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Preliminary Geotechnical Report for South of Bay Road (Draft)

SAFER Bay Project, Task Order No. 4

Prepared for San Francisquito Creek Joint
Powers Authority

East Palo Alto, California
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CHAPTER 1 INTRODUCTION

This report presents the results of a preliminary geotechnical investigation conducted by HDR Engineering, Inc. (HDR) to support 30 percent level design of the portion of the Strategy to Advance Flood Protection, Ecosystem Restoration and Recreation along San Francisco Bay shoreline project (SAFER Bay Project) south of Bay Road in East Palo Alto, California. The Project site is located along the San Francisco Bay shoreline between Bay Road and San Francisquito Creek, as shown on the Vicinity Map, Figure 1.

1.1 Project Background

The San Francisquito Creek Joint Powers Authority (SFCJPA) and its member agencies seek to protect the City of East Palo Alto and the City of Menlo Park from San Francisco Bay coastal flooding. To accomplish this goal, SFCJPA is undertaking the SAFER Bay project. SFCJPA is planning for the construction of new flood protection features along the Bay shoreline from the Menlo Park/Redwood City border (including unincorporated areas) south to San Francisquito Creek. The project also seeks to further habitat restoration for the Bay's tidal marsh ecosystem, and to enhance recreation opportunities along the Bay shoreline.

SFCJPA received grants from the San Francisco Bay Restoration Authority (SFBRA) and the State of California Department of Water Resources (DWR) to advance both the preliminary engineering design and the California Environmental Quality Act (CEQA) environmental clearance process for the SAFER Bay project. With these grants, SFCJPA awarded HDR Task Order No. 4 (TO4) to advance the design and CEQA process to a 30 percent level for the portion of the SAFER Bay project south of Bay Road to San Francisquito Creek, and to at least a 10 percent (conceptual) level, for the portion of the project north of Bay Road to the north end of the project at the Menlo Park/Redwood City border. The preliminary geotechnical investigation presented herein was performed to support the 30 percent level design effort south of Bay Road. HDR provided feasibility level geotechnical services for this project documented in a geotechnical report dated 2016 (HDR 2016).

1.2 Project Description

The proposed flood protection system between the southern end of the project at San Francisquito Creek and Bay Road will be a combination embankment and floodwall. The embankment/floodwall will be located along approximately the existing San Francisco Bay Trail (Bay Trail), along the western edge of marshland, as shown on Figure 2.

The flood protection system is to be constructed to a final top of wall elevation of 16.5 feet¹. The goal is to provide for a top of wall elevation sufficient for recognition by the Federal Emergency Management Agency (FEMA) as an embankment/floodwall system that provides 100-year flood protection (Elevation 13.0 feet) plus 3.5 feet of sea level rise (SLR). As established during project planning, the embankment/floodwall will have the following main features:

- The southern terminus of the embankment/floodwall will be located just north of the left bank of San Francisquito Creek and the O'Connor Pump Station. The embankment/floodwall will extend north to its northern terminus at Bay Road, a distance of about 5,200 feet.

¹ Elevations in this report are referenced to North American Vertical Datum of 1988 (NAVD88).

- The embankment/floodwall will have a typical crown width of 20 feet and finished side slopes of 3:1 (horizontal to vertical) on the waterside and 2:1 on the landside.
- The floodwall will consist of a steel sheet pile wall embedded within the embankment along the waterside crown hinge point. The sheet pile wall will include a concrete cap. The sheet piles will extend to a tip elevation of either -40 feet along the southern portion of the project (Station 0+00 to Station 24+00) or -25 feet along the northern portion of the project (Station 24+00 to Bay Road). These tip elevation were selected to achieve adequate embedment and to provide for groundwater cutoff for underseepage, based on geotechnical analyses presented herein.
- The existing levee will be degraded to construct the new embankment where present along the alignment.
- Horizontal layers of geogrid will be required in the embankment material to provide stability and to help facilitate construction over soft soil.

The Project is not under the jurisdiction of the United States Army Corps of Engineers (USACE). However, FEMA customarily looks to whether projects have been designed to recognized engineering guidelines and standards, such as those published by USACE, for their determination of acceptance into the National Flood Insurance Program (NFIP) as providing 100-year flood protection. Therefore, the engineering analyses that are presented herein have been performed in general accordance with USACE and other recognized engineering guidelines.

1.3 Scope of Services

The purpose of this geotechnical investigation was to obtain information on subsurface conditions in order to evaluate the geotechnical aspects of the project. The scope of services performed included:

- Compiling and reviewing available existing geologic and geotechnical data for the project area;
- Performing a subsurface investigation consisting of a test boring, cone penetration tests (CPTs), and laboratory testing;
- Performing engineering analyses of the subsurface data to develop geotechnical conclusions, recommendations, and design criteria for the project, including:
 - o Site geology and seismicity;
 - o Soil and groundwater conditions encountered;
 - o Discussion of the potential for seismic hazards;
 - o Analysis-based confirmation and recommendations for the proposed embankment/floodwall configuration, including embankment slope inclination, top of floodwall elevation, and depth of sheet pile cutoff;
 - o Recommendations for earthwork, including subgrade preparation, criteria for allowable embankment fill materials, criteria for placement and compaction of fill, and suitability of onsite soil for use as embankment fill; and
 - o Estimates of total embankment settlement.
- Preparing this geotechnical report presenting the results of the field exploration, laboratory testing, discussion of geotechnical considerations, and geotechnical recommendations.

CHAPTER 2 DATA REVIEW AND FIELD EXPLORATION

2.1 Data Review

Prior to conducting the field investigation, HDR obtained and reviewed logs of past subsurface explorations in the site vicinity provided by SFCJPA and its member agencies, adjacent property owners, and from an HDR exploration program for a 2016 geotechnical feasibility study for the SAFER Bay Project (HDR 2016). Past explorations judged to be relevant to this project are summarized in Table 1 below, and their approximate locations are shown on Figure 2. Logs of the past explorations are presented in Appendix A. Graphic representation of the logs are shown on profiles presented on Figures 3 through 5.

Table 1. Summary of Past Explorations in Site Vicinity

Data Source	Type	Original Exploration Designation	Exploration Designation In This Report	Approximate Depth (feet)
HDR (2016)	Geotechnical Boring	B-06	B-06	50
Arup (2021)	Geotechnical Boring	A-B2	A-B2	50
		A-B3	A-B2	51.5
	Cone Penetration Test	A-CPT2	A-CPT2	128
		A-CPT3	A-CPT3	101
	Seismic Cone Penetration Test	A-SCPT4	A-SCPT4	121
TRC (2018) ¹	Geotechnical Boring	EB-5	TRC-EB-5	51.5
	Cone Penetration Test	CPT-5	TRC-CPT-5	101
		CPT-6	TRC-CPT-6	101
Ninyo & Moore (2014)	Geotechnical Boring	B-4	NM-B-4	20
		B-5	NM-B-5	20
Iris Environmental (2013)	Cone Penetration Test	CPT-2	I-CPT-2	74
		CPT-3	I-CPT-3	75
GEI Consultants, Inc. (2012)	Geotechnical Boring	B-5	GEI-B-5	51.5
	Cone Penetration Test	CPT-4	GEI-CPT-4	80.1
Lowney Associates (2002)	Geotechnical Boring	EB-5	LVN-EB-5	40
Lowney Associates (2000) ¹	Geotechnical Boring	EB-103	LVN-EB-103	26.5
		EB-104	LVN-EB-104	6.5
		EB-107	LVN-EB-107	20
		EB-109	LVN-EB-109	16.5
Earth Systems Consultants (1983)	Geotechnical Boring	B-1	ES-B-1	44.5
		B-4	ES-B-4	24.0
		B-5	ES-B-5	50.0
		B-6	ES-B-6	25.0
		B-7	ES-B-7	20.0
		B-8	ES-B-8	20.0
AMEC/Geomatrix (2009) ²	Environmental Boring (Direct Push)	RSD-1	RSD-1	20
		RSD-2	RSD-2	15
		RSD-3	RSD-3	15

Data Source	Type	Original Exploration Designation	Exploration Designation In This Report	Approximate Depth (feet)
AMEC (2011)²	Environmental Well Log	W-135A	W-135A	6.5
Geomatrix Consultants (2001)²	Environmental Well Log	W-142	W-142	33 (See Note 3)
Geomatrix Consultants (1998)²	Environmental Well Log	W-127	W-127	9.5
Geomatrix Consultants (1988)²	Environmental Well Log	W-122	W-122	36
		W-123	W-123	15
		W-124	W-124	32
Geomatrix Consultants (No Date)²	Environmental Well Log	W-102	W-102	32
		W-114	W-114	12.5
		W-115	W-115	14
Geomatrix Consultants (1987)²	Environmental Well Log	M-1	M-1	12.5
		M-3	M-3	11.5
		M-4	M-4	6
		R8-1/M9	M-9	9.5

Notes:

1. TRC (2018) and Lowney Associates (2002) data were included in Arup's (2021) geotechnical report for 1990 Bay Road and 1175 Weeks Street. Source reports for these data were not made available to HDR.
2. Environmental borings by AMEC/Geomatrix (2009) and environmental well logs by Amec (2011) and Geomatrix Consultants (1987 to 2001) were provided to HDR as separate logs. Source reports for these data were not made available to HDR
3. The well log for W-142 notes a boring depth of 38.5 feet; however data to only 33 depth are available. The last page of the log was missing which presumably included the depth range of 33 to 38.5 feet.

2.2 Field Exploration

HDR's subsurface investigation for the current phase of the project consisted of advancing one test boring and five CPTs along the proposed flood protection system alignment to fill identified data gaps or confirm subsurface conditions. The approximate locations of the explorations are shown on Figure 2 and Figures 3 through 5. The locations of the HDR explorations were determined by hand-held GPS and are accurate only to the degree implied by the method used. The HDR logs of the borings and CPTs are presented in Appendix B.

Prior to performing the test boring and CPTs, HDR performed a site reconnaissance, obtained the required San Mateo County subsurface exploration permit, marked the proposed exploration locations, and contacted Underground Service Alert (USA) to check the site for the presence of underground utilities.

2.2.1 Test Boring

One test boring, designated Boring B-107, was performed along the north side of Bay Road to a depth of about 51.5 feet. Pitcher Services LLC (Pitcher) advanced the boring on November 14, 2022 with a track-mounted drill rig using the mud rotary drilling method. Soil samples were collected at approximately 5-foot intervals or less. Disturbed samples were obtained by driving either a Standard Penetration Test (SPT) split-barrel sampler without liners or a Modified California split-barrel sampler with 6-inch-long liners. Resistance blow counts were obtained with both Modified California and SPT samplers by dropping a 140-pound automatic trip hammer through a 30-inch free fall. Blows counts for each 6 inches of penetration were recorded. The field penetration resistance

for each sample was recorded as the sum of the blows over the final 12 inches. Relatively undisturbed thin wall Shelby Tube samples were obtained using the direct push sampling method. The relatively undisturbed samples were collected to perform triaxial strength testing and consolidation testing.

Soil samples collected from the boring were initially classified and described by an HDR field representative in general accordance with ASTM D2488. Soil samples were transported to a geotechnical laboratory for selected testing and confirmation of classification. The field log classifications were then edited based upon the results of the laboratory testing, as needed.

2.2.2 Cone Penetration Tests

Gregg Drilling LLC (Gregg) advanced five CPTs, designated CPT-104 through CPT-108, to depths of about 70 feet. CPT-104, CPT-105, CPT-106, and CPT-108 were advanced on the Bay Trail using a track-mounted rig on November 14, 2022. CPT-107 was advanced in the Beech Street cul de sac using a truck-mounted rig. Pore pressure dissipation tests were performed at selected depths in all the CPTs. The CPTs were backfilled upon completion with cement grout per San Mateo County exploration permit requirements. An HDR field representative observed the CPT activities.

Logs of the CPTs are included in Appendix C. The CPT logs and related information show Gregg's interpretation of the subsurface conditions at the date and location indicated.

The CPT logs provide graphical plots of tip resistance (q_t), sleeve friction (f_s), pore pressure (u), and friction ratio (R_f). The logs also include interpreted Soil Behavior Type (SBT) based on the Robertson (2010) classification system.

The piezocone assembly used for this project has a cone tip with a 60-degree apex, and a tip area of 15 square centimeters (cm^2). The friction sleeve has an area of 225 cm^2 . The piezocone had a pore pressure (u) transducer near the base (shoulder) of the cone tip. The CPT probe was hydraulically pushed into the ground. As the cone advanced, additional cone rods were added such that a "string" of rods continuously advanced through the subsurface soils.

2.3 Laboratory Testing

2.3.1 Testing on Boring Samples

Selected soil samples obtained from Boring B-107 test boring were delivered to Cooper Testing Laboratory (Cooper) in Palo Alto, California for geotechnical laboratory testing. Testing was performed on selected soil samples to assist in soil classification, and to evaluate geotechnical engineering characteristics such as soil strength and compressibility. Field soil descriptions were updated as needed based on laboratory testing results in accordance with ASTM D2487. The results of the laboratory tests are presented on the boring logs at the appropriate sample depths and/or in Appendix C. Laboratory test results from the 2016 HDR Boring B-06, which has been re-designated as Boring B-106 in this report, are also included in Appendix C.

The following laboratory testing was performed on samples collected from the borings:

- Moisture Content and Density (ASTM D7263);
- Atterberg Limits (ASTM D4318);
- Triaxial compression – unconsolidated undrained (ASTM D2850);
- Consolidation (ASTM D2435); and

- Particle Size Distribution (ASTM D6913).

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CHAPTER 3 GEOLOGIC SETTING

3.1 Regional Geology

The site is located within the Northern California Coast Ranges Geomorphic Province, which is characterized by northwest trending valleys and mountain ranges, and northwest striking faults. This province is a belt of Mesozoic and Cenozoic sedimentary, volcanic, and metamorphic rocks that extend from just north of Santa Barbara and up to the northern border with Oregon. The geology of the Coast Ranges is complex and presently dominated by a transpressive tectonic regime resulting from the relative movements of the Pacific and North American plates. The movement between the two plates is accommodated along strike-slip dominant faults primarily within the San Andreas fault system and has resulted in the northwest-trending ridge and valley topography that characterize the province.

Geologic formations in the San Francisco Bay region range in age from Jurassic (190 to 135 million years ago) to recent Holocene (less than 11 thousand years ago). The oldest rocks are deformed Mesozoic sedimentary and volcanic rocks of the tectonically accreted Mesozoic Franciscan Complex and the contemporaneous Great Valley Sequence. During the last glacial maximum, approximately 20,000 years ago, global sea level was approximately 140 feet lower than sea level today resulting in the incision of the coastline as creeks and streams cut down to reach the new base level. As sea level rose with the onset of the current interglacial, a transgressive sequence of alluvial sediments were deposited in the lowland areas of the San Francisco Bay area. Holocene alluvial, marine and marsh deposits have accumulated in the valleys and bays of the region as a result of weathering in the surrounding mountains.

3.2 Regional Seismicity

Geologists and seismologists recognize the San Francisco Bay Area as one of the most active seismic regions in the United States. Active faults extending through the Bay Area have produced 11 large (moment magnitude, M_w 6.0 or greater) earthquakes over the last two centuries that have damaged buildings and other infrastructure. Most recently, the August 24, 2014 M_w 6.0 South Napa Earthquake caused extensive damage to the local built environment. The faults causing such earthquakes are part of a system of faults along the boundary of the Pacific and North American plates and locally include the San Andreas, Calaveras, and Hayward-Rodgers Creek faults. The major fault in the system is the San Andreas Fault that extends for at least 450 miles along the coast of California.

The 2014 Working Group on California Earthquake Probabilities (WGCEP) published an updated report evaluating the probabilities of significant earthquakes occurring in the Bay Area over the next three decades (Field et al, 2015). The WGCEP estimated a 72 percent probability that at least one moment magnitude 6.7 or greater earthquake will occur in the San Francisco Bay region by 2044. This probability is an aggregate value that considers principal Bay Area fault systems and unknown faults (background values) including the potential for multi-fault ruptures. The project site is not located within an Alquist-Priolo Earthquake Fault Zone.

Table 2 summarizes the approximate distances between the site and the four nearest mapped active faults based on the 2008 update to the United States National Seismic Hazard Maps online Fault Parameter database (USGS 2008). The online information is documented by the United States

Geological Survey (USGS) Open File Report 2008–1128 (Petersen et al., 2008). We note that this is not an exhaustive list of nearby faults. The project site is not located within an Alquist-Priolo Earthquake Fault Zone.

Table 2. Regional Faults and Seismicity

Fault (segments)	Approximate Distance from Site, miles	Direction from Site	Maximum Moment Magnitude
Monte Vista-Shannon	6.1	North	6.5
N. San Andreas (SAO+SAN+SAP+SAS) ²	8.0	Southwest	7.9
Hayward-Rodgers Creek (RC+HN+HS) ³	11.0	Northeast	7.3
Calaveras (CN+CC+CS) ⁴	15.8	Northeast	7.0
San Gregorio Connected	18.1	Southwest	7.5

1. Approximate fault distances are in reference to Latitude 37.4676 and Longitude -122.1263.
2. San Andreas segments: SAO = Offshore, SAN = North Coast, SAP = Peninsula, SAS = Santa Cruz Mountains
3. Hayward-Rodgers Creek segments: RC = Rodgers Creek, HN = North Hayward, HS = South Hayward
4. Calaveras segments: CN = Northern, CC = Central, CS = Southern

Earthquakes on these or other active faults (including unmapped faults) could cause strong ground shaking at the site. Earthquake intensities vary throughout the Bay Area depending on the magnitude of the earthquake, the distance of the site from the causative fault, the type of materials underlying the site, and other factors.

CHAPTER 4 SITE CONDITIONS

4.1 Surface Conditions

The proposed project alignment is located along the bay margin of the City of East Palo Alto and extends from Bay Road south to San Francisquito Creek. The proposed alignment is located along the eastern edge of developed areas. Areas on the bayside of the alignment consist of marsh, referred to as Laumeister Marsh between Bay Road and Runnymede Street, and Faber Tract between Runnymede Street and San Francisquito Creek. Areas on the landside of the alignment are generally developed with commercial and residential properties with some undeveloped parcels. The San Francisco Bay Trail (Bay Trail) levee exists along the edge of marsh along the proposed project alignment. A drainage channel exists along the landside of the Bay Trail levee south of Runnymede Street. The channel flows south to Bayshore Pond and the O'Connor Pump Station near the south end of the project alignment.

The proposed flood protection system embankment will generally span over the existing Bay Trail levee and extend landward from the edge of marsh. Grades along the top of the Bay Trail levee generally increase gently from Bay Road to San Francisquito Creek and range from approximately Elevation 9 to 13 feet from Bay Road to Bayshore Pond. Along Bayshore Pond, grades along the top of the Bay Trail levee increase from approximately Elevation 12 feet to Elevation 14 feet near the O'Connor Pump Station. Measured from crest elevation to landside toe, the Bay Trail levee typically ranges from about 7 to 10 feet in height south of Runnymede Street and 3 to 6 feet from Runnymede Street to Weeks Street. North of Weeks Street to Bay Road, the landside ground surface is approximately even with the Bay Trail grade. Existing site grades in the adjacent marsh are estimated at approximately Elevation 8 feet. The bottoms of the drainage channel and Bayshore Pond are estimated to be at approximately Elevation 0 feet. Bathymetry is not available for the marsh, drainage channel, and pond. Thus, the surfaces used for the lower elevation areas are rough approximations and need to be verified during subsequent phases of the project. Existing site grades landside of the Bay Trail and drainage channel generally range from approximately Elevation 6 to 10 feet.

4.2 Site Geology

Brabb et al (1998) mapped surficial deposits beneath the fill along the project alignment as Holocene age Bay Mud deposits consisting predominantly of gray, green and blue clay and silty clay underlying marshlands and tidal mud flats. This is consistent with an older map by Dibblee (1966), who mapped surficial deposits along the project alignment as Recent Quaternary age Bay Mud and clay deposits. The soil encountered in the HDR explorations and past explorations by others are generally consistent with this geologic classification.

4.3 Subsurface Conditions

Explorations advanced from the Bay Trail levee encountered fill to depths ranging from about 7 to 13.5 feet (relative to the Bay Trail levee crest). Fill thickness was generally greater toward the southern end of the alignment to as much as 13.5 feet (to about Elevation 0 feet) in Boring ES-B-5 where the Bay Trail levee joins with the San Francisquito Creek levee near the O'Connor Pump Station. The levee fill encountered generally consisted of medium stiff to very stiff sandy to silty clay,

sandy silt, and fat clay, and medium dense silty to clayey sand. Young Bay Mud (YBM) was encountered beneath the levee fill to depths as shallow as about 9 feet (Elevation +1 foot) along the Faber Tract to 26 feet (Elevation -9) along Laumeister Marsh. The YBM generally consists of soft to medium stiff sandy to silty clay and fat clay, with some organics. It is anticipated that the YBM in the marsh beyond the toe of the Bay Trail levee is relatively softer, weaker and more compressible as it has not been preloaded with fill. Beneath the YBM, alluvial deposits generally consisting of interlayered stiff to very stiff lean clay with varying amounts of sand and silt, silt and sandy silt, and loose to dense sand, silty sand, clayey sand, were encountered to the maximum depth explored of about 70 feet.

The area immediately landward of the proposed flood protection system alignment consists of both developed and undeveloped parcels underlain by fill. The majority of past subsurface explorations landward of the project alignment that HDR obtained were included in a geotechnical report by Arup for Harvest Properties, Inc. for the 1990 Bay Road and 1175 Weeks Street parcels, located between Bay Road and Weeks Street (Arup, 2021). Other available subsurface explorations landward of the project alignment that Arup and Harvest Properties provided include borings performed by Ninyo and Moore on Bay Road and Runnymede Street (Borings NM-B-5 and NM-B-4, respectively), and borings by AMEC/Geomatrix at/near the east end of Runnymede Street (Borings W-135A, RSD-1, RSD-2, and RSD-3). Where discernable or where noted, fill was encountered in these explorations to depths of about 2.5 to 6 feet. The fill encountered generally consisted of loose to medium dense silty to clayey sand, clayey gravel, and stiff sandy silt and lean to fat clay with varying amounts of sand and gravel.

Landward of the proposed embankment/floodwall, available explorations indicate decreased YBM thickness or no YBM. Where noted or inferred from landward explorations, YBM was encountered to depths of about 9 feet. Beneath the fill or YBM, where encountered, alluvial deposits generally consisting of interlayered stiff to very stiff lean to fat clay with varying amounts of sand and silt, and loose to dense sand, silty sand, clayey sand, and gravelly sand. These alluvial deposits were encountered to the maximum depth explored of about 128 feet.

Additional subsurface investigation will be required to better characterize subsurface conditions beyond the centerline of the levee. YBM soils will be weaker than those beneath (surcharged by) the existing levee. Subsurface conditions have been extrapolated assuming conditions are uniform toward the marsh with an allowance for softer soils. Sufficient additional explorations will need to be performed during subsequent design phases to fully characterize the soils and confirm conditions assumed in the 30 percent design evaluations.

4.4 Groundwater

In explorations performed along and immediately adjacent to the Bay Trail levee, groundwater was encountered in HDR CPT-104 CPT-108 at depths ranging from about 3 to 12 feet, corresponding to about Elevation +4 to -2 feet, at the time of drilling. Groundwater was encountered in Earth Systems Borings ES-B-4 through ES-B-8 at depths ranging from about 11 to 14 feet, corresponding to about Elevation +1 to -6 feet. Groundwater was encountered in Geomatrix Borings W-122, W-123, W-124, W-127, and W-142 at depths ranging from about 1.5 to 8 feet, corresponding to about Elevation -1 to -7.5 feet at the time of drilling. Due to the proximity of the site to the bay, HDR estimates that groundwater levels at the site may be near high water levels in the bay and tidally influenced. Given the relatively low-lying elevation of the site, groundwater levels may be expected to be higher than those encountered during the field investigations and could be near the ground surface. Fluctuations

in the groundwater level could occur due to changes in seasons, variations in rainfall, tides, and other factors.

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CHAPTER 5 GEOTECHNICAL ANALYSES

The project alignment is located along the margin of San Francisco Bay and is underlain by, in order of occurrence, existing embankment (levee fill) material, YBM deposits, and interlayered clay, silt, and sand deposits. As described in Section 4.3, the YBM layer ranges from soft to medium stiff beneath the existing levee and toward the landside. However, the YBM is anticipated to be softer and weaker within the marsh beyond the waterside (east side) of the existing levee. The waterside marsh soil is soft, weak and highly compressible and, when loaded can settle excessively (loss of levee top elevation) and/or have associated stability concerns (embankment deformations, cracking and slope failure). Additionally, coarse-grained alluvial deposits are present along the alignment that, if continuous, could act as aquifers that can be potential underseepage paths, transmitting seepage toward the protected side of the levee. The embankment/floodwall configuration recommended herein was developed to address these concerns. Based on the anticipated site conditions, key considerations for the project include the following:

- **Settlement:** Load from the embankment fill will cause settlement over time, primarily from consolidation of near-surface YBM deposits (with additional contribution from underlying fine-grained deposits).
- **Seepage:** During periods of high water when the embankment/floodwall are loaded, seepage can occur both through more pervious foundation layers (underseepage), and through more pervious reaches of the embankment (through-seepage). Both underseepage and through-seepage can initiate embankment failure modes including erosion, piping, slope instability which could lead to breach and interior flooding.
- **Stability:** The stability of the combined embankment/floodwall needs to be evaluated to confirm that levee performance standards (i.e., factors of safety) can be achieved under key loading conditions described in Section 5.5.

Discussion of settlement, seepage, and stability analyses performed for the recommended embankment/floodwall to develop the 30 percent design configurations is presented in the subsections below.

5.1 Cross Sections for Analyses

Geotechnical analyses were performed to address the key considerations described above based on the proposed project presented in the 30 percent drawings. Five analysis cross sections representing critical surface and subsurface conditions were developed to evaluate the settlement, seepage, and stability performance of the proposed embankment/floodwall. Each cross section and the reasons for selection are described below. Locations of each analysis cross section are presented on

Figure 2, and the cross sections are shown on Figures 6 through 10. These are considered as the “base case” cross sections for analyses.

- **Analysis Cross Section 1 (Station 5+30)** shown on Figure 6, is taken along the southern segment of the alignment adjacent to Faber Tract (to the east) and Bayshore Pond and the

drainage channel² (to the west). This cross section was selected to evaluate the effect of the pond on seepage and stability and to evaluate underseepage through the coarse-grained alluvium. For 30% design, the existing levee is degraded to about Elevation +0.5 feet, and the new embankment encompasses the footprint of the existing levee. A sheet pile wall will extend to Elevation -40 feet. The centerline of the new embankment is offset landward of the existing levee centerline. The embankment is founded on YBM which is underlain by coarse-grained alluvium starting as shallow as about Elevation -9 feet (based on Boring ES-B-6) and extending to about Elevation -34 feet (based on CPT C-108).

- **Analysis Cross Section 2 (Station 16+40)** shown on Figure 7 is taken along the southern segment of the alignment adjacent to Faber Tract (to the east) and the drainage channel (to the west). This cross section was selected to evaluate the effect of the drainage channel on seepage and stability and because it coincides with the locations of Borings B-06 and CPT C-107. For 30% design the embankment and sheet pile wall configuration is similar to that of Cross Section 1. YBM beneath the embankment extends to about Elevation -9 feet (based on Boring B-06) which is underlain by interlayered fine- and coarse-grained alluvium.
- **Analysis Cross Section 3 (Station 26+00)** shown on Figure 8, is taken along the middle portion of the alignment adjacent to Faber Tract (to the east) and the drainage channel (to the west). This cross section was selected primarily to evaluate the effects of seepage through the sand layer based on the assumption that the layer is continuous from the waterside to the landside. For 30% design the embankment and sheet pile wall configuration are similar to that of Cross Sections 1 and 2 except that the sheet pile wall tip elevation is shallower, extending to Elevation -25 feet. CPT C-106 indicated the presence of a sand layer from about Elevation -15 feet to Elevation -20 feet.
- **Analysis Cross Section 4 (Station 37+65)** shown on Figure 9, is taken along the northern portion of the alignment along the western margin of Laumeister Marsh and adjacent to the 1990 Bay Road property (to the west). This cross section was used to evaluate the effect of sloughs on underseepage performance of the embankment/floodwall system. For 30% design the embankment footprint is within the marsh and the foundation will be overexcavated to about 2 feet below the existing marsh surface. The sheet pile wall tip extends to Elevation -25 feet. This cross section was selected primarily to evaluate settlement and stability for an embankment/floodwall built over the soft YBM soil within the marsh. Additionally, a layer of potentially liquefiable soil was encountered immediately underlying the YBM in several subsurface explorations along Laumeister Marsh. This cross section was used to evaluate the effect of this potentially liquefiable layer on seismic stability of the embankment. Lastly, small sloughs within the marsh are present along the landside of the embankment in some areas (which are shown as filled with engineered fill as the base case for this cross section).
- **Analysis Cross Section 5 (Station 44+00)** shown on Figure 10, is taken along the northern portion of the alignment along the western margin of Laumeister Marsh and adjacent to open space within the 1990 Bay Road property. The embankment and sheet pile wall configuration is similar to that of Cross Section 4. This cross section was selected as a second check on settlement and stability for an embankment/floodwall constructed over soft marsh deposits, and to evaluate underseepage and seismic stability related to a coarse-grained layer present beneath the YBM marsh deposits. Another reason for selecting this cross section location was

² The drainage channel runs from the Runnymede Storm Drain outlet (at Runnymede Street) to Bayshore Pond just north of the O'Connor Pump Station, as shown on Figure 2.

the presence of several quality deep subsurface explorations available near this location that help constrain the model stratigraphy (i.e., CPT 104, A-B2, and A-CPT2).

At each cross section, horizontal layers of geogrid are included in the model, representing geogrid placed within and across the entire widths of the embankment during construction, spaced at 3 feet vertical intervals starting at the base of the embankment. Typically, 3:1 vertical slopes would be recommended for an embankment constructed over YBM to address stability concerns. The inclusion of the geogrid layers allow for the landside of the embankment to be steepened to a 2:1 slope to reduce the embankment footprint. Geogrid was also included to account for uncertainty of the strength of the YBM within the marsh for which site-specific strength data are not yet available. Modeling details for the geogrid are included in Section 5.5.

The soil stratigraphy and soil parameters developed for the analyses are based on the subsurface conditions presented in available explorations (Table 1). Tables on Figures 6 through 10 summarize soil parameters used for analyses of each cross section. It should be noted that due to the limited amount of data landward and no data waterward of the embankment, Cross Sections 1 through 3 assume horizontal layering which is supported by the layering observed for Cross Section 5 and 6.

5.2 Evaluation Criteria

Project geotechnical design criteria were established to evaluate the levees for acceptable performance with respect to settlement, seepage, and stability based on commonly used and accepted guidelines. The criteria used are based on published federal and state regulations and technical guidance documents. The following documents were used as guidance for establishing performance criteria for the berm analysis and evaluation:

- USACE Engineering Manual (EM) 1110-2-2502 *Floodwalls and Other Hydraulic Retaining Walls* (USACE 2022)
- USACE EM 1110-2-1913 *Design and Construction of Levees* (USACE 2000)
- USACE EM 1110-2-1902 *Slope Stability* (USACE 2000)
- California Department of Water Resources (DWR) Urban Levee Design Criteria (ULDC) (DWR 2012)
- DWR Guidance Document for Geotechnical Analyses, Urban Levee Evaluation (ULE) Project (DWR 2015) (hereafter “ULE Guidance Document”)

To comply with FEMA requirements, the proposed embankment/floodwall is intended to provide 100-year flood protection (Elevation 13.0 feet) plus 3.5 feet of SLR resulting in a final top of floodwall elevation of 16.5 feet. Elevation 13.0 feet is based on a 100-year flood elevation of 11.0 feet plus 2 feet of freeboard. Therefore, the design water surface elevation (DWSE) for analysis was taken as 11.0 feet for the purpose of steady state seepage and stability analyses herein (Section 5.4). To account for larger floods, as well as sea level rise, analyses were also performed with the flood level at the target top of floodwall elevation of 16.5 feet. This higher water level was designated as the Hydraulic Top of Levee (HTOL) herein. Evaluating both the DWSE and HTOL provides reasonable lower and upper bounds for coastal floods that the embankment/floodwall could be subjected to over its design life.

For the purpose of selecting minimum Factor of Safety criteria (hereafter “FOS criteria”) for seepage and stability analyses, the DWSE of 11.0 feet was taken as an “unusual” load, and the HTOL of 16.5 feet was taken as an “extreme” load per USACE floodwall criteria in EM 1110-2-2502. Specific

minimum FOS criteria selected for the project are discussed in subsequent sections. Further, a site classification of “ordinary” was assumed per EM 1110-2-2502. Note that the site does not currently meet the ordinary site classification definition which requires that subsurface investigations be spaced at a maximum of 500 feet and that sampling be performed within each geologic unit. Currently, there are several areas where spacing of investigation is greater than 500 feet, and quality sampling within the marsh soils (within which portions of the embankment/floodwall will be founded) is not currently available. Additional investigations would need to be performed in future design phases in order to fill these data gaps to meet the ordinary site classification requirements. HDR judges that designing the embankment/floodwall for the significantly higher minimum FOS criteria associated with a “limited” site classification per EM 1110-2-2502 would either be unfeasible or too costly.

5.3 Settlement Analysis

Settlement analysis was performed using the computer program Settle3 by Rocscience (2024) which allows for estimating time-dependent soil settlement. Analysis was performed at four of the five design cross sections in order to evaluate the magnitude of settlement that could occur following construction of the embankment/floodwall. Settlement estimates were used to select overbuild height so that the top of the floodwall does not settle below the target top of wall elevation of 16.5 feet. Analysis Cross Section 3 at Station 26+00 was omitted from the settlement analysis. Because of similar bay mud thickness, it was judged that settlement would be of similar magnitude as Cross Section 2. For Cross Sections 4 and 5, the embankment/floodwall would be constructed over YBM soil within Laumeister Marsh which is assumed to be significantly softer and more compressible than the soil beneath or landside of the existing levee.

Compressibility and time-rate of settlement soil parameters were estimated primarily based on laboratory test data from available subsurface information for the site with the exception of the near-surface marsh soil for which site-specific lab testing was not available. For the virgin YBM soil within the marsh (not yet loaded), settlement parameters were selected based on engineering judgment and experience with similar soils in the greater Bay Area. The soil parameters and subsurface stratigraphy used in the settlement analysis are summarized on Figures 6, 7, 9, and 10 for Cross Sections 1, 2, 4, and 5, respectively.

Long-term settlement magnitudes estimated beneath the embankment crest (i.e., where maximum settlement occurs) are shown in Table 3 for each cross section evaluated. Settlement magnitude would decrease toward the toe of the embankment. These settlement estimates include consolidation settlement of YBM and underlying fine-grained alluvium, as well as secondary compression of YBM for a period of 50 years after construction. These settlement estimates do not include elastic compression of coarse-grained alluvium. This is because such settlement would occur immediately during construction and would not contribute to long-term settlement.

Table 3. Settlement Analysis Results

Analysis Cross section	Station	Total Long-term Settlement Beneath Crest (inches)	Consolidation Settlement in YBM and Fine-grained Alluvium (inches)	Secondary Compression in YBM (inches)
1	5+30	3.7	3.2	0.5
2	16+40	5.6	5.0	0.6
4	37+65	10.1	8.4	1.7
5	44+00	8.6	7.2	1.4

Note: The settlement analyses incorporated overbuild heights of 6 inches for Cross Sections 1 and 2 and 12 inches for Cross Section 4 and 5.

It is estimated that about 90 percent of the total settlement would occur between 2 to 5 years after construction. Additionally, settlement for Cross Section 4 and 5 is estimated to be significantly greater than Cross Section 1 and 2. This is due the Cross Section 4 and 5 embankment/floodwall being built directly over soft soil within the marsh which has not been preloaded by an existing embankment or fill. Based on the above settlement magnitudes, an overbuild height of 6 inches is incorporated for Cross Sections 1, 2, and 3 and overbuild height of 12 inches is incorporated for Cross Sections 4 and 5. Overbuild heights were applied to both the embankment and the floodwall and are considered in subsequent seepage and stability analyses. Resulting top of wall elevations are 17.0 feet for Cross Sections 1, 2, and 3 and 17.5 feet for Cross Section 4 and 5. Recommendations related to embankment/floodwall overbuild are provided in Section 6.1.

5.4 Seepage Analysis

Through-seepage and under-seepage are important considerations for flood protection, and the potential for both of these seepage conditions were evaluated for the combined embankment and floodwall. In addition, the steady state pore pressures and phreatic surface lines are applied in subsequent landside steady state stability and waterside rapid drawdown stability analyses. Steady state seepage analyses were performed for each representative cross section for both the 100-yr DWSE of 11.0 feet and the HTOL of 16.5 feet. Analyses were performed for the representative “base case” cross sections shown on Figures 6 to 10. Selected sensitivity seepage analyses were also performed, and the results of these sensitivity analyses are presented herein. The finite element computer program SEEP/W was used to perform the seepage analyses (GEO-SLOPE 2024).

5.4.1 Seepage Analysis Modeling

Permeability parameters were selected using engineering judgment based on soil type and data from previous projects with similar soils in Northern California and the Bay Area. Determination of permeability was based on the percentage of fines content identified for each soil layer. If there were no available fines content data for the soil layer, a permeability value was selected using empirical data based on the minimum amount of fines content corresponding to the soil layer’s USCS classification. The selected permeability parameters used for the seepage analyses are presented on Figures 6 through 10.

Boundary conditions used for the SEEP/W modeling are as follows:

- Nodes along the waterside ground surface were set to a constant head equal to the DWSE of 11.0 feet or the HTOL of 16.5 feet.
- Nodes along the waterside vertical edge were set to a no-flow boundary at a location 2,000 feet from the centerline of the embankment. This boundary condition was selected based on the presence of a YBM blanket extending across the marsh toward the bay. McDonald et al. (1978) mapped thickness of YBM deposits on the order of about 5 to 10 feet within the marsh (consistent with available subsurface data). Further, the map shows YBM thickening to about 20 feet within about 1,500 feet beyond the shoreline, suggesting that the blanket would not be truncated by the Bay deepening just offshore. It is also assumed that sloughs within the marsh would be naturally partially filled with low permeability fine-grained soil consistent with the depositional environment. Therefore, the waterside blanket is assumed to be continuous, and assigning a no flow boundary condition along the waterside edge of the model is appropriate. This assumption is generally consistent with Waterside Seepage Model Boundary Condition Case IV-1 described in the ULE Guidance Document (DWR 2015).
- Nodes on the landside berm and ground surface were modeled as potential seepage faces. This is a no-flow boundary condition that allows SEEP/W to check if there is flow out of the model. If SEEP/W determines potential for flow out of the model (by calculating positive pore pressure at the node), the node is assigned a pressure head of zero and flow out of the model is allowed.
- Nodes on the landside vertical edge were set to a constant head equal to the lower of the landside levee toe elevation or the elevation of the landside edge of the model at a location 2,000 feet from the centerline of the embankment.
- Nodes along the bottom of the model (Elevation -70 feet) were set to a no-flow boundary condition.

Sheet pile walls were modeled as impermeable for the purpose of this 30 percent design evaluation. However, actual sheet pile walls are not completely impermeable due to the presence of the interlocks which can allow a small amount of seepage to pass through the wall. It is judged that the quantity of seepage through the interlocks would be several orders of magnitude lower than seepage quantity assuming no wall is present, especially within the low permeability embankment, YBM, and fine-grained alluvium layers. Given the expected short duration and cyclic nature of coastal tidal flooding and the conservativeness of assuming of steady state seepage conditions for coastal flooding, modeling the sheet pile wall as impermeable is judged to be reasonable for the purpose of these 30 percent design seepage analyses. However, consideration should be given to evaluating the potentially effects of interlock seepage in future design phases, including consideration of sheet pile joint sealants that expand upon exposure to water.

5.4.2 Through-Seepage

Through-seepage occurs when there is near-horizontal seepage flow through the embankment and the steady state phreatic surface daylights on the landside slope (also referred to as breakout). Through seepage may be detrimental if the berm is constructed of permeable or erodible materials. Potential negative effects of through-seepage include a reduction in slope stability, sloughing and erosion of the landside berm slope surface, and internal erosion due to backward erosion piping. Low-plasticity soils are more susceptible to erosion than soils with medium to high plasticity.

The proposed embankment would be comprised of erosion resistant clayey soil and would include an embedded sheet pile wall extending through the embankment that would cut off the majority of seepage. Additionally, steady state seepage analyses indicate low potential seepage breakout along the landside slope. For these reasons, the potential for detrimental effects of through-seepage to occur is judged to be very low.

5.4.3 Underseepage

Underseepage conditions occur when flow through permeable layers beneath the embankment causes hydraulic uplift of less permeable landside foundation soils (i.e., blanket layers). This uplift can lead to reductions in landside stability as well as foundation erosion due to backward erosion piping. Detrimental effects to embankment performance due to underseepage are related to the vertical seepage gradients through the landside blanket under flood conditions which could lead to piping from backward erosion, and potential breach.

The average vertical exit gradient at the landside toe of the embankment is compared to the critical exit gradient (where erosion begins to occur) to assess underseepage erosion potential. The average vertical exit gradient (i_e) is calculated as the vertical head drop across the landside blanket layer divided by the thickness of the blanket layer. Allowable vertical exit gradients for each WSE were evaluated based on minimum vertical gradient FOS criteria using ordinary site classification in EM 1110-2-2502, as follows:

- Minimum vertical gradient FOS of 2.0 for the DWSE of 11.0 feet (unusual load category)
- Minimum vertical gradient FOS of 1.6 for the HTOL of 16.5 feet (extreme load category).

The vertical gradient FOS is evaluated as the ratio of the critical exit gradient (i_c) to the allowable exit gradient. The critical exit gradient (i_c) is calculated as the ratio of the buoyant unit weight (γ_b) of the blanket layer to the unit weight of water (γ_w). The maximum total unit weight (γ_t) used to evaluate the critical gradient is 112.5 pcf per the ULE Guidance Document. The FOS calculation is demonstrated below and Table 4 summarizes required critical gradients for each cross section location:

FOS = minimum required factor of safety

$$\text{FOS} = i_c / i_e$$

Where:

$$i_c = \gamma_b / \gamma_w = (\gamma_t - \gamma_w) / \gamma_w$$

$$\gamma_t \leq 112.5 \text{ pcf}$$

Steady state seepage analysis results evaluated according to the above criteria are summarized in Table 4 for each representative cross section. Seepage analysis results indicate that base case embankment/floodwall configurations meet required minimum vertical gradient FOS. Seepage analysis figures are included in Appendix D and are referenced in Table 4.

Table 4. Steady State Underseepage Analysis Results for Base Case Models

Analysis Cross section (Station)	Blanket Layer(s) for Evaluating Vertical Exit Gradient ¹	Average Unit Weight of Blanket Layer (pcf)	Critical Exit Gradient, i_c	Exit Gradient Calculation Location	DWSE of 11.0 feet [Required FOS of 2.0]			HTOL of 16.5 feet [Required FOS of 1.6]		
					Average Vertical Gradient	FOS	Result Figure	Average Vertical Gradient	FOS	Result Figure
1 (5+30)	2	110	0.76	Embankment toe	0.013	59.5	Figure D.2	0.014	55.8	Figure D.3
				Pond	0.294	2.58		0.299	2.54	
2 (16+40)	2 and 3	> 112.5	0.80	Embankment toe	0.056	14.4	Figure D.5	0.063	12.7	Figure D.6
				Drainage Channel	0.163	4.90		0.182	4.39	
3 (26+00)	2	110	0.76	Embankment / Drainage Channel toe ²	0.193	3.93	Figure D.10	0.203	3.75	Figure D.11
4 (37+65)	3	100	0.60	Embankment toe	0.077	7.74	Figure D.13	0.194	3.10	Figure D.14
5 (44+00)	3	100	0.60	Embankment toe	0.126	4.76	Figure D.18	0.255	2.35	Figure D.19

Notes:

- 1) See Figures 6 to 10 for stratigraphy and properties for each analysis section. See Figures D.1, D.4, D.9, D.12, and D.17 for model setup figures.
- 2) For Cross Section 3, the drainage channel toe is taken as the embankment toe for the purpose of the underseepage evaluation.

Sensitivity analyses were performed for Cross Section 2 and Cross Section 4, as described below:

- 1) The Cross Section 2 sensitivity analysis consisted of a sheet pile wall extending to Elevation -25 feet, 15 feet shallower than the base case sheet pile wall that extends to Elevation -40 feet (Figure 7). The intent of this sensitivity analysis was to evaluate seepage and stability performance with the sheet pile wall terminating at the same elevation as Cross Section 3, 4, and 5. The sheet piles would terminate above sandy and silty layers identified in Boring B-06 between approximate elevations -28 to -36.5 feet. Sensitivity analysis results indicate higher vertical gradients for this shallower wall compared to the base case, but the higher gradients still meet the required minimum vertical gradient FOS criteria, as shown on Table 5. This sensitivity analysis was then carried forward to the stability analysis discussed in Section 5.5.
- 2) The Cross Section 4 sensitivity analysis consisted of not filling in a small slough present within the marsh near the landside toe of the new embankment/floodwall. The base case includes filling the slough with engineered fill (modeled as the same material as embankment fill). The intent of this sensitivity analysis was to evaluate if the presence of the slough would cause the levee/floodwall to not meet the required underseepage criteria. The slough was modeled as about 4 feet deep and empty (i.e., not filled with water). The sensitivity analysis results indicate high vertical gradients at the slough location and unacceptable vertical gradient FOS of less than 1 for both the DWSE and HTOL (see Table 5). The conclusion of this sensitivity analysis is that natural sloughs present within marsh soil to the landside of the proposed embankment should be filled with engineered fill. This sensitivity analysis was not carried forward for stability analysis.

Table 5. Steady-State Underseepage Sensitivity Analysis Results

Analysis Cross section (Station)	Blanket Layer(s) for Evaluating Vertical Exit Gradient ¹	Average Unit Weight of Blanket Layer (pcf)	Critical Exit Gradient, i _c	Exit Gradient Calculation Location	DWSE of 11.0 feet (Required FOS of 2.0)			HTOL of 16.5 feet (Required FOS of 1.6)		
					Average Vertical Gradient	FOS	Result Figure	Average Vertical Gradient	FOS	Result Figure
Cross Section 2 Sensitivity Analysis: Sheet pile wall installed to Elevation -25 feet										
2 (16+40)	2 and 3	> 112.5	0.80	Embankment toe	0.100	7.98	Figure D.7	0.178	4.48	Figure D.8
				Drainage Channel	0.271	2.96		0.363	2.20	
Cross Section 4 Sensitivity Analysis: Slough to the landside of the embankment is not filled in with engineered fill										
4 (37+65)	3	100	0.60	Embankment toe	0.680	0.88	Figure D.13	0.895	0.67	Figure D.14

5.5 Stability Analysis

Slope stability analysis was performed for the five representative cross section using the limit equilibrium software program SLOPE/W (GEO-SLOPE 2024) and the Spencer (1967) method. Stability analyses were performed to evaluate the proposed embankment/floodwall configurations for the conditions and minimum stability FOS criteria listed below:

- Long-term landside stability under steady state seepage conditions were evaluated based on minimum stability FOS criteria for global stability of floodwalls in EM 1110-2-2502 with an ordinary site classification:
 - Minimum FOS of 1.5 for the DWSE of 11.0 feet (unusual load category)
 - Minimum FOS of 1.4 for the HTOL of 16.5 feet (extreme load category)
- Waterside rapid drawdown conditions were evaluated following guidance in EM 1110-2-1902 *Slope Stability* (USACE 2000):
 - Minimum FOS of 1.3 for the DWSE of 11.0 feet
 - Minimum FOS of 1.1 for the HTOL of 16.5 feet; and
- End of construction (EOC) stability: minimum FOS of 1.3 per EM 1110-2-1902 *Slope Stability* (USACE 2000) and EM 1110-2-1913 *Design and Construction of Levees* (USACE 2000).

Seismic stability analyses were also performed and are presented in Section 5.6.

5.5.1 Material Parameter Selection and Modeling Details

Soil properties of the YBM, existing fill, and underlying alluvium soils were selected based on a combination of laboratory test results, in situ test data (blow count and CPT measurements), and engineering judgment. Effective (i.e., drained) strength parameters for the fill and the underlying fine-grained alluvium were primarily based on engineering judgment and experience with similar soils in the greater Bay Area and Northern California. Effective strength parameters for coarse-grained alluvium were estimated based on correlation with CPT data and blow counts. Undrained strength parameters for YBM and fine-grained alluvium were estimated based on available lab data and CPT interpretations. Material parameters for new embankment fill were conservatively selected based on

engineering judgment to be consistent with well-compacted clayey soil. Refer to Figures 6 through 10 for stability analysis parameters selected for each analysis section.

As discussed in Section 5.1, horizontal layers of geogrid are embedded in the proposed embankment. Fortrac 55 geogrid by Huesker was selected for analysis, which has a uniaxial long-term design strength of 2,207 pounds per foot (lb./ft) of length. The geogrid layers were modeled as “reinforcement loads” in SLOPE/W. For landside steady state stability, the bond strength between the grid and the soil is based on an interface adhesion angle of about 20° for the bottom layer atop YBM soil (i.e., at the base of the embankment) and 21° for overlying layers embedded completely within the embankment fill. These values were selected based on the soil effective friction angle (ϕ') following guidance in FHWA Publication No. NHI-10-024 (FHWA 2009). For RDD and EOC stability, a short-term geogrid-soil bond strength was selected as either 350 psf for bottom layer atop the YBM or 750 psf for overlying layers embedded completely within the embankment. A surface area factor of 2 and resistance reduction factor of 0.8 were used per FHWA (2009) guidance.

To account for potential levee cracking from differential settlement or desiccation cracking associated with wetting and drying cycles, tension cracks were applied along the crest of the embankment. The maximum tension crack depth was assumed to be four feet based on recommendations in the ULE Guidance Document (DWR 2015) for clayey soil. It was also assumed that cracks could not extend through the upper layer of geogrid, or even if they could extend deeper, the geogrid would still provide tensile reinforcing perpendicular to the crack. Therefore, crack depth was assigned as four feet or to the upper geogrid layer, whichever is shallower. The tension cracks were included for both landside steady state and RDD stability analyses. They were not included for EOC analyses, because it is assumed that tension cracks would take some time to develop after construction is completed. Tension cracks were modeled as being filled with water in which the water applies a horizontal hydrostatic driving force.

For all stability analyses, slip surfaces were not allowed to pass through the sheet pile. Additionally, it was judged that the proposed sheet pile wall will be embedded a sufficient depth into stiff alluvial deposits that slip surfaces would not be able to reasonably pass beneath the sheet pile tip. Therefore, potential deep slip surfaces were not explicitly analyzed.

5.5.2 Landside Steady-State Stability

Landside steady-state stability (landside stability) analyses were performed assuming steady state seepage conditions and long-term effective soil strength properties. The stability analyses imported steady state pore pressures calculated from the seepage analyses presented above. Stability slip surfaces through the crest area were analyzed to evaluate the long-term stability of the proposed embankment/floodwall configurations. The results of the landside stability analyses are presented in Table 6 for the base case configurations. Stability analysis figures are included in Appendix E and are referenced in Table 6. Appendix E Figures E.1, E.7, E.17, E.23, and E.29 present stability model setup figures.

Table 6. Landside Steady State Stability Analysis Results for Base Case Models

Analysis Cross section (Station)	Landside Steady-State Stability FOS DWSE of 11.0 feet [Required FOS of 1.5]		Landside Steady-State Stability FOS HTOL of 16.5 feet [Required FOS of 1.4]	
	FOS	Result Figure	FOS	Result Figure
1 (5+30)	2.23	E.2	2.23	E.3
2 (16+40)	1.99	E.8	1.96	E.9
3 (26+00)	1.74	E.18	1.73	E.19
4 (37+65)	2.32	E.24	2.18	E.25
5 (44+00)	2.94	E.30	2.80	E.31

The landside stability analyses indicate that the proposed configurations at each representative cross section exceed the minimum required stability FOS of 1.5 for the DWSE and 1.4 for the HTOL flood conditions.

As noted in Section 5.4.3, the Cross Section 2 seepage sensitivity analysis in which the sheet pile wall extends to Elevation -25 feet was carried forward for evaluation of landside stability. Stability results indicate that the east bank of the drainage channel just to the landside of the proposed embankment toe would not meet the required minimum stability FOS if the sheet pile wall is terminated at Elevation -25 feet. This is due to the increased seepage gradients and pore pressures compared to the base case (i.e., sheet pile wall terminating at Elevation -40 feet). Table 7 below compares stability FOS of the channel bank for both the base case (i.e., sheet pile wall to Elevation -40 feet) and the sensitivity case (i.e., sheet pile wall to Elevation -25 feet). It was decided for the purpose of this 30 percent design evaluation that a failure of the channel bank would not be acceptable. HDR judges that progressive failure of the east channel bank could potentially threaten the proposed embankment. Additionally, the channel could potentially be blocked by a slide mass which could reduce flow capacity for storm runoff from the Runnymede Storm Drain outlet. Reduced channel flow capacity could pose flood risk for adjacent residential areas if the opposite (west) bank of the channel were to overtop. Based on this sensitivity analysis, the base case with the sheet pile wall terminating at Elevation -40 feet was carried forward for subsequent analyses.

Table 7. Cross Section 2 (Station 16+40) Drain Channel Bank Stability

Analysis Cross section (Station)	Embankment / Floodwall Configuration	Drain Channel Bank Stability FOS DWSE of 11.0 feet [Required FOS of 1.5]		Drain Channel Bank Stability FOS HTOL of 16.0 feet [Required FOS of 1.4]	
		FOS	Result Figure	FOS	Result Figure
2 (16+40)	Base case with sheet pile wall to Elevation -40 feet	1.69	E.10	1.60	E.11
	Sensitivity case with sheet pile wall to Elevation -25 feet	1.22	E.12	0.97	E.13

5.5.3 Waterside Rapid Drawdown Stability

Waterside rapid drawdown conditions occur when the water level suddenly drops from a steady state flood water level to a lower water level. A full flood drawdown condition is assumed for these analyses. That is, the water level is assumed to instantaneously drop from the flood level to the waterside toe. A full flood drawdown is a conservative modeling assumption. Rapid drawdown analyses were performed using both drained and undrained strength parameters in accordance with Duncan et al.'s (1990) staged rapid drawdown procedure.

Results of the waterside rapid drawdown analyses are presented in Table 8 for the base case configurations. The proposed configurations at each representative cross section exceed the minimum required waterside rapid drawdown stability FOS of 1.3 for the DWSE and 1.1 for the HTOL flood conditions.

Table 8. Waterside Rapid Drawdown Stability Analysis Results

Analysis Cross section (Station)	Landside Steady-State Stability FOS DWSE of 11.0 feet [Required FOS of 1.5]		Landside Steady-State Stability FOS HTOL of 16.5 feet [Required FOS of 1.4]	
	FOS	Result Figure	FOS	Result Figure
1 (5+30)	1.97	E.4	1.91	E.5
2 (16+40)	2.11	E.14	2.06	E.15
3 (26+00)	2.09	E.20	2.05	E.21
4 (37+65)	1.84	E.26	1.77	E.27
5 (44+00)	2.05	E.32	2.00	E.33

5.5.4 End of Construction Stability

End of construction (EOC) stability was analyzed for both the waterside and landside slopes, and the more critical case (i.e., the side with lower stability FOS) between the landside and waterside stability is reported herein. The EOC stability was performed assuming undrained soil strength properties for fine-grained soil (embankment fill, YBM, and fine-grained alluvium) which is appropriate for short-term loading conditions. Drained parameters were used for coarse-grained alluvium. Additionally, EOC stability slip surfaces were constrained within the critical YBM layer though the use of a composite slip surface model. The composite slip surface model consists of a generally circular shape, but it also allows for slip along the interface of weaker overlying layer (i.e., the YBM) and a stronger underlying layer (i.e., the alluvium). The composite slip surface is judged to be appropriate for the YBM over stiffer alluvium, and it generally produces lower stability FOS than using a purely circular slip surface.

Pore pressure conditions were modeled as a piezometric line set at the lower of either the ground surface elevation or an assumed groundwater level of Elevation. 3.3 feet. This groundwater level is approximately equal to mean sea level from the Redwood City tide station³. Note that the EOC stability analyses are not particularly sensitive to the selected groundwater level.

³ The Redwood City tide station is No. 9414523 available at the National Oceanic and Atmospheric Administration (NOAA) Tides & Current database.

Results of the EOC stability analyses are presented in Table 8 for the base case configurations. The proposed configurations at each representative cross section exceed the minimum required EOC stability FOS of 1.3.

Table 9. Waterside Rapid Drawdown Analysis Results

Analysis Cross section (Station)	Critical Side of the Embankment / Floodwall	End of Construction Stability FOS [Required FOS of 1.3]	
		FOS	Result Figure
1 (5+30)	Landside	2.20	E.6
2 (16+40)	Landside	2.07	E.16
3 (26+00)	Landside	2.23	E.22
4 (37+65)	Landside	2.83	E.28
5 (44+00)	Waterside	3.47	E.34

Based on the results of these EOC stability analyses, HDR judges that proposed embankment/floodwall can be constructed in one stage (i.e., staged embankment construction would not be needed).

5.6 Seismic Considerations

As discussed in Section 3.2, the project site is located in the seismically active San Francisco Bay region. Earthquakes occurring along the many active or potentially active Bay Area faults have the potential to produce strong ground shaking at the site. Additionally, ground shaking can be exacerbated by the presence of soft soils (i.e., YBM) below embankment fill and in the marsh area.

The likelihood of a flood and earthquake occurring simultaneously or in short succession is low, but it is possible that the combined embankment/floodwall could experience damage as a result of strong seismic shaking. Potential seismic impacts could include levee embankment cracking, surficial slumping, deformations, and liquefaction-induced settlement. After a significant earthquake, the levee would need to be inspected and quickly repaired, if necessary, to maintain the required level of flood protection.

Seismic hazard, liquefaction potential, and seismic slope stability for the embankment were evaluated are presented below.

5.6.1 Seismic Hazard

Following the guidelines presented in the Urban Levee Design Criteria (ULDC 2012), the seismic hazard level for seismic assessment of a levee is typically taken at the same return period as the design flood condition. This concept was applied to the combined embankment/floodwall evaluated herein. Therefore, a 100-year return period Uniform Hazard Response Spectrum (UHS) was developed to evaluate the seismic parameters for consistency with the 100-year flood level being evaluated. In addition, the seismic hazard disaggregation was performed at the same return period. The USGS Earthquake Hazard Toolbox (EHT) was used to develop 100-year return period UHS and perform the 100-year seismic hazard disaggregation (USGS 2023). The USGS EHT toolbox utilizes the 2018 National Seismic Hazard Model (NSHM) to perform regional probabilistic seismic hazard calculations (Petersen et al. 2019).

The input parameters required to develop UHS and perform hazard disaggregation using the USGS EHT are described below:

- **Site Location:** The site coordinates were taken as Latitude 37.467618 and Longitude -122.126297 degrees which is at approximately middle of the project site.
- **Return Period:** Based on the discussion above, a return period of 100 years was used.
- **Site Class:** Site class is a function of time averaged seismic shear wave velocity in the top 30 meters (about 100 feet) of the soil profile, designated as $V_{s,30}$ (or $V_{s,100}$ in feet). Shear wave measurements were performed by Arup (Arup 2021) for seismic CPT A-SCPT4. The shear wave velocity measurements were performed to a depth of about 125 feet. Based on these measurements, $V_{s,100}$ is approximately 680 feet/second (207 meters/second) (Figure 11). CPT A-SCPT4 was advanced about 135 feet to the landside of the embankment centerline (Figure 4). Considering the presence of softer near-surface marsh deposits adjacent to or underlying the embankment, a Site Class D/E representing a lower $V_{s,100}$ of 606 feet/sec (185 m/sec) was selected to perform the seismic hazard disaggregation and develop the UHS.

Disaggregation of the seismic hazard associated with the 100-year return period over a spectral period range of 0 seconds (i.e., peak ground acceleration or PGA) to 1 second was performed using the USGS EHT. This is judged to be the spectral range of interest for the embankment. Summary of the dominant scenarios and their relative contributions to the hazard at PGA, 0.2 sec and 1.0 sec period are provided below in Table 10. These results represent known fault sources contributing at least 2 percent to the seismic hazard at the site. The rupture distances (RRUP) and mean moment magnitudes (MW) listed are based on values assigned according to the 2018 NSHM, and the numbers in parentheses after the fault names correspond to fault subsections assigned by the model. Figure 12 presents the graphical disaggregation for PGA.

Table 10. Disaggregation of Probabilistic Seismic Hazard

Seismic Source	R_{Rup} (km)	M_w	Contribution (%)		
			PGA	0.5 Sec	1.0 Sec
Hayward (South) (3)	17.8	6.96	22.6	20.6	24.2
San Andreas (Peninsula) (5)	12.9	7.81	18.1	13.8	20.9
Calaveras (North) (5)	25.3	7.17	5.4	5.0	6.1
Monte Vista-Shannon (1)	9.9	6.75	3.5	2.9	3.5
San Gregorio (North) (11)	27.6	7.61	3.0	2.6	3.7

Note: These results are based on the USGS NSHM Conterminous US 2018 Disaggregation Tool available through the USGS EHT.

Utilizing the input parameters described above, the USGS EHT was used to develop the 100-year return period UHS. The developed Site Class D/E UHS is provided in Table 11 and shown on Figure 13.

Table 11. 100-Year Return Period UHS for Site Class D/E Boundary

Spectral Period (seconds)	SPECTRAL ACCELERATION (g)
PGA	0.283
0.020	0.281
0.030	0.279
0.050	0.305
0.075	0.380
0.100	0.461
0.125	0.531
0.150	0.587
0.175	0.632
0.200	0.667
0.250	0.712
0.300	0.751
0.400	0.742
0.500	0.706
0.600	0.650
0.750	0.555
0.800	0.529
1.000	0.453
1.500	0.322
2.000	0.246
3.000	0.154
4.000	0.104
5.000	0.074

5.6.2 Liquefaction

Soil liquefaction is a phenomenon in which saturated (submerged), primarily cohesionless soil experiences a temporary loss of strength due to buildup of excess pore water pressure during cyclic loading induced by an earthquake. Key triggers for liquefaction include moderate to strong ground shaking, the presence of relatively clean and loose granular soils, and saturated soil conditions. Historical evidence indicates that loose silty sand as well as lean silt and some low plasticity clays are also potentially liquefiable. The susceptibility of a soil to liquefaction is a function of the gradation, density, aging/cementation, and fines content of the soil. Denser soils are more resistant to liquefaction than looser soils, and soils with significant fines content are more resistant to liquefaction than clean sands. Liquefaction triggering analyses were performed for available project subsurface data by HDR and CPTs by Arup (2021) to assess the potential for liquefaction triggering and liquefaction-induced settlement along the project alignment.

Liquefaction triggering was evaluated based on the 100-year return period PGA of 0.28g and a M_w of 6.96 earthquake as discussed above. The analysis was performed following the Boulanger and Idriss (2014) CPT- and SPT-based liquefaction triggering methods. The software LiqSVs (Geologismiki n.d.) was used to evaluate the SPT blow count based liquefaction triggering on data from B-107. Additionally, CPT based liquefaction triggering was evaluated using the software program CLiq (Geologismiki n.d.). Weighting factor on volumetric strain was used to limit the liquefaction analysis to depth of 60 feet (Cetin et al. 2009). It is judged that liquefaction at deeper layers is unlikely to impact the embankment/floodwall and would not manifest at the ground surface.

Based on the liquefaction triggering analysis, intermittent coarse-grained alluvium layers along the embankment/floodwall alignment may be susceptible to liquefaction. The majority of the

potentially liquefiable layers are interlayered with stiff fine-grained alluvium beneath the YBM. However, a relatively loose near-surface silty to clayey sand layer immediately underlying the YBM was identified as being generally continuous between about Elevation 1 foot and Elevation 6 feet from about Station 36+00 to 53+00 (i.e., at Bay Road). This near-surface potentially liquefiable layer has implications for seismic stability of the embankment/floodwall, which was evaluated for representative Cross Sections 4 and 5 (see Section 5.6.3). Note that the assessment of this near-surface layer is based on limited quality sampling data, and additional future explorations may be warranted to better understand the liquefaction susceptibility of this layer.

HDR estimates that liquefaction-induced settlement of up to two inches could occur along the alignment. The presence of a YBM blanket layer and interbedded stiff fine-grained alluvium may help to reduce surface manifestation of liquefaction such as liquefaction induced-ejecta (e.g., sand boils) (Hutabarat and Bray 2021) and liquefaction-induced settlement of the embankment/flood wall. A summary of estimated liquefaction-induced settlement is provided in Table 12, and calculation outputs of liquefaction triggering and settlement are provided in Appendix F.

Table 12. Summary of Liquefaction-Induced Settlement Estimates

Exploration Location	Approximate Station (Figure 2)	Analysis Type	Estimated Total Liquefaction-induced Settlement (inch)
C-108	9+15	CPT-based	0.7
C-107	15+50	CPT-based	1.8
C-106	24+60	CPT-based	1.0
C-105	34+20	CPT-based	0.7
A-SCPT4	37+50	CPT-based	1.4
A-CPT2	43+80	CPT-based	2.1
C-104	44+00	CPT-based	1.3
A-CPT3	45+10	CPT-based	1.4
B-107	53+00	SPT-based	1.5

5.6.3 Seismic Stability Analysis

Seismic slope stability was evaluated using the 100-year return period UHS presented in Section 5.6.1 above. A pseudostatic analysis approach was used in which a horizontal seismic coefficient (k_h) is applied in the limit-equilibrium stability analysis. Analyses were performed assuming non-liquefied soil conditions for each representative cross section. In addition, pseudostatic seismic slope stability for liquefied conditions was evaluated at Cross Sections 4 and 5 to account for the potentially liquefiable layer that was identified immediately underlying the YBM in these areas.

Peak ground acceleration of 0.28g from the 100-year return period UHS was used for developing the k_h -value. USACE EM 1110-2-2502 prescribes k_h as equal to 50 percent of the PGA for the pseudostatic seismic stability analyses (USACE 2022). Based on this k_h of 0.14g was used for analyses. EM 1110-2-2502 suggests that typical minimum stability FOS for pseudostatic stability analyses range from 1.1 to 1.2. The following criteria were adopted for this project:

- Minimum FOS of 1.2 for non-liquefied conditions.
- Minimum FOS of 1.1 for liquefied conditions.

The pseudostatic stability analysis were performed assuming undrained soil strength properties for fine-grained soil (embankment fill, YBM, and fine-grained alluvium), which is appropriate for short-term loading conditions. Drained parameters were used for coarse-grained alluvium. The same undrained strength parameters used for the EOC stability analyses were also used for seismic stability analyses with the exception that YBM undrained strengths were reduced by 20 percent to account for cyclic strength degradation. This is to account for the fact that soft soils have been shown to be susceptible to cyclic strength degradation from moderate to large earthquakes (Rau and Sitar 1999). Additionally, soil liquefaction can result in temporary loss of shear strength that could exacerbate embankment deformations. For Cross Sections 4 and 5, the potentially liquefiable layer underlying the YBM was modeled using post-liquefaction residual strengths based on an empirical blow count correlation by Weber et al. (2015). Residual strength of 100 psf was used for Layer 4 in both cross sections, as noted on Figures 9 and 10.

The results of the pseudostatic seismic slope stability are presented in Table 13. The results of the analyses indicate that all the representative cross sections meet the minimum required FOS with the exception of the Cross Section 4 post-liquefaction analysis. Similar to the EOC stability analyses, results are reported for the more critical side of the embankment, and the composite slip surface method was used.

Table 13. Seismic Slope Stability Analysis Results

Analysis Cross section (Station)	Critical Side of the Embankment / Floodwall	Pseudo-Static Seismic Stability FOS [Required FOS of 1.2]		Post-Liquefaction Seismic Pseudo-Static Stability FOS (Required FOS of 1.1)	
		FOS	Result Figure	FOS	Result Figure
1 (5+30)	Landside	1.24	G.1	--	--
2 (16+40)	Landside	1.22	G.2	--	--
3 (26+00)	Landside	1.36	G.3	--	--
4 (37+65)	Landside	1.44	G.4	1.07	G.5
5 (44+00)	Waterside	1.69	G.8	1.17	G.9

Since the Cross Section 4 configuration with post-liquefaction strength did not meet the required stability FOS criterion, seismic deformation analysis was then performed to evaluate if seismic deformations could be expected to remain within generally acceptable limits following a design earthquake. The ULDC guidelines indicate that earthquake-induced deformation for frequently loaded levees with less than 5 feet of freeboard should be limited to less than 3 feet of total deformation and about 1 foot of vertical displacement. The embankment/floodwall evaluated herein is more akin to an intermittently loaded levee which would not typically have water against it; therefore, this criterion was judged to be appropriate and conservative to adopt herein.

Bray and Macedo (2019) was used to evaluate the seismic deformation associated with the yield coefficient of the embankment. The yield coefficient (k_y) is defined as the horizontal seismic coefficient (k_h) resulting in stability FOS of 1.0. The Bray and Macedo (2019) method accounts for the geometry of the sliding mass, fundamental period of the sliding mass, stiffness of the sliding mass, and earthquake magnitude to determine an appropriate horizontal seismic coefficient for an

allowable seismic deformation. For this analysis, the procedure was applied in reverse to estimate potential deformation based on a prescribed seismic coefficient, which in this case is k_y -value.

The k_y -value for the Cross Section post-liquefaction model was determined to be 0.168g using limit-equilibrium stability analysis, as shown on Appendix G Figure G.6. Using this k_y -value, total seismic embankment displacements were estimated to be about 2.9 inches at the 16 percent probability of exceedance level and about 1.4 inches at the 50 percent probability of exceedance level, as shown in Table 14 and Appendix G Figure G.7⁴. Vertical displacement (which can result in loss of freeboard) would likely be less than the total displacement. These displacement estimates do not account for liquefaction-induced settlement which would be in addition to the seismic slope displacement.

Table 14. Yield Coefficient (K_y) and Seismic Displacement for Cross Section 4 (37+65) with Post-liquefaction Strength

Analysis Cross section (Station)	Pseudo-Static Seismic Stability [Required FOS of 1.2]			Seismic Displacement for $K_y=0.168$ Using Bray and Macedo (inch)		
	K_y	FOS	Result Figure	16% Probability of Exceedance	50% Probability of Exceedance	Result Figure
4 (37+65)	0.168	1.0	G.6	2.9	1.4	G.7

It is important to note that the Bray and Macedo (2019) method was not originally developed to account for liquefaction effects. Therefore, it is judged that embankment displacements could exceed these estimates in consideration of liquefaction effects. It is also not clear how geogrid reinforcement within the embankment affects the applicability of the Bray and Macedo method. However, even if actual total displacement were several times greater than these estimates, it is reasonable to assume that the displacement would still be within the ULDC allowable displacement criteria noted above. Based on this analysis, it is judged that seismic displacement of Cross Section 4 would remain within generally acceptable levels. This conclusion also applies to Cross Section 5 given its similarity to Cross Section 4.

Note that liquefaction analysis presented above or this seismic deformation analysis do not account for potential lateral spreading. However, based on the relatively flat topography of the marsh (on the waterside) and the presence of higher ground (on the landside), it is judged that the potential for lateral spreading is low.

⁴ Parameter inputs for Bray and Macedo (2019) calculation are shown on Appendix G, Figure G.7.

CHAPTER 6 RECOMMENDATIONS

6.1 Embankment/Floodwall Recommendations

Recommendations for 30 percent design of the combined embankment floodwall are outlined below:

- Include overbuild of 6 inches (top of wall at Elevation 17.0 feet) for Station 0+00 to Station 33+50 and 12 inches for Station 34+00 to Bay Road (top of wall at Elevation 17.0 feet). Station 33+50 to Station 34+00 would be a transition zone.
- Extend the sheet pile wall to Elevation -40 feet from Station 0+00 to Station 24+00 and to Elevation -25 feet from Station 24+00 to Bay Road.
- Include layers of geogrid spaced 3 feet vertically starting at the base of the embankment. Based on the analyses presented herein, geogrid consisting of Huesker Fortrac 55 or equivalent should be used. Note that the geogrid configuration and type could potentially be refined/optimized in future design phases.

6.2 Site Preparation and Grading

6.2.1 Site Preparation

The site should be cleared of all obstructions, including stockpiled material, abandoned utilities, visible organic material, and debris. Holes resulting from the removal of underground obstructions extending below the proposed finish grade should be cleared and backfilled with suitable material compacted to the requirements in Section 6.2.4. After clearing, the portions of the site containing surface vegetation or organic laden topsoil should be stripped to an appropriate depth to remove these materials.

6.2.2 Subgrade Preparation

After clearing, the existing Bay Trail levee should be entirely removed and areas beneath the footprint of the future embankment should be excavated to a depth of at least 2 feet below the adjacent marsh surface elevation. From a geotechnical perspective, the excavated Bay Trail levee soil can be reused as fill for the future embankment provided it meets the requirements of Section 6.2.3. It is anticipated that the soil beneath the existing Bay Trail levee and marsh soil generally consists of YBM and would not be suitable for reuse as embankment fill.

The resulting subgrade is anticipated to be in YBM or other wet, soft, weak soil. It may be difficult to place and compact the initial lifts of material over this soil. Geogrid reinforcement placed on the foundation surface will help stabilize the subgrade within the degraded areas to facilitate compaction of the initial lifts of levee fill. The Contractor will need to use appropriately sized equipment to place and compact levee fill in the degraded areas and to not damage the geogrid. Additionally, spreading fill over soft soils can result in mud waves building up in front of the fill material being pushed/spread. To limit the potential for burying these mud waves within the levee foundation, the fill material should be spread in a primarily perpendicular direction to the levee centerline.

Locally weak soil, if encountered, should be excavated and replaced, or otherwise stabilized as recommended by the geotechnical engineer at the time of construction. The compacted surface

should be firm and unyielding and should be protected from damage caused by traffic or weather. Soil subgrades should be kept moist during construction. If the subgrade is allowed to become dry, it should be moisture conditioned to close the shrinkage cracks.

In order to achieve satisfactory compaction in the subgrade and fill materials, the water content may need to be adjusted at the time of construction. This may require that water be added to dry soil or scarification and aeration be performed in soil that is too wet.

6.2.3 Engineered Fill Material

The embankment should be constructed of low to medium plasticity cohesive soil that exhibits relatively low shrink and swell potential and provide resistance to external and internal erosion. The fill material should meet the requirements presented in the table below. Imported fill material should meet the requirements presented in Table 15.

Table 15. Suitable Embankment Fill Material Requirements

Material Property	Berm Fill Requirement	ASTM Test Standard
USCS Classification	CL, ML, SC	D2487
Liquid Limit	LL ≤ 45	D4318
Plasticity Index	10 ≤ PI ≤ 25	D4318
% Passing 2.5-inch Sieve	100	D6913
% Passing #4 Sieve	≥ 70	D6913
% Passing #200 Sieve	≥ 30	D6913
Organic Content	≤ 3% and no visible concentrations of organic material	D2974

Note:

CL refers to variations of Lean Clay, as defined in ASTM D2487.

ML refers to variations of Silt, as defined in ASTM D2487.

SC refers to variations of Clayey Sand, as defined in ASTM D2487.

Soils should meet the additional plasticity, gradation, and organic content requirements presented in this table.

6.2.4 Fill Placement and Compaction

Embankment fill and reworked subgrade fill should be entirely compacted to at least 95 percent relative compaction. Embankment fill material should be spread and compacted in lifts not exceeding 8 inches in pre-compacted thickness. Soil should be compacted at moisture content at or slightly above the laboratory optimum. In order to achieve satisfactory compaction of the subgrade and fill materials, it may be necessary to adjust the water content at the time of construction. This may require that water be added to soil that is too dry, or that aeration be performed in any soil that is too wet.

6.3 Construction Slopes, Shoring and Dewatering

6.3.1 Temporary Construction Slopes and Shoring

Excavations will be required to degrade the existing Bay Trail levee, construct the flood protection embankment and possibly for removal of underground obstructions and abandoned utilities. All excavations that will be deeper than 5 feet, or are found to be potentially unstable, and will be entered by workers should be sloped or shored for safety in accordance with applicable local, state, and/or federal safety regulations, such as the Occupational Safety and Health Administration

(OSHA) guidelines (29 CFR Part 1926, Subpart P). The selection, design, and installation of the shoring system(s) or temporary excavation slopes needed for the project should be made the responsibility of the contractor.

HDR anticipates that the majority of excavations needed for construction can be performed using temporary slopes due to the relatively shallow depths required and the available open space. If temporary slopes are selected, the contractor should be aware that in no case should slope height, inclination, and excavation depths exceed those specified in the applicable regulations. The contractor, or responsible subcontractor, should determine temporary slope inclinations based on the subsurface conditions exposed at the time of construction. If temporary slopes are left open for extended periods of time, exposure to weathering and rain could have detrimental effects such as sloughing and erosion. HDR recommends that all vehicles and other surcharge loads be kept at least 10 feet away from the top of temporary slopes and that the temporary slopes are protected from excessive drying or saturation during construction.

6.3.2 Groundwater Control

The site is located in a low-lying area with shallow groundwater conditions. Groundwater and water from other sources, such as precipitation, surface water, or perched water, may be encountered. Localized groundwater or surface water control will likely be required. The design, installation, and maintenance of all necessary systems for groundwater and surface water control and dewatering during construction should be made the responsibility of the contractor, including testing of water and permitting for proper disposal.

CHAPTER 7 LIMITATIONS

This report has been prepared for the use of the San Francisquito Creek Joint Powers Authority and their consultants for specific application to the SAFER Bay, South of Bay Road Project, in accordance with generally accepted geotechnical engineering practice. No warranty, express or implied, is made. The analyses and recommendations submitted are preliminary and not intended for use in final design. The analyses and recommendations are based on the data available to HDR at the time of this geotechnical investigation and on the data collected during the field investigation. Additional subsurface exploration along and transverse to the flood protection system alignment will be required in future phases of the project to confirm subsurface layering and associated material properties assigned for the 30 percent evaluations and to support final design. This report does not reflect subsurface soil variations that may occur between the locations of the explorations or variations in groundwater conditions which may occur over a period of time. Changes in the state of practice for floodwall and levee design could result in changes to the conclusions and recommendations presented herein.

Historical explorations and testing were not performed by HDR, and HDR cannot vouch for the accuracy of data and information obtained by others. The historical information and subsurface data by others are referenced herein in an attempt to include data relevant to this project. Data by others should not be relied upon unless the originator of that data is available to confirm its accuracy.

This geotechnical study did not include an investigation regarding the existence, location, or type of possible hazardous materials. If any hazardous materials are encountered during construction of the project, the proper regulatory officials should be notified immediately.

CHAPTER 8 REFERENCES

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FIGURES

DRAFT

Figure 1. Vicinity Map

Figure 2. Site Plan – South of Bay Road

Figure 3. Subsurface Profile, Station -4+00 to 18+00

Figure 4. Subsurface Profile, Station 18+00 to 40+00

Figure 5. Subsurface Profile, Station 40+00 to 54+00

Figure 6. Analysis Cross Section 1, Station 5+30

Figure 7. Analysis Cross Section 2, Station 16+40

Figure 8. Analysis Cross Section 3, Station 26+00

Figure 9. Analysis Cross Section 4, Station 37+65

Figure 10. Analysis Cross Section 5, Station 44+00

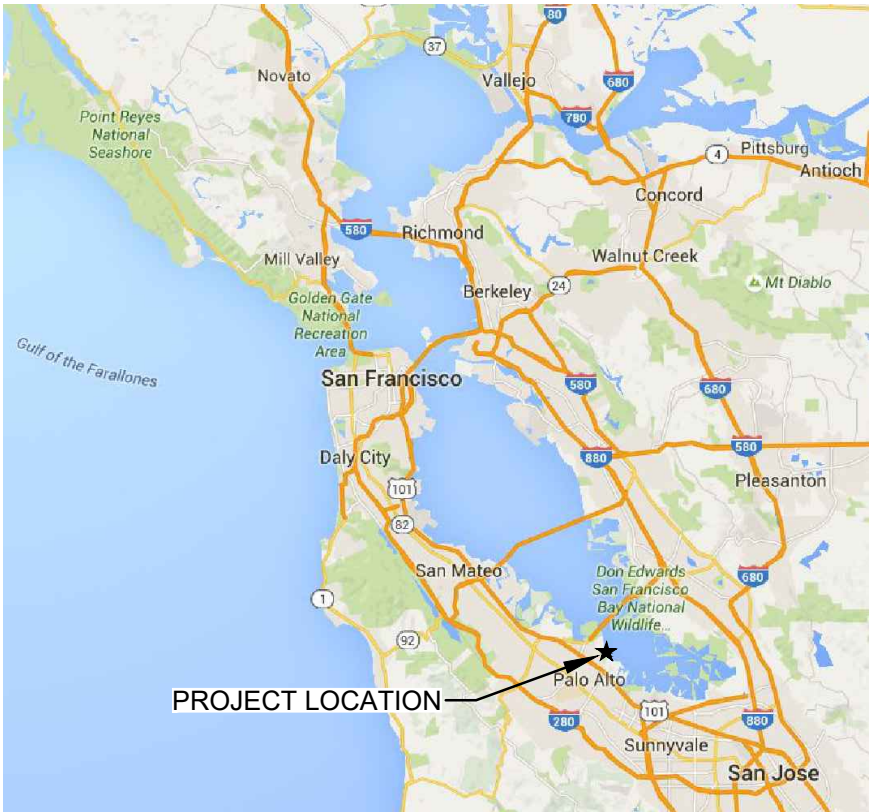
Figure 11. Shear Wave Velocity Profile

Figure 12. USGS Hazard Disaggregation, 100-yr Return Period and Site Class D/E, Peak Ground Acceleration

Figure 13. 100-Year Return Period Uniform Hazard Spectrum, Site Class D/E Boundary

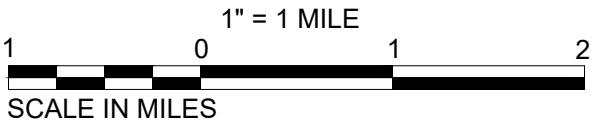


SOURCE: GOOGLE Earth Pro Aerial Imagery



SOURCE: GOOGLE MAPS

NOT TO SCALE

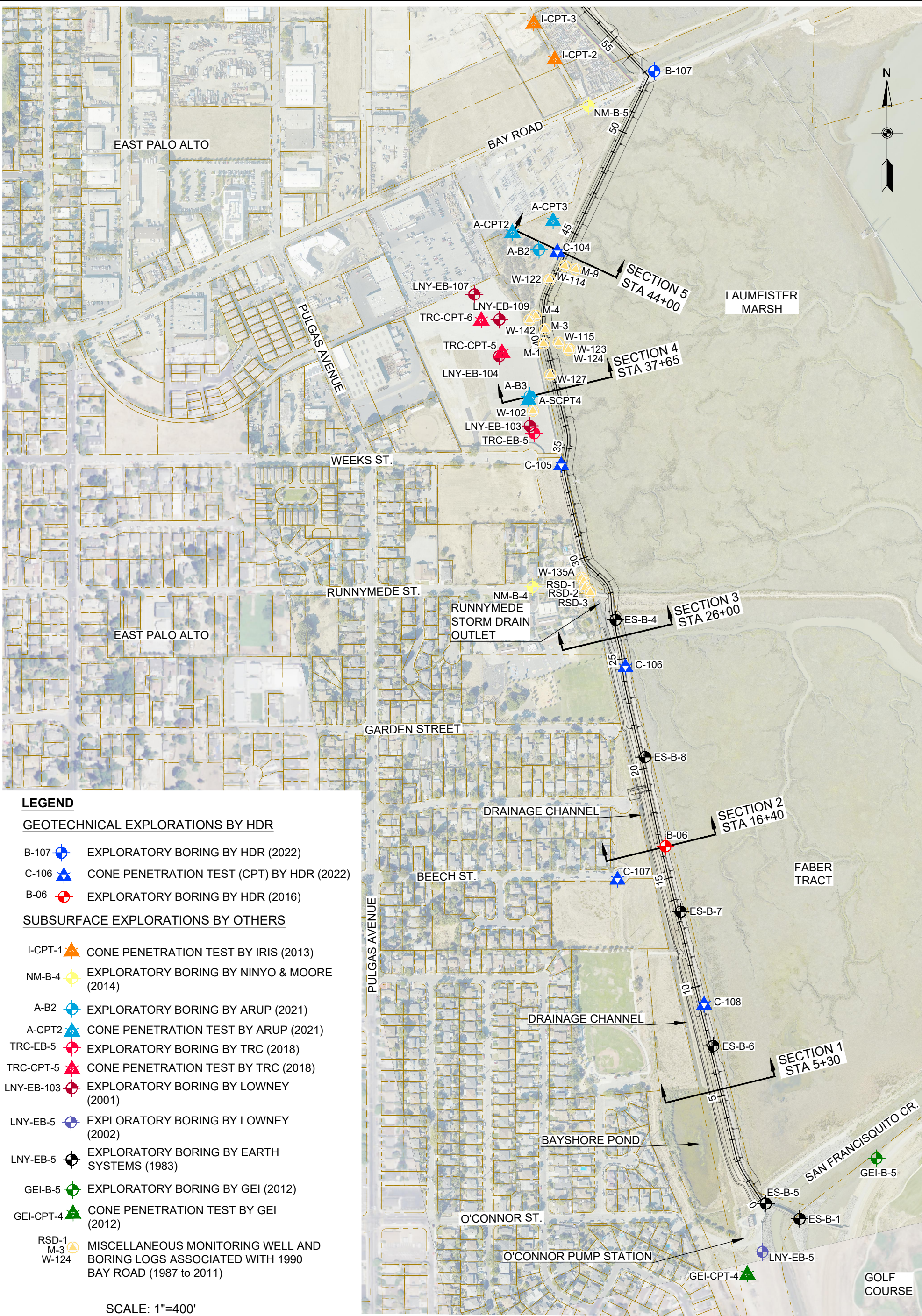


VICINITY MAP

SAFER BAY PROJECT
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
1



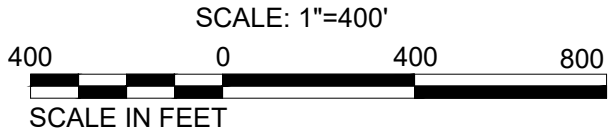
LEGEND

GEOTECHNICAL EXPLORATIONS BY HDR

- B-107 EXPLORATORY BORING BY HDR (2022)
- C-106 CONE PENETRATION TEST (CPT) BY HDR (2022)
- B-06 EXPLORATORY BORING BY HDR (2016)

SUBSURFACE EXPLORATIONS BY OTHERS

- I-CPT-1 CONE PENETRATION TEST BY IRIS (2013)
- NM-B-4 EXPLORATORY BORING BY NINYO & MOORE (2014)
- A-B2 EXPLORATORY BORING BY ARUP (2021)
- A-CPT2 CONE PENETRATION TEST BY ARUP (2021)
- TRC-EB-5 EXPLORATORY BORING BY TRC (2018)
- TRC-CPT-5 CONE PENETRATION TEST BY TRC (2018)
- LNY-EB-103 EXPLORATORY BORING BY LOWNEY (2001)
- LNY-EB-5 EXPLORATORY BORING BY LOWNEY (2002)
- LNY-EB-5 EXPLORATORY BORING BY EARTH SYSTEMS (1983)
- GEI-B-5 EXPLORATORY BORING BY GEI (2012)
- GEI-CPT-4 CONE PENETRATION TEST BY GEI (2012)
- RSD-1
M-3
W-124 MISCELLANEOUS MONITORING WELL AND BORING LOGS ASSOCIATED WITH 1990 BAY ROAD (1987 to 2011)



NOTE: ALL PREVIOUS AND PROPOSED SUBSURFACE EXPLORATIONS LOCATIONS SHOWN ARE APPROXIMATE.



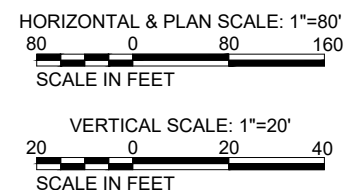
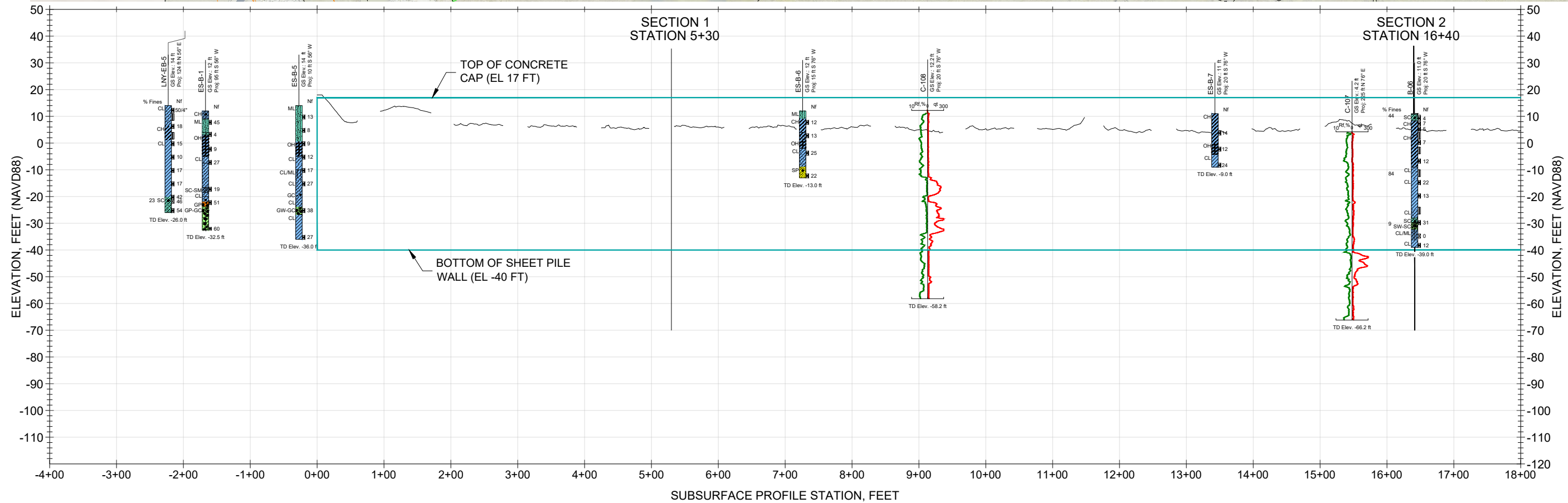
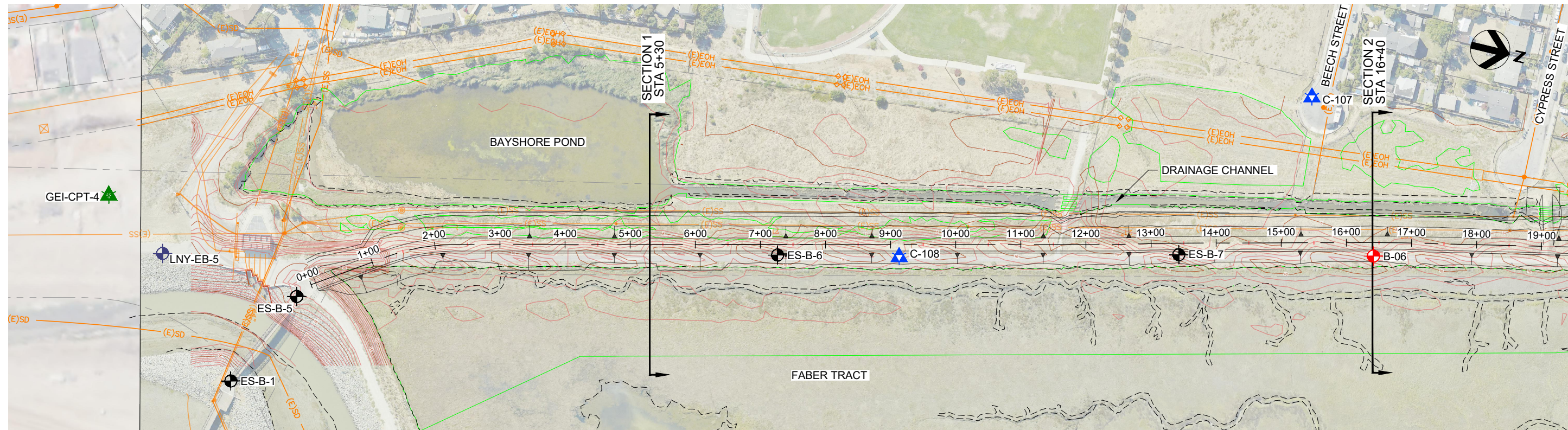
AERIAL IMAGE SOURCE: GOOGLE EARTH PRO

SITE PLAN - SOUTH OF BAY ROAD

SAFER BAY PROJECT
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure

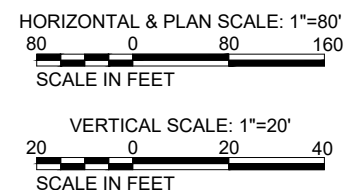
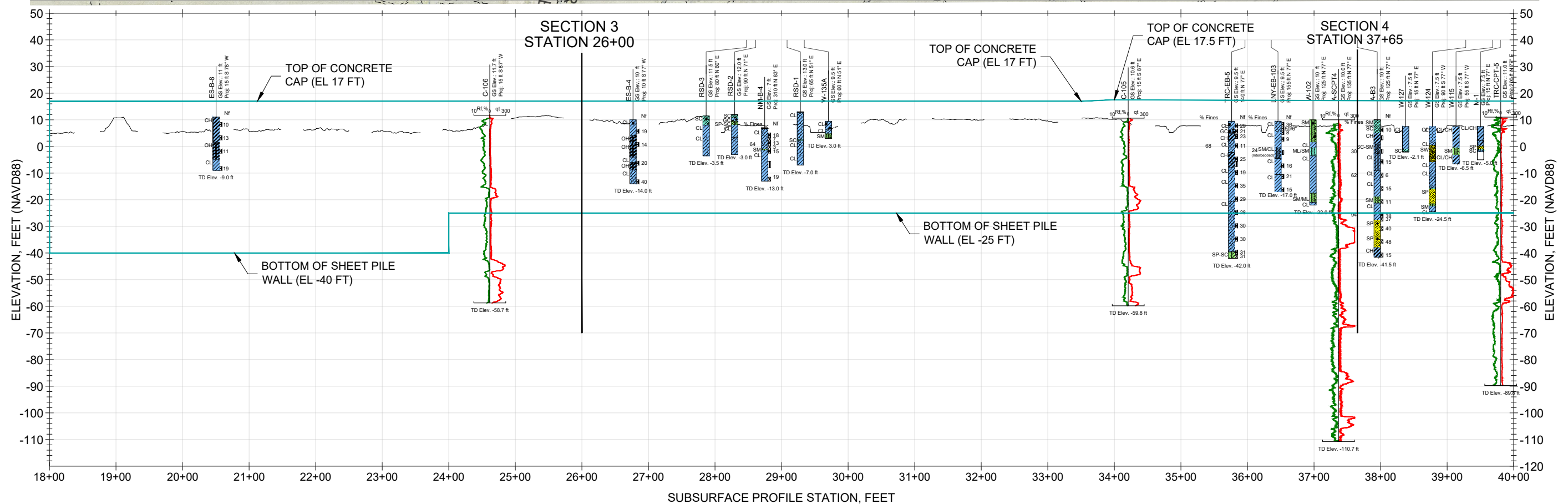
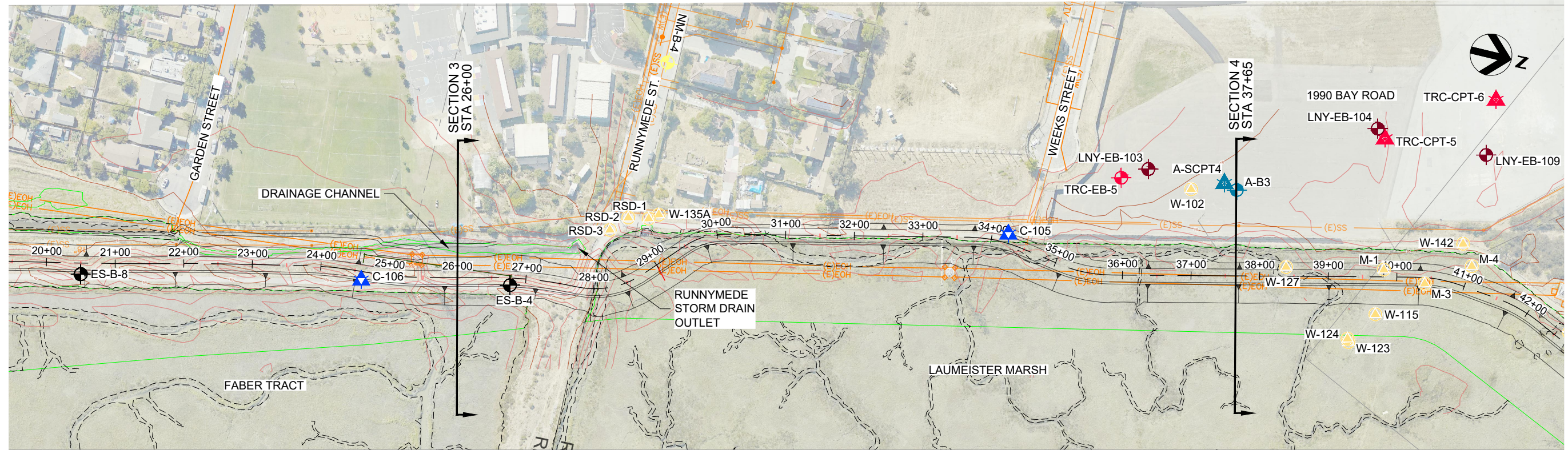


SUBSURFACE PROFILE (SOUTH OF BAY ROAD)
STATION -4+00 TO 18+00
PROFILE SHEET 1 OF 3

SAFER BAY PROJECT
 SAN MATEO COUNTY, CALIFORNIA

NOTE:
 1. REFER TO FIGURE 2 FOR A LEGEND PROVIDING SOURCES FOR THE SUBSURFACE EXPLORATION LOCATIONS SHOWN ON THIS PLAN AND PROFILE.

