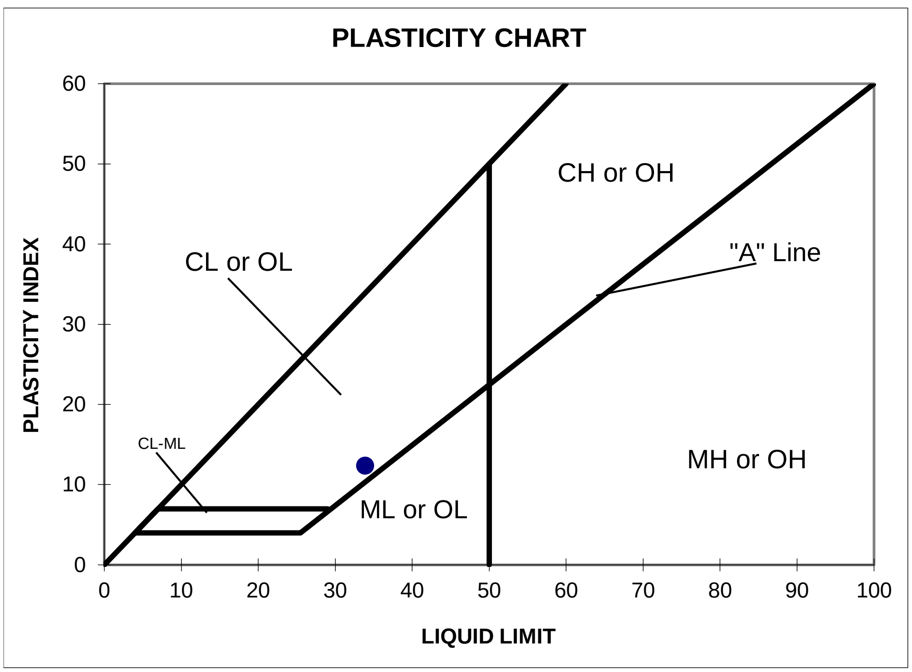
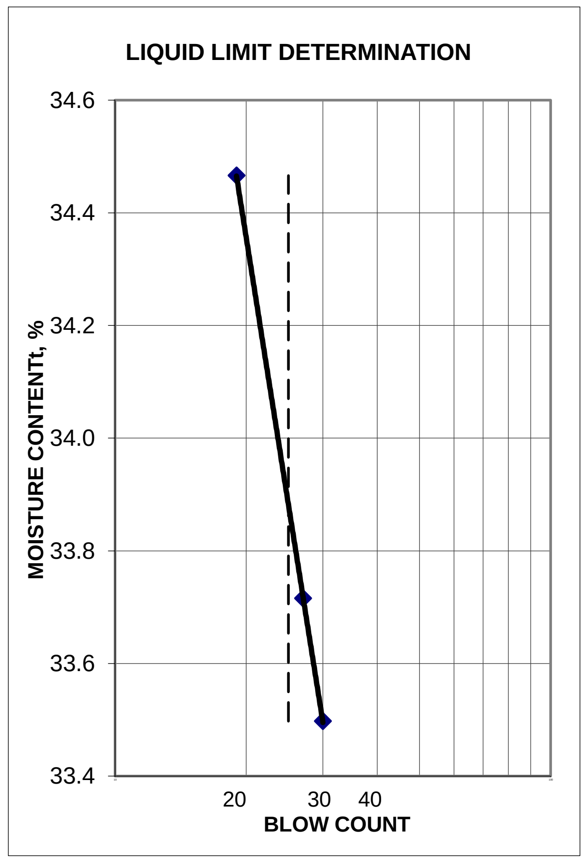
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	**CPH ERSC**	JOB #:	**023098**	LAB SAMPLE #:	**23-541**
SAMPLE ID:	**B-03 1.5-2**	PERFORMED BY:	**KEW**	DATE:	**6/16/2023**
PROJECT MANAGER:	**G. Simpson**	CHECKED BY:	**KEW**	DATE:	**6/22/2023**

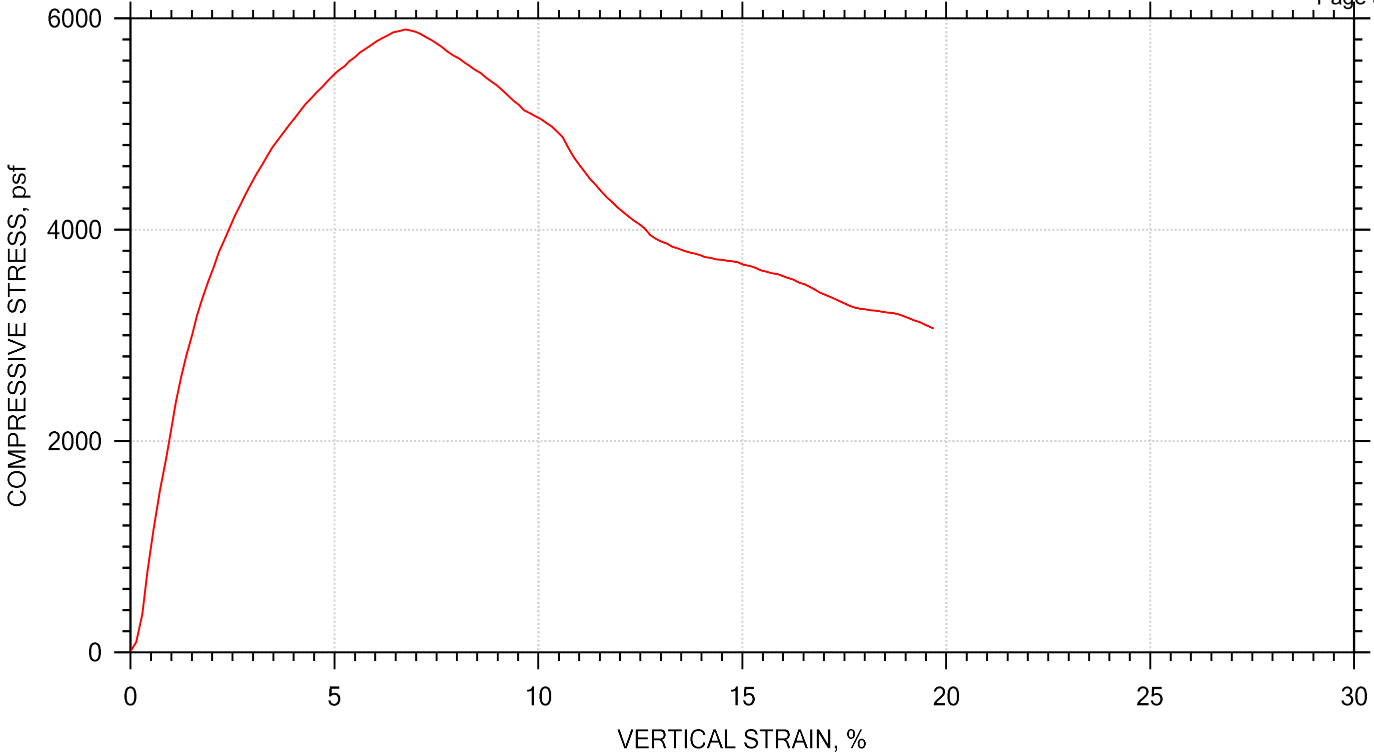
LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	13	14	1	2	3
B	PAN WT. (g)	21.960	20.130	29.580	28.950	28.970
C	WT. WET SOIL & PAN (g)	30.360	28.170	35.000	34.780	34.510
D	WT. DRY SOIL & PAN (g)	28.880	26.740	33.640	33.310	33.090
E	WT. WATER (C-D)	1.480	1.430	1.360	1.470	1.420
F	WT. DRY SOIL (D-B)	6.920	6.610	4.060	4.360	4.120
G	BLOW COUNT	--	--	30	27	19
H	MOISTURE CONTENT (E/F*100)	21.4	21.6	33.5	33.7	34.5