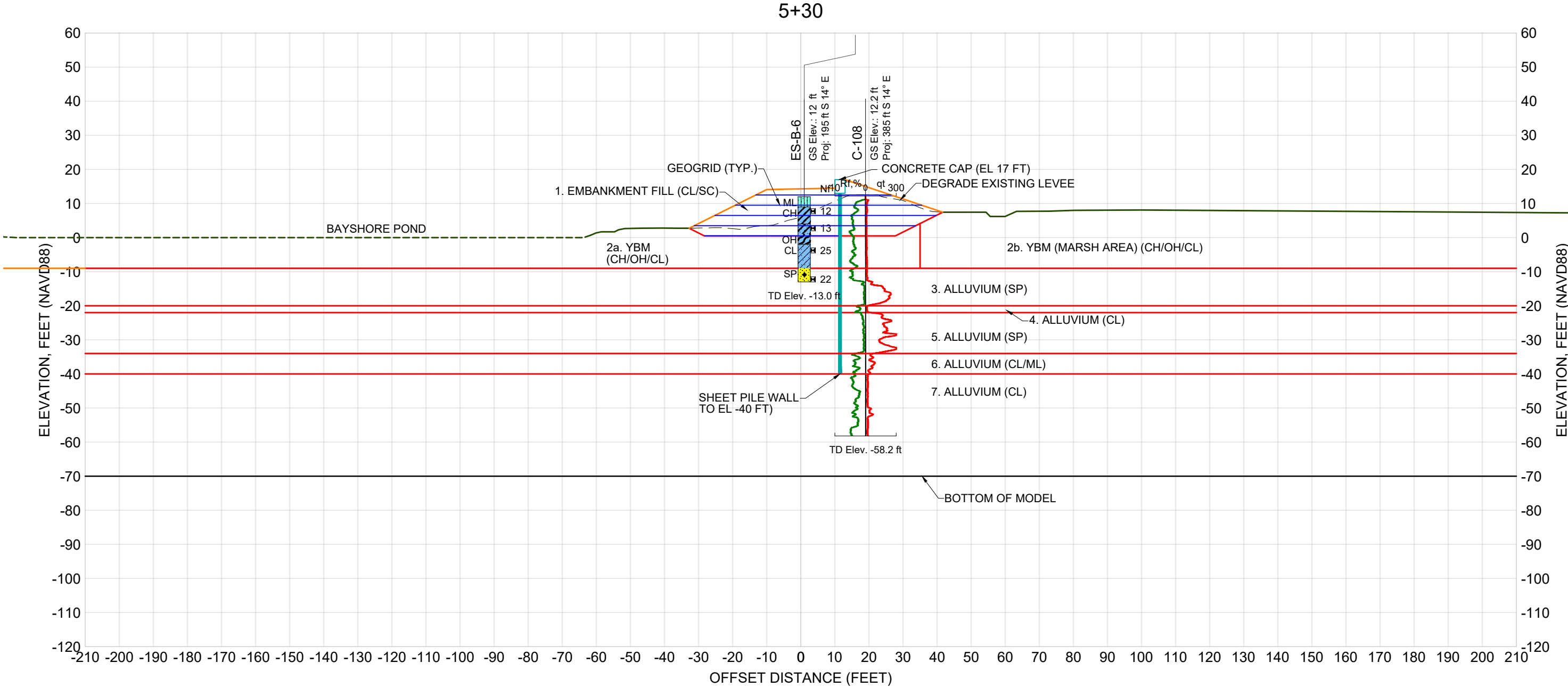
Date	JUNE 2024
Figure	3



SUBSURFACE PROFILE (SOUTH OF BAY ROAD)
STATION 18+00 TO 40+00
PROFILE SHEET 2 OF 3

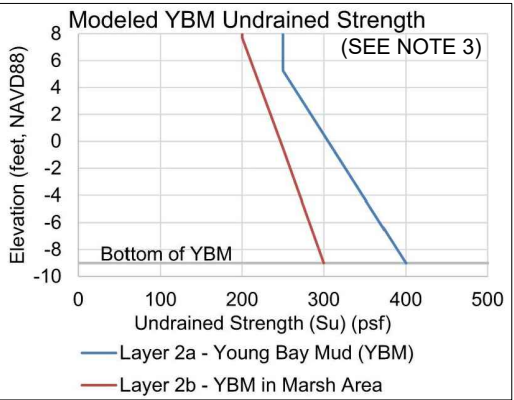
SAFER BAY PROJECT
 SAN MATEO COUNTY, CALIFORNIA

NOTE:
 1. REFER TO FIGURE 2 FOR A LEGEND PROVIDING SOURCES FOR THE SUBSURFACE EXPLORATION LOCATIONS SHOWN ON THIS PLAN AND PROFILE.

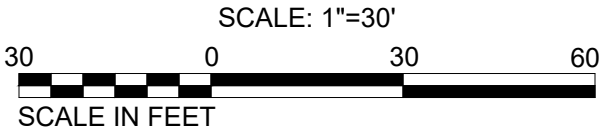


SOIL PARAMETERS FOR SEEPAGE AND STABILITY ANALYSIS

MODEL STRATIGRAPHY			SEEPAGE PARAMETERS			UNIT WEIGHT AND STRENGTH PARAMETERS						SETTLEMENT PARAMETERS							
LAYER	LAYER DESCRIPTION	USCS SOIL TYPE	K _H (cm/s)	K _V (cm/s)	K _V /K _H	γ _T (pcf)	φ' (deg)	c' (psf)	φ _R (deg)	c _R (psf)	Su (psf)	C _{ce}	C _{re}	C _{ae/ce}	P _c (ksf)	C _v (ft ² /d)	C _{vr} (ft ² /d)	E _s (ksf)	
1	EMBANKMENT FILL	CL/SC	4.0X10 ⁻⁶	1.0x10 ⁻⁶	0.25	125	30	75	--	750	750	--	--	--	1.4	--	--	--	
2a	YOUNG BAY MUD (YBM)	CH/OH/CL	1.0X10 ⁻⁶	2.5x10 ⁻⁷	0.25	110	29	0	0	300	250 - 400	0.17	0.032	0.04	1.4 - 1.7	15	50	--	
2b	YBM IN MARSH AREA	CH/OH/CL	1.0X10 ⁻⁶	2.5x10 ⁻⁷	0.25	100	29	0	0	225	200 - 300	--	--	--	--	--	--	--	
3	ALLUVIUM (COARSE-GRAINED)	SP	1.0X10 ⁻²	1.0x10 ⁻²	1	125	36	0	--	--	--	--	--	--	1.7 - 2.8	--	--	600	
4	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5x10 ⁻⁷	0.25	120	30	50	0	900	900	0.15	0.030	--	2.8 - 3.0	40	200	--	
5	ALLUVIUM (COARSE-GRAINED)	SP	1.0X10 ⁻²	1.0X10 ⁻²	1	125	36	0	--	--	--	--	--	--	3.0 - 4.2	--	--	900	
6	ALLUVIUM (FINE-GRAINED)	CL/ML	1.0X10 ⁻⁵	2.5X10 ⁻⁶	0.25	120	30	50	0	1200	1200	0.15	0.020	--	4.2 - 4.9	40	200	--	
7	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	1200	1200	0.15	0.020	--	4.9 - 8.5	40	200	--	



- NOTES:
- TOTAL STRENGTH (UNDRAINED) PARAMETERS ϕ_R AND C_R ARE USED FOR WATERSIDE RAPID DRAWDOWN STABILITY ANALYSIS AND UNDRAINED STRENGTH (S_u) IS USED IN END OF CONSTRUCTION STABILITY ANALYSIS.
 - UNDRAINED STRENGTH (S_u) FOR THE YOUNG BAY MUD LAYER VARIES AS SHOWN IN THE "MODELED YBM UNDRAINED STRENGTH" PLOT ABOVE. THIS UNDRAINED STRENGTH IS REDUCED BY 20 PERCENT IN SEISMIC STABILITY ANALYSES TO ACCOUNT FOR CYCLIC STRENGTH DEGRADATION (APPENDIX G).

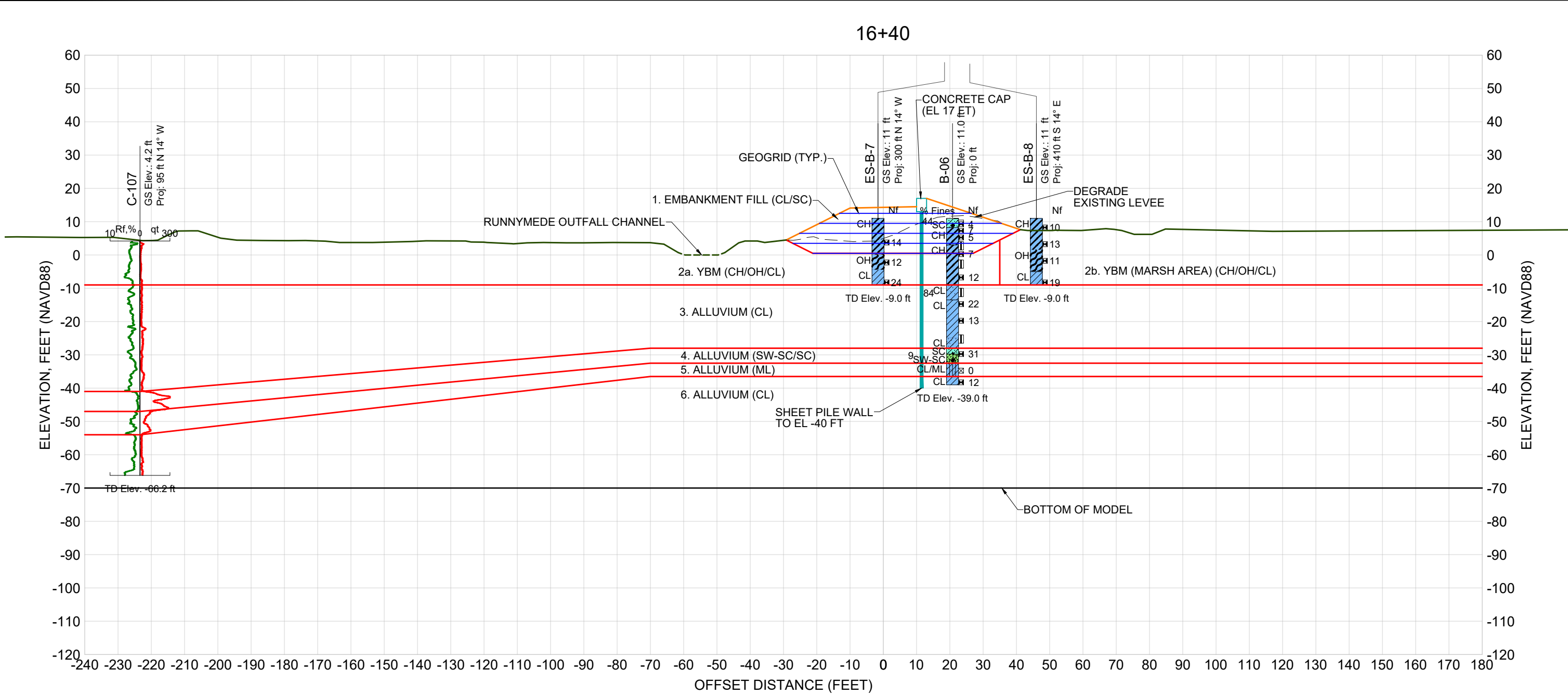


ANALYSIS CROSS SECTION 1
STATION 5+30

SAFER BAY PROJECT
SAN MATEO COUNTY, CALIFORNIA

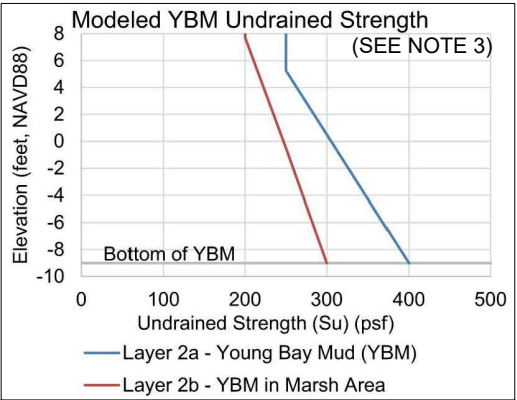
Date
JUNE 2024

Figure
6

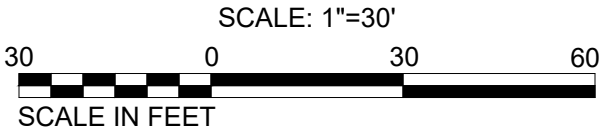


SOIL PARAMETERS FOR SEEPAGE AND STABILITY ANALYSIS

MODEL STRATIGRAPHY			SEEPAGE PARAMETERS			UNIT WEIGHT AND STRENGTH PARAMETERS						SETTLEMENT PARAMETERS							
LAYER	LAYER DESCRIPTION	USCS SOIL TYPE	K _H (cm/s)	K _V (cm/s)	K _V /K _H	γ _T (pcf)	ϕ' (deg)	c' (psf)	ϕ _R (deg)	c _R (psf)	Su (psf)	C _{ce}	C _{re}	C _{ae/ce}	P _c (ksf)	C _v (ft²/d)	C _{vr} (ft²/d)	E _s (ksf)	
1	EMBANKMENT FILL	CL/SC	4.0X10 ⁻⁶	1.0x10 ⁻⁶	0.25	125	30	75	0	750	750	--	--	--	1.4	--	--	--	
2a	YOUNG BAY MUD (YBM)	CH/OH/CL	1.0X10 ⁻⁶	2.5x10 ⁻⁷	0.25	110	29	0	0	300	250 - 400	0.17	0.032	0.04	1.4 - 1.7	15	50	--	
2b	YBM IN MARSH AREA	CH/OH/CL	1.0X10 ⁻⁶	2.5x10 ⁻⁷	0.25	100	29	0	0	225	200 - 300	--	--	--	--	--	--	--	
3	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5x10 ⁻⁷	0.25	120	30	50	0	700	700	0.15	0.03	--	2.4 - 3.6	40	200	--	
4	ALLUVIUM (COARSE-GRAINED)	SW-SC/SC	1.0X10 ⁻³	2.5X10 ⁻⁴	0.25	125	36	0	--	--	--	--	--	--	3.6 - 4.1	--	--	900	
5	ALLUVIUM (FINE-GRAINED)	ML	4.0X10 ⁻⁵	1.0x10 ⁻⁵	0.25	120	30	50	0	900	1200	0.15	0.020	--	4.1 - 4.5	40	200	--	
6	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	--	1200	0.15	0.020	--	4.5 - 8.5	40	200	--	



- NOTES:
- TOTAL STRENGTH (UNDRAINED) PARAMETERS ϕ_R AND C_R ARE USED FOR WATERSIDE RAPID DRAWDOWN STABILITY ANALYSIS AND UNDRAINED STRENGTH (S_u) IS USED IN END OF CONSTRUCTION STABILITY ANALYSIS.
 - UNDRAINED STRENGTH (S_u) FOR THE YOUNG BAY MUD LAYER VARIES AS SHOWN IN THE "MODELED YBM UNDRAINED STRENGTH" PLOT ABOVE. THIS UNDRAINED STRENGTH IS REDUCED BY 20 PERCENT IN SEISMIC STABILITY ANALYSES TO ACCOUNT FOR CYCLIC STRENGTH DEGRADATION (APPENDIX G).



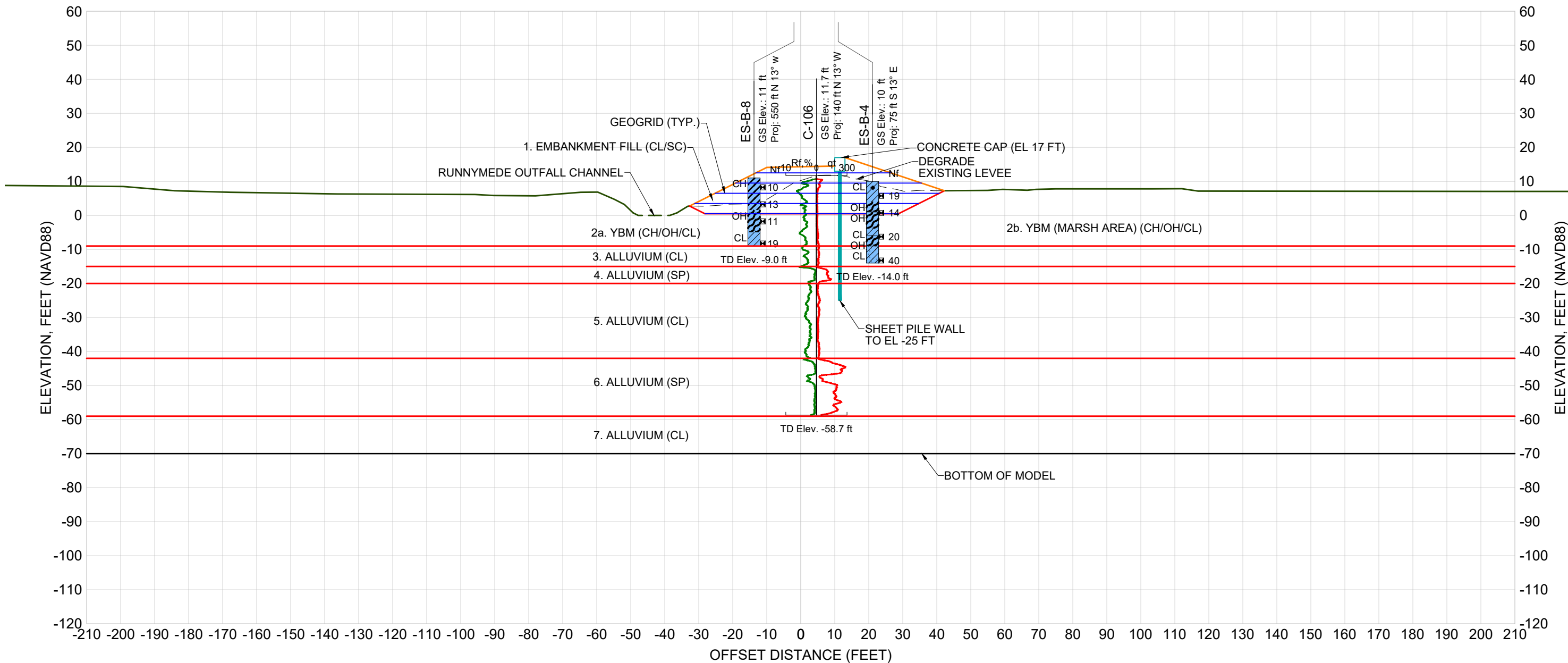
ANALYSIS CROSS SECTION 2
STATION 16+40

SAFER BAY PROJECT
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

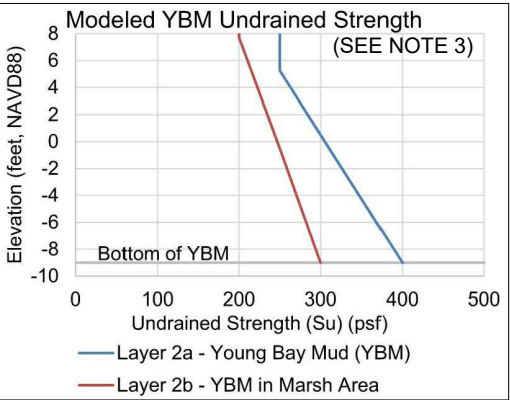
Figure
7

26+00

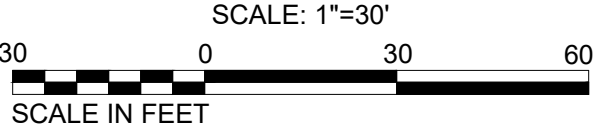


SOIL PARAMETERS FOR SEEPAGE AND STABILITY ANALYSIS

MODEL STRATIGRAPHY			SEEPAGE PARAMETERS			UNIT WEIGHT AND STRENGTH PARAMETERS						
LAYER	LAYER DESCRIPTION	USCS SOIL TYPE	K_H (cm/s)	K_V (cm/s)	K_V/K_H	γ_T (pcf)	ϕ' (deg)	c' (psf)	ϕ_R (deg)	c_R (psf)	S_u (psf)	
1	EMBANKMENT FILL	CL/SC	4.0×10^{-6}	1.0×10^{-6}	0.25	125	30	75	0	750	750	
2a	YOUNG BAY MUD (YBM)	CH/OH/CL	1.0×10^{-6}	2.5×10^{-7}	0.25	110	29	0	0	300	250 - 400	
2b	YBM IN MARSH AREA	CH/OH/CL	1.0×10^{-6}	2.5×10^{-7}	0.25	100	29	0	0	225	200 - 300	
3	ALLUVIUM (FINE-GRAINED)	CL	1.0×10^{-6}	2.5×10^{-7}	0.25	120	30	50	0	700	700	
4	ALLUVIUM (COARSE-GRAINED)	SP	1.0×10^{-2}	1.0×10^{-2}	1	125	36	0	--	--	--	
5	ALLUVIUM (FINE-GRAINED)	CL	1.0×10^{-3}	2.5×10^{-4}	0.25	120	30	50	0	1200	1200	
6	ALLUVIUM (COARSE-GRAINED)	SP	1.0×10^{-2}	1.0×10^{-2}	1	125	36	0	--	--	--	
7	ALLUVIUM (FINE-GRAINED)	CL	1.0×10^{-6}	2.5×10^{-7}	0.25	120	30	50	0	1200	1200	



- NOTES:
- TOTAL STRENGTH (UNDRAINED) PARAMETERS ϕ_R AND c_R ARE USED FOR WATERSIDE RAPID DRAWDOWN STABILITY ANALYSIS AND UNDRAINED STRENGTH (S_u) IS USED IN END OF CONSTRUCTION STABILITY ANALYSIS.
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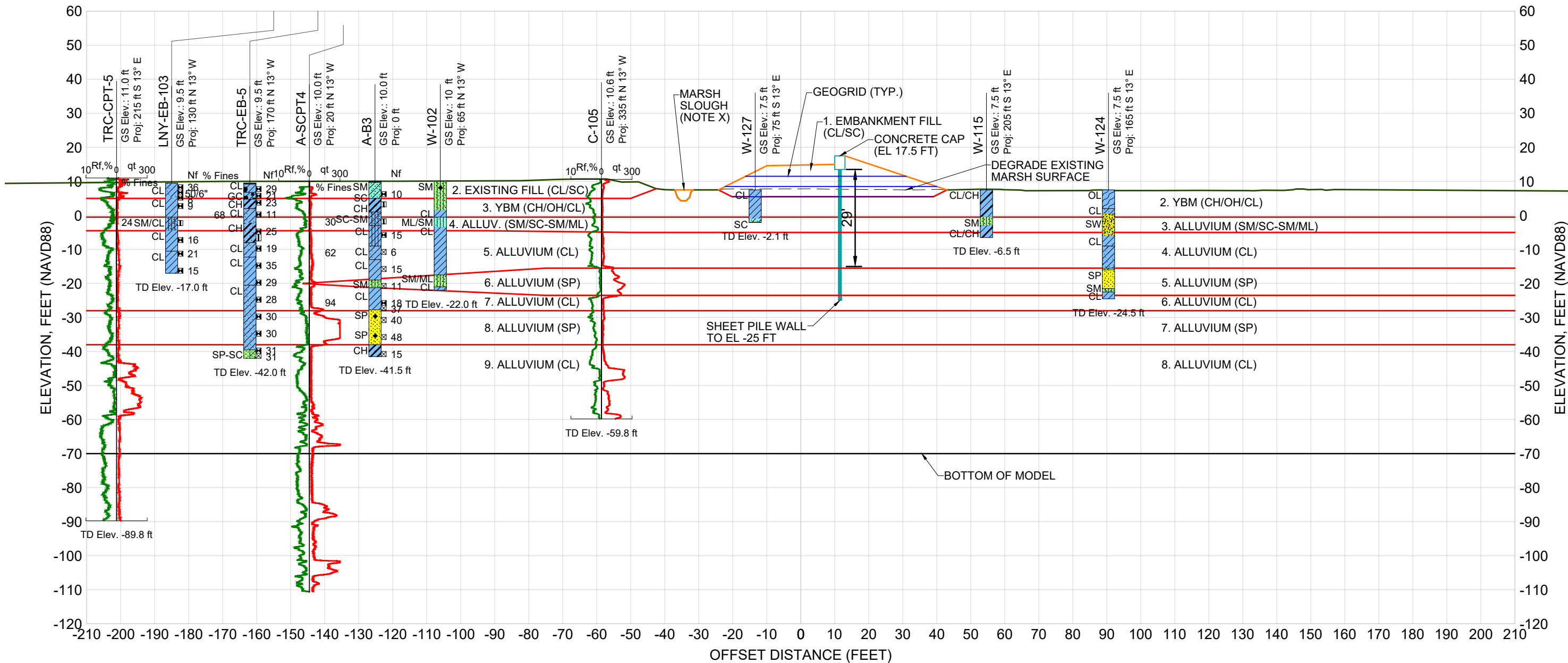


ANALYSIS CROSS SECTION 3
STATION 26+00

SAFER BAY PROJECT
SAN MATEO COUNTY, CALIFORNIA

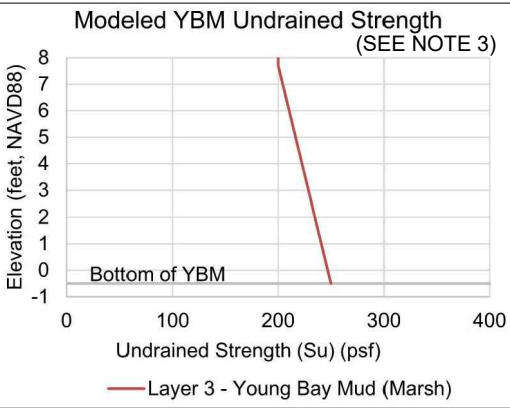
Date
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Figure
8

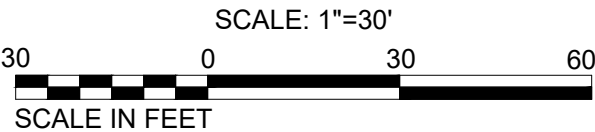


SOIL PARAMETERS FOR SEEPAGE AND STABILITY ANALYSIS

MODEL STRATIGRAPHY			SEEPAGE PARAMETERS			UNIT WEIGHT AND STRENGTH PARAMETERS						SETTLEMENT PARAMETERS						
LAYER	LAYER DESCRIPTION	USCS SOIL TYPE	K _H (cm/s)	K _V (cm/s)	K _V /K _H	γ _T (pcf)	φ' (deg)	c' (psf)	φ _R (deg)	C _R (psf)	Su (psf)	C _{ce}	C _{re}	C _{ae/ce}	P _c (ksf)	C _v (ft ² /d)	C _{vr} (ft ² /d)	E _s (ksf)
1	EMBANKMENT FILL	CL/SC	4.0X10 ⁻⁶	1.0X10 ⁻⁶	0.25	125	30	75	0	750	750	--	--	--	0.7	--	--	--
2	EXISTING FILL	CL/SC	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	25	0	500	500	--	--	--	--	--	--	--
3	YOUNG BAY MUD (MARSH)	CH/OH/CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	100	29	0	0	225	200 - 250	0.30	0.040	0.04	0.7 - 0.9	15	50	--
4	ALLUVIUM (COARSE-GRAINED)	SM/SC-SM/SM	1.0X10 ⁻⁴	2.5X10 ⁻⁵	0.25	120	32	0	--	90	--	--	--	--	0.9 - 1.3	--	--	200
5	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	600	600	0.15	0.030	--	1.6 - 2.4	40	200	--
6	ALLUVIUM (COARSE-GRAINED)	SP	1.0X10 ⁻²	1.0X10 ⁻²	1	125	36	0	--	--	--	--	--	--	2.4 - 3.0	--	--	600
7	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	800	800	0.15	0.020	--	3.0 - 3.5	40	200	--
8	ALLUVIUM (COARSE-GRAINED)	SP	1.0X10 ⁻²	1.0X10 ⁻²	1	125	36	0	--	--	--	--	--	--	3.5 - 4.7	--	--	800
9	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	1200	1200	0.15	0.020	--	4.7 - 8.5	40	200	--



- NOTES:
- TOTAL STRENGTH (UNDRAINED) PARAMETERS ϕ_R AND C_R ARE USED FOR WATERSIDE RAPID DRAWDOWN STABILITY ANALYSIS AND UNDRAINED STRENGTH (S_u) IS USED IN END OF CONSTRUCTION STABILITY ANALYSIS.
 - UNDRAINED STRENGTH (S_u) FOR THE YOUNG BAY MUD LAYER VARIES AS SHOWN IN THE "MODELED YBM UNDRAINED STRENGTH" PLOT ABOVE. THIS UNDRAINED STRENGTH IS REDUCED BY 20 PERCENT IN SEISMIC STABILITY ANALYSES TO ACCOUNT FOR CYCLIC STRENGTH DEGRADATION (APPENDIX G).
 - RESIDUAL SHEAR STRENGTH OF 100 PSF IS USED FOR LAYER 4 IN PSEUDOSTATIC SEISMIC STABILITY ANALYSIS CONSIDERING LIQUEFACTION (SEE FIGURES G.5 TO G.7).

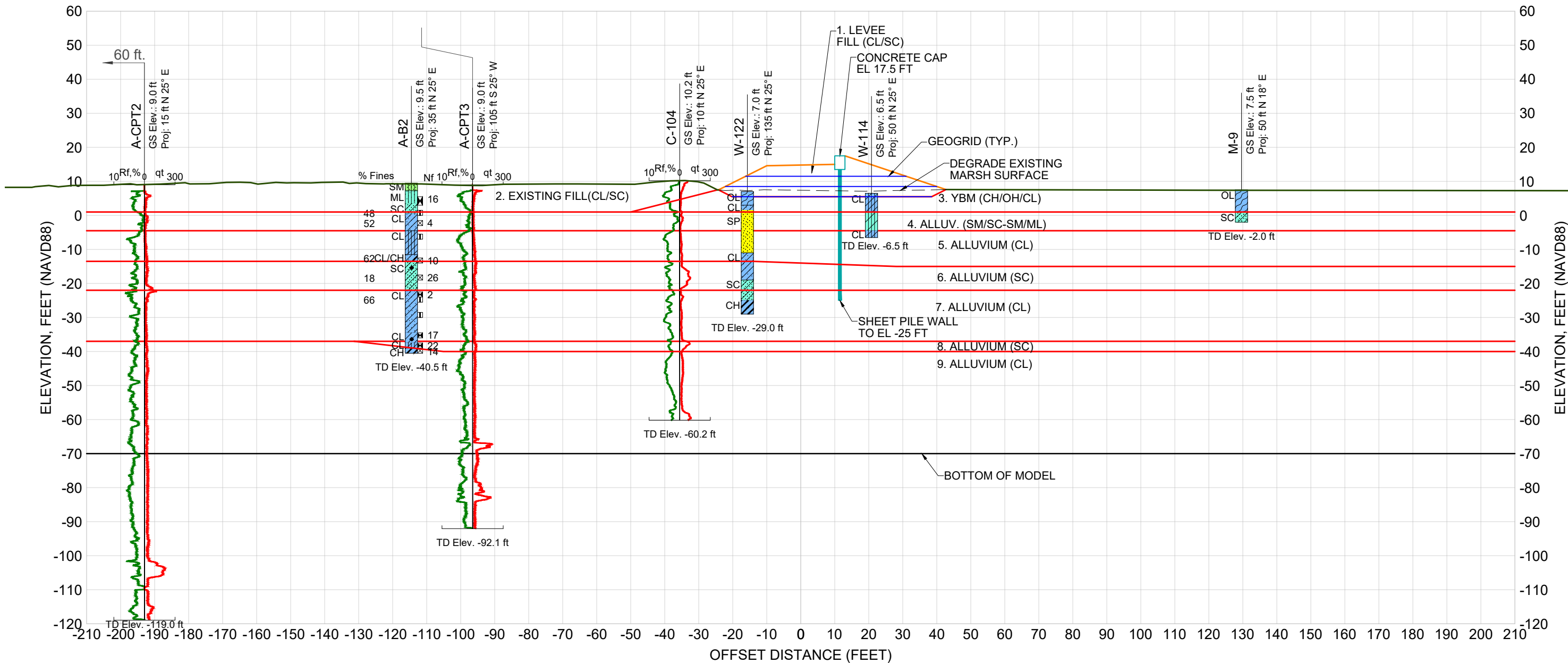


ANALYSIS CROSS SECTION 4
STATION 37+65

SAFER BAY PROJECT
SAN MATEO COUNTY, CALIFORNIA

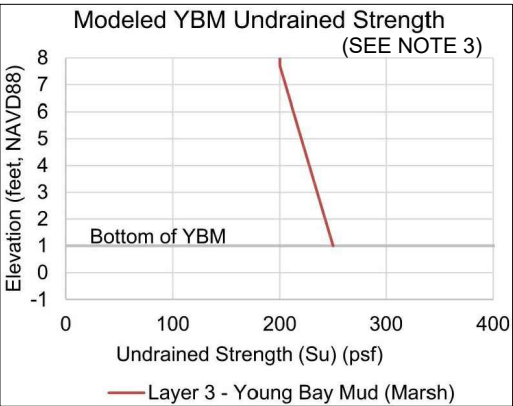
Date
JUNE 2024

Figure
9

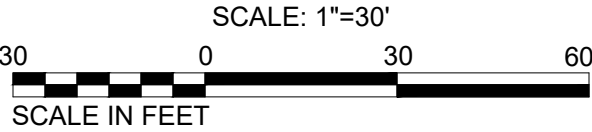


SOIL PARAMETERS FOR SEEPAGE AND STABILITY ANALYSIS

MODEL STRATIGRAPHY			SEEPAGE PARAMETERS			UNIT WEIGHT AND STRENGTH PARAMETERS						SETTLEMENT PARAMETERS							
LAYER	LAYER DESCRIPTION	USCS SOIL TYPE	K _H (cm/s)	K _V (cm/s)	K _V /K _H	γ _T (pcf)	φ' (deg)	c' (psf)	φ _R (deg)	C _R (psf)	c (psf)	C _{ce}	C _{re}	C _{ae/ce}	P _c (ksf)	C _v (ft²/d)	C _{vr} (ft²/d)	E _s (ksf)	
1	EMBANKMENT FILL	CL/SC	4.0X10 ⁻⁶	1.0X10 ⁻⁶	0.25	125	30	75	0	750	750	--	--	--	0.7	--	--	--	
2	EXISTING FILL	CL/SC	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	25	0	500	500	--	--	--	--	--	--	--	
3	YOUNG BAY MUD (MARSH)	CH/OH/CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	100	29	0	0	225	200 - 250	0.30	0.040	0.04	0.7 - 0.9	15	50	--	
4	ALLUVIUM (COARSE-GRAINED)	SM/SC-SM/ML	1.0X10 ⁻⁴	2.5X10 ⁻⁵	0.25	120	32	0	--	90	--	--	--	--	0.9 - 1.3	--	--	200	
5	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	600	600	--	--	--	1.6 - 2.3	40	200	--	
6	ALLUVIUM (COARSE-GRAINED)	SC	1.0X10 ⁻⁴	2.5X10 ⁻⁵	0.25	125	36	0	--	--	--	0.15	0.030	--	2.3 - 2.9	--	--	600	
7	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	900	900	--	--	--	2.9 - 4.6	40	200	--	
8	ALLUVIUM (COARSE-GRAINED)	SC	1.0X10 ⁻⁴	2.5X10 ⁻⁵	0.25	125	36	0	--	--	--	0.15	0.020	--	4.6 - 5.0	--	--	800	
9	ALLUVIUM (FINE-GRAINED)	CL	1.0X10 ⁻⁶	2.5X10 ⁻⁷	0.25	120	30	50	0	1200	1200	--	--	--	5.0 - 8.6	40	200	--	



- NOTES:
- TOTAL STRENGTH (UNDRAINED) PARAMETERS ϕ_R AND C_R ARE USED FOR WATERSIDE RAPID DRAWDOWN STABILITY ANALYSIS AND UNDRAINED STRENGTH (S_u) IS USED IN END OF CONSTRUCTION STABILITY ANALYSIS.
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 - RESIDUAL SHEAR STRENGTH OF 100 PSF IS USED FOR LAYER 4 IN PSEUDOSTATIC SEISMIC STABILITY ANALYSIS CONSIDERING LIQUEFACTION (SEE FIGURES G.9).

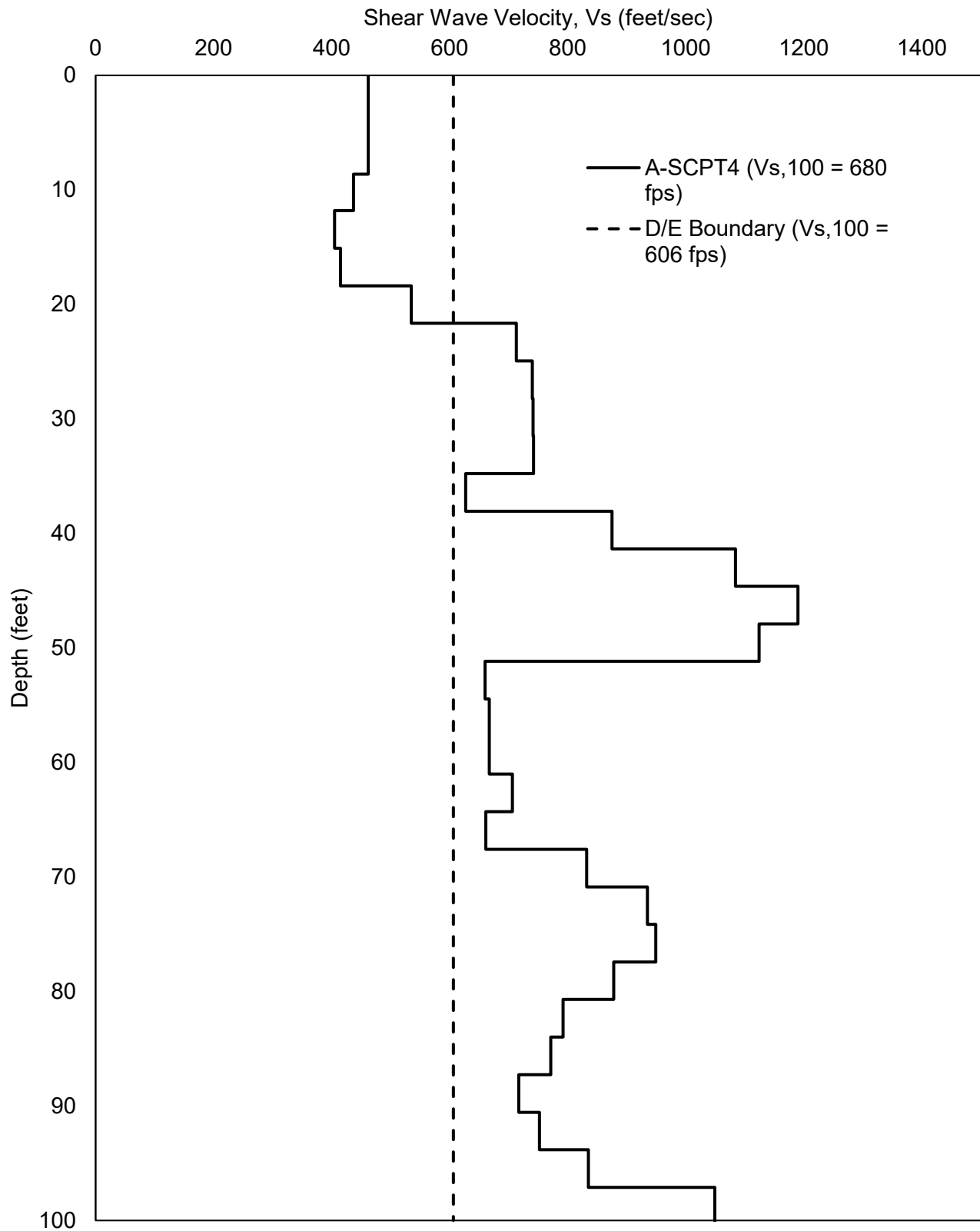


ANALYSIS CROSS SECTION 5
STATION 44+00

SAFER BAY PROJECT
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure



SHEAR WAVE VELOCITY PROFILE

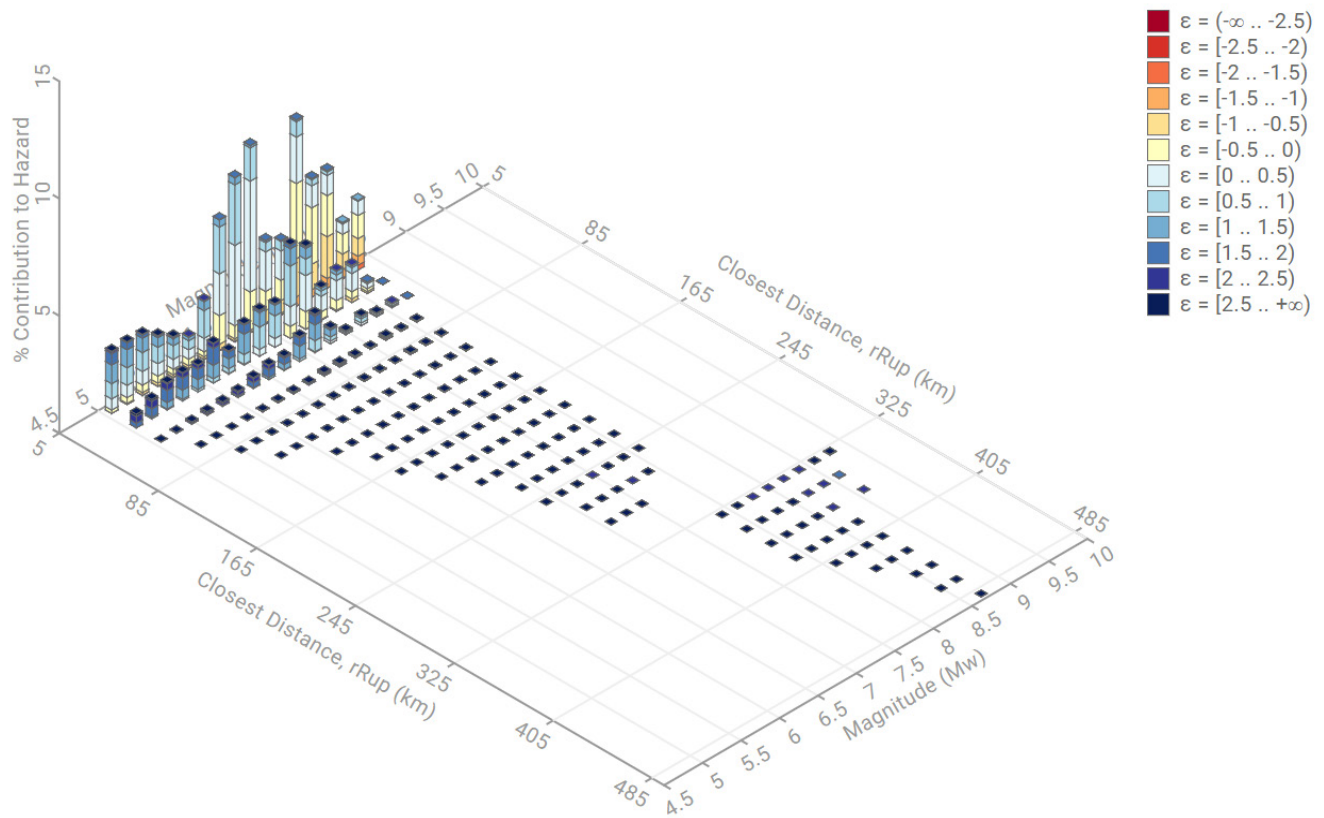
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date

JUNE 2024

Figure

11



Mean (over all sources)

m : 6.87
 r : 21.26 km
 ϵ_0 : 0.46 σ

Mode (largest m - r - ϵ_0 bin)

m : 6.87
 r : 17.68 km
 ϵ_0 : 0.36 σ
 Contribution : 4.73 %

Disaggregation targets

Return period : 100 yrs
 Exceedance rate : 0.01 yr^{-1}
 PGA ground motion : 2.783e-1 g

Disaggregation Contributions

Source Set	L_p	Source	Type	r	m	ϵ_0	lon	lat	az	%
UCERF3 Fault Model 3.2			FaultSystem							39.49
Hayward (south) (3)				17.84	6.94	0.32	121.959°W	37.553°N	57.26	11.31
San Andreas (Peninsula) (5)				12.92	7.80	-0.35	122.244°W	37.399°N	233.89	9.11
Calaveras (north) (5)				25.26	7.15	0.46	121.864°W	37.554°N	67.29	2.72
Monte Vista - Shannon (1)				9.91	6.73	-0.12	122.191°W	37.396°N	215.39	1.67
San Gregorio (north) (11)				27.62	7.60	0.36	122.418°W	37.378°N	249.03	1.49
UCERF3 Fault Model 3.1			FaultSystem							39.36
Hayward (south) (3)				17.84	6.94	0.32	121.959°W	37.553°N	57.26	11.29
San Andreas (Peninsula) (5)				12.92	7.80	-0.35	122.244°W	37.399°N	233.89	9.02
Calaveras (north) (5)				25.26	7.16	0.45	121.864°W	37.554°N	67.29	2.67
Monte Vista - Shannon (1)				9.91	6.73	-0.13	122.191°W	37.396°N	215.39	1.78
San Gregorio (north) (11)				27.62	7.61	0.36	122.418°W	37.378°N	249.03	1.54
Calaveras (center) (9)				27.50	6.70	0.98	121.815°W	37.457°N	92.31	1.08
UCERF3 Fault Model 3.1 (opt)			Grid							10.52
UCERF3 Fault Model 3.2 (opt)			Grid							10.5

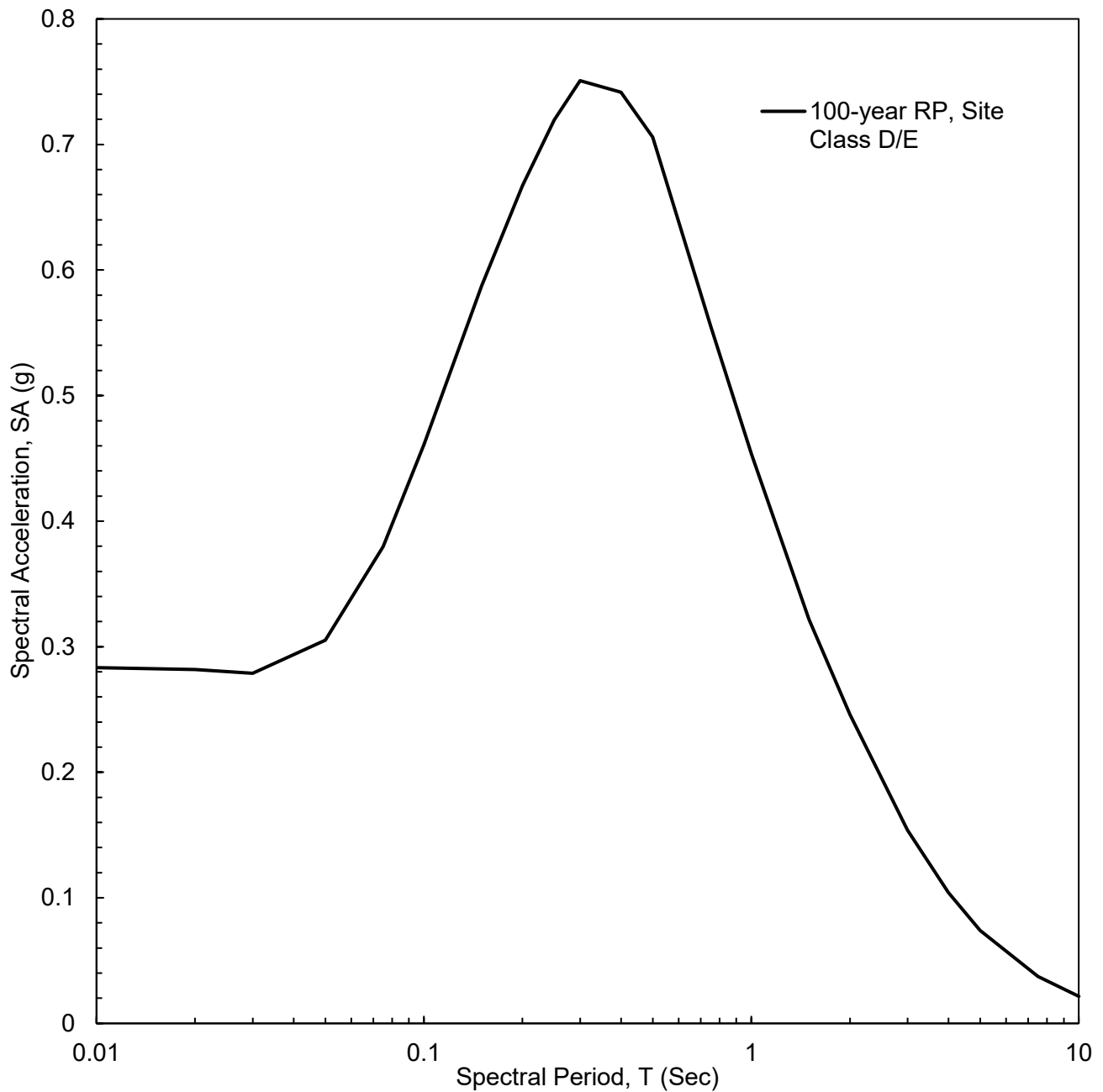
Source Model: NSHM Conterminous U.S. 2018

Earthquake Hazard Toolbox, Response Spectra Tool: <https://earthquake.usgs.gov/nshmp/hazard/disagg>



USGS HAZARD DISAGGREGATION (2018 NSHM)
100-YR RETURN PERIOD AND SITE CLASS D/E
PEAK GROUND ACCELERATION
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 12



**100-YEAR RETURN PERIOD UNIFORM HAZARD SPECTRUM
SITE CLASS D/E BOUNDARY**

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
13

Appendix A. Past Subsurface Explorations

DRAFT

HDR (2016)

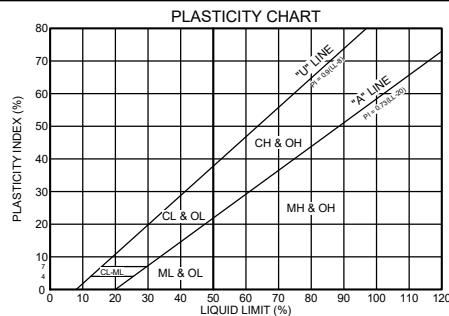
B-06

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND	
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	$C_u \geq 4$ AND $1 \leq C_c \leq 3$	GW	WELL-GRADED GRAVEL	
			$C_u < 4$ AND/OR $1 > C_c > 3$	GP	POORLY-GRADED GRAVEL	
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL	
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL	
	SANDS >50% OF COARSE FRACTION PASSES NO 4. SIEVE	CLEAN SANDS <5% FINES	$C_u \geq 6$ AND $1 \leq C_c \leq 3$	SW	WELL-GRADED SAND	
			$C_u < 6$ AND/OR $1 > C_c > 3$	SP	POORLY-GRADED SAND	
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND	
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND	
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY	
			PI<4 OR PLOTS<"A" LINE	ML	SILT	
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT	
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY	
			PI PLOTS <"A" LINE	MH	ELASTIC SILT	
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT	
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT	

OTHER SYMBOLS

MATERIALS	SAMPLERS
Asphalt	SPT (2" OD)
Aggregate Base	Modified California (3" OD)
Boulders & Cobbles	California (2.5" OD)
Fill	Shelby Tube
Topsoil	Pitcher Barrel
	HQ Core
	Grab/Bulk
PIEZOMETER	
Concrete Grout/Fill	INITIAL WATER LEVEL MEASUREMENT (WITH DATE)
Bentonite/Grout Seal	STABILIZED WATER LEVEL MEASUREMENT (WITH DATE)
Sand Pack + Solid Pipe	
Sand Pack + Slotted Pipe	



U.S. STANDARD SIEVE		GRAIN SIZES					
	200	40	10	4	3/4"	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

PENETRATION RESISTANCE				
SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	UNC. COMP. STRENGTH (KSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 1	0 - 1/2
LOOSE	5 - 10	SOFT	2 - 4	1/2 - 1
MEDIUM DENSE	11 - 30	MEDIUM STIFF	5 - 8	1 - 2
DENSE	31 - 50	STIFF	9 - 15	2 - 4
VERY DENSE	OVER 50	VERY STIFF	16 - 30	4 - 8
		HARD	OVER 30	OVER 8

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

LABORATORY TESTS

AT ATTERBERG LIMITS
 CD CONSOLIDATED DRAINED TRIAXIAL
 CN CONSOLIDATION
 CR CORROSION
 CU CONSOLIDATED UNDRAINED TRIAXIAL
 DS DIRECT SHEAR
 HY HYDROMETER
 PR PERMEABILITY
 RV R-VALUE
 SA SIEVE ANALYSIS
 TC CYCLIC TRIAXIAL
 UC UNCONFINED COMPRESSION
 UU UNCONSOLIDATED UNDRAINED TRIAXIAL
 -200 % PASSING NO. 200 SIEVE

PROPERTIES

c COHESION
 DD DRY DENSITY
 EI EXPANSION INDEX
 LL LIQUID LIMIT
 MC MOISTURE CONTENT
 N₆₀ FIELD BLOW COUNT
 PI PLASTICITY INDEX
 S_u UNDRAINED STRENGTH

UNDRAINED SHEAR STRENGTH

V FIELD VANE
 P POCKET PENETROMETER
 T TORVANE
 Q UNCONFINED COMPRESSION
 U UNCONSOLIDATED UNDRAINED TRIAXIAL

INCREASING VISUAL
MOISTURE CONTENT

↑
 WET
 MOIST
 DRY

Boring Legend

SAFER Bay, Task Order 1
 Menlo Park and East Palo Alto, CA

Date

Figure

A-1





Project: SAFER Bay, Task Order 1	Boring ID: B-06	Sheet 1 of 2
Project Location: Menlo Park and East Palo Alto, CA		
Project Number: 028-222952		

Start Date: 1/19/2016	End Date: 1/19/2016	Logged By: V. Crosariol	Checked By: E. Woo	Date Checked: 3/14/2016
Drilling Company (Rig Type): Pitcher Drilling Co. (Fraste XL)		Inspector: San Mateo County	Weather Conditions: Cloudy, rain, wind	
Drill Method: Mud Rotary		Drilled By: Will Halai	Elevation Top of Boring: 11.0 ft. Vertical Datum: NAVD88	
Drill Bit (Type/Size): Drag Bit / 3" : Tri-cone / 5"		Total Depth Drilled: 50 ft.	Latitude: 37.465580° Longitude: -122.125688° Horizontal Datum: NAD83	
Hammer Type: Automatic		Hole Backfill: Cement grout	Northing: 1,996,091 ft. Easting: 6,089,875 ft. Coordinate System: California State Plane Zone 3	
Hammer Efficiency: 84 %	Rod Type: NWJ	Total Number of Samples: 20 Disturbed: 16 Undisturbed: 4	Initial Groundwater Depth: Not Established Static Groundwater Depth: Not Established	

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N _r	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No	Laboratory					Su (ksf)	REMARKS
									Fines	LL	PL	DD	MC		
10			1	4		1" Asphalt Concrete over 2" Aggregate Base.		S1	44						Begin drilling with 6" Core Barrel.
			2			FILL (af)	78	S2							
			2			CLAYEY SAND with Gravel (SC): medium stiff, dark brown mottled light brown, moist, fine to coarse sand, fine to coarse angular gravel (up to 1.5"), high plasticity clay fines, red brick fragments.									
			1	7		FAT CLAY (CH): medium stiff, dark brown slightly mottled light brown, moist, high plasticity, trace sand.	28	L1				86	35	0.7 T	Install casing to 3'; change to mud rotary with 5" tri-cone bit.
5			0	5			50	L2						0.9 T	
5			2			- stiff, dark brown mottled grayish brown.		L3						1.3 T	
			3			- trace fine gravel.		L4							
			<50 psi			YOUNG BAY MUD (Qbm)	80			73	44	77	41	0.7 U	UU test at 8'.
						FAT CLAY (CH): medium stiff, greenish gray, moist, high plasticity, trace fine to coarse sand, trace fine angular gravel, trace organics, slight organic odor.								0.6 T	
-10			0	7		- greenish gray mottled very dark brown at 11'.	39	L5						1.0 T	Change to 3" drag bit at 10'.
0			3			- very dark brown to black at 11.5'.		L6		54	28	80	41		
			4			- greenish gray.	97								
			<50 psi												
-15				12		- stiff, dark gray.	44	L7				97	27	2.2 T 1.8 P 2.0 T	UU test at 14.5'. CN test at 15'. Finish advancing casing at 15'.
			3			- dark greenish gray.									
			6			ALLUVIUM (Qal)									
-20						LEAN CLAY with Sand (CL): stiff, olive, moist, medium plasticity, fine to coarse sand, trace fine angular gravel (up to 1/4").	100	L8	84	34	17	102	23	0.9 U	UU test at 21'.
-10			300 psi											1.4 T	
-25			6	22		LEAN CLAY (CL): stiff to very stiff, olive mottled brown, moist, medium plasticity, trace fine to coarse sand.	67	L9 L10						3.0 T 2.0 T	
-15			11												
			11												

HDR SOIL BORING LOG 2016_R2: 222952 AND 243911 SAFER BAY WITH LAB 20160404.GPJ; HDR_FOLSOM_OAKLAND APRIL 2016_WIP.GLB: 4/13/16



Project: SAFER Bay, Task Order 1

Project Location: Menlo Park and East Palo Alto, CA

Project Number: 028-222952

Boring ID:

B-06

Sheet

2 of 2

Sheets

ELEV	DEPTH	SAMPLE	Blows/ft ² or Press.	N ₆₀	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory					Su (ksf)	REMARKS
									Fines	LL	PI	DD	MC		
-20		X	3 6 7	13		- medium stiff to stiff, light brown mottled olive.	56	L11 L12				103	25	1.4 T 0.9 T	
-35								L13							
-25			200 psi			SANDY LEAN CLAY (CL): stiff, olive gray mottled strong brown, moist, medium plasticity, fine to coarse sand, trace fine angular gravel.	97							1.3 P	
-40		X	11 17 14	31		CLAYEY SAND with Gravel (SC): medium dense, grayish brown, wet, fine to coarse sand, fine angular gravel, medium plasticity fines.	67	L14 L15	9						
-30						Well-Graded SAND with Clay and Gravel (SW-SC): medium dense, very dark brown to black, wet, fine to coarse sand, fine subangular to rounded gravel, trace fines.									
-45			0 0 0	0		SILT with Sand to LEAN CLAY with Sand (CL/ML): very soft, grayish brown mottled strong brown, moist, low plasticity, fast dilatancy, trace fine sand.	83	S3		37	13		37		Zero blows (weight of hammer) indicates potential soil disturbance during drilling.
-35															
-50		X	4 5 7	12		LEAN CLAY (CL): stiff, greenish gray, moist, medium plasticity, trace fine sand.	61	L16 L17						1.6 T	

Bottom of boring at 50.0 feet depth.

HDR SOIL BORING LOG 2016_R2: 222952 AND 243911 SAFER BAY WITH LAB 20160404.GPJ; HDR_FOLSOM_OAKLAND_APRIL 2016_WIP.GLB; 4/13/16

Arup (2021)

A-B2

A-B3

A-CPT2

A-CPT3

A-SCPT4

1.02A-REV BOREHOLE LOG (SOIL) - US 280873 GINT 1775 WEEKS.GPJ ARUPSGINTLIBRARY MASTER.GLB 4/9/21

PROJECT NAME 1990 Bay Road, 1175 Weeks Street, and 1250 Weeks Street				PROJECT NUMBER 280873	
LOGGED BY P. Kumar	BEGIN DATE Feb-25-21	COMPLETION DATE Feb-25-21	BOREHOLE LOCATION (Lat/Long or North/East and Datum) N1998750.799 / E6089311.045 (NAD83)		HOLE ID A-B2
DRILLING CONTRACTOR/DRILLER Pitcher Services LLC/Marcos/Jake			IN-SITU TESTING		SURFACE ELEVATION Not Surveyed
DRILLING METHOD HAND AUGER(0'-2.25'), MUD ROTARY(2.25'-50')			DRILL RIG Failing 1500		BOREHOLE DIAMETER 3-7/8 in
SAMPLER TYPE(S) AND SIZE(S) (ID) MC(2-1/2"), P(2-1/2"), SPT(1-3/8")			SPT HAMMER TYPE/HAMMER ID Automatic, 140 lbs, 30-inch drop		HAMMER EFFICIENCY, ERI 76%
BOREHOLE BACKFILL AND COMPLETION Neat cement grout (up to 27"); topped with excavated soil			GROUNDWATER READINGS Depth (Date/Time)		TOTAL DEPTH OF BORING 50 ft

Elevation (ft)	Depth (ft)	Material Graphics	Description	Sample Location	Sampler Type	Sample Number	N-Value (bl/ft)	Penetration (in)	Recovery (in)	200 Wash (%)	Moisture Content (%)	Total Unit Wt. (pcf)	Liquid Limit (%)	Plasticity Index (%)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks/ Other Tests
	0		SILTY SAND (SM); dark yellowish brown; moist; medium to coarse SAND; trace GRAVEL; [FILL].															Low-lying native grass at ground surface Casing diameter = 5.0"
			SANDY SILT with CLAY (ML); hard; dark gray; moist; medium to coarse SAND; occasional GRAVEL (up to 1/2"); [FILL].															2.25', clay-max liner cut and exposed with hand tool
	5				MC	S1	16	18	16									PP: >4.5 tsf
			CLAYEY SAND (SC); loose; grayish brown; moist.															
					P	S2	50 psi	18	15	47.8			30	9				CORR
	10		SANDY CLAY (CL); soft; yellowish brown; moist; loose, fine to medium SAND.															
					SPT	S3	4	18	9	52			30	10				
			SILTY CLAY (CL); medium stiff; gray; moist.															
	15				P	S4	150 psi	18	17		41	110			UU 0.319			CONSOL
	20																	

(continued)

ARUP

BOREHOLE NO. A-B2
SHEET 1 OF 3

1.0.2A-REV BOREHOLE LOG (SOIL) - US 280873 GINT 1775 WEEKS.GPJ ARUPSGINTLIBRARY MASTER.GLB 4/9/21

PROJECT NAME 1990 Bay Road, 1175 Weeks Street, and 1250 Weeks Street				PROJECT NUMBER 280873	
LOGGED BY P. Kumar	BEGIN DATE Feb-25-21	COMPLETION DATE Feb-25-21	BOREHOLE LOCATION (Lat/Long or North/East and Datum) N1998750.799 / E6089311.045 (NAD83)		HOLE ID A-B2
DRILLING CONTRACTOR/DRILLER Pitcher Services LLC/Marcos/Jake			IN-SITU TESTING		SURFACE ELEVATION Not Surveyed
DRILLING METHOD HAND AUGER(0'-2.25'), MUD ROTARY(2.25'-50')			DRILL RIG Failing 1500		BOREHOLE DIAMETER 3-7/8 in
SAMPLER TYPE(S) AND SIZE(S) (ID) MC(2-1/2"), P(2-1/2"), SPT(1-3/8")			SPT HAMMER TYPE/HAMMER ID Automatic, 140 lbs, 30-inch drop		HAMMER EFFICIENCY, ERI 76%
BOREHOLE BACKFILL AND COMPLETION Neat cement grout (up to 27"); topped with excavated soil			GROUNDWATER READINGS Depth (Date/Time)		TOTAL DEPTH OF BORING 50 ft

Elevation (ft)	Depth (ft)	Material Graphics	Description	Sample Location	Sampler Type	Sample Number	N-Value (bl/ft)	Penetration (in)	Recovery (in)	200 Wash (%)	Moisture Content (%)	Total Unit Wt. (pcf)	Liquid Limit (%)	Plasticity Index (%)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks/ Other Tests
	20																	
			SANDY CLAY (CL-CH); stiff; yellowish brown; moist.															
				X	SPT	S5	10	18	12	61.7			50	33				
			CLAYEY SAND with GRAVEL (SC); yellowish brown; occasional GRAVEL (up to 2").															
	25																	
				X	SPT	S6	26	18	16	17.5								
	30																	
			SANDY CLAY (CL); medium stiff; yellowish brown; moist.															
				X	MC	S7	2	18	18									TV: .375 tsf
					P	S8	100 psi	18	18	65.6			32	11				TV: .35 tsf
	35																	
			- grades stiff.		P	S9	300 psi	18	17		23	126			UU 0.522			CONSOL
	40																	

(continued)

ARUP

BOREHOLE NO. A-B2
SHEET 2 OF 3

1.0.2A-REV BOREHOLE LOG (SOIL) - US 280873 GINT 1775 WEEKS.GPJ ARUPSGINTLIBRARY MASTER.GLB 4/9/21

PROJECT NAME 1990 Bay Road, 1175 Weeks Street, and 1250 Weeks Street				PROJECT NUMBER 280873	
LOGGED BY P. Kumar	BEGIN DATE Feb-25-21	COMPLETION DATE Feb-25-21	BOREHOLE LOCATION (Lat/Long or North/East and Datum) N1998750.799 / E6089311.045 (NAD83)		HOLE ID A-B2
DRILLING CONTRACTOR/DRILLER Pitcher Services LLC/Marcos/Jake			IN-SITU TESTING		SURFACE ELEVATION Not Surveyed
DRILLING METHOD HAND AUGER(0'-2.25'), MUD ROTARY(2.25'-50')			DRILL RIG Failing 1500		BOREHOLE DIAMETER 3-7/8 in
SAMPLER TYPE(S) AND SIZE(S) (ID) MC(2-1/2"), P(2-1/2"), SPT(1-3/8")			SPT HAMMER TYPE/HAMMER ID Automatic, 140 lbs, 30-inch drop		HAMMER EFFICIENCY, ERI 76%
BOREHOLE BACKFILL AND COMPLETION Neat cement grout (up to 27"); topped with excavated soil			GROUNDWATER READINGS Depth (Date/Time)		TOTAL DEPTH OF BORING 50 ft

Elevation (ft)	Depth (ft)	Material Graphics	Description	Sample Location	Sampler Type	Sample Number	N-Value (bl/ft)	Penetration (in)	Recovery (in)	200 Wash (%)	Moisture Content (%)	Total Unit Wt. (pcf)	Liquid Limit (%)	Plasticity Index (%)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks/ Other Tests
40																		
	45		Lean CLAY with GRAVEL (CL); medium stiff; yellowish brown; moist; medium to coarse GRAVEL.		MC	S10	17	18	12									
			SILTY CLAY (CL); stiff; greenish gray; trace SAND.		MC	S11	22	18	13									
	50		Fat CLAY (CH); stiff; greenish gray; moist; trace medium SAND.		SPT	S12	14	18	18									
			Borehole terminated at a depth of 50.0 feet.															
			See Borehole Log Legend for soil classification chart and key to test data and sampler type.															
	55																	
	60																	

ARUP

BOREHOLE NO. A-B2
SHEET 3 OF 3

1.02A-REV BOREHOLE LOG (SOIL) - US 280873 GINT 1775 WEEKS.GPJ ARUPSGINTLIBRARY MASTER.GLB 4/9/21

PROJECT NAME 1990 Bay Road, 1175 Weeks Street, and 1250 Weeks Street				PROJECT NUMBER 280873	
LOGGED BY P. Kumar	BEGIN DATE Feb-24-21	COMPLETION DATE Feb-24-21	BOREHOLE LOCATION (Lat/Long or North/East and Datum) N1998098.579 / E6089269.513 (NAD83)		HOLE ID A-B3
DRILLING CONTRACTOR/DRILLER Pitcher Services LLC/Marcos/Mike			IN-SITU TESTING		SURFACE ELEVATION Not Surveyed
DRILLING METHOD SOLID STEM AUGER(0'-3.5'), MUD ROTARY(3.5'-51.5')			DRILL RIG Failing 1500		BOREHOLE DIAMETER 3-7/8 in
SAMPLER TYPE(S) AND SIZE(S) (ID) MC(2-1/2"), P(2-1/2"), SPT(1-3/8")			SPT HAMMER TYPE/HAMMER ID Automatic, 140 lbs, 30-inch drop		HAMMER EFFICIENCY, ERI 76%
BOREHOLE BACKFILL AND COMPLETION Neat cement grout (up to 35"); topped with concrete (3,000 psi)			GROUNDWATER READINGS Depth (Date/Time)		TOTAL DEPTH OF BORING 51.5 ft

Elevation (ft)	Depth (ft)	Material Graphics	Description	Sample Location	Sampler Type	Sample Number	N-Value (bl/ft)	Penetration (in)	Recovery (in)	200 Wash (%)	Moisture Content (%)	Total Unit Wt. (pcf)	Liquid Limit (%)	Plasticity Index (%)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks/ Other Tests
	0		3.5" ASPHALTIC CONCRETE (AC).															Casing diameter = 5.0"
			CLAYEY SAND with SILT (SC); olive brown; moist; medium to coarse SAND; trace GRAVEL; [FILL].															
				X	SPT	S1	10	18	18									
	5		SILTY CLAY (CH); stiff; dark gray.															
					P	S2	220 psi	18	15		34	113	67	43				PP: 1.5 tsf
																		Losing fluid
																		Stabilized
	10		SILTY CLAYEY SAND (SC-SM); olive brown; moist; fine SAND; trace GRAVEL. - yellowish brown.															
			- greenish gray; 2" piece of gravel at top of sample.		P	S3	100 psi	18	12.5	30			27	6				
			SILTY lean CLAY (CL); medium stiff; dark olive brown.															
	15		- stiff.		MC	S4	15	18	12									PP: 1.25 tsf
			SANDY CLAY (CL); medium stiff; gray with reddish brown mottling; moist.															
	20																	

(continued)

ARUP

BOREHOLE NO. A-B3
SHEET 1 OF 3

1.0.2A-REV BOREHOLE LOG (SOIL) - US 280873 GINT 1775 WEEKS.GPJ ARUPSGINTLIBRARY MASTER.GLB 4/9/21

PROJECT NAME 1990 Bay Road, 1175 Weeks Street, and 1250 Weeks Street				PROJECT NUMBER 280873	
LOGGED BY P. Kumar	BEGIN DATE Feb-24-21	COMPLETION DATE Feb-24-21	BOREHOLE LOCATION (Lat/Long or North/East and Datum) N1998098.579 / E6089269.513 (NAD83)		HOLE ID A-B3
DRILLING CONTRACTOR/DRILLER Pitcher Services LLC/Marcos/Mike			IN-SITU TESTING		SURFACE ELEVATION Not Surveyed
DRILLING METHOD SOLID STEM AUGER(0'-3.5'), MUD ROTARY(3.5'-51.5')			DRILL RIG Failing 1500		BOREHOLE DIAMETER 3-7/8 in
SAMPLER TYPE(S) AND SIZE(S) (ID) MC(2-1/2"), P(2-1/2"), SPT(1-3/8")			SPT HAMMER TYPE/HAMMER ID Automatic, 140 lbs, 30-inch drop		HAMMER EFFICIENCY, ERI 76%
BOREHOLE BACKFILL AND COMPLETION Neat cement grout (up to 35"); topped with concrete (3,000 psi)			GROUNDWATER READINGS Depth (Date/Time)		TOTAL DEPTH OF BORING 51.5 ft

Elevation (ft)	Depth (ft)	Material Graphics	Description	Sample Location	Sampler Type	Sample Number	N-Value (bl/ft)	Penetration (in)	Recovery (in)	200 Wash (%)	Moisture Content (%)	Total Unit Wt. (pcf)	Liquid Limit (%)	Plasticity Index (%)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks/ Other Tests
	20				SPT	S5	6	18	18	62.1			42	23				
	25		Lean CLAY (CL); stiff; variegated yellowish brown, reddish brown, and gray; moist; interbeds of SANDY CLAY.		SPT	S6	15	18	7									
	30		SILTY SAND (SM); reddish brown; moist; medium SAND.		SPT	S7	11	18	18									
	35		SILTY CLAY (CL); stiff; reddish brown with gray mottling; moist; trace SAND.		MC	S8	18	18	15	93.5			48	30				
	40		GRAVELLY SAND (SP); reddish brown (dark gray GRAVEL); moist; occasional coarse GRAVEL (>1"); trace fines.		SPT	S9	37	18	12									

(continued)

ARUP

BOREHOLE NO. A-B3
SHEET 2 OF 3

1.0.2A-REV BOREHOLE LOG (SOIL) - US 280873 GINT 1775 WEEKS.GPJ ARUPSGINTLIBRARY MASTER.GLB 4/9/21

PROJECT NAME 1990 Bay Road, 1175 Weeks Street, and 1250 Weeks Street				PROJECT NUMBER 280873	
LOGGED BY P. Kumar	BEGIN DATE Feb-24-21	COMPLETION DATE Feb-24-21	BOREHOLE LOCATION (Lat/Long or North/East and Datum) N1998098.579 / E6089269.513 (NAD83)		HOLE ID A-B3
DRILLING CONTRACTOR/DRILLER Pitcher Services LLC/Marcos/Mike			IN-SITU TESTING		SURFACE ELEVATION Not Surveyed
DRILLING METHOD SOLID STEM AUGER(0'-3.5'), MUD ROTARY(3.5'-51.5')			DRILL RIG Failing 1500		BOREHOLE DIAMETER 3-7/8 in
SAMPLER TYPE(S) AND SIZE(S) (ID) MC(2-1/2"), P(2-1/2"), SPT(1-3/8")			SPT HAMMER TYPE/HAMMER ID Automatic, 140 lbs, 30-inch drop		HAMMER EFFICIENCY, ERI 76%
BOREHOLE BACKFILL AND COMPLETION Neat cement grout (up to 35"); topped with concrete (3,000 psi)			GROUNDWATER READINGS Depth (Date/Time)		TOTAL DEPTH OF BORING 51.5 ft

Elevation (ft)	Depth (ft)	Material Graphics	Description	Sample Location	Sampler Type	Sample Number	N-Value (bl/ft)	Penetration (in)	Recovery (in)	200 Wash (%)	Moisture Content (%)	Total Unit Wt. (pcf)	Liquid Limit (%)	Plasticity Index (%)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks/ Other Tests
	40				SPT	S10	40	18	16									
	45		GRAVELLY SAND with interbeds of SANDY GRAVEL (GP) (SP); reddish brown; moist; coarse GRAVEL (up to 3/4"); medium to coarse SAND.		SPT	S11	48	18	10									
	50		CLAY with SILT (CH); grayish brown; moist; medium to high plasticity.		SPT	S12	15	18	9									
	55		Borehole terminated at a depth of 51.5 feet.															
	60		See Borehole Log Legend for soil classification chart and key to test data and sampler type.															

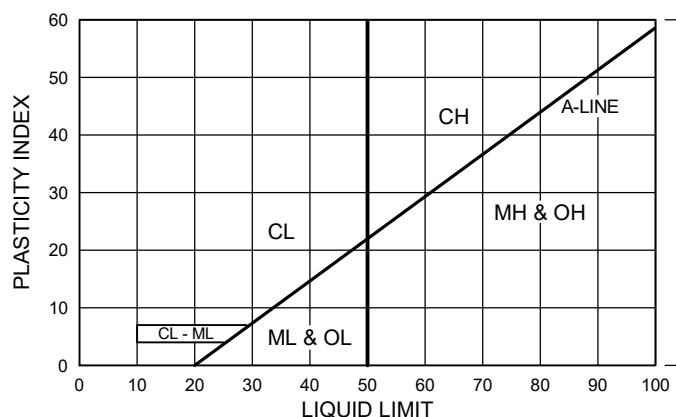
ARUP

BOREHOLE NO. A-B3
SHEET 3 OF 3

INDEXED SOIL CLASSIFICATIONS

GRAPHIC	SYMBOL	DESCRIPTION	MAJOR DIVISIONS					
	GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	CLEAN GRAVELS (LITTLE OR NO FINES)	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO.4 SIEVE SIZE	FOR VISUAL CLASSIFICATION, THE 1/4" SIZE MAY BE USED AS EQUIVALENT TO THE NO.4 SIEVE SIZE	COARSE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO.200 SIEVE SIZE	THE NO.200 U.S. STANDARD SIEVE IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE	
	GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES						
	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES						
	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES						
	SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES	CLEAN SANDS (LITTLE OR NO FINES)	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO.4 SIEVE SIZE				
	SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES						
	SM	SILTY SANDS, SAND-SILT MIXTURES						
	SC	CLAYEY SANDS, SAND-CLAY MIXTURES						
	ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	SILTS & CLAYS LIQUID LIMIT LESS THAN 50			FINE-GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO.200 SIEVE SIZE		
	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS						
	OL	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF LOW PLASTICITY						
	MH	ORGANIC SILTS AND ORGANIC SILT-CLAYS OF HIGH PLASTICITY	SILTS & CLAYS LIQUID LIMIT GREATER THAN 50					
	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS						
	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS						
	PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS					
	OS	OILY SEDIMENTS						

PLASTICITY CHART



Descriptors for Percent or Proportion of Soils

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

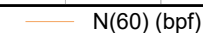
Based on ASTM D24188 and used by Caltrans Soil and Rock Logging, Classification, and Presentation Manual, 2010 Edition

KEY TO TEST DATA

CONSOL = CONSOLIDATION
 CORR = CORROSIVITY
 DS = DIRECT SHEAR
 ORG = ORGANIC CONTENT
 PERM = PERMEABILITY
 PP = POCKET PENETROMETER
 RV = R-VALUE
 TV = FIELD TORVANE
 TXCD = CONSOLIDATED DRAINED TRIAXIAL
 TXCU = CONSOLIDATED UNDRAINED TRIAXIAL
 UCS = UNCONFINED COMPRESSIVE STRENGTH
 UU = UNCONSOLIDATED UNDRAINED TRIAXIAL

KEY TO SAMPLER TYPE

	HQ = HQ CORE BARREL SAMPLER
	MC = MODIFIED CALIFORNIA SAMPLER
	P = DAMES & MOORE PISTON SAMPLER
	PS = PITCHER SAMPLER
	SPT = STANDARD PENETRATION TEST SAMPLER
	ST = SHELBY TUBE SAMPLER
	NO RECOVERY



 Equilibrium Pore Pressure (Ueq)
  Assumed Ueq
  Dissipation, Ueq achieved
  Dissipation, Ueq not achieved
  Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

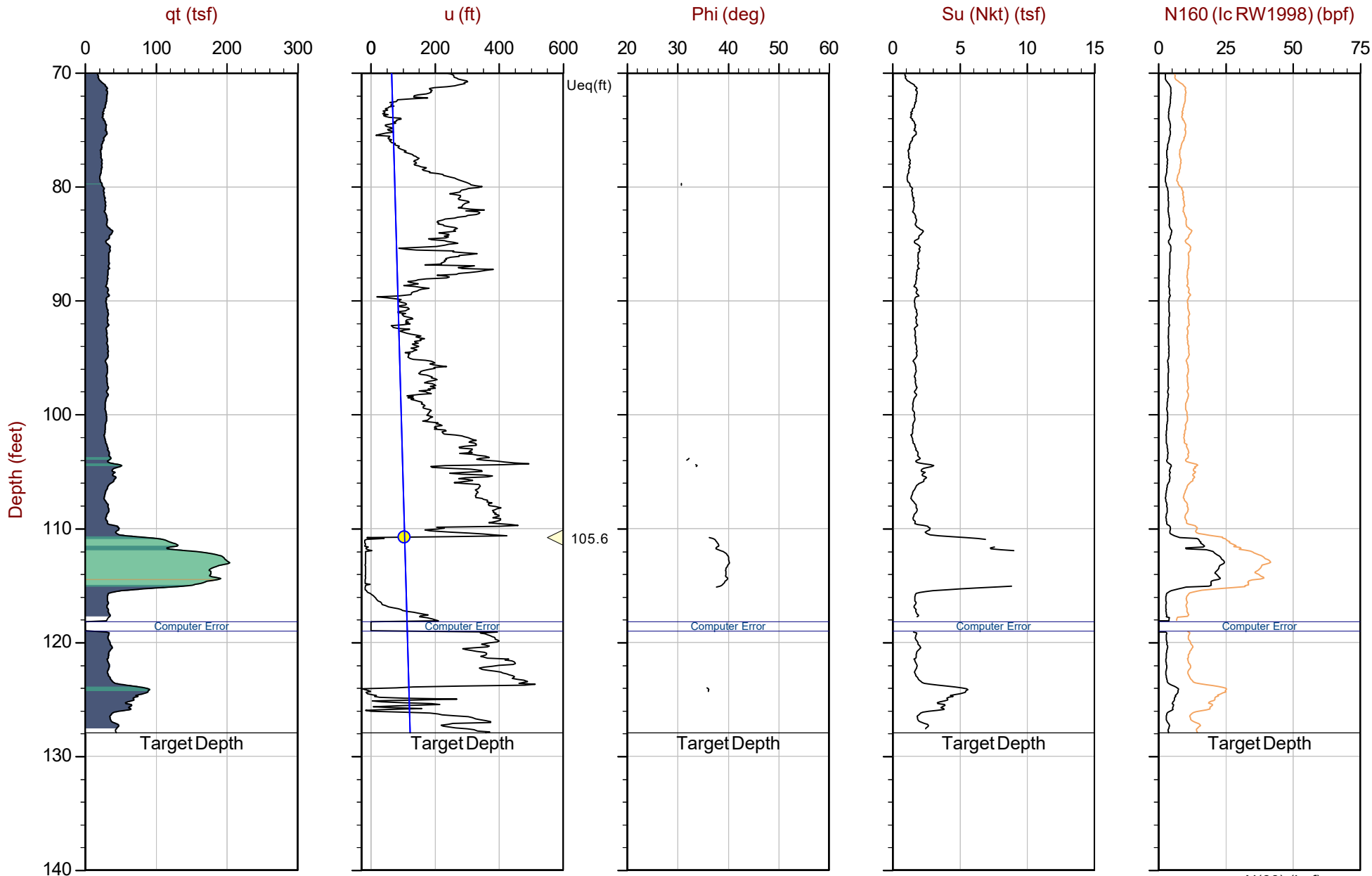
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Date: 2021-02-18 12:34

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-CPT02

Cone: 672:T1500F15U500



Max Depth: 39.000 m / 127.95 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_CP02.COR
Unit Wt: SBTQtn(PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147707m E: 577083m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

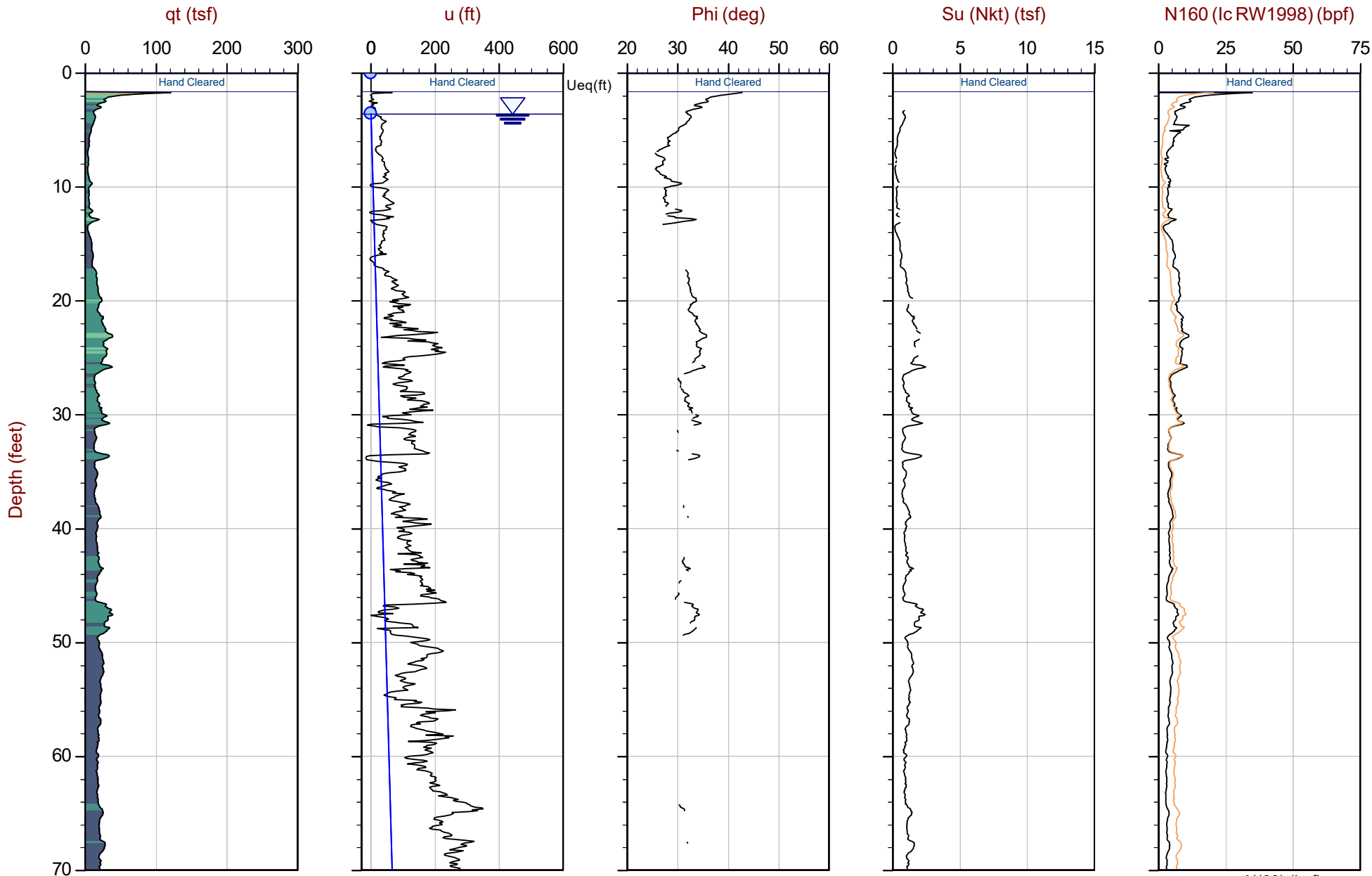
Job No: 21-56-21977

Date: 2021-02-18 10:01

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-CPT03

Cone: 672:T1500F15U500



Max Depth: 30.800 m / 101.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_CP03.COR
Unit Wt: SBTQtn(PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147730m E: 577139m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

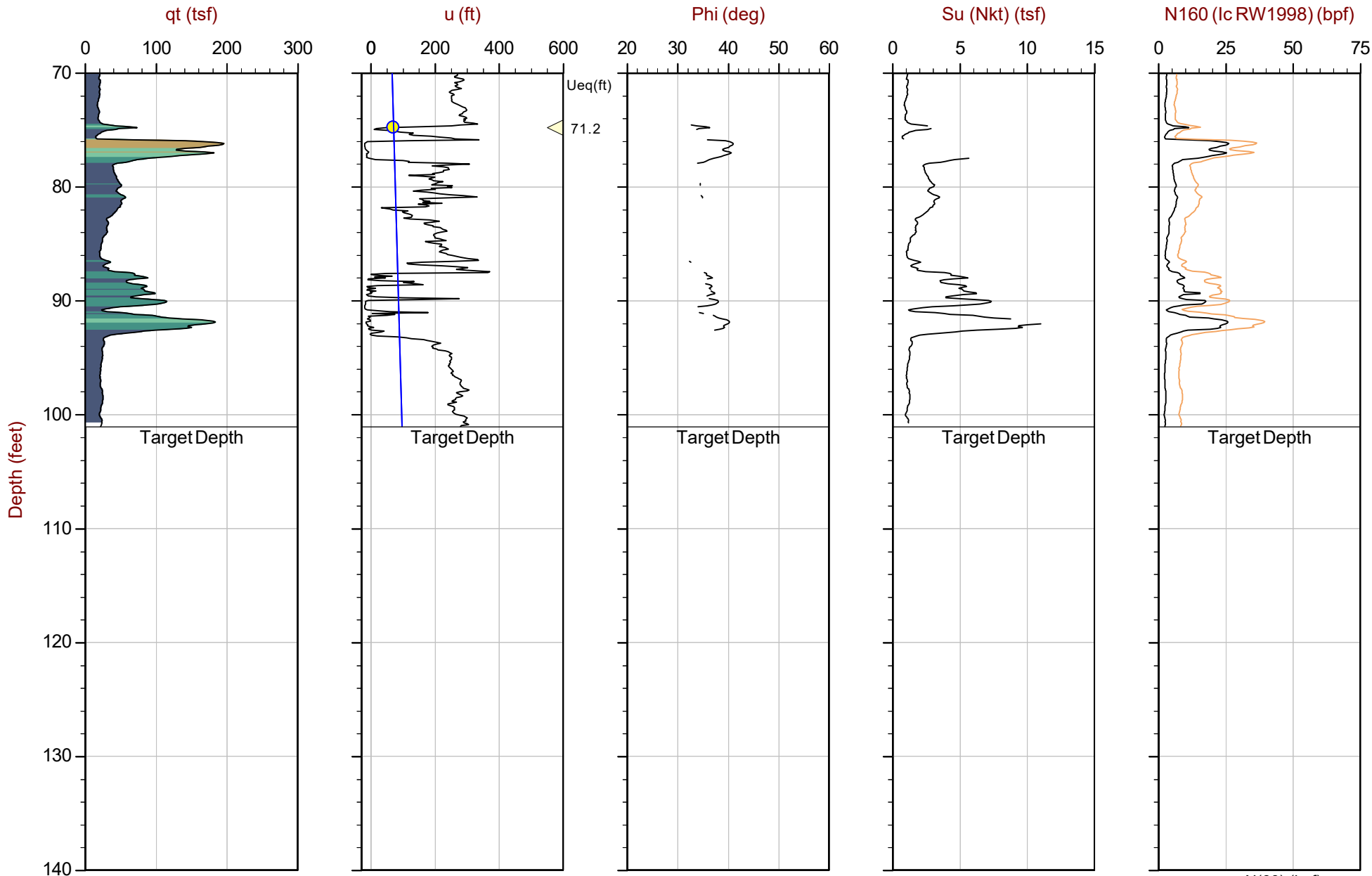
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Date: 2021-02-18 10:01

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-CPT03

Cone: 672:T1500F15U500



Max Depth: 30.800 m / 101.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_CP03.COR
Unit Wt: SBTQtn(PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147730m E: 577139m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line