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
34	**12**	22





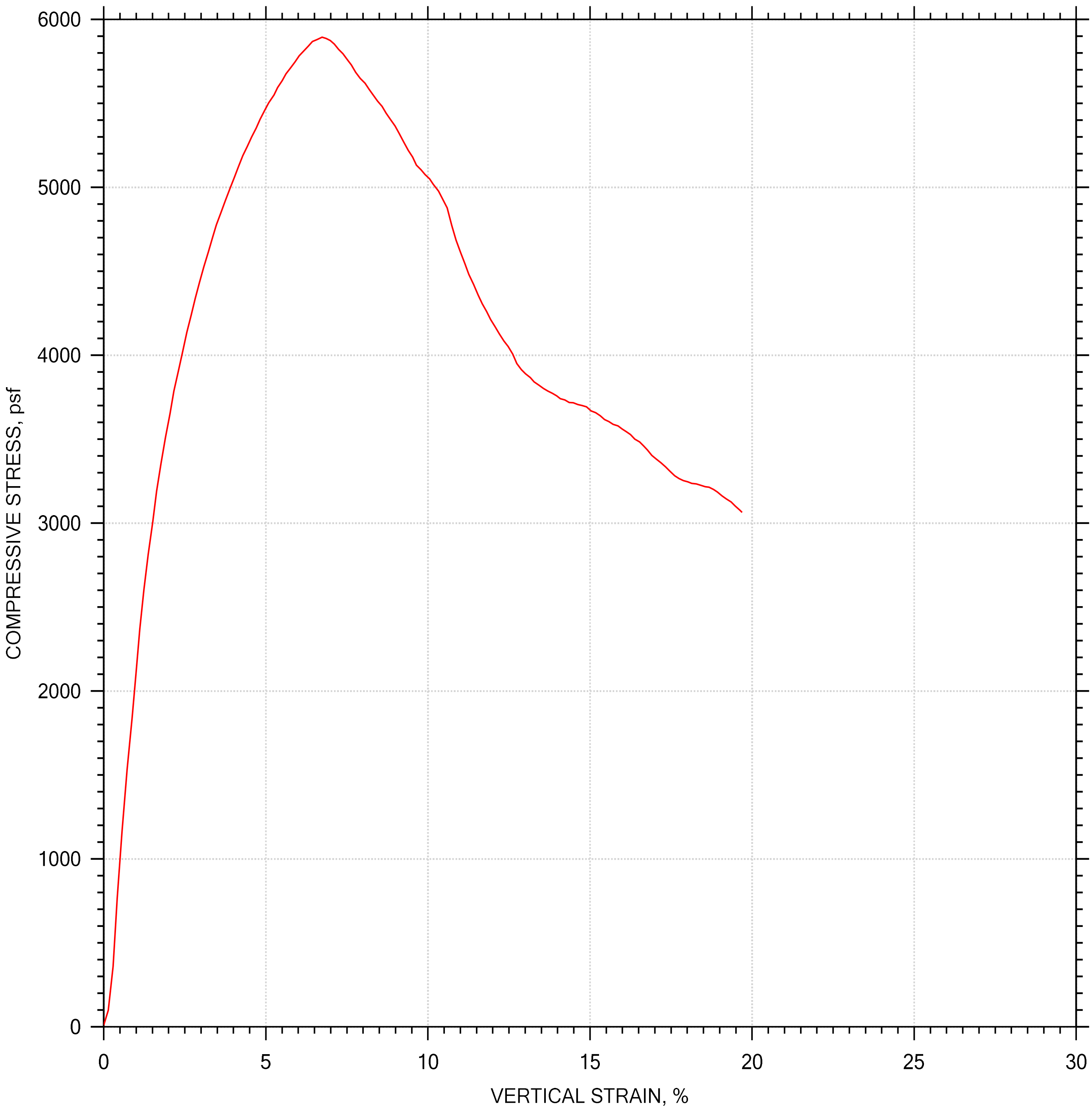
UNCONFINED COMPRESSION TEST REPORT



Symbol					
Test No.		23-506			
Initial	Diameter, in	2.42			
	Height, in	5.08			
	Water Content, %	26.10			
	Dry Density, pcf	98.37			
	Saturation, %	101.44			
	Void Ratio	0.682			
Unconfined Compressive Strength, psf		5895			
Undrained Shear Strength, psf		2947			
Time to Failure, min		5.0059			
Strain Rate, %/min		0.01			
Estimated Specific Gravity		2.65			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

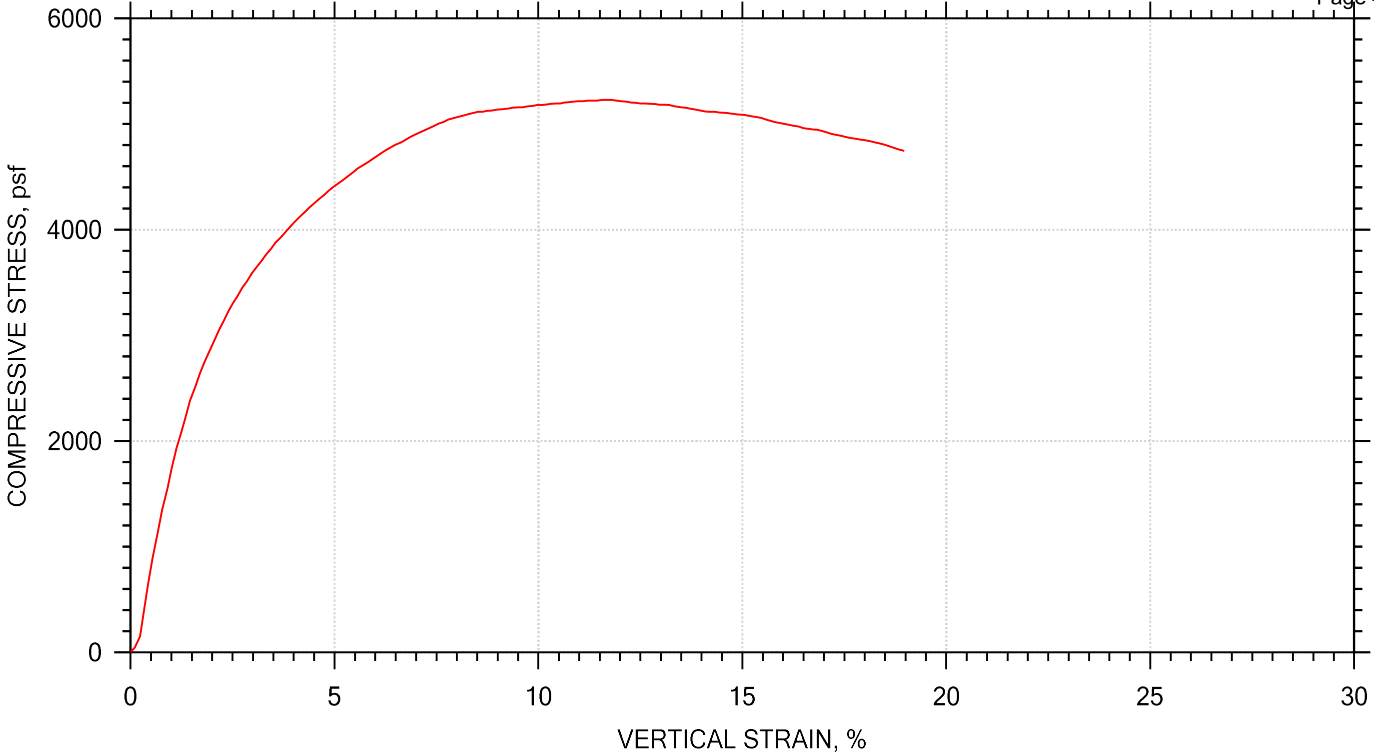
Project: CPH ERSC	Location: Arcata	Project No.: 023098
Boring No.: B-01	Tested By: JMA	Checked By: KEW
Sample No.: 4	Test Date: 6/23/23	Elevation:
Test No.: 23-506	Preparation: Undisturted	Depth: 4-4.5'
Description: Reddish Brown Stiff CLAY		
Remarks:		

UNCONFINED COMPRESSION TEST REPORT



	Project: CPH ERSC	Location: Arcata	Project No.: 023098
	Boring No.: B-01	Tested By: JMA	Checked By: KEW
	Sample No.: 4	Test Date: 6/23/23	Elevation:
	Test No.: 23-506	Preparation: Undisturted	Depth: 4-4.5'
	Description: Reddish Brown Stiff CLAY		
	Remarks:		