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Arup

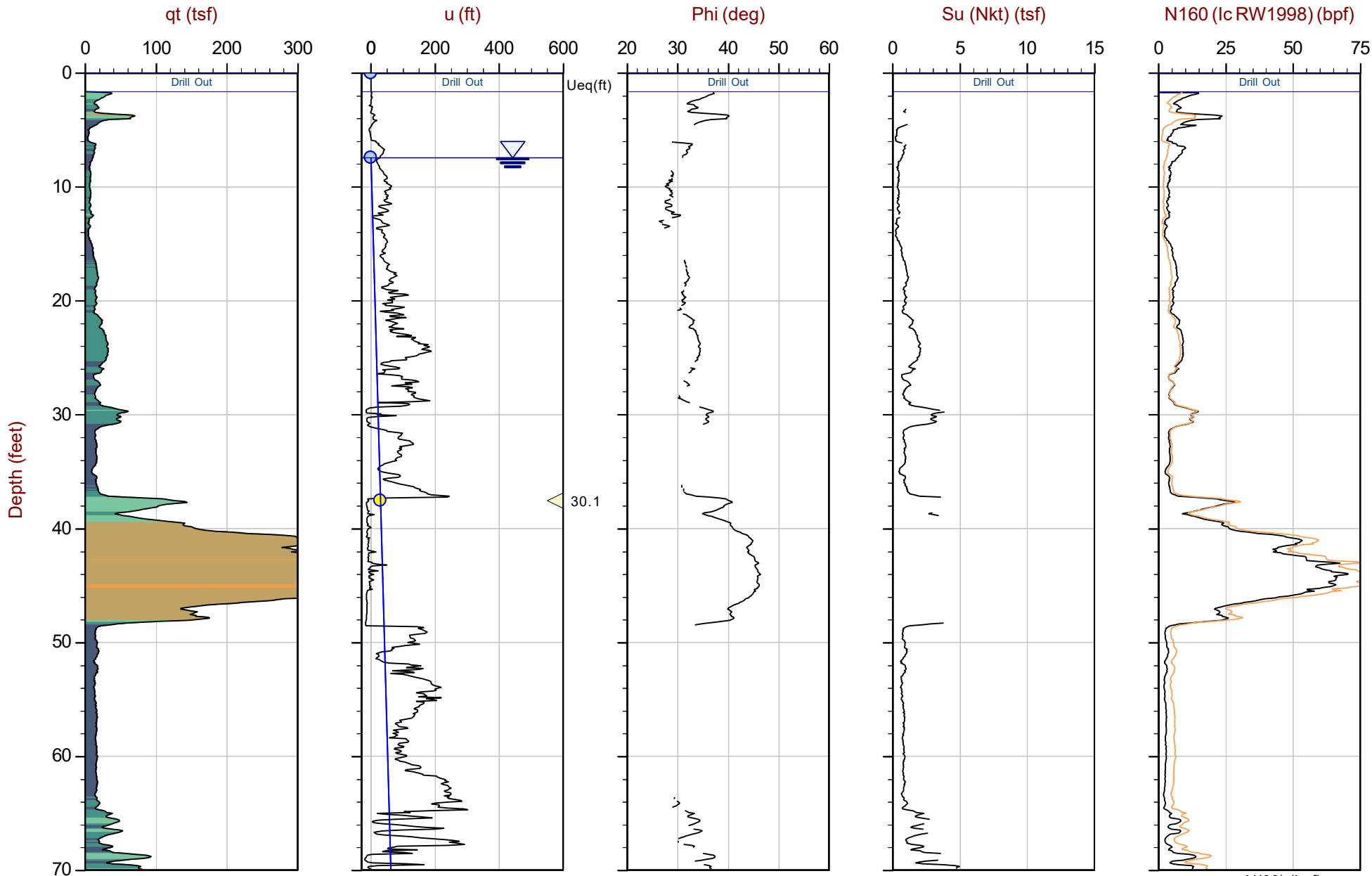
Job No: 21-56-21977

Date: 2021-02-17 12:43

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-SCPT04

Cone: 672:T1500F15U500



Max Depth: 36.800 m / 120.73 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_SP04.COR
Unit Wt: SBTQtn(PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147483m E: 577113m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

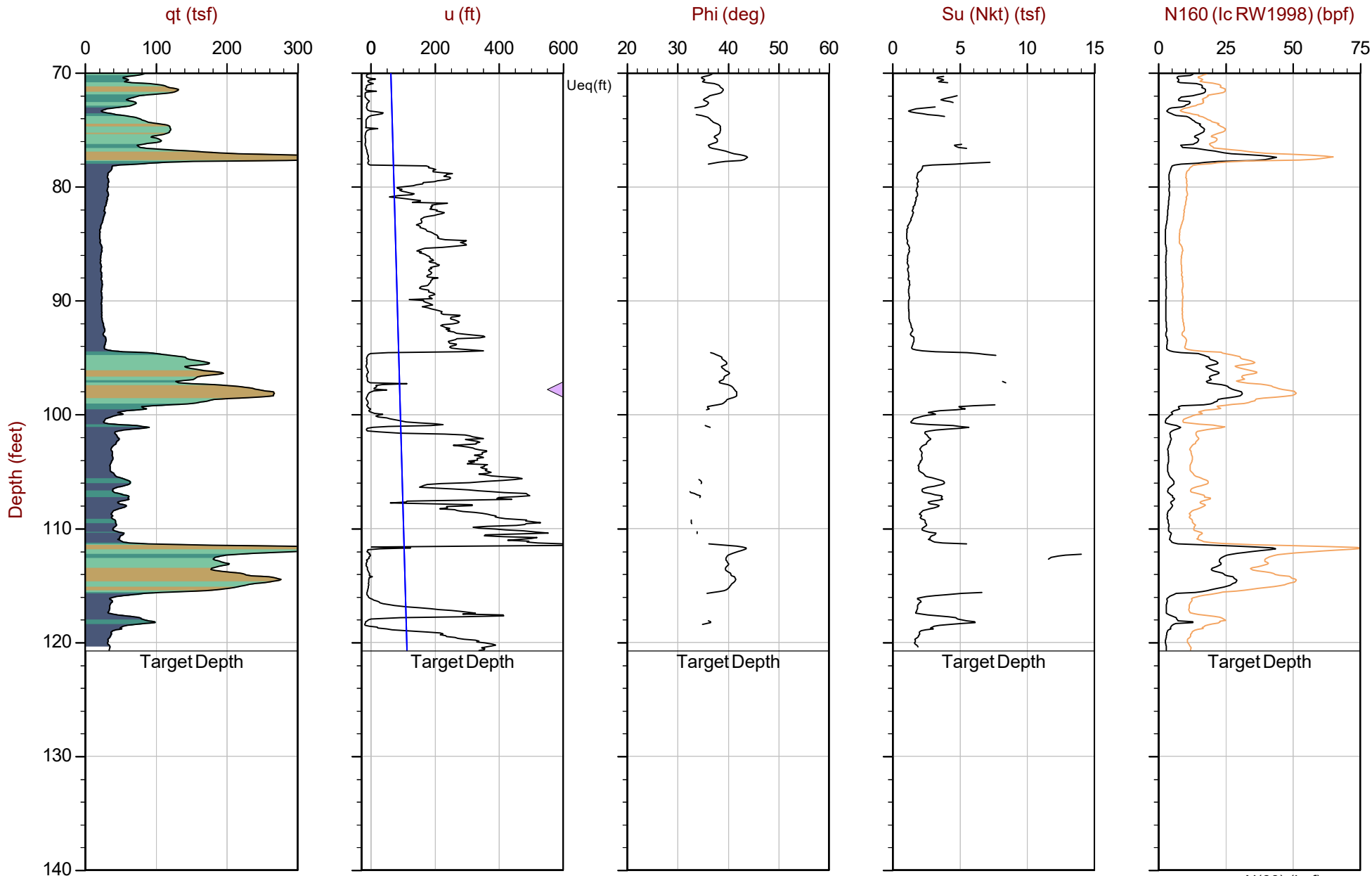
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Date: 2021-02-17 12:43

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-SCPT04

Cone: 672:T1500F15U500



Max Depth: 36.800 m / 120.73 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 21-56-21977_SP04.COR

Unit Wt: SBTQn(PKR2009)

Su Nkt: 15.0

SBT: Robertson, 2009 and 2010

Coords: UTM 10S N: 4147483m E: 577113m

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Normalized Cone Penetration Test Plots



Arup

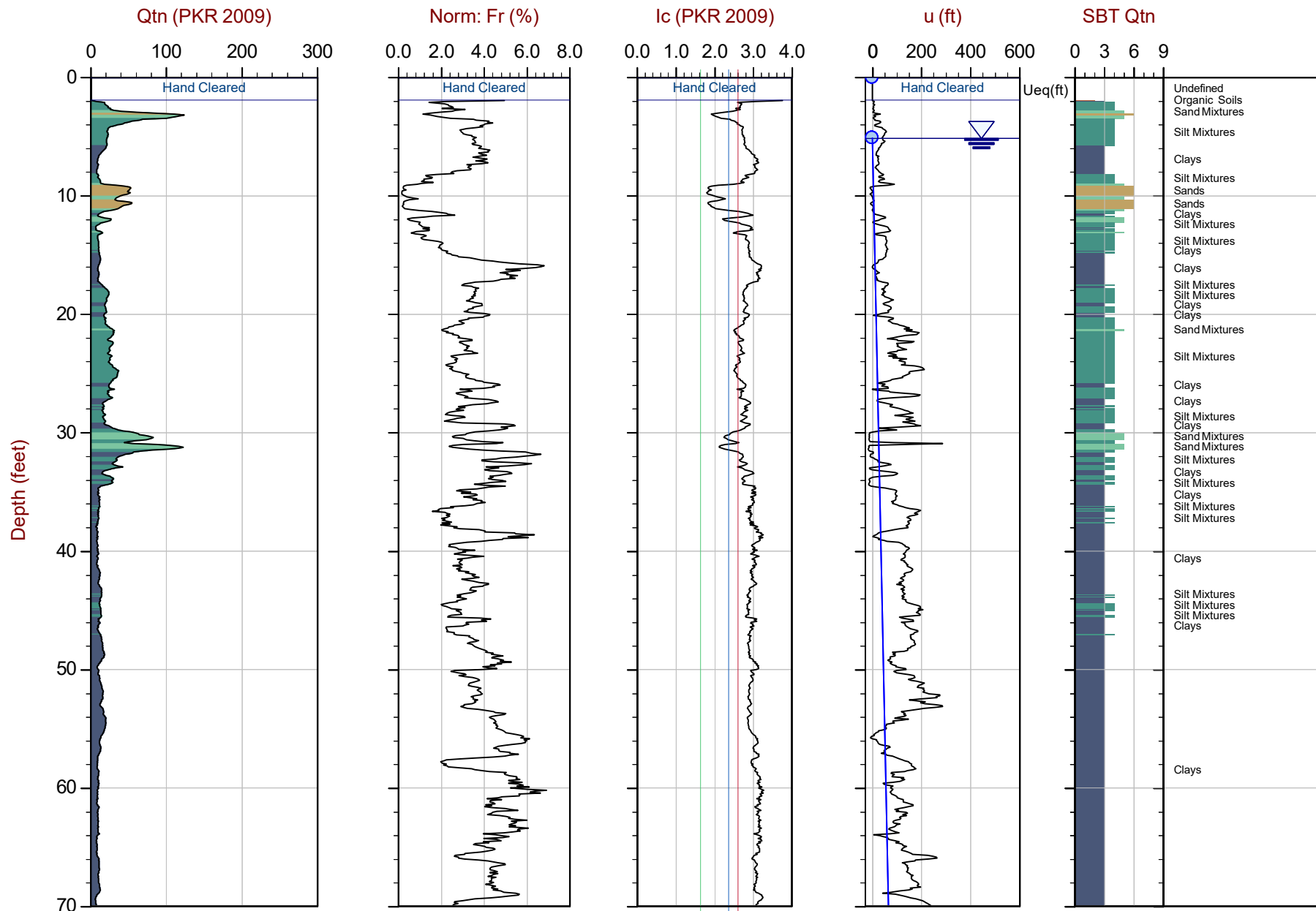
Job No: 21-56-21977

Date: 2021-02-18 12:34

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-CPT02

Cone: 672:T1500F15U500



Max Depth: 39.000 m / 127.95 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_CP02.COR
Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147707m E: 577083m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

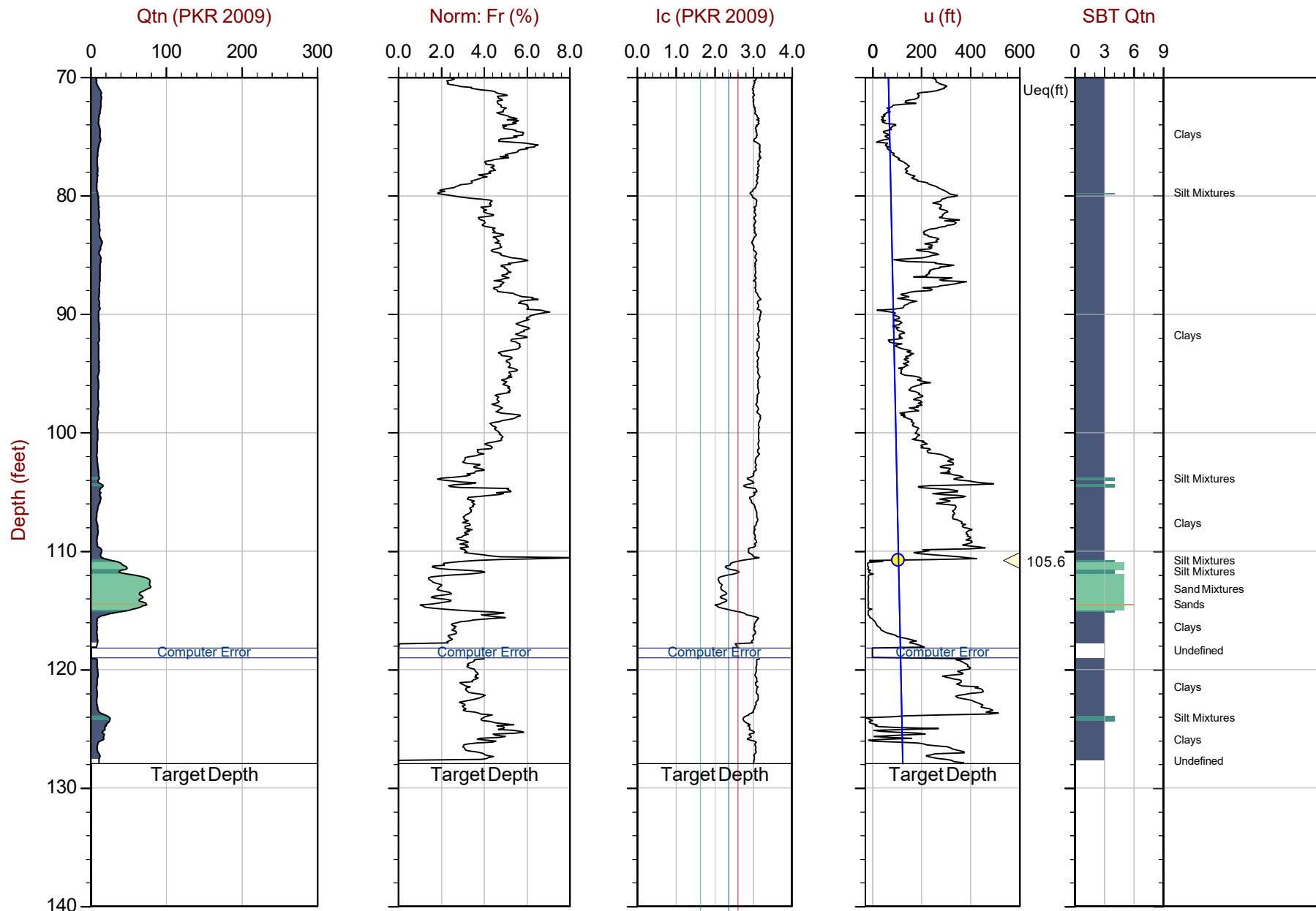
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Date: 2021-02-18 12:34

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-CPT02

Cone: 672:T1500F15U500

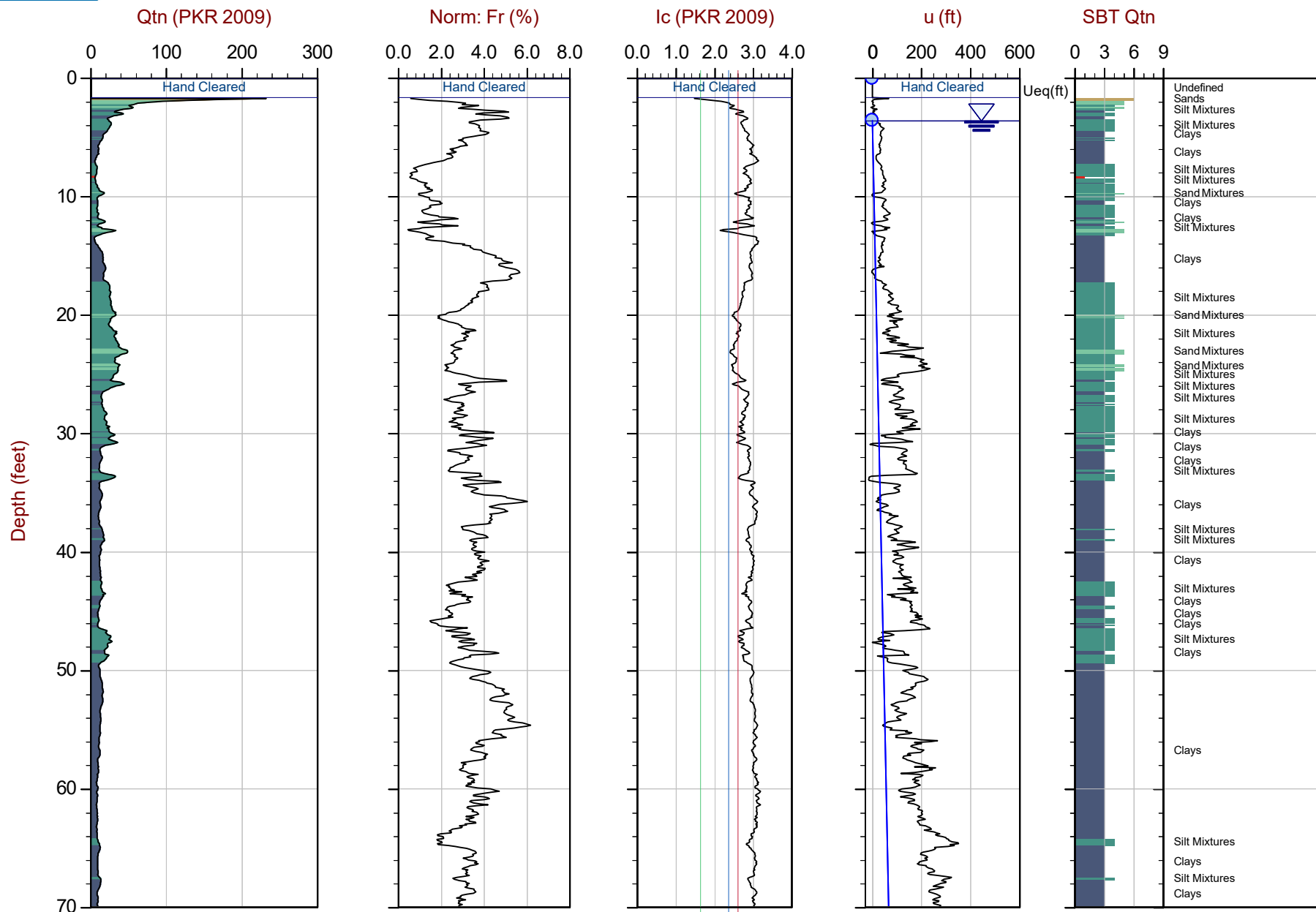


Max Depth: 39.000 m / 127.95 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_CP02.COR
Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147707m E: 577083m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Max Depth: 30.800 m / 101.05 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 21-56-21977 CP03.COR

Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010

Coords: [UTM 10S N: 4147730m E: 577139m](#)

- Equilibrium Pore Pressure (U_{eq})

- Assumed Ueq

◀ Dissipation, U_{eq} achieved

Dissipation, U_{eq} not achieved

— Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

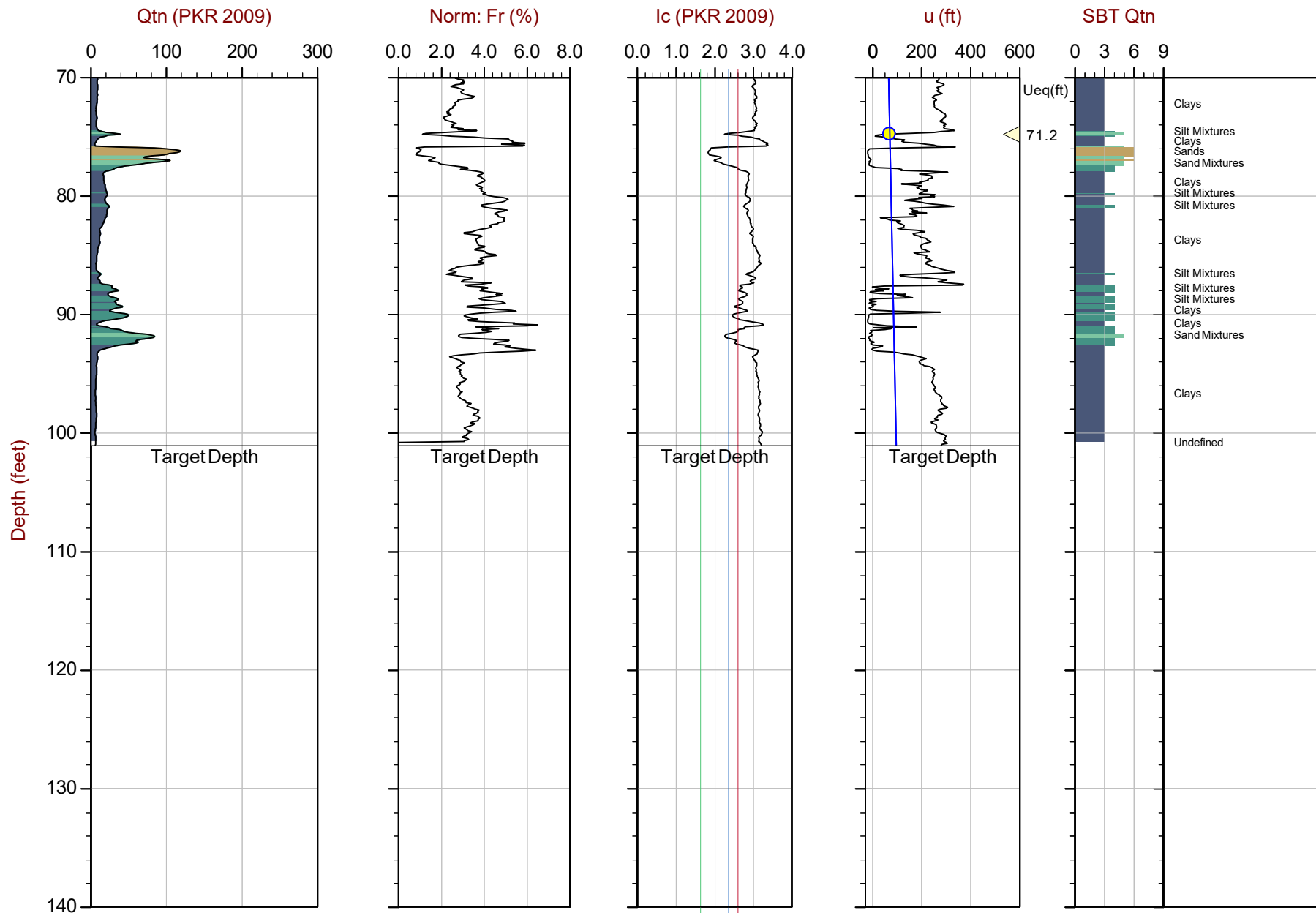
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Date: 2021-02-18 10:01

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-CPT03

Cone: 672:T1500F15U500



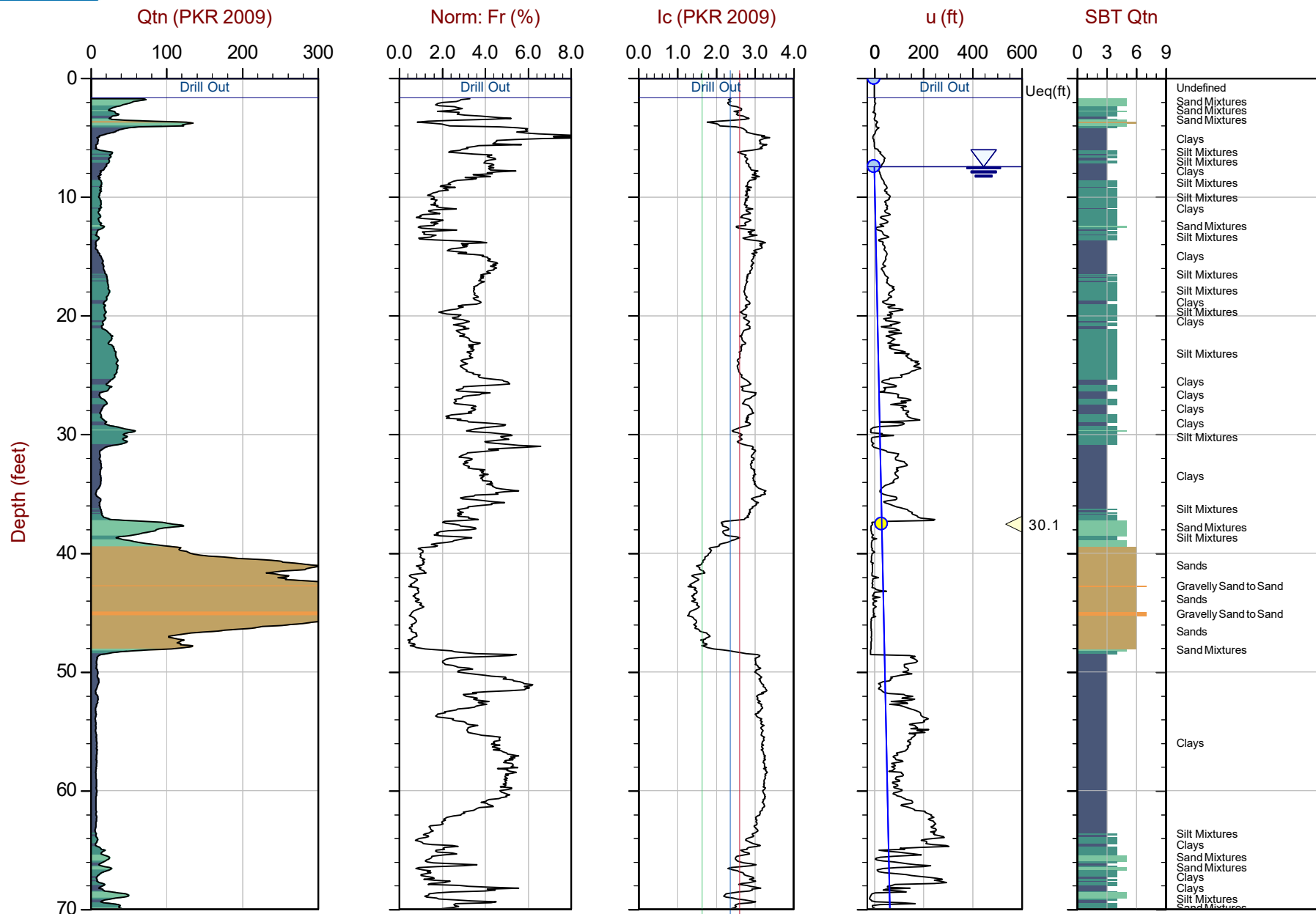
Max Depth: 30.800 m / 101.05 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_CP03.COR
Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147730m E: 577139m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Max Depth: 36.800 m / 120.73 ft

Depth Inc: 0.025 m / 0.082 ft

Avg Int: Every Point

File: 21-56-21977 SP04.COR

Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010

Coords: [UTM 10S N: 4147483m E: 577113m](#)

- Equilibrium Pore Pressure (U_{eq})

- Assumed Ueq

◀ Dissipation, U_{eq} achieved

Dissipation, U_{eq} not achieved

— Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

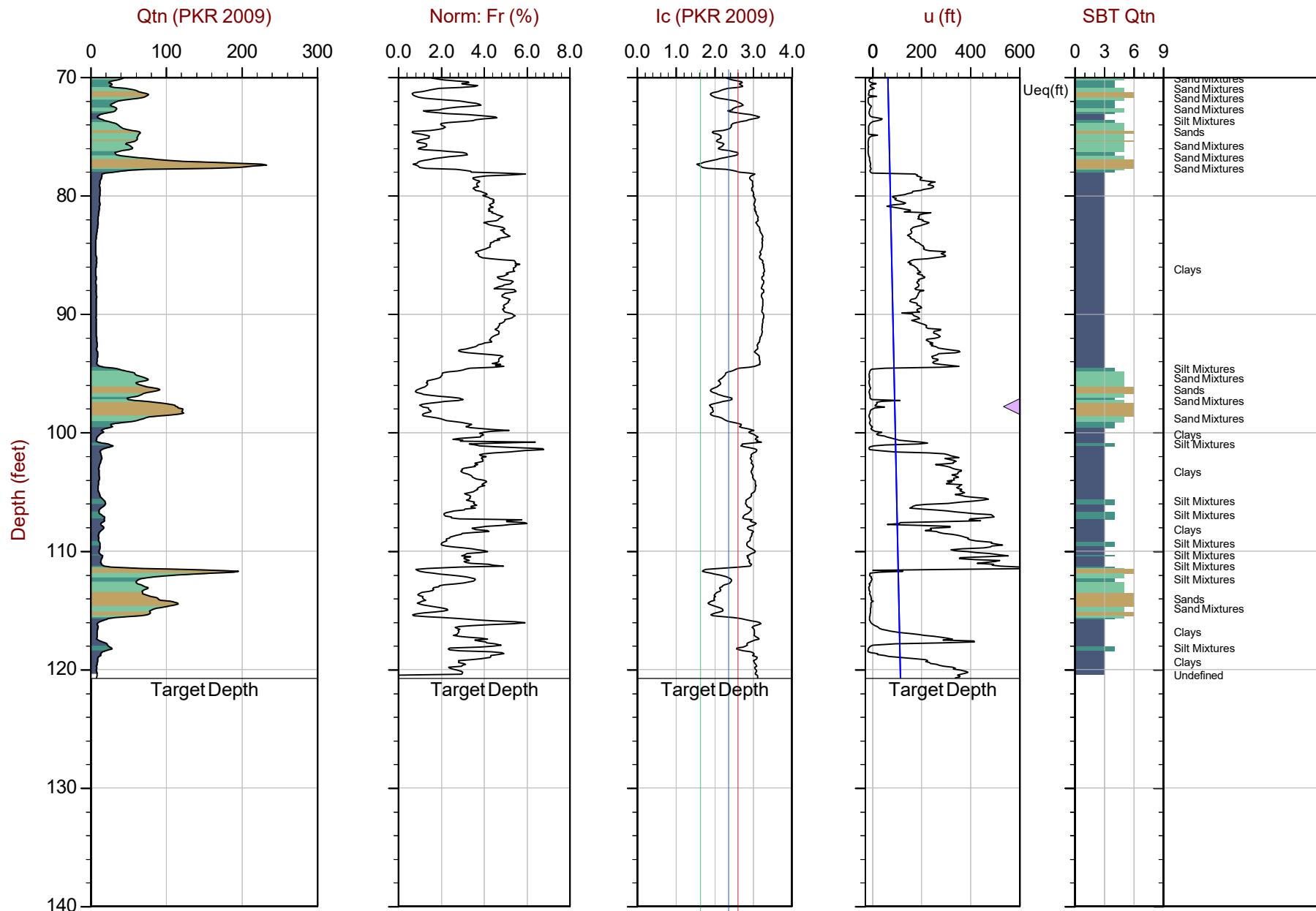
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Date: 2021-02-17 12:43

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-SCPT04

Cone: 672:T1500F15U500



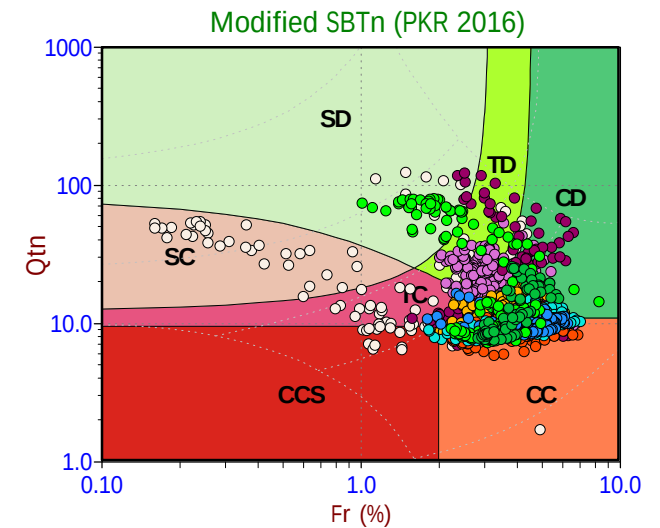
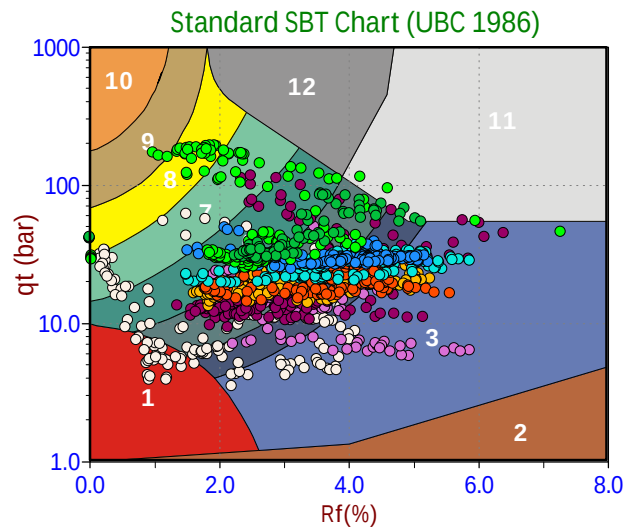
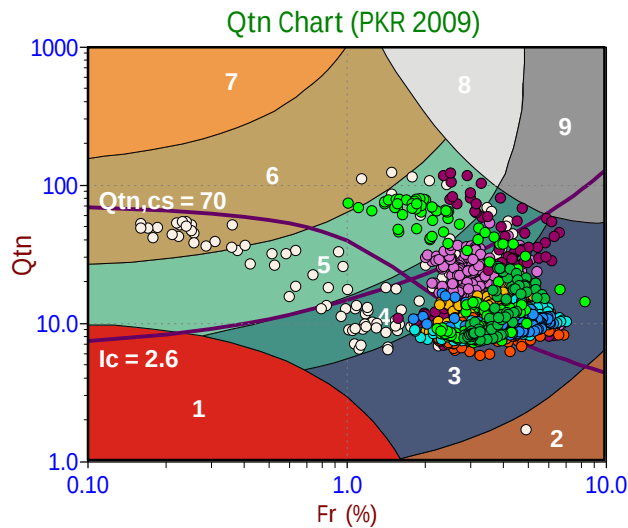
Max Depth: 36.800 m / 120.73 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_SP04.COR
Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147483m E: 577113m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved — Hydrostatic Line
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Soil Behavior Type (SBT) Scatter Plots



Depth Ranges

- >0.0 to 15.0 ft
- >15.0 to 30.0 ft
- >30.0 to 45.0 ft
- >45.0 to 60.0 ft
- >60.0 to 75.0 ft
- >75.0 to 90.0 ft
- >90.0 to 105.0 ft
- >105.0 to 120.0 ft
- >120.0 to 135.0 ft
- >135.0 to 150.0 ft
- >150.0 ft

Legend

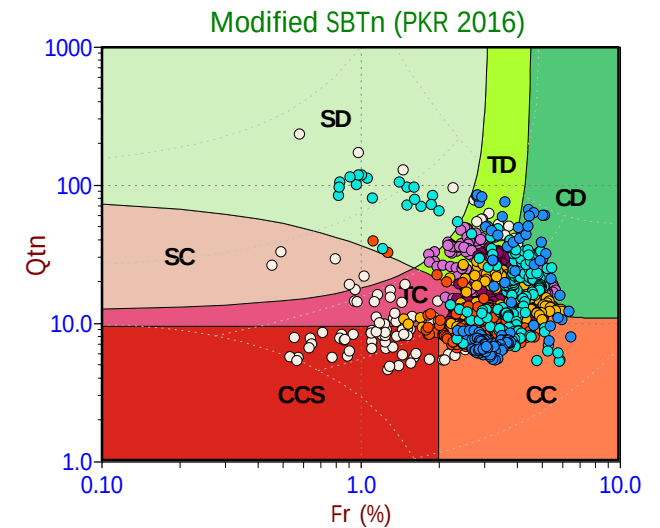
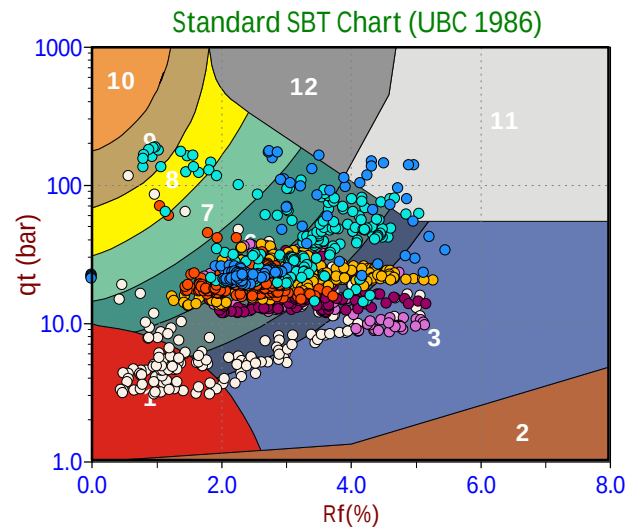
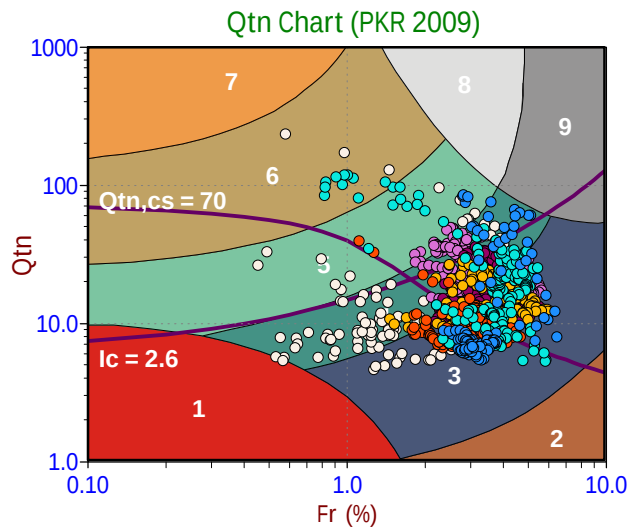
- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Depth Ranges

- >0.0 to 15.0 ft
- >15.0 to 30.0 ft
- >30.0 to 45.0 ft
- >45.0 to 60.0 ft
- >60.0 to 75.0 ft
- >75.0 to 90.0 ft
- >90.0 to 105.0 ft
- >105.0 to 120.0 ft
- >120.0 to 135.0 ft
- >135.0 to 150.0 ft
- >150.0 ft

Legend

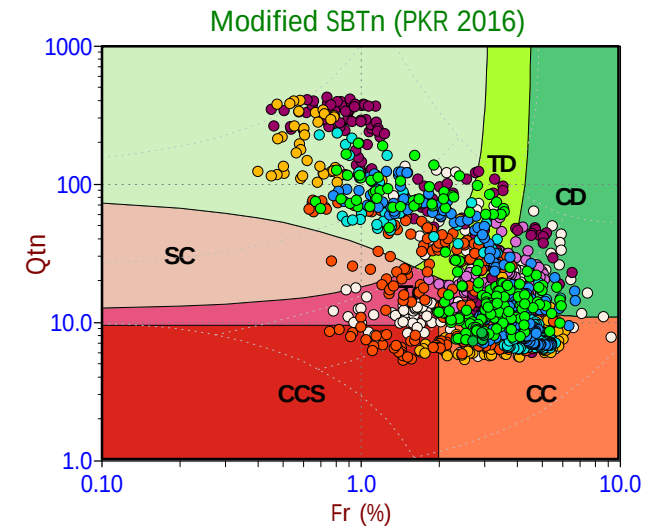
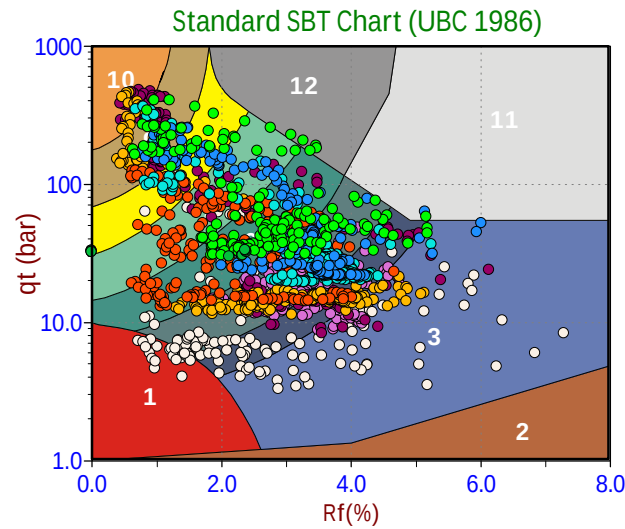
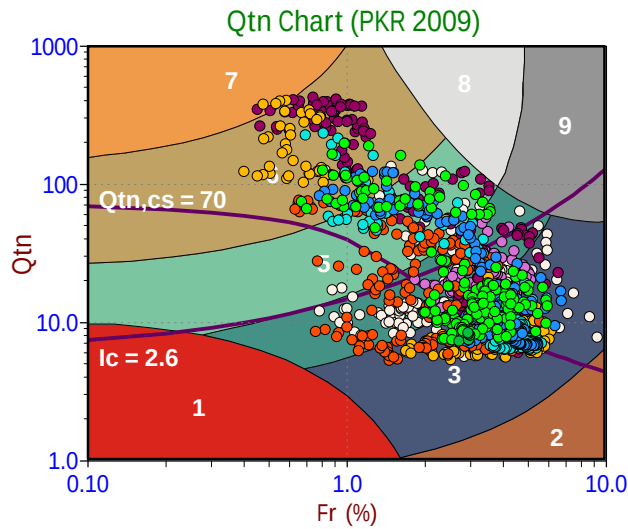
- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)



Depth Ranges

- >0.0 to 15.0 ft
- >15.0 to 30.0 ft
- >30.0 to 45.0 ft
- >45.0 to 60.0 ft
- >60.0 to 75.0 ft
- >75.0 to 90.0 ft
- >90.0 to 105.0 ft
- >105.0 to 120.0 ft
- >120.0 to 135.0 ft
- >135.0 to 150.0 ft
- >150.0 ft

Legend

- Sensitive, Fine Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Seismic Cone Penetration Test Plots



Arup

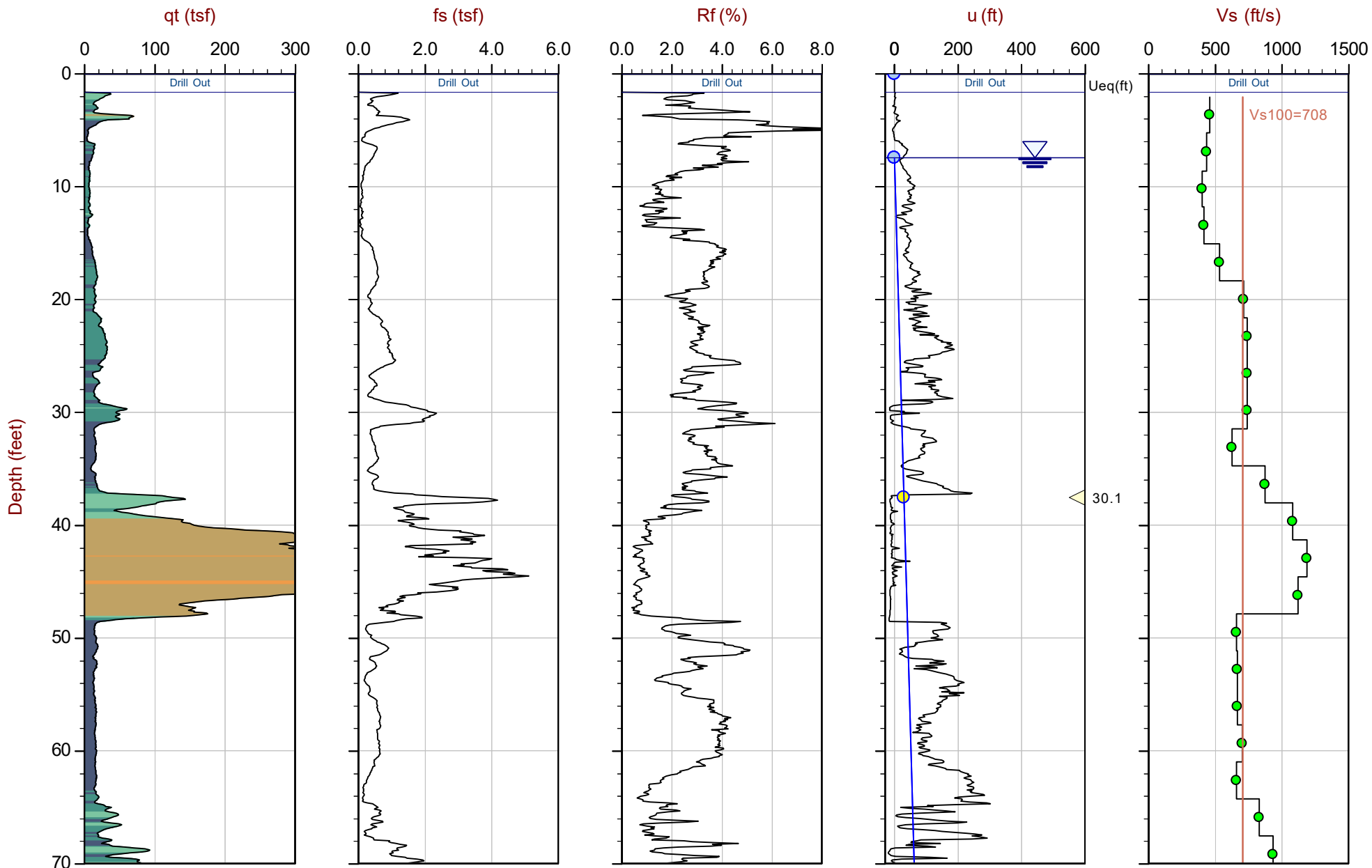
Job No: 21-56-21977

Date: 2021-02-17 12:43

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-SCPT04

Cone: 672:T1500F15U500



Max Depth: 36.800 m / 120.73 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_SP04.COR
Unit Wt: SBTQtn(PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147483m E: 577113m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▼ Dissipation, Ueq not achieved — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.



Arup

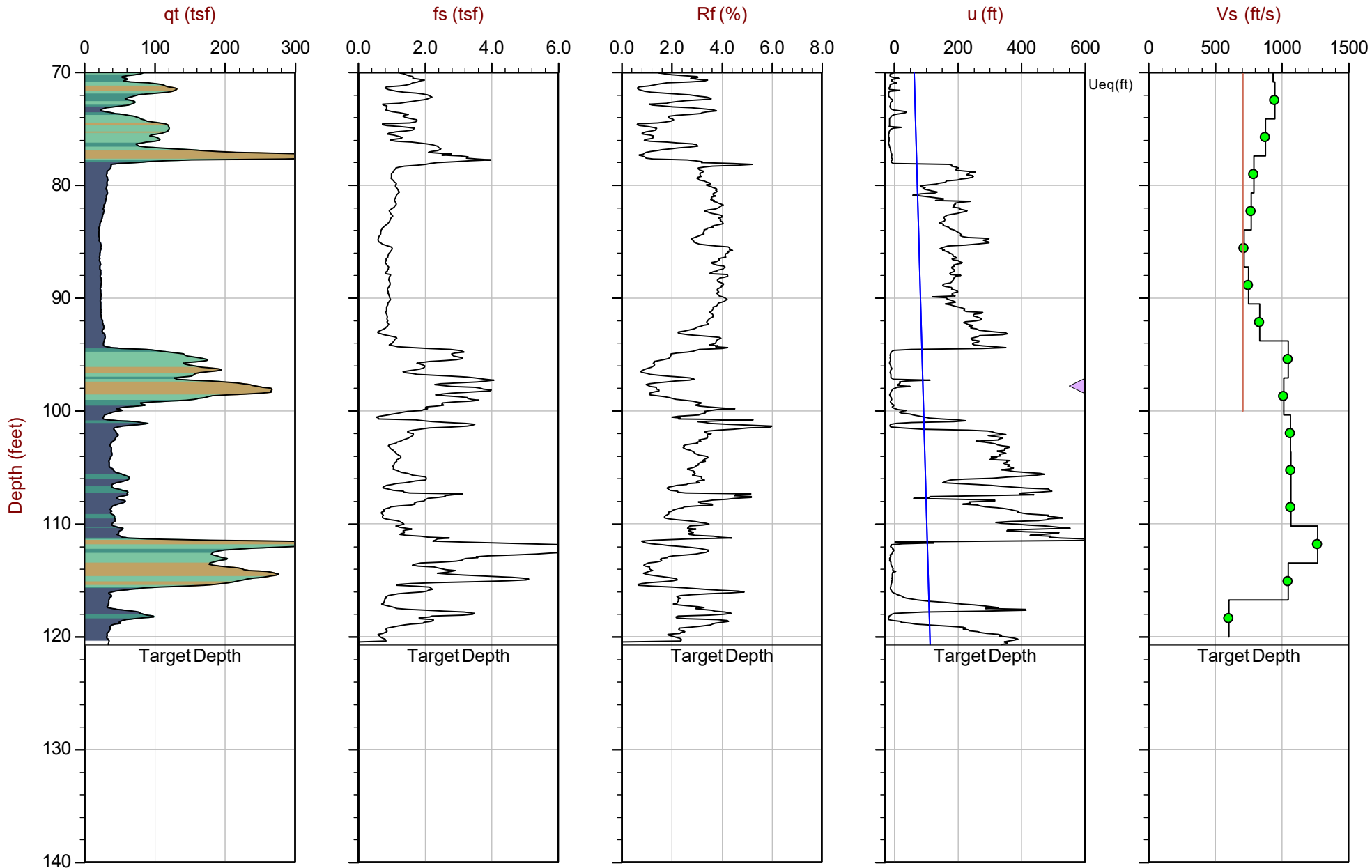
Job No: 21-56-21977

Date: 2021-02-17 12:43

Site: 1175 Weeks St and 1990 Bay Rd

Sounding: A-SCPT04

Cone: 672:T1500F15U500



Max Depth: 36.800 m / 120.73 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 21-56-21977_SP04.COR
Unit Wt: SBTQn(PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM 10S N: 4147483m E: 577113m

● Equilibrium Pore Pressure (Ueq) ● Assumed Ueq ▲ Dissipation, Ueq achieved ▲ Dissipation, Ueq not achieved — Hydrostatic Line

The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

Seismic Cone Penetration Test Tabular Results



Job No: 21-56-21977
Client: Arup
Project: 1175 Weeks St and 1990 Bay Rd
Sounding ID: A-SCPT04
Date: 02:17:21 12:43

Seismic Source: Beam
Seismic Offset (ft): 2.10
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPTu SHEAR WAVE VELOCITY TEST RESULTS - Vs

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
2.72	2.07	2.95			
5.91	5.25	5.65	2.71	5.86	462
9.28	8.63	8.88	3.23	7.38	437
12.47	11.81	12.00	3.12	7.70	405
15.75	15.09	15.24	3.24	7.80	415
19.03	18.37	18.49	3.26	6.08	535
22.31	21.65	21.76	3.26	4.58	713
25.59	24.93	25.02	3.27	4.41	740
28.87	28.22	28.29	3.27	4.41	741
32.15	31.50	31.57	3.27	4.41	742
35.43	34.78	34.84	3.27	5.22	627
38.71	38.06	38.12	3.28	3.74	875
42.00	41.34	41.39	3.28	3.02	1084
45.28	44.62	44.67	3.28	2.75	1190
48.56	47.90	47.95	3.28	2.92	1124
51.84	51.18	51.22	3.28	4.97	660
55.12	54.46	54.50	3.28	4.91	667
58.40	57.74	57.78	3.28	4.92	667
61.68	61.02	61.06	3.28	4.64	706
64.96	64.30	64.34	3.28	4.96	661
68.24	67.59	67.62	3.28	3.94	832
71.52	70.87	70.90	3.28	3.51	935
74.80	74.15	74.18	3.28	3.46	949
78.08	77.43	77.46	3.28	3.74	878
81.36	80.71	80.74	3.28	4.14	792
84.65	83.99	84.02	3.28	4.25	771
87.93	87.27	87.30	3.28	4.58	717
91.21	90.55	90.58	3.28	4.36	752
94.49	93.83	93.86	3.28	3.93	835
97.77	97.11	97.14	3.28	3.13	1049
101.05	100.39	100.42	3.28	3.23	1016



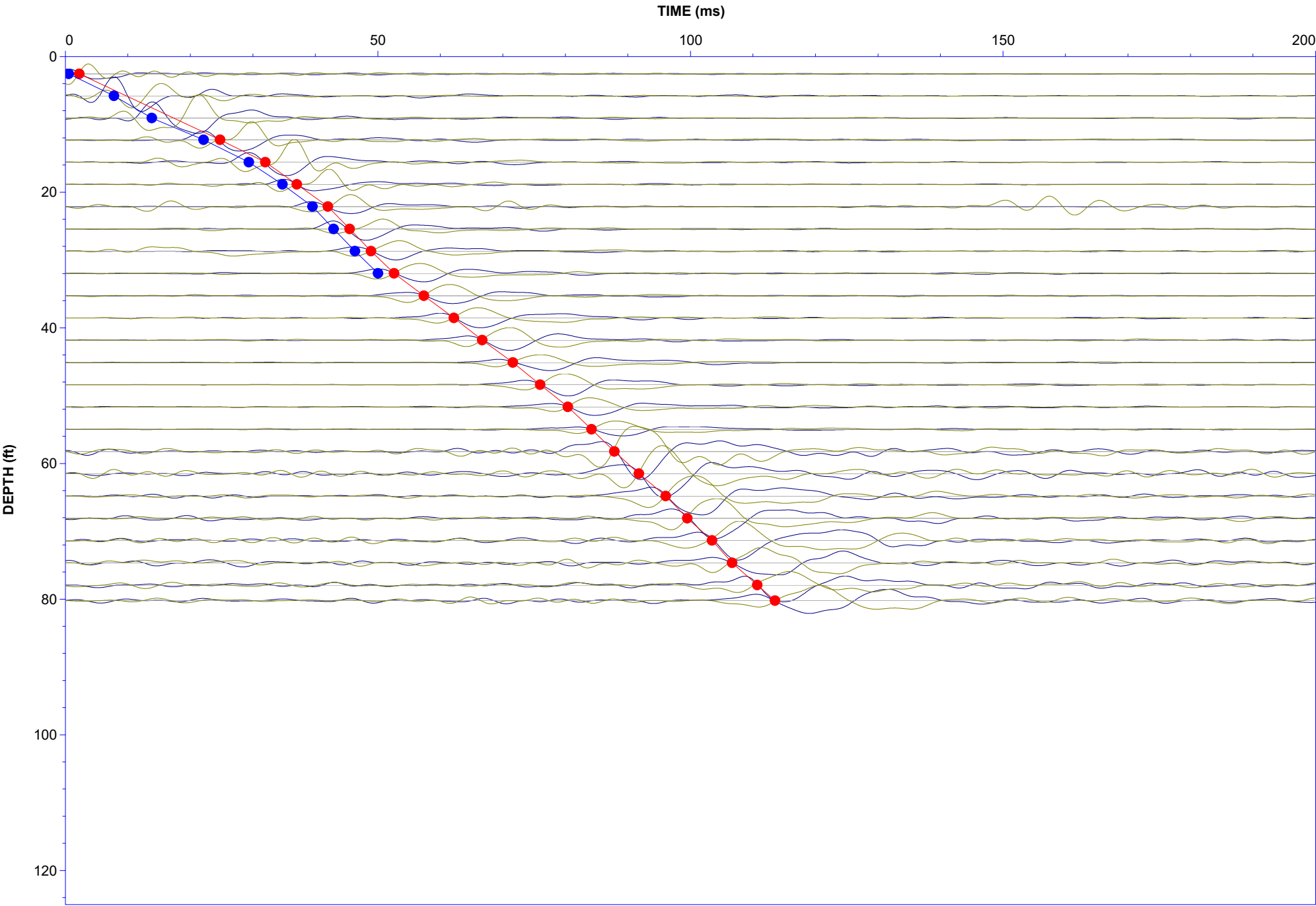
Job No: 21-56-21977
Client: Arup
Project: 1175 Weeks St and 1990 Bay Rd
Sounding ID: A-SCPT04
Date: 02:17:21 12:43

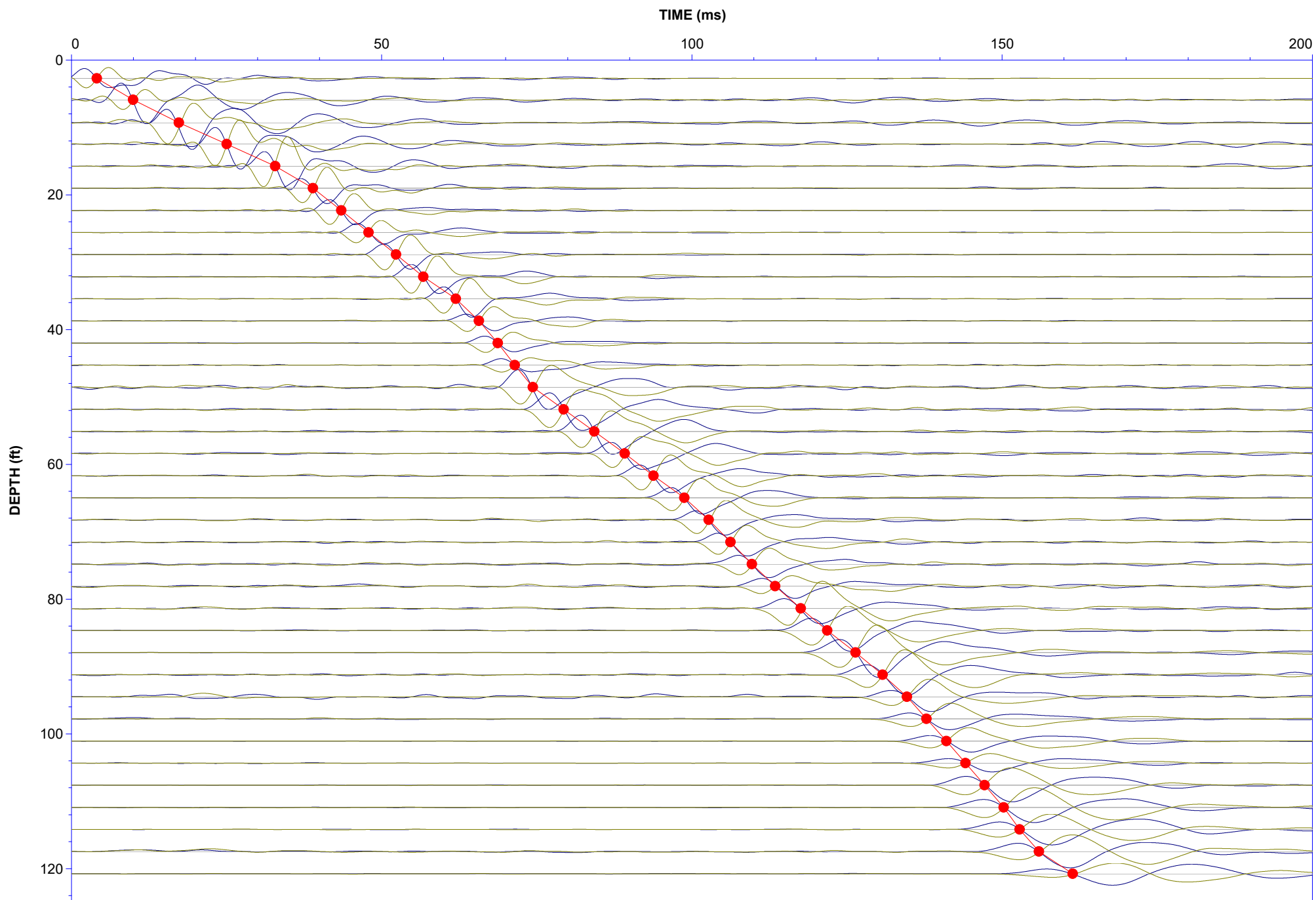
Seismic Source: Beam
Seismic Offset (ft): 2.10
Source Depth (ft): 0.00
Geophone Offset (ft): 0.66

SCPT_u SHEAR WAVE VELOCITY TEST RESULTS - V_s

Tip Depth (ft)	Geophone Depth (ft)	Ray Path (ft)	Ray Path Difference (ft)	Travel Time Interval (ms)	Interval Velocity (ft/s)
104.33	103.67	103.70	3.28	3.07	1068
107.61	106.96	106.98	3.28	3.07	1070
110.89	110.24	110.26	3.28	3.07	1069
114.17	113.52	113.54	3.28	2.58	1269
117.45	116.80	116.82	3.28	3.12	1051
120.73	120.08	120.10	3.28	5.44	603

Seismic Cone Penetration Test Shear Wave (V_s) Traces







Job No: 21-56-21977
Client: Arup
Project: 1175 Weeks St and 1990 Bay Rd
Start Date: 17-Feb-2021
End Date: 18-Feb-2021

CPT_u PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm ²)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U _{eq} (ft)	Calculated Phreatic Surface (ft)
A-SCPT01	21-56-21977_SP01	15	380	23.54	17.2	6.3
A-CPT02	21-56-21977_CP02	15	470	110.81	105.7	5.1
A-CPT03	21-56-21977_CP03	15	420	74.80	71.2	3.6
A-SCPT04	21-56-21977_SP04	15	620	37.57	30.1	7.4
A-SCPT04	21-56-21977_SP04	15	525	97.77	Not Achieved	

TRC (2018)

TRC-EB-5
TRC-CPT-5
TRC-CPT-6

EXPLORATORY BORING: EB-5

Sheet 1 of 2

DRILL RIG: TRUCK MOBILE B-53

BORING TYPE: 8-INCH HOLLOW-STEM AUGER

LOGGED BY: JA

START DATE: 9-23-18

FINISH DATE: 9-23-18

PROJECT NO: 315276

PROJECT: 1990 Bay Road/1175 Weeks Street Development

LOCATION: EAST PALO ALTO, CA

COMPLETION DEPTH: 51.5 FT.

This log is a part of a report by TRC, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual.

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf)
	0		3" of AC	AC/AB						
			GRAVELLY LEAN CLAY (CL) [FILL] hard, moist, dark gray, medium plasticity, fine to coarse gravel (sub-angular/rounded), trace coarse sand	CL	29		12	113		
			CLAYEY GRAVEL (GC) [FILL] medium dense, moist, brown, medium plasticity, fine to coarse sand, fine to coarse gravel (sub-angular/rounded)	GC	21		14	105		
	5		FAT CLAY (CH) stiff, moist, dark gray, high plasticity	CH	23		34	86		
			SANDY LEAN CLAY (CL) medium stiff, moist, brown, medium plasticity, fine sand	CL	11		33	85	68	
			SANDY FAT CLAY (CH) medium stiff, moist, dark gray, high plasticity	CH	25		26	88		
			stiff Liquid Limit = 62, Plasticity Index = 44							
			LEAN CLAY WITH SAND (CL) soft, moist, gray to light gray, medium plasticity, fine to medium sand	CL	19		37	83		
			LEAN CLAY (CL) very stiff, moist, olive brown, medium plasticity, trace fine to medium sand	CL	35					
			stiff		29		26	93		

Continued Next Page

GROUND WATER OBSERVATIONS:

▽ : FREE GROUND WATER MEASURED DURING DRILLING AT 11.0 FEET

LA CORP GDT 10/29/18 MV, CA*



EB-5
315276

EXPLORATORY BORING: EB-5 Cont'd

Sheet 2 of 2

DRILL RIG: TRUCK MOBILE B-53

BORING TYPE: 8-INCH HOLLOW-STEM AUGER

LOGGED BY: JA

START DATE: 9-23-18

FINISH DATE: 9-23-18

PROJECT NO: 315276

PROJECT: 1990 Bay Road/1175 Weeks Street Development

LOCATION: EAST PALO ALTO, CA

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ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf)
										○ Pocket Penetrometer △ Torvane ● Unconfined Compression ▲ U-U Triaxial Compression
	30		LEAN CLAY (CL) medium stiff, moist, olive brown, medium plasticity, trace fine to medium sand							1.0 2.0 3.0 4.0
	35				28	×	33	86		○
	40		stiff Liquid Limit = 44, Plasticity Index = 25	CL	30	×				○
	45		brown, no trace		30	×	31	88		○
	50		SANDY LEAN CLAY (CL) stiff, very moist, brown, medium plasticity, fine to medium sand	CL	31	×				
	50		POORLY GRADED SAND WITH CLAY (SP-SC) medium dense to dense, moist, brown, medium plasticity, fine to coarse sand	SP-SC	31	×				
	51.5		Bottom of boring at 51.5 feet							
	55									
	60									

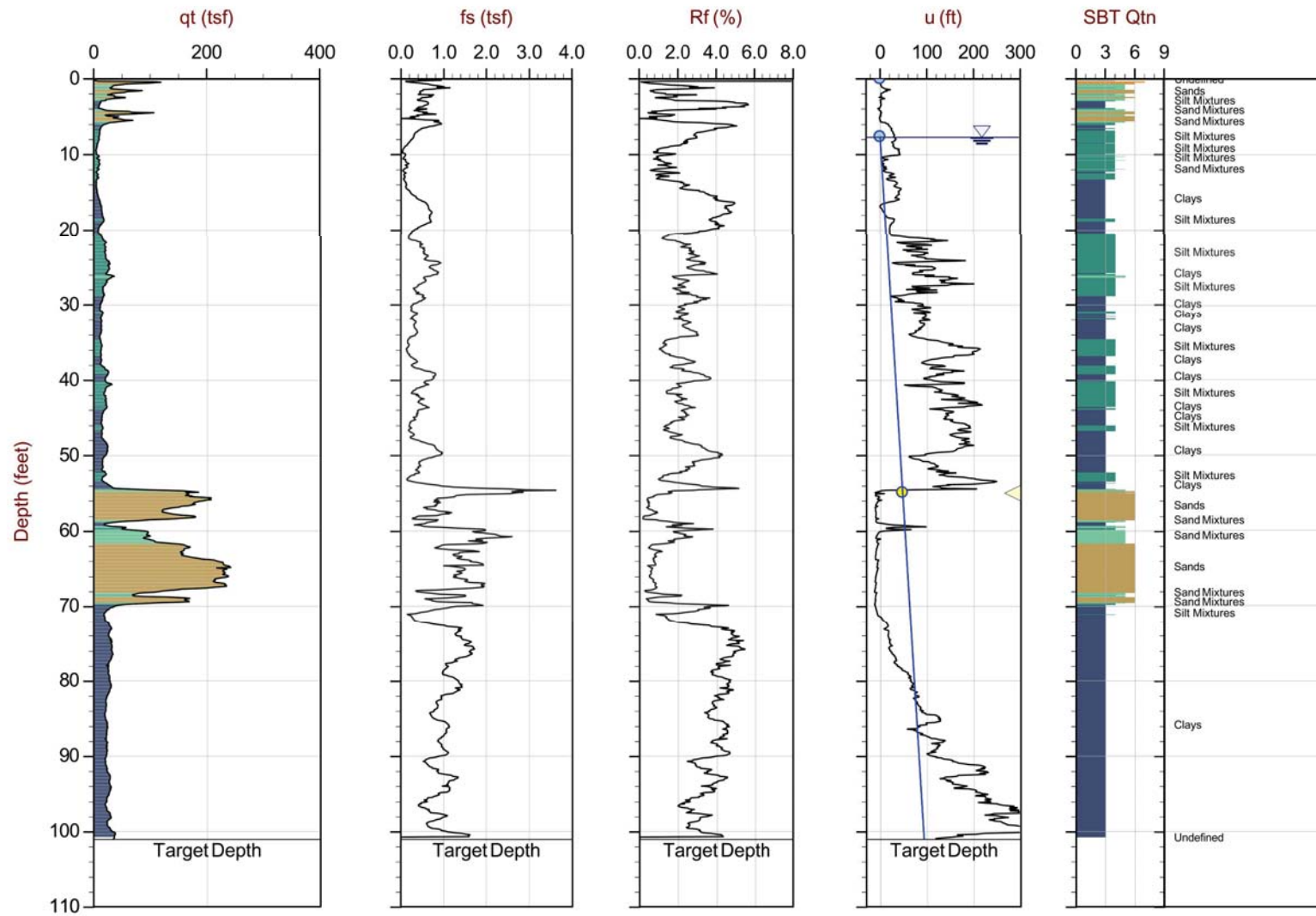
GROUND WATER OBSERVATIONS:

▽ : FREE GROUND WATER MEASURED DURING DRILLING AT 11.0 FEET

LA CORP.GDT 10/29/18 MV, CA*



EB-5
315276



Avg Int: Every Point

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

Sheet No: 1 of 1

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

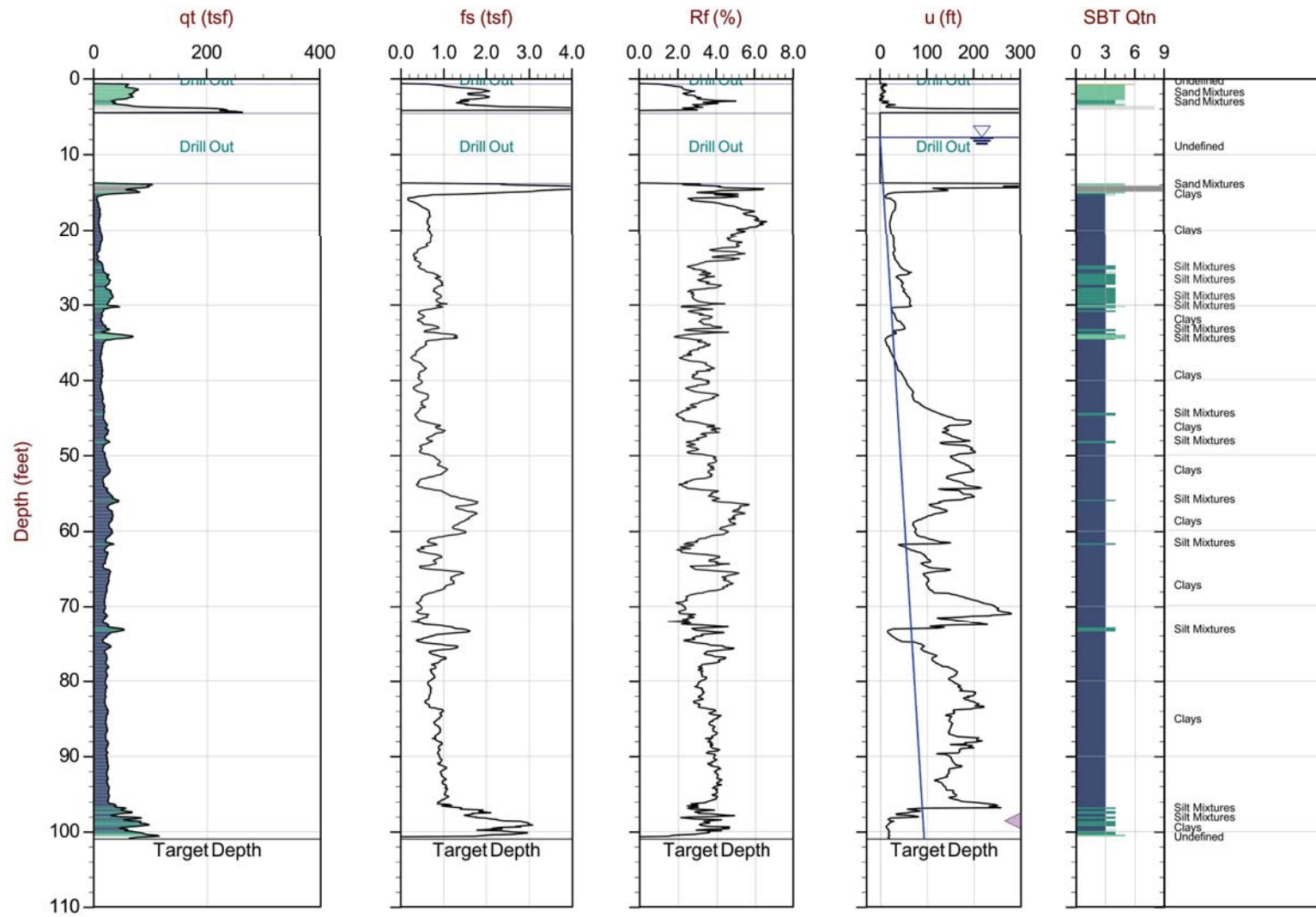
CONE PENETRATION TEST CPT-5

1175 Weeks Street and 1990 Bay Road
Development
East Palo Alto, California



315276

CPT-5



Avg Int: Every Point

● Equilibrium Pore Pressure (Ueq)

● Assumed Ueq

◀ Dissipation, Ueq achieved

Sheet No: 1 of 1

◀ Dissipation, Ueq not achieved

— Hydrostatic Line

CONE PENETRATION TEST CPT-6

1175 Weeks Street and 1990 Bay Road
Development
East Palo Alto, California



315276

CPT-6

Ninyo & Moore (2014)

NM-B-5

NM-B-4

BORING LOG EXPLANATION SHEET

DEPTH (feet)	Bulk Driven	SAMPLES	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0								Bulk sample.
								Modified split-barrel drive sampler.
								No recovery with modified split-barrel drive sampler.
								Sample retained by others.
								Standard Penetration Test (SPT).
5								No recovery with a SPT.
			XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
								No recovery with Shelby tube sampler.
								Continuous Push Sample.
								Seepage.
10								Groundwater encountered during drilling.
								Groundwater measured after drilling.
							SM	ALLUVIUM:
								Solid line denotes unit change.
								Dashed line denotes material change.
15								Attitudes: Strike/Dip
								b: Bedding
								c: Contact
								j: Joint
								f: Fracture
								F: Fault
								cs: Clay Seam
								s: Shear
								bss: Basal Slide Surface
								sf: Shear Fracture
								sz: Shear Zone
								sbs: Sheared Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

Ninyo & Moore

BORING LOG

EXPLANATION OF BORING LOG SYMBOLS

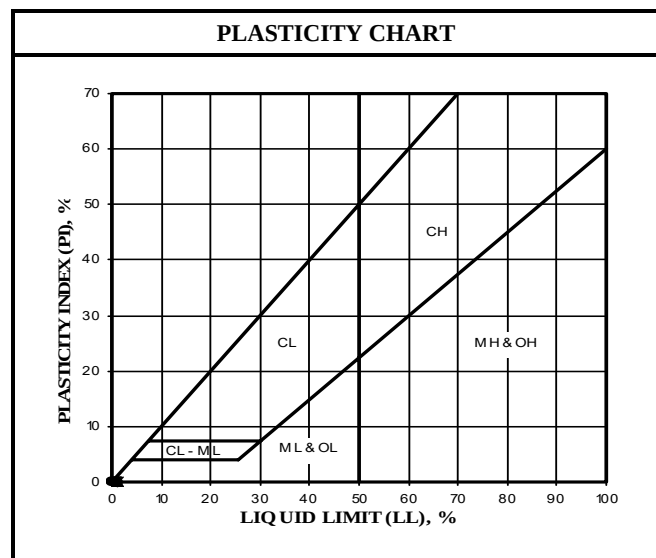
PROJECT NO.

DATE
Rev. 01/03

FIGURE

U.S.C.S. METHOD OF SOIL CLASSIFICATION				
MAJOR DIVISIONS		SYMBOL		TYPICAL NAMES
COARSE-GRAINED SOILS (More than 1/2 of soil >No. 200 sieve size)	GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size)		GW	Well graded gravels or gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
			GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction <No. 4 sieve size)		SW	Well graded sands or gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines
			SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than 1/2 of soil <No. 200 sieve size)	SILTS & CLAYS Liquid Limit <50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean
			OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit >50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils	

GRAIN SIZE CHART		
CLASSIFICATION	RANGE OF GRAIN SIZE	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL Coarse Fine	3" to No. 4	76.2 to 4.76
	3" to 3/4"	76.2 to 19.1
	3/4" to No. 4	19.1 to 4.76
SAND Coarse Medium Fine	No. 4 to No. 200	4.76 to 0.075
	No. 4 to No. 10	4.76 to 2.00
	No. 10 to No. 40	2.00 to 0.420
	No. 40 to No. 200	0.420 to 0.075
SILT & CLAY	Below No. 200	Below 0.075



Ninyo & Moore	U.S.C.S. METHOD OF SOIL CLASSIFICATION
--------------------------	--

DEPTH (feet)	SAMPLES Bulk Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S	DATE DRILLED <u>7/23/14</u> BORING NO. <u>B-4</u>	
							GROUND ELEVATION <u>7'± (MSL)</u> SHEET <u>1</u> OF <u>2</u>	
METHOD OF DRILLING <u>8" Hollow Stem Auger (Exploration Geoservices) Mobile B-53 Drill</u>							DRIVE WEIGHT <u>140 LBS Wireline Hammer</u> DROP <u>30"</u>	
SAMPLED BY <u>DWM</u> LOGGED BY <u>DWM</u> REVIEWED BY <u>KG/SG</u>							DESCRIPTION/INTERPRETATION	
0							<u>ASPHALT CONCRETE</u> : Approximately 4 inches thick.	
							<u>AGGREGATE BASE</u> : Approximately 4 inches thick.	
						CL	<u>ALLUVIUM</u> : Gray to black, moist, stiff, sandy CLAY; few gravel.	
18			19.8	105.5			Black, wet, firm.	
7							Gray to black, stiff.	
5							Soft.	
13			24.8	97.4			Brown, wet, loose, silty SAND.	
3						SM	White, wet, stiff, CLAY.	
15						CL	15 PSI.	
23"/30"							Olive brown; very stiff.	
19								

Ninyo & Moore

BORING LOG

BAY ROAD IMPROVEMENT PHASE 2 & 3
EAST PALO ALTO, CALIFORNIA

PROJECT NO.
402371001

DATE
9/14

FIGURE
A-7

Ninyo & Moore

BAY ROAD IMPROVEMENT PHASE 2 & 3
EAST PALO ALTO, CALIFORNIA

FIGURE
A-9

Iris Environmental (2013)

I-CPT-2

I-CPT-3



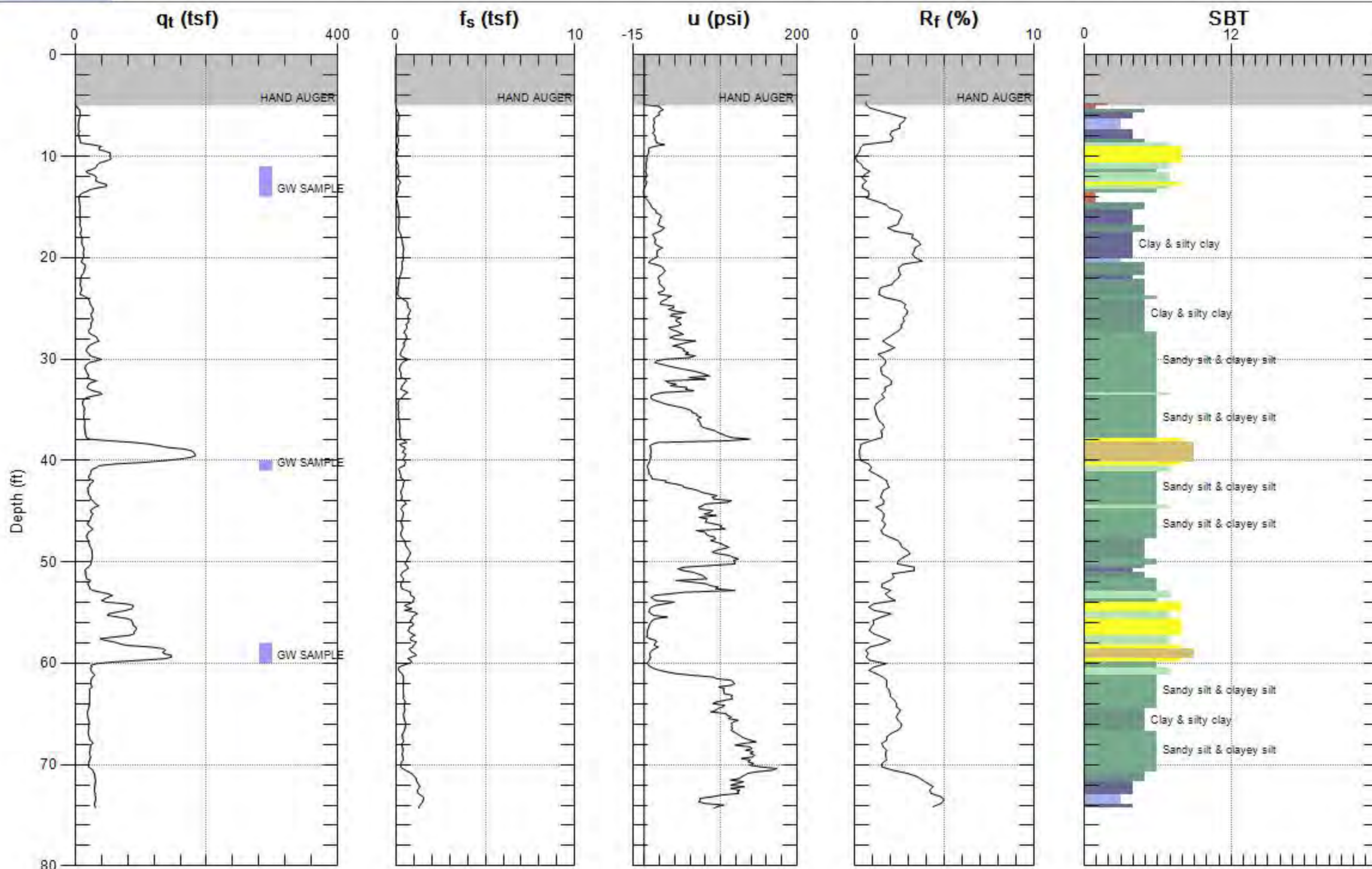
IRIS ENVIRONMENTAL

Site: FMR. ROMIC SITE

Sounding: CPT-2

Engineer: C.ALGER

Date: 1/24/2012 08:56



Max. Depth: 74.311 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



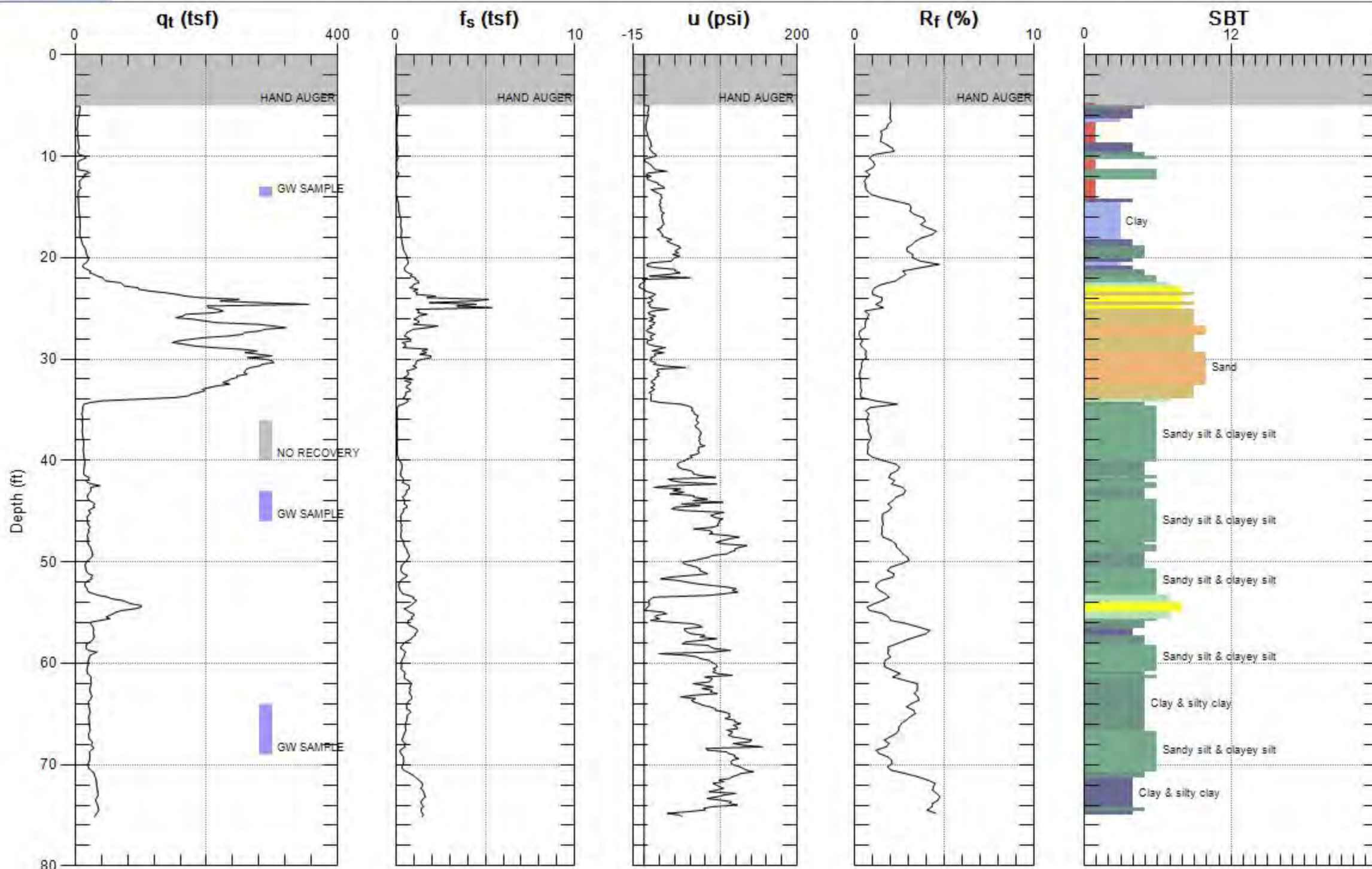
IRIS ENVIRONMENTAL

Site: FMR. ROMIC SITE

Sounding: CPT-3

Engineer: C.ALGER

Date: 1/24/2012 05:38



Max. Depth: 75.131 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GEI Consultants, Inc.
(2012)

GEI-B-5
GEI-CPT-4

SOIL CLASSIFICATION CHART

UNIFIED SOIL CLASSIFICATION SYSTEM

GRAPHIC SYMBOL	LETTER	DESCRIPTION OF SYMBOLS USED IN BORING LOGS	MAJOR DIVISIONS		
	GW	WIDELY GRADED GRAVELS	CLEAN GRAVELS (LITTLE OR NO FINES)	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	COARSE GRAIN SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE
	GP	NARROWLY GRADED GRAVELS			
	GM	SILTY GRAVELS	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		
	GC	CLAYEY GRAVELS			
	SW	WIDELY GRADED SANDS	CLEAN SANDS (LITTLE OR NO FINES)	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	
	SP	NARROWLY GRADED SANDS			
	SM	SILTY SANDS	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		
	SC	CLAYEY SANDS			
	ML	SILTS	SILTS & CLAYS LIQUID LIMIT LESS THAN 50		FINE GRAIN SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE
	CL	LEAN CLAYS			
	OL	ORGANIC SILTS/ORGANIC CLAYS			
	MH	ELASTIC SILTS	SILTS & CLAYS LIQUID LIMIT GREATER THAN 50		
	CH	FAT CLAYS			
	OH	ORGANIC CLAYS/ORGANIC SILTS			
	PT	PEATS	HIGHLY ORGANIC SOILS		

SOIL SAMPLER SYMBOLS



MODIFIED CALIFORNIA SAMPLER



SHELBY TUBE



STANDARD PENETRATION SAMPLER

FIELD TEST

250 PSI = GAUGE PRESSURE TO ADVANCE THE SHELBY TUBE SAMPLER

NOTES

1. For driven sampler, sampling resistance is the number of hammer blows required to advance the sampler 12-inches, after an initial 6-inches seating penetration. Liners were not used in the SPT sampler.
2. Description of the hammer used to drive the samplers are presented in the text.
3. Description of the drilling method and bit used are presented in the logs.

SAN FRANCISQUITO CREEK
FLOOD CONTROL PROJECT



KEY TO BORING
LOGS

Project 092850

July 2010

Boring Location				BORING	
NORTHING: _____		EASTING: _____		STATION: _____	
HORIZONTAL DATUM: NAD 83		STATION CENTERLINE: _____			
VERTICAL DATUM: NAVD 88		GROUND SURFACE ELEVATION (FT): 14			
LOCATION: On Levee Crown, ~300' E of Frienship Bridge, Palo Alto					

B-5

PAGE 1 of 2

Drilling Information

DATE START / END: 2/8/10		TOTAL DEPTH (FT): 51.5	
CONTRACTOR: Pitcher Drilling Co.		DRILLER: Will	
EQUIPMENT: Fraste Multidrill XL Rubber Track		LOGGED BY: T. Haynes	
AUGER ID/OD: N/A / 5 in, 2.625 in		BORING METHOD: Solid Stem Auger/Mud Rotary	
CASING ID/OD: N/A / N/A			
HAMMER TYPE: Automatic Hammer		HAMMER WEIGHT (lbs): 140	
HAMMER DROP (inch): 30			
WATER LEVEL DEPTHS (ft): Water level not observed during rotary wash exploration			
GENERAL NOTES: Fraste Multidrill XL Rubber Track Rig			

ABBREVIATIONS:	ID = Inside Diameter OD = Outside Diameter Pen. = Penetration Length Rec. = Recovery Length	bpf = Blows per Foot mpf = Minute per Foot S = Split Spoon DP = Direct Push Sample	U = Undisturbed Tube Sample C = Rock Core V = Field Vane Shear SC = Sonic Core	WOR = Weight of Rods WOH = Weight of Hammer RQD = Rock Quality Designation OVM = Organic Vapor Meter	Q _p = Pocket Penetrometer Strength S _v = Pocket Torvane Shear Strength F _v = Field Vane Shear Strength NA, NM = Not Applicable, Not Measured
-----------------------	--	---	---	---	--

Elev. (ft)	Depth (ft)	SAMPLE INFORMATION					GRAPHIC LOG	Sample Description & Classification	Moisture Content (%)	Dry Density (pcf)	Fines % <#200	LL	PI	Other Tests	Remarks
		Type	Sample No.	Pen./ Rec. (in)	Blow Count or RQD	Field Test Data (ksf)									
			S1	18/12	4 4 7	Q _p =5.0 S _u =2.5		Lean CLAY (CL); very stiff; very dark gray (10YR 3/1); moist; medium plasticity fines; fine to coarse gravel at ground surface [FILL].	35	76					Q _u =2.60 ksf
	10		S2	18/8	3 5 5			~2-inch sandy silt seam at 3.3' trace fine sand from 3.5 to 7.0'.							
	5														
			S3	18/14	3 3 4	Q _p =1.5 S _u =1.0		Sandy Lean CLAY (CL); dark grayish brown (10YR 4.2); moist; 70% low to medium plasticity fines; 30% fine sand [FILL]. Driller's Note: sand mixed with clay in cuttings at 7.0'.	45	71					
	10		S4	18/11	1 2 2			Lean CLAY (CL); medium stiff; dark gray (2.5Y 4/1) mottled with brown (7.5YR 4/3); moist; medium plasticity fines; trace organics (plant fibers) [FILL].							
	0		S5	30/29	0 psi	S _u =0.5		Elastic Silt (MH); soft; very dark greenish gray (5G 3/1); moist to wet; medium to high plasticity fines.	86	51		96	52		S _v =0.58 ksf Consol
	15														
			S6	30/30	240 psi	Q _p =3.5 S _u =2.25									
	-5														
	20							Lean CLAY (CL); stiff to very stiff; dark greenish gray (10Y 4/1); moist; medium to high plasticity fines.	30	93					
			S7	18/14	5 6 8	Q _p =3.0 S _u =2.25		olive gray (5Y 5/2); medium plasticity fines.							
	-10														
	25														
			S8	30/24	200 psi	Q _p =2.5 S _u =1.0		Color change to gray (5Y 5/1) mottled with strong brown (7.5YR 4/6); medium stiff to stiff from 28.0 to 31.0'.	25						
	-15														

Strata lines represent the approximate boundaries between soil types. Actual transitions may be gradual. Water level readings have been made at times stated. Water levels may be different at other times.

CLIENT: HDR Engineering, Inc.
PROJECT NAME: San Francisquito Flood Control Project
CITY/STATE: Palo Alto/East Palo Alto, California
GEI PROJECT NUMBER: 092850

GEI Consultants
180 Grand Ave
Oakland Ca 94611
510-350-2900



GEOTECHNICAL BORING LOG 02_SF_CREEK_FLOOD_CONTROL.GPJ GEI DATA TEMPLATE.GDT 7/21/10

Boring Location
NORTHING: _____ **EASTING:** _____ **STATION:** _____ **OFFSET:** _____
HORIZONTAL DATUM: NAD 83 **STATION CENTERLINE:** _____
VERTICAL DATUM: NAVD 88 **GROUND SURFACE ELEVATION (FT):** 14
LOCATION: On Levee Crown, ~300' E of Frienship Bridge, Palo Alto

BORING
B-5
PAGE 2 of 2

Elev. (ft)	Depth (ft)	SAMPLE INFORMATION					GRAPHIC LOG	Sample Description & Classification	Moisture Content (%)	Dry Density (pcf)	Fines % <#200	LL	PI	Other Tests	Remarks
		Type	Sample No.	Pen./ Rec. (in)	Blow Count or RQD	Field Test Data (ksf)									
									33	88					
								Poorly Graded SAND with Gravel (SP); medium dense to dense; dark brown (10YR 3/3); moist to wet; 80% fine to coarse sand; 20% fine gravel. Driller's Note: loss of water in mud tub at 31.0'.							
	-20	X	S9	18/14	22 23 24										
	35	X	S10	18/6	2 4 13										
	-25														
	40	X	S11	18/8	10 15 18			65% fine to coarse sand; 35% fine gravel from 40.0 to 45.0'.							
	-30														
	45	X	S12	18/18	3 5 5			Lean CLAY (CL); stiff; yellowish brown (10YR 5/4); medium plasticity fines; trace fine sand.							
	-35														
	50	X	S13	18/15	5 10 11	Q _u =2.0 S _u =1.2		Color change to dark greenish gray (10YR 4/1) from 50.0 to 51.5'.							
	-40							End of Boring at 51.5 feet							
	55														
	-45														
	60														
	-50														
	65														

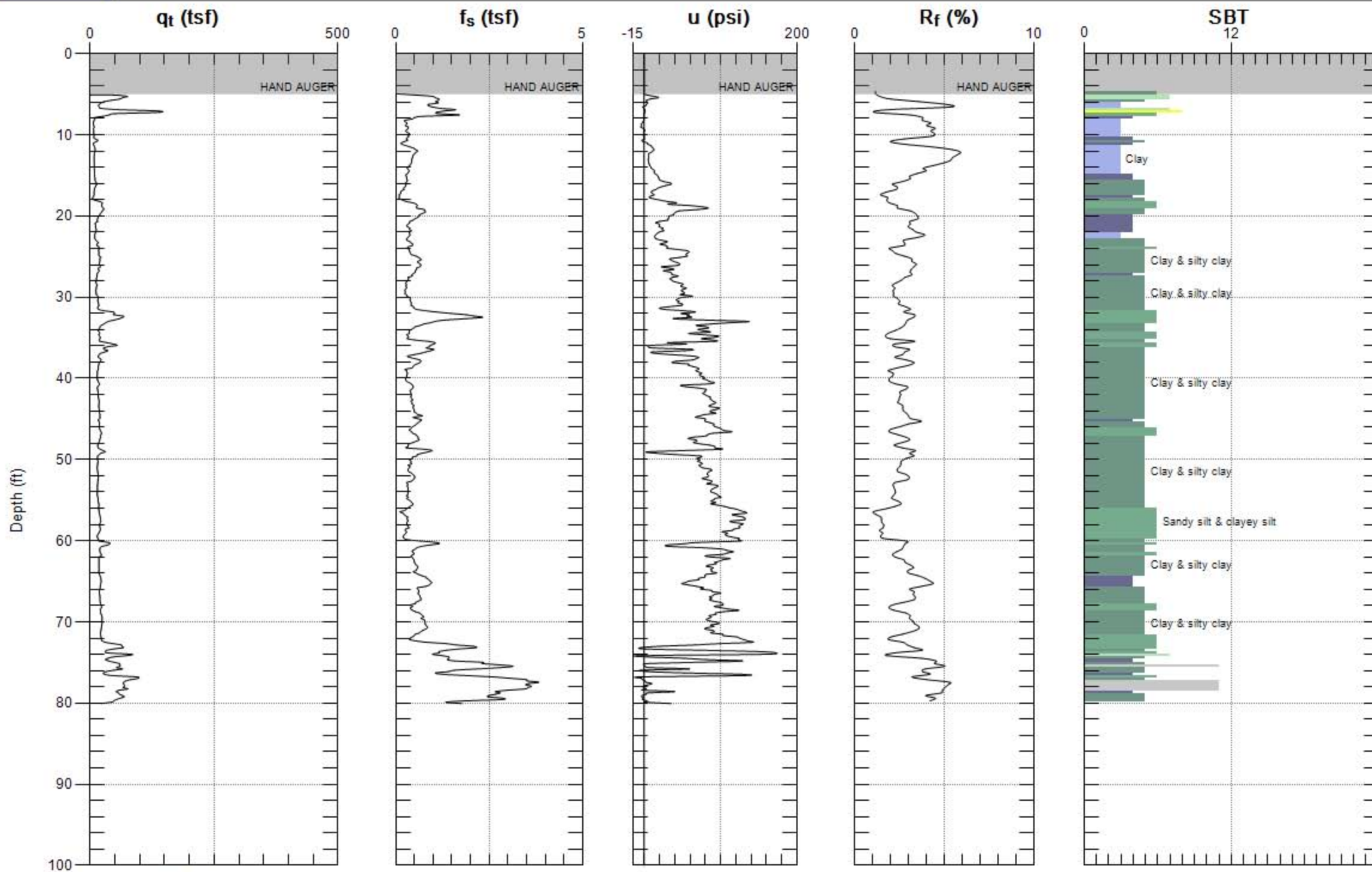
Strata lines represent the approximate boundaries between soil types. Actual transitions may be gradual. Water level readings have been made at times stated. Water levels may be different at other times.

CLIENT: HDR Engineering, Inc.
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180 Grand Ave
Oakland Ca 94611
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GEOTECHNICAL BORING LOG 02_SF_CREEK_FLOOD_CONTROL.GPJ GEI DATA TEMPLATE.GDT 7/21/10



Max. Depth: 80.052 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

Lowney Associates (2002)

LNY-EB-5

EXPLORATORY BORING: EB-5

Sheet 1 of 2

DRILL RIG: FAILING 1500

BORING TYPE: ROTARY WASH

LOGGED BY: BAH

START DATE: 2-20-02

FINISH DATE: 2-20-02

PROJECT NO: 109-17

PROJECT: SAN FRANCISQUITO CREEK LEVEE

LOCATION: PALO ALTO, CA

COMPLETION DEPTH: 40.0 FT.

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf)			
										○ Pocket Penetrometer	△ Torvane	● Unconfined Compression	▲ U-U Triaxial Compression
			SURFACE ELEVATION:										
	0		SANDY LEAN CLAY (CL) [FILL] hard, moist, brown, fine to medium sand, some fine to coarse gravel, low plasticity	CL, FILL	50/4"		12	114					
	5		very stiff										
	10		FAT CLAY (CH) [BAY MUD] medium stiff, moist, dark gray, trace organics, high plasticity	CH	18		34	86					
	15				15		50	75					
	20		LEAN CLAY (CL) medium stiff to stiff, moist to wet, bluish gray, some fine gravel, low to moderate plasticity	CL	10		23	104					
	25		color changes to brown with orange mottles		17		31	93					
	30				17		38	84					

Continued Next Page

GROUND WATER OBSERVATIONS:

NOT APPLICABLE DUE TO ROTARY WASH DRILLING METHOD

LA CORP GDT 7/2/02 MV-FLL

EXPLORATORY BORING: EB-5 Cont'd

Sheet 2 of 2

DRILL RIG: FAILING 1500

BORING TYPE: ROTARY WASH

LOGGED BY: BAH

START DATE: 2-20-02 FINISH DATE: 2-20-02

PROJECT NO: 109-17

PROJECT: SAN FRANCISQUITO CREEK LEVEE

LOCATION: PALO ALTO, CA

COMPLETION DEPTH: 40.0 FT.

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf)			
										○ Pocket Penetrometer	△ Torvane	● Unconfined Compression	▲ U-U Triaxial Compression
			This log is a part of a report by Lowney Associates, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual.										
	30		LEAN CLAY (CL) medium stiff to stiff, moist to wet, bluish gray, some fine gravel, low to moderate plasticity	CL									
	35		CLAYEY SAND WITH GRAVEL (SC) dense, moist, brown, fine to coarse sand, fine gravel	SC	42	×	15		23				
					46	×							
	40				54	×							
			Bottom of Boring at 40 feet										
	45												
	50												
	55												
	60												

GROUND WATER OBSERVATIONS:

NOT APPLICABLE DUE TO ROTARY WASH DRILLING METHOD

LA CORP GDT 7/2/02 MV-FLL

Lowney Associates (2000)

LNy-EB-103

LNy-EB-104

LNy-EB-107

LNy-EB-109

EXPLORATORY BORING: EB-103

Sheet 1 of 1

DRILL RIG: FAILING 1500

BORING TYPE: 4-7/8 INCH ROTARY WASH

LOGGED BY: JGH

START DATE: 8-24-00

FINISH DATE: 8-24-00

PROJECT NO: 1636-1

PROJECT: TORRES PROPERTY, 1175 WEEKS STREET

LOCATION: EAST PALO ALTO, CA

COMPLETION DEPTH: 26.5 FT.

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf)				
										○ Pocket Penetrometer	△ Torvane	● Unconfined Compression	▲ U-U Triaxial Compression	
			This log is a part of a report by Lowney Associates, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual. MATERIAL DESCRIPTION AND REMARKS SURFACE ELEVATION: 5 FT. (+/-)											
5	0		SANDY CLAY (CL) [FILL] hard, dry, light to dark brown mottled, with fine to coarse gravel, low plasticity	CL, FILL	36	50/6"								
0.8	5		SILTY CLAY (CL) medium stiff, moist, black, with trace organics, moderate plasticity, 6.6% organics color grades to brown and gray mottled, with trace fine gravel		8		44	74		○				
					9		31	94		○				
	10		interbedded seams of silty sand color grades to dark gray, with gravel	CL			40	82	24					
	15		less gravel		16		27	99		○				
	20		color grades to light gray											
-15.0	20		SILTY CLAY (CL) stiff, moist, gray and brown mottled, low plasticity		21		21	113		○				
	25		trace fine gravel	CL										
-21.5			Bottom of Boring at 26½ feet		15		29	92		○				
	30													

DRAFT

GROUND WATER OBSERVATIONS:

▽: FREE GROUND WATER MEASURED DURING DRILLING AT 9.0 FEET

Northing: 1,997,966

Easting: 6,089,270

LA CORP. GDT 1/15/01 MV-FLL

EXPLORATORY BORING: EB-104

Sheet 1 of 1

DRILL RIG: FAILING 1500

BORING TYPE: 4-7/8 INCH ROTARY WASH

LOGGED BY: JGH

START DATE: 8-24-00

FINISH DATE: 8-24-00

PROJECT NO: 1636-1

PROJECT: TORRES PROPERTY, 1175 WEEKS STREET

LOCATION: EAST PALO ALTO, CA

COMPLETION DEPTH: 6.5 FT.

This log is a part of a report by Lowney Associates, and should not be used as a stand-alone document. This description applies only to the location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with time. The description presented is a simplification of actual conditions encountered. Transitions between soil types may be gradual.

MATERIAL DESCRIPTION AND REMARKS

SURFACE ELEVATION:

SANDY CLAY (CL) [FILL]

very stiff, dry, light brown to dark brown, fine to coarse gravel

very stiff, moist

hard, asphalt

Bottom of Boring at 6½ feet

DRAFT

SOIL TYPE

PENETRATION
RESISTANCE
(BLOWS/FT.)

SAMPLER

MOISTURE
CONTENT (%)

DRY DENSITY
(PCF)

PERCENT PASSING
NO. 200 SIEVE

Undrained Shear Strength
(ksf)

○ Pocket Penetrometer

△ Torvane

● Unconfined Compression

▲ U-U Triaxial Compression

1.0 2.0 3.0 4.0

ELEVATION
(FT)

DEPTH
(FT)

SOIL LEGEND

0

5

10

15

20

25

30

CL, FILL

28

13

16

61

10

119

GROUND WATER OBSERVATIONS:

NO FREE GROUNDWATER ENCOUNTERED

Northing: 1,998,278

Easting: 6,089,166

LA CORP GDT 1/15/01 MV-FLL

EXPLORATORY BORING: EB-107

Sheet 1 of 1

DRILL RIG: MOBILE B-40

BORING TYPE: 8-INCH HOLLOW STEM AUGER

LOGGED BY: JK

START DATE: 10-27-00

FINISH DATE: 10-27-00

PROJECT NO: 1636-1

PROJECT: TORRES PROPERTY, 1175 WEEKS STREET

LOCATION: EAST PALO ALTO, CA

COMPLETION DEPTH: 20.0 FT.

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf)			
										○ Pocket Penetrometer	△ Torvane	● Unconfined Compression	▲ U-U Triaxial Compression
9	0		SURFACE ELEVATION: 9 FT. (+/-)										
8.5	0		6-inches asphalt concrete	AC									
			SILTY CLAY (CL) [CEMENT TREATED] very stiff, moist, dark brown, visible seams of cement mixing, low plasticity		50/5"	×	37	72					
					50/5"	×	38	77					
	5				49	×	43	73					
				CL	54	×	23	102					
	10				50/6"	×	38	82					
			5.8 ksf Unconfined Compression		50/3"	×	39	70					
	15												
-9.3					20	×	57						
			SILTY CLAY (CL) stiff, moist, dark and light brown mottled, low plasticity	CL	27	×							
-11.0	20		Bottom of Boring at 20 feet										
	25												
	30												

DRAFT

GROUND WATER OBSERVATIONS:

NO FREE GROUNDWATER ENCOUNTERED

Northing: 1,998,571

Easting: 6,089,040

LA CORP.GDT 2/22/01 MW-FLL

EXPLORATORY BORING: EB-109

Sheet 1 of 1

DRILL RIG: MOBILE B-40

BORING TYPE: 8-INCH HOLLOW STEM AUGER

LOGGED BY: JK

START DATE: 10-27-00

FINISH DATE: 10-27-00

PROJECT NO: 1636-1

PROJECT: TORRES PROPERTY, 1175 WEEKS STREET

LOCATION: EAST PALO ALTO, CA

COMPLETION DEPTH: 16.5 FT.

ELEVATION (FT)	DEPTH (FT)	SOIL LEGEND	MATERIAL DESCRIPTION AND REMARKS	SOIL TYPE	PENETRATION RESISTANCE (BLOWS/FT.)	SAMPLER	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	PERCENT PASSING NO. 200 SIEVE	Undrained Shear Strength (ksf)			
										○ Pocket Penetrometer	△ Torvane	● Unconfined Compression	▲ U-U Triaxial Compression
10	0		SURFACE ELEVATION: 10 FT. (+/-)										
9.5	0.5		6-inches asphalt concrete	AC									
			SANDY SILT (ML) [CEMENT TREATED] very stiff, moist, light brown, trace gravel and clay, low plasticity	SM	50/6"		27						○
					43								○
5.0	5		SILTY CLAY (CL) [CEMENT TREATED] hard, wet, dark brown and greenish-gray mottled, visible seams of cement mixing, low plasticity	CL	65		36	73		●			○
					50/5"		34	83					○
					50/5"		35	85					○
-4.5	15		SAND (SP) medium dense, moist, brown and gray	SM	22		32	76					○
-5.0			SILTY CLAY (CL) soft, moist, brown and gray mottled, low plasticity	CL	4					○			
-6.5			Bottom of Boring at 16½ feet										
	20												
	25												
	30												

DRAFT

GROUND WATER OBSERVATIONS:

▽: FREE GROUND WATER MEASURED DURING DRILLING AT 9.0 FEET

Northing: 1,998,450

Easting: 6,089,150

LA CORP GDT 2/22/01 MV* FL

PRIMARY DIVISIONS			SOIL TYPE		SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (Less than 5% Fines)	GW		Well graded gravels, gravel-sand mixtures, little or no fines
			GP		Poorly graded gravels or gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES	GM		Silty gravels, gravel-sand-silt mixtures, plastic fines
			GC		Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (Less than 5% Fines)	SW		Well graded sands, gravelly sands, little or no fines
			SP		Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH FINES	SM		Silty sands, sand-silt-mixtures, non-plastic fines
			SC		Clayey sands, sand-clay mixtures, plastic fines
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50 %		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL		Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50 %		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
			HIGHLY ORGANIC SOILS		PT

DEFINITION OF TERMS

U.S. STANDARD SIEVE SIZE					CLEAR SQUARE SIEVE OPENINGS				
200		40		10	4	3/4"		3"	12"
SILTS AND CLAY	SAND				GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE				
0.08		0.4	2	5	19	76mm			

GRAIN SIZES

	TERZAGHI SPLIT SPOON STANDARD PENETRATION		MODIFIED CALIFORNIA		D&M UNDERWATER SAMPLER		SHELBY TUBE		NO RECOVERY
--	---	--	---------------------	--	------------------------------	--	-------------	--	-------------

SAMPLERS

SAND AND GRAVEL	BLOWS/FOOT*
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

RELATIVE DENSITY

SILTS AND CLAYS	STRENGTH+	BLOWS/FOOT*
VERY SOFT	0-1/4	0-2
SOFT	1/4-1/2	2-4
MEDIUM STIFF	1/2-1	4-8
STIFF	1-2	8-16
VERY STIFF	2-4	16-32
HARD	OVER 4	OVER 32

CONSISTENCY

*Number of blows of 140 pound hammer falling 30 inches to drive a 2-inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).
+Unconfined compressive strength in tons/sq.ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

KEY TO EXPLORATORY BORING LOGS

Unified Soil Classification System (ASTM D-2487)

EXPLORATORY BORING: EB-103

Sheet 1 of 1

DRILL RIG: FAILING 1500

BORING TYPE: 4-7/8 INCH ROTARY WASH

LOGGED BY: JGH

START DATE: 8-24-00

FINISH DATE: 8-24-00

PROJECT NO: 1636-1

PROJECT: TORRES PROPERTY, 1175 WEEKS STREET

LOCATION: EAST PALO ALTO, CA

COMPLETION DEPTH: 26.5 FT.

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MATERIAL DESCRIPTION AND REMARKS										
SURFACE ELEVATION: 5 FT. (+/-)										
SANDY CLAY (CL) [FILL] hard, dry, light to dark brown mottled, with fine to coarse gravel, low plasticity										
CL, FILL										
SILTY CLAY (CL) medium stiff, moist, black, with trace organics, moderate plasticity, 6.6% organics color grades to brown and gray mottled, with trace fine gravel										
CL										
interbedded seams of silty sand color grades to dark gray, with gravel										
less gravel										
color grades to light gray										
SILTY CLAY (CL) stiff, moist, gray and brown mottled, low plasticity										
CL										
trace fine gravel										
Bottom of Boring at 26½ feet										
DRAFT										

DRAFT

GROUND WATER OBSERVATIONS:

▽: FREE GROUND WATER MEASURED DURING DRILLING AT 9.0 FEET

Northing: 1,997,966

Easting: 6,089,270

LA CORP. GDT 1/15/01 MV-FLL

PRIMARY DIVISIONS			SOIL TYPE		SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (Less than 5% Fines)	GW		Well graded gravels, gravel-sand mixtures, little or no fines
			GP		Poorly graded gravels or gravel-sand mixtures, little or no fines
		GRAVEL WITH FINES	GM		Silty gravels, gravel-sand-silt mixtures, plastic fines
			GC		Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (Less than 5% Fines)	SW		Well graded sands, gravelly sands, little or no fines
			SP		Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH FINES	SM		Silty sands, sand-silt-mixtures, non-plastic fines
			SC		Clayey sands, sand-clay mixtures, plastic fines
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT IS LESS THAN 50 %		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL		Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS LIQUID LIMIT IS GREATER THAN 50 %		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH		Inorganic clays of high plasticity, fat clays
			OH		Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT		Peat and other highly organic soils

DEFINITION OF TERMS

U.S. STANDARD SIEVE SIZE			CLEAR SQUARE SIEVE OPENINGS			
200	40	10	4	3/4"	3"	12"
SILTS AND CLAY	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	
						BOULDERS

GRAIN SIZES

	TERZAGHI SPLIT SPOON STANDARD PENETRATION		MODIFIED CALIFORNIA		D&M UNDERWATER SAMPLER		SHELBY TUBE		NO RECOVERY
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SAMPLERS

SAND AND GRAVEL	BLOWS/FOOT*
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

RELATIVE DENSITY

SILTS AND CLAYS	STRENGTH+	BLOWS/FOOT*
VERY SOFT	0-1/4	0-2
SOFT	1/4-1/2	2-4
MEDIUM STIFF	1/2-1	4-8
STIFF	1-2	8-16
VERY STIFF	2-4	16-32
HARD	OVER 4	OVER 32

CONSISTENCY

*Number of blows of 140 pound hammer falling 30 inches to drive a 2-inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).
+Unconfined compressive strength in tons/sq.ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

KEY TO EXPLORATORY BORING LOGS

Unified Soil Classification System (ASTM D-2487)

Earth Systems (1983)

ES-B-1

ES-B-4

ES-B-5

ES-B-6

ES-B-7

ES-B-8

DEPTH IN FEET	SAMPLE NO	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE		
					DRY DENSITY pcf.	MOISTURE CONTENT % dry wt	
0				Boring 1 - Elevation 110±			
				FILL: Light brown silty CLAY with occasional gravel, slightly damp, hard (CL)			
	1-1-1		45	-brown sandy silt (ML)	4.5+	98	10.5
5	1-1-2				○ 108		15.0
				-medium stiff			
	1-2-1		4	-medium orange-brown clayey SILT, saturated, soft (ML)	▽ 87		33.0
	1-2-2				○ 91		31.2
	1-2-3				○ 84		36.5
10				NATURAL GROUND: Dark to medium grey organic silty CLAY with peat, medium stiff (OH) (BAY MUD)	0.25		
					○ 0.85		
	1-3		9		0.75	74	45.4
15					○		
	1-4-1		27	Greenish-grey sandy CLAY with caliche, stiff (CL)	1.75		
20	1-4-2			-very stiff	○ 108		20.3
				Greenish-brown (mottled) sandy CLAY, very stiff (CL)	3.0	126	16.2
					○		
25				-very stiff to hard			
	1-5-1		19	Orange-brown clayey SAND to silty SAND, medium dense (SC-SM)	107		21.5
30	1-5-2				103		23.6
	1-6			Orange-brown sandy CLAY, stiff (CL)			
				Medium dark orange-brown sandy CLAY with fine gravel, very stiff (CL)			
	1-7-1				121		11.7
	1-7-2		51	Orange-brown sandy GRAVEL, dense (GP)	121		12.8

continued...

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN - PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
35				Boring 1 - continued		
40				Orange-brown sandy GRAVEL ($\frac{1}{4}$ - 1") with varying clay binder, saturated, dense (GP-GC)		
45	1-8		60	-with trace clay binder	115	12.1
50				Boring terminated at 44½ feet. Drilled on September 19, 1983.		

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
0				Boring 2 - Elevation 110±		
2-A				FILL: Light brown silty CLAY with occasional gravel, slightly damp, very stiff-hard (CL)		
2-1			28	-grey and medium brown mottled silty CLAY with minor organics, moist, very stiff (CL) 3.0 ○	105	20.4
2-2			22	-dark grey clayey SILT moist, very stiff (ML) 3.75 ○	108	18.8
2-3			10	NATURAL GROUND: Dark grey silty CLAY with sandy SILT seams, medium stiff (OH) (BAY MUD) 0.6 ○ -dark grey organic silty CLAY, medium stiff	77	42.0
2-4			27	Greenish-grey sandy CLAY with caliche, stiff-very stiff (CL) 3.5 ○ -green-orange mottled silty CLAY with caliche, very stiff	103	22.6
				Boring terminated at 20 feet. Drilled on September 19, 1983.		

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
0.				Boring 3 - Elevation 111±		
3-1			27	FILL: Medium brown silty CLAY with gravel, damp, very stiff-hard (CL) ○ 4.0	120	14.0
3-2			42	Dark brown silty CLAY with minor silty sand pockets, minor gravel, moist, hard (CL) ○ 4.5+	115	13.8
3-3-1			8	Dark grey to black silty CLAY with organics, medium stiff (OH) (BAY MUD) ○ 0.75	56	73.1
3-3-2					47	89.3
3-4			25	Greenish-grey sandy CLAY with minor fine gravel, caliche, very stiff (CL) 3.0 ○	109	20.2
20.				Boring terminated at 20 feet. Drilled on September 19, 1983.		
25.						

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
0.				Boring 4 - Elevation 108±		
4-1			19	FILL: Brown silty CLAY with minor gravel, and varying amounts of grey silty CLAY, slightly damp, very stiff (CL) 4.5 ○	110	8.6
4-2			14	FILL/TRANSITION ZONE: Black silty CLAY with minor brown sandy clay, medium stiff-stiff (OH) NATURAL GROUND: Dark grey organic silty CLAY with abundant organics, wet, medium stiff-stiff (OH) (BAY MUD) ○ 1.1	74	43.5
4-3-1			8	Greenish-grey organic silty CLAY, medium stiff (CL) ▽ 0.75 ○	77	41.7
4-3-2			12	Dark grey silty CLAY with organics, stiff (OH) (BAY MUD) 1.5 ○	85	36.5
4-4			40	Greenish-grey sandy CLAY with caliche, very stiff (CL) -brownish-grey silty CLAY with sand minor gravel, caliche, very stiff 3.5 ○	112	18.3
				Boring terminated at 24 feet. Drilled on September 19, 1983.		

DEPTH IN FEET	SAMPLE NO	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt
0				Boring 5 - Elevation 112±		
5	5-1		13	FILL: Brown sandy SILT to silty SAND and black silty CLAY, moist, stiff (ML) 1.5 ○	97	21.8
10	5-2		8	-dark brown sandy SILT with minor black silty clay, moist, medium stiff (ML) -saturated ▽	100	24.6
15	5-3-1 5-3-2		9	NATURAL GROUND: medium to dark grey silty CLAY with minor organics, medium stiff (OH) (BAY MUD) 0.75 ○	61 66	61.2 53.0
20	5-4		12	Greenish-grey silty CLAY with fine sand, moist to medium stiff to stiff (CL) 1.5 ○ 0.75 ○	91	31.3
25	5-5-1 5-5-2		17	Orange-brown silty CLAY with caliche, very stiff (CL) Mottled brown alternating sandy SILT and sandy CLAY, stiff (ML-CL) 1.0 ○	100 99	25.0 25.7
30	5-6		27	Mottled grey-brown sandy CLAY with caliche, very stiff (CL) 2.0 ○	99	25.6
				Brown clayey GRAVEL, dense (GC)		
				Mottled brown sandy CLAY (CL)		

continued...

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
35				Boring 5 - continued		
36				Mottled brown sandy CLAY, very stiff (CL)		
37						
38						
39	5-7		38	Brown sandy GRAVEL (fine, minor coarse) with varying clay binder, dense (GP)	121	14.1
40						
41				Greenish-grey silty CLAY, very stiff (CL)		
42						
43						
44						
45						
46						
47						
48						
49	5-8		27	2.25 ○	97	27.6
50				Boring terminated at 50 feet. Drilled on September 19, 1983.		
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN- PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
0.				Boring 6 - Elevation 110±		
1.5				FILL: Orange-brown sandy SILT, slightly damp, stiff (ML)		
6-1			12	-dark grey silty CLAY with occasional orange-brown sandy SILT, moist, stiff (CH)	75	41.8
6-2			13	-dark grey silty CLAY with minor tan sandy SILT to silty SAND, occasional fine gravel, moist stiff	92	28.0
				NATURAL GROUND: Dark grey organic silty CLAY, medium stiff (OH) (BAY MUD)		
6-3			25	Greenish-grey CLAY sandy, very stiff, with abundant fine gravel (CL)	116	16.3
6-4			22	Orange-brown sandy fine gravel-gravelly coarse SAND, dense (GP)		
25.				Boring terminated at 25 feet. Drilled on September 19, 1983.		

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
0				Boring 7 - Elevation 109±		
7-B				FILL: Grey silty CLAY with minor brown sandy SILT, occasional gravel, damp, stiff (CH)		
7-1			14	-dark grey silty CLAY with organics, occasional orange-brown sandy silt, moist, stiff (OH) 1.35 ○	80	38.3
7-2			12	NATURAL GROUND: dark to medium grey silty CLAY with organics, saturated, stiff (OH) (BAY MUD) 1.15 ○	76	43.9
				Greenish-grey sandy CLAY with caliche, moist, stiff-very stiff (CL)		
7-3			24	Grey-brown silty CLAY, moist, very stiff (CL) 2.25 ○	110	19.1
				Boring terminated at 20 feet. Drilled on September 19, 1983.		

DEPTH IN FEET	SAMPLE NO.	LOG & LOCATION OF SAMPLE	Penetration Resistance Blows/ft	DESCRIPTION	IN-PLACE	
					DRY DENSITY p.c.f.	MOISTURE CONTENT % dry wt.
0.				Boring 8 - Elevation 109±		
1.	8-1		10	FILL: Medium grey silty CLAY with ½" shrinkage cracks (CH) -dark grey and orange-brown mottled silty CLAY with sand, gravel, slightly damp, very stiff (CH)	4.5+ ○	106 10.9
2.						
3.						
4.						
5.						
6.						
7.	8-2		13	-moist -dark grey silty CLAY with minor tan sandy SILT, moist, stiff (OH)	0.85 ○ 1.25	94 27.1
8.						
9.						
10.						
11.	8-3-1		11	NATURAL GROUND: Greenish-brown silty CLAY with organics, medium stiff (OH) (BAY MUD)	▽ 0.05	90 33.4
12.	8-3-2				○ 0.75	
13.						
14.						
15.						
16.						
17.						
18.	8-4		19	Grey-brown silty CLAY with caliche, very stiff (CL)	2.25 ○	101 24.1
19.						
20.				Boring terminated at 20 feet. Drilled on September 19, 1983.		
21.						
22.						
23.						
24.						
25.						
26.						
27.						
28.						
29.						
30.						

AMEC/Geomatrix (2009)

RSD-1

RSD-2

RSD-3

PROJECT: 1990 BAY ROAD SITE East Palo Alto, California					Boring Log Explanation			
BORING LOCATION:					ELEVATION AND DATUM:			
DRILLING CONTRACTOR:					DATE STARTED:		DATE FINISHED:	
DRILLING METHOD:					TOTAL DEPTH (ft.):		MEASURING POINT:	
DRILLING EQUIPMENT:					DEPTH TO WATER (ft.):		FIRST	COMPL.
SAMPLING METHOD:					LOGGED BY:			
HAMMER WEIGHT:			DROP:		RESPONSIBLE PROFESSIONAL:		REG. NO.	

DEPTH (feet)	SAMPLES			OVM READING (ppm)	DESCRIPTION	REMARKS
	Sample No.	Sample Blows/ Foot			NAME (USCS): color, moist, % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	
					Surface Elevation:	
1					Notes: 1. Soil described using visual-manual procedures of American Society of Testing and Materials (ASTM) Standard D 2488 for guidance; a Standard based on the Unified Soil Classification System. 2. Soil color described according to Munsell Color Chart.	
2						
3					3. Dashed lines separating soil strata represent inferred boundaries between sampled intervals that may be abrupt or gradual transitions.	
4						
5					4. Solid lines represent approximate boundaries observed within sample intervals. 5. OVM = organic vapor meter, reading in volumetric parts per million (ppm). 6. Odor, if noted is subjective and not necessarily indicative of specific compounds or concentrations. 7. NA = not applicable. 8. ND = no data.	
6						
7						
8						
9					Interval of recovered soil collected with a continuous core sampler.	
10						
11					Interval of no recovery.	
12						
13						
14						
15						

AMEC Geomatrix		Project No. 1220.000/505	Page 1 of 1
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PROJECT: 1990 BAY ROAD SITE East Palo Alto, California					Log of Boring No. RSD-1			
BORING LOCATION: On levee, end of Runnymede Street					ELEVATION AND DATUM: Not surveyed; datum is ground surface			
DRILLING CONTRACTOR: PeneCore Drilling					DATE STARTED: 11/16/09		DATE FINISHED: 11/16/09	
DRILLING METHOD: Direct push					TOTAL DEPTH (ft.): 20.0		MEASURING POINT: Ground surface	
DRILLING EQUIPMENT: Geoprobe 6600					DEPTH TO WATER (ft.)		FIRST 10.5	COMPL. NA
SAMPLING METHOD: Geoprobe DT-22 dual-tube sampling system [5' x 2.25"]					LOGGED BY: M. Gilmore			
HAMMER WEIGHT: NA			DROP: NA		RESPONSIBLE PROFESSIONAL: M. Gilmore		REG. NO. PG 8492	

DEPTH (feet)	SAMPLES			OVM READING (ppm)	DESCRIPTION	REMARKS
	Sample No.	Sample	Blows/ Foot		NAME (USCS): color, moist, % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	
					Surface Elevation: Not surveyed	
					ASPHALTIC CONCRETE : (2 inches thick)	
1					CLAYEY SAND with GRAVEL (SC): very dark grayish brown (10YR 3/2), moist, 40% fine to coarse sand, 35% fine gravel, 25% low plasticity fines	Composite soil sample RSD-1-2.5 collected by compositing soil from 0 to 2.5 feet bgs.
2					LEAN CLAY with SAND (CL): dark grayish brown (10YR 4/2) with trace mottles of black (10YR 2/1) and light gray (10YR 7/2), moist, 80% fines, 20% fine to coarse sand, low plasticity, firm	Composite soil sample RSD-1-7.5 collected by compositing soil from 5 to 7.5 feet bgs.
3						Composite soil sample RSD-1-11.5 collected by compositing soil from 10 to 11.5 feet bgs.
4						
5					85% fines, 15% fine to coarse sand	
6						Grab groundwater sample RSD-1U and RSD-1F collected through 10 feet of 1-inch OD Sch. 40 PVC screen (0.010-inch slot size) placed in borehole from 10 to 20 feet bgs. Drive casing retracted from bottom of boring to 10 feet bgs to maintain surface seal.
7					soft dark gray (10YR 4/1), 80% fines, 20% fine to coarse sand, slight hydrocarbon odor	
8						
9						
10					dark gray (N 4/), hydrocarbon odor	
11					CLAYEY SAND (SC): wet, no odor black (10YR 2/1) mottled with dark gray (10YR 4/1), 85% fines, 15% fine to coarse sand, no odor	
12						
13						
14						
15						

AMEC Geomatrix

Project No. 1220.000/505

OAKBORE (REV. 6/2008)
Page 1 of 2

PROJECT: 1990 BAY ROAD SITE
East Palo Alto, California

Log of Boring No. RSD-1 (cont'd)

DEPTH (feet)	SAMPLES			OVM READING (ppm)	DESCRIPTION NAME (USCS): color, moist, % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	REMARKS
	Sample No.	Sample	Blows/ Foot			
16					↓ grayish brown (10YR 5/2) with trace mottles of dark yellowish brown (10YR 4/6), moist, soft LEAN CLAY with SAND (CL): cont'd	Composite soil sample RSD-1-17.5 collected by compositing soil from 15 to 17.5 feet bgs.
17					LEAN CLAY (CL): very dark gray (10YR 3/1), moist, 95% fines, 5% fine sand, low to medium plasticity, firm	
18						
19						
20					Bottom of boring at 20.0 feet	Borehole destroyed using Type I-II neat cement grout placed from total depth to ground surface with a tremie pipe.
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						

OAKBORE (REV. 6/2008)

PROJECT: 1990 BAY ROAD SITE East Palo Alto, California					Log of Boring No. RSD-2			
BORING LOCATION: On levee, end of Runnymede Street					ELEVATION AND DATUM: Not surveyed; datum is ground surface			
DRILLING CONTRACTOR: PeneCore Drilling					DATE STARTED: 11/16/09		DATE FINISHED: 11/16/09	
DRILLING METHOD: Direct push					TOTAL DEPTH (ft.): 15.0		MEASURING POINT: Ground surface	
DRILLING EQUIPMENT: Geoprobe 6600					DEPTH TO WATER (ft.)		FIRST NA	COMPL. NA
SAMPLING METHOD: Geoprobe DT-22 dual-tube sampling system [5' x 2.25"]					LOGGED BY: M. Gilmore			
HAMMER WEIGHT: NA			DROP: NA		RESPONSIBLE PROFESSIONAL: M. Gilmore		REG. NO. PG 8492	

DEPTH (feet)	SAMPLES			OVM READING (ppm)	DESCRIPTION	REMARKS
	Sample No.	Sample	Blows/ Foot		NAME (USCS): color, moist, % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	
					Surface Elevation: Not surveyed	
1					ASPHALTIC CONCRETE : (2 inches thick)	Composite soil sample RSD-2-3.0 collected by compositing soil from 0 to 3.0 feet bgs.
2					CLAYEY SAND with GRAVEL (SC): very dark grayish brown (10YR 3/2), moist, 50% fine to coarse sand, 35% fine gravel, 15% low plasticity fines	
3					CLAYEY GRAVEL (GC): black (10YR 2/1), moist, 50% fine to coarse gravel, 40% low plasticity fines, 10% fine to coarse sand	
4					POORLY-GRADED SAND with CLAY (SP-SC): dark yellowish brown (10YR 4/6), moist, 90% fine to coarse sand, 10% low plasticity fines	Composite soil sample RSD-2-7.5 collected by compositing soil from 5 to 7.5 feet bgs.
5					LEAN CLAY (CL): black (10YR 2/1) with trace mottles of brown (10YR 4/3), moist, 90% fines, 10% fine to coarse sand, low plasticity, firm	Composite soil sample RSD-2-13 collected by compositing soil from 10 to 13 feet bgs.
6						
7					black (10YR 2/1) mottled with dark gray (N 4/), soft	
8						Grab groundwater sample RSD-2U and RSD-2F collected through 5 feet of 1-inch OD Sch. 40 PVC screen (0.010-inch slot size) placed in borehole from 10 to 15 feet bgs.
9					LEAN CLAY with SAND (CL): gray (N 5/), moist, 85% fines, 15% fine to coarse sand, low plasticity, firm	
10						
11					mottled with brown (10YR 4/3), 80% fines, 20% fine to coarse sand, soft	Borehole destroyed using Type I-II neat cement grout placed from total depth to ground surface with a tremie pipe.
12					85% fines, 15% fine to coarse sand, firm	
13					soft	
14						
15					Bottom of boring at 15.0 feet	

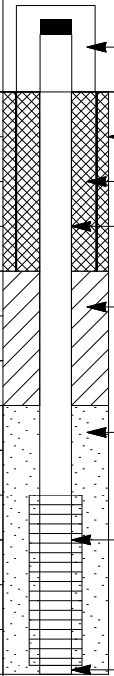
PROJECT: 1990 BAY ROAD SITE East Palo Alto, California					Log of Boring No. RSD-3				
BORING LOCATION: On levee, end of Runnymede Street					ELEVATION AND DATUM: Not surveyed; datum is ground surface				
DRILLING CONTRACTOR: PeneCore Drilling					DATE STARTED: 11/16/09		DATE FINISHED: 11/16/09		
DRILLING METHOD: Direct push					TOTAL DEPTH (ft.): 15.0		MEASURING POINT: Ground surface		
DRILLING EQUIPMENT: Geoprobe 6600					DEPTH TO WATER (ft.)		FIRST NA	COMPL. NA	
SAMPLING METHOD: Geoprobe DT-22 dual-tube sampling system [5' x 2.25"]					LOGGED BY: M. Gilmore				
HAMMER WEIGHT: NA			DROP: NA		RESPONSIBLE PROFESSIONAL: M. Gilmore			REG. NO. PG 8492	

DEPTH (feet)	SAMPLES			OVM READING (ppm)	DESCRIPTION	REMARKS
	Sample No.	Sample	Blows/ Foot		NAME (USCS): color, moist, % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	
					Surface Elevation: Not surveyed	
1					CLAYEY SAND with GRAVEL (SC): dark grayish brown (10YR 4/2), moist, 60% fine to coarse sand, 25% fine to coarse gravel, 15% low plasticity fines	Composite soil sample RSD-3-1.5 collected by compositing soil from 0 to 1.5 feet bgs.
2					CLAYEY GRAVEL (GC)	
3						
4					LEAN CLAY (CL): black (10YR 2/1), moist, 90% fines, 10% fine to coarse sand, medium plasticity, soft	Composite soil sample RSD-3-8.5 collected by compositing soil from 5 to 8.5 feet bgs.
5						Composite soil sample RSD-3-13 collected by compositing soil from 10 to 13 feet bgs.
6					firm	
7					soft	
8					LEAN CLAY with SAND (CL): gray (10YR 5/1) mottled with brown (10YR 4/3), moist, 80% fines, 20% fine to coarse sand, low plasticity, firm	Grab groundwater sample RSD-3U and RSD-3F collected through 5 feet of 1-inch OD Sch. 40 PVC screen (0.010-inch slot size) placed in borehole from 10 to 15 feet bgs.
9						
10						
11					75% fines, 25% fine to coarse sand, soft	Borehole destroyed using Type I-II neat cement grout placed from total depth to ground surface with a tremie pipe.
12					85% fines, 15% fine to medium sand, contains rootlets	
13						
14						
15					Bottom of boring at 15.0 feet	

Amec (2011)

W-135A

PROJECT: 1990 BAY ROAD SITE East Palo Alto, California						Log of Well No. W-135A			
BORING LOCATION: Lat: 37.4688487; Long: -122.1270436						GROUND SURFACE ELEVATION AND DATUM: 4.58' (NAVD 88)			
DRILLING CONTRACTOR: PeneCore Drilling						DATE STARTED: 10/7/11		DATE FINISHED: 10/7/11	
DRILLING METHOD: Hand auger						TOTAL DEPTH (ft.): 6.5		SCREEN INTERVAL (ft.): 4.5-6.4	
DRILLING EQUIPMENT: Hand auger						DEPTH TO WATER: 4.7	FIRST NA	COMPL. NA	CASING: 2" Sch. 40 PVC
SAMPLING METHOD: Hand auger						LOGGED BY: M. Calhoun			
HAMMER WEIGHT: NA			DROP: NA			RESPONSIBLE PROFESSIONAL: M. Calhoun			REG. NO. PG 8525

DEPTH (feet)	SAMPLES				OVM Reading	DESCRIPTION	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows/ Foot	Foot		NAME (USCS): color, moist, % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	
						Surface Elevation: 4.58' (NAVD 88)	
0						GRAVELLY LEAN CLAY (CL): dark grayish brown (10YR 4/2), moist, 70% fines, 20% fine to coarse gravel, 10% fine to coarse sand, low plasticity, soft	 Locking steel monument 6" diameter borehole Neat cement grout 2" diameter Schedule 40 PVC casing Bentonite chip seal #2/12 filter pack sand Prepacked Schedule 40 PVC screen, 2-inch inside diameter, 3-inch outside diameter, 0.010-inch slot size Schedule 40 PVC endcap
1				0			
2				0		55% fines, 35% gravel, 10% sand	
3				0		LEAN CLAY with SAND (CL): dark greenish gray (10Y 4/1) mottled with black (N 2.5/), moist, 85% fines, 15% fine to medium sand, trace coarse sand, low plasticity, firm, hydrocarbon odor	
4				0			
5				0		SILTY SAND (SM): light olive brown (2.5Y 5/4), wet, 85% fine sand, 15% nonplastic fines	
6				0		POORLY-GRADED SAND (SP)	
6				0		LEAN CLAY (CL)	
7						Bottom of boring at 6.5 feet	
8							
9							
10							
11							
12							
13							
14							
15							

Notes:

- Boring location coordinates are based on North American Datum of 1983.
- OVM = MiniRAE 2000 PID calibrated with 100 ppm isobutylene standard.



I:\PROJECT\...1220\GINT LOGS\DRAWING FILES\W-135a_WELL.GDW OAKWELLY (REV. 8/2011)

Project No. 0012200000.00310 Page 1 of 1

Amec (2011)

W-142

PROJECT: 1990 BAY ROAD SITE AND VICINITY
East Palo Alto, California

Log of Well No. W-142

BORING LOCATION: SE portion of site along levee

GROUND SURFACE ELEVATION AND DATUM:
7.37' MSL (NGVD29)

DRILLING CONTRACTOR: HEW Drilling Company

DATE STARTED:
8/2/01

DATE FINISHED:
8/3/01

DRILLING METHOD: Hollow-stem auger

TOTAL DEPTH (ft.):
38.5

SCREEN INTERVAL (ft.):
28-36.9

DRILLING EQUIPMENT: CME-75/CME-95

DEPTH TO FIRST
WATER: 8.0

COMPL.
ND

CASING:
Sch. 40 PVC

SAMPLING METHOD: CME continuous core system [5' x 3"]

LOGGED BY:
T. Loar

HAMMER WEIGHT: NA

DROP: NA

RESPONSIBLE PROFESSIONAL:
J. Carolan

REG. NO.
CHG 589

DEPTH (feet)	SAMPLES			OVM Reading	DESCRIPTION NAME (USCS): color, moist, % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample Blows/ Foot	Foot			
					Surface Elevation: 7.37' MSL	
1				0	SILTY SAND with GRAVEL (SM): yellowish brown (10YR 5/4), dry, 65% fine to coarse sand, 20% low plasticity fines, 15% fine angular gravel [FILL]	Traffic Box
2					bluish gray (10B 5/1)	14" diameter borehole
3					SANDY LEAN CLAY (CL): black (10YR 2/1), moist, 70% fines, 30% fine sand, trace coarse sand, trace fine rounded gravel, medium plasticity, firm [FILL]	10-3/4" diameter steel conductor casing
4				0	LEAN CLAY with SAND (CL): black (10YR 2/1), moist, 80% fines, 20% fine sand, medium plasticity, firm	Neat cement grout
5					soft	2" diameter Schedule 40 PVC casing
6						
7						
8						
9					SANDY LEAN CLAY (CL): mottled dark bluish gray (10B 4/1), and dark yellowish brown (10YR 3/6), moist, 65% fines, 35% fine to medium sand, trace fine rounded gravel, low plasticity, soft	
10				0	CLAYEY SAND (SC): mottled dark bluish gray (10B 4/1) and dark yellowish brown (10YR 3/6), wet, 60% fine to coarse sand, 40% low plasticity fines	
11						
12					SILTY SAND (SM): dark yellowish brown (10YR 4/6), wet, 60% fine to medium sand, 40% low plasticity fines	
13					75% fine sand, 25% fines	
14					SANDY SILT (ML): dark yellowish brown (10YR 4/6), wet, 70% fines, 30% fine sand, low plasticity, soft	
15				0		

Note:
OVM = Thermo
Environmental
Instruments 580B PID
calibrated with 100 ppm
isobutylene standard.



Geomatrix Consultants

I:\PROJECT\1200S\1220\GINTW\142LOG.GDW OAKWELLV_COND CASE (REV 10/99)

Project No. 1220 000 R

Page 1 of 3

DEPTH (feet)	SAMPLES			OVM Reading	DESCRIPTION NAME (USCS): color, moist. % by wt., plast. density, structure, cementation, react. w/HCl, geo. inter.	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows/ Foot			
16				0	LEAN CLAY with SAND (CL): mottled greenish black (5GY 2.5/1) and dark reddish brown (5YR 3/3), moist, 80% fines, 20% fine sand, medium plasticity, soft	14" diameter borehole
17					LEAN CLAY (CL): dark greenish gray (10GY 3/1), moist, 90% fines, 10% fine sand, medium plasticity, firm	10-3/4" diameter steel conductor casing
18						8" diameter borehole
19				0		Neat cement grout
20						
21					LEAN CLAY with SAND (CL): greenish gray (10Y 6/1), moist, 80% fines, 20% fine sand, trace angular coarse sand, medium plasticity, firm	
22				0	mottled greenish gray (10GY 5/1) and olive (5Y 5/4)	
23						Bentonite chip seal
24						
25				0	mottled greenish gray (10Y 5/1) and dark yellowish brown (10YR 4/4)	#2/12/ filter pack sand
26						
27						2" diameter Schedule 40 PVC (0.010-inch slot size) screen
28				0	SILTY SAND (SM): mottled dark yellowish brown (10YR 4/6) and greenish gray (5G 5/1), wet, 60% fine sand, 40% low plasticity fines	
29					POORLY GRADED SAND (SP)	
30					POORLY GRADED SAND (SP)	
31				0	LEAN CLAY (CL): dark yellowish brown (10YR 5/6), moist, 90% fines, 10% fine sand, medium plasticity, firm	
32						
33						

Geomatrix Consultants (1998)

W-127

PROJECT: 1990 BAY ROAD SITE AND VICINITY
East Palo Alto, California

Log of Well No. W-127

BORING LOCATION: Tidal marsh

ELEVATION AND DATUM:
Ground surface

DRILLING CONTRACTOR: Gregg Drilling and Testing, Inc.

DATE STARTED:
6/23/98

DATE FINISHED:
6/23/98

DRILLING METHOD: Hand auger

TOTAL DEPTH:
9.58 feet

SCREEN INTERVAL:
5.41-8.89 feet

DRILLING EQUIPMENT: Hand auger

DEPTH TO FIRST WATER: 1.5 feet

COMPL. ---

CASING:
2-inch Sch. 40 PVC

SAMPLING METHOD: Hand auger

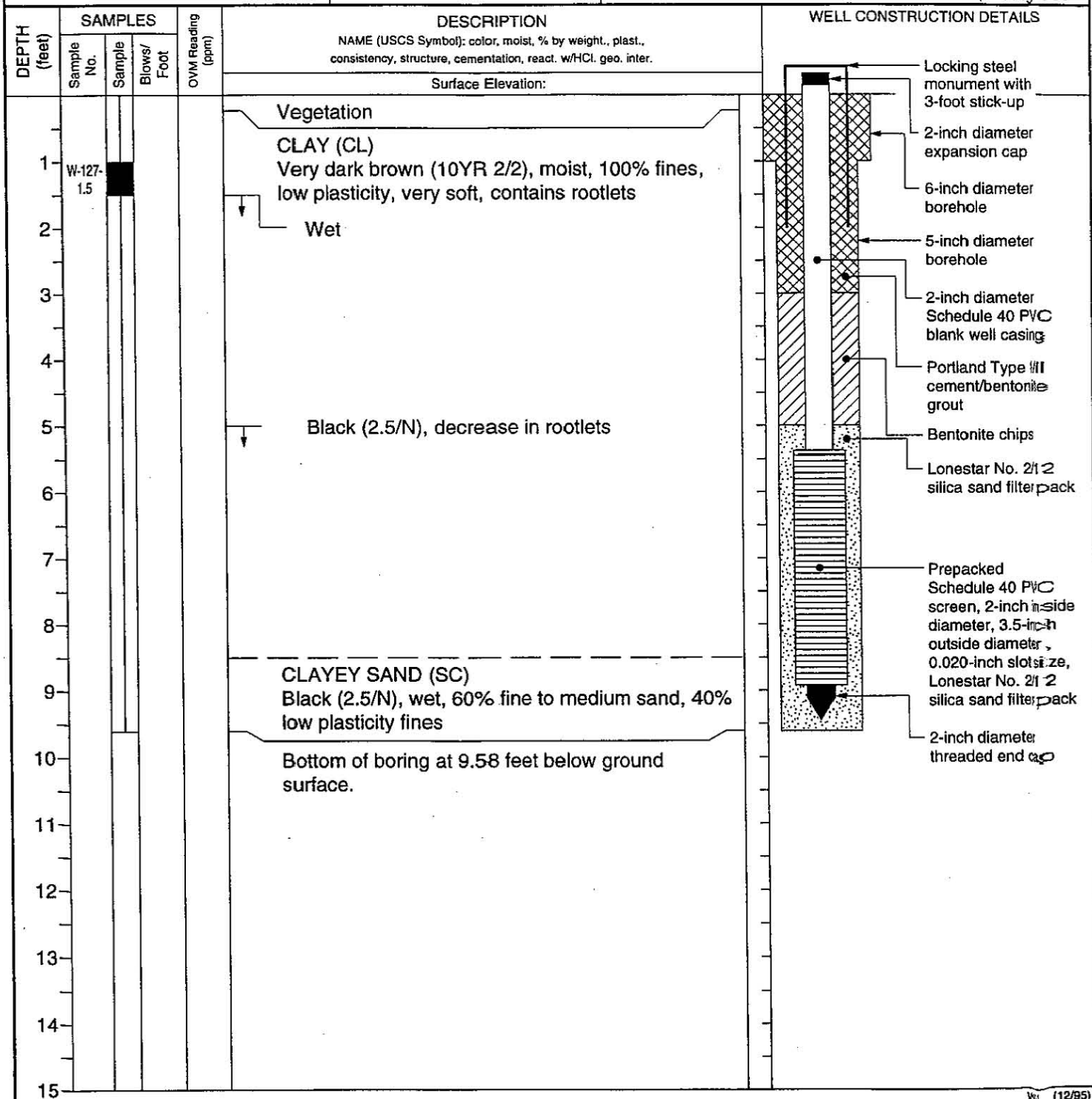
LOGGED BY:
Charles Rome

HAMMER WEIGHT: NA

DROP: NA

RESPONSIBLE PROFESSIONAL:
James Carolan

REG. NO.
CHG 589



Project No. 1220B

Geomatrix Consultants

Figure ---

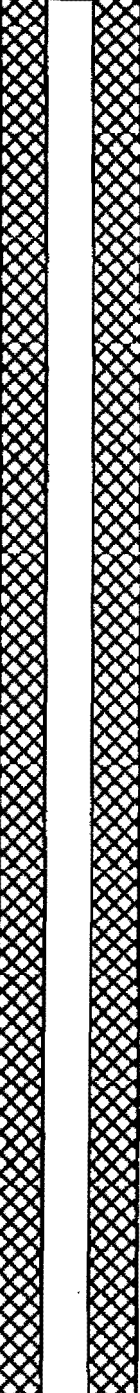
Geomatrix Consultants (1988)

W-122

W-123

W-124

PROJECT: 1990 BAY ROAD SITE AND VICINITY East Palo Alto, California				Log of Well No. W-122			
BORING LOCATION: Base of levee near W-114				DRILLED BY: All Terrain Drilling Co.			
DATE STARTED: 8/18/88		DATE FINISHED: 8/19/88		CASING: 2" diameter SCH 40 PVC, 0.02" slot			
DRILLING METHOD: 8" OD hollowstem, floatation track rig				DEPTH TO WATER ATD: 5.5 feet			
HAMMER WEIGHT: ---		DROP: ---		LOGGED BY: C.D. Young		CHECKED BY: J.D.Gallinatti CEG 1335	
SAMPLER: CME dry core, 5' x 2.5" ID							

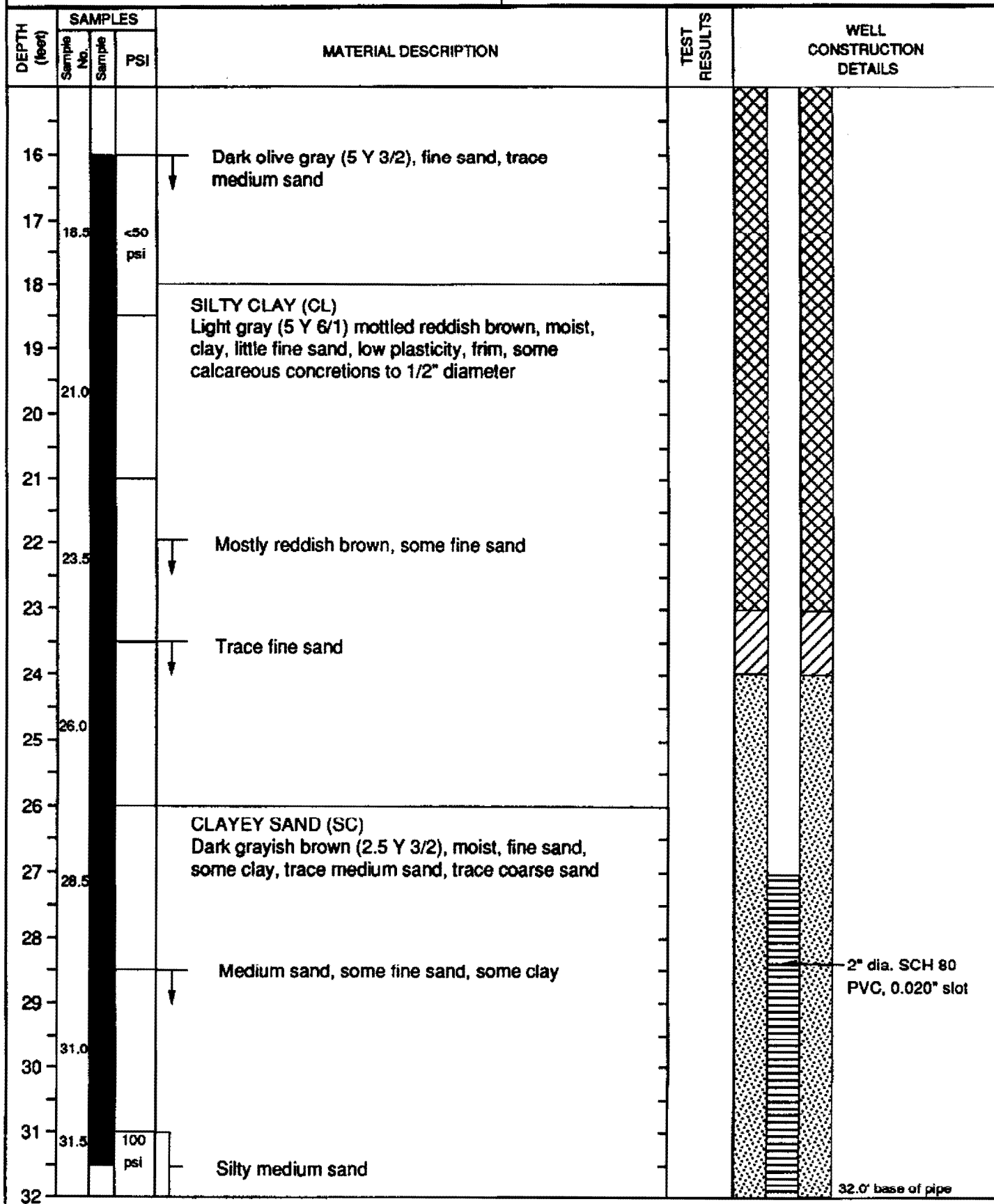
DEPTH (feet)	SAMPLES			PSI	MATERIAL DESCRIPTION	TEST RESULTS	WELL CONSTRUCTION DETAILS
	Sample No.	Sample					
Surface Elevation:							
1	1.5			<50 psi	CLAY (OL) Black (5 Y 2.5/1), wet, clay, trace fine sand, low plasticity, soft, organic odor, top 6" brown		 Riser pipe and locking steel monument above ground surface
2							
3							
4							
5					SANDY CLAY (CL) Very dark gray (5 Y 3/1), moist, clay, some fine sand, low plasticity, firm		
6	6.5			<50 psi	SAND (SP) Olive gray (5 Y 4/2), wet, medium sand, trace fine sand, mostly lithic fragments, subrounded to rounded		
7	8.0				Coarser medium sand		
8							
9							
10				<50 psi			
11							
12							
13							
14				<50 psi			
15							

Geomatrix Consultants

Project No. 1220A-1300

Figure L-58

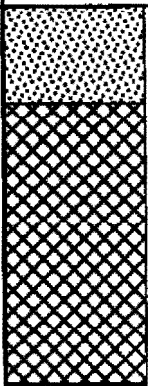
W-1-88



W-2-88

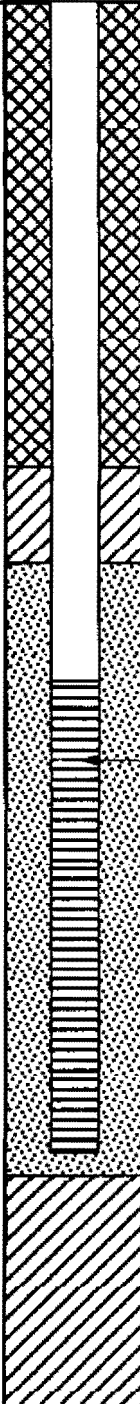
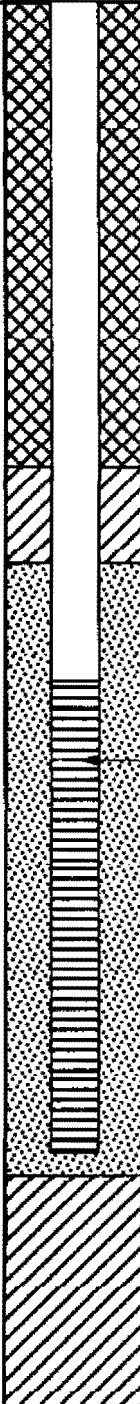
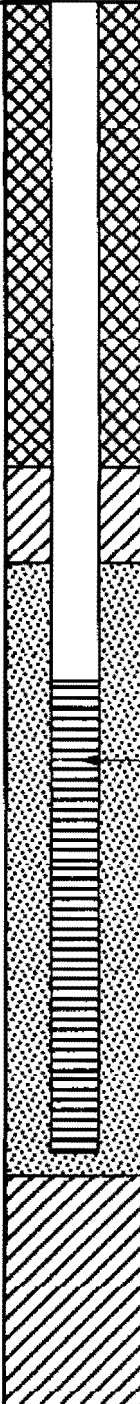
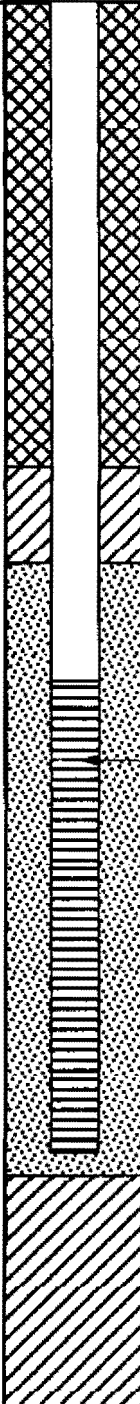
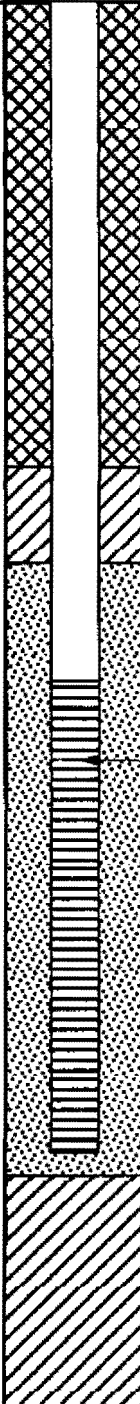
PROJECT: 1990 BAY ROAD SITE AND VICINITY
East Palo Alto, California

Log of Well No. W-122 cont.

DEPTH (feet)	SAMPLES			MATERIAL DESCRIPTION	TEST RESULTS	WELL CONSTRUCTION DETAILS
	Sample No.	Sample	PSI			
32.5				CLAY (CH) Dark grayish brown (2.5 Y 4/2), moist, clay, trace medium sand, high plasticity, firm		
33	33.5					
34						
35			100 psi			
36.0				Bottom of boring 36.0 feet		
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						

W-2-88

PROJECT: 1990 BAY ROAD SITE AND VICINITY East Palo Alto, California				Log of Well No. W-123			
BORING LOCATION: Marsh 55' SE of W-115						DRILLED BY: All Terrain Drilling	
DATE STARTED: 8/16/88			DATE FINISHED: 8/16/88			CASING: 2" diameter SCH 40 PVC, 0.02" slot	
DRILLING METHOD: 8" OD hollowstem, floatation track rig						DEPTH TO WATER ATD: 6.5 feet	
HAMMER WEIGHT: ---			DROP: ---			LOGGED BY: C.D. Young	
SAMPLER: 5' x 2.5" ID CME dry core						CHECKED BY: J.D. Gallinatti CEG 1335	

DEPTH (feet)	SAMPLES		PSI	MATERIAL DESCRIPTION	TEST RESULTS	WELL CONSTRUCTION DETAILS
	Sample No.	Sample		Surface Elevation:		
0.5				CLAY (OL) Very dark gray (7.5 YR N3/0), wet, clay, some silt, trace fine sand, medium plasticity, soft, organic odor, top 1' brown, no odor		 Riser pipe and locking steel monument above ground surface
1						
2	3.0		<50 psi			
3				SANDY CLAY (CL) Olive gray (5 Y 4/2), mottled blue gray, moist, clay, some sand, low plasticity, soft		 2" dia. SCH 80 PVC, 0.020" slot
4						
5						
6	6.5			SAND (SP) Very dark gray (5 Y 3/1), wet, medium to coarse sand		 2" dia. SCH 80 PVC, 0.020" slot
7						
8			<50 psi			
9				CLAY (CH) Very dark gray (7.5 YR N/3), moist, clay, high plasticity, very hard		 2" dia. SCH 80 PVC, 0.020" slot
10						
11			<50 psi			
12				CLAY (CH) Very dark gray (7.5 YR N/3), moist, clay, high plasticity, very hard		 2" dia. SCH 80 PVC, 0.020" slot
13	13.5		<100 psi			
14						
15				Bottom of boring 15.0 feet		

W-1-88

PROJECT: 1990 BAY ROAD SITE AND VICINITY East Palo Alto, California				Log of Well No. W-124			
BORING LOCATION: Marsh, 55' SE of W-115				DRILLED BY: All Terrain Drilling			
DATE STARTED: 8/17/88		DATE FINISHED: 8/17/88		CASING: 2" diameter SCH 40 PVC, 0.02" slot			
DRILLING METHOD: 8" OD hollowstem, floatation track rig				DEPTH TO WATER ATD: 7.0 feet			
HAMMER WEIGHT: ---		DROP: ---		LOGGED BY: C.D. Young		CHECKED BY: J.D. Gallinatti CEG 1335	
SAMPLER: CME dry core 5' X 2.5" ID							

DEPTH (feet)	SAMPLES			PSI	MATERIAL DESCRIPTION	TEST RESULTS	WELL CONSTRUCTION DETAILS
	Sample No.	Sample					
Surface Elevation:							
1	2.5			<50 psi	CLAY (OL) Very dark gray (2.5 YR N3/), wet, clay, trace fine sand, high plasticity, soft, organic odor, rootlets, top 1.5' olive brown (2.5 Y 4/4), no organic odor		Riser pipe and locking steel monument above ground surface
2							
3							
4							
5							
6	7.0			<50 psi	CLAY with SAND Dark gray (2.5 Y N4/) mottled olive brown (2.5 Y 4/4), moist, clay, little fine sand, trace medium sand, medium plasticity, soft, trace calcareous concretions		
7							
8					SAND (SW) Dark gray (5 Y 4/1), wet, medium sand, trace coarse sand		
9							
10							
11				<50 psi			
12							
13							
14							
15	12.0			<100 psi	SILTY CLAY (CL) Very dark gray (2.5 Y N3/) mottled gray (2.5 Y N5/), moist, clay, little fine sand, low plasticity, firm		
	14.5						
	15.5						

W-1-88

PROJECT: 1990 BAY ROAD SITE AND VICINITY
East Palo Alto, California

Log of Well No. W-124 cont.

DEPTH (feet)	SAMPLES			MATERIAL DESCRIPTION	TEST RESULTS	WELL CONSTRUCTION DETAILS
	Sample No.	Sample	PSI			
16						
17	18.0		75 psi	SANDY CLAY (CL) Gray (2.5 Y N5/) mottled olive gray (5 Y 4/2) and light gray (5 Y 6/1), moist, clay, some fine sand, some irregular calcareous concretions, low plasticity, hard		
18						
19						
20						
21	22.0		75 psi			
22						
23	23.5		150 psi	CLAYEY SAND (SW) Olive brown (2.5 Y 4/4) mottled yellowish brown (10 YR 5/8), moist, medium sand, some clay, little gravel to 1/2", trace coarse sand		
24						
25	26.5		300 psi	SAND (SP) Dark grayish brown (2.5 Y 4/2), wet, medium sand, little fine sand, mostly lithic fragments, subrounded		
26						
27						
28						
29			300 psi	SILTY SAND (SW) Light yellowish brown (2.5 Y 6/4) mottled red brown, moist, medium sand, trace fine sand, trace coarse sand		
30			200 psi			
31				SILTY CLAY (CL) Olive brown (2.5 Y 4/4), moist, clay, low plasticity, hard		
32						
Bottom of boring 32.0 feet						

2" dia. SCH 80
PVC, 0.020" slot

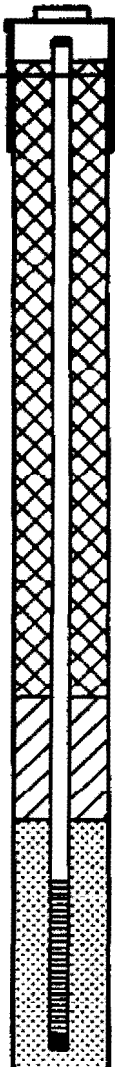
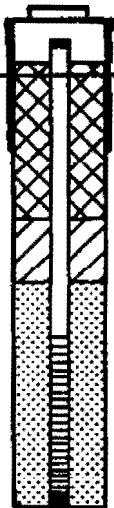
W-2-88

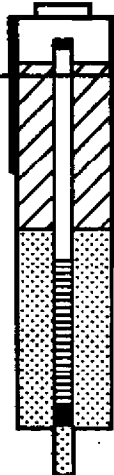
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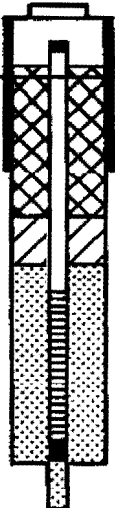
W-102

W-114

W-115

BAY ROAD PROJECT 1990 Bay Road Site and Vicinity East Palo Alto, California				LITHOLOGIC LOG AND CONSTRUCTION DETAILS OF WELLS W-102 AND W-103			
Depth, feet	LITHOLOGY	W-102		W-103		CONSTRUCTION DETAILS	
		Sample Interval	Blow count/12"	Sample Interval	Blow count/12"	W-102	W-103
	Ground surface-elevation approx. 7.2 feet						
2	SILTY SAND with GRAVEL, fill, some miscellaneous debris, medium brown, loose, dry						
4							
6			3				
8							
10	SILTY CLAY, dark brown mottled with orange-brown, wet, some decomposed vegetation		4	4			
12	SANDY SILT interbedded with silty sand, medium brown, mottled with gray, wet,			2			
14	SILTY CLAY, dark blue-gray		7				
16							
18							
20			8				
22	Grading to medium gray mottled with medium brown, occasional white nodules to 0.25 inch in diameter						
24	SILTY SAND interbedded with clayey silt, medium brown mottled with gray, medium sand						
26			8				
28			7				
30			8				
32	SILTY CLAY, medium brown						
	Bottom of boring at 32.0 feet						
34							
36							
38							
40							
42							
44							
46							
Project No. 1057A		Geomatrix Consultants				L-43	

BAY ROAD PROJECT 1990 Bay Road Site and Vicinity East Palo Alto, California				LITHOLOGIC LOG AND CONSTRUCTION DETAILS OF WELL W-114			
Depth, feet	LITHOLOGY	W-114		CONSTRUCTION DETAILS			
		Sample Interval	Blow count/12"	Sample Interval	Blow count/12"		
	Ground surface-elevation approx. 3.6 feet						
2	SILTY CLAY, dark gray, wet, soft, with decomposed vegetation						
4							
6	CLAYEY SILT interbedded with silty sand, medium gray, loose, wet, fine sand		4				
8							
10			3				
12	SILTY CLAY, dark gray		6				
14	Bottom of boring at 13.0 feet						
16							
18							
20							
22							
24							
26							
28							
30							
32							
34							
36							
38							
40							
42							
44							
46							
Project No. 1057A		Geomatrix Consultants				L-49	

BAY ROAD PROJECT 1990 Bay Road Site and Vicinity East Palo Alto, California				LITHOLOGIC LOG AND CONSTRUCTION DETAILS OF WELL W-115			
Depth, feet	LITHOLOGY	W-115		CONSTRUCTION DETAILS			
		Sample Interval	Blow count/12"	Sample Interval	Blow count/12"		
	Ground surface-elevation approx. 3.8 feet						
2	SILTY CLAY, medium gray, wet, soft, with decomposed vegetation						
4							
6			3				
8	SILTY SAND, gray-green, occasional gravel to 0.5 inch in diameter, wet, fine to coarse sand		3				
10			4				
12	SILTY CLAY, dark gray, occasional white nodules		10				
14							
16	Bottom of boring at 14.0 feet						
18							
20							
22							
24							
26							
28							
30							
32							
34							
36							
38							
40							
42							
44							
46							
Project No. 1057A		Geomatrix Consultants				L-50	

Geomatrix Consultants (1987)

M-1

M-3

M-4

M-9

PROJECT: 1990 BAY ROAD AND VICINITY
East Palo Alto, California

Log of Boring No. M-1

BORING LOCATION: Tidal Marsh

DATE STARTED: 9/11/87

DATE FINISHED: 9/11/87

NOTES: Logged by Cheri Young

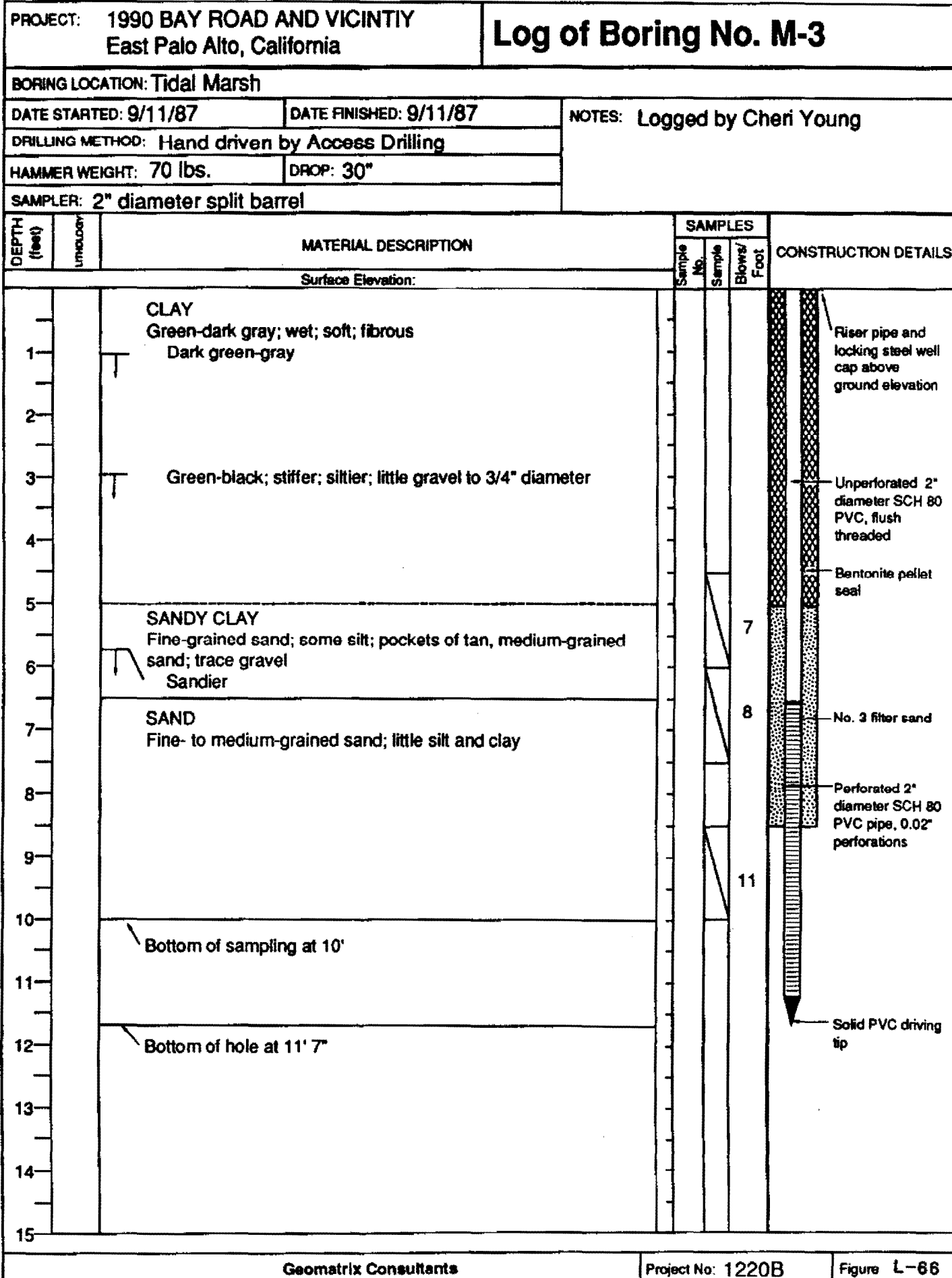
DRILLING METHOD: Hand driven by Access Drilling

HAMMER WEIGHT: 70 lbs.

DROP: 30"

SAMPLER: 2" diameter split barrel

DEPTH (feet)	LITHOLOGY	MATERIAL DESCRIPTION	SAMPLES			CONSTRUCTION DETAIL
			Sample No.	Sample	Blows/ Foot	
Surface Elevation:						
1		CLAY Black-gray; wet; soft; fibrous				Riser pipe and locking steel well cap above ground elevation Unperforated 2" diameter SCH 80 PVC, flush threaded Bentonite pellet seal No. 3 filter sand Perforated 2" diameter SCH 80 PVC pipe, 0.02" perforations Solid PVC driving tip
2						
3		Little stiffer, still fibrous				
4		Medium stiff, not fibrous				
5		Some very fine sand				
6		SANDY CLAY Mottled greenish-dark gray; stiff; fine-grained sand; pockets of gold-green, medium to fine-grained sand; trace subrounded gravel to 2" diameter; slightly fibrous			12	
7					9	
8		SAND Very coarse to coarse-grained; some gravel to 1/8" diameter				
9		CLAYEY SAND Medium grained			11	
10		SANDY CLAY Fine-grained; some silt				
11		Bottom of sampling at 9' 5"				
12						
13		Bottom of hole at 12' 6"				
14						
15						



PROJECT: 1990 BAY ROAD AND VICINTIY East Palo Alto, California		Log of Boring No. M-4		
BORING LOCATION: Tidal Marsh				
DATE STARTED: 9/11/87		DATE FINISHED: 9/11/87		NOTES: Logged by Cheri Young
DRILLING METHOD: Hand driven by Access Drilling				
HAMMER WEIGHT: 70 lbs.		DROP: 30"		
SAMPLER: 2" diameter split barrel				

DEPTH (feet)	LITHOLOGY	MATERIAL DESCRIPTION	SAMPLES			CONSTRUCTION DETAILS
			Sample No.	Sample	Blows/ Foot	
Surface Elevation:						
1		CLAY Brown-gray to greenish-dark gray; wet; soft; fibrous Gray-black clay; little gravel to 1/2" diameter				Riser pipe and locking steel well cap above ground elevation Unperforated 2" diameter SCH 80 PVC, flush threaded Bentonite pellet seal No. 3 filter sand
2		Stiffer More gravel				
3		SILTY CLAY Dark green-gray; some silt; some gravel to 1" in top 6"			8	
4						
5		SAND and GRAVEL Fine-to coarse-grained sand, gravel to 1" diameter			7	
6		Bottom of sampling at 6'				Perforated 2" diameter SCH 80 PVC pipe, 0.02" perforations Solid PVC driving tip
7						
8						
9						
10		Bottom of hole at 10'				
11						
12						
13						
14						
15						

Geomatrix Consultants
Project No: 1220B
Figure L-67

PROJECT: 1990 BAY ROAD SITE AND VICINITY
East Palo Alto, California

Log of Boring No. R8-1/Well M-9

BORING LOCATION: 99 feet from break in slope of dike, 53 feet east of W-114

DATE STARTED: 6/28/88

DATE FINISHED: 6/28/88

NOTES:

DRILLING METHOD: 3 1/2" hand auger, hand-held hammer

HAMMER WEIGHT: 70 lbs.

DROP: 30 inches

Drilled by: Access Drilling Co.

Logged by: C. D. Young

Checked by: J.D. Gallinatti, CEG 1335

SAMPLER: 2 1/2" ID modified California drive sampler

DEPTH (feet)	SAMPLES			ARSENIC (mg/kg)	MATERIAL DESCRIPTION	WELL CONSTRUCTION DETAILS
	Sample No.	Sample	Blows/ Foot			
1	1			3.3	CLAY (OL) Very dark gray (2.5 Y 3/0), wet, clay, medium to low plasticity, very soft, many rootlets, organic odor Color change to black Consistency change to firm Color change back to very dark gray, trace green fine sand (glauconite?)	 Riser pipe and locking steel monument above ground surface
1.5				5.1		
2	2					
3	3					
4	4		17			
5	5					
6	6			5.7	CLAYEY SAND (SC) Very dark grayish brown (2.5 YR 3/2), wet, sand, some clay, trace gravel, firm	 2" dia. SCH 80 PVC, 0.010" slot
7	7					
8	8		4			
9			10		Bottom of boring at 9.5 feet	
10						
11						
12						
13						
14						
15						

BL-1-88

Appendix B. Subsurface Explorations

DRAFT

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND	
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	$C_u \geq 4$ AND $1 \leq C_c \leq 3$	GW	WELL-GRADED GRAVEL	
			$C_u < 4$ AND/OR $1 > C_c > 3$	GP	POORLY-GRADED GRAVEL	
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL	
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL	
	SANDS >50% OF COARSE FRACTION PASSES NO 4. SIEVE	CLEAN SANDS <5% FINES	$C_u \geq 6$ AND $1 \leq C_c \leq 3$	SW	WELL-GRADED SAND	
			$C_u < 6$ AND/OR $1 > C_c > 3$	SP	POORLY-GRADED SAND	
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND	
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND	
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT <50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY	
			PI<4 OR PLOTS<"A" LINE	ML	SILT	
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT	
	SILTS AND CLAYS LIQUID LIMIT >50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY	
			PI PLOTS <"A" LINE	MH	ELASTIC SILT	
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT	
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT	

OTHER SYMBOLS

MATERIALS	SAMPLERS
Asphalt	SPT (2" OD)
Aggregate Base	Modified California (3" OD)
Topsoil	California (2.5" OD)
Bedrock	Shelby Tube
PIEZOMETER	Pitcher Barrel
	HQ Core
	Grab/Bulk
Grout Seal or Fill	INITIAL WATER LEVEL MEASUREMENT (WITH DATE)
Bentonite Seal or Fill	STABILIZED WATER LEVEL MEASUREMENT (WITH DATE)
Sand Pack + Solid Pipe	
Sand Pack + Slotted Pipe	

GRAIN SIZES							
U.S. STANDARD SIEVE	200	40	10	4	3/4"	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

PENETRATION RESISTANCE				
SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	UNC. COMP. STRENGTH (KSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 1	0 - 1/2
LOOSE	5 - 10	SOFT	2 - 4	1/2 - 1
MEDIUM DENSE	11 - 30	MEDIUM STIFF	5 - 8	1 - 2
DENSE	31 - 50	STIFF	9 - 15	2 - 4
VERY DENSE	OVER 50	VERY STIFF	16 - 30	4 - 8
		HARD	OVER 30	OVER 8

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

LABORATORY TESTS

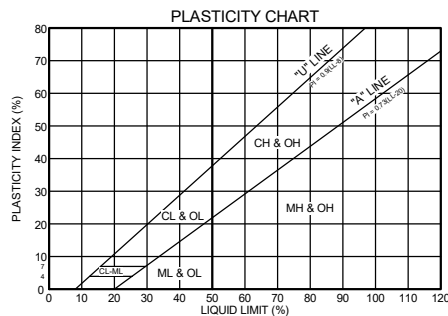
AT ATTERBERG LIMITS
 CD CONSOLIDATED DRAINED TRIAXIAL
 CN CONSOLIDATION
 CR CORROSION
 CU CONSOLIDATED UNDRAINED TRIAXIAL
 DS DIRECT SHEAR
 HY HYDROMETER
 PR PERMEABILITY
 RV R-VALUE
 SA SIEVE ANALYSIS
 TC CYCLIC TRIAXIAL
 UC UNCONFINED COMPRESSION
 UU UNCONSOLIDATED UNDRAINED TRIAXIAL
 -200 % PASSING NO. 200 SIEVE

PROPERTIES

c COHESION
 DD DRY DENSITY
 EI EXPANSION INDEX
 LL LIQUID LIMIT
 MC MOISTURE CONTENT
 N_e FIELD BLOW COUNT
 PI PLASTICITY INDEX
 S_u UNDRAINED STRENGTH

UNDRAINED SHEAR STRENGTH

V FIELD VANE
 P POCKET PENETROMETER
 T TORVANE
 Q UNCONFINED COMPRESSION
 U UNCONSOLIDATED UNDRAINED TRIAXIAL



Boring Legend

SAFER Bay Project
East Palo Alto, California

Date

Figure

A-1



HDR SOIL BORING LOG 2017 MARCH R1: 10151664 SAFER-T03 B-107 2024-05-27 GP-J: HDR_FOLSOM_OAKLAND_SEP 2021_WIP.GLB: 5/27/24

		Project: SAFER Bay Project		Boring ID: B-107		Sheet 1 of 2 Sheets	
		Project Location: East Palo Alto, California					
		Project Number: 10151664					
Start Date: 11/14/2022		End Date: 11/14/2022		Logged By: J. Wong		Checked By: V. Crosariol	
Date Checked: 1/13/2023		Drilling Company (Rig Type): Pitcher Drilling (Track Mounted)		Inspector: K. Atkinson		Weather Conditions: Sunny/Clear	
Drill Method: Mud Rotary		Drilled By: Will Halai		Elevation Top of Boring: 10.5 ft.		Vertical Datum: NAVD88	
Drill Bit (Type/Size): Rock Bit / 3-3/4"		Total Depth Drilled: 61.5 ft.		Latitude: 37.475070° Longitude: -122.126070°		Horizontal Datum: NAD83	
Hammer Type: Automatic		Hole Backfill: Cement Grout		Northing: 1,999,548 ft. Easting: 6,089,825 ft.		Coordinate System: California State Plane Zone 3	
Hammer Efficiency:		Rod Type:		Total Number of Samples: 23		Initial Groundwater Depth: Not established	
				Disturbed: 21 Undisturbed: 2		Static Groundwater Depth: Not established	

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N _r	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No	Laboratory						Su (ksf)	REMARKS
									Fines	LL	PL	DD	MC			
10						2" Asphalt Concrete.										Begin with 6" core barrel
			6			Fill		G1								Took grab sample at 2'
			5	9		SANDY LEAN CLAY (CL): medium stiff, grayish brown, dry, medium toughness, medium plasticity, fine sand, trace organics (rootlets) and fine gravel. Color change to darker shade at 2'.	56	L2	40	12	92	26	1.25 P			Pushed casing to 4' and switched to mud rotary; start with 3-7/8" rock bit
			4			SANDY SILT with Gravel (ML): medium stiff, dark gray, dry, high toughness, low plasticity, fine sand, trace fine gravel and organics (rootlets).										
5			2	8		FAT CLAY (CH): soft, dark gray to black, moist, high plasticity, faint organic odor.	39	L3					0.26 T			CR performed on Liner L3
			3													
			5													
			0			Young Bay Mud (Qybm)										
			0	1		SANDY LEAN to FAT CLAY (CL/CH): soft, dark gray, moist, high plasticity, trace subrounded gravel.	56	L4					0.10 T			
			1													
-10			0			Color change to brownish gray.		T5					0.80 T			CN and UU performed on T5
			0				73		49	26						
			0													
			1	3			33	L6					0.10 T			
			2													
-5			0													
			1	4			50	L7								Noted material change in Liner L7 between 16' and 16.5'
			3			SILTY SAND (SM): very loose, dark gray, wet.										
			0													
			1	2		FAT CLAY (CH): soft, brownish gray mottled reddish gray, moist, high plasticity.	67	S8				48				Material transitions back to CH at 17'
			1													
			1													
-20			1	9		Dark gray.	33	L9				83	39	0.90 T		
			4													
			5			Trace fine sand.		T10						0.60 T		CN and UU performed on T10
			0				100		50	28						
			0													
			1													
			2													
			2	4			83	L11								
			2			Alluvium (Qal)		L12								
			7			SANDY LEAN CLAY with Gravel (CL): soft, light grayish brown, moist, medium plasticity, fine gravel up to 0.5".										
			12			Very stiff, medium plasticity, subangular coarse gravel up to 3/4".	100	L13				95	34	3.00 P		
			15	27		SANDY LEAN CLAY (CL): stiff, light grayish brown mottled reddish brown, moist, medium plasticity.		L14								Shelby tube push pressure increased to 25 psi at 24.5'



Project: SAFER Bay Project
Project Location: East Palo Alto, California
Project Number: 10151664

Boring ID: B-107

Sheet 2 of 2
Sheets

ELEV	DEPTH	SAMPLE	Blows/6" or Press.	N _r	LEGEND	DESCRIPTION OF MATERIALS	% REC	Samp No.	Laboratory					Su (ksf)	REMARKS
									Fines	LL	PI	DD	MC		
-20		X	5 4 7	11		trace coarse gravel.	67	L15 L16		38	18	95	29	1.00 P	1.5" rock fragment observed at bottom of L16
-25		X	6 7 8	15		Light gray mottled reddish brown, moist, trace fine sand.	78	L17		33	15	100	26	1.10 T	
-30		X	7 10 14	24		Very stiff, no apparent sand.	44	L18						3.25 P	Driller noted material change at 43'
-35		X	5 7 15	22		SILTY SAND (SM): medium dense, light brown mottled reddish brown, moist, fine sand, few plastic fines.	83	L19 L20		27	1				
-40		X	5 8 10	18		Grayish brown, nonplastic fines.	78	L21	42						Color change in liner L19
-45		X	10 19 23	42		Poorly Graded SAND (SP): medium dense, dark brown, wet, subrounded fine to medium sand, few coarse sand up to 0.3", fine gravel up to 0.5".	67	S22							
-50			11 15 15	30		Dense, trace subrounded gravel up to 1".	67	S23							Sandy gravel observed in drilling fluid
-55															

HDR SOIL BORING LOG 2017 MARCH R1: 10151664 SAFER-T03 B-107 2024-05-27 GP-J HDR FOLSOM OAKLAND SEP 2021 WIP GLB: 5/27/24

Gregg Drilling CPT Report

November 16, 2022

HDR

Attn: Olen Gover

Subject: CPT Site Investigation
Safer Bay Project
East Palo Alto, CA
GREGG Project Number: P7222034

Dear Olen:

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

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☐
4	Groundwater Samples	(GWS)	☐
5	Soil Samples	(SS)	☐
6	Vapor Samples	(VS)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact me at 562-427-6899.

Sincerely,

CPT Reports Team
Gregg Drilling, LLC.