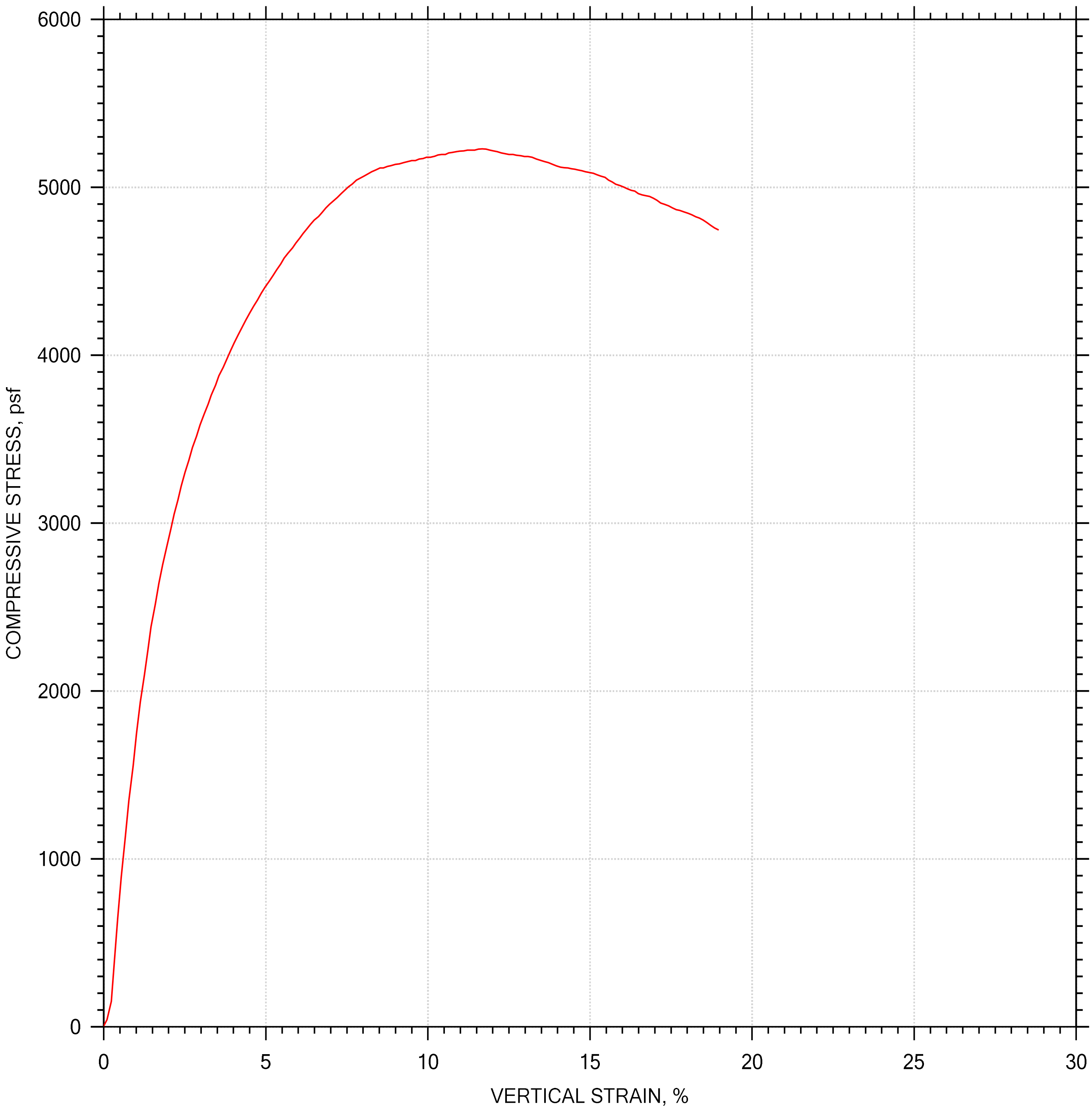
UNCONFINED COMPRESSION TEST REPORT



Symbol					
Test No.		23-528			
Initial	Diameter, in	2.42			
	Height, in	5.18			
	Water Content, %	28.85			
	Dry Density, pcf	94.94			
	Saturation, %	102.97			
	Void Ratio	0.742			
Unconfined Compressive Strength, psf		5230			
Undrained Shear Strength, psf		2615			
Time to Failure, min		10.003			
Strain Rate, %/min		0.01			
Estimated Specific Gravity		2.65			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

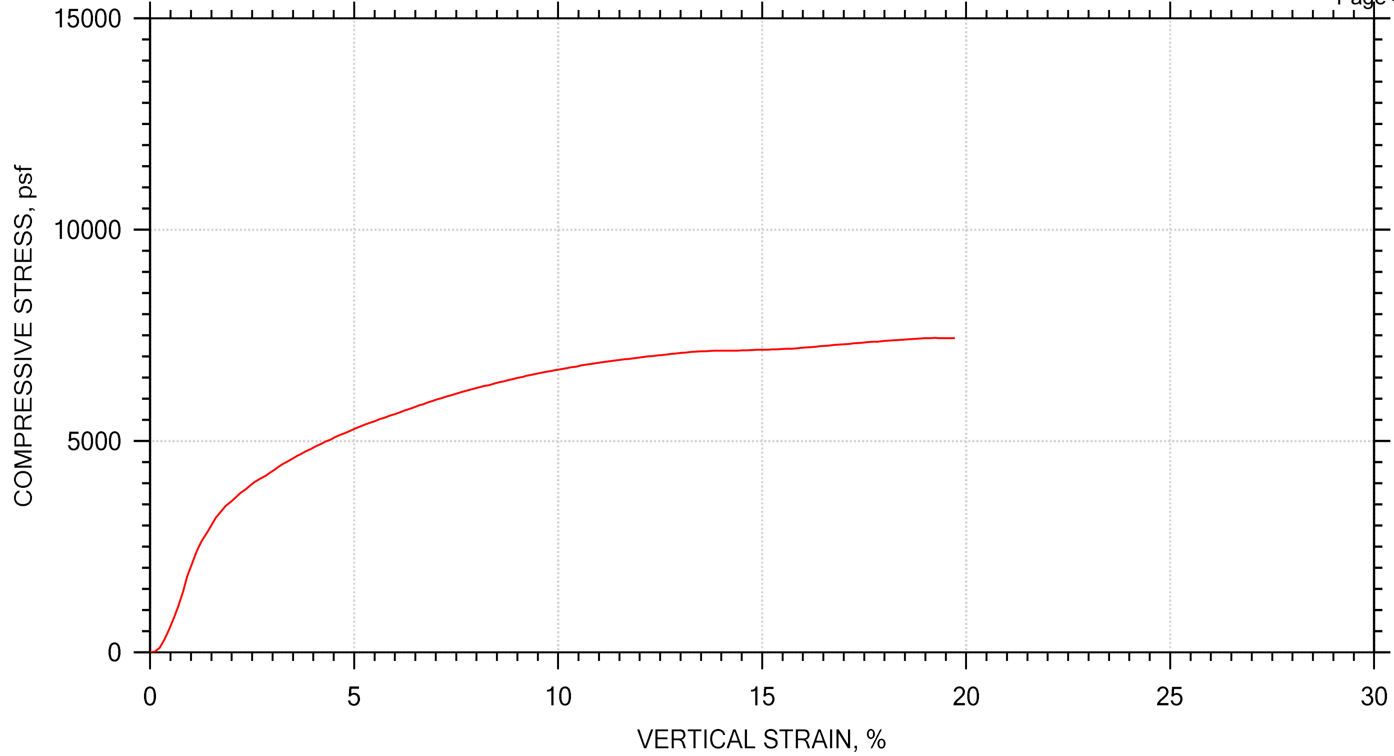
Project: CPH ERSC	Location: Arcata	Project No.: 023098
Boring No.: B-02	Tested By: JMA	Checked By: KEW
Sample No.: 2	Test Date: 6/23/23	Elevation:
Test No.: 23-528	Preparation: Undisturted	Depth: 2.5-3
Description: Reddish Brown Stiff CLAY		
Remarks:		

UNCONFINED COMPRESSION TEST REPORT



	Project: CPH ERSC	Location: Arcata	Project No.: 023098
	Boring No.: B-02	Tested By: JMA	Checked By: KEW
	Sample No.: 2	Test Date: 6/23/23	Elevation:
	Test No.: 23-528	Preparation: Undisturted	Depth: 2.5-3
	Description: Reddish Brown Stiff CLAY		
	Remarks:		