Cone Penetration Testing (CPT) Procedure

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

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

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

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

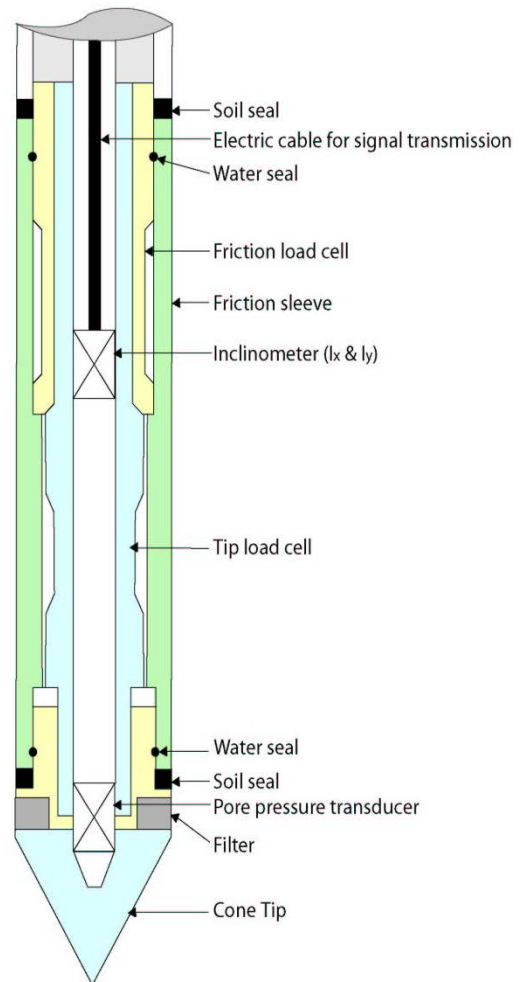


Figure CPT

15cm² Standard Cone Specifications

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

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

Table 1: Cone Penetration Testing Summary

CPT Sounding Identification	Date	Termination Depth (ft)	Depth of Soil Samples (ft)	Depth of Groundwater Samples (ft)	Depth of Pore Pressure Dissipation Tests (ft)
CPT-104	11/15/2022	70.37	-	-	47.57
CPT-105	11/14/2022	70.37	-	-	27.72
CPT-106	11/14/2022	70.37	-	-	28.54
CPT-107	11/15/2022	70.37	-	-	26.57
CPT-108	11/14/2022	70.37	-	-	25.43

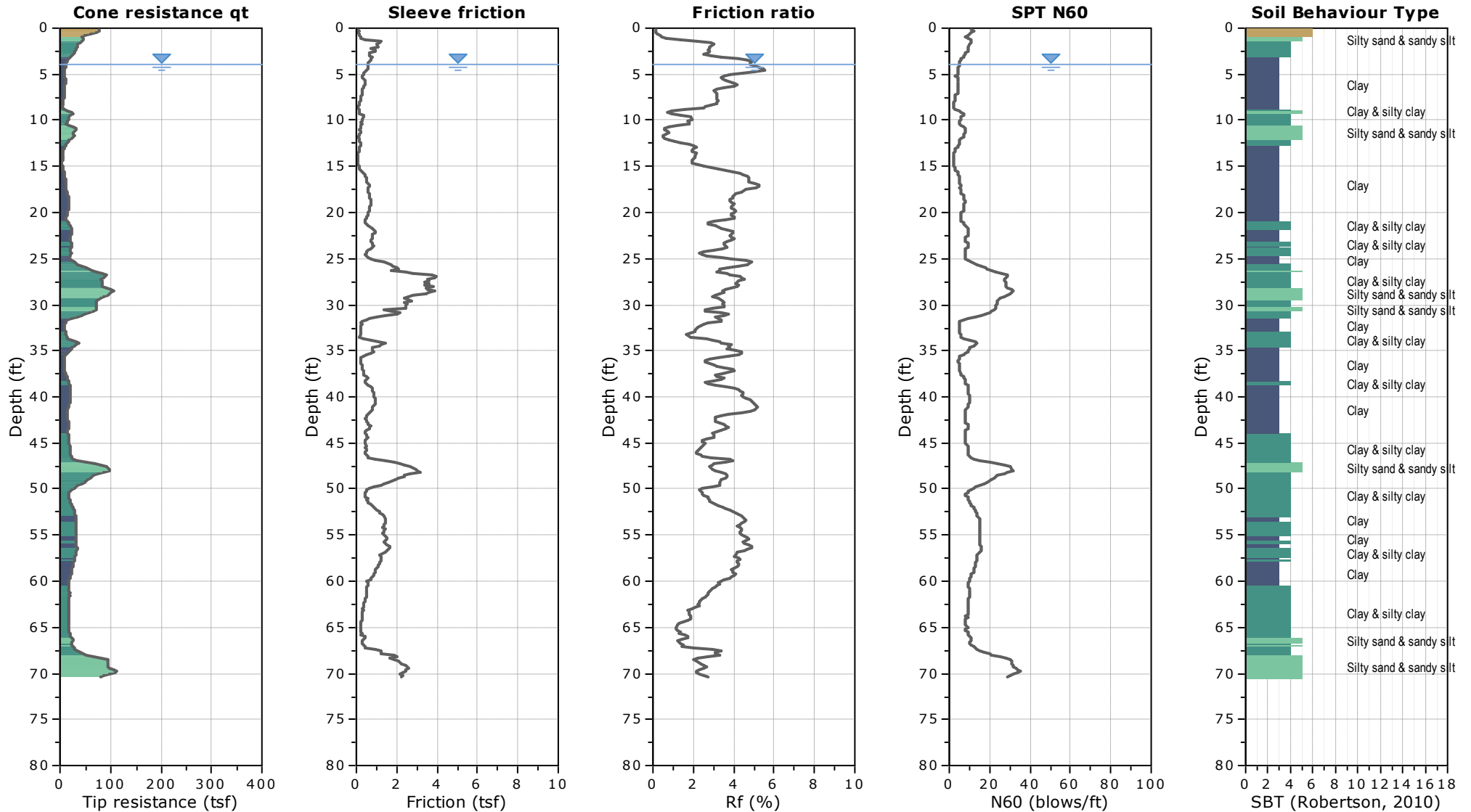


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/15/2022



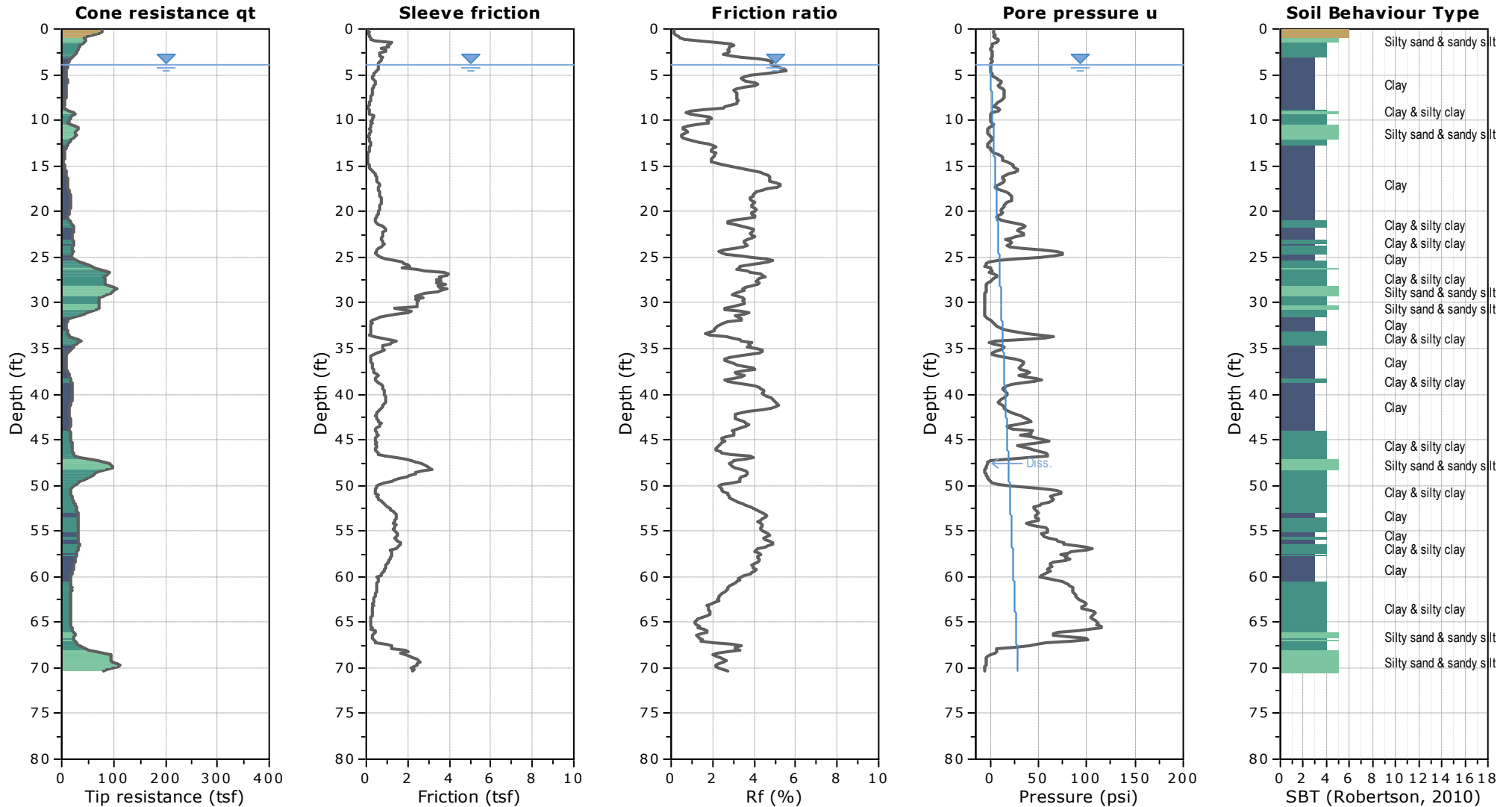


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/15/2022



WATER TABLE FOR ESTIMATING PURPOSES ONLY

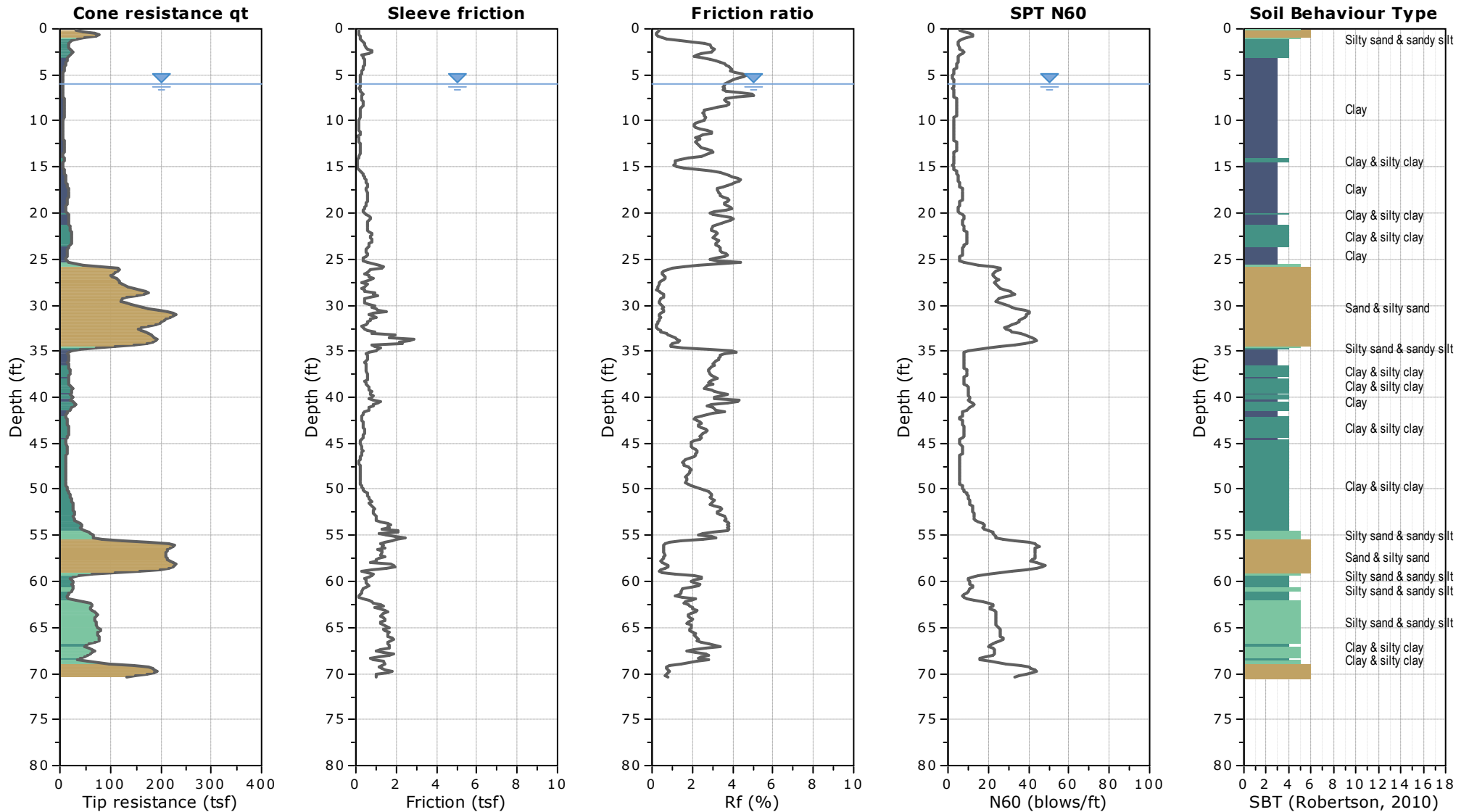


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/14/2022



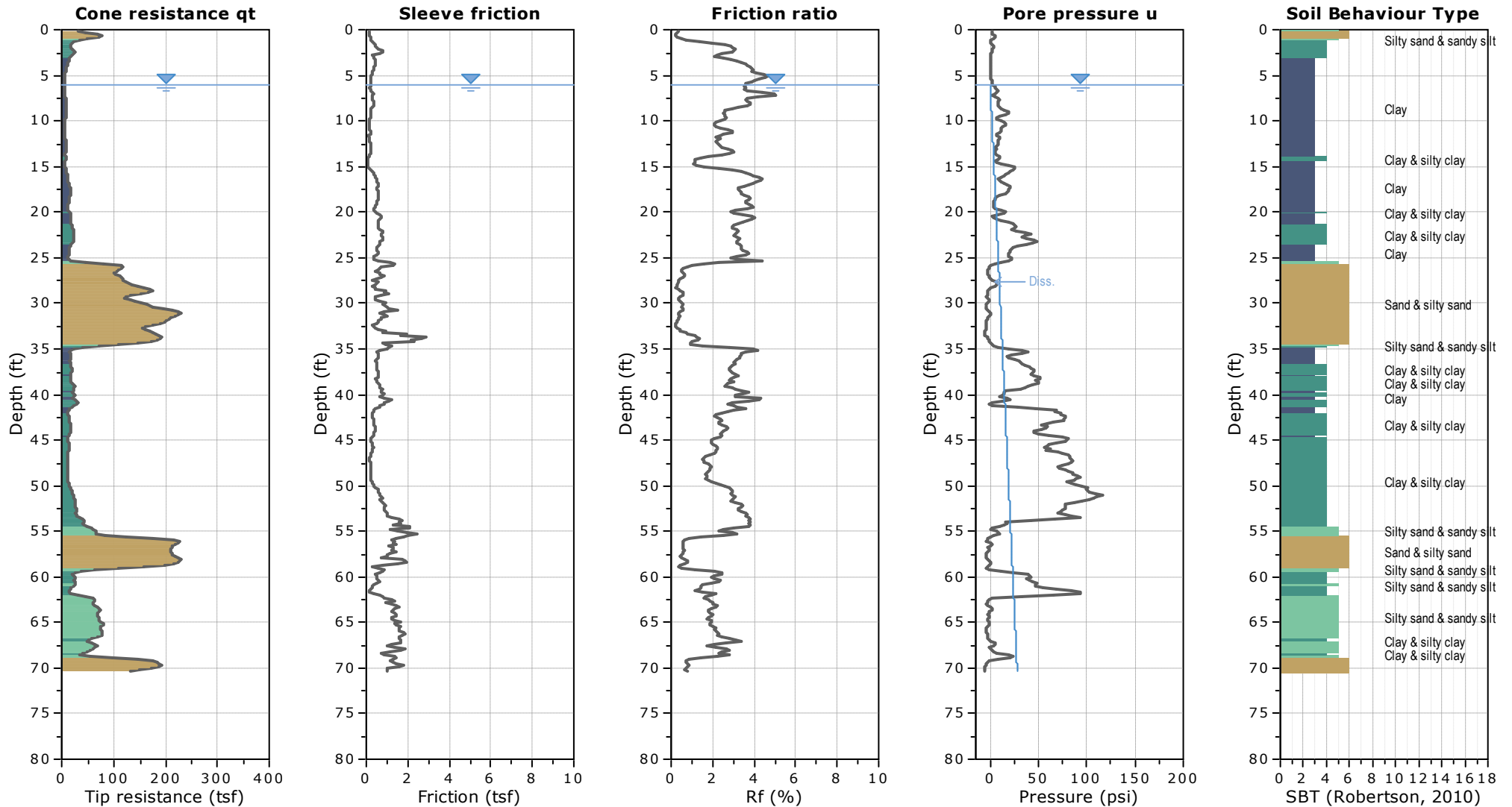


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/14/2022



WATER TABLE FOR ESTIMATING PURPOSES ONLY

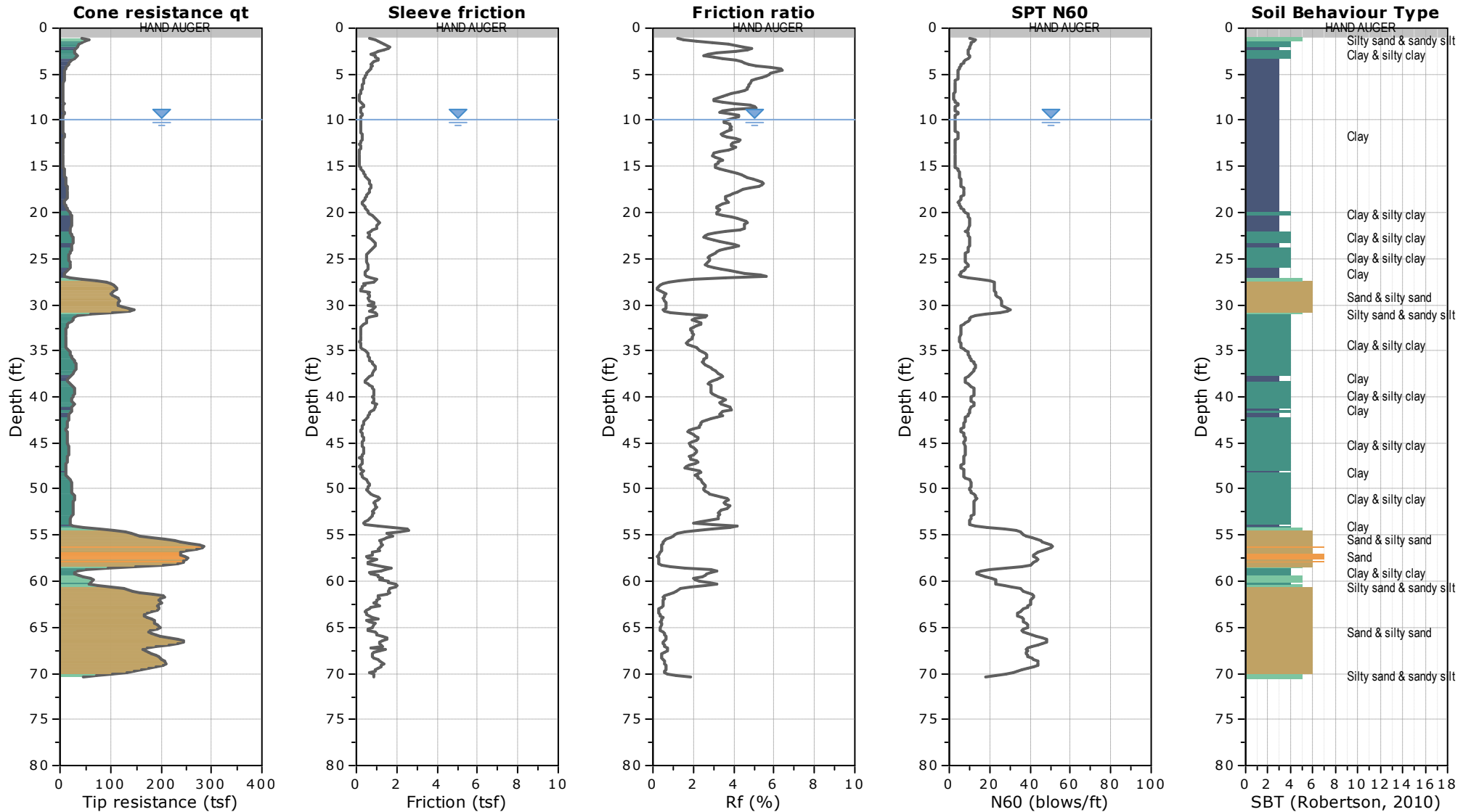


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/14/2022



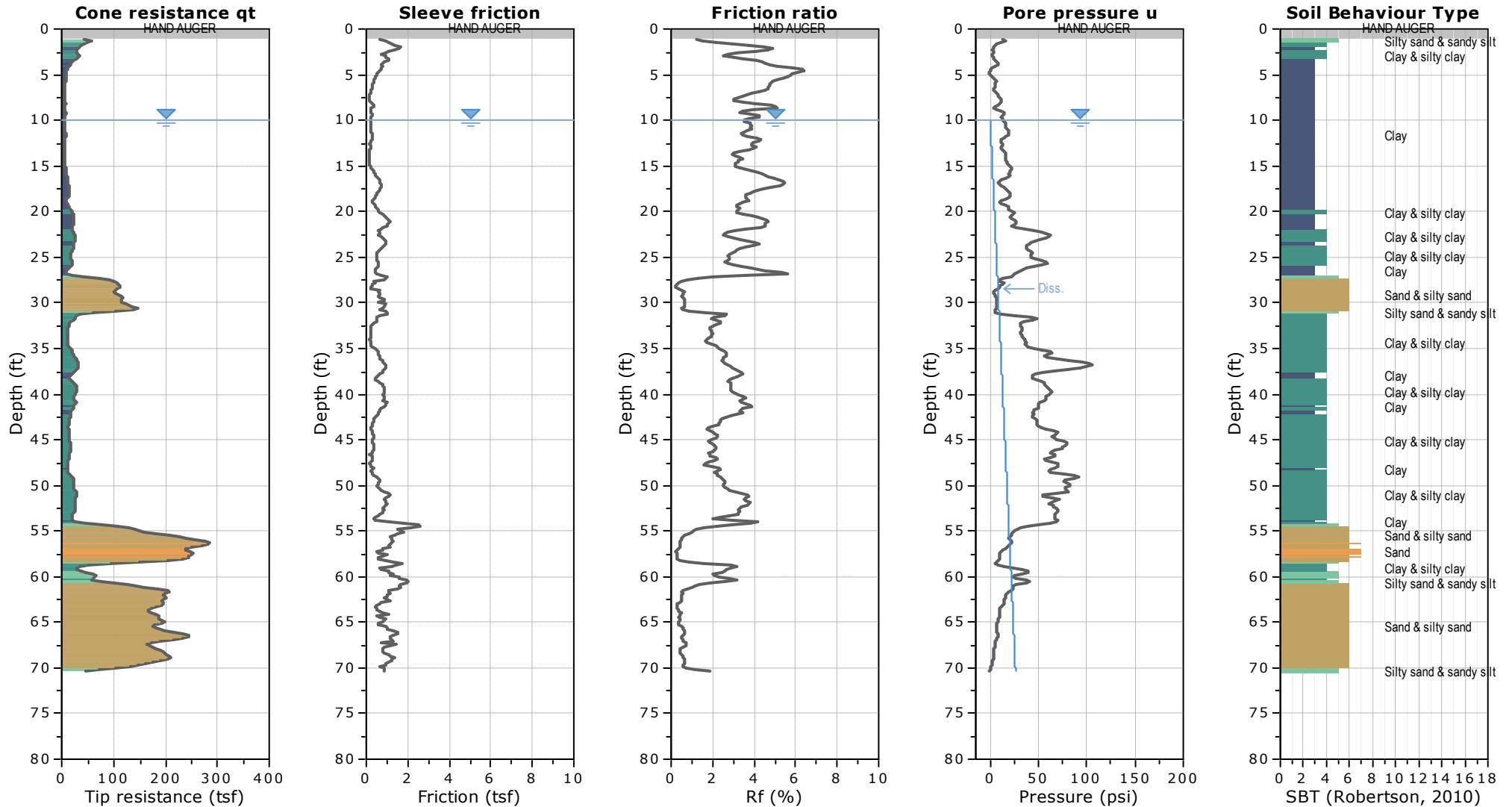


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/14/2022



WATER TABLE FOR ESTIMATING PURPOSES ONLY

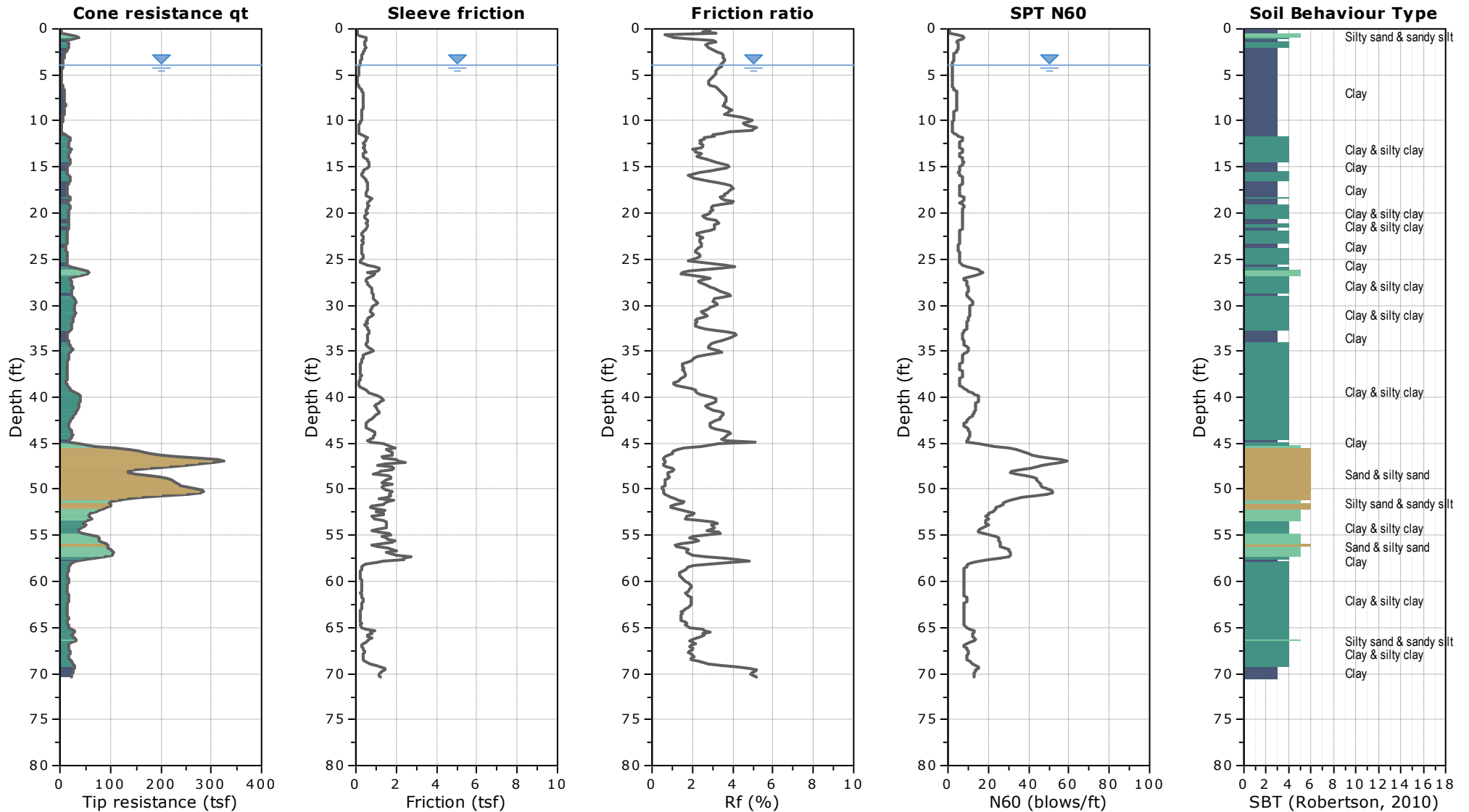


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/15/2022



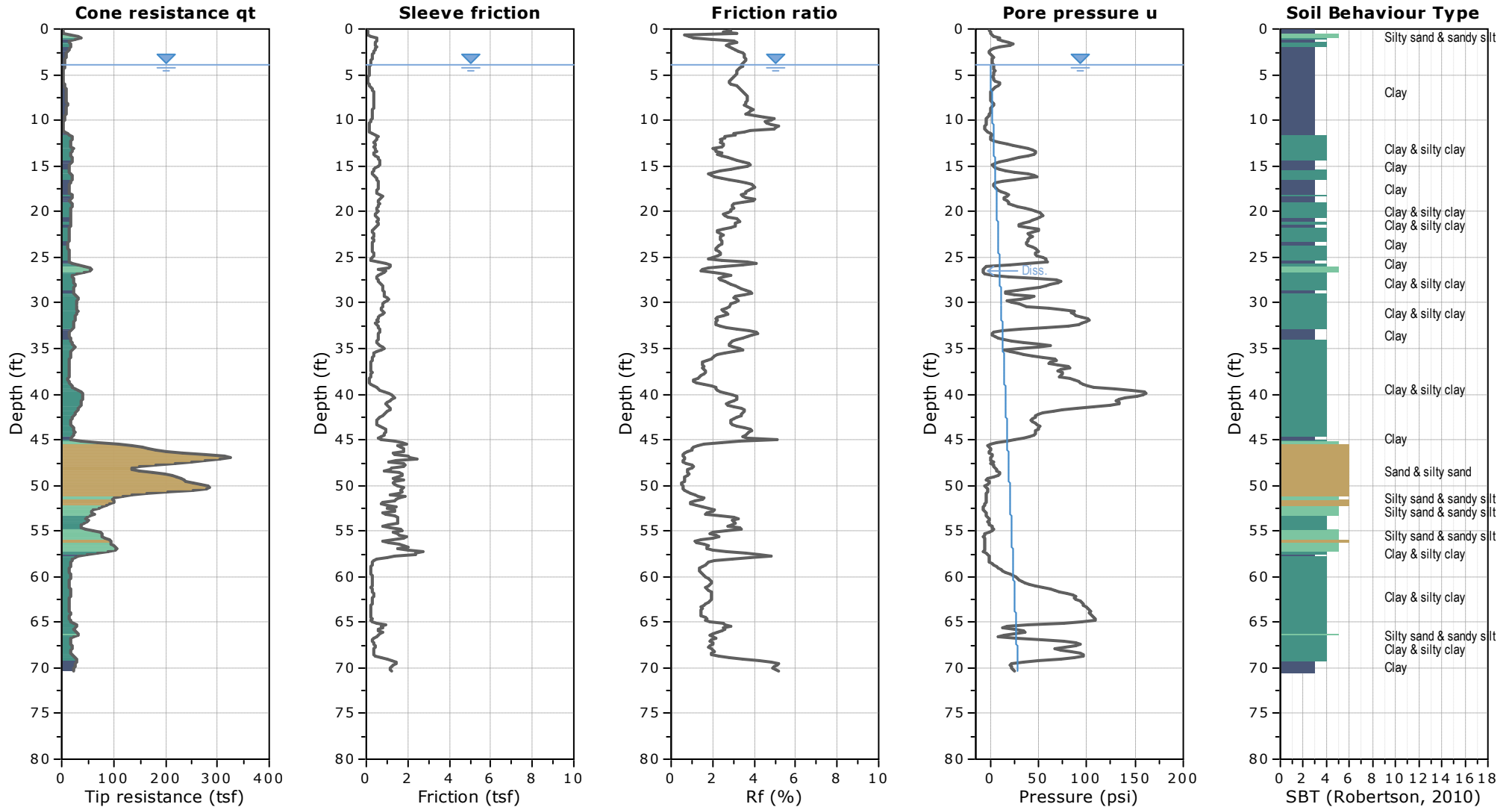


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/15/2022



WATER TABLE FOR ESTIMATING PURPOSES ONLY

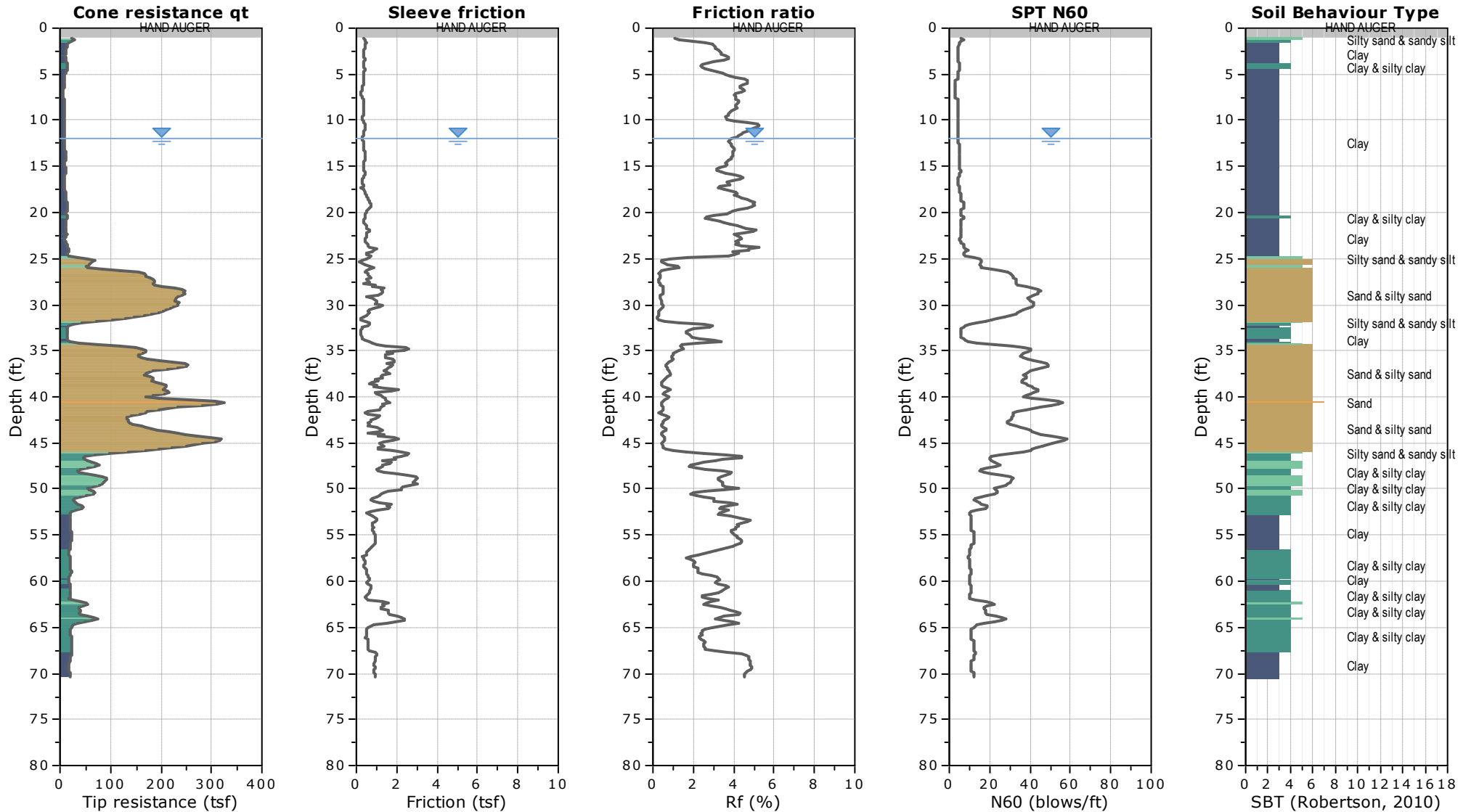


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/14/2022



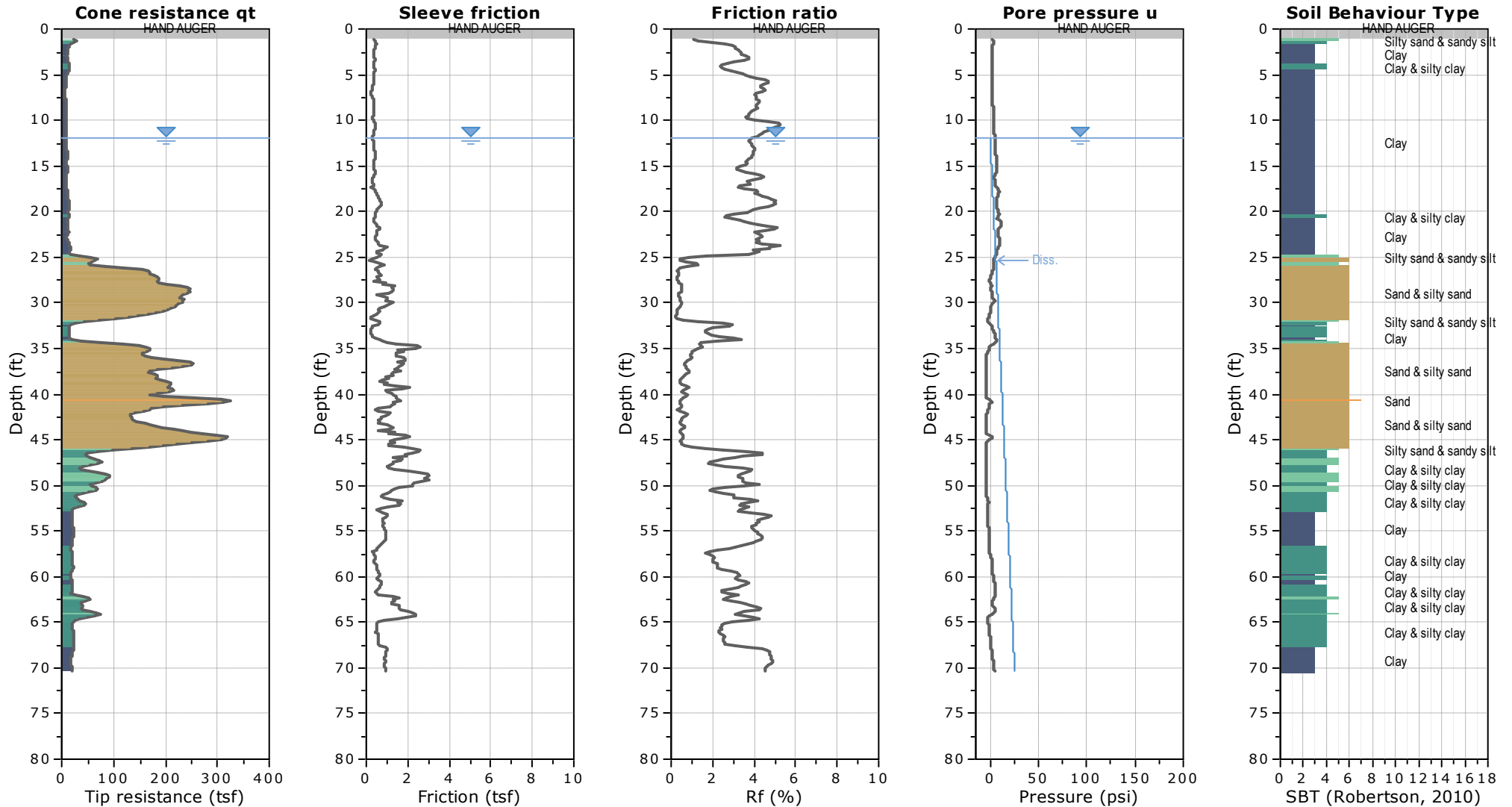


CLIENT: HDR

FIELD REP: OLEN
Cone ID: GDC-82

SITE: SAFER BAY PROJECT, EAST PALO ALTO, CA

Total depth: 70.37 ft, Date: 11/14/2022



WATER TABLE FOR ESTIMATING PURPOSES ONLY

APPENDIX B:

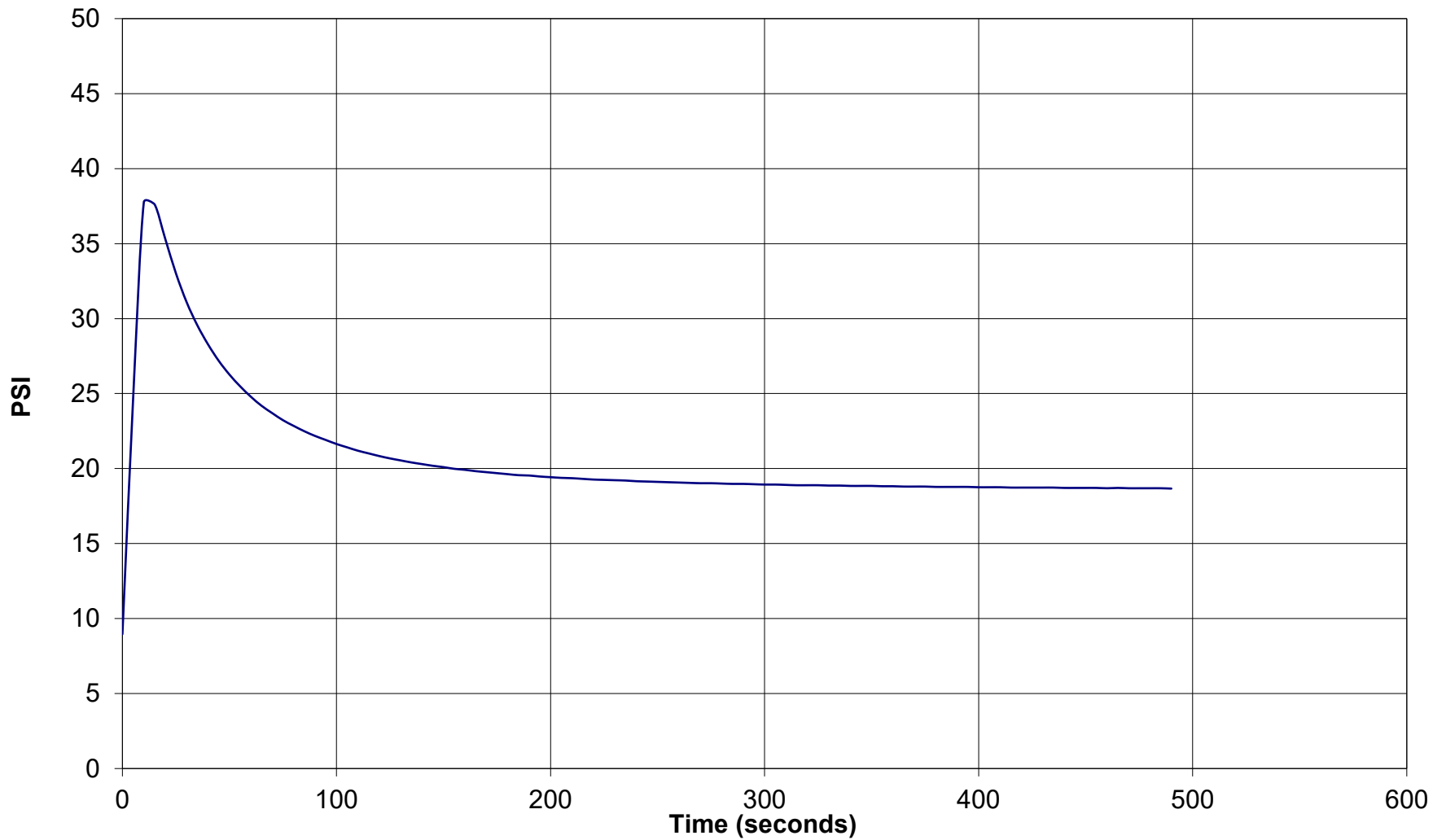
PORE PRESSURE DISSIPATION TEST PLOTS



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: CPT-104
Depth (ft): 47.57
Site: San Frasquito
Engineer: Olen

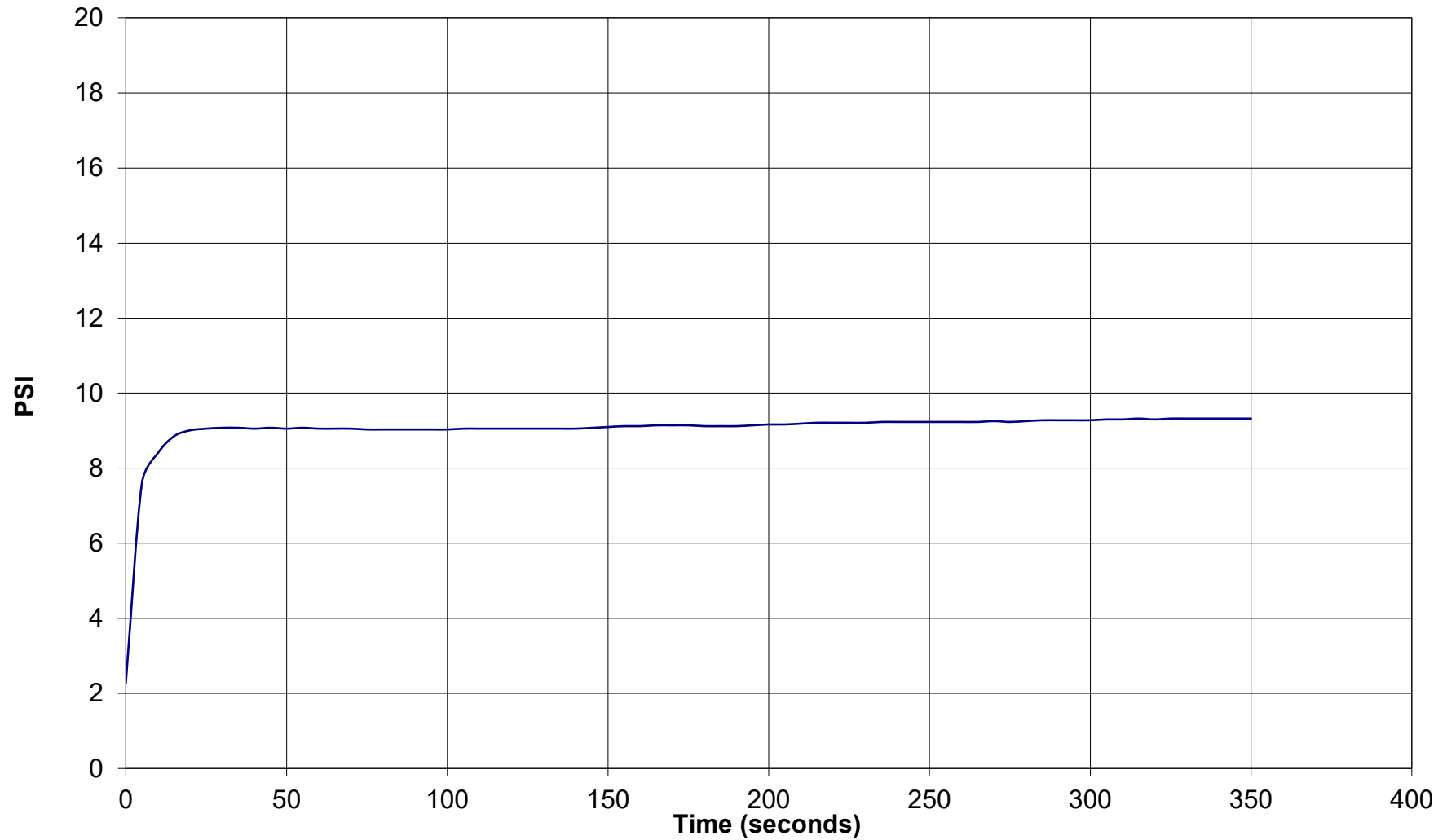




GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: CPT-105
Depth (ft): 27.72
Site: San Frasquito
Engineer: Olen

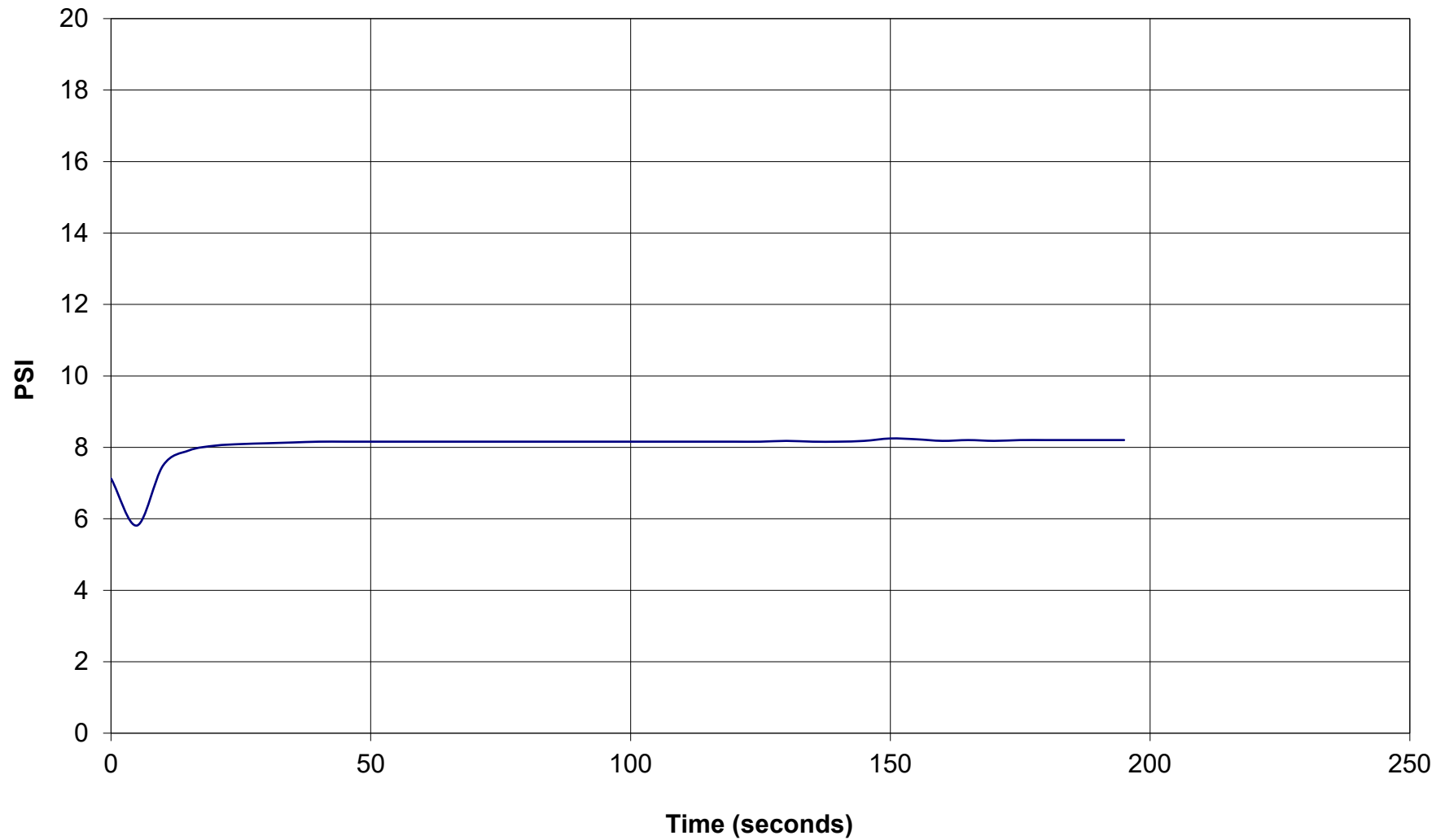




GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: CPT-106
Depth (ft): 28.54
Site: San Frasquito
Engineer: Olen

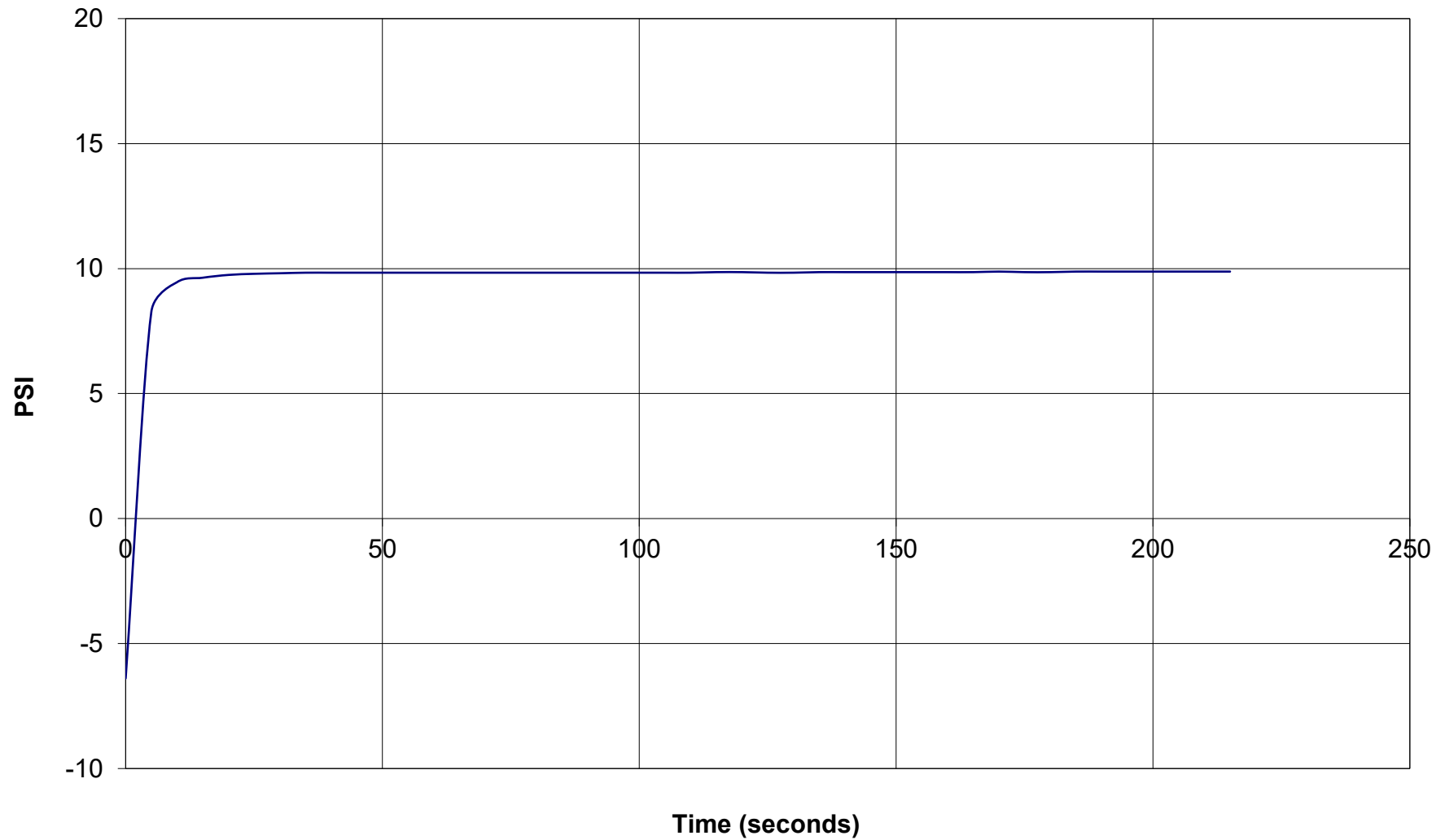




GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: CPT-107
Depth (ft): 26.57
Site: San Frasquito
Engineer: Olen

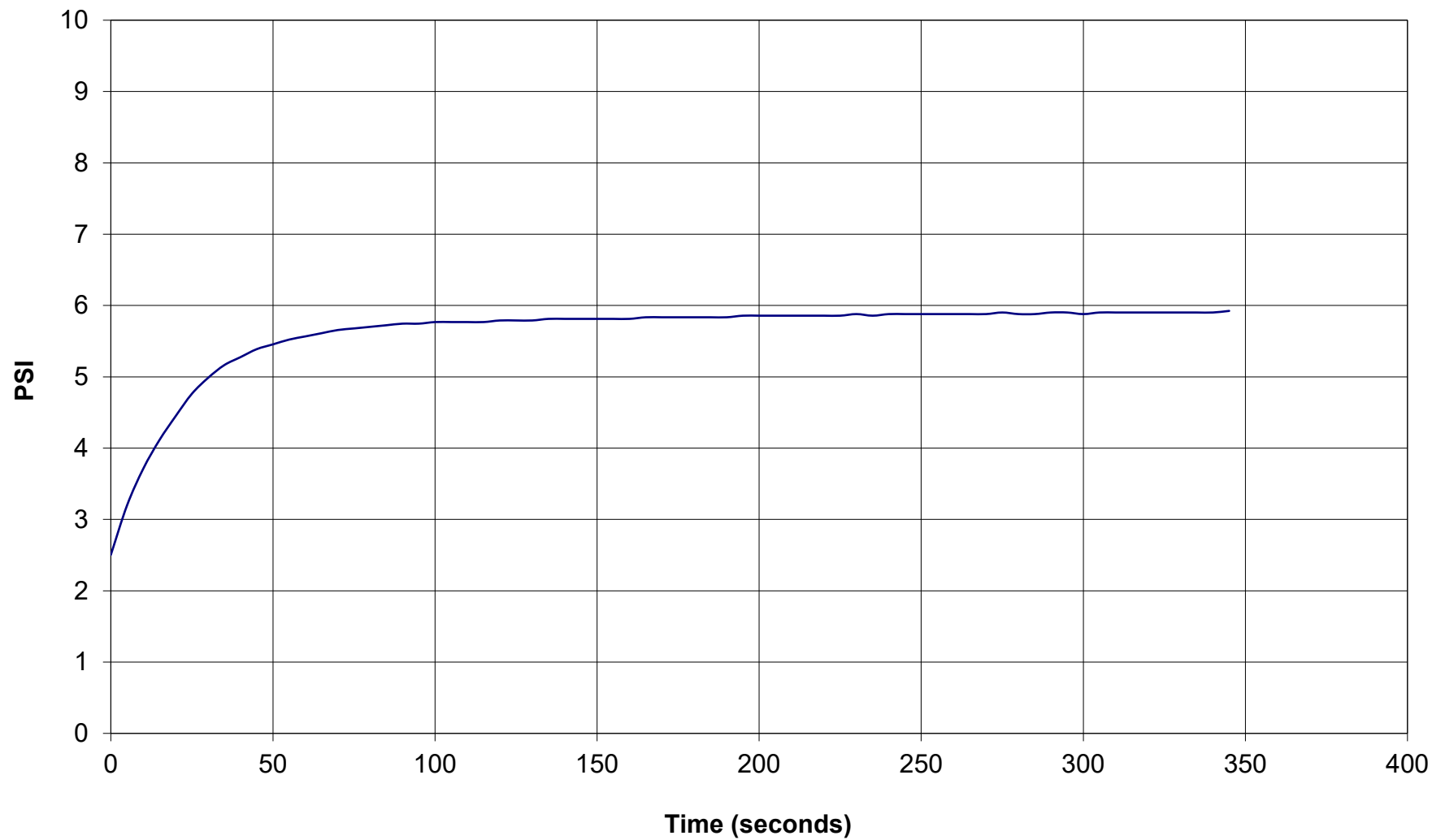




GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: CPT-108
Depth (ft): 25.43
Site: San Frasquito
Engineer: Olen



Appendix C. Laboratory Testing

DRAFT

Lab Data for Boring B-107



Moisture-Density-Porosity Report

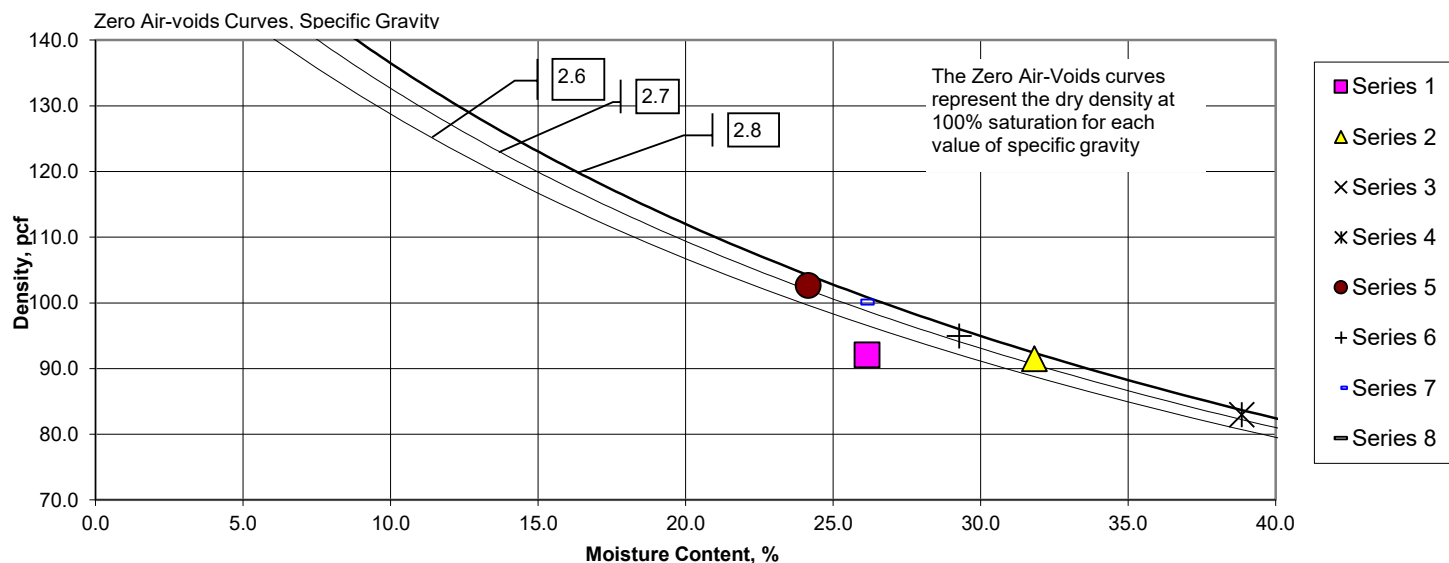
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 855-048 Project No. 10151664 By: RU
 Client: HDR Engineering Date: 12/05/22
 Project Name: SAFER Bay Remarks:

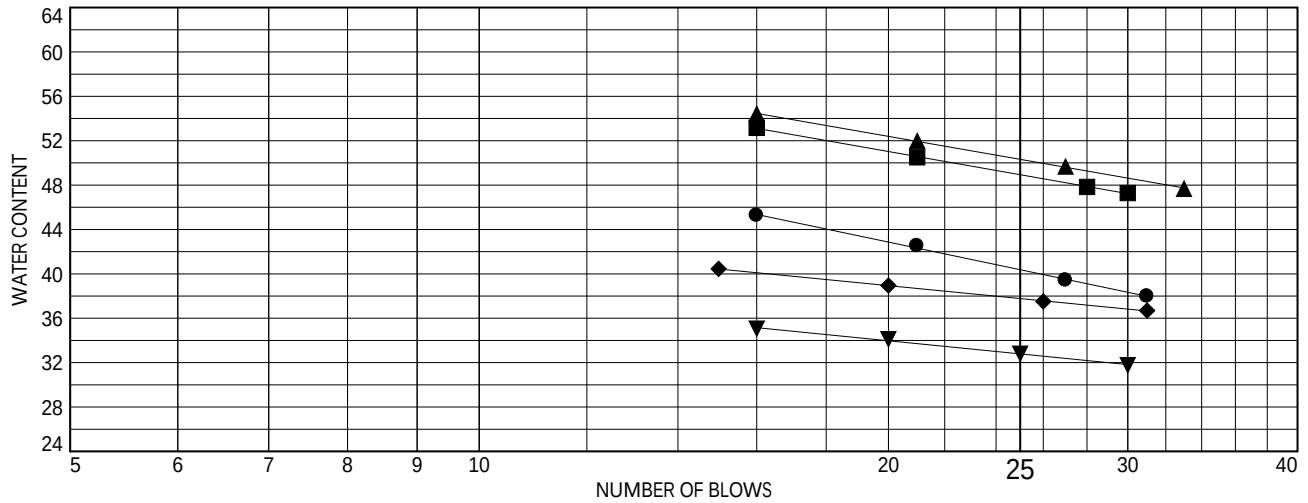
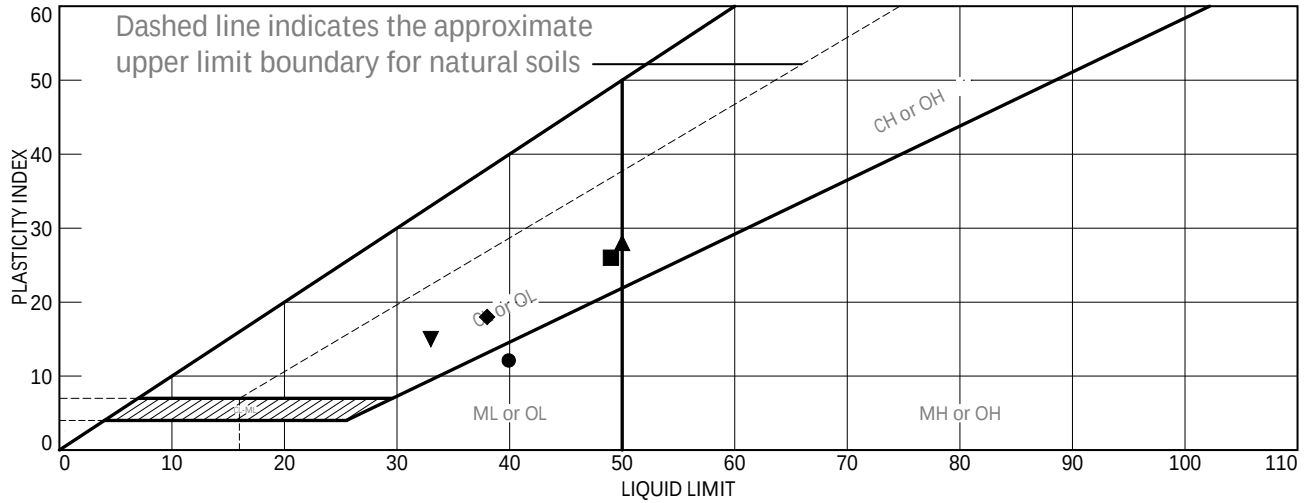
Boring:	B-107	B-107	B-107	B-107	B-107	B-107	B-107	
Sample:	L2	L6	S8	L9	L13	L16	L17	
Depth, ft:	3.5-4	13.5-14	17.5-19	21-21.5	28-28.5	31-31.5	36-36.5	
Visual Description:	Dark Brown Sandy SILT w/ Gravel	Gray CLAY w/ Sand	Gray CLAY w/ Sand	Very Dark Gray CLAY	Olive Gray Sandy CLAY	Olive Gray Sandy Lean CLAY	Olive Gray Sandy Lean CLAY	
Actual G_s								
Assumed G_s	2.70	2.75		2.75	2.75	2.75	2.75	
Moisture, %	26.1	31.8	48.5	38.9	24.2	29.3	26.0	
Wet Unit wt, pcf	116.2	120.6		115.2	127.4	122.7	126.1	
Dry Unit wt, pcf	92.1	91.5		83.0	102.6	94.9	100.1	
Dry Bulk Dens.pb, (g/cc)	1.47	1.47		1.33	1.64	1.52	1.60	
Saturation, %	85.0	99.9		99.9	98.8	99.6	99.8	
Total Porosity, %	45.4	46.7		51.7	40.2	44.7	41.7	
Volumetric Water Cont., θ_w , %	38.6	46.7		51.6	39.7	44.5	41.6	
Volumetric Air Cont., θ_a , %	6.8	0.1		0.0	0.5	0.2	0.1	
Void Ratio	0.83	0.88		1.07	0.67	0.81	0.72	
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (G_s) was used then the saturation, porosities, and void ratio should be considered approximate.

Moisture-Density



LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Brown Sandy SILT w/ Gravel	40	28	12			
■	Greenish Gray Sandy Lean CLAY	49	23	26			
▲	Very Dark Gray Fat CLAY, trace Sand	50	22	28			
◆	Olive Gray Sandy Lean CLAY	38	20	18			
▼	Olive Gray Sandy Lean CLAY	33	18	15			

Project No. 855-048 Client: HDR Engineering

Project: SAFER Bay - 10161664

● Source of Sample: B-107 Depth: 3.5-4' Sample Number: L2
 ■ Source of Sample: B-107 Depth: 10-12.5' Sample Number: T5
 ▲ Source of Sample: B-107 Depth: 22.5-25' Sample Number: T10
 ◆ Source of Sample: B-107 Depth: 31-31.5' Sample Number: L16
 ▼ Source of Sample: B-107 Depth: 36-36.5' Sample Number: L17

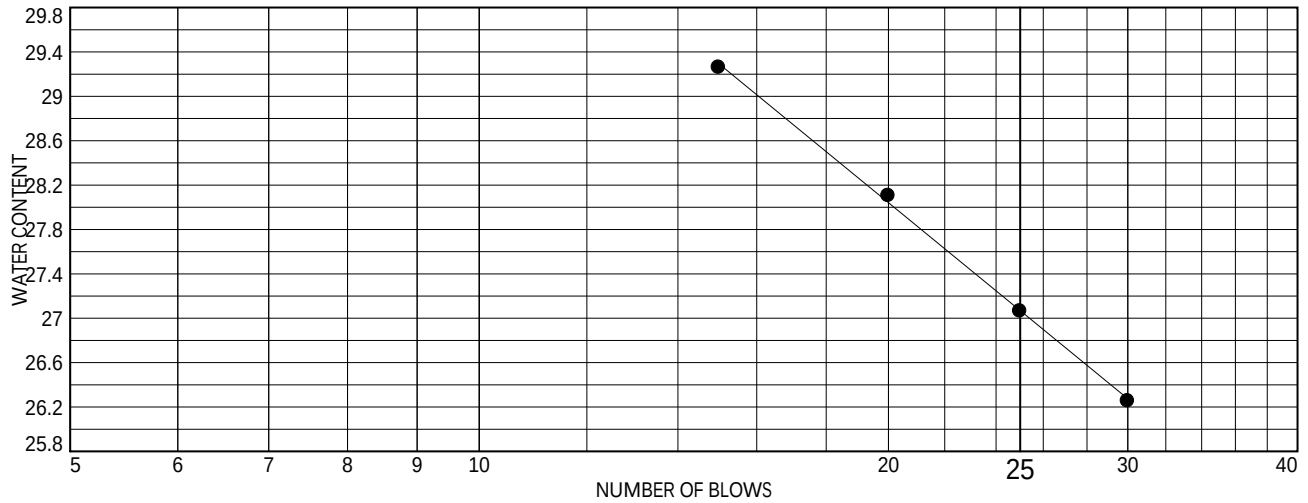
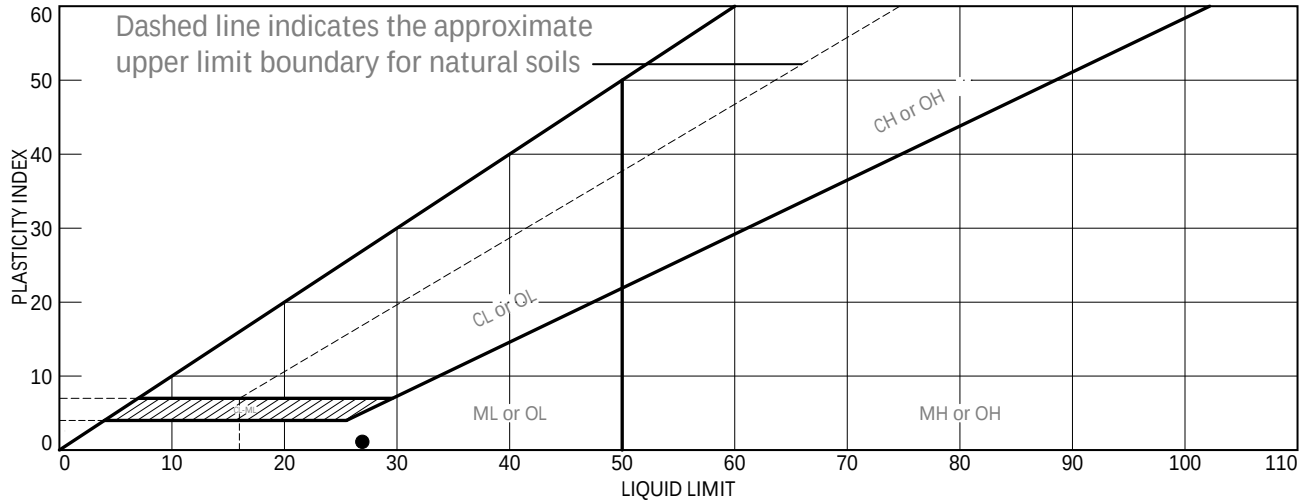
Remarks:

■ Sample was prepared using the wet prep method.
 ▲ Sample was prepared using the wet prep method.

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT (ASTM D4318)



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Olive Brown Silty SAND	27	26	1			

Project No. 855-048 Client: HDR Engineering

Project: SAFER Bay - 10161664

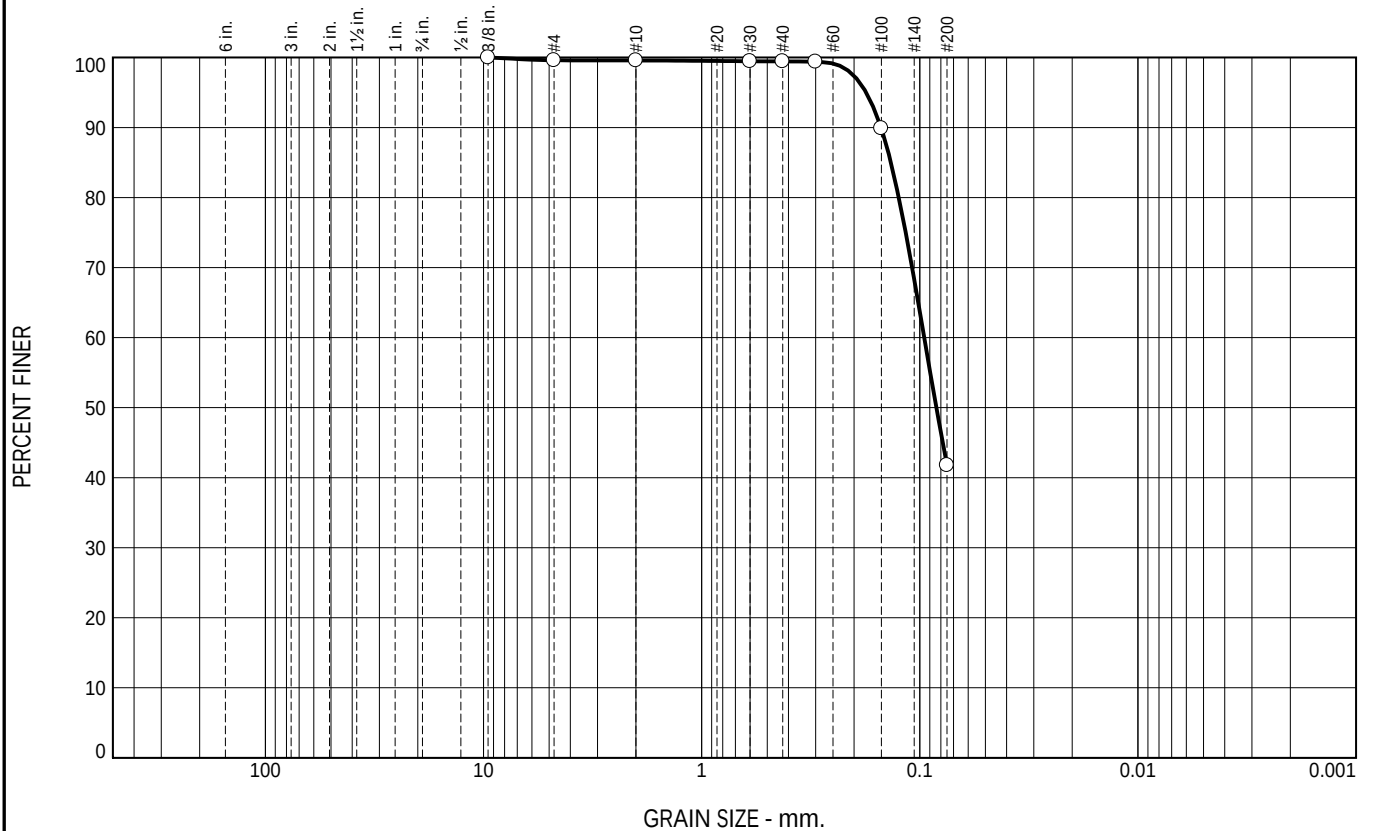
● Source of Sample: B-107 Depth: 45.5-46' Sample Number: L19

Remarks:

COOPER TESTING LABORATORY

Figure

Particle Size Distribution Report



+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
0.0	0.4	57.8	41.8					

SIEVE inches size	PERCENT FINER		
3/8"	100.0		
GRAIN SIZE			
D ₆₀	0.0953		
D ₃₀			
D ₁₀			
COEFFICIENTS			
C _c			
C _u			

SIEVE number size	PERCENT FINER		
#4	99.6		
#10	99.6		
#30	99.5		
#40	99.4		
#50	99.4		
#100	89.9		
#200	41.8		

<u>Material Description</u>
○ Dark Brown Silty SAND

<u>REMARKS:</u>
○

○ Source of Sample: B-107 Depth: 51-51.5' Sample Number: L21

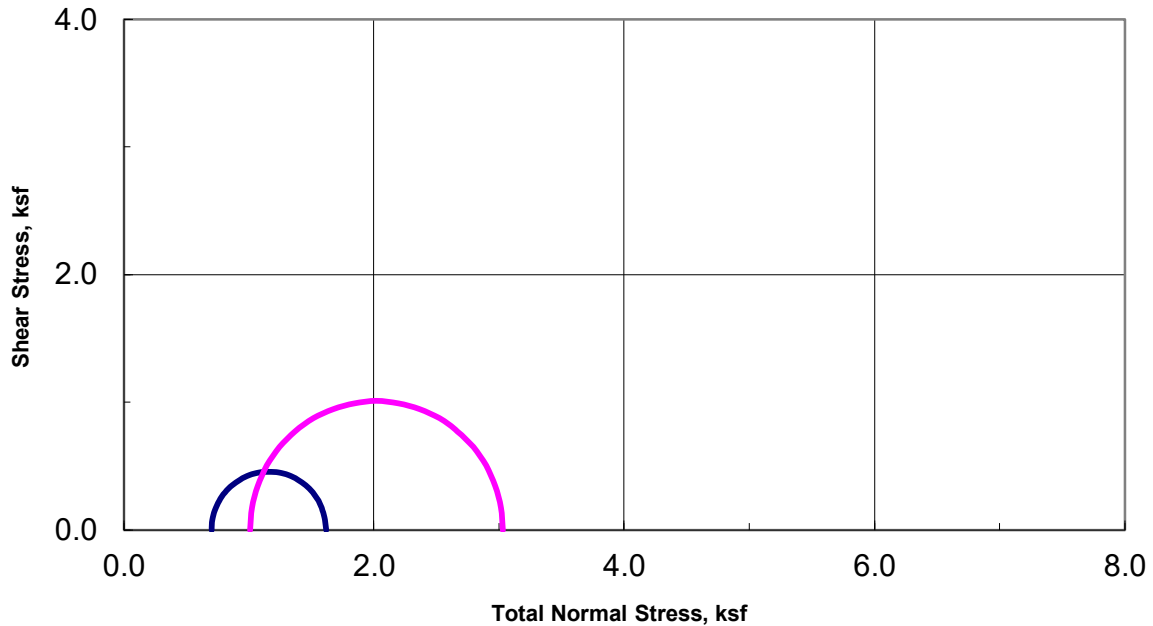
COOPER TESTING LABORATORY

Client: HDR Engineering
Project: SAFER Bay - 10161664
Project No.: 855-048

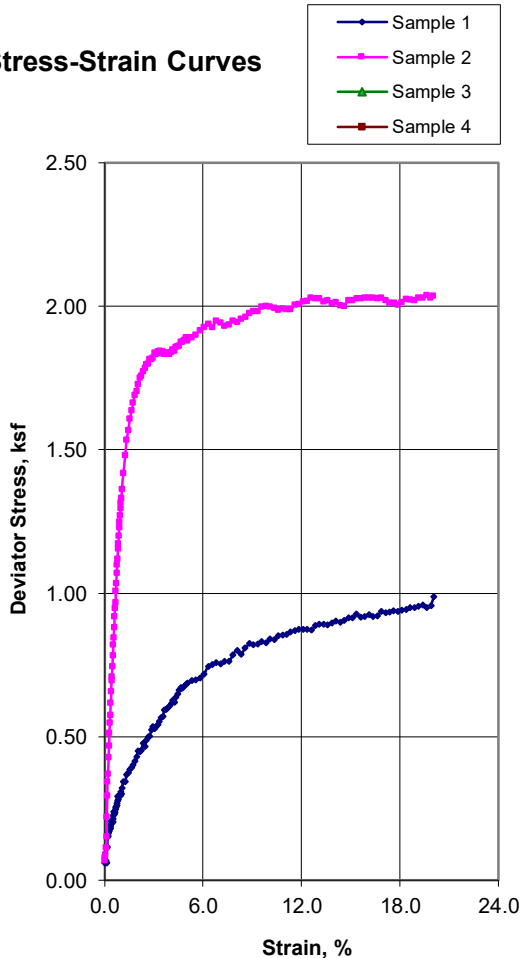
Figure



Unconsolidated-Undrained Triaxial Test ASTM D2850



Stress-Strain Curves



Sample Data

	1	2	3	4
Moisture %	27.1	32.9		
Dry Den,pcf	96.1	87.0		
Void Ratio	0.754	0.938		
Saturation %	97.1	94.8		
Height in	6.03	6.07		
Diameter in	2.86	2.87		
Cell psi	4.9	7.0		
Strain %	15.00	15.00		
Deviator, ksf	0.915	2.021		
Rate %/min	1.00	1.00		
in/min	0.060	0.061		
Job No.:	855-048			
Client:	HDR Engineering			
Project:	10151664			
Boring:	B-107	B-107		
Sample:	T5	T10		
Depth ft:	10-12.5(Tip-4")	22.5(Tip-10")		

Visual Soil Description

Sample #	
1	Greenish Gray Sandy Lean CLAY
2	Very Dark Gray Fat CLAY, trace Sand
3	
4	

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

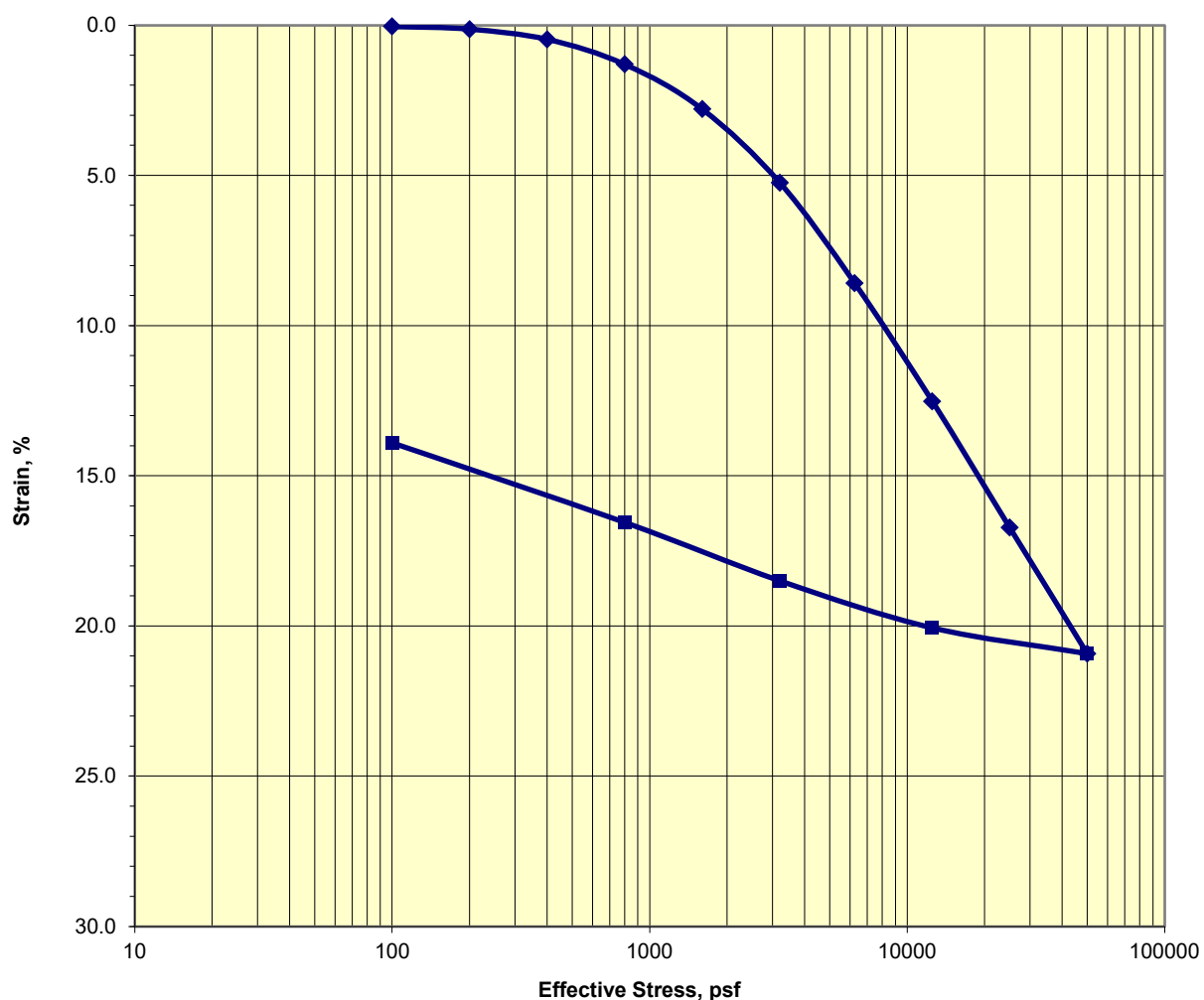


Consolidation Test

ASTM D2435

Job No.:	855-048	Boring:	B-107	Run By:	MD
Client:	HDR	Sample:	T5	Reduced:	PJ
Project:	10151664	Depth, ft.:	10-12.5(Tip-3")	Checked:	PJ/DC
Soil Type:	Greenish Gray Sandy Lean CLAY			Date:	12/13/2022

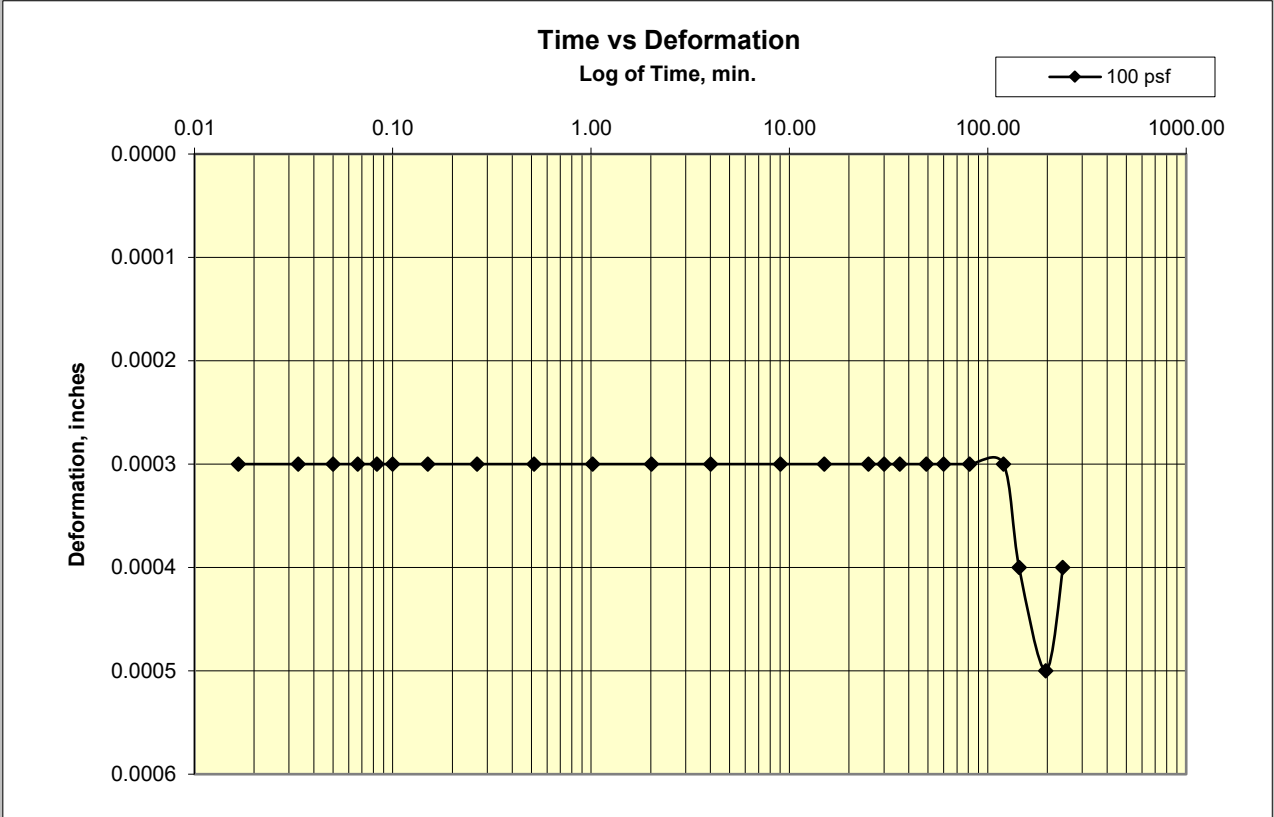
Strain-Log-P Curve



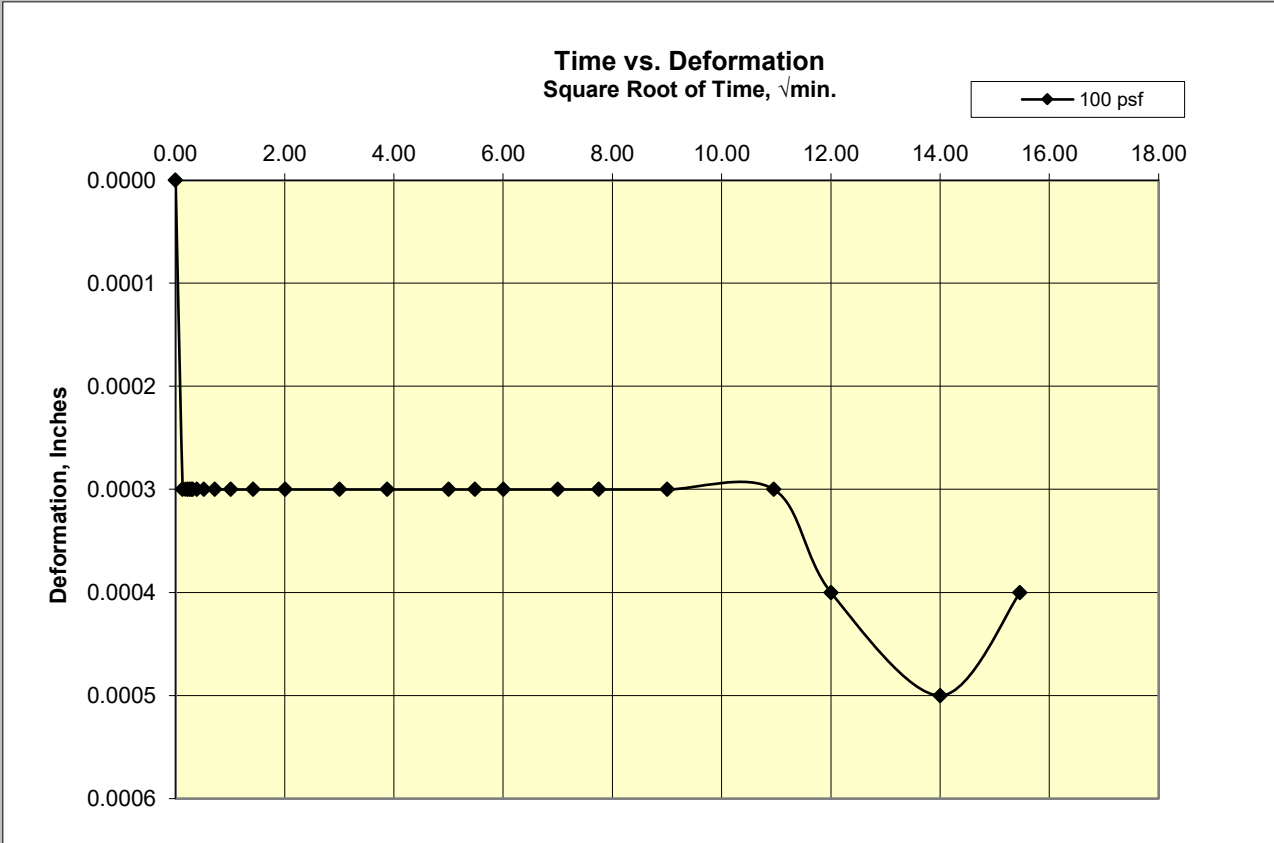
Assumed Gs	2.7	Initial	Final	Remarks:
Moisture %:		30.6	23.9	
Dry Density, pcf:		88.6	102.4	
Void Ratio:		0.902	0.646	
% Saturation:		91.7	100.0	

Load 1

100 psf



100 psf



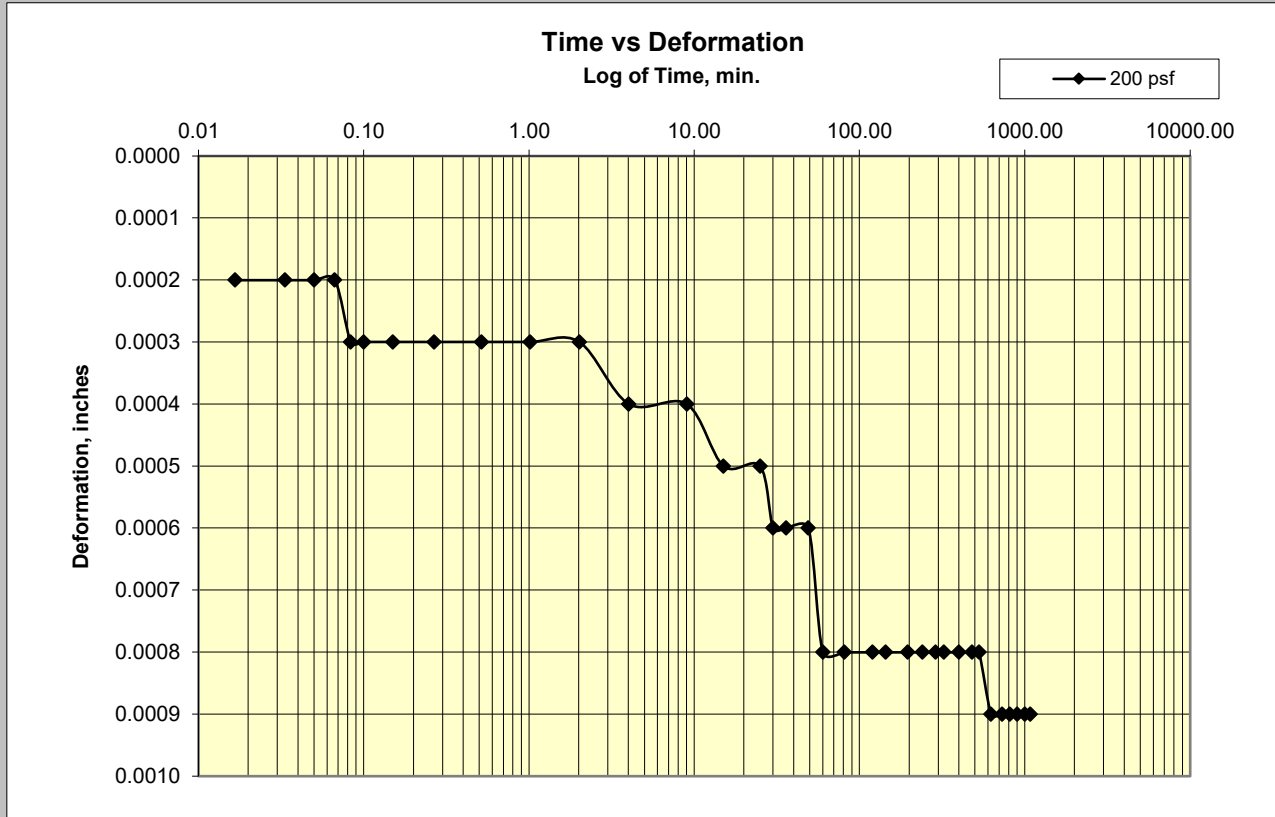
Cooper Testing Labs, Inc.

B-107, Sample T5, 10-12.5 feet

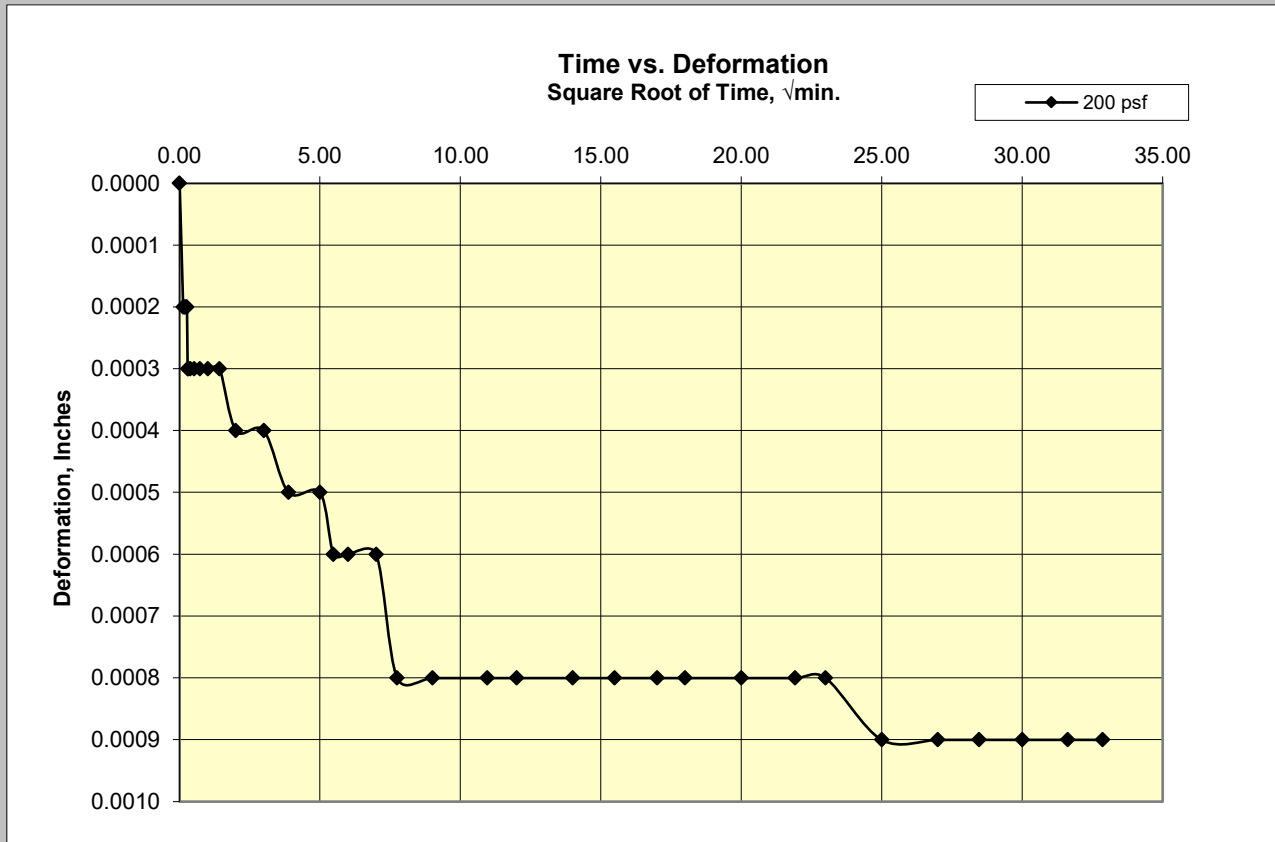
B-107, Sample T5, 10-12.5 feet

Load 2

200 psf

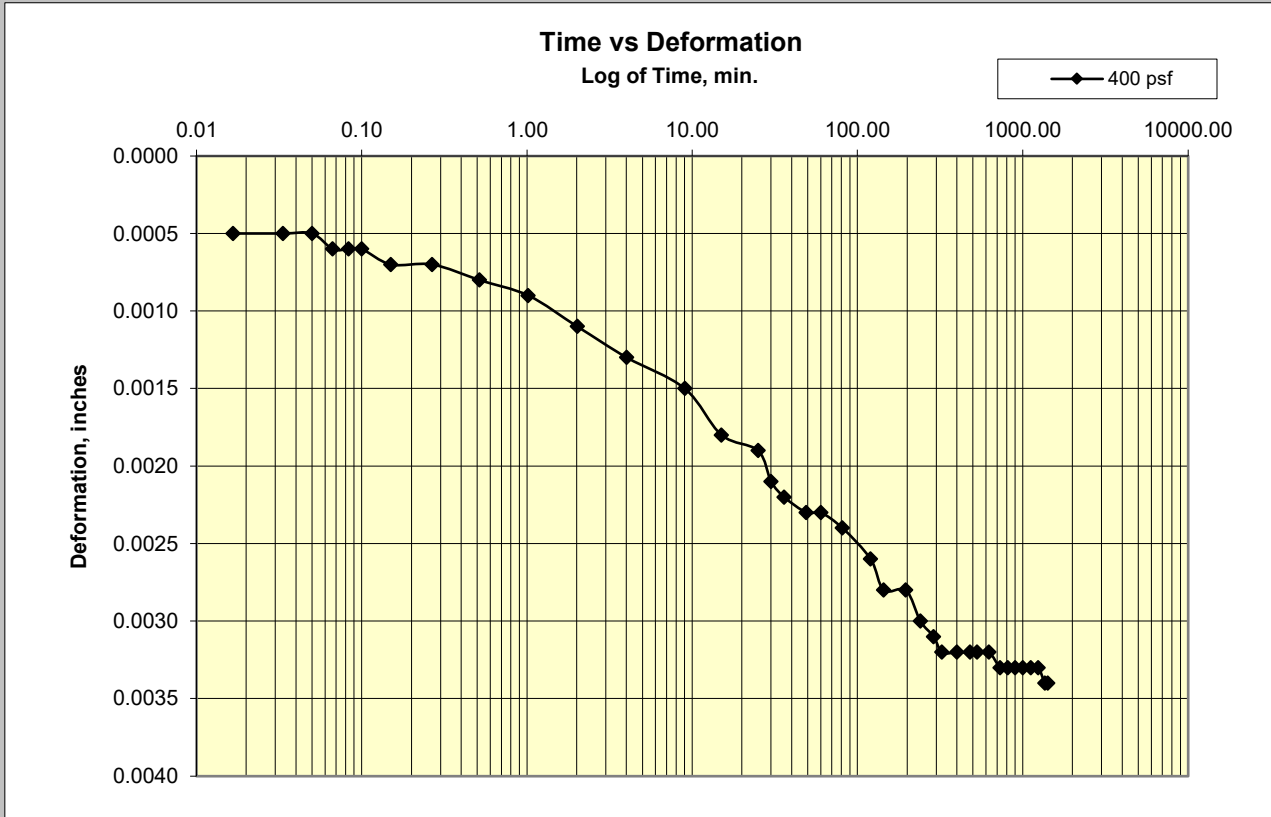


200 psf

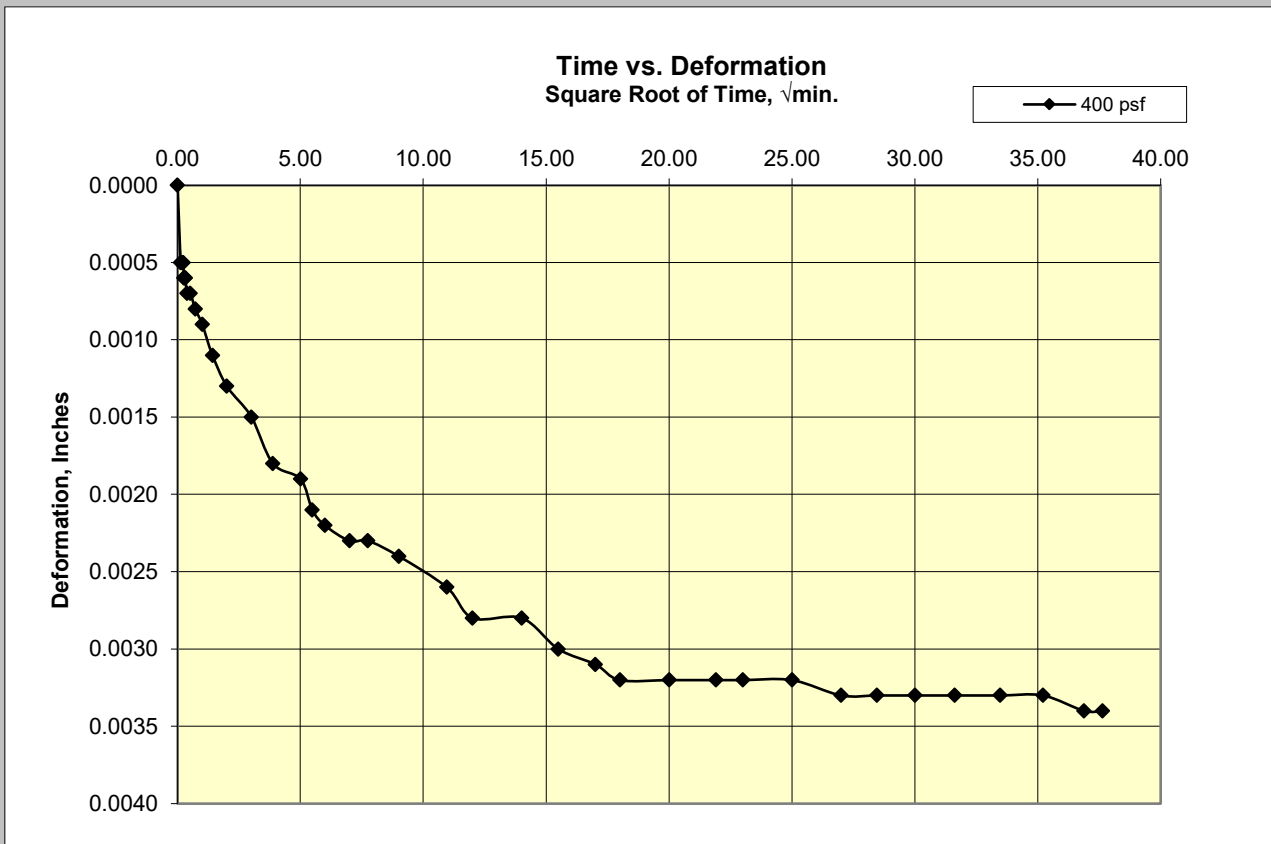


Load 3

400 psf

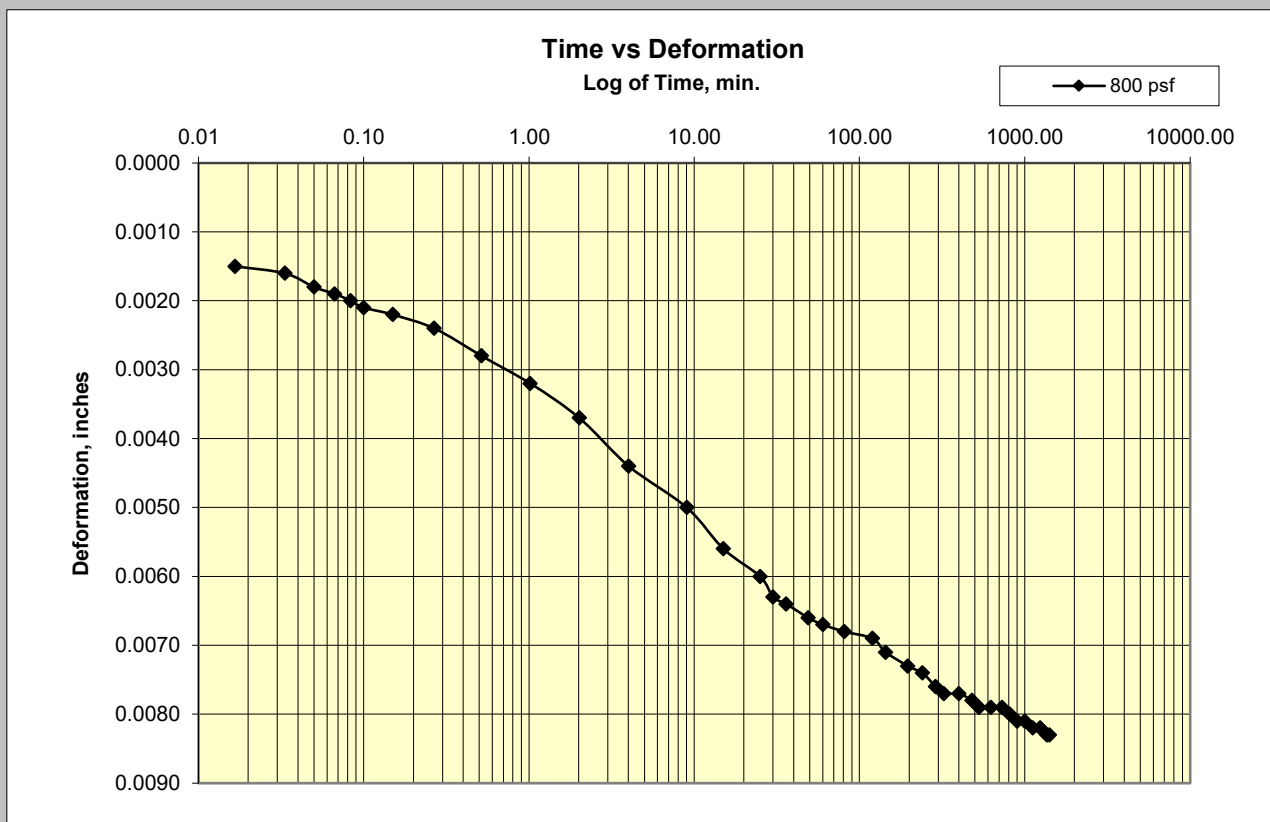


400 psf

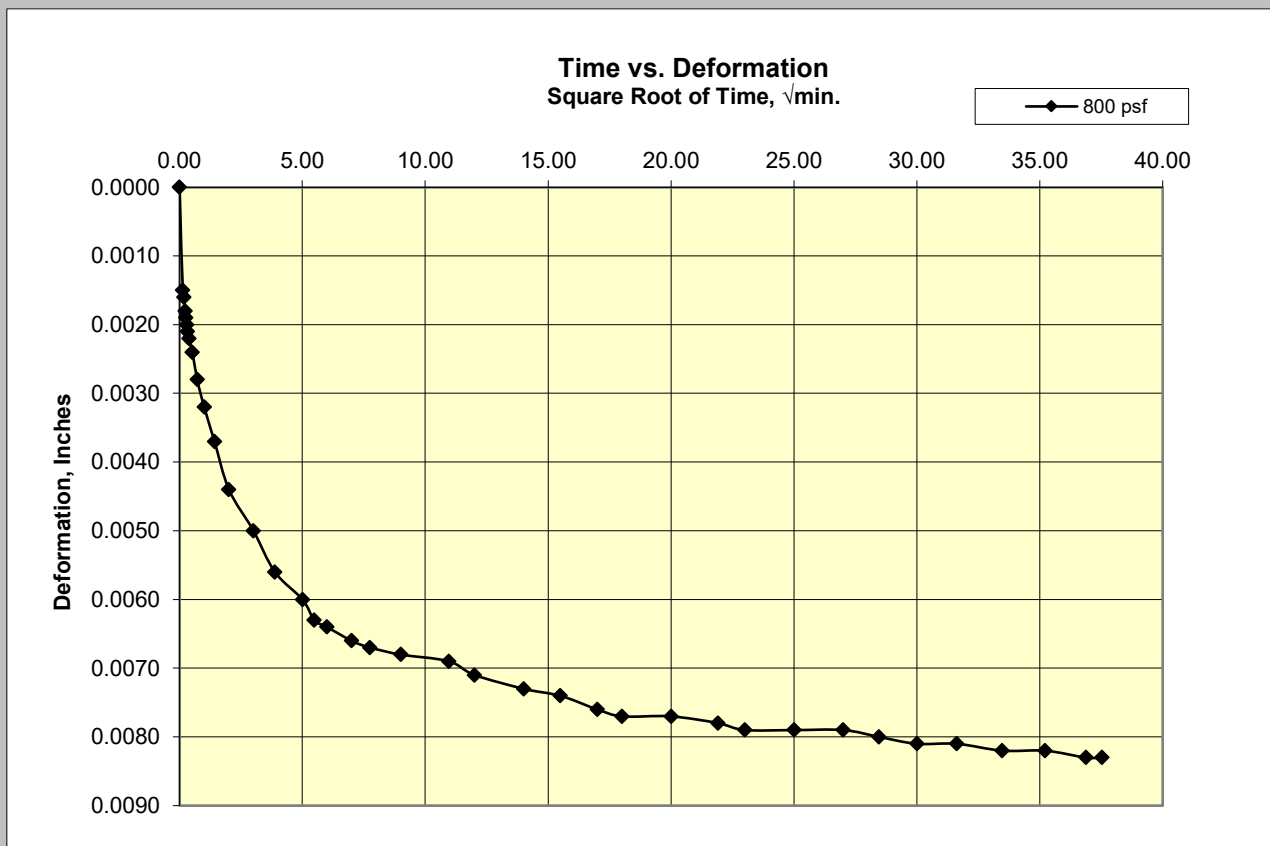


Load 4

800 psf

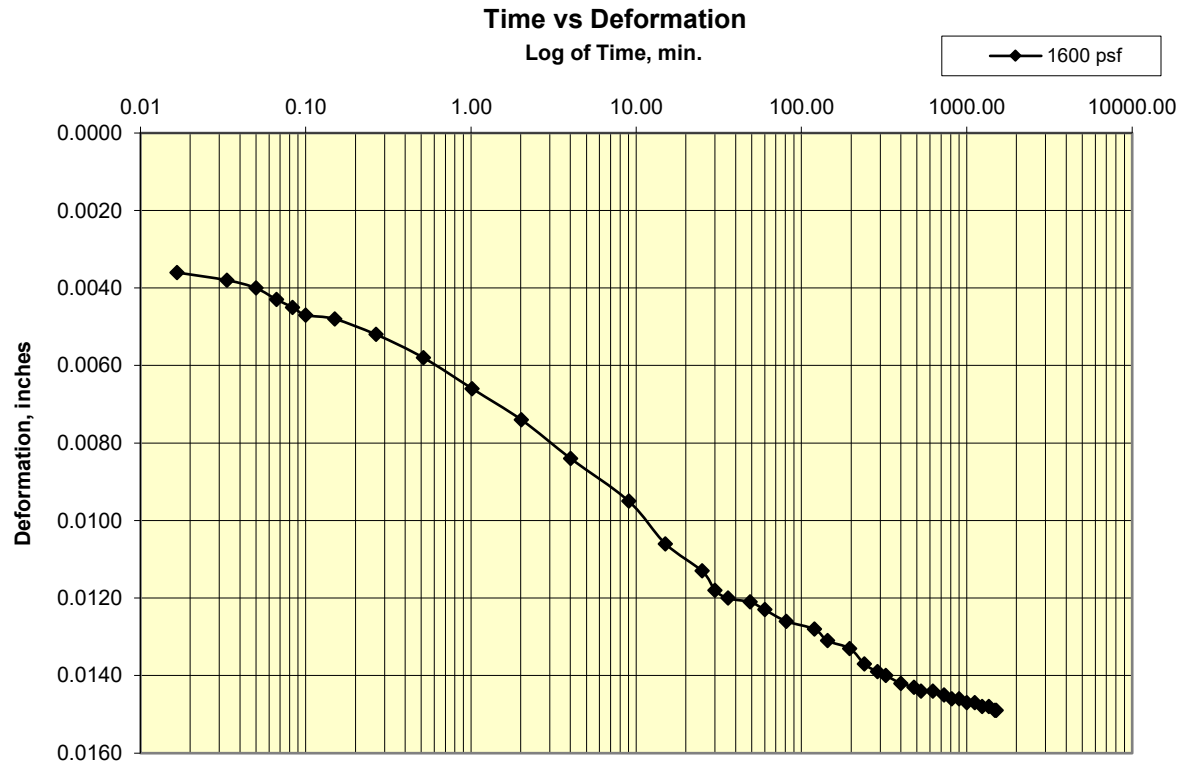


800 psf

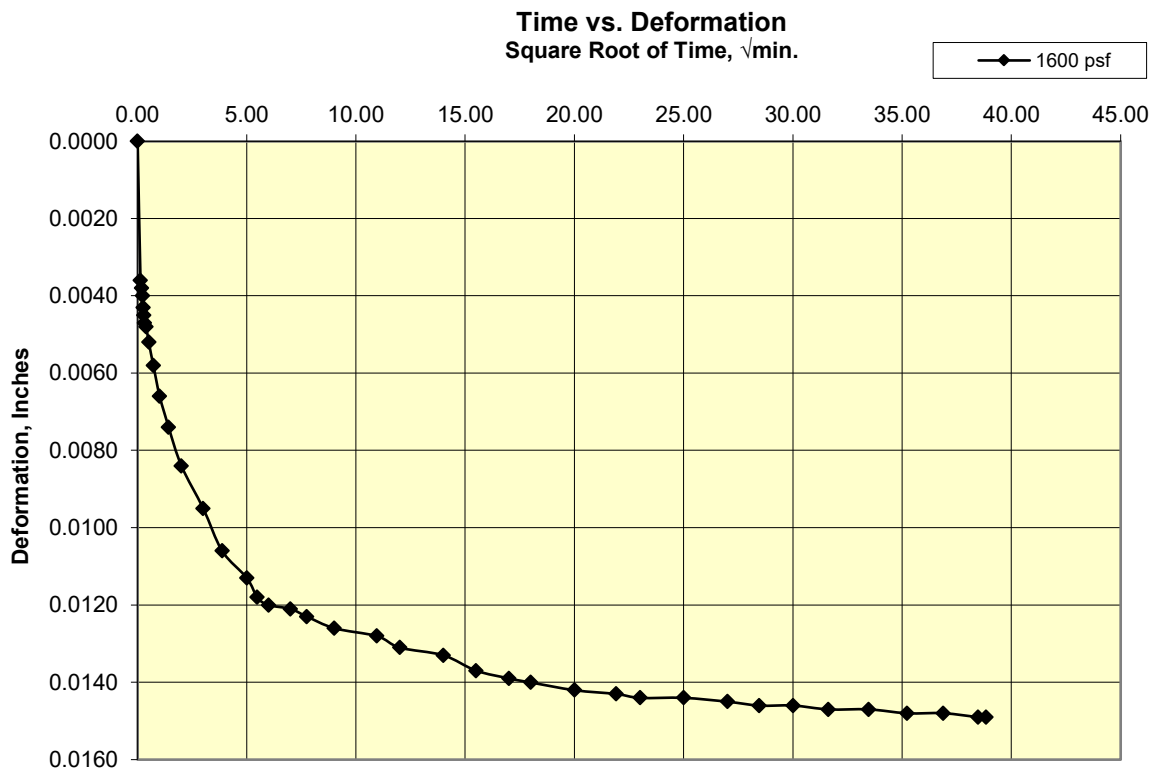


Load 5

1600 psf

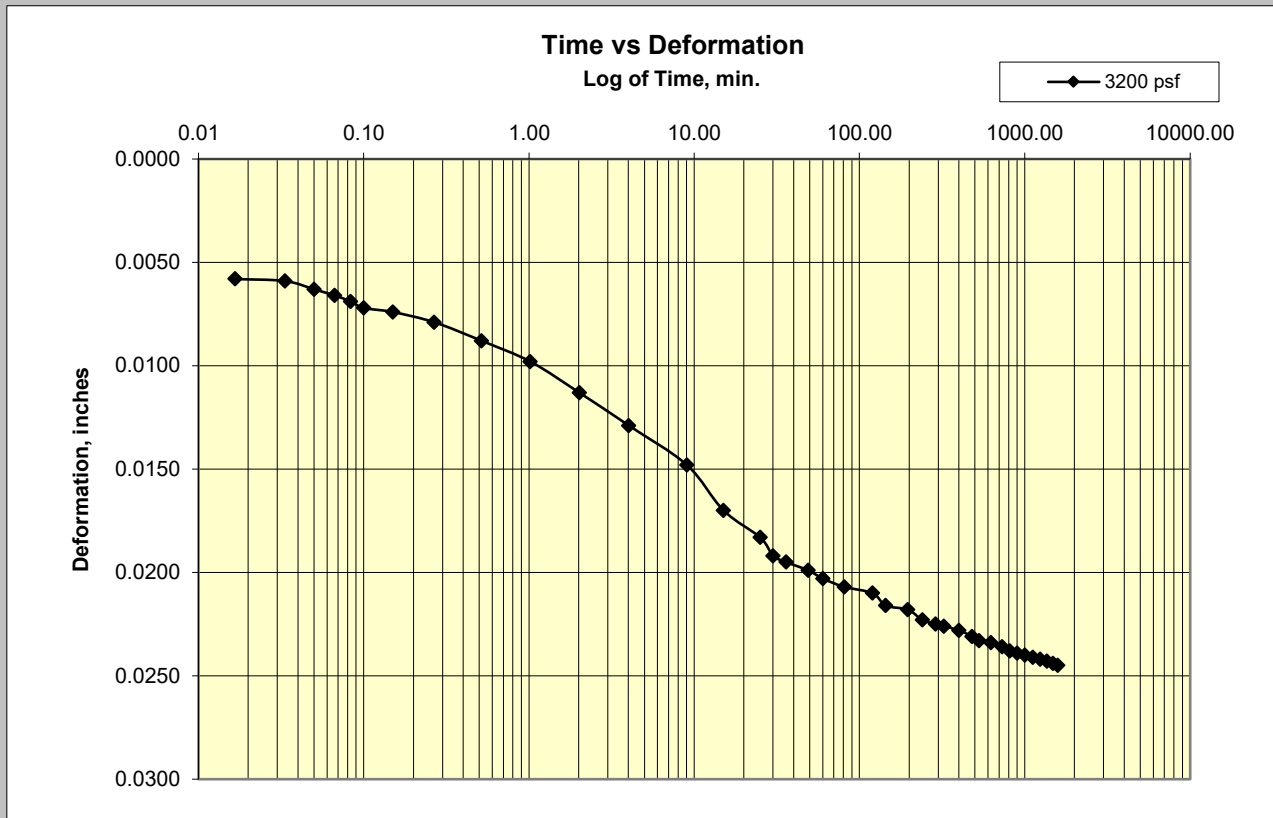


1600 psf

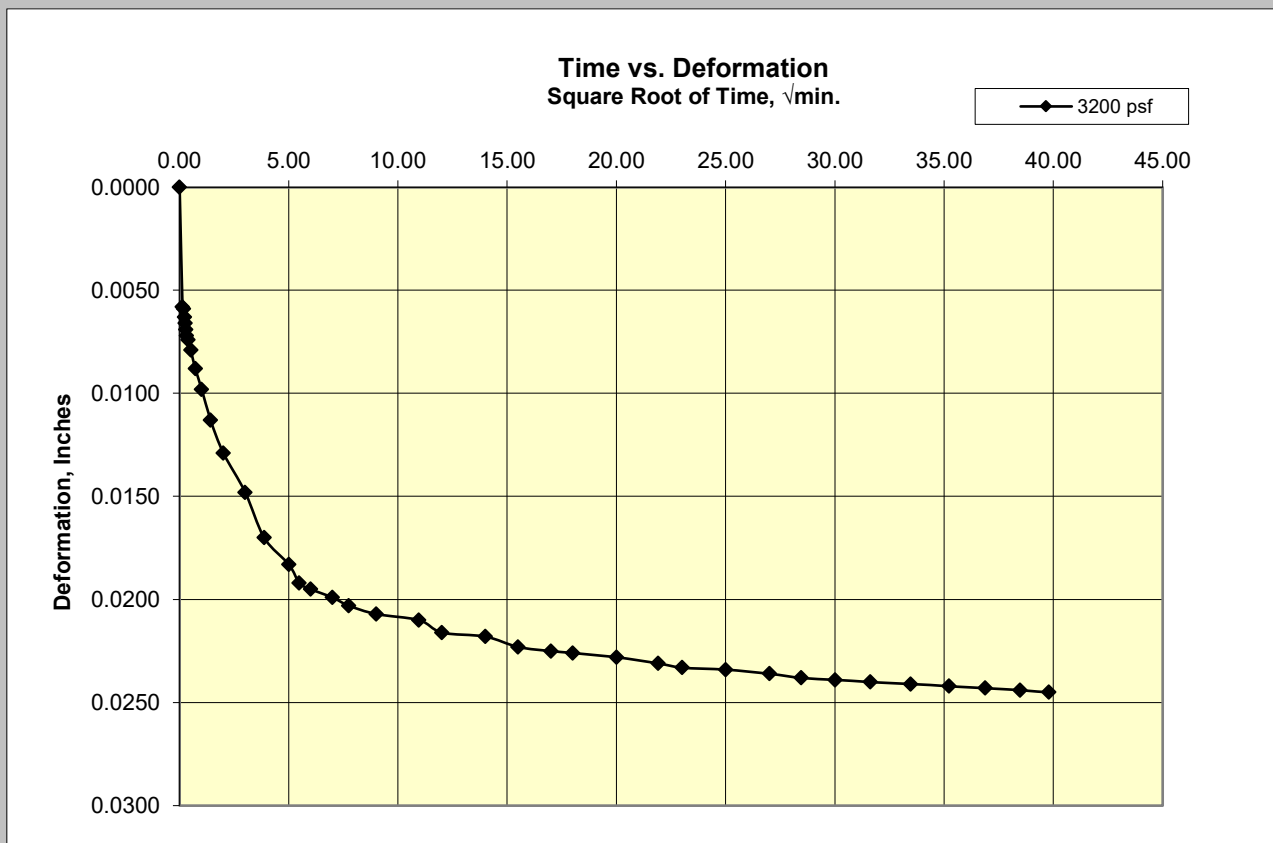


Load 6

3200 psf

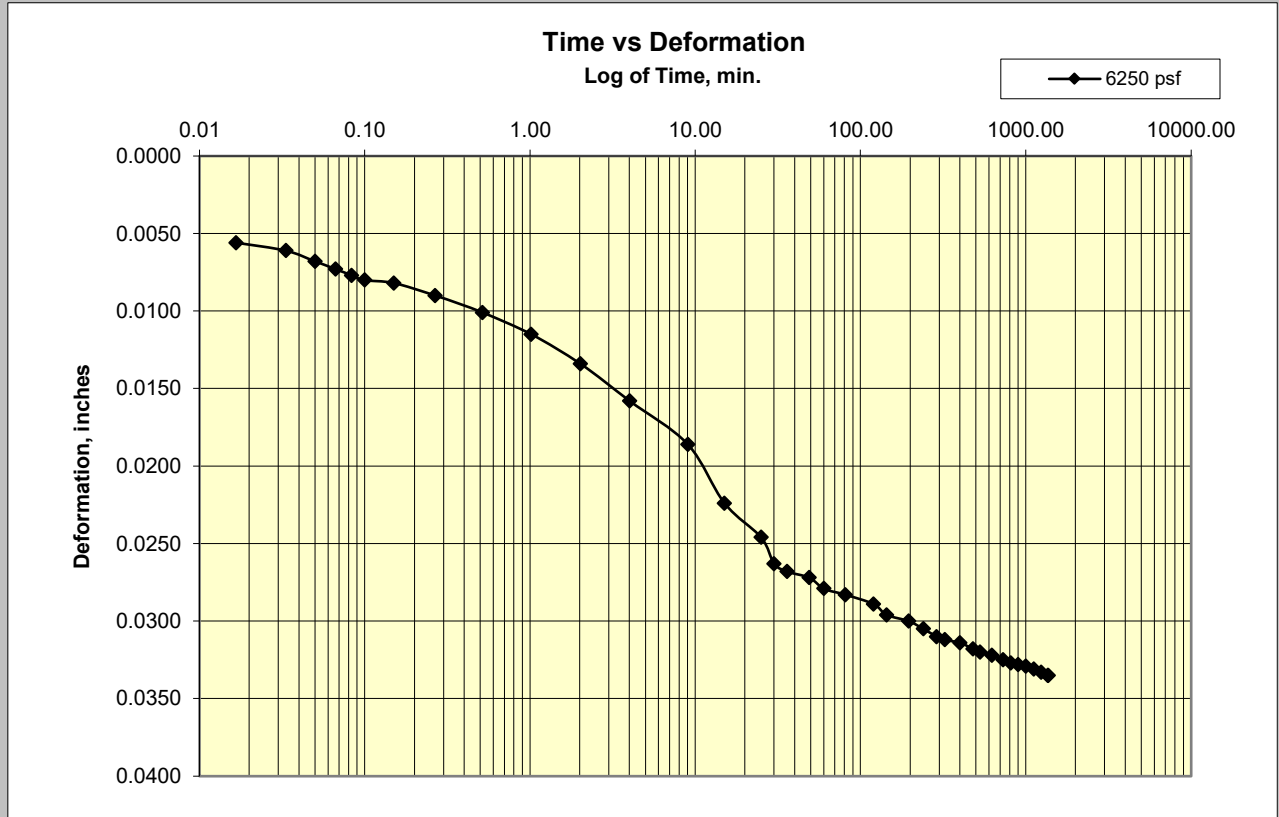


3200 psf

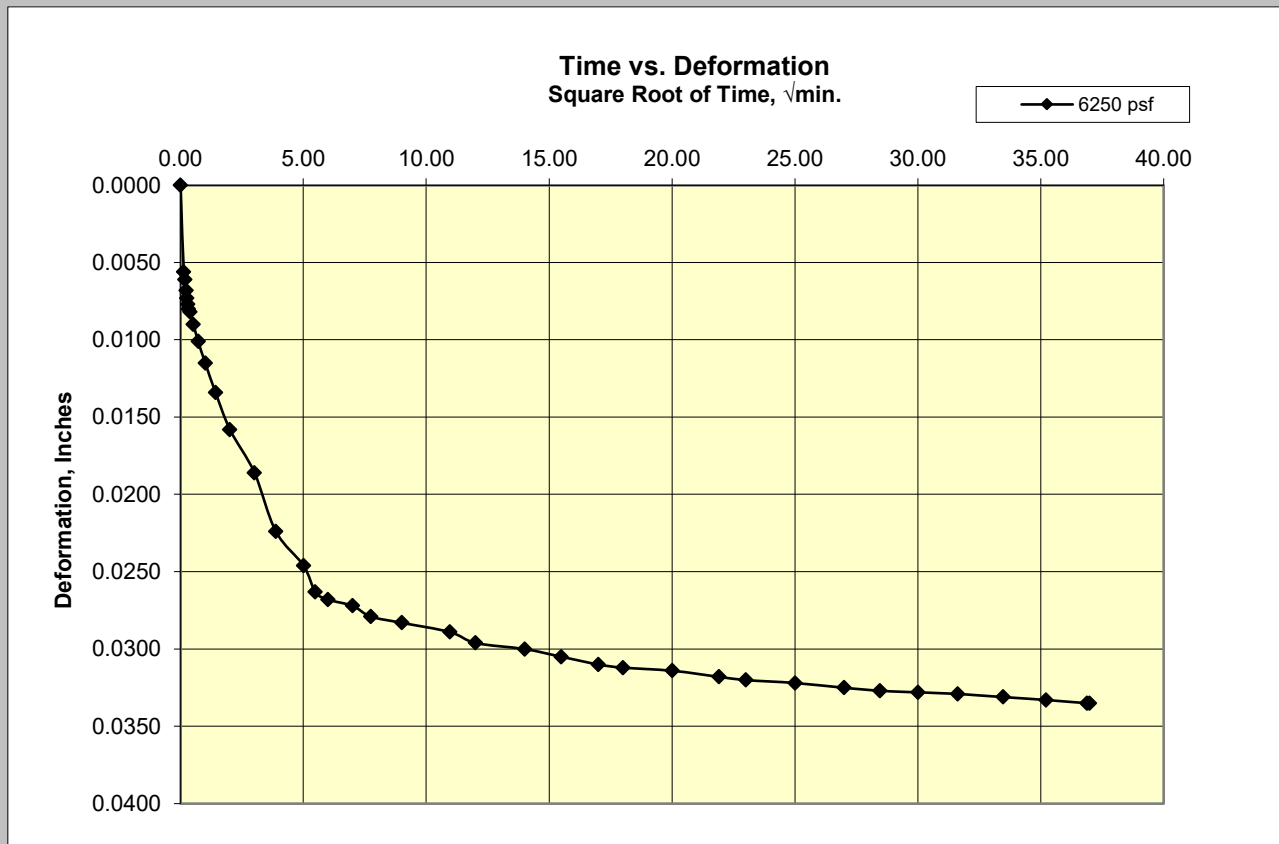


Load 7

6250 psf



6250 psf

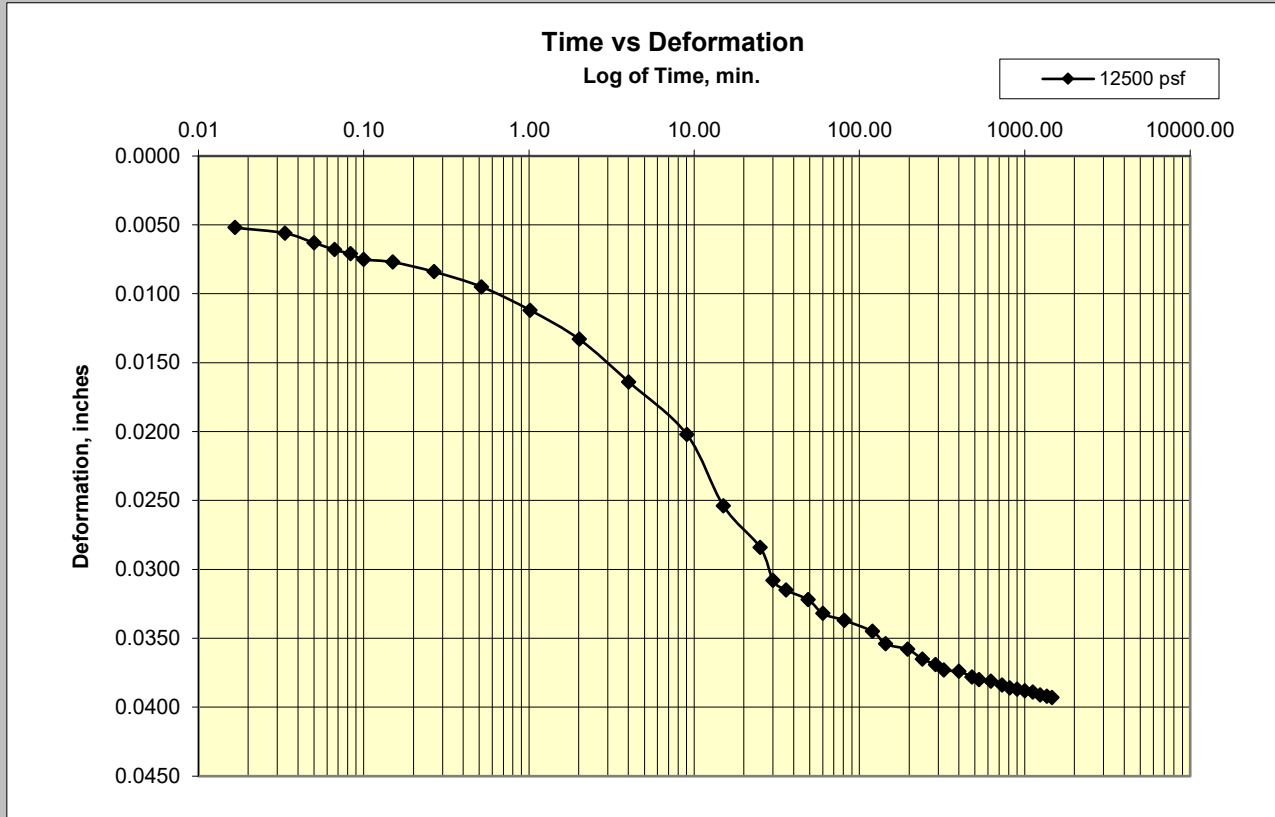


Cooper Testing Labs, Inc.

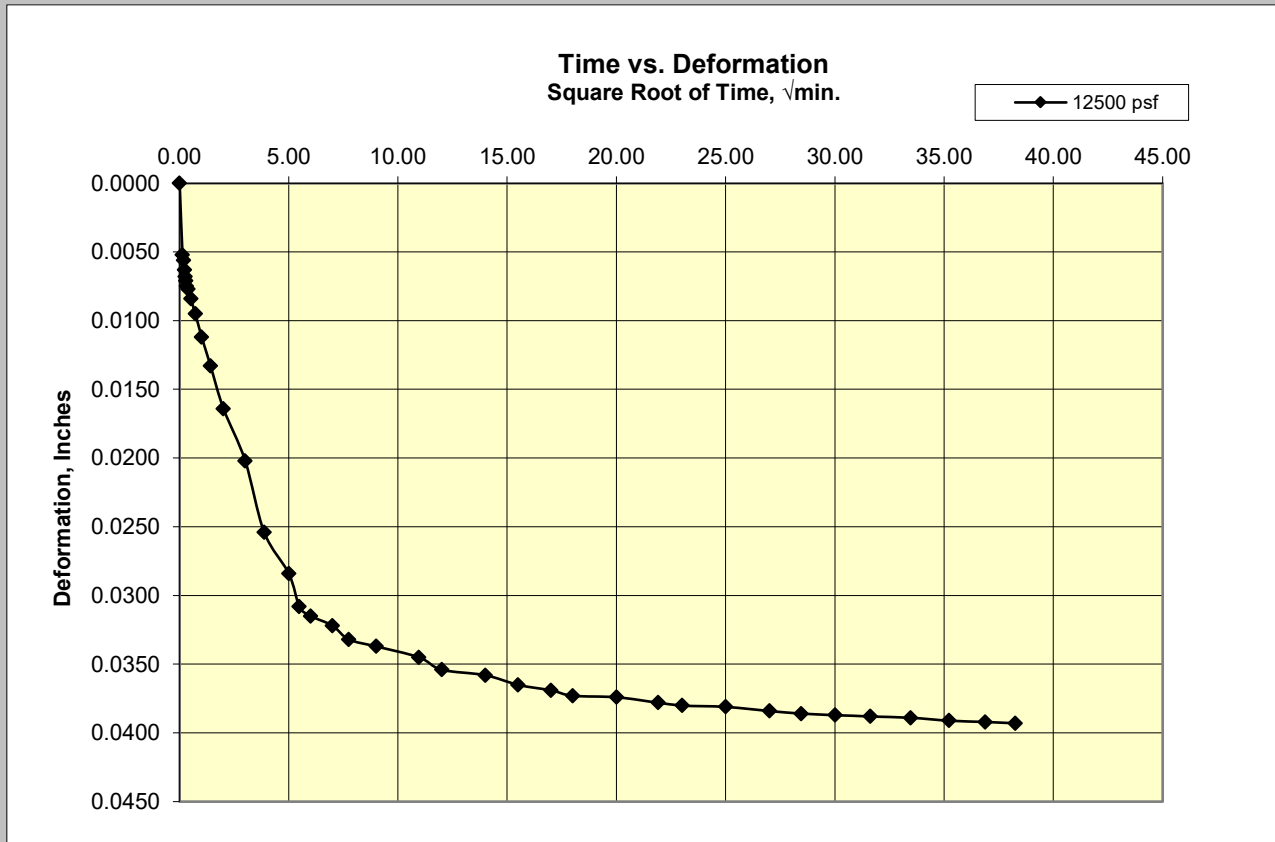
B-107, Sample T5, 10-12.5 feet

Load 8

12500 psf



12500 psf

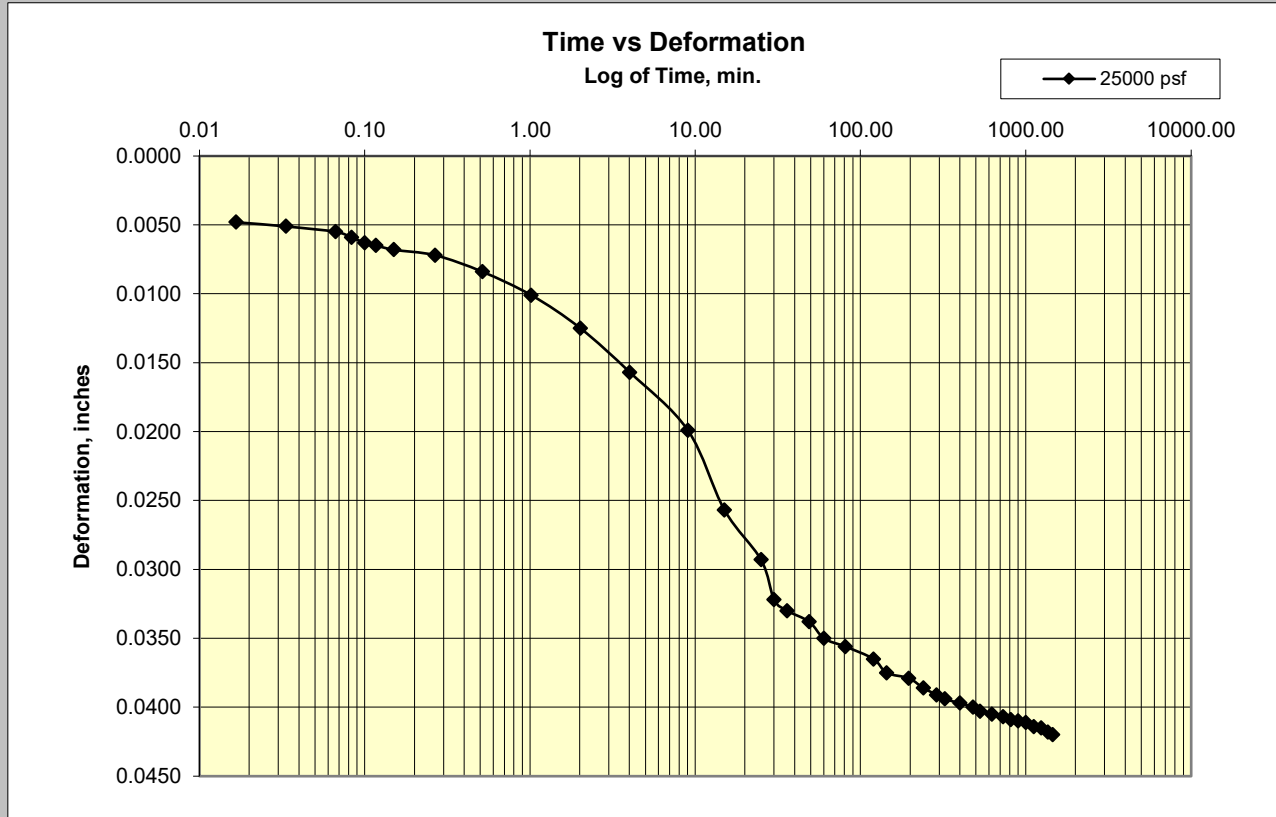


Cooper Testing Labs, Inc.

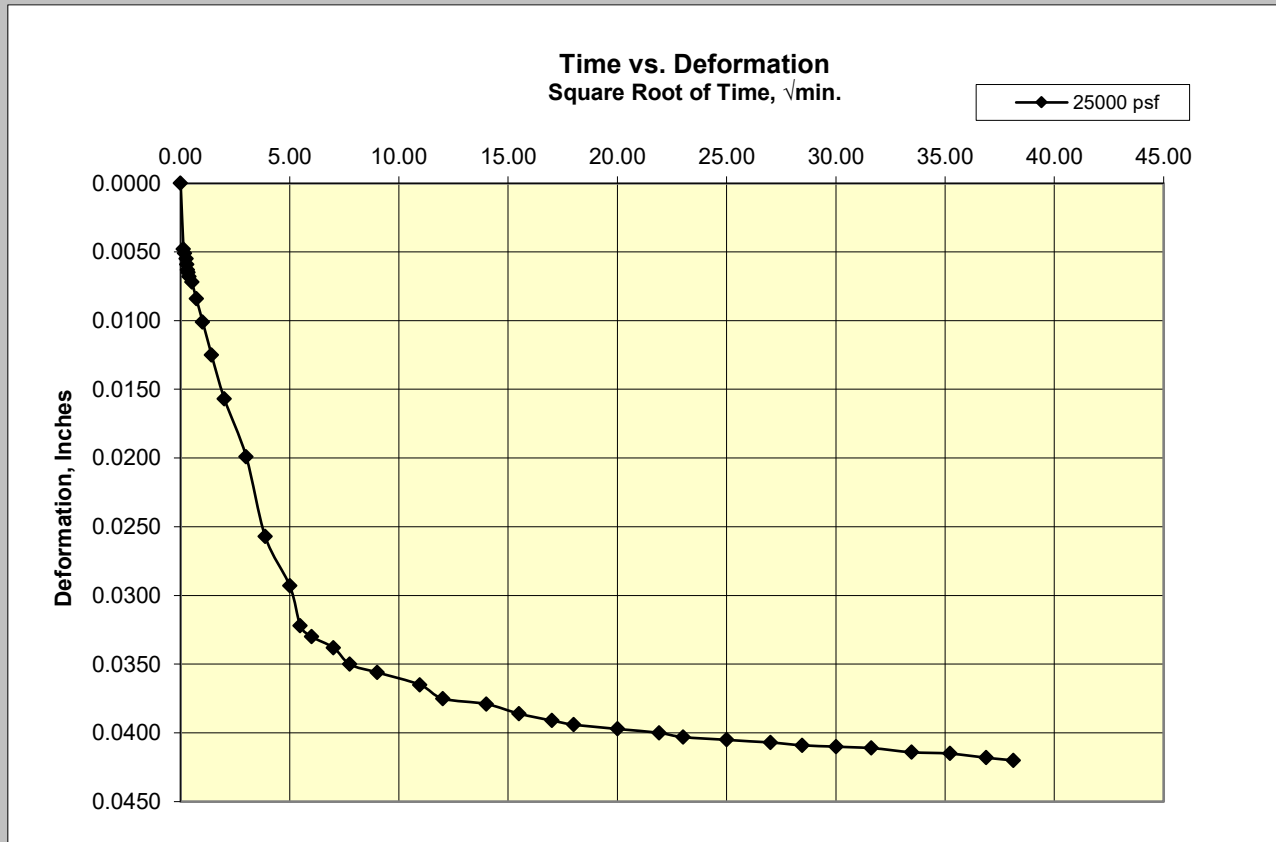
B-107, Sample T5, 10-12.5 feet

Load 9

25000 psf



25000 psf

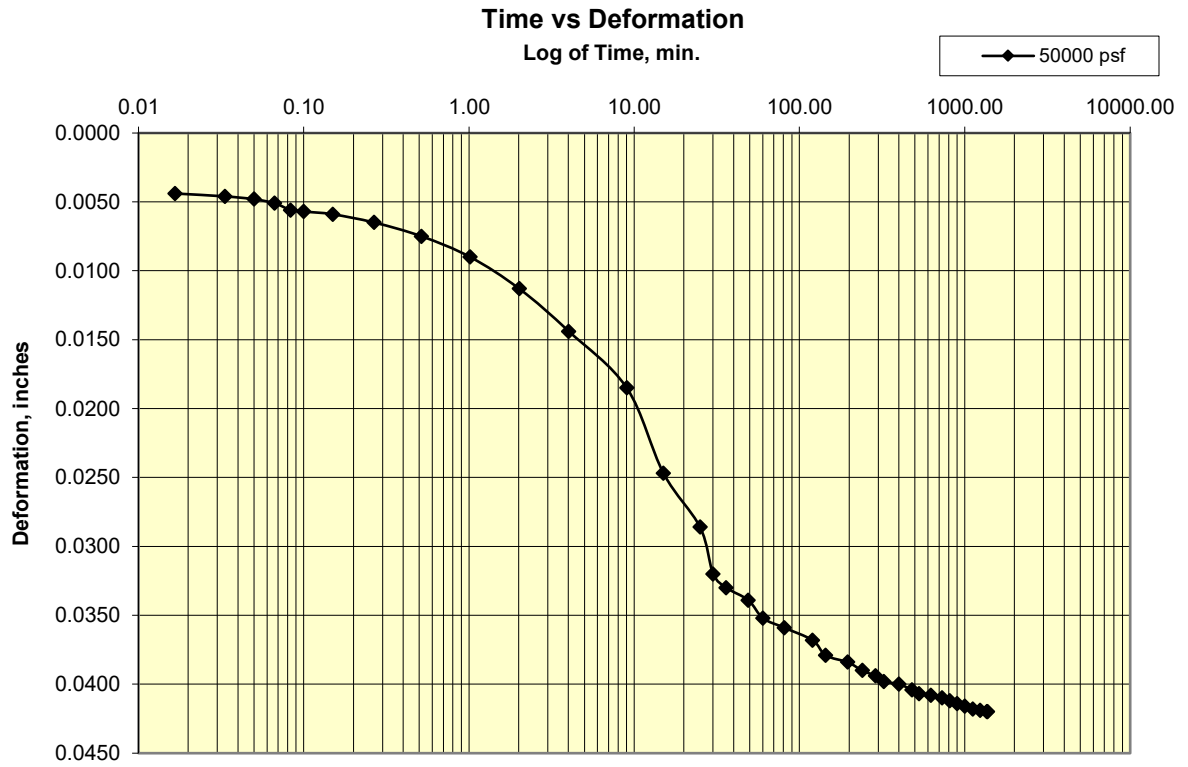


B-107, Sample T5, 10-12.5 feet

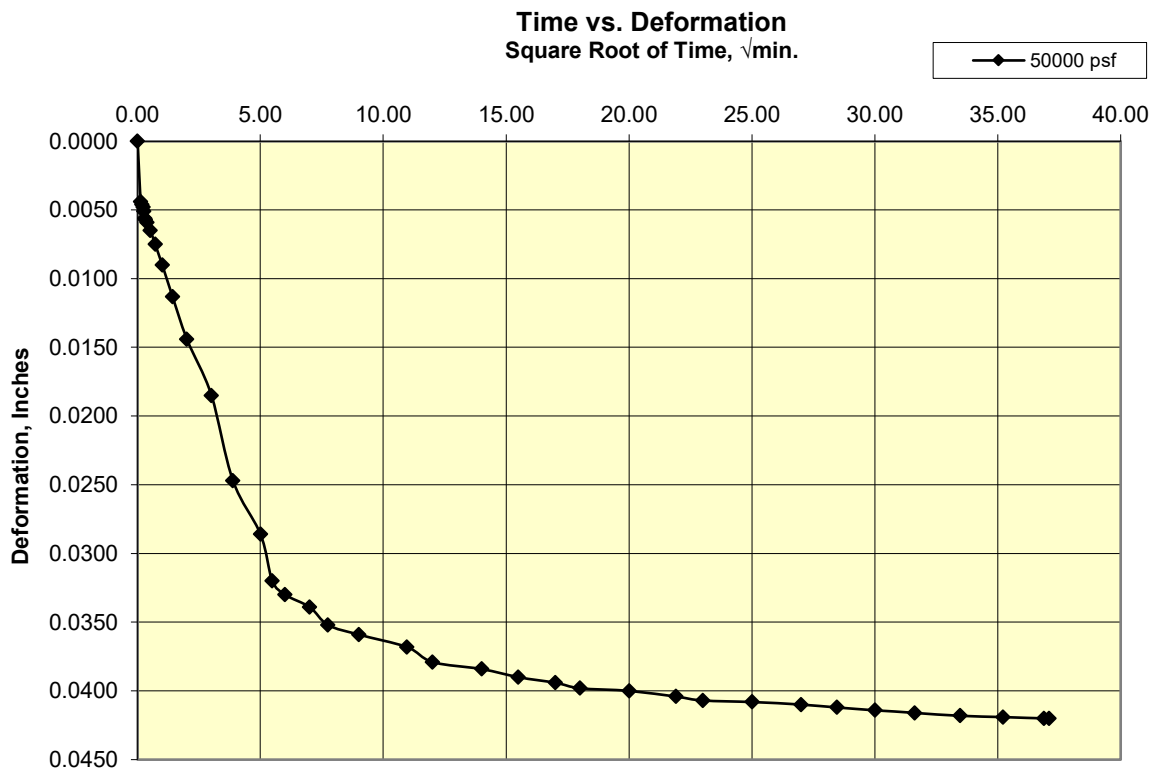
Cooper Testing Labs, Inc.

Load 10

50000 psf



50000 psf



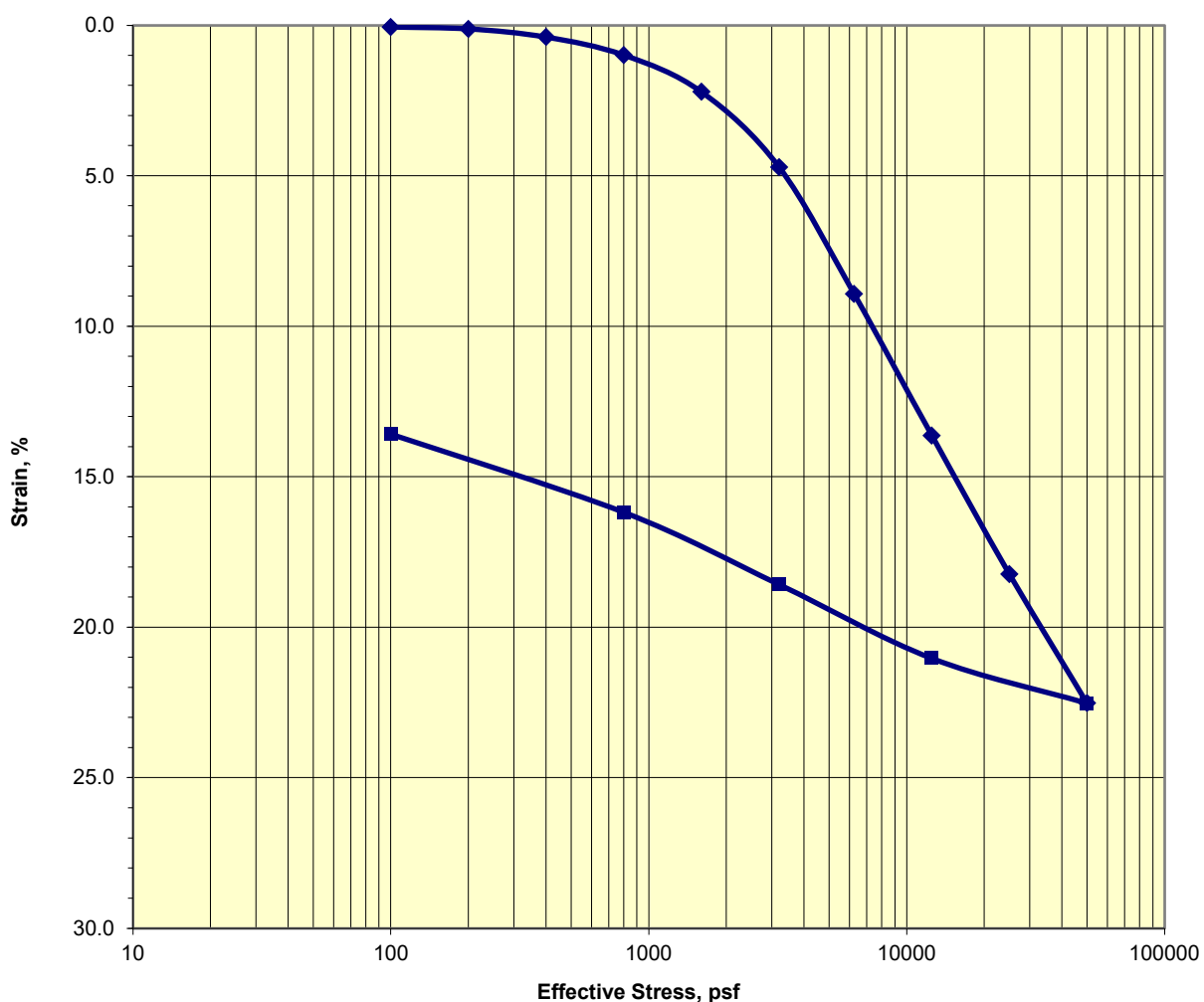


Consolidation Test

ASTM D2435

Job No.:	855-048	Boring:	B-107	Run By:	MD
Client:	HDR	Sample:	T10	Reduced:	PJ
Project:	10151664	Depth, ft.:	22.5-25(Tip-3")	Checked:	PJ/DC
Soil Type:	Very Dark Gray Fat CLAY, trace Sand			Date:	12/13/2022

Strain-Log-P Curve



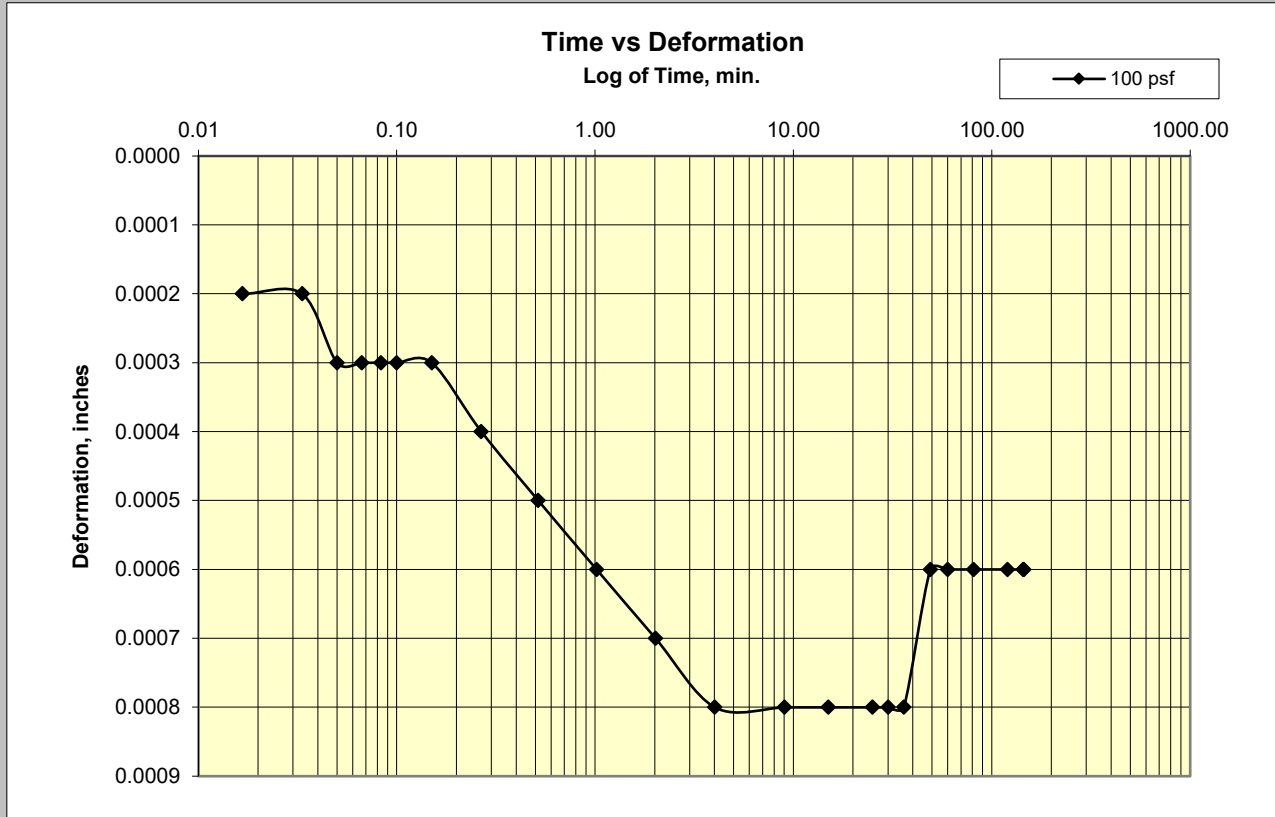
Assumed Gs	2.7	Initial	Final	Remarks:
Moisture %:		34.6	27.5	
Dry Density, pcf:		83.5	96.7	
Void Ratio:		1.019	0.743	
% Saturation:		91.5	100.0	

Cooper Testing Labs, Inc.

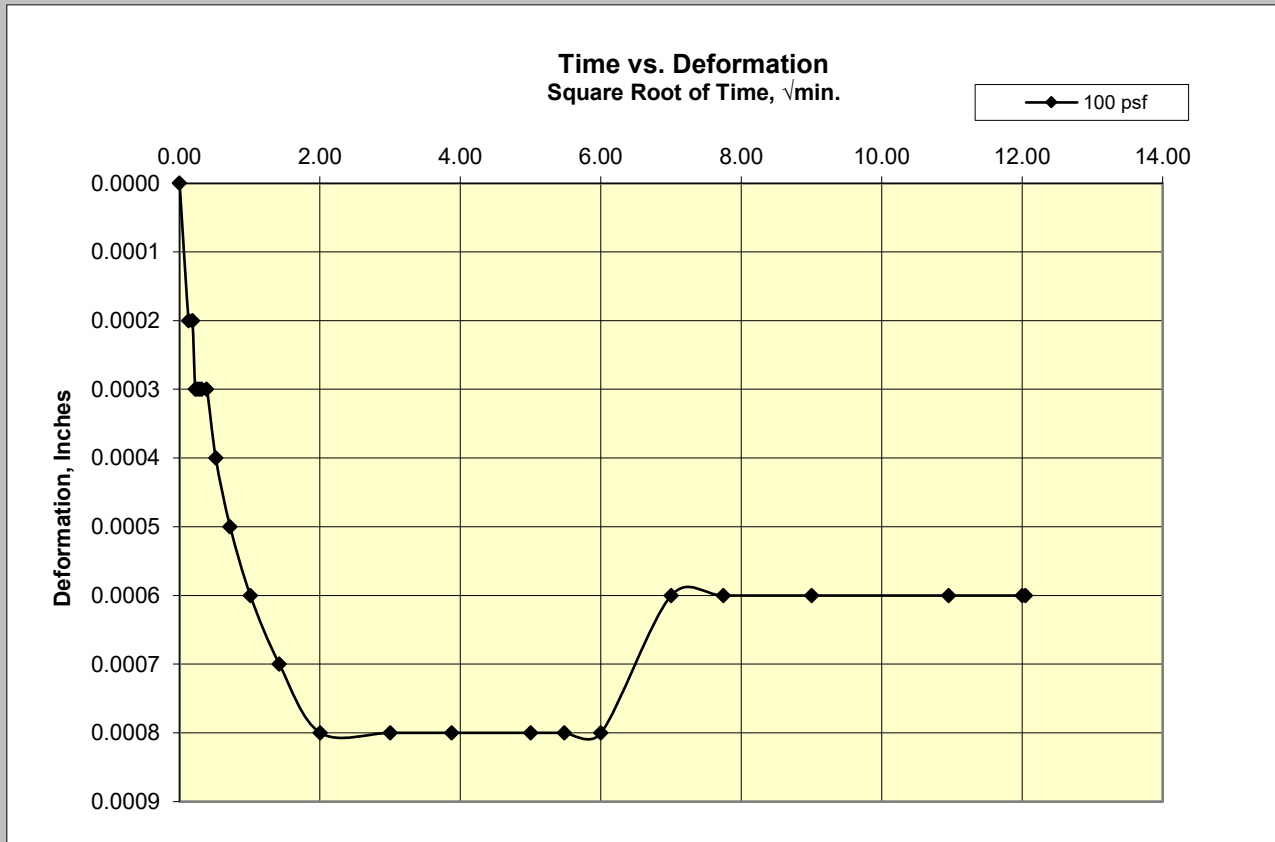
B-107, Sample T10, 22.5-25 feet

Load 1

100 psf



100 psf

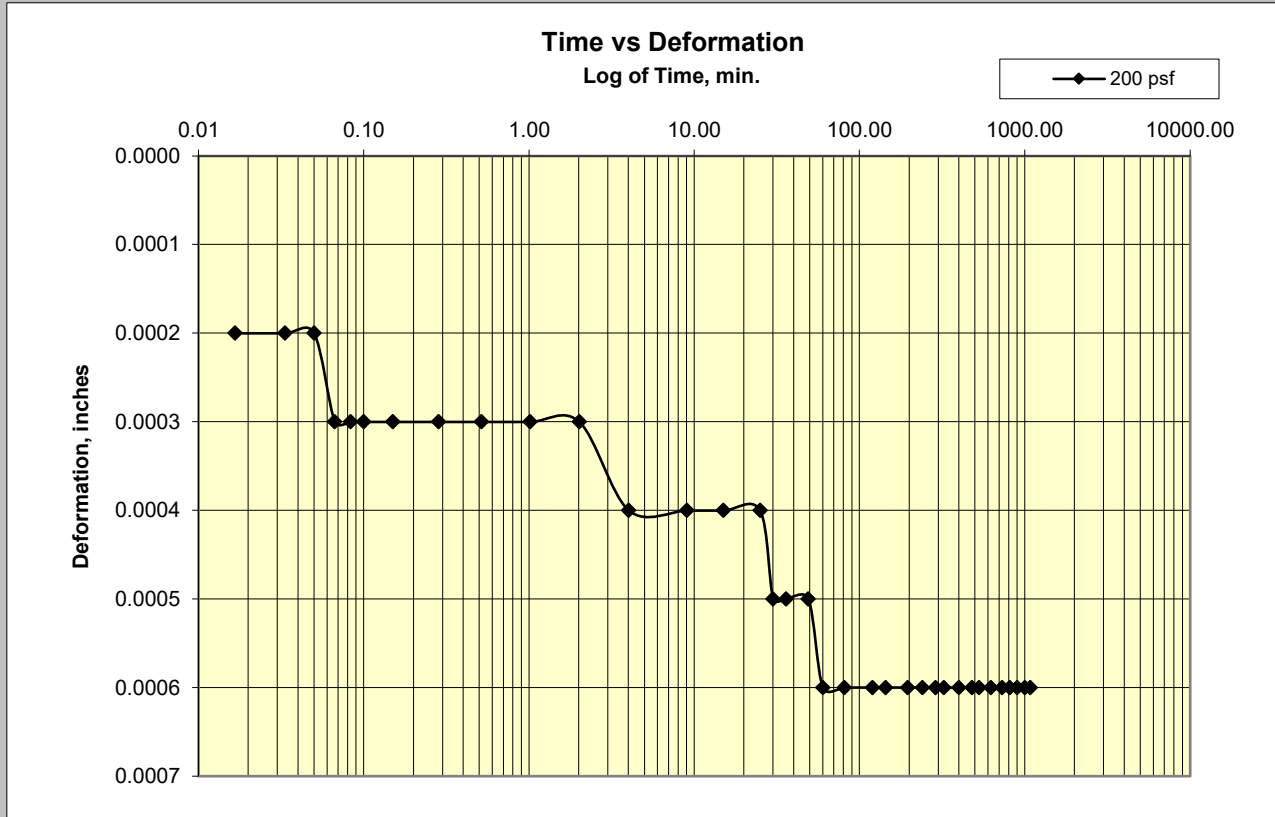


Cooper Testing Labs, Inc.

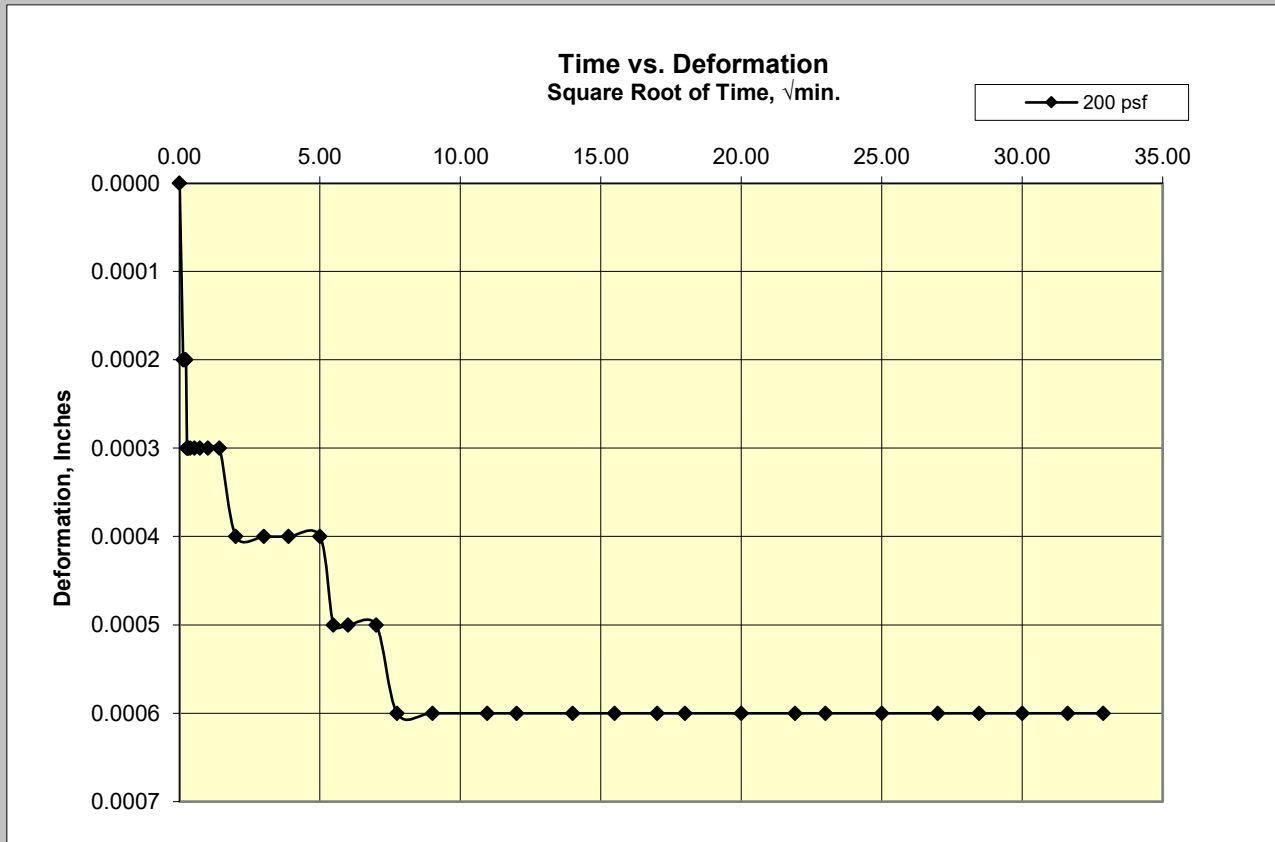
B-107, Sample T10, 22.5-25 feet

Load 2

200 psf



200 psf

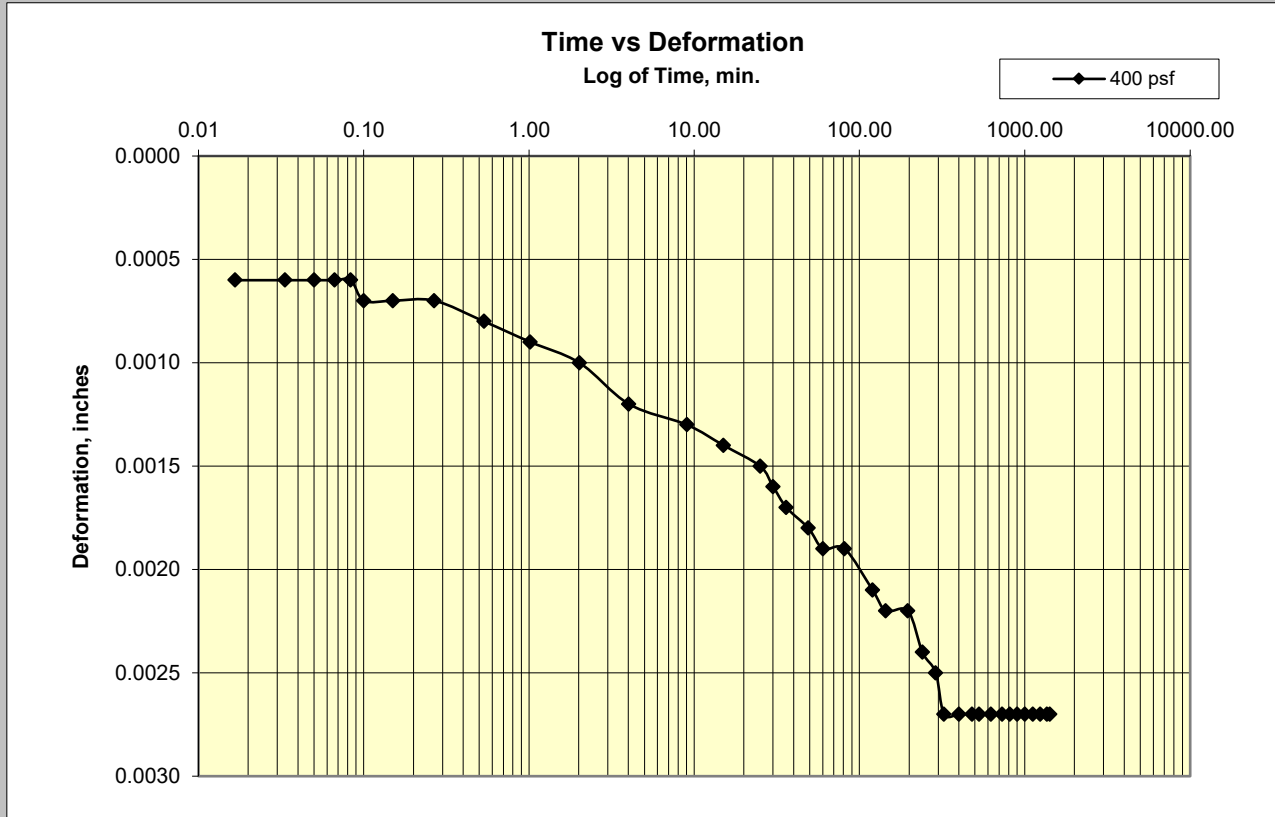


Cooper Testing Labs, Inc.

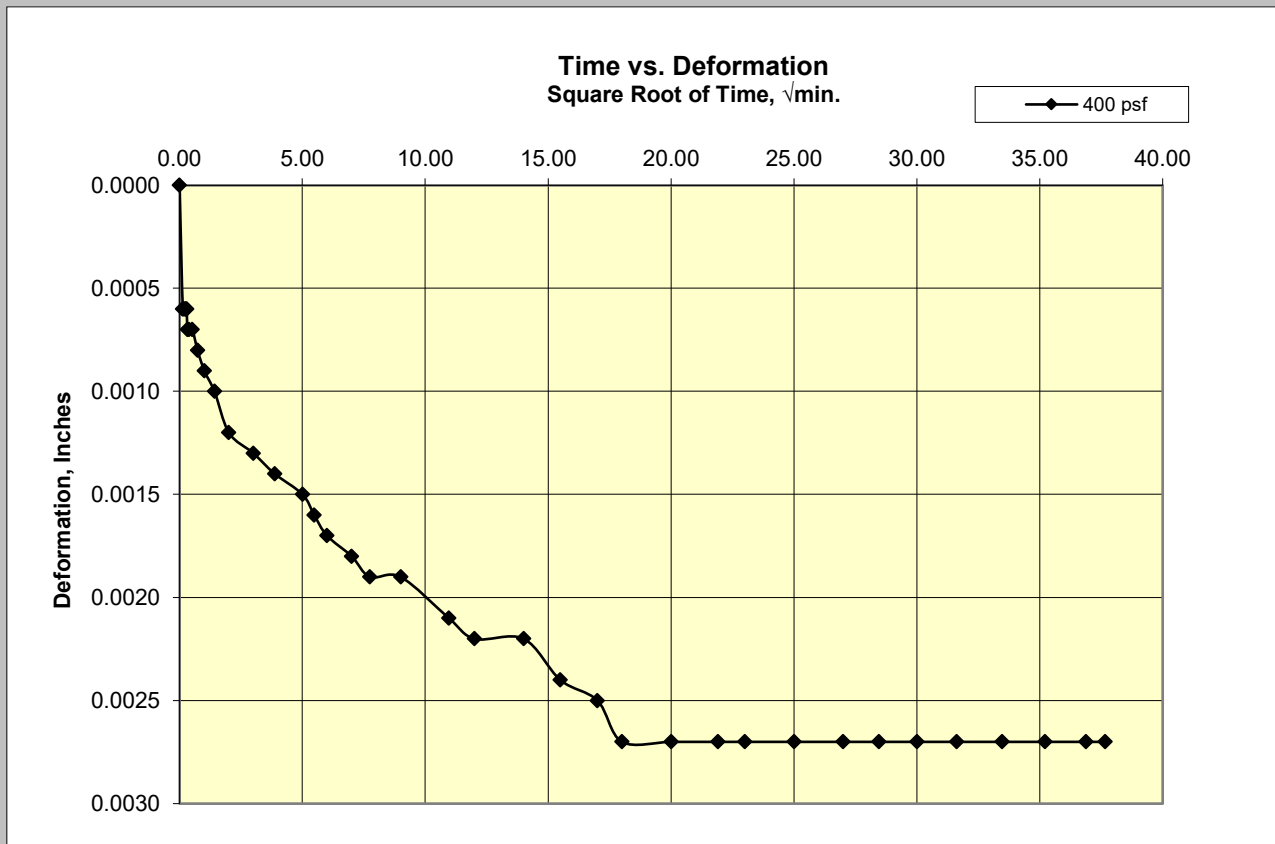
B-107, Sample T10, 22.5-25 feet

Load 3

400 psf



400 psf

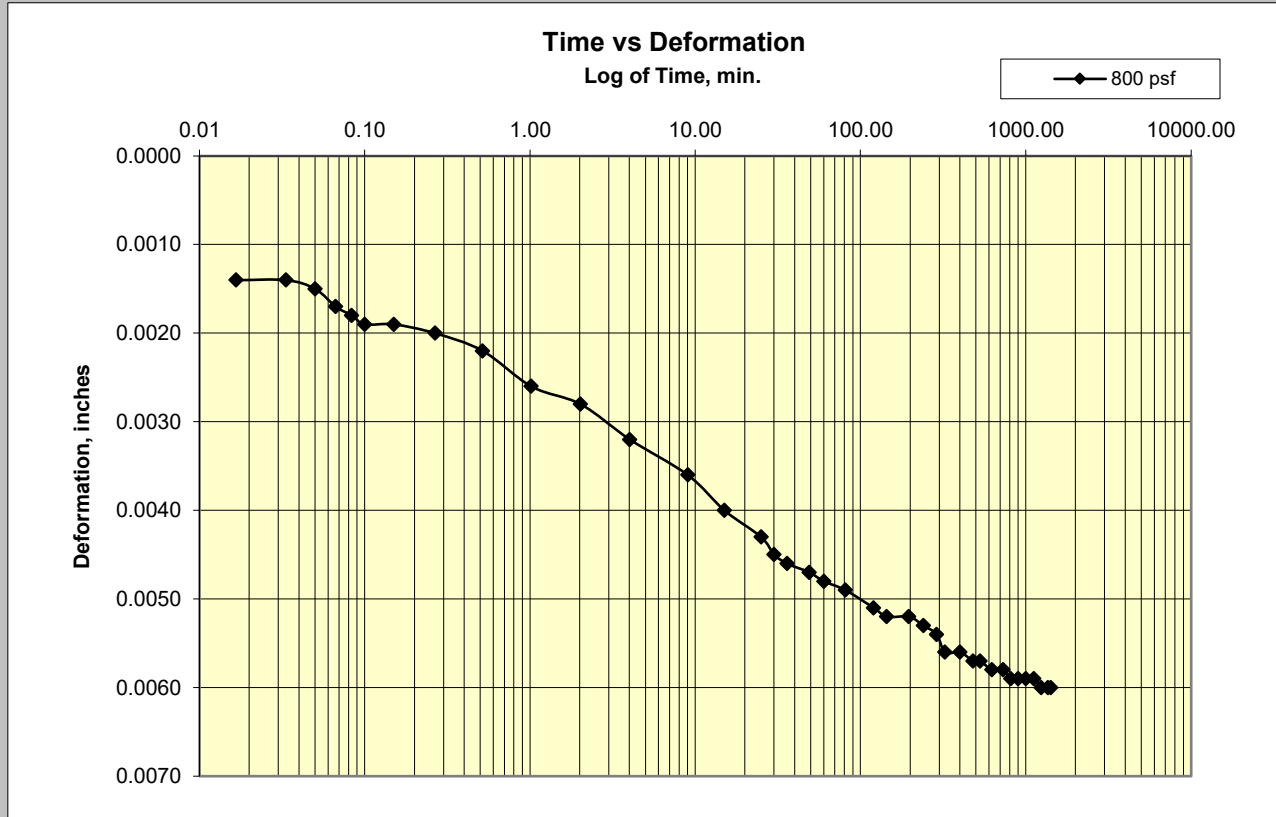


Cooper Testing Labs, Inc.

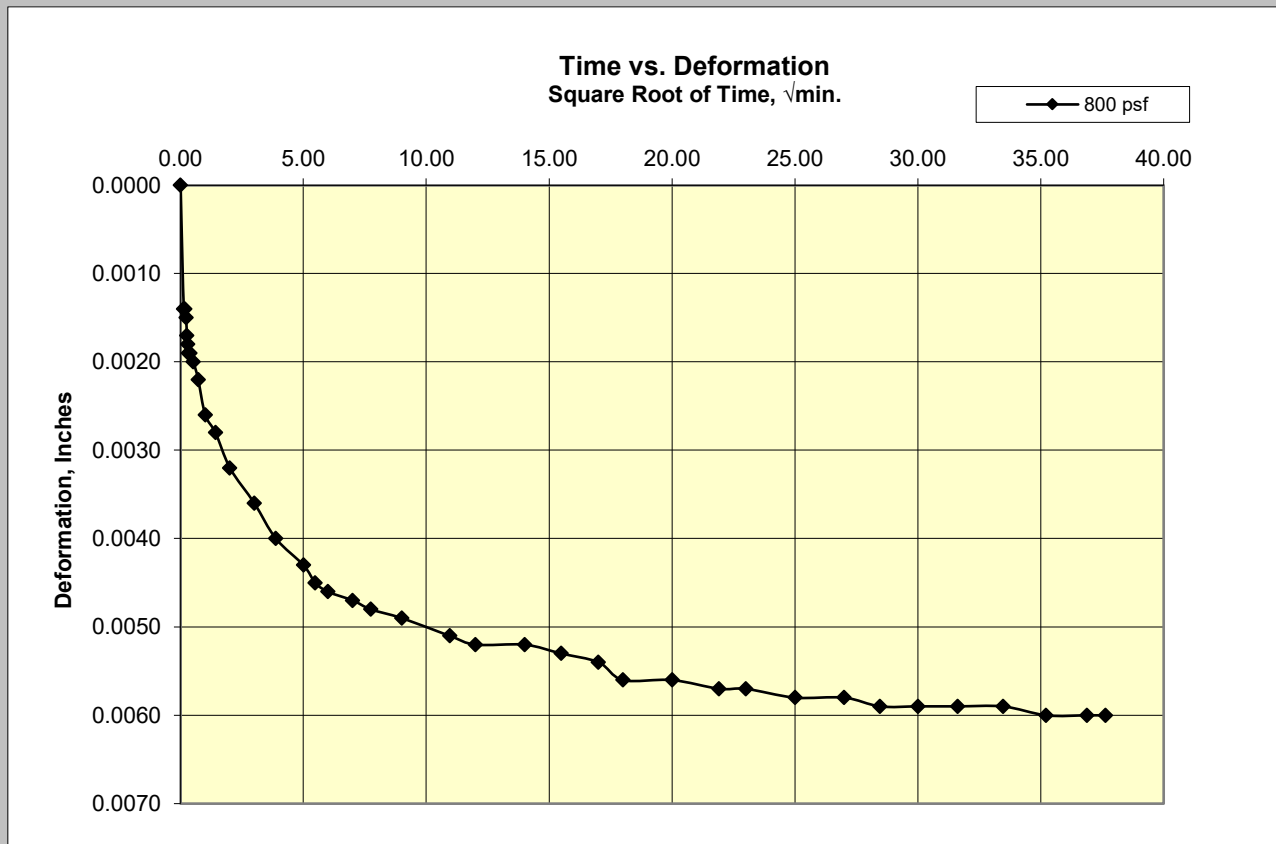
B-107, Sample T10, 22.5-25 feet

Load 4

800 psf

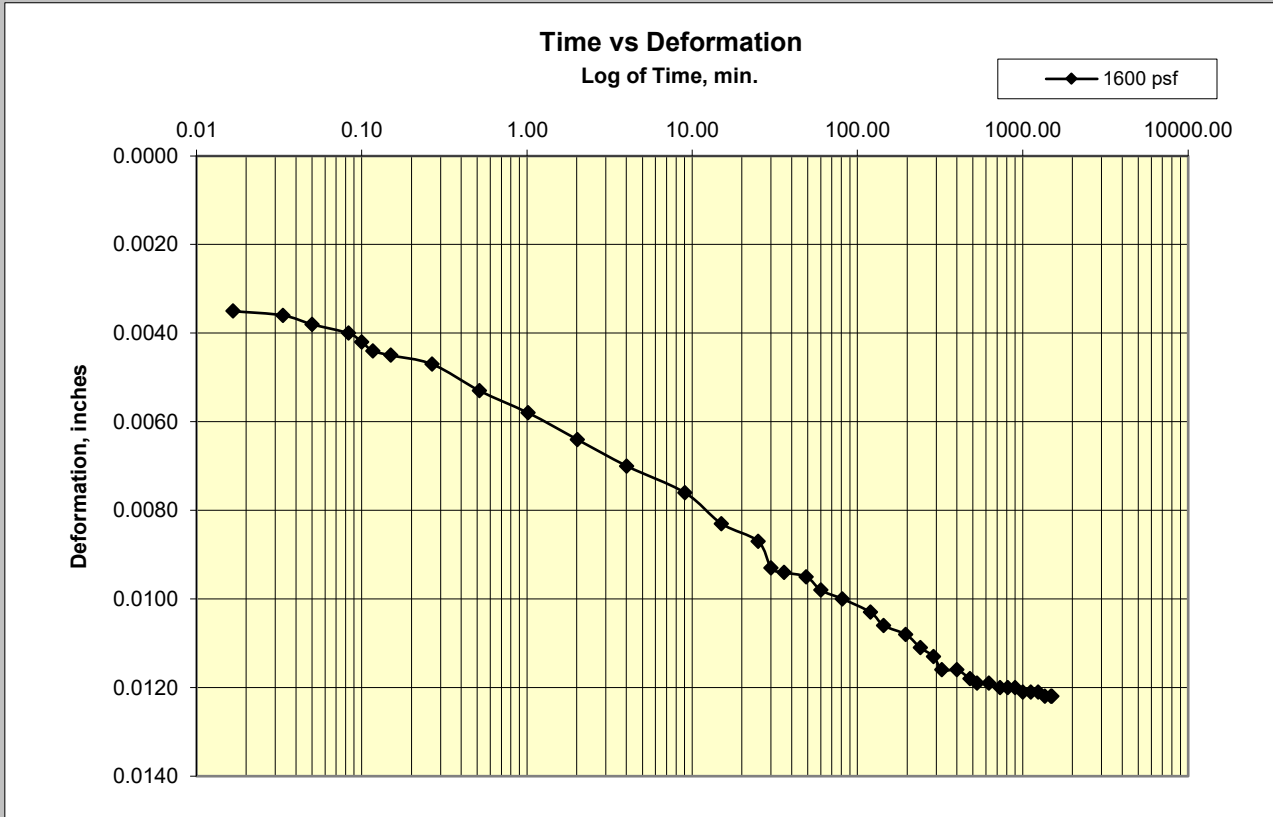


800 psf

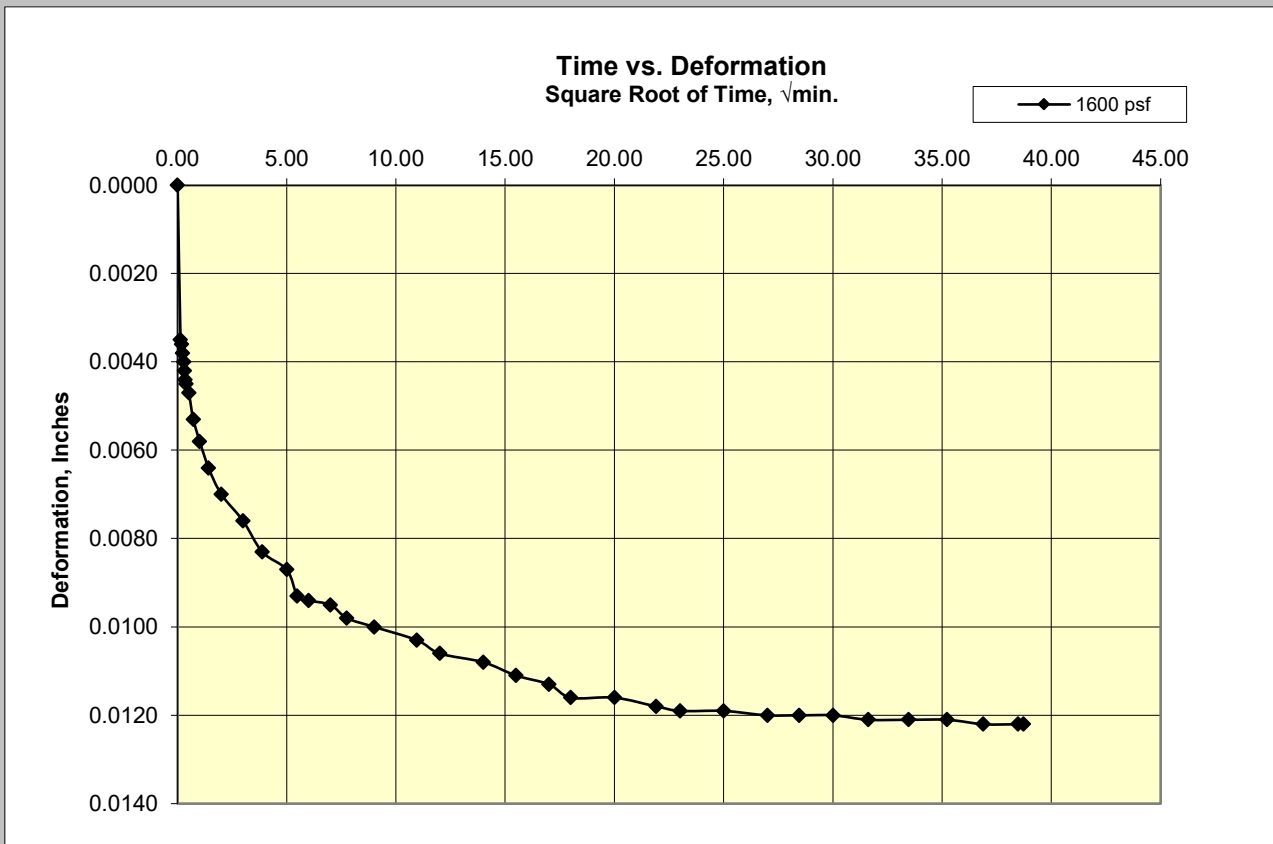


Load 5

1600 psf



1600 psf

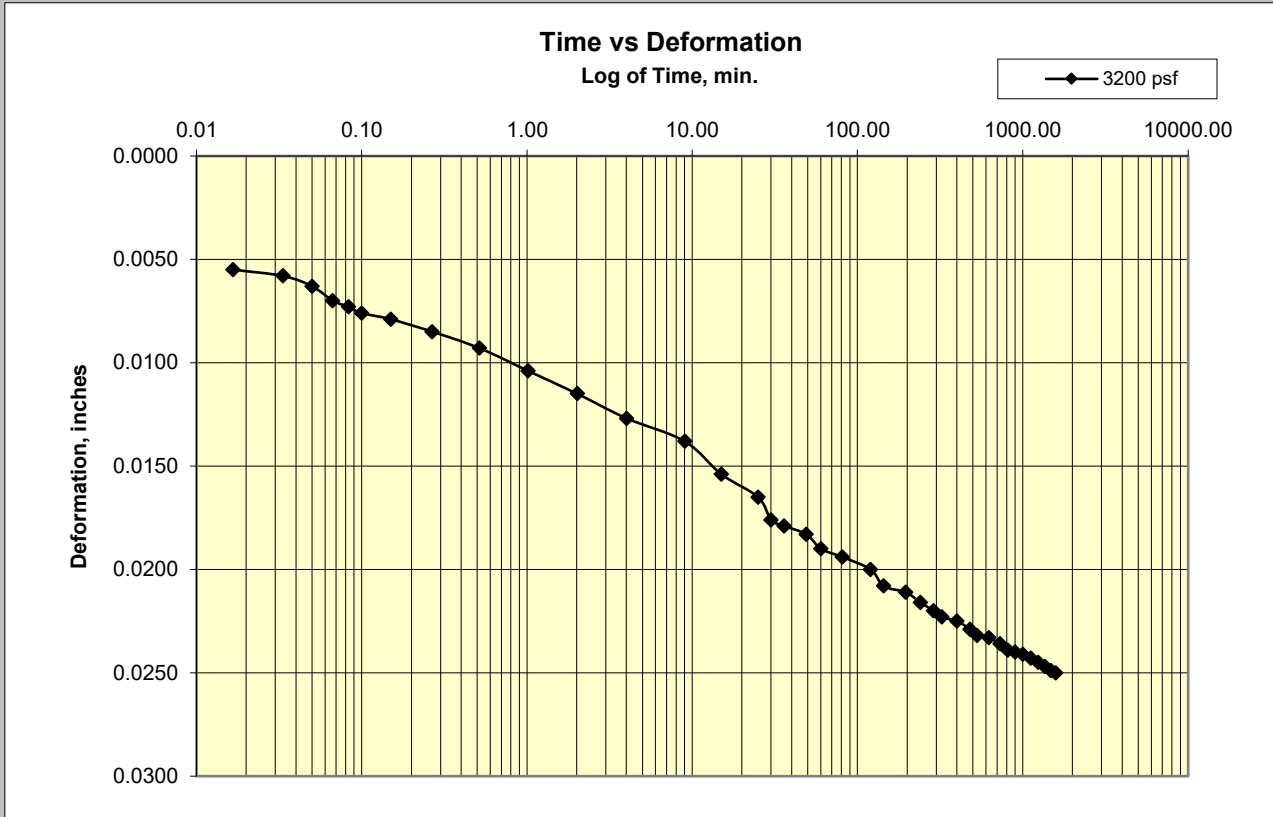


Cooper Testing Labs, Inc.