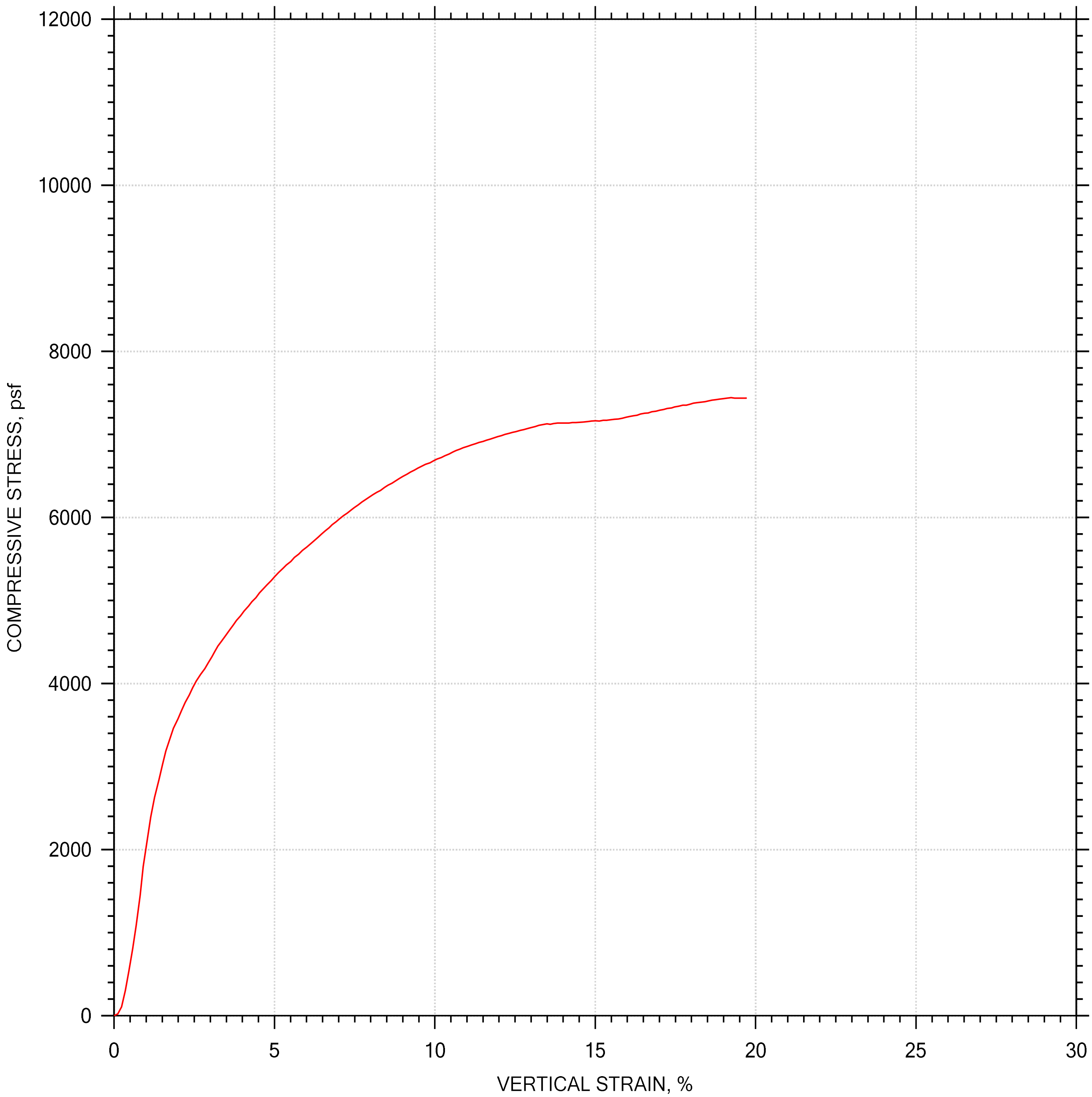
UNCONFINED COMPRESSION TEST REPORT



Symbol					
Test No.		23-530			
Initial	Diameter, in	2.42			
	Height, in	5.07			
	Water Content, %	29.33			
	Dry Density, pcf	92.25			
	Saturation, %	97.96			
	Void Ratio	0.793			
Unconfined Compressive Strength, psf		7444			
Undrained Shear Strength, psf		3722			
Time to Failure, min		16.402			
Strain Rate, %/min		0.01			
Estimated Specific Gravity		2.65			
Liquid Limit		---			
Plastic Limit		---			
Plasticity Index		---			
Failure Sketch					

Project: CPH ERSC	Location: Arcata	Project No.: 023098
Boring No.: B-02	Tested By: JMA	Checked By: KEW
Sample No.: 4	Test Date: 6/23/23	Elevation:
Test No.: 23-530	Preparation: Undisturted	Depth: 4.5-5
Description: Reddish Brown Stiff CLAY		
Remarks:		

UNCONFINED COMPRESSION TEST REPORT



	Project: CPH ERSC	Location: Arcata	Project No.: 023098
	Boring No.: B-02	Tested By: JMA	Checked By: KEW
SHN	Sample No.: 4	Test Date: 6/23/23	Elevation:
	Test No.: 23-530	Preparation: Undisturted	Depth: 4.5-5
	Description: Reddish Brown Stiff CLAY		
	Remarks:		

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