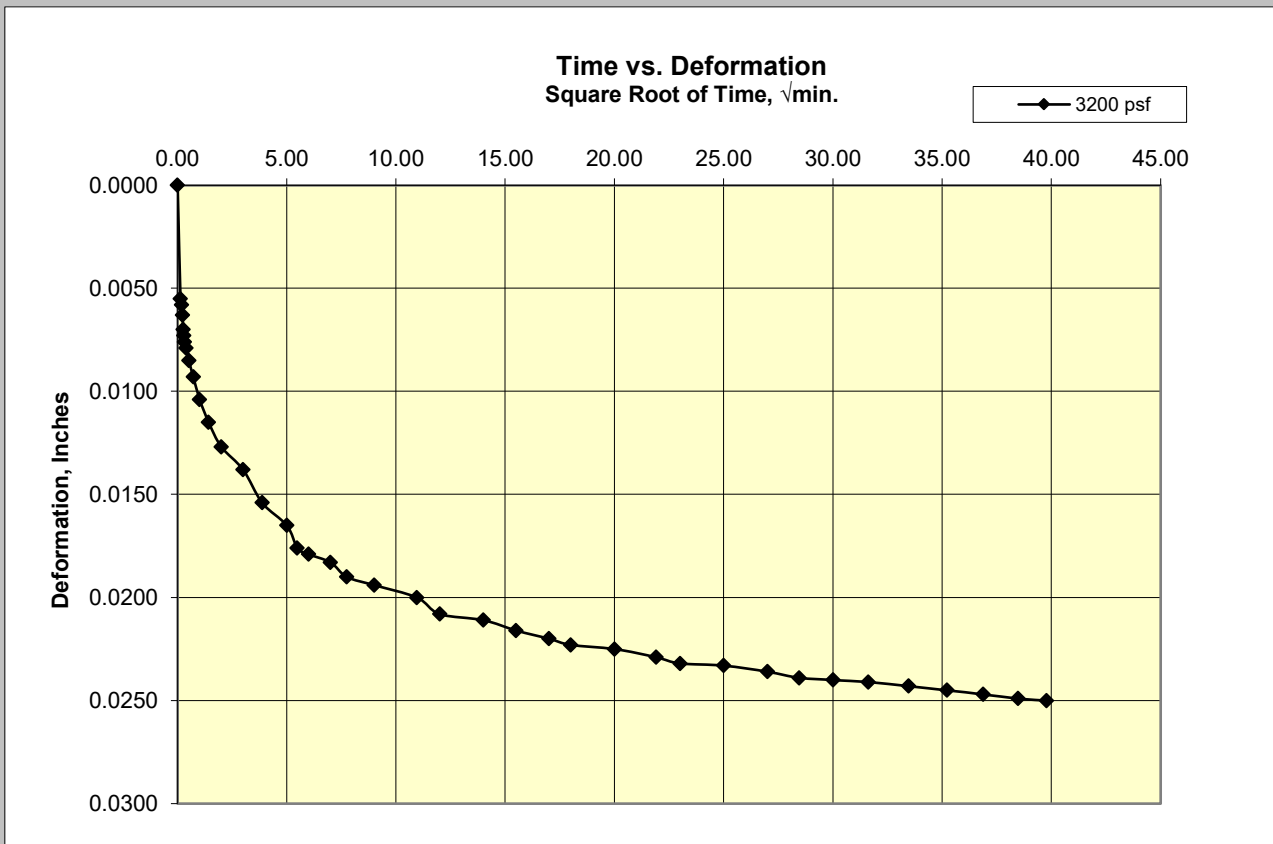
B-107, Sample T10, 22.5-25 feet

Load 6

3200 psf



3200 psf

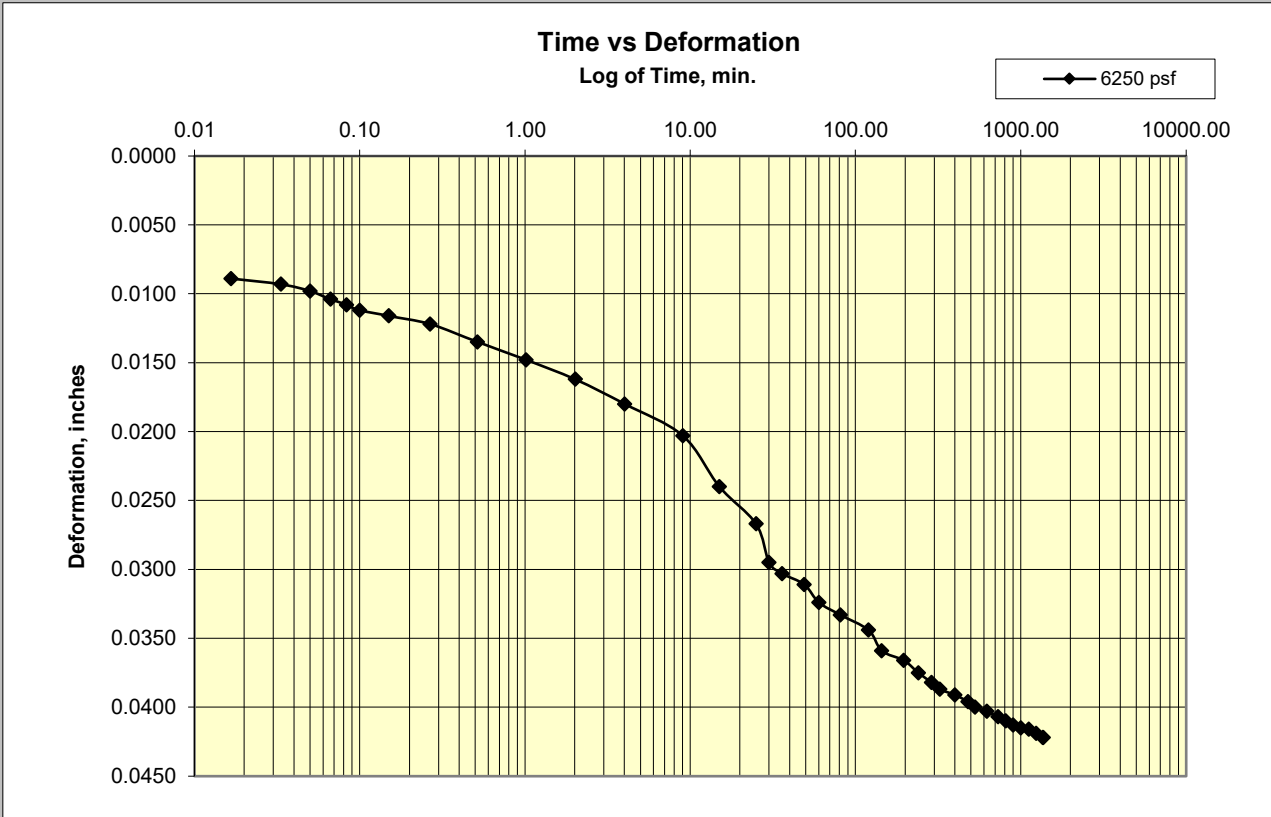


Cooper Testing Labs, Inc.

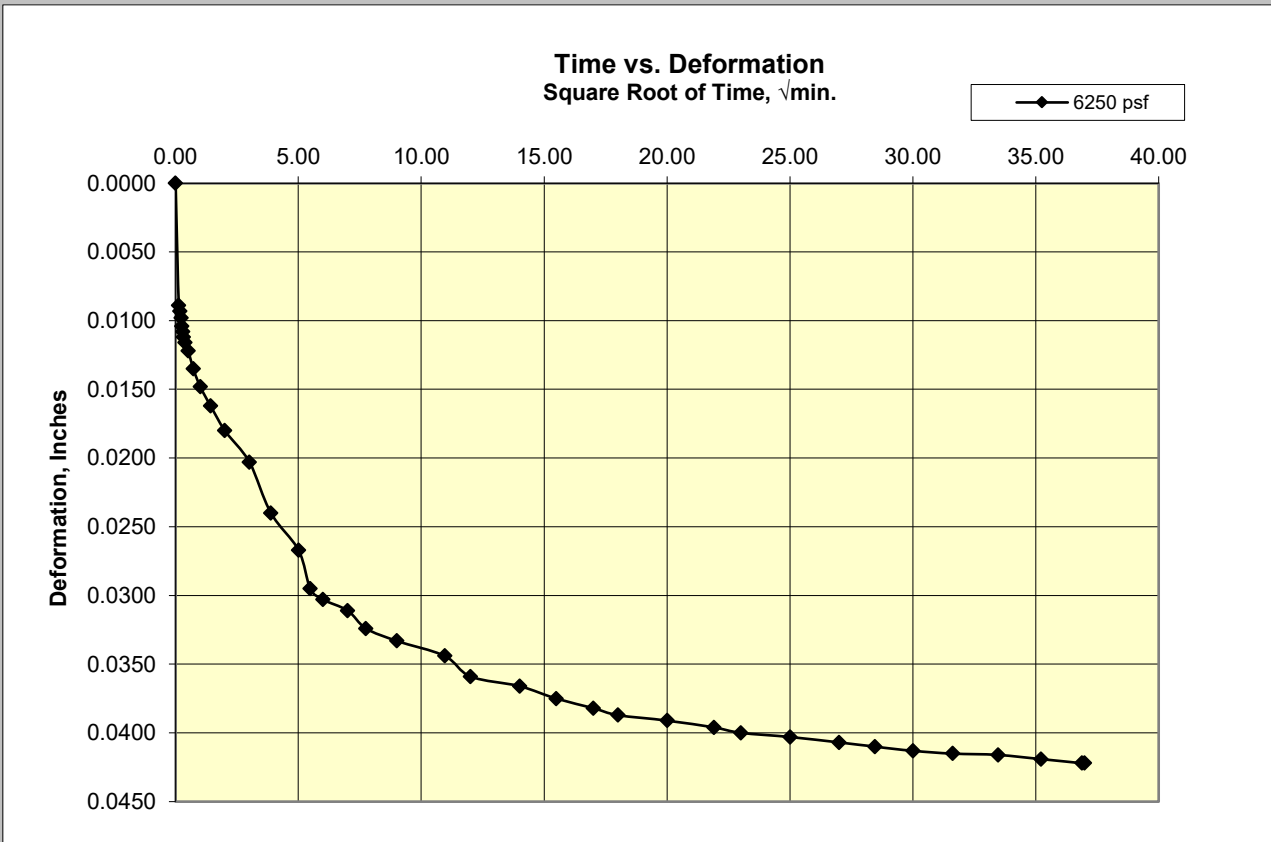
B-107, Sample T10, 22.5-25 feet

Load 7

6250 psf



6250 psf

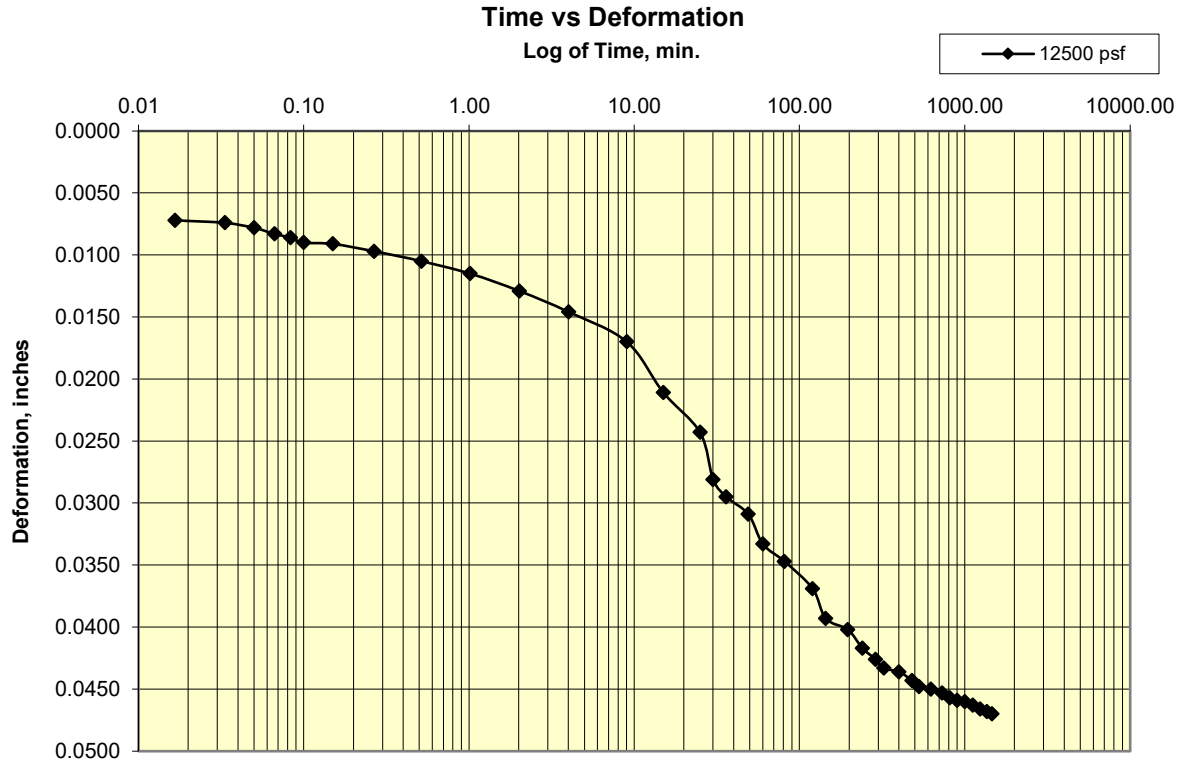


Cooper Testing Labs, Inc.

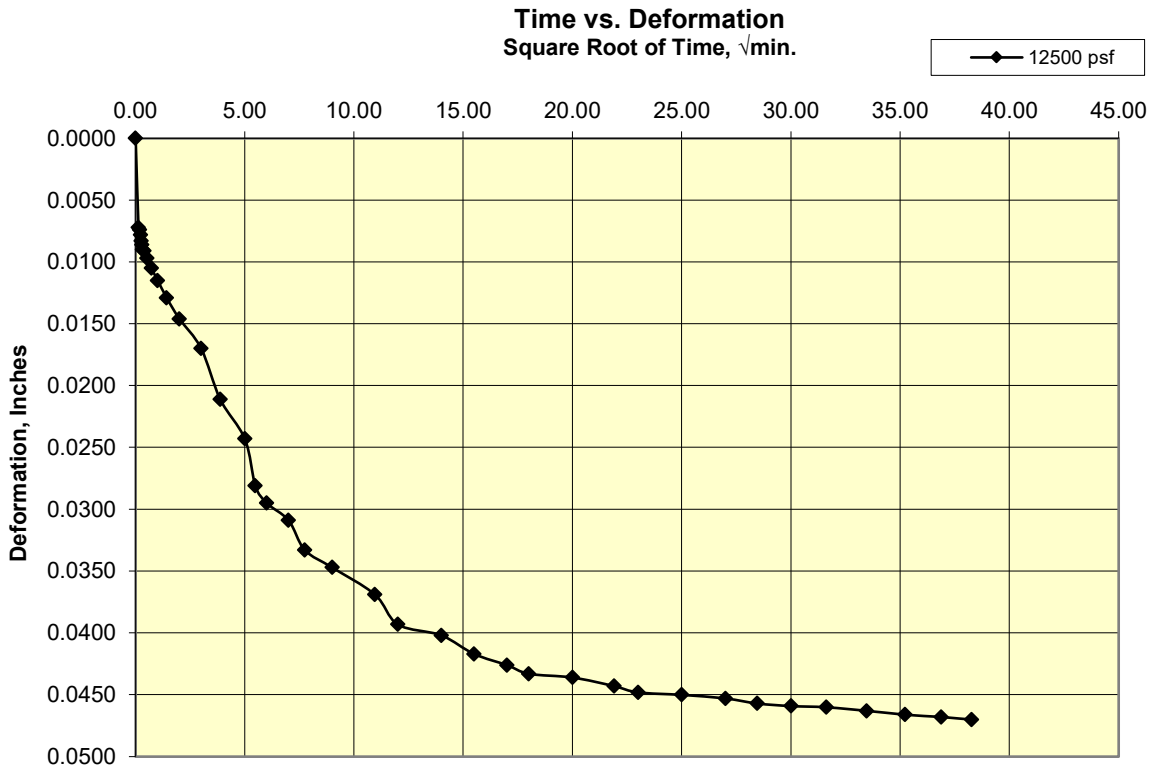
B-107, Sample T10, 22.5-25 feet

Load 8

12500 psf



12500 psf

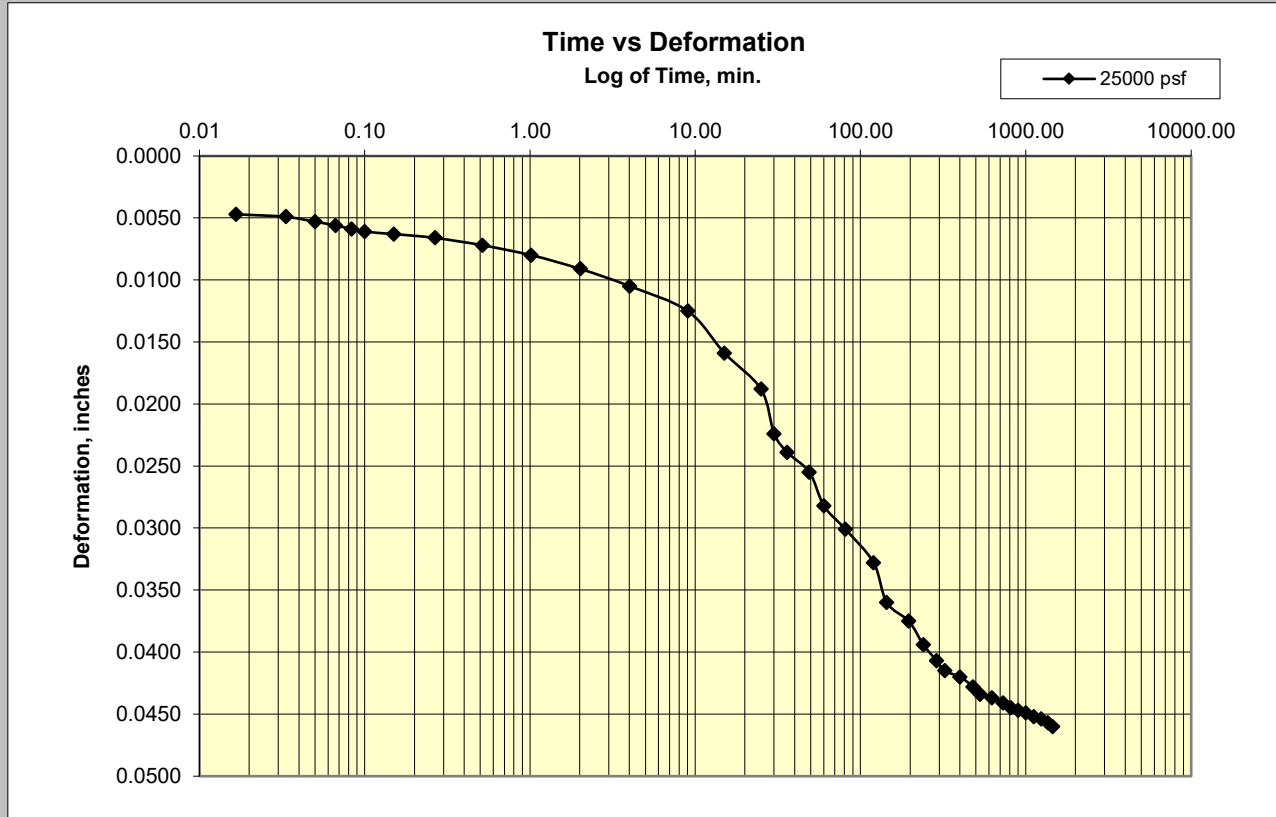


Cooper Testing Labs, Inc.

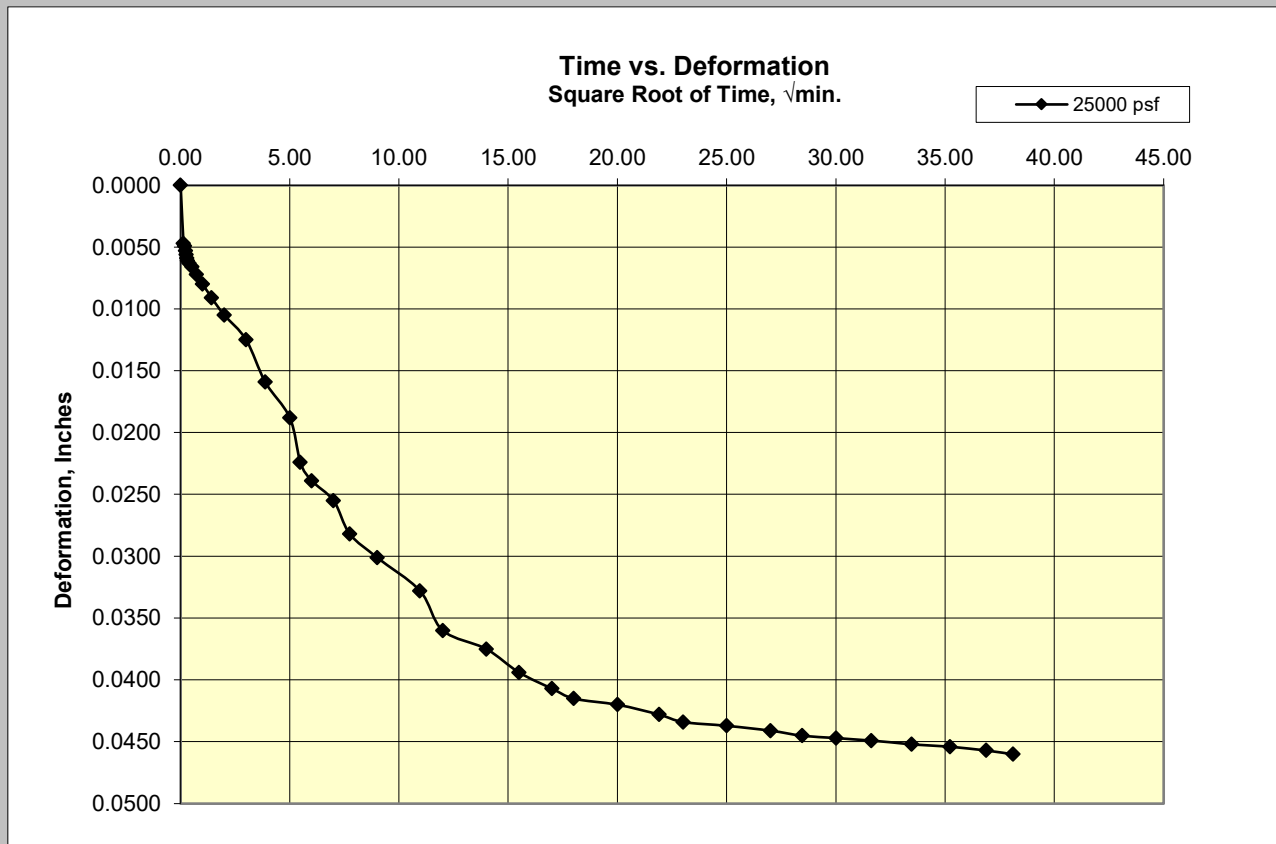
B-107, Sample T10, 22.5-25 feet

Load 9

25000 psf

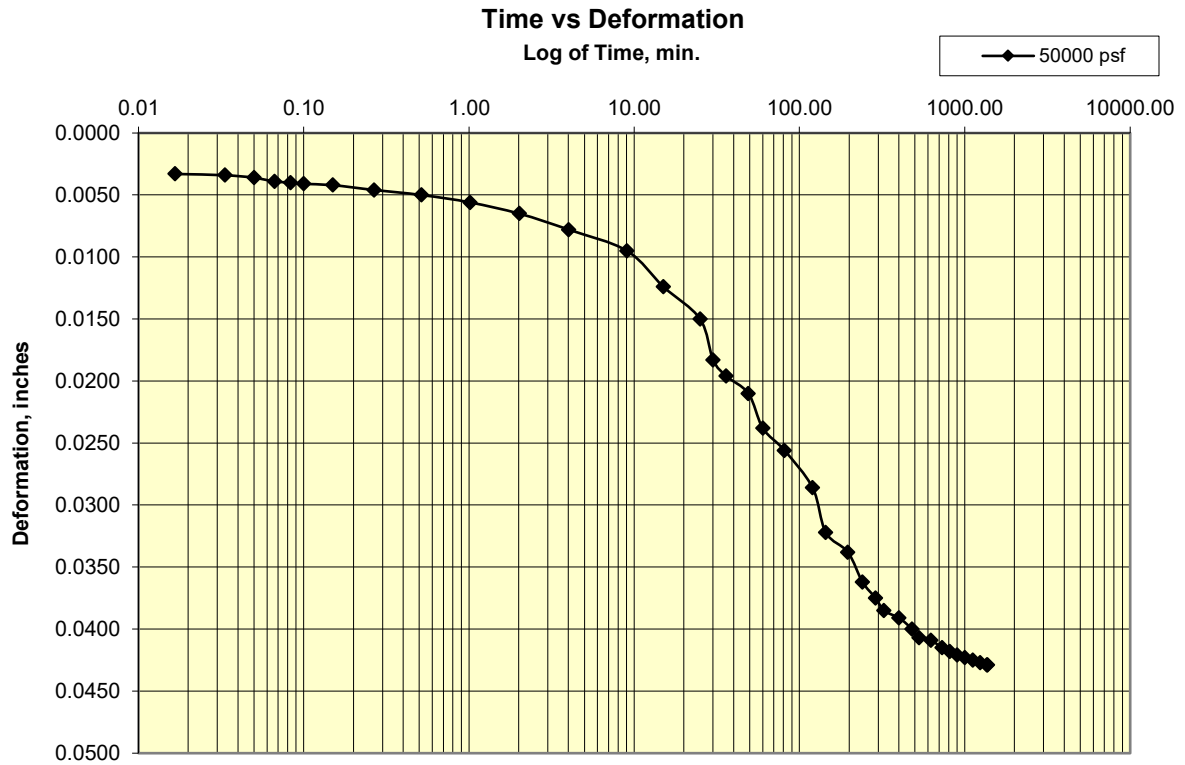


25000 psf

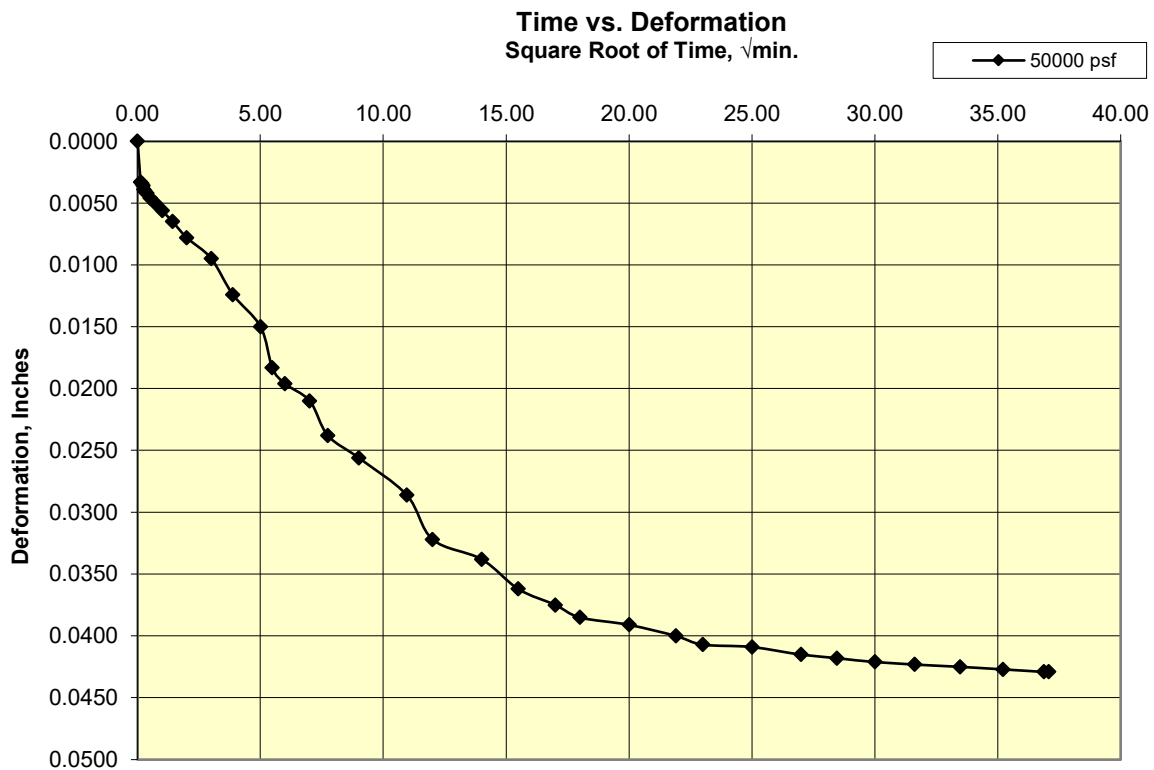


Load 10

50000 psf



50000 psf





Checked: PJ

Proj. No: 10151664

Remarks:

[illegible]

HDR (2016)

Lab Data for Boring B-06

Note: Lab data shown herein for borings other B-06 do not apply for this portion of the project (i.e., south of Bay Road)



Moisture-Density-Porosity Report

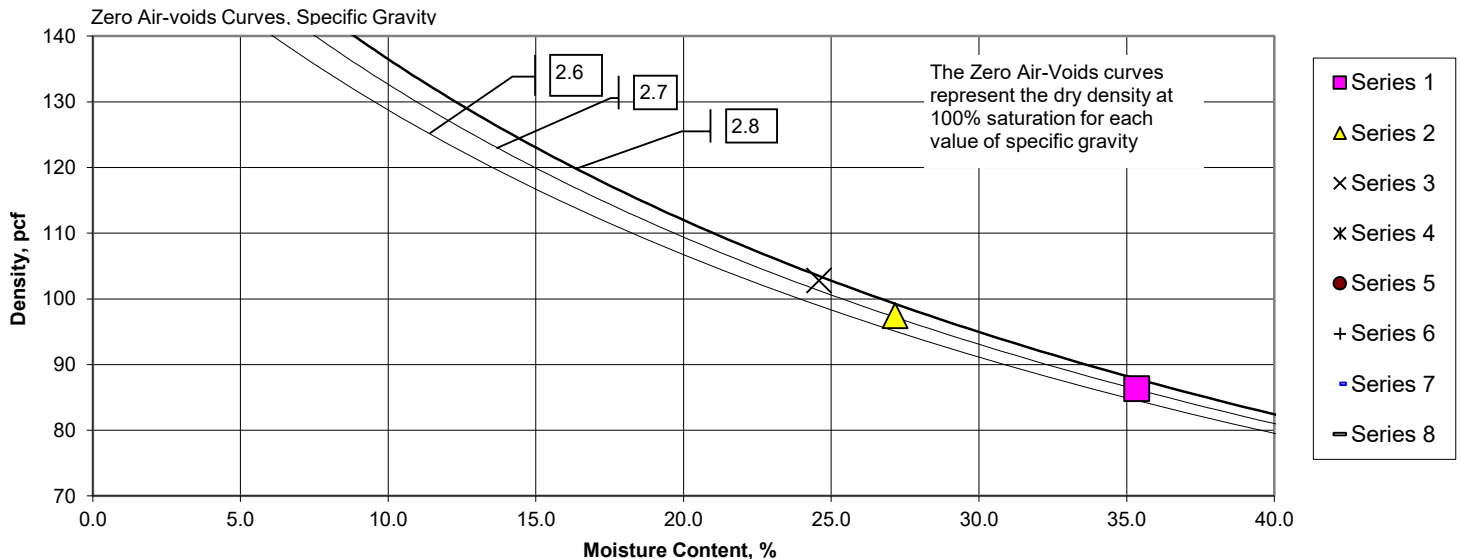
Cooper Testing Labs, Inc. (ASTM D7263b)

CTL Job No: 855-013c Project No. 028-222952 By: RU
 Client: HDR Engineering, Inc. Date: 02/22/16
 Project Name: SAFER Bay-Task Order 1 Remarks:

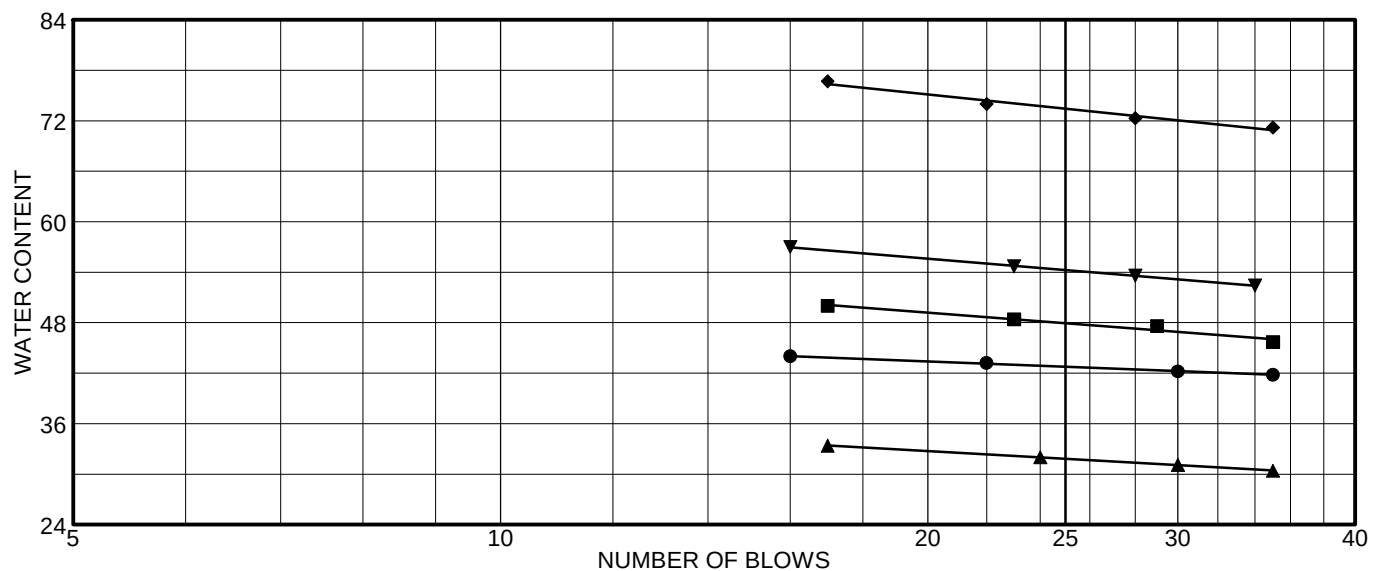
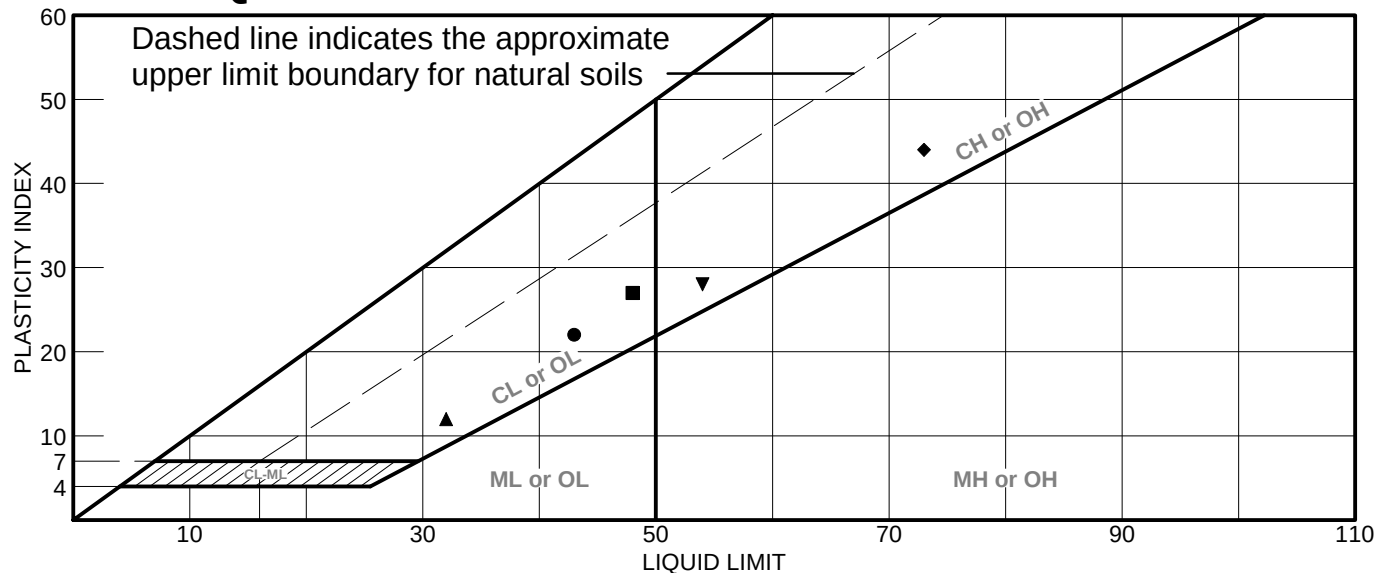
Boring:	B-06	B-06	B-06	B-06				
Sample:	L1	L7	L12	S3				
Depth, ft:	4-4.5	18-18.5	31-31.5	45-46.5				
Visual Description:	Dark Olive Brown Sandy CLAY w/ Gravel	Gray CLAY w/ Sand	Olive Brown Sandy CLAY	Olive Brown Lean CLAY w/ Sand				
Actual G_s								
Assumed G_s	2.80	2.80	2.80					
Moisture, %	35.3	27.2	24.6	37.1				
Wet Unit wt, pcf	116.8	123.9	128.1					
Dry Unit wt, pcf	86.3	97.4	102.8					
Dry Bulk Dens.pb, (g/cc)	1.38	1.56	1.65					
Saturation, %	96.4	95.6	98.1					
Total Porosity, %	50.6	44.3	41.2					
Volumetric Water Cont., θ_w , %	48.8	42.4	40.4					
Volumetric Air Cont., θ_a , %	1.8	1.9	0.8					
Void Ratio	1.03	0.80	0.70					
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (G_s) was used then the saturation, porosities, and void ratio should be considered approximate.

Moisture-Density



LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Olive Brown Sandy Lean CLAY	43	21	22			
■	Dark Grayish Brown Lean CLAY	48	21	27			
▲	Olive Brown Lean CLAY w/ Sand	32	20	12			
◆	Dark Gray Fat CLAY	73	29	44			
▼	Dark Greenish Gray Fat CLAY (Bay Mud)	54	26	28			

Project No. 855-013 **Client:** HDR Engineering, Inc.

Project: SAFER Bay-Task Order 1 - 028-222952

● Source: B-05	■ Source: B-05	▲ Source: B-05	◆ Source: B-06	▼ Source: B-06
Sample No.: L2	Sample No.: L10	Sample No.: L14	Sample No.: L4	Sample No.: L6
Elev./Depth: 2.5-3'	Elev./Depth: 20-22.5'	Elev./Depth: 31-31.5'	Elev./Depth: 7-9.5(Tip-14")	Elev./Depth: 12.5-15'

Remarks:

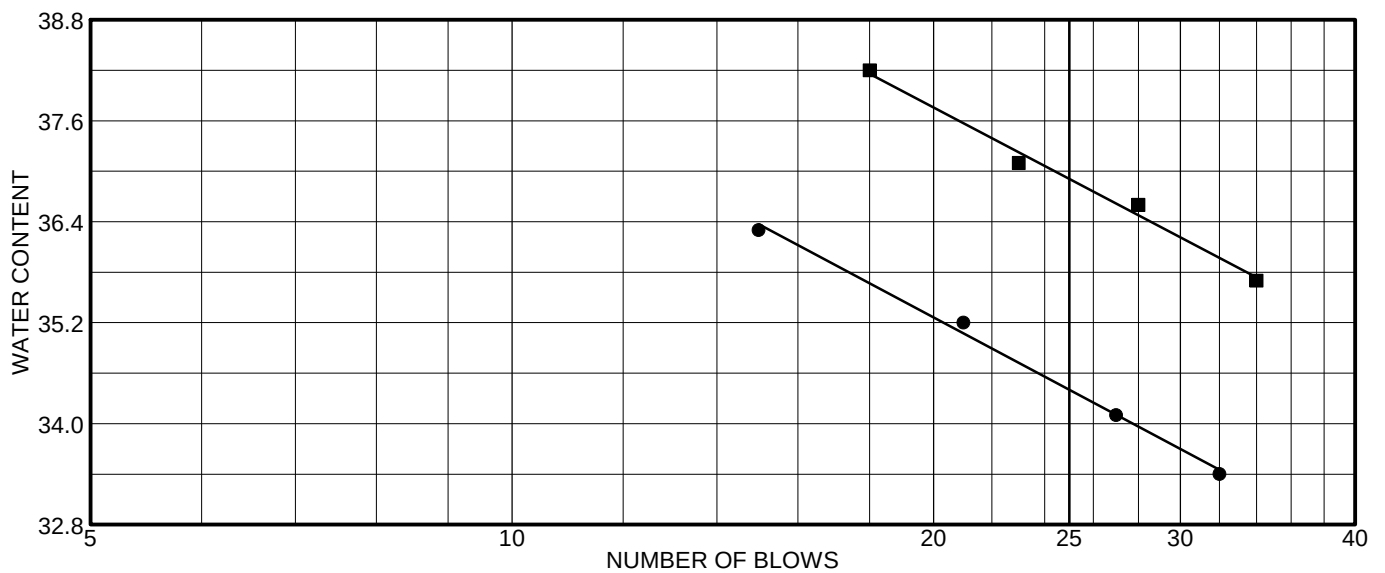
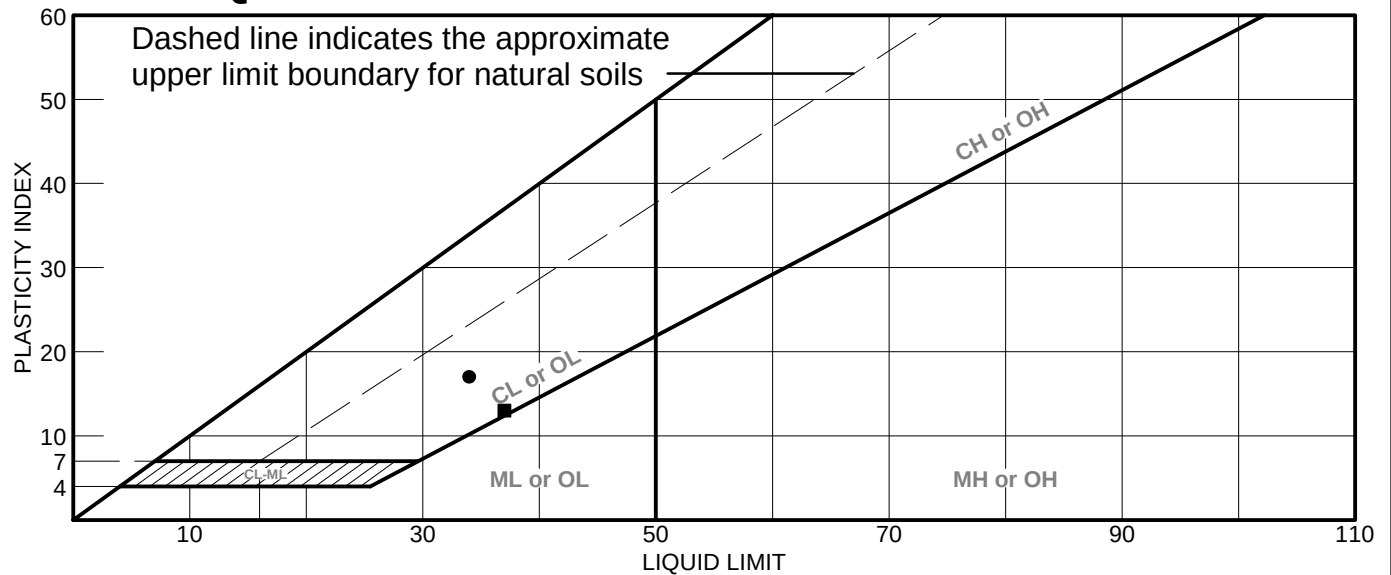
- Sample was prepared using the wet prep method.
- Sample was prepared using the wet prep method.
- ▲ Sample was prepared using the wet prep method.
- ◆ Sample was prepared using the wet prep method.
- ▼ Sample was prepared using the wet prep method.

LIQUID AND PLASTIC LIMITS TEST REPORT

COOPER TESTING LABORATORY

Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Greenish Gray Lean CLAY w/ Sand	34	17	17			
■	Olive Brown Lean CLAY w/ Sand	37	24	13			

Project No. 855-013

Client: HDR Engineering, Inc.

Project: SAFER Bay-Task Order 1 - 028-222952

● Source: B-06

Sample No.: L8

Elev./Depth: 21-23.5'

■ Source: B-06

Sample No.: S3

Elev./Depth: 45-46.5'

Remarks:

- Sample was prepared using the wet prep method.

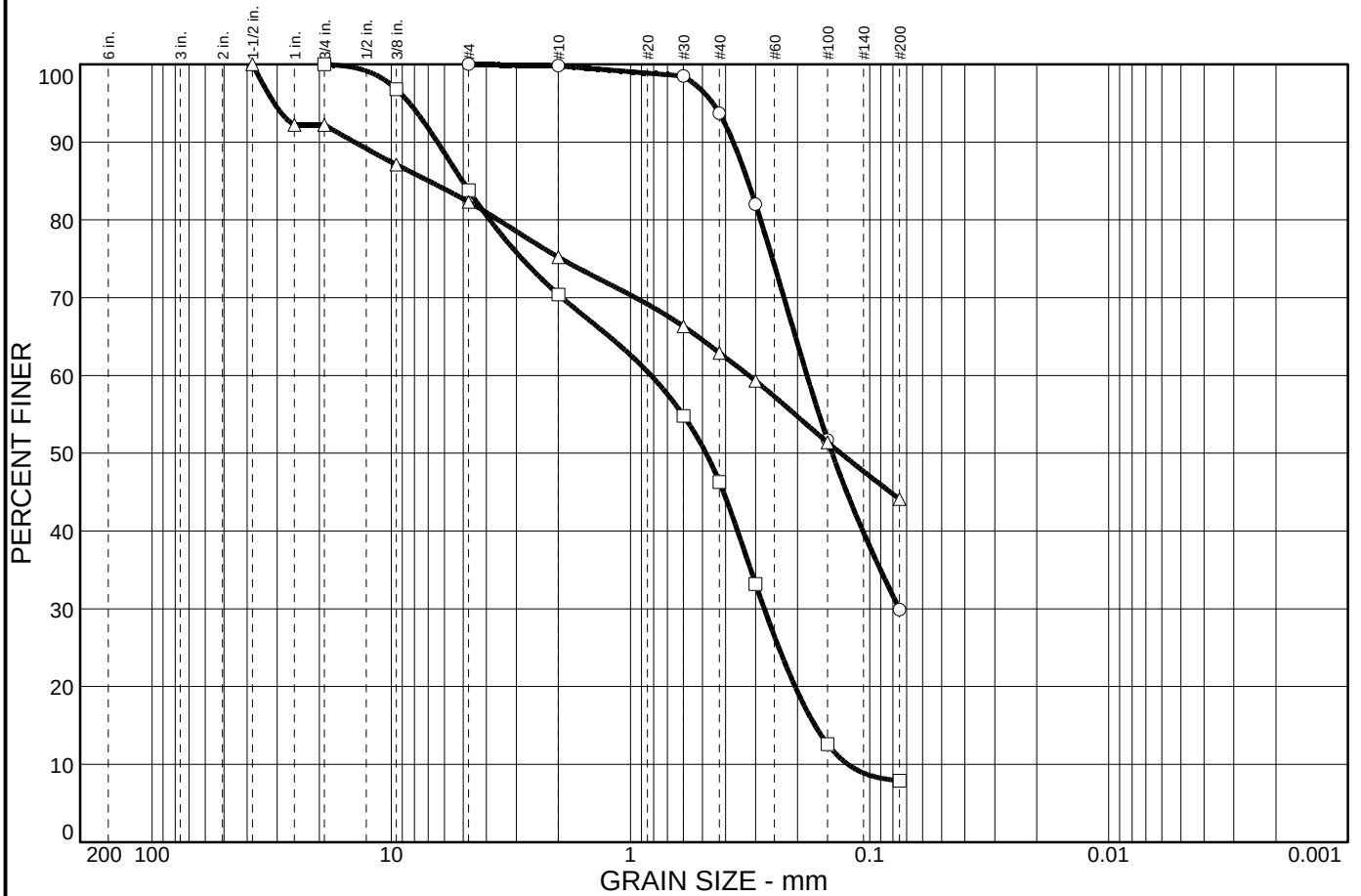
■

LIQUID AND PLASTIC LIMITS TEST REPORT

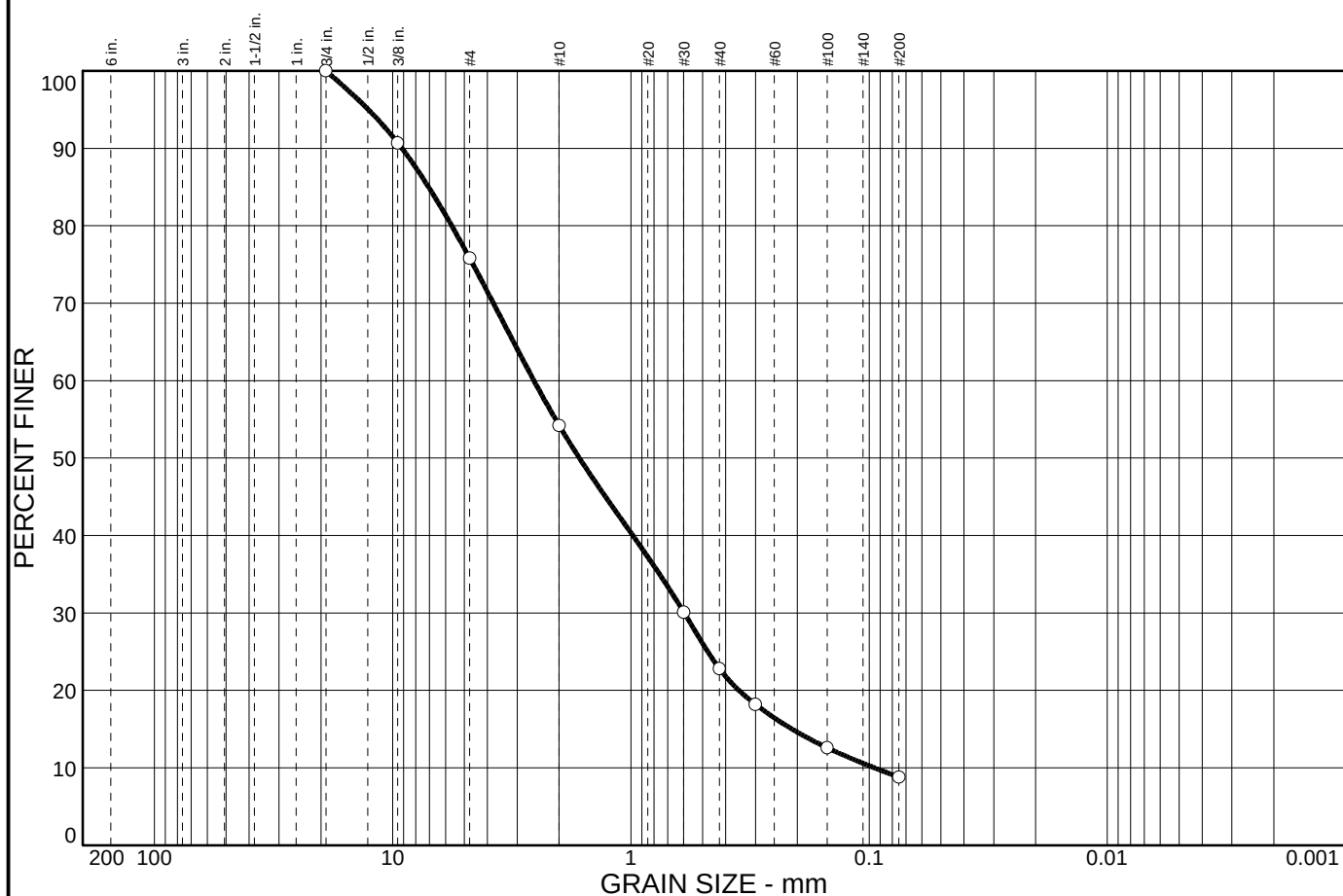
COOPER TESTING LABORATORY

Figure

Particle Size Distribution Report



Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
	24.2	67.0	8.8					

SIEVE inches size	PERCENT FINER		
	○		
3/4"	100.0		
3/8"	90.7		
GRAIN SIZE			
D ₆₀	2.55		
D ₃₀	0.597		
D ₁₀	0.0949		
COEFFICIENTS			
C _c	1.47		
C _u	26.90		

SIEVE number size	PERCENT FINER		
	○		
#4	75.8		
#10	54.2		
#30	30.1		
#40	22.8		
#50	18.2		
#100	12.6		
#200	8.8		

SOIL DESCRIPTION
○ Olive Brown Well-Graded SAND w/ Clay & Gravel

REMARKS:
○

○ Source: B-06

Sample No.: L15

Elev./Depth: 41-41.5'

COOPER TESTING LABORATORY

Client: HDR Engineering, Inc.
Project: SAFER Bay-Task Order 1 - 028-222952
Project No.: 855-013

Figure



#200 Sieve Wash Analysis

ASTM D 1140

Job No.: 855-013
Client: HDR Engineering, Inc.
Project: SAFER Bay-Task Order 1

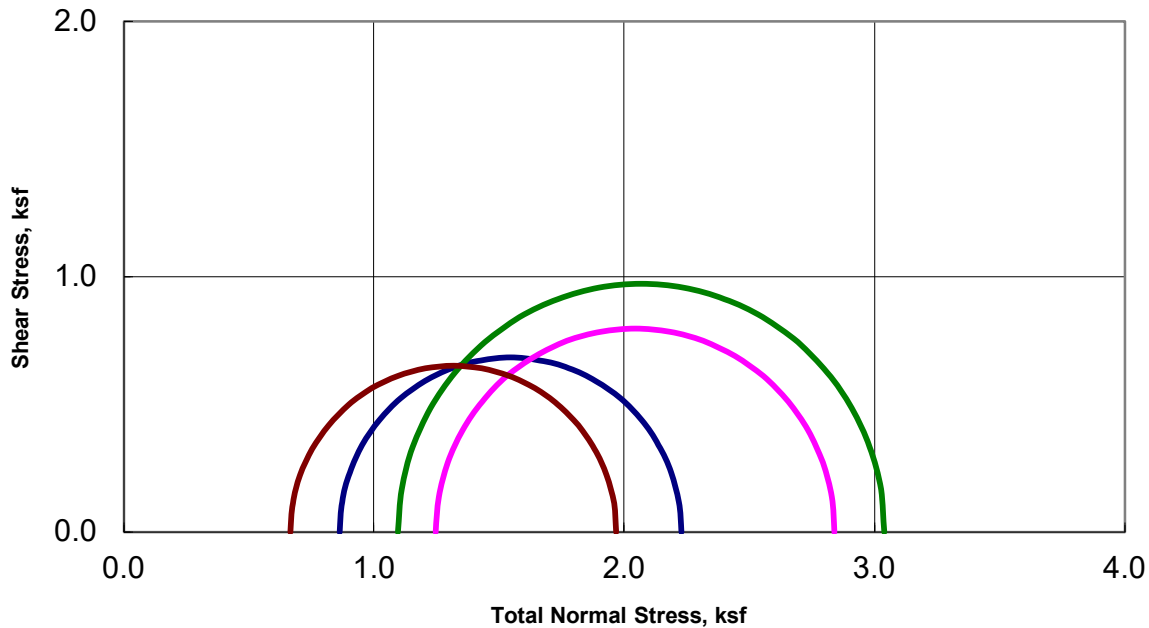
Project No.: 028-222952
Date: 3/3/2016
Run By: MD
Checked By: DC

Boring:	B-06							
Sample:	L8							
Depth, ft.:	21-23.5							
Soil Type:	Greenish Gray Lean CLAY w/ Sand							
Wt of Dish & Dry Soil, gm	634.3							
Weight of Dish, gm	304.4							
Weight of Dry Soil, gm	329.9							
Wt. Ret. on #4 Sieve, gm	0.5							
Wt. Ret. on #200 Sieve, gm	53.0							
% Gravel	0.2							
% Sand	15.9							
% Silt & Clay	83.9							

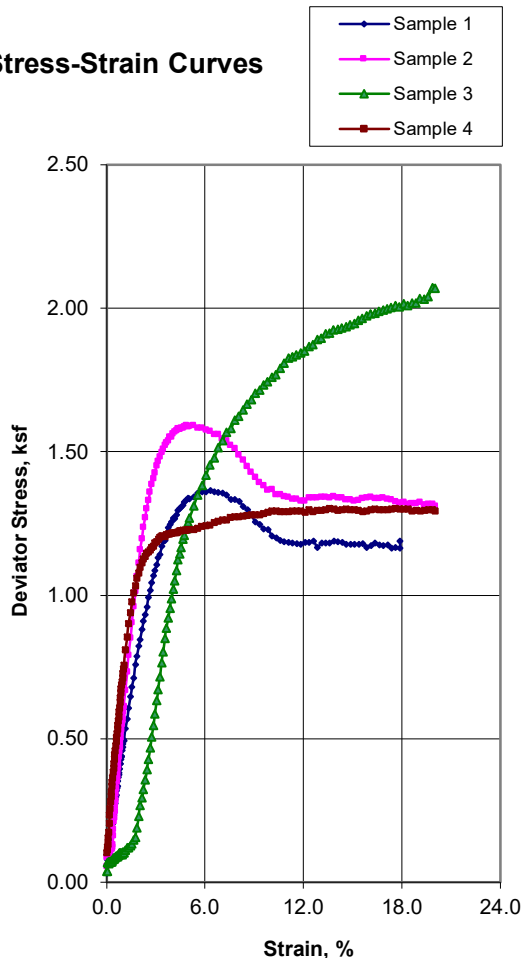
Remarks: As an added benefit to our clients, the gravel fraction may be included in this report. Whether or not it is included is dependent upon both the technician's time available and if there is a significant enough amount of gravel. The gravel is always included in the percent retained on the #200 sieve but may not be weighed separately to determine



Unconsolidated-Undrained Triaxial Test ASTM D2850



Stress-Strain Curves



Sample Data

	1	2	3	4
Moisture %	71.3	60.9	26.3	41.4
Dry Den,pcf	56.9	63.3	96.8	77.3
Void Ratio	1.960	1.664	0.742	1.181
Saturation %	98.3	98.8	95.7	94.5
Height in	6.14	6.10	6.10	6.09
Diameter in	2.86	2.87	2.86	2.89
Cell psi	6.0	8.7	7.6	4.6
Strain %	6.30	5.29	15.00	13.58
Deviator, ksf	1.367	1.594	1.944	1.302
Rate %/min	1.00	1.00	1.00	1.00
in/min	0.061	0.061	0.061	0.061
Job No.:	855-013b			
Client:	HDR Engineering, Inc.			
Project:	028-222952			
Boring:	B-03	B-03	B-05	B-06
Sample:	L6	L10	L10	L4
Depth ft:	19-21.5	30-32.5(Tip-1")	20-22.5	7-9.5(Tip14")

Visual Soil Description

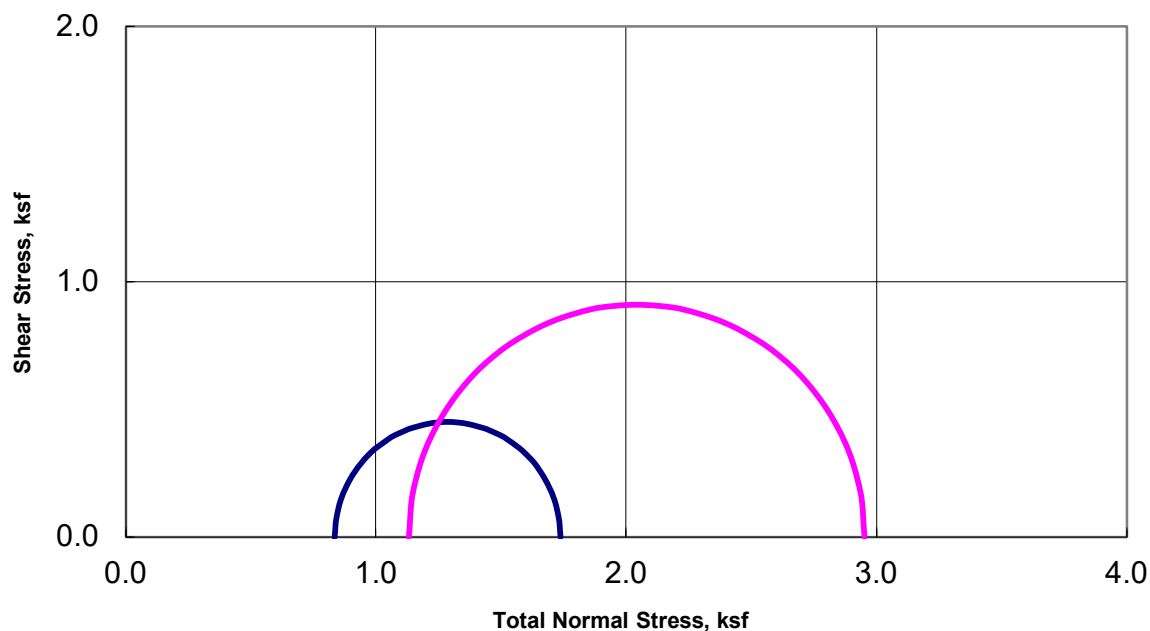
Sample #	
1	Greenish Gray Elastic SILT (Bay Mud)
2	Greenish Gray Elastic SILT (Bay Mud)
3	Dark Grayish Brown Lean CLAY
4	Dark Gray Fat CLAY

Remarks:

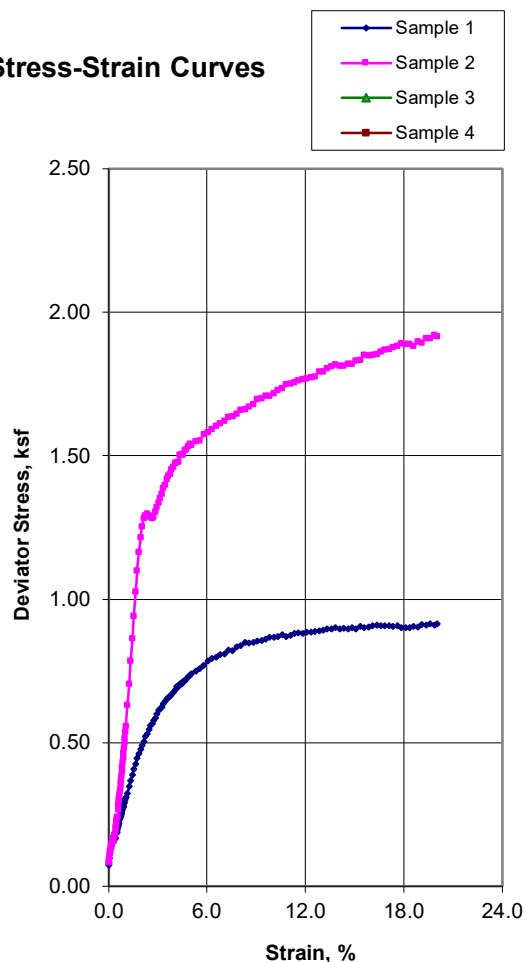
Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.



Unconsolidated-Undrained Triaxial Test ASTM D2850



Stress-Strain Curves



Sample Data

	1	2	3	4
Moisture %	40.7	22.9		
Dry Den,pcf	79.8	101.9		
Void Ratio	1.112	0.653		
Saturation %	98.8	94.6		
Height in	6.10	6.12		
Diameter in	2.86	2.87		
Cell psi	5.8	7.9		
Strain %	15.00	15.00		
Deviator, ksf	0.901	1.821		
Rate %/min	1.00	1.00		
in/min	0.061	0.061		
Job No.:	855-013c			
Client:	HDR Engineering, Inc.			
Project:	028-222952			
Boring:	B-06	B-06		
Sample:	L6	L8		
Depth ft:	12.5-15	21-23.5		

Visual Soil Description

Sample #	
1	Dark Greenish Gray Fat CLAY (Bay Mud)
2	Greenish Gray Lean CLAY w/ Sand
3	
4	

Remarks:

Note: Strengths are picked at the peak deviator stress or 15% strain which ever occurs first per ASTM D2850.

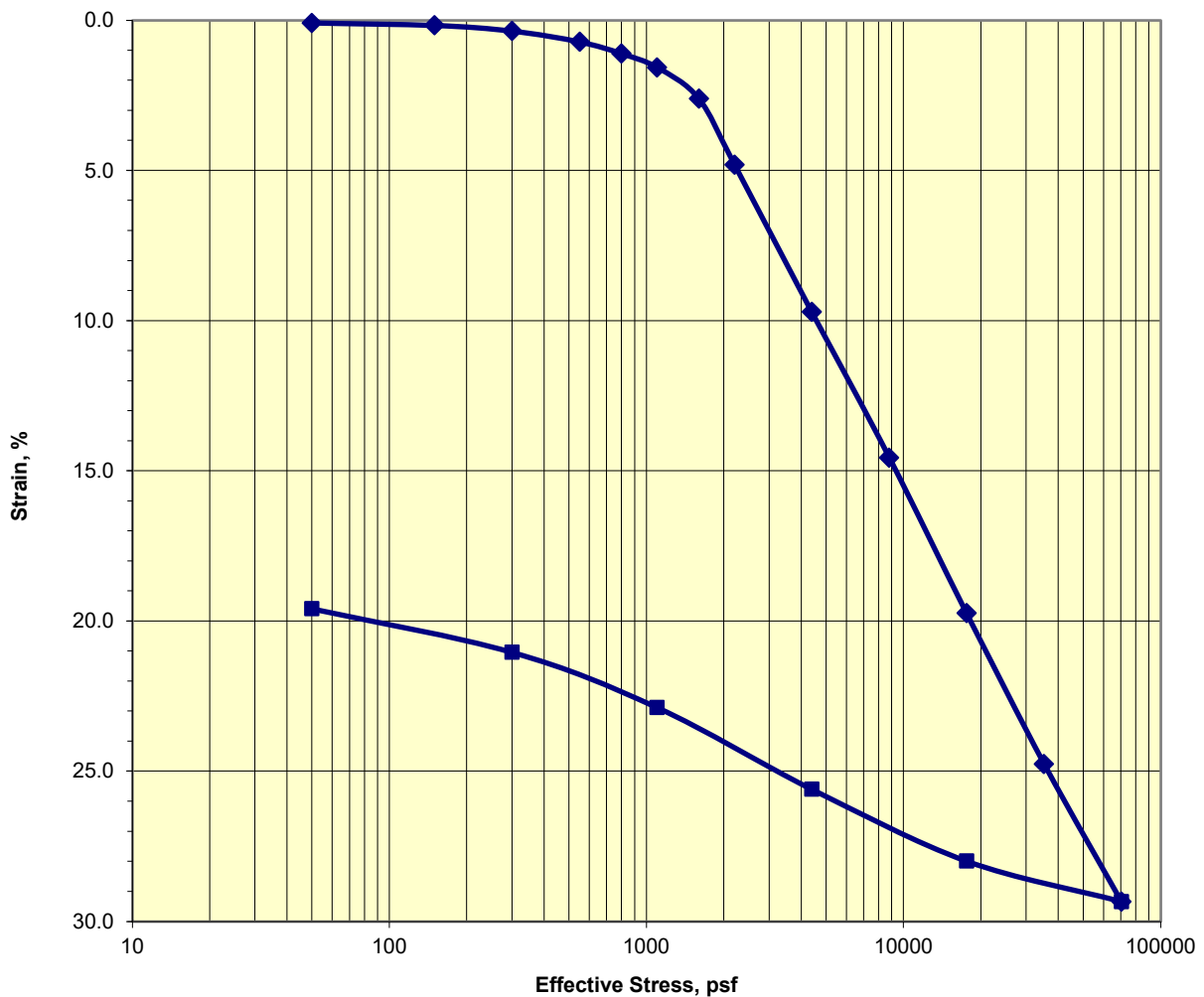


Consolidation Test

ASTM D2435

Job No.: 855-013	Boring: B-06	Run By: MD
Client: HDR Engineering, Inc.	Sample: L6	Reduced: PJ
Project: 028-222952	Depth, ft.: 12.5-15 (tip-3")	Checked: PJ/DC
Soil Type: Dark Greenish Gray Fat CLAY (Bay Mud)		Date: 3/7/2016

Strain-Log-P Curve



Assumed Gs	2.75	Initial	Final
Moisture %:		41.4	27.9
Dry Density, pcf:		78.7	97.1
Void Ratio:		1.182	0.767
% Saturation:		96.3	100.0

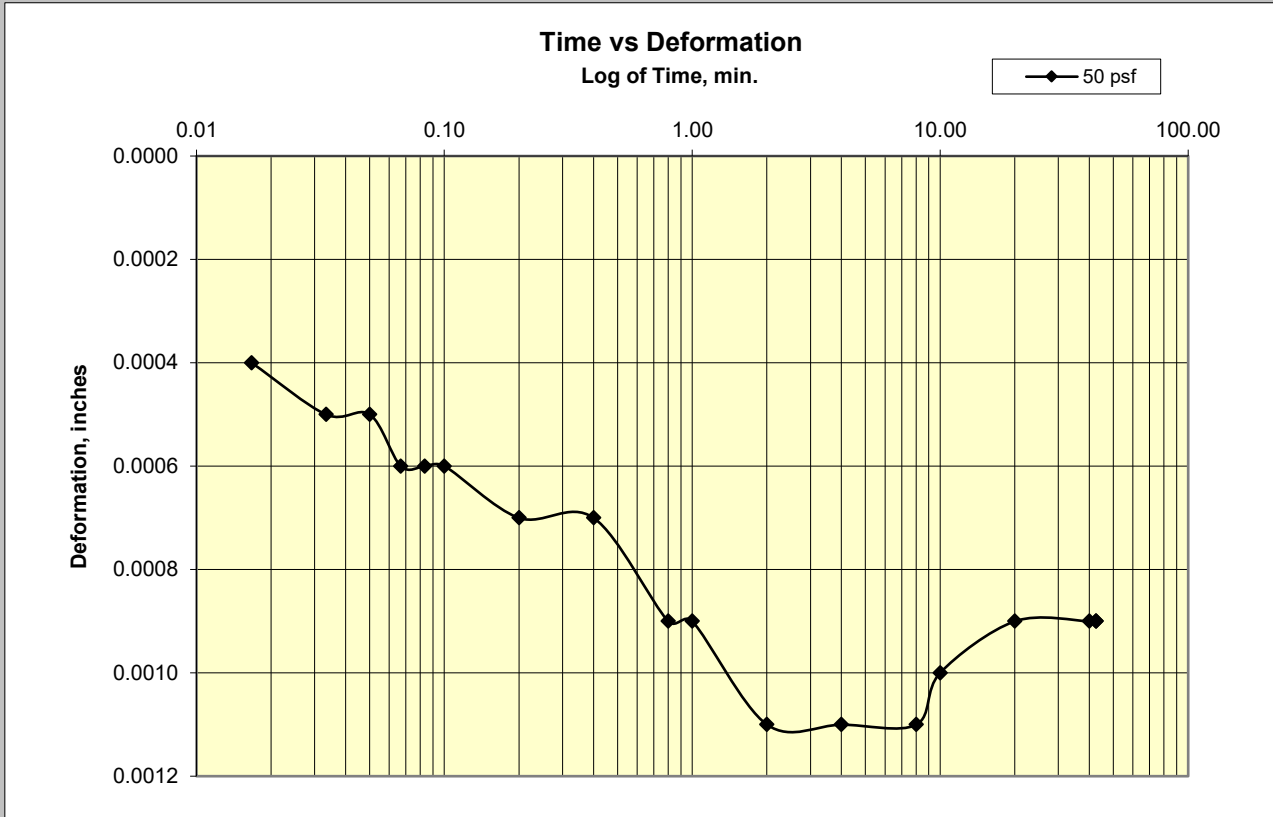
Remarks:

Cooper Testing Labs, Inc.

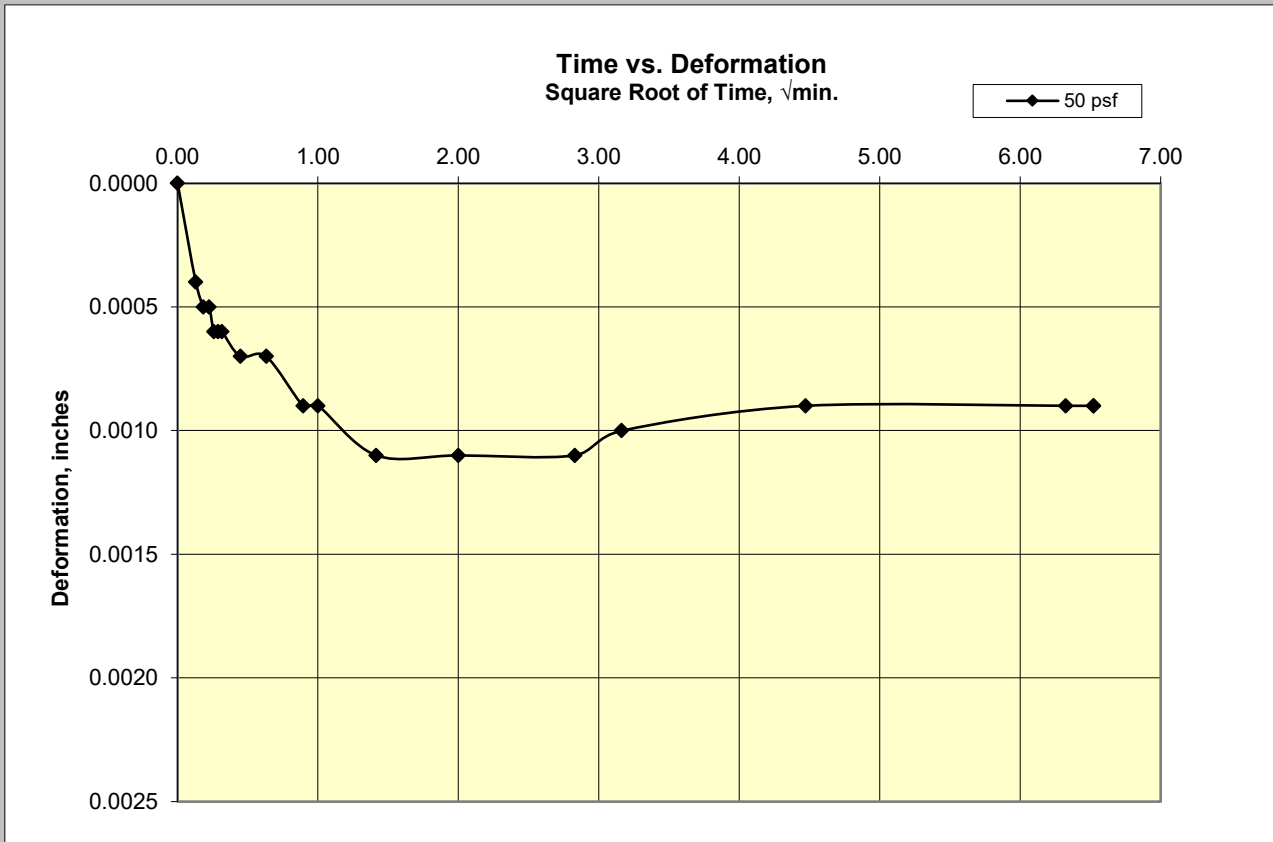
B-06, Sample L6, 12-15.0 feet

Load 1

50 psf



50 psf

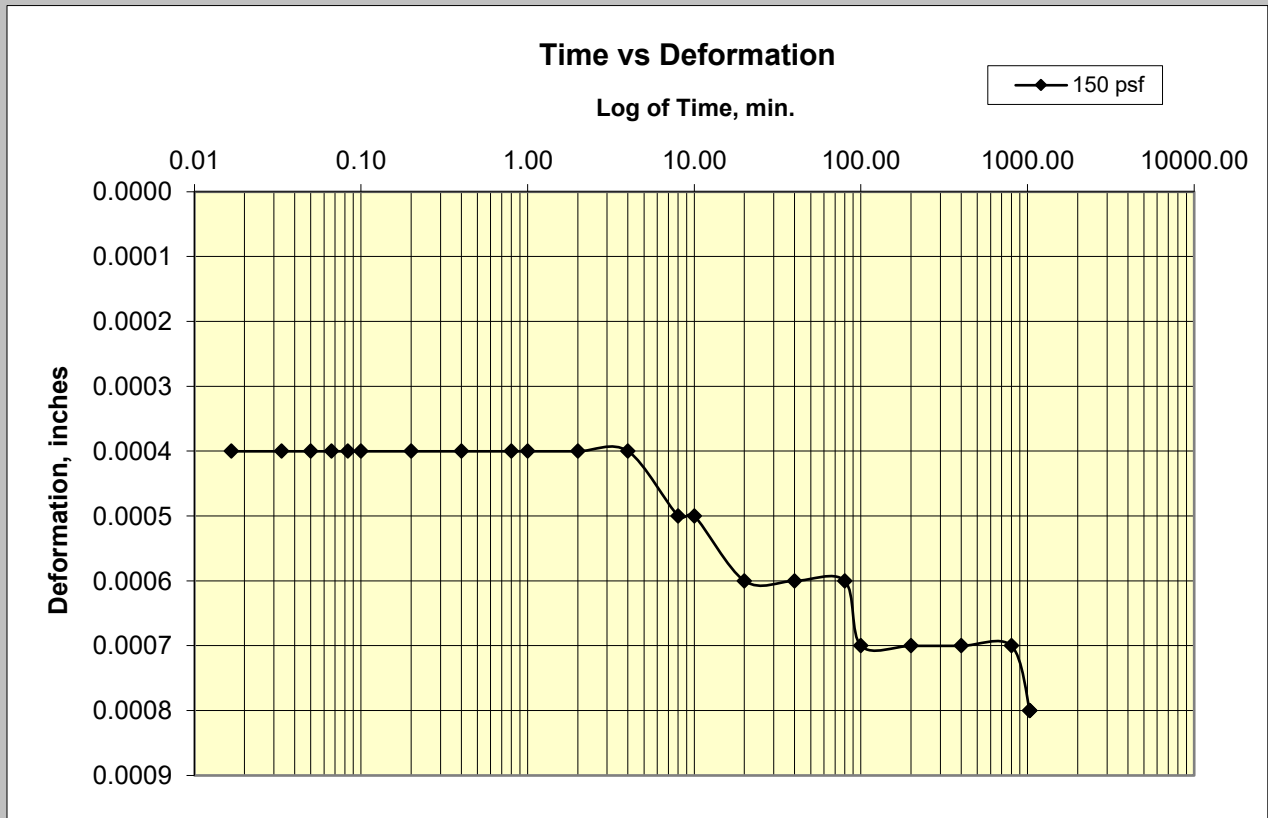


Cooper Testing Labs, Inc.

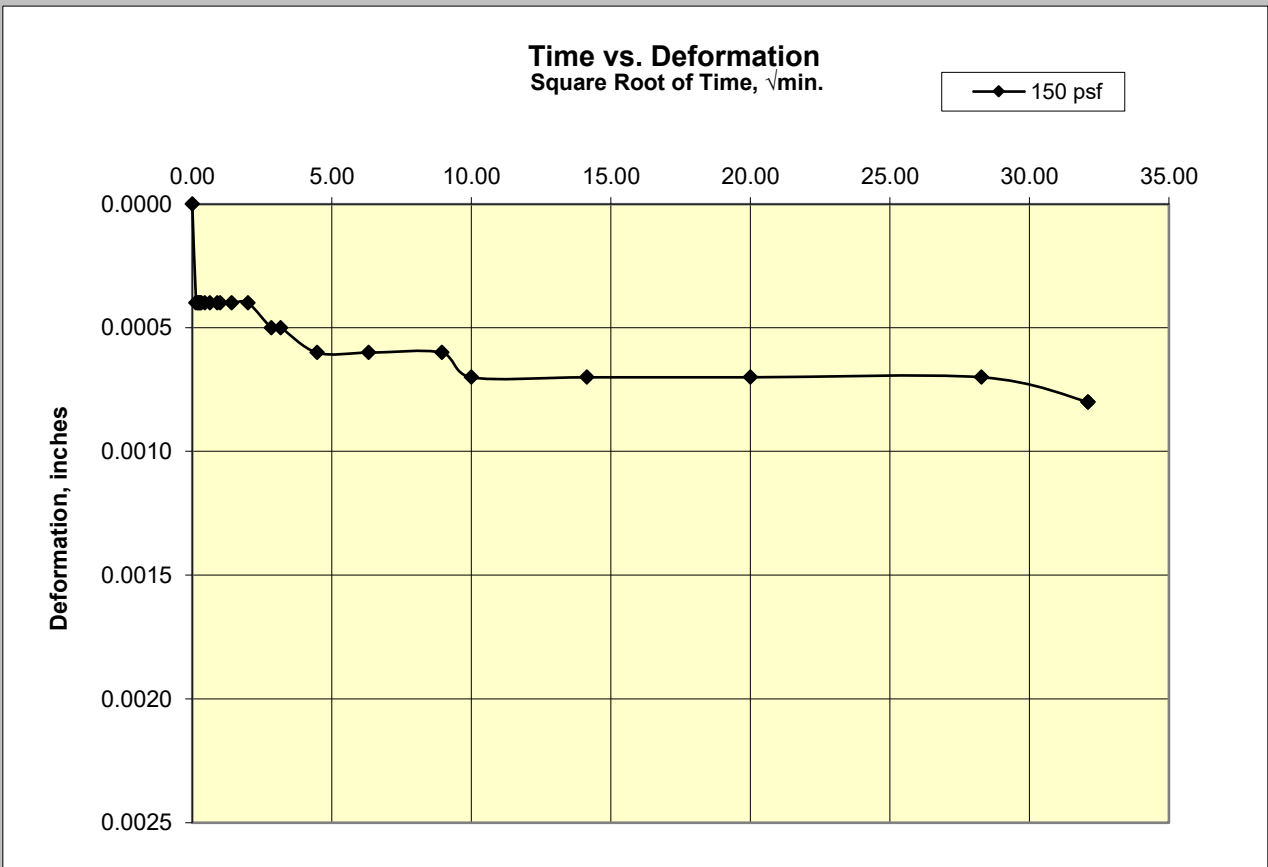
B-06, Sample L6, 12-15.0 feet

Load 2

150 psf



150 psf

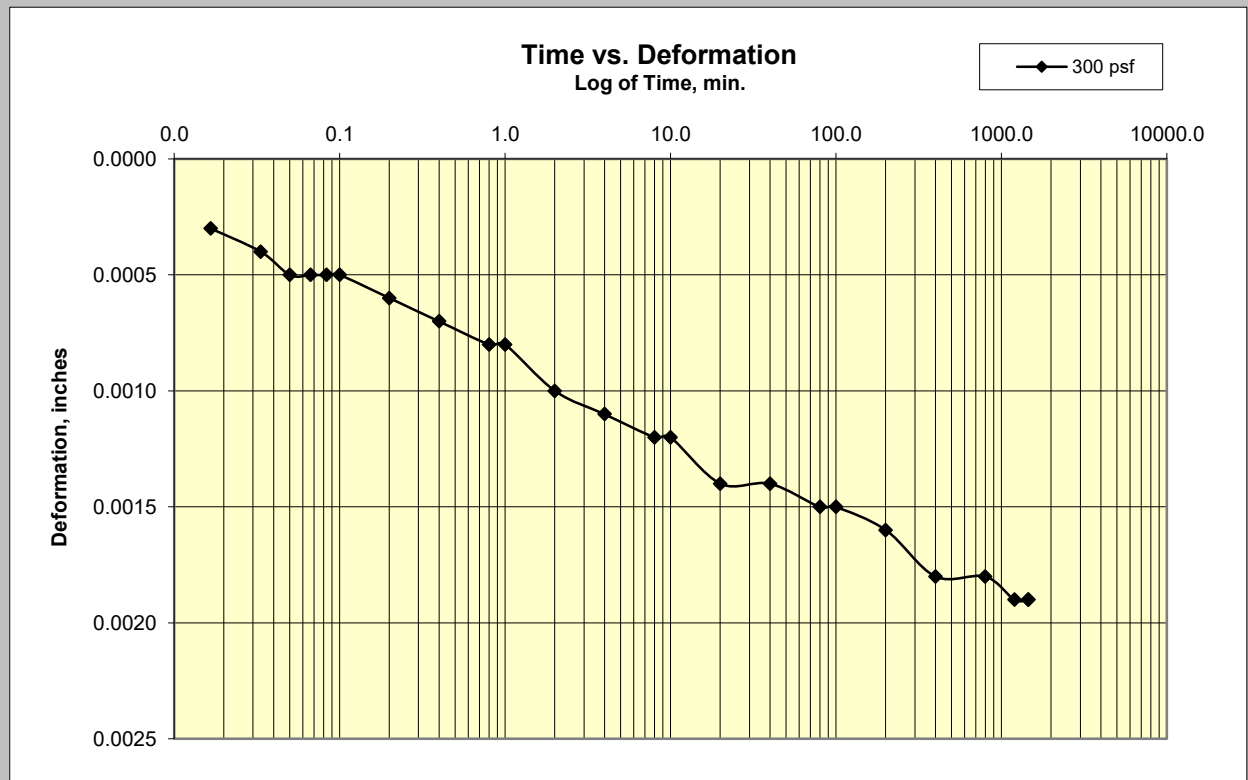


Cooper Testing Labs, Inc.

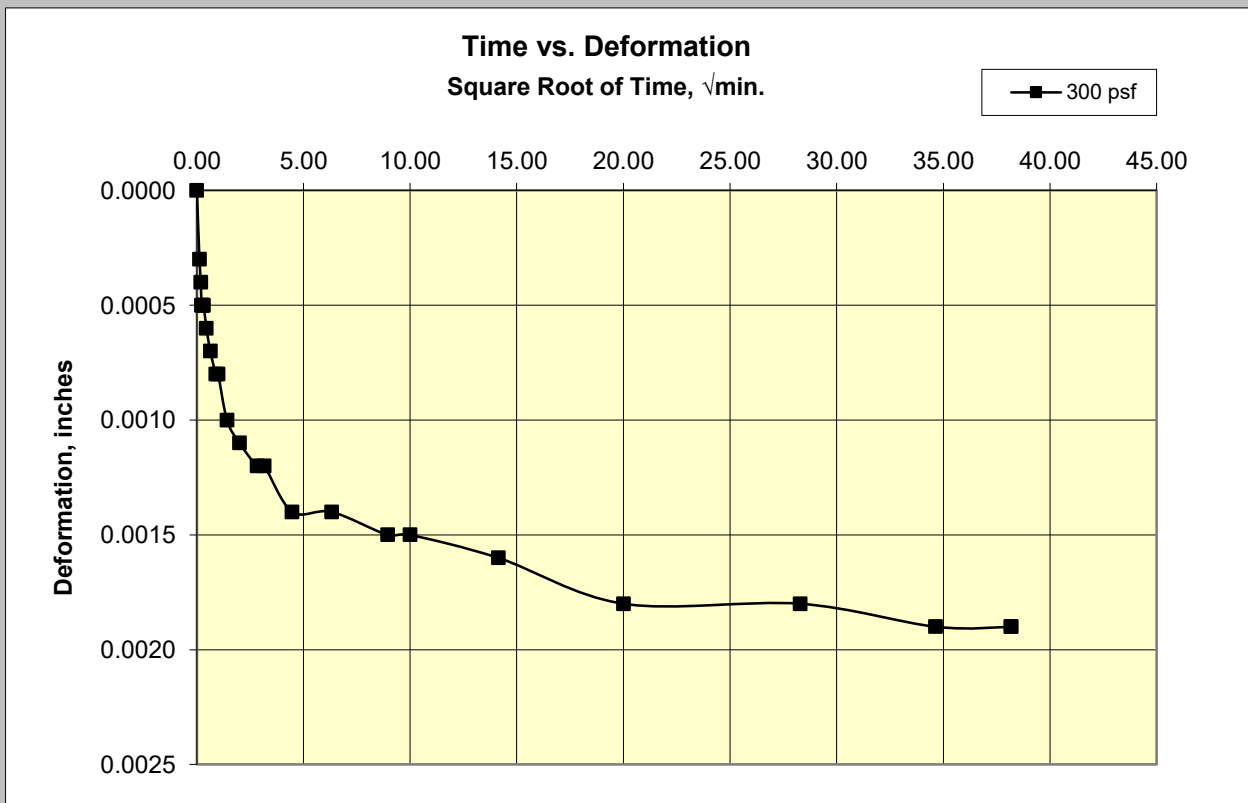
B-06, Sample L6, 12-15.0 feet

Load 3

300 psf



300 psf

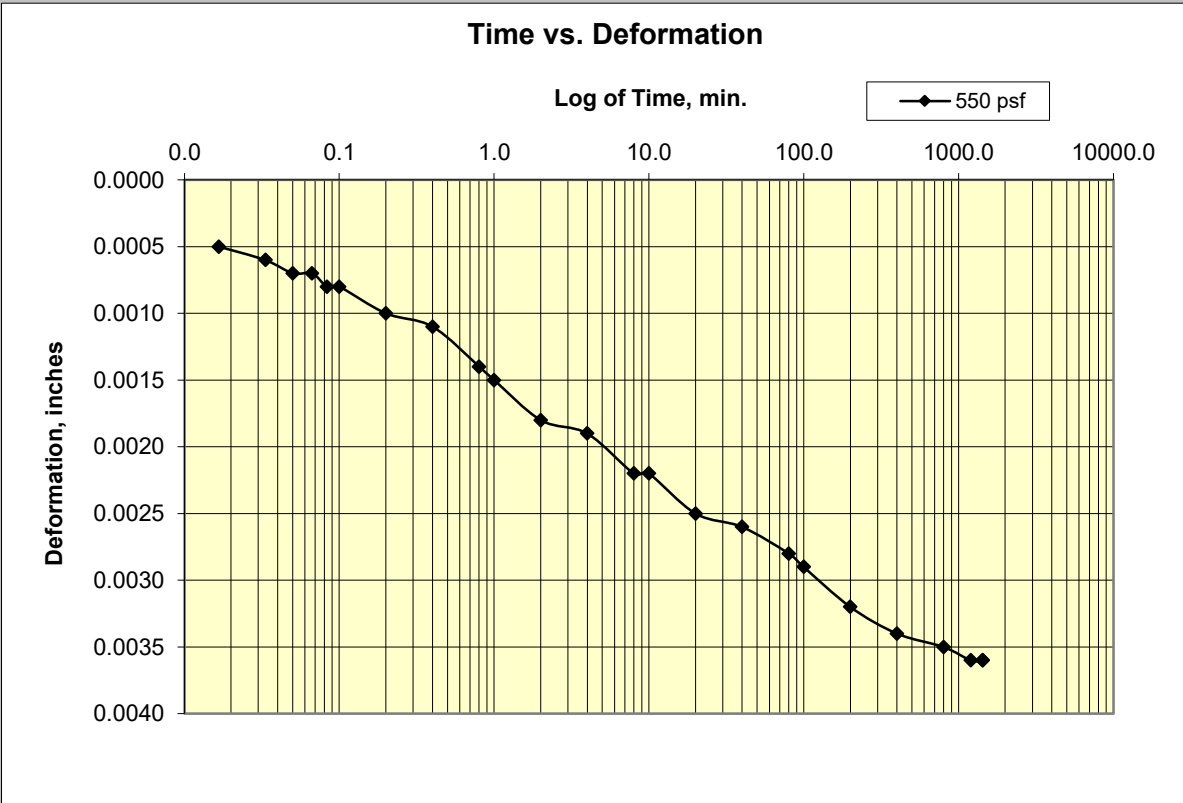


Cooper Testing Labs, Inc.

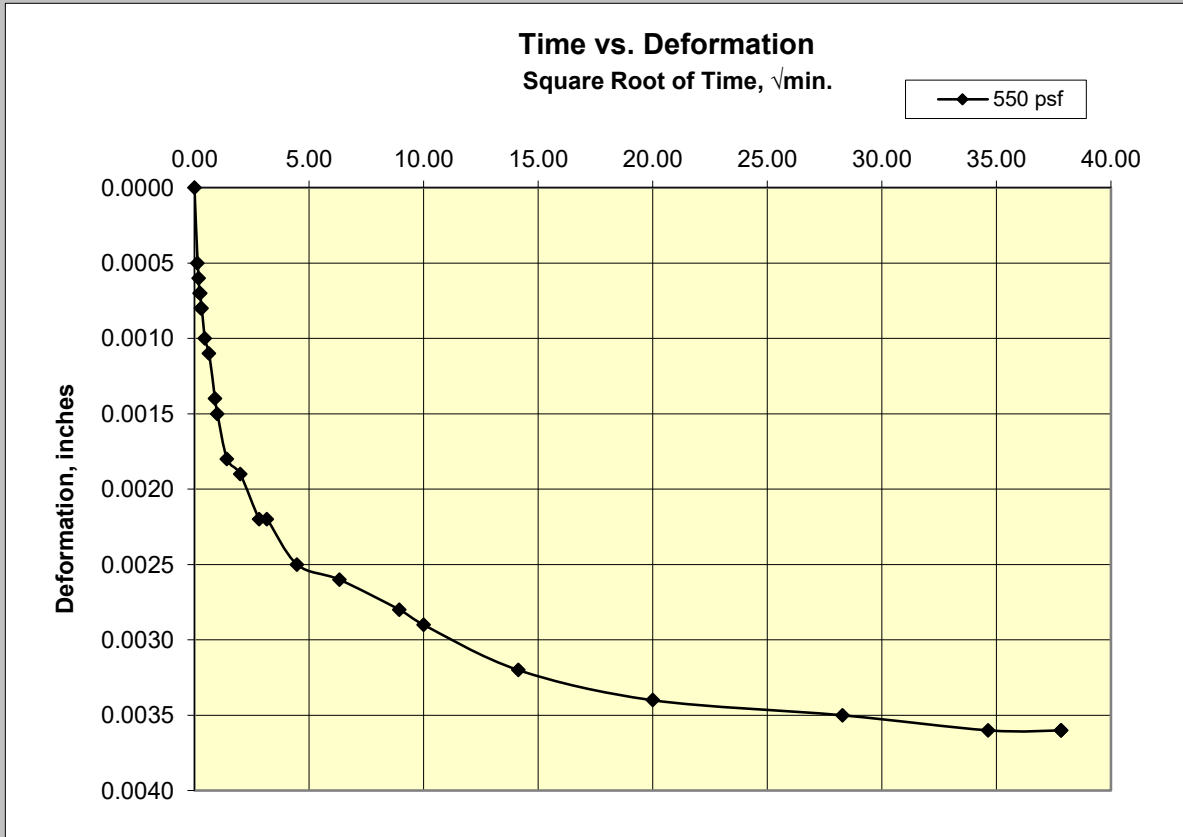
B-06, Sample L6, 12-15.0 feet

Load 4

550 psf



550 psf

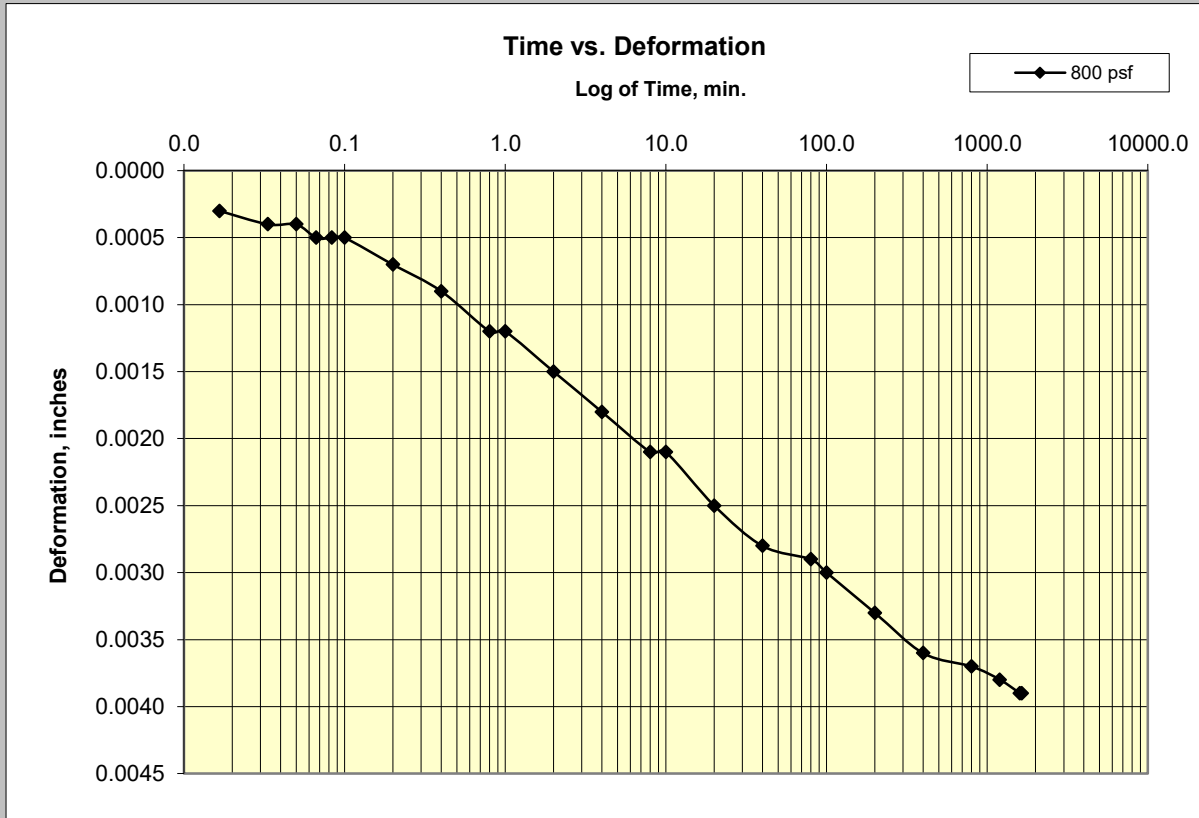


Cooper Testing Labs, Inc.

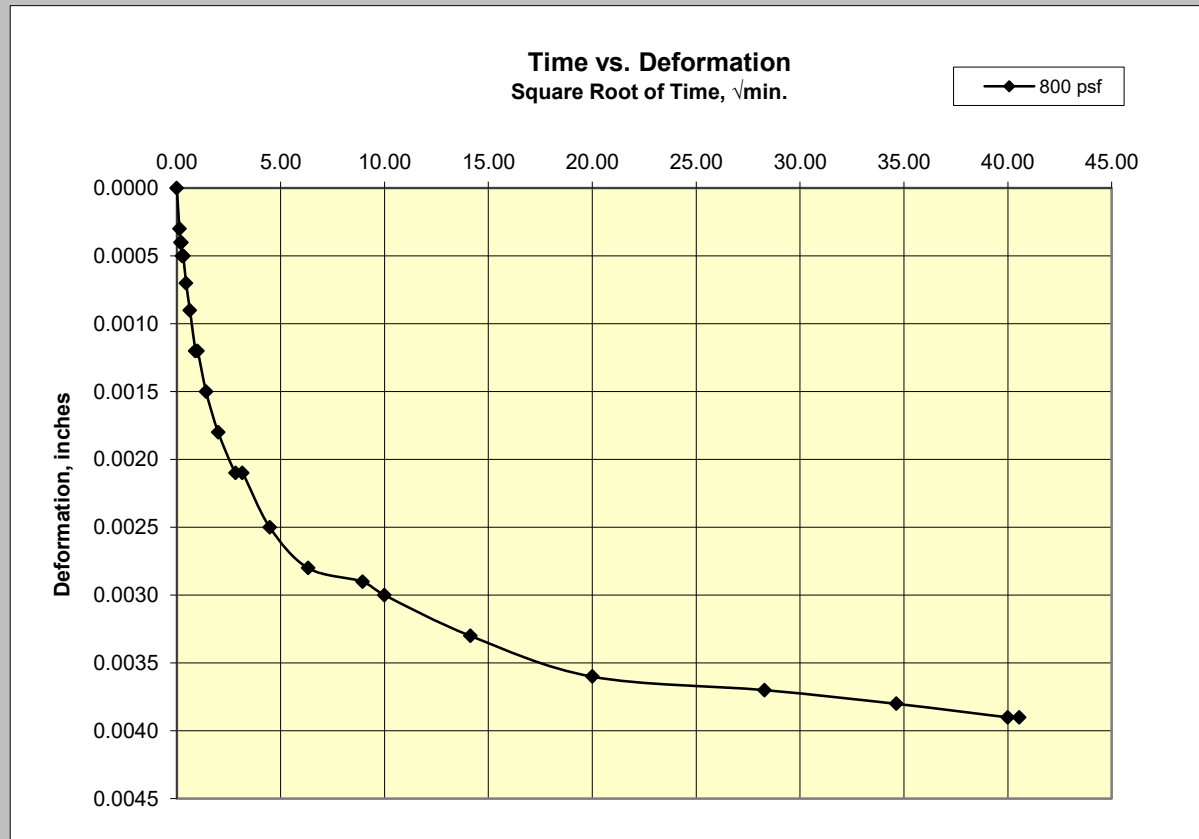
B-06, Sample L6, 12-15.0 feet

Load 5

800 psf



800 psf

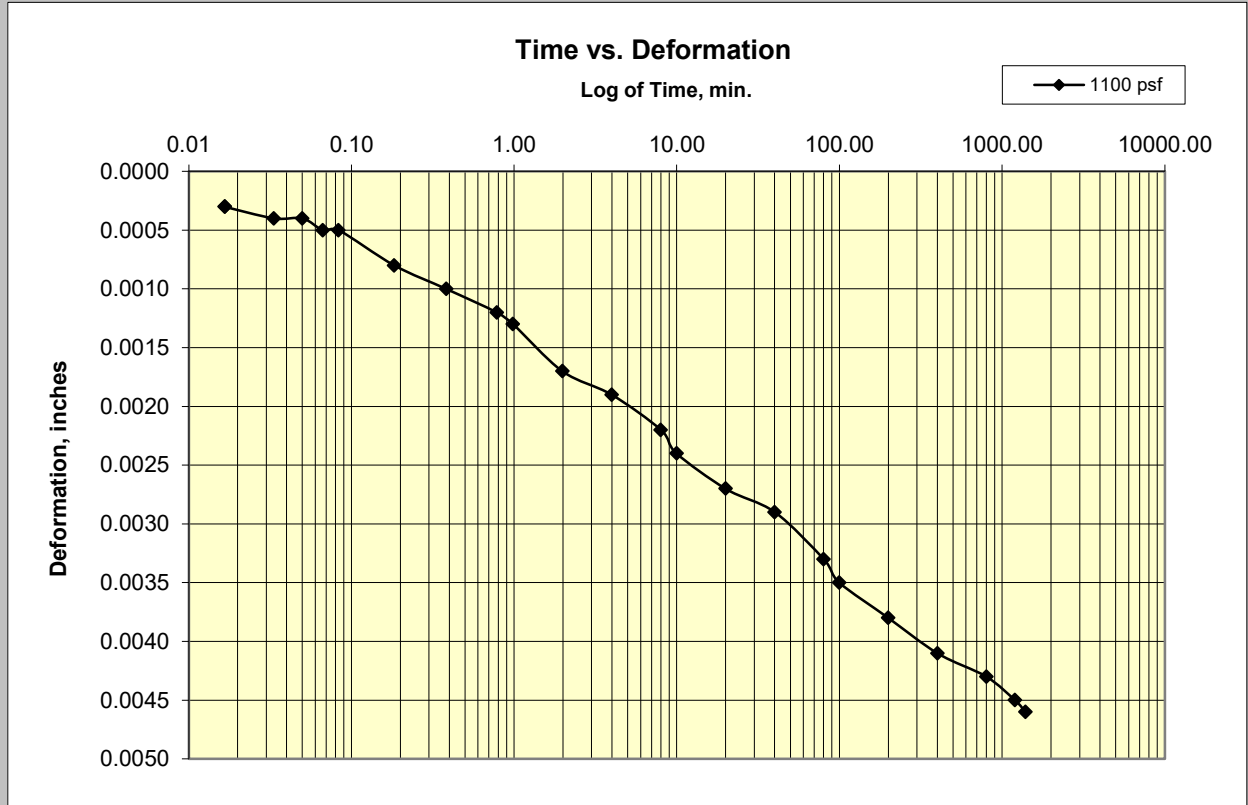


Cooper Testing Labs, Inc.

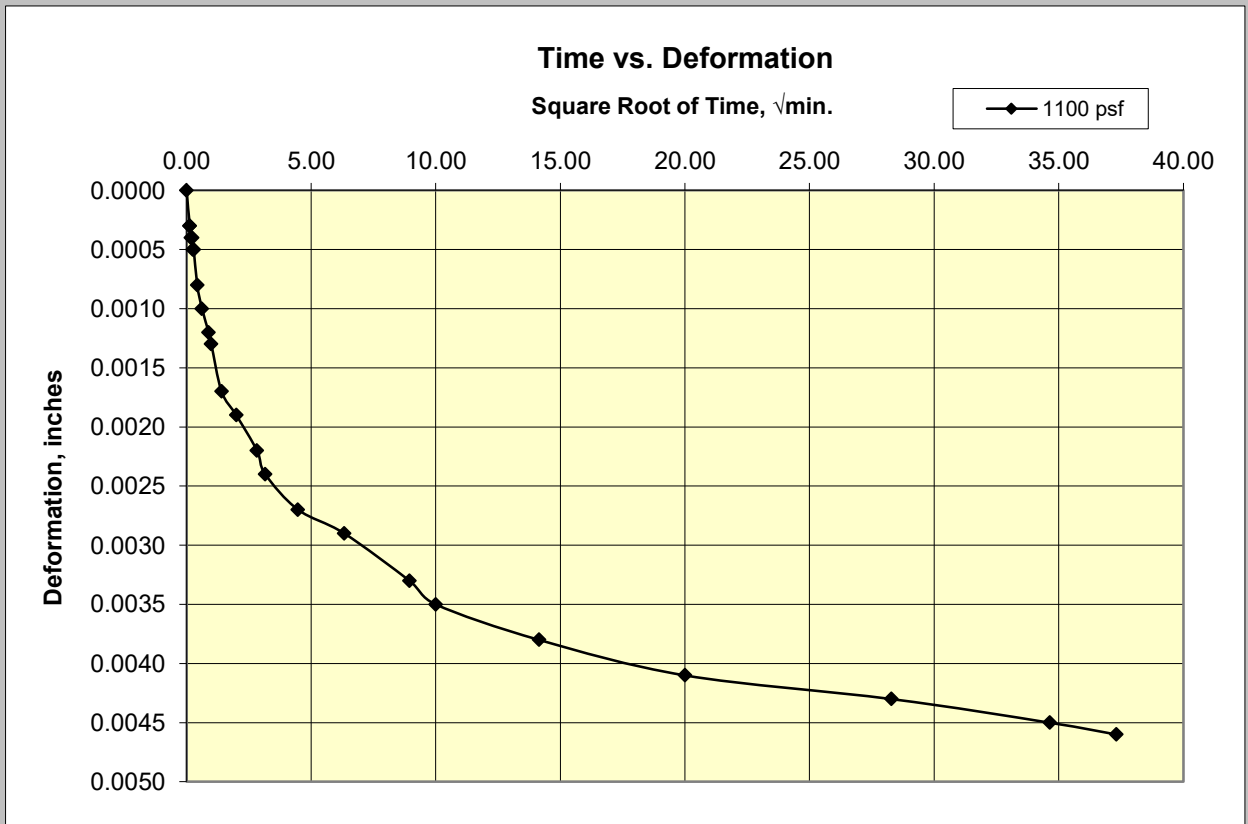
B-06, Sample L6, 12-15.0 feet

Load 6

1100 psf



1100 psf

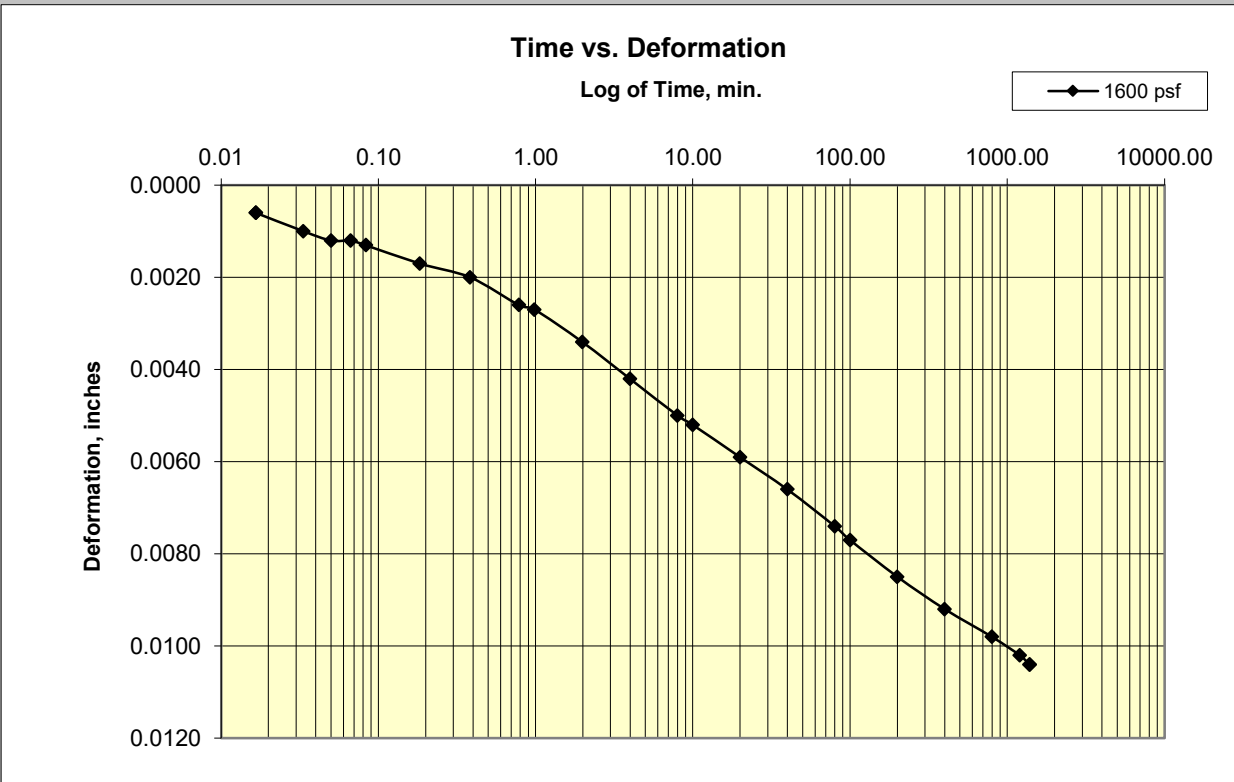


Cooper Testing Labs, Inc.

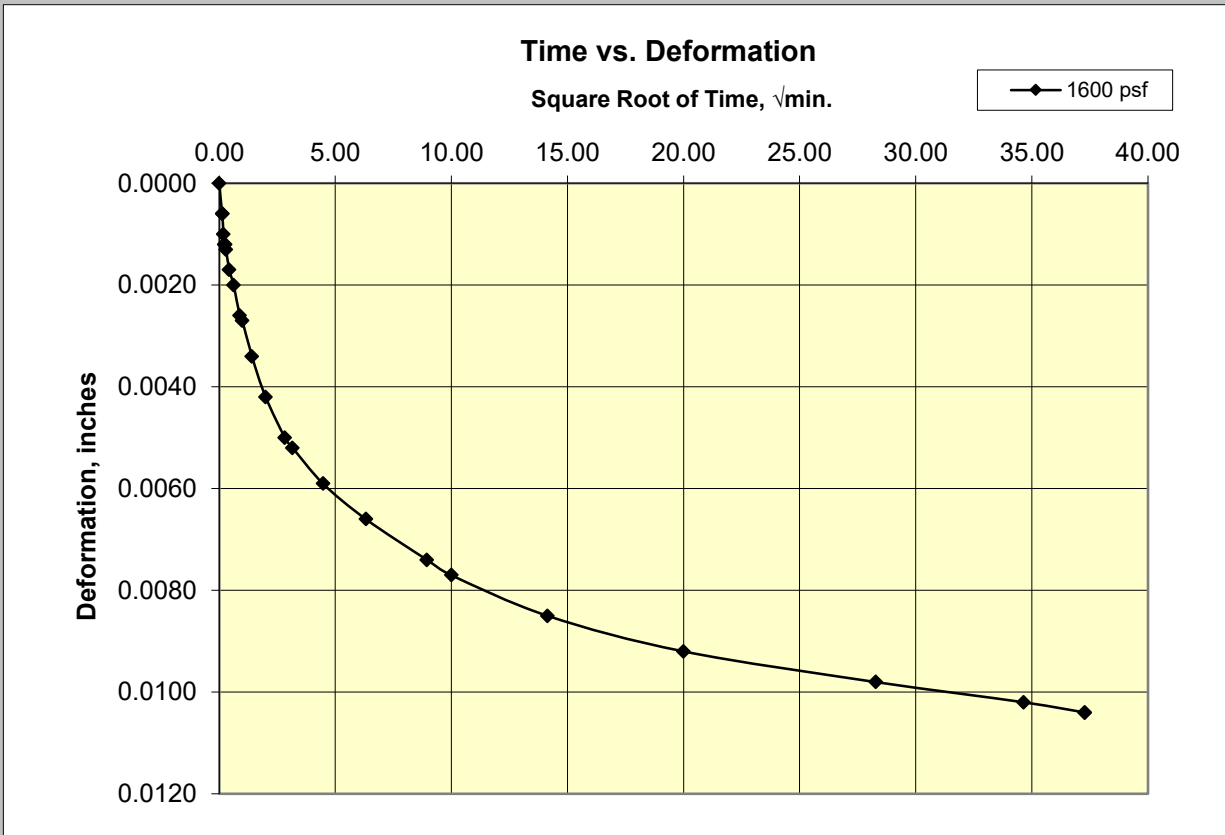
B-06, Sample L6, 12-15.0 feet

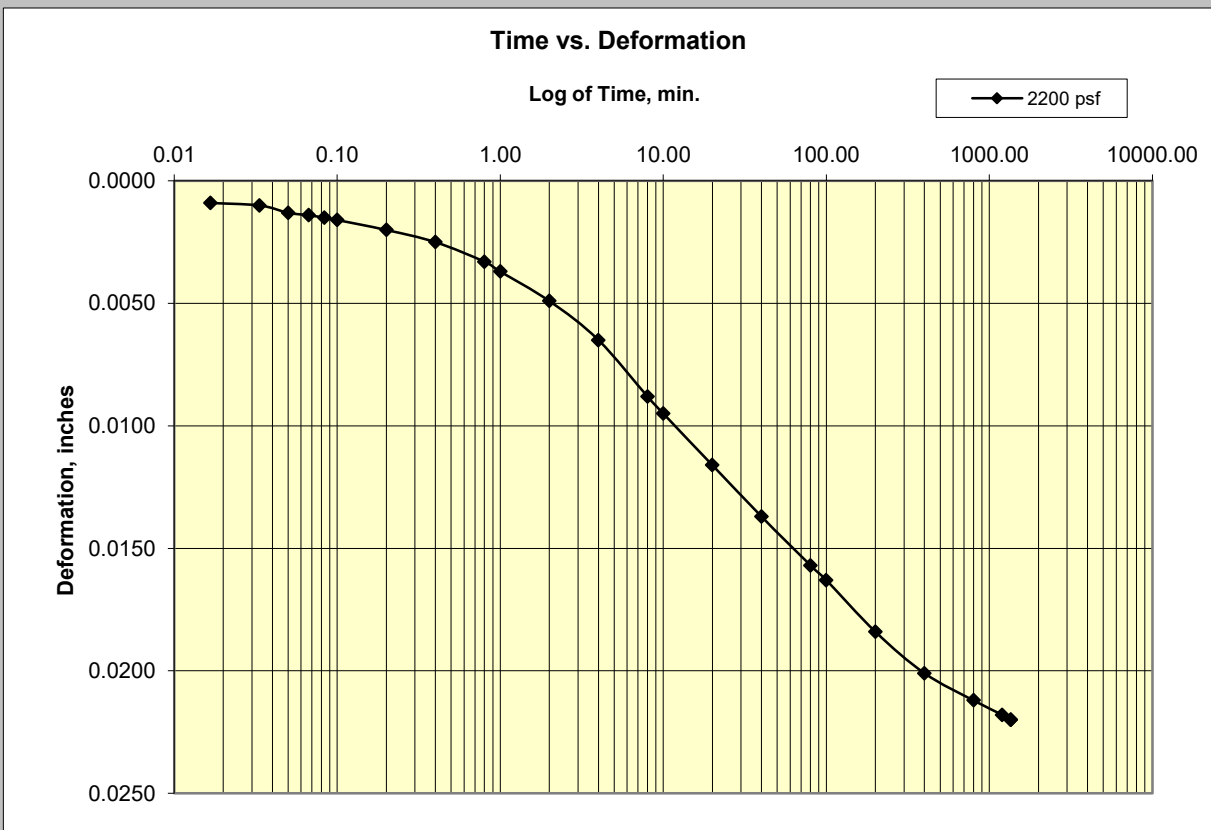
Load 7

1600 psf

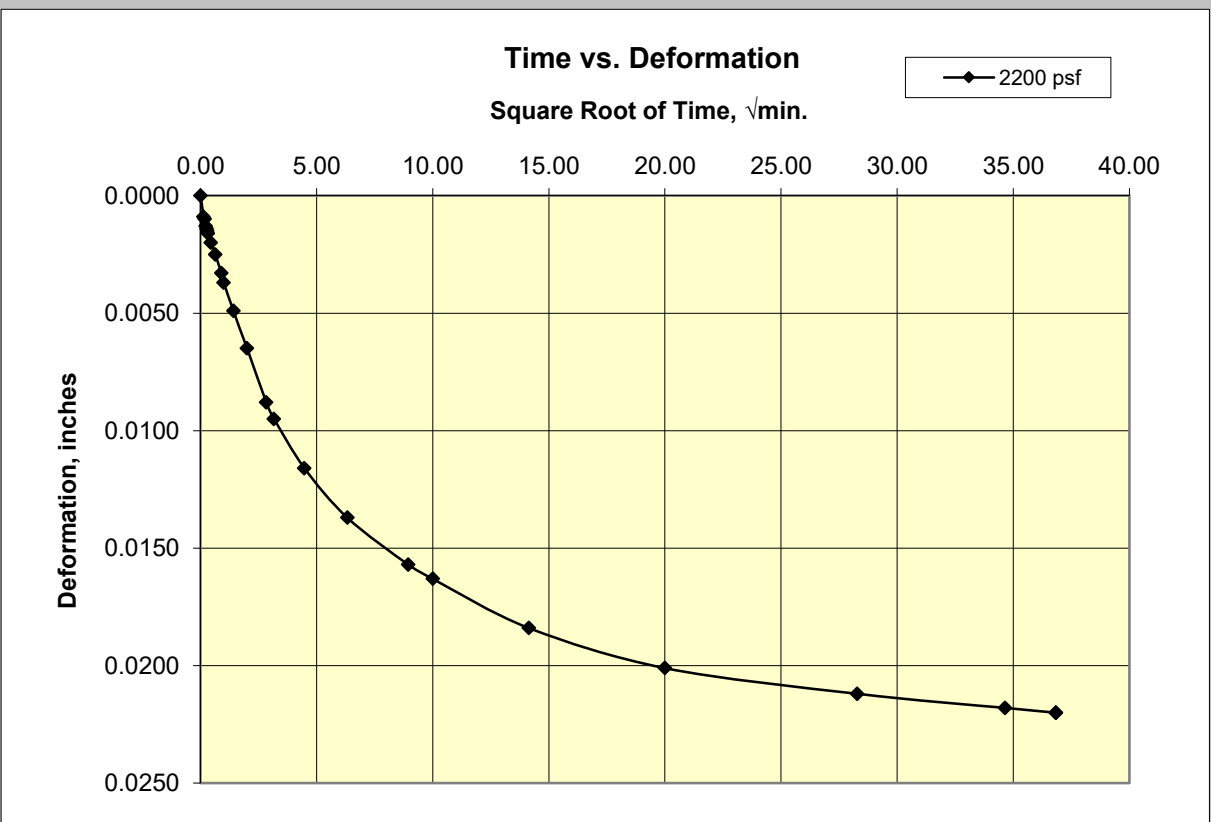


1600 psf



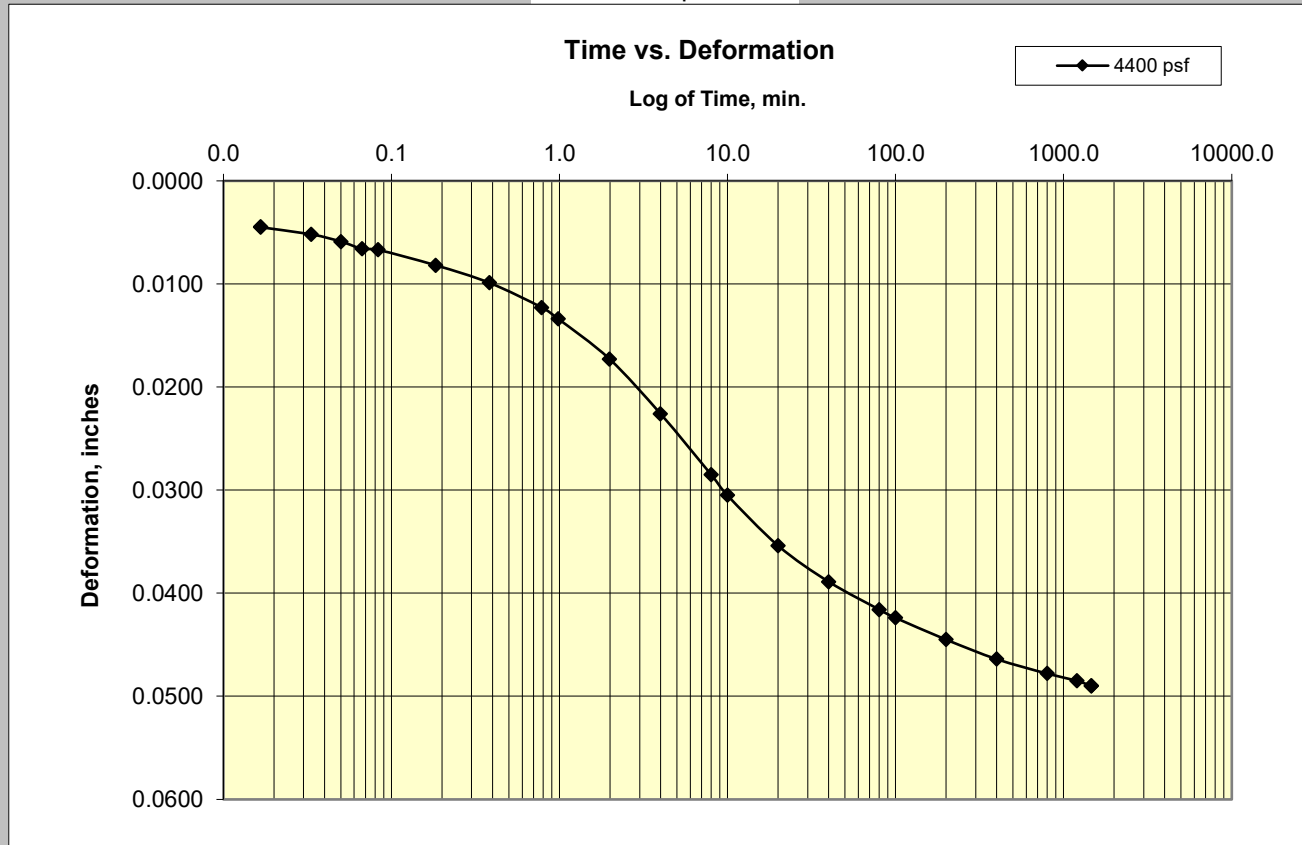


2200 psf

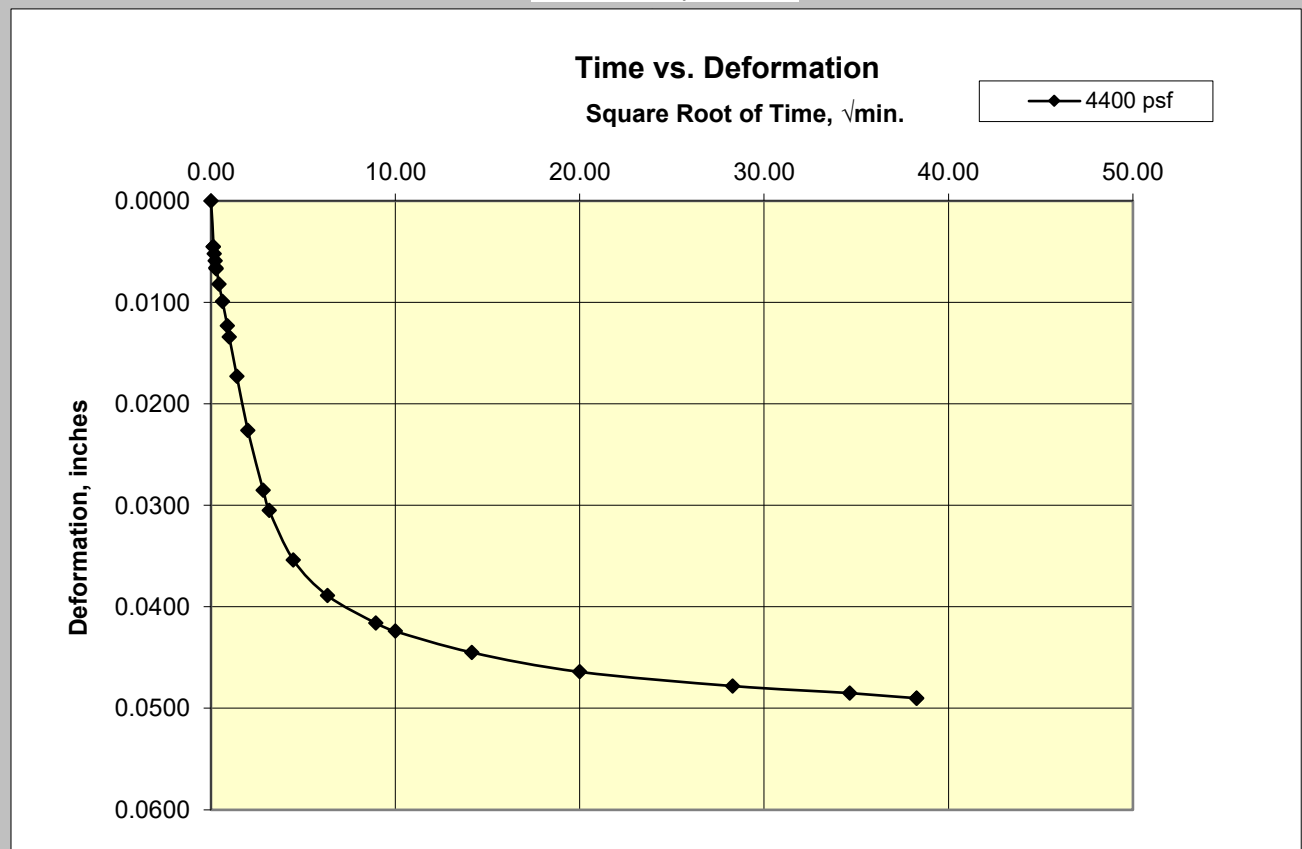


Load 9

4400 psf



4400 psf

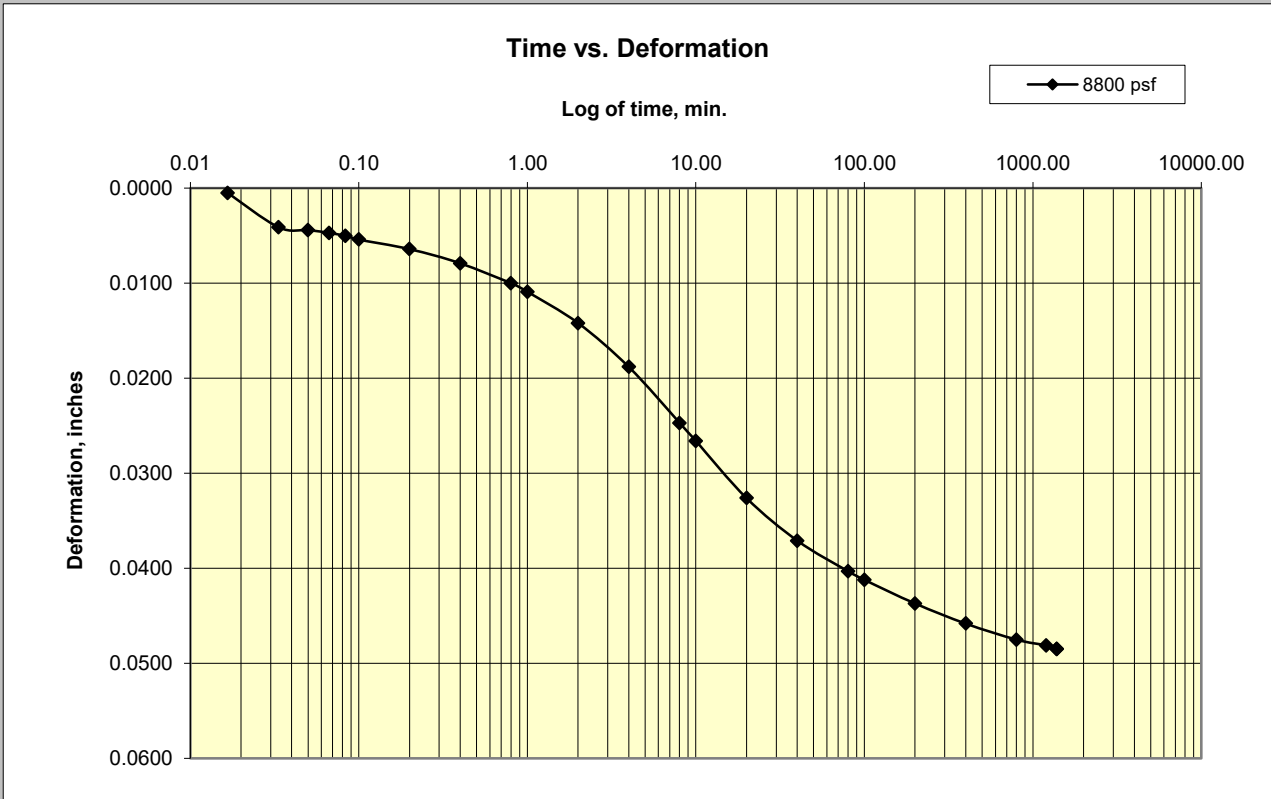


Cooper Testing Labs, Inc.

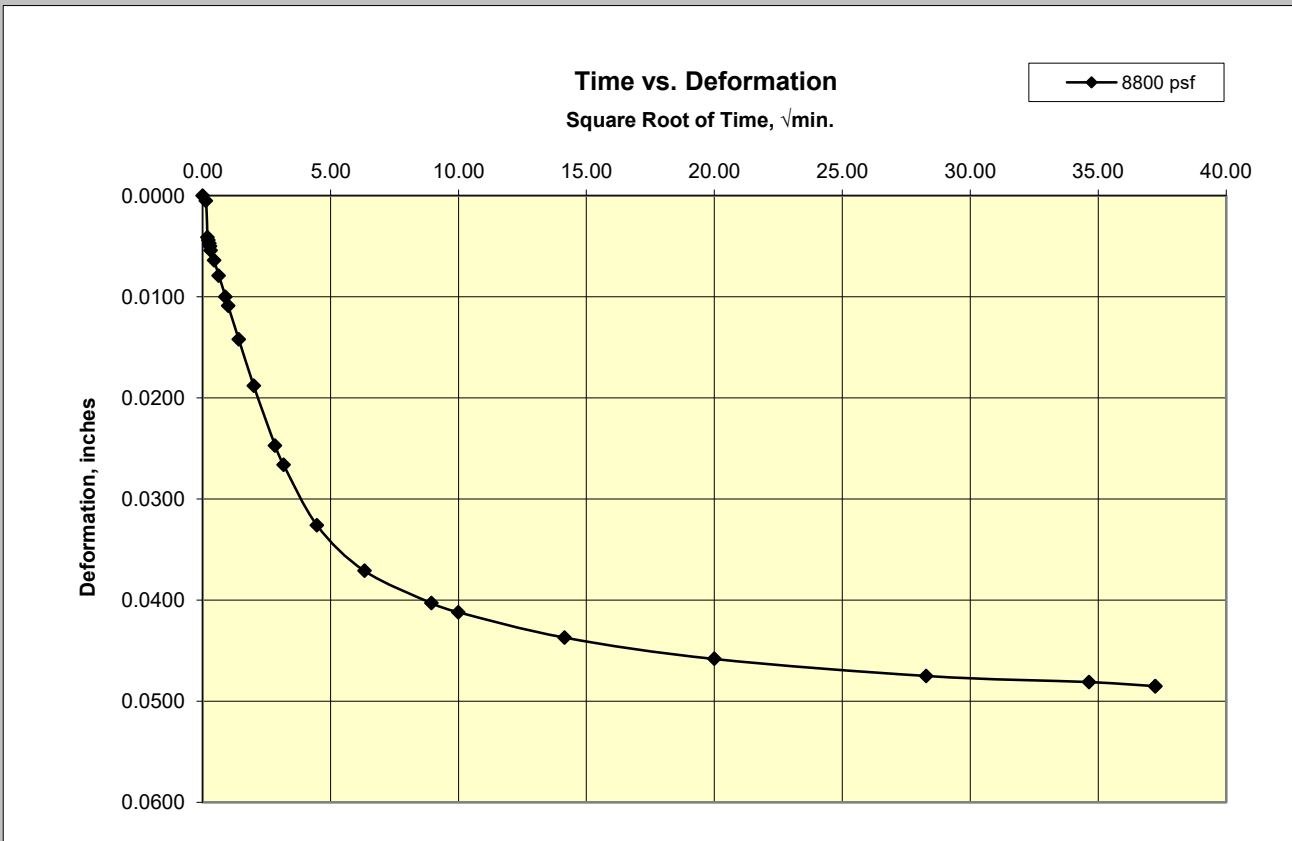
B-06, Sample L6, 12-15.0 feet

Load 10

8800 psf



8800 psf

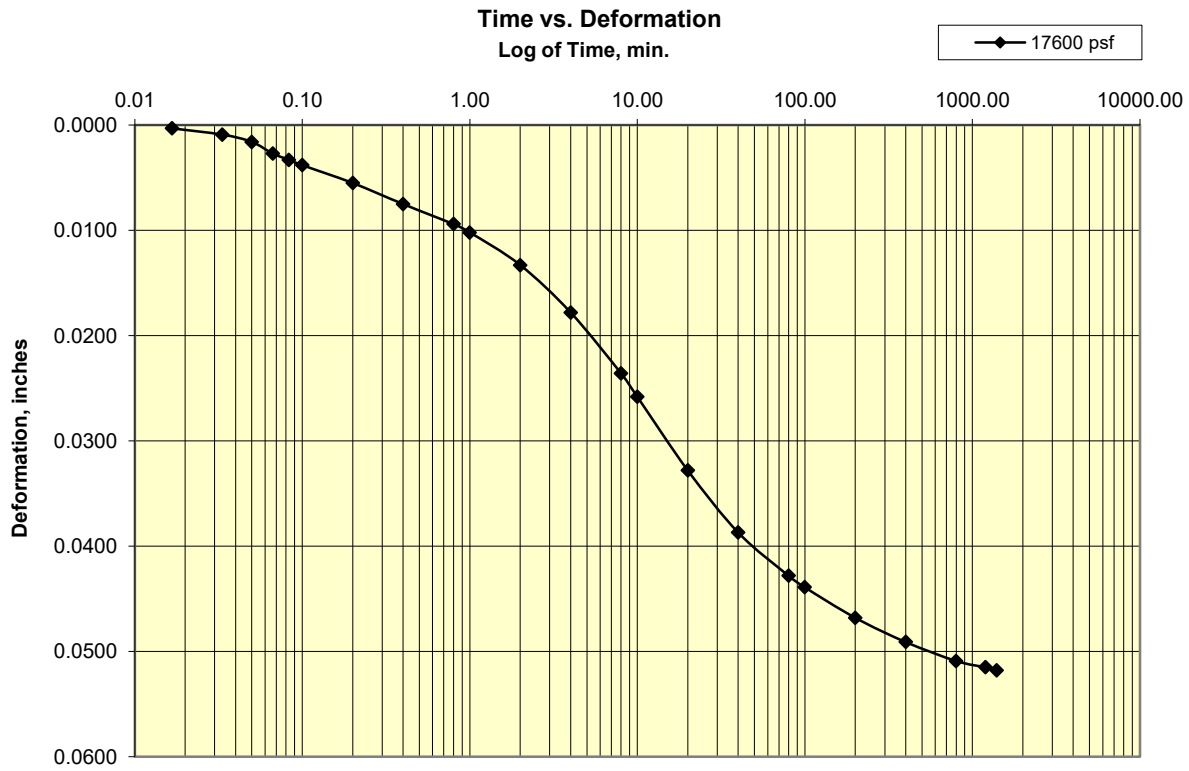


Cooper Testing Labs, Inc.

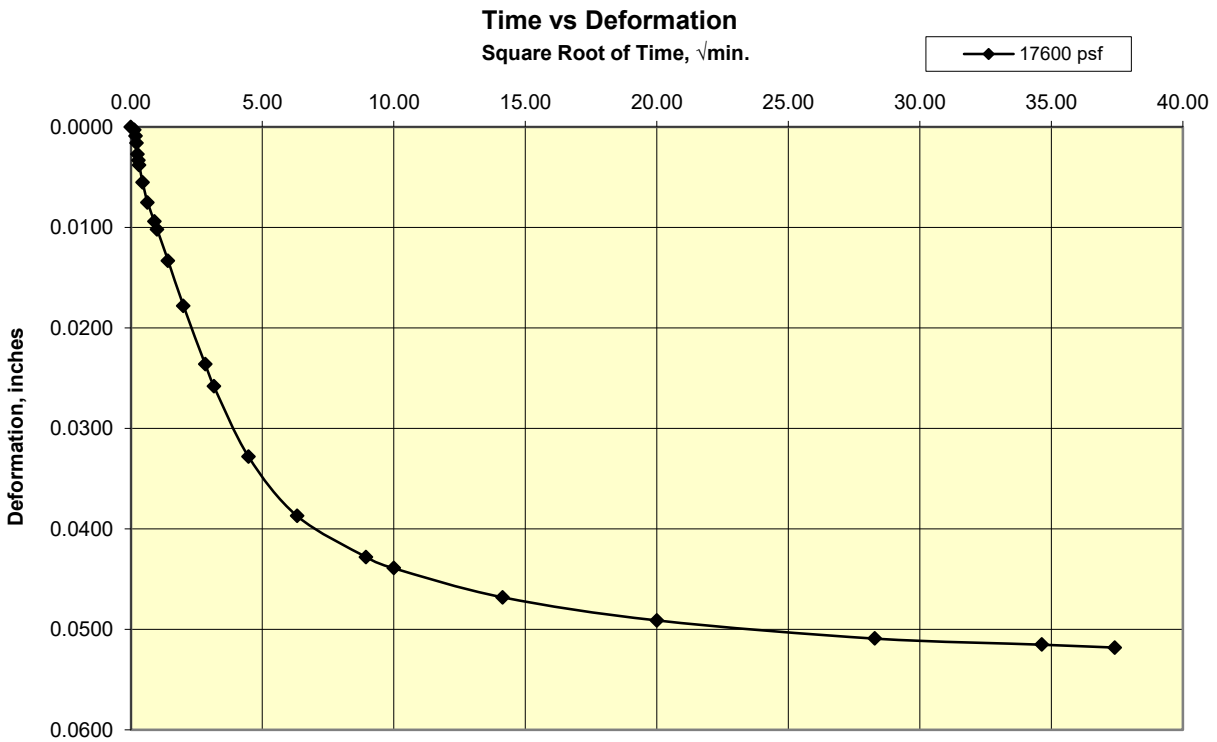
B-06, Sample L6, 12-15.0 feet

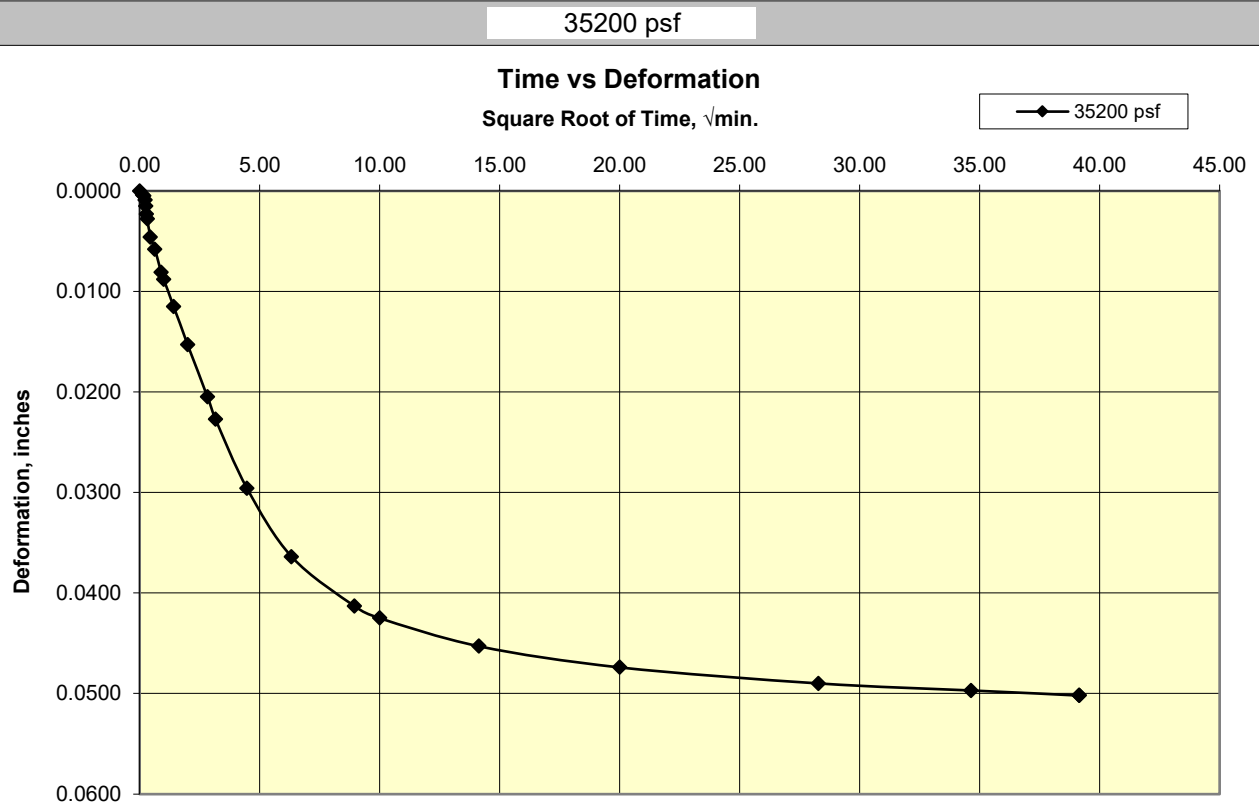
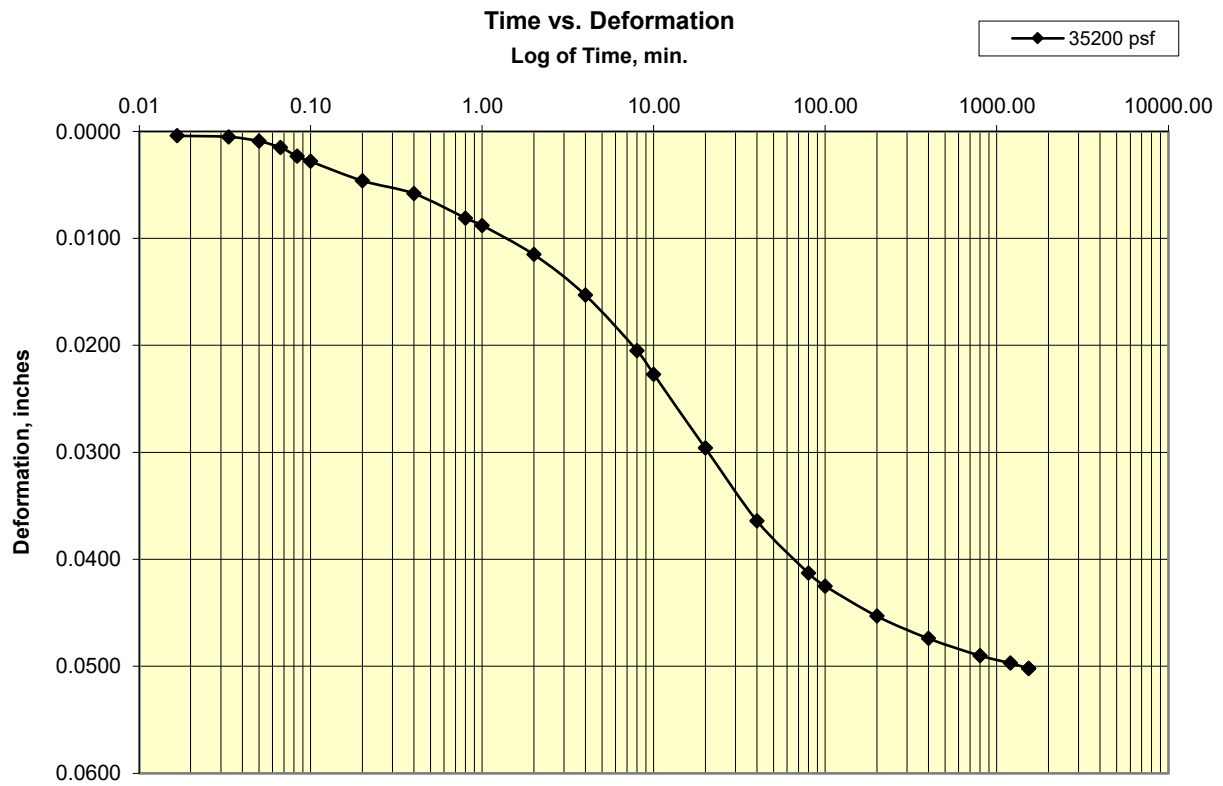
Load 11

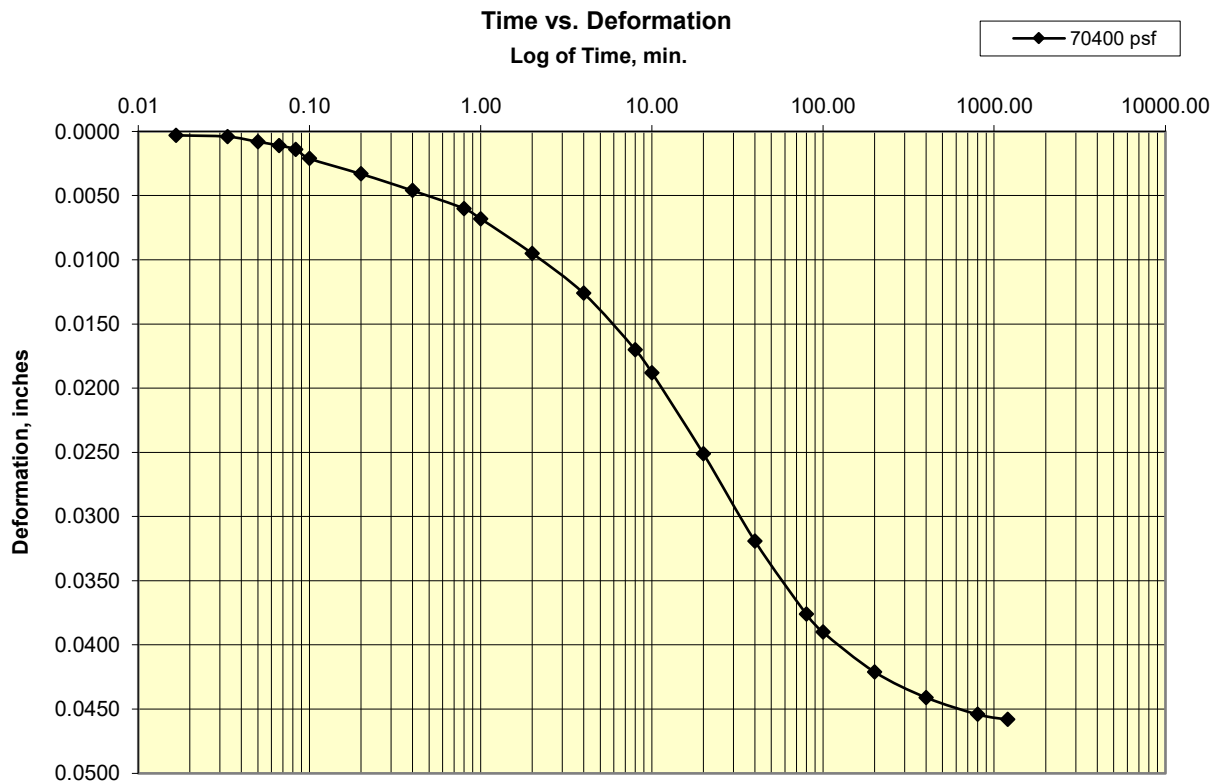
17600 psf



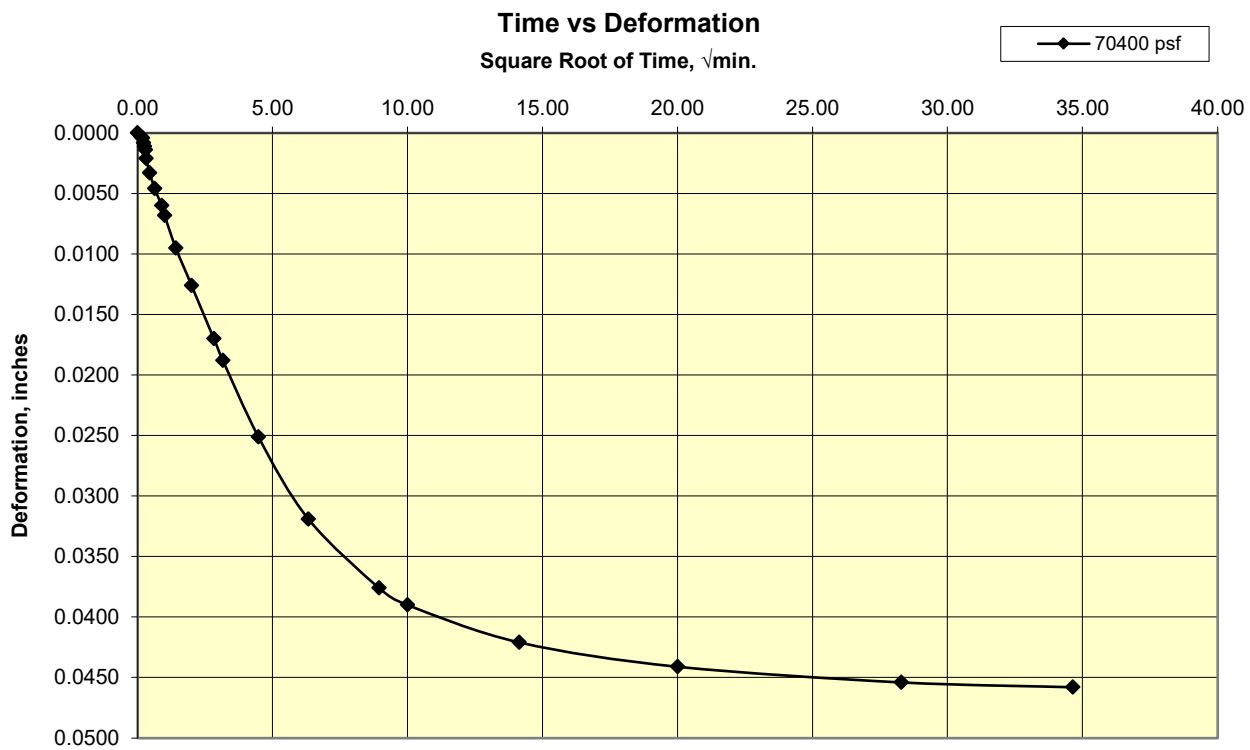
17600 psf







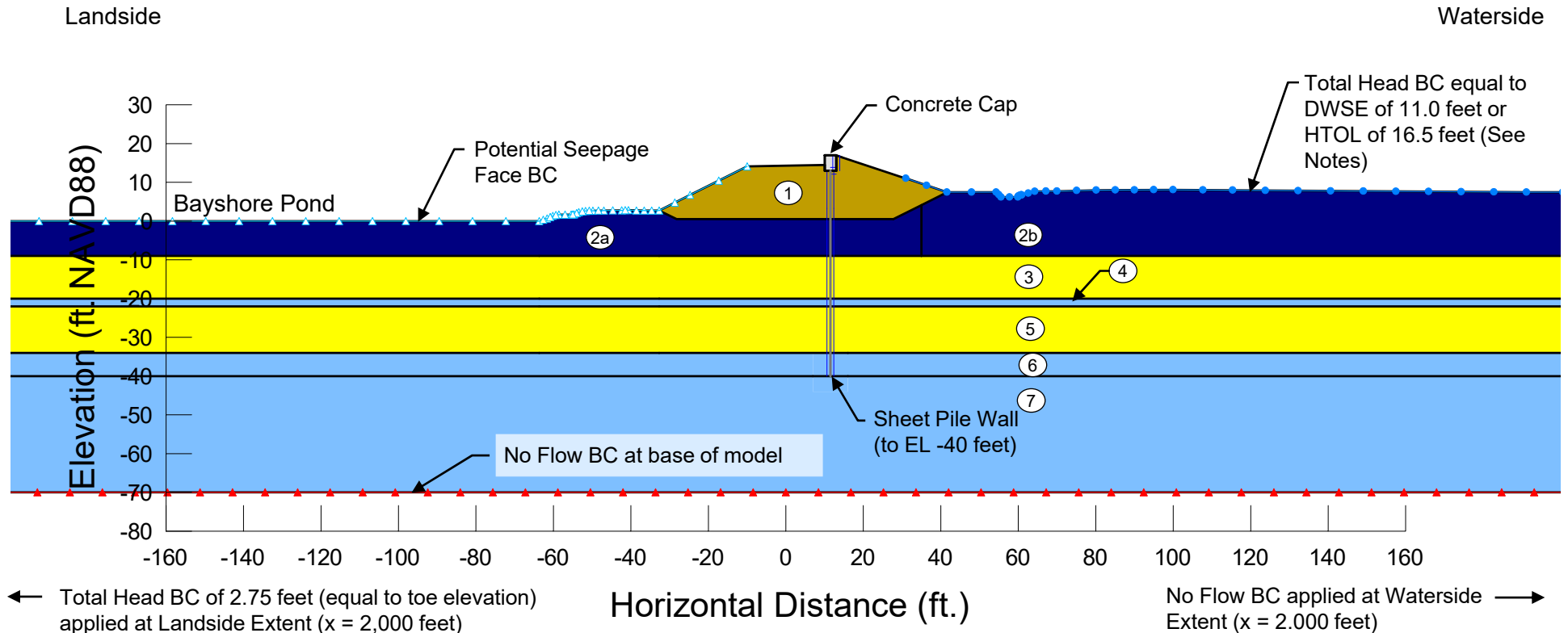
70400 psf



Appendix D. Seepage Analysis

DRAFT

Layer Number	Layer Name	k_h	k_v	k_h/k_v
		(cm/sec)	(cm/sec)	(-)
1	CL/SC - EMBANKMENT FILL	4.0E-06	1.0E-06	0.25
2	CH/OH/CL - YBM	1.0E-06	2.5E-07	0.25
3	SP - ALLUVIUM	1.0E-02	1.0E-02	1.0
4	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
5	SP - ALLUVIUM	1.0E-02	1.0E-02	1.0
6	CL/ML - ALLUVIUM	1.0E-05	2.5E-06	0.25
7	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25



Note:

1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise).
2. The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
3. The sheet pile wall is modeled as an impermeable boundary. See discussion in Section 5.4.1 of the report text.



CROSS SECTION 1 (STATION 5+30)
SEEPAGE ANALYSIS
MODEL SETUP AND MATERIAL PARAMETERS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.1

Factor of Safety for Underseepage

Average blanket unit weight = 110 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{110 - 62.4}{62.4} = 0.76$$

Required FOS = 2.0

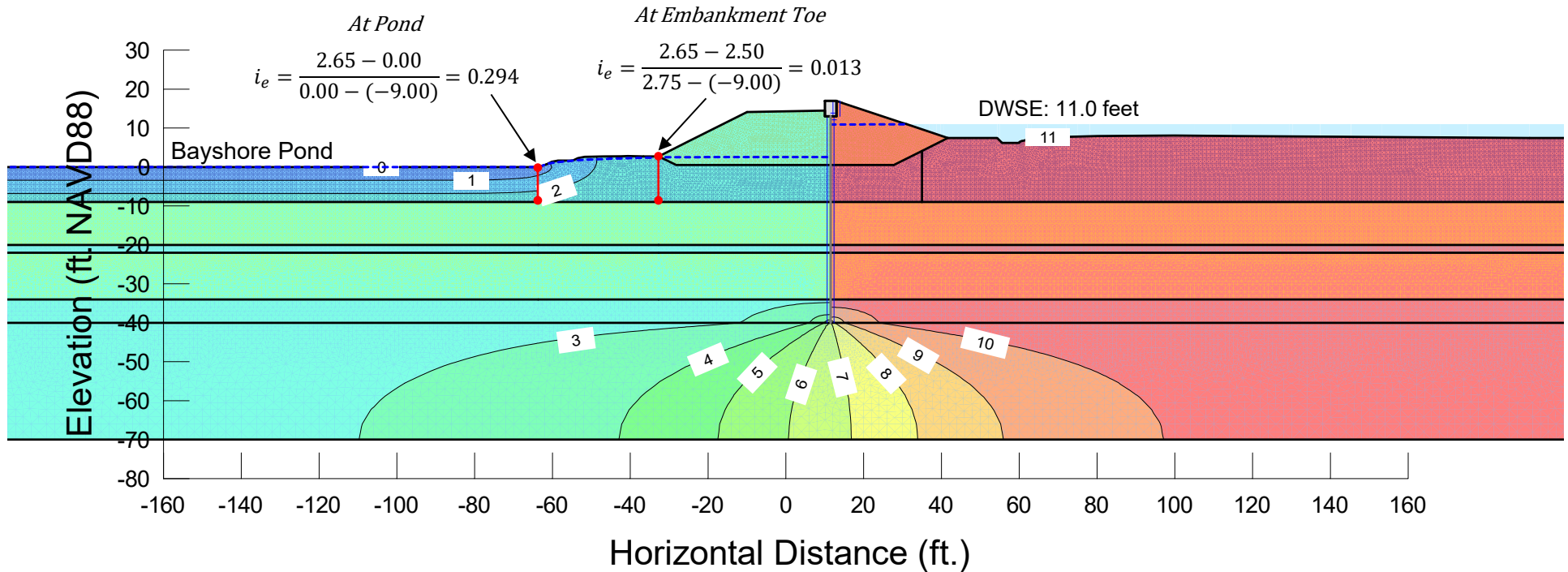
$$FOS = \frac{i_c}{i_e} = 59.5 > 2.0 \text{ (Embankment Toe)}$$

$$FOS = \frac{i_c}{i_e} = 2.58 > 2.0 \text{ (Pond)}$$

Landside

Average Vertical Gradient (Layer 2)

Waterside



CROSS SECTION 1 (STATION 5+30)
DWSE 11.0 FEET WITH WALL TO EL -40 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.2

Factor of Safety for Underseepage

Average blanket unit weight = 110 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{110 - 62.4}{62.4} = 0.76$$

Required FOS = 1.6

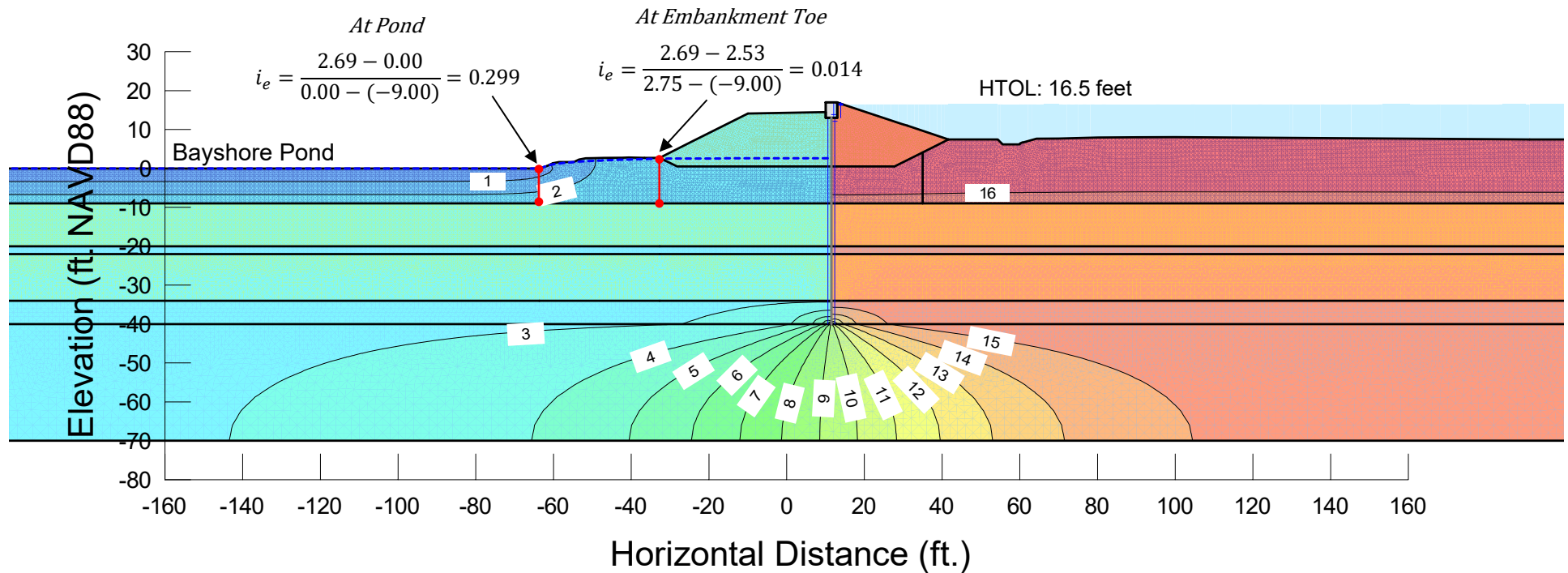
$$FOS = \frac{i_c}{i_e} = 55.8 > 1.6 \text{ (Embankment Toe)}$$

$$FOS = \frac{i_c}{i_e} = 2.54 > 1.6 \text{ (Pond)}$$

Landside

Average Vertical Gradient (Layer 2)

Waterside



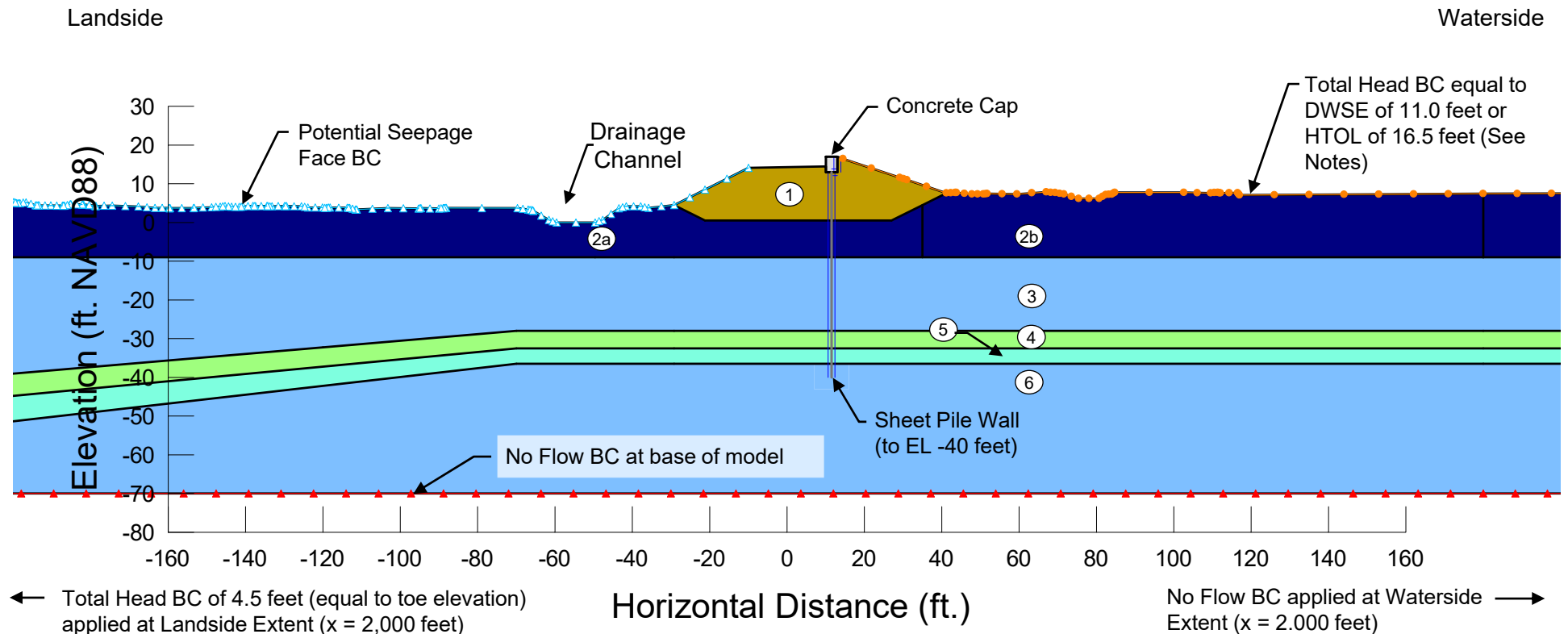
CROSS SECTION 1 (STATION 5+30)
HTOL 16.5 FEET WITH WALL TO EL -40 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.3

Layer Number	Layer Name	k_h	k_v	k_h/k_v
		(cm/sec)	(cm/sec)	(-)
1	CL/SC - EMBANKMENT FILL	4.0E-06	1.0E-06	0.25
2	CH/OH/CL - YBM	1.0E-06	2.5E-07	0.25
3	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
4	SW-SC/SC - ALLUVIUM	1.0E-03	2.5E-04	0.25
5	ML - ALLUVIUM	4.0E-05	1.0E-05	0.25
6	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25



Note:

1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise).
2. The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
3. The sheet pile wall is modeled as an impermeable boundary. See discussion in Section 5.4.1 of the report text.



CROSS SECTION 2 (STATION 16+40)
SEEPAGE ANALYSIS
MODEL SETUP AND MATERIAL PARAMETERS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.4

Factor of Safety for Underseepage

Average blanket unit weight = 115.8 – 116.8 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{112.5 - 62.4}{62.4} = 0.80$$

Required FOS = 1.6

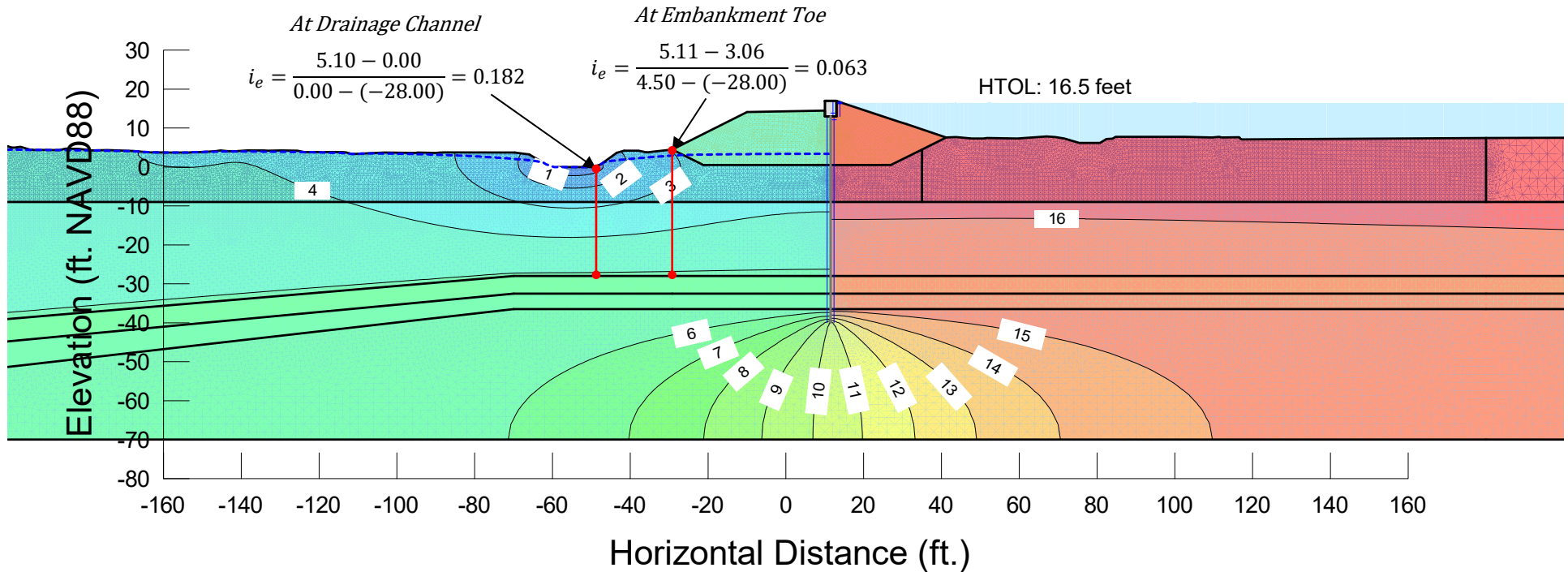
$$FOS = \frac{i_c}{i_e} = 12.7 > 1.6 \text{ (Embankment Toe)}$$

$$FOS = \frac{i_c}{i_e} = 4.39 > 1.6 \text{ (Drainage Channel)}$$

Landside

Average Vertical Gradient (Layer 2 & 3)

Waterside



CROSS SECTION 2 (STATION 16+40)
HTOL 16.5 FEET WITH WALL TO EL -40 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.6

SENSITIVITY ANALYSIS:

Sheet pile wall installed to EL -25 feet (otherwise model is unchanged from the base case).

Factor of Safety for Underseepage

Average blanket unit weight = 115.8 – 116.8 pcf

(max. 112.5 pcf for i_c)

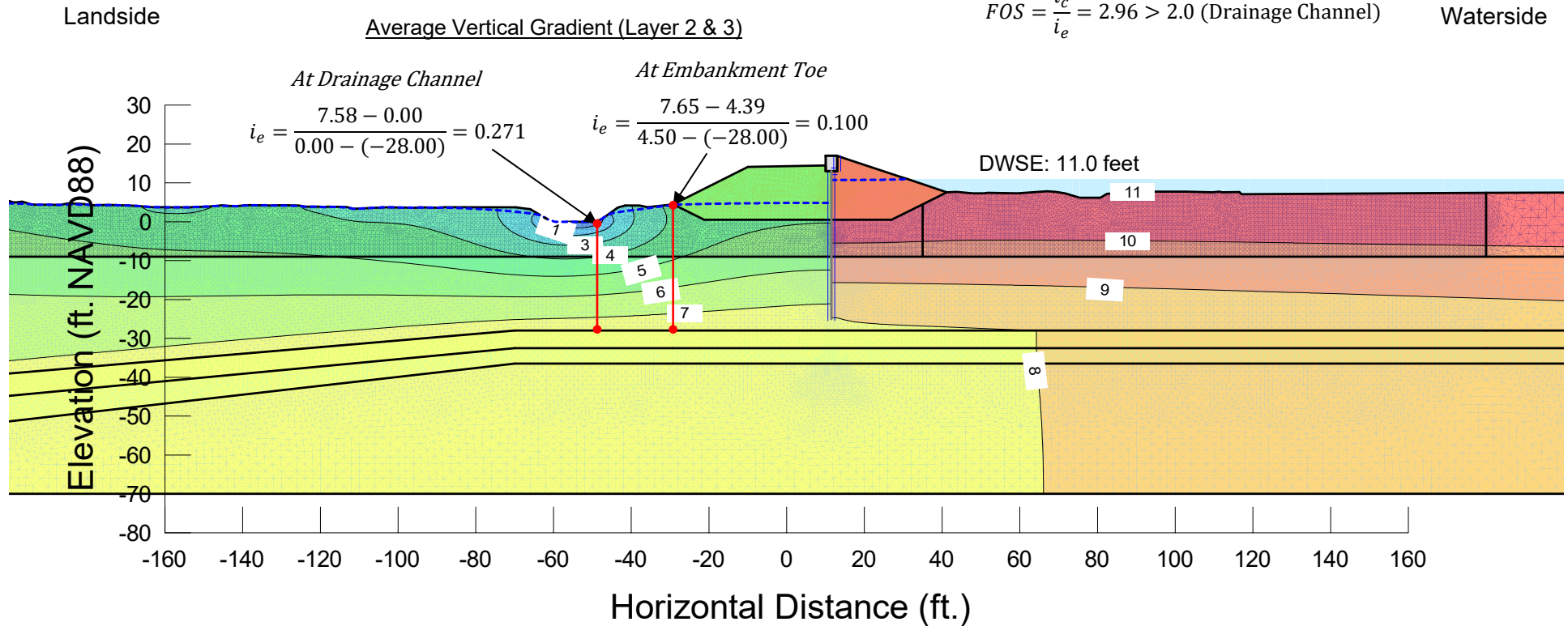
$$i_c = \frac{112.5 - 62.4}{62.4} = 0.80$$

Required FOS = 2.0

$$FOS = \frac{i_c}{i_e} = 7.98 > 2.0 \text{ (Embankment Toe)}$$

$$FOS = \frac{i_c}{i_e} = 2.96 > 2.0 \text{ (Drainage Channel)}$$

Waterside



CROSS SECTION 2 (STATION 16+40)
SENSITIVITY ANALYSIS: WALL TO EL -25 FEET (DWSE)
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.7

SENSITIVITY ANALYSIS:

Sheet pile wall installed to EL -25 feet (otherwise model is unchanged from the base case).

Factor of Safety for Underseepage

Average blanket unit weight = 115.8 – 116.8 pcf

(max. 112.5 pcf for i_c)

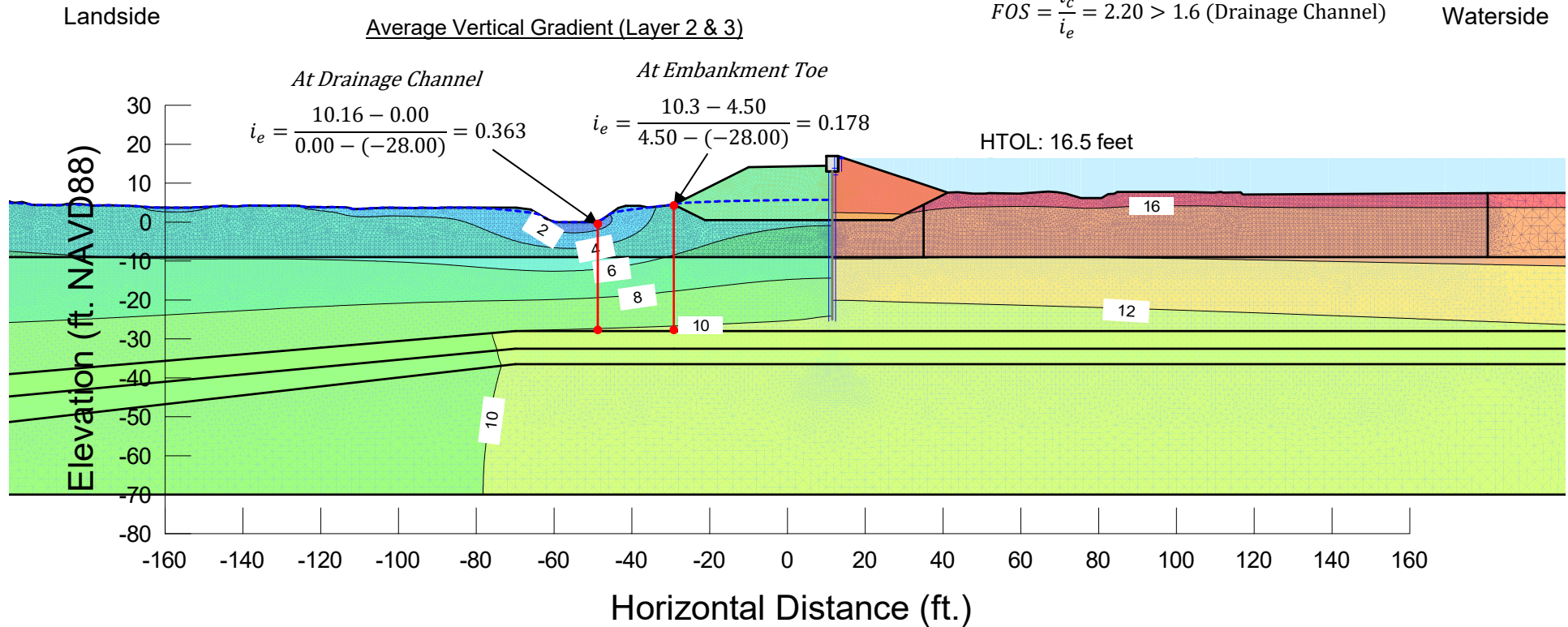
$$i_c = \frac{112.5 - 62.4}{62.4} = 0.80$$

Required FOS = 1.6

$$FOS = \frac{i_c}{i_e} = 4.48 > 1.6 \text{ (Embankment Toe)}$$

$$FOS = \frac{i_c}{i_e} = 2.20 > 1.6 \text{ (Drainage Channel)}$$

Waterside



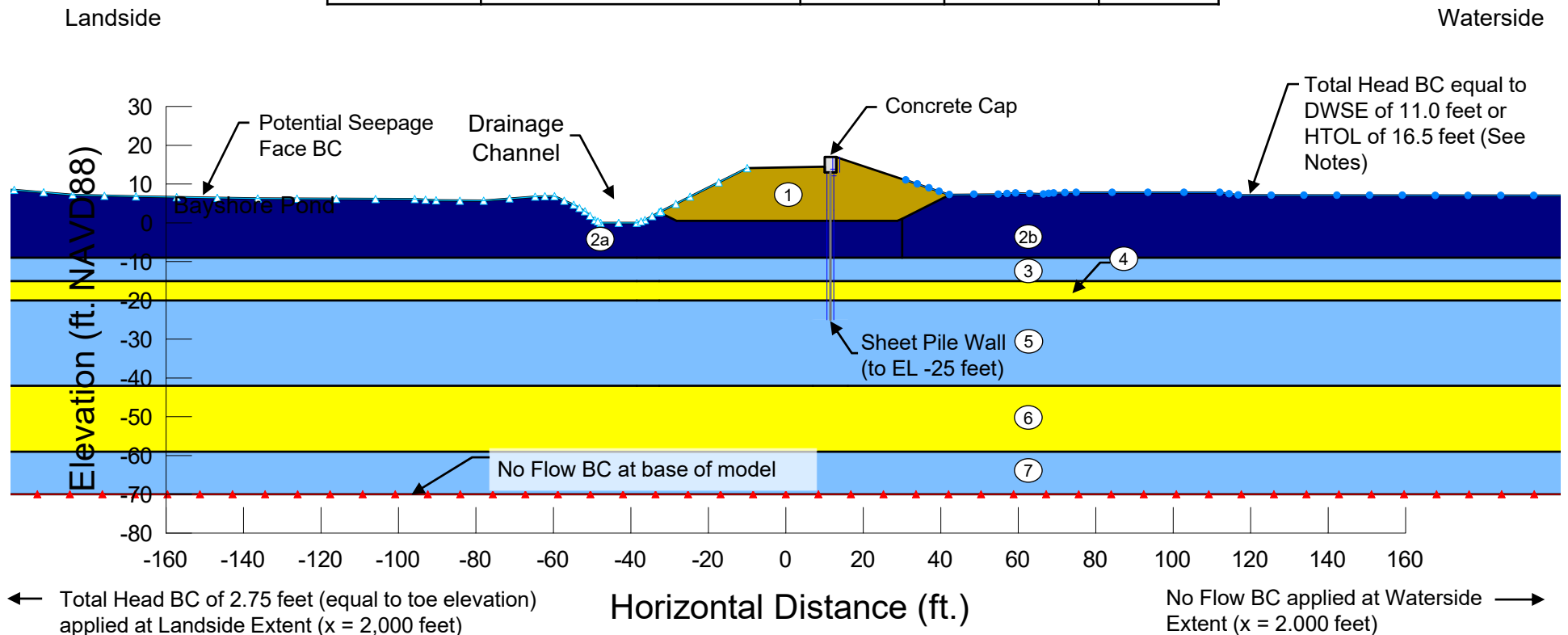
CROSS SECTION 2 (STATION 16+40)
SENSITIVITY ANALYSIS: WALL TO EL -25 FEET (HTOL)
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.8

Layer Number	Layer Name	k_h	k_v	k_h/k_v
		(cm/sec)	(cm/sec)	(-)
1	CL/SC - EMBANKMENT FILL	4.0E-06	1.0E-06	0.25
2	CH/OH/CL - YBM	1.0E-06	2.5E-07	0.25
3	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
4	SP - ALLUVIUM	1.0E-02	1.0E-02	1.0
5	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
6	SP - ALLUVIUM	1.0E-02	1.0E-02	1.0
7	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25



Note:

1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise).
2. The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
3. The sheet pile wall is modeled as an impermeable boundary. See discussion in Section 5.4.1 of the report text.



CROSS SECTION 3 (STATION 26+00)
SEEPAGE ANALYSIS
MODEL SETUP AND MATERIAL PARAMETERS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.9

Factor of Safety for Underseepage

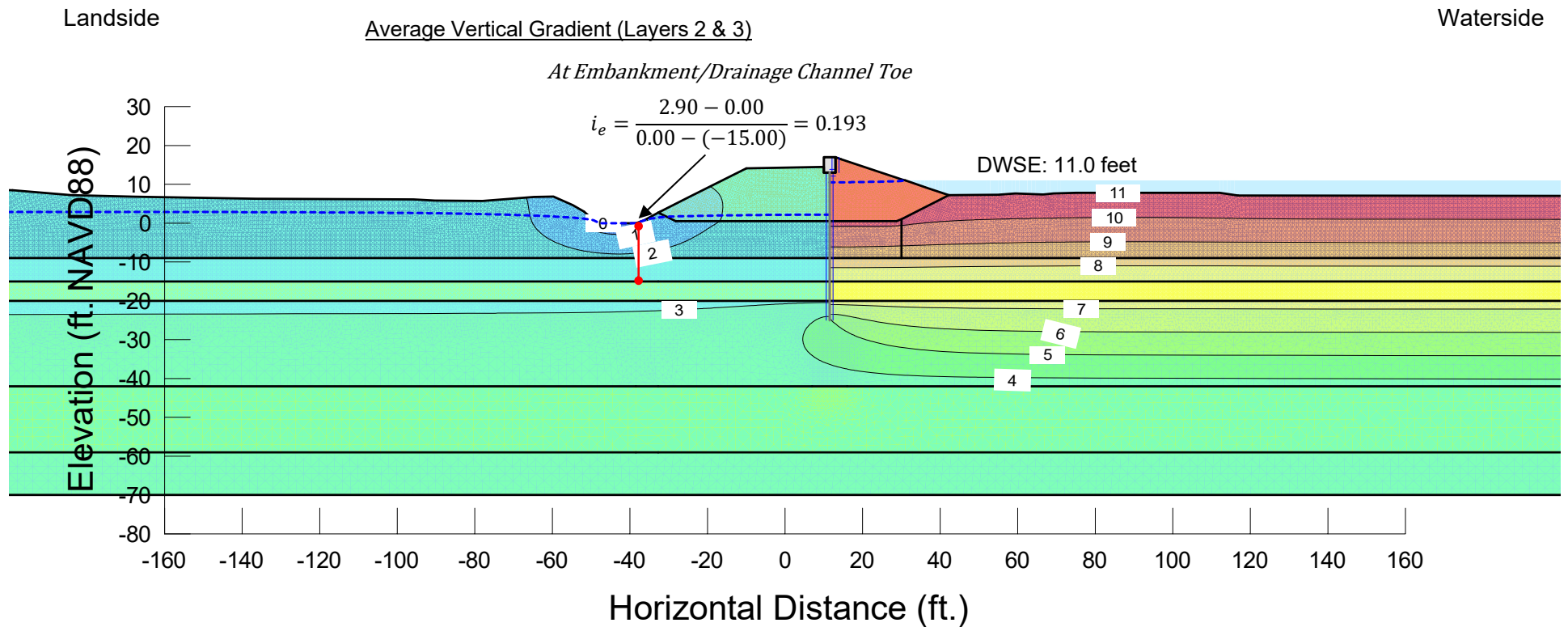
Average blanket unit weight = 110 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{110 - 62.4}{62.4} = 0.76$$

Required FOS = 2.0

$$FOS = \frac{i_c}{i_e} = 3.93 > 2.0$$



CROSS SECTION 3 (STATION 26+00)
DWSE 11.0 FEET WITH WALL TO EL -25 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.10

Factor of Safety for Underseepage

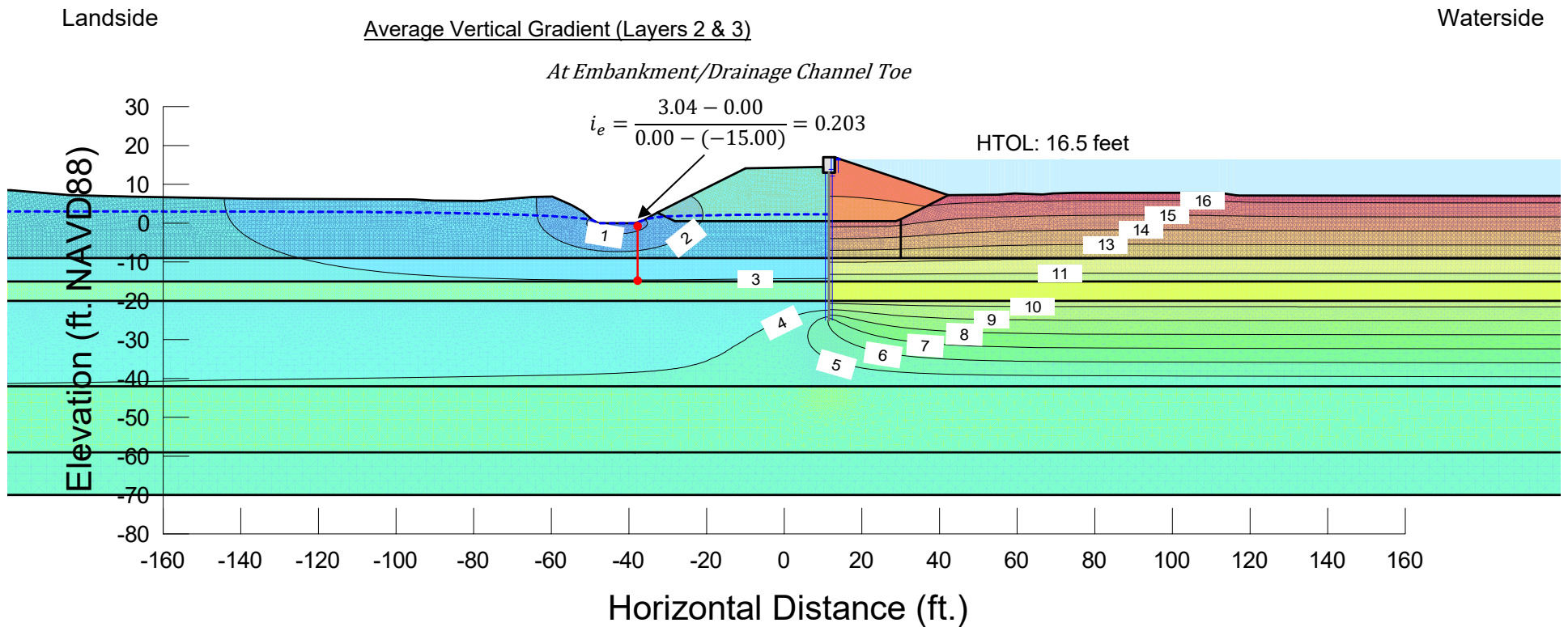
Average blanket unit weight = 110 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{110 - 62.4}{62.4} = 0.76$$

Required FOS = 1.6

$$FOS = \frac{i_c}{i_e} = 3.75 > 1.6$$



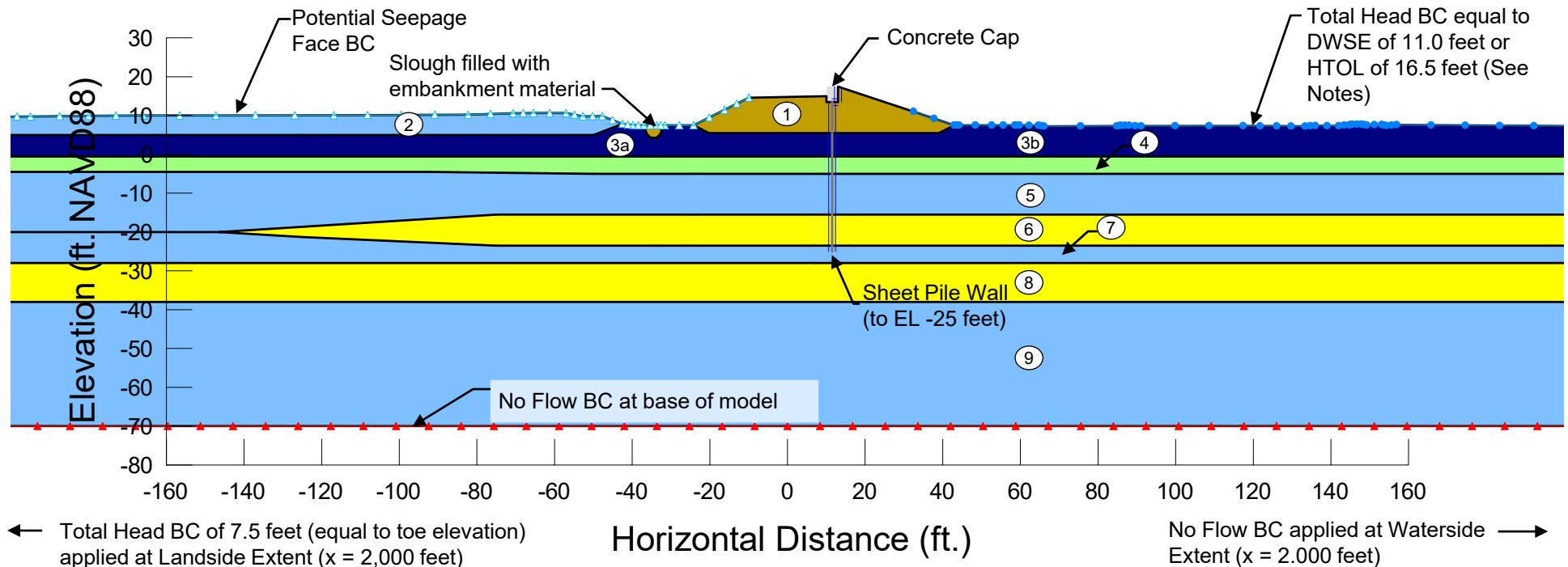
CROSS SECTION 3 (STATION 26+00)
HTOL 16.5 FEET WITH WALL TO EL -25 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.11

Layer Number	Layer Name	k_h	k_v	k_h/k_v
		(cm/sec)	(cm/sec)	(-)
1	CL/SC - EMBANKMENT FILL	4.0E-06	1.0E-06	0.25
2	CL/SC - EXISTING FILL	4.0E-06	1.0E-06	0.25
3	CH/OH/CL - YBM	1.0E-06	2.5E-07	0.25
4	SM/SC-SM/ML - ALLUVIUM	1.0E-04	2.5E-05	0.25
5	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
6	SP - ALLUVIUM	1.0E-02	1.0E-02	1.0
7	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
8	SP - ALLUVIUM	1.0E-02	1.0E-02	1.0
9	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25



Note:

1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise).
2. The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
3. The sheet pile wall is modeled as an impermeable boundary. See discussion in Section 5.4.1 of the report text.



CROSS SECTION 4 (STATION 37+65)
SEEPAGE ANALYSIS
MODEL SETUP AND MATERIAL PARAMETERS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.12

Factor of Safety for Underseepage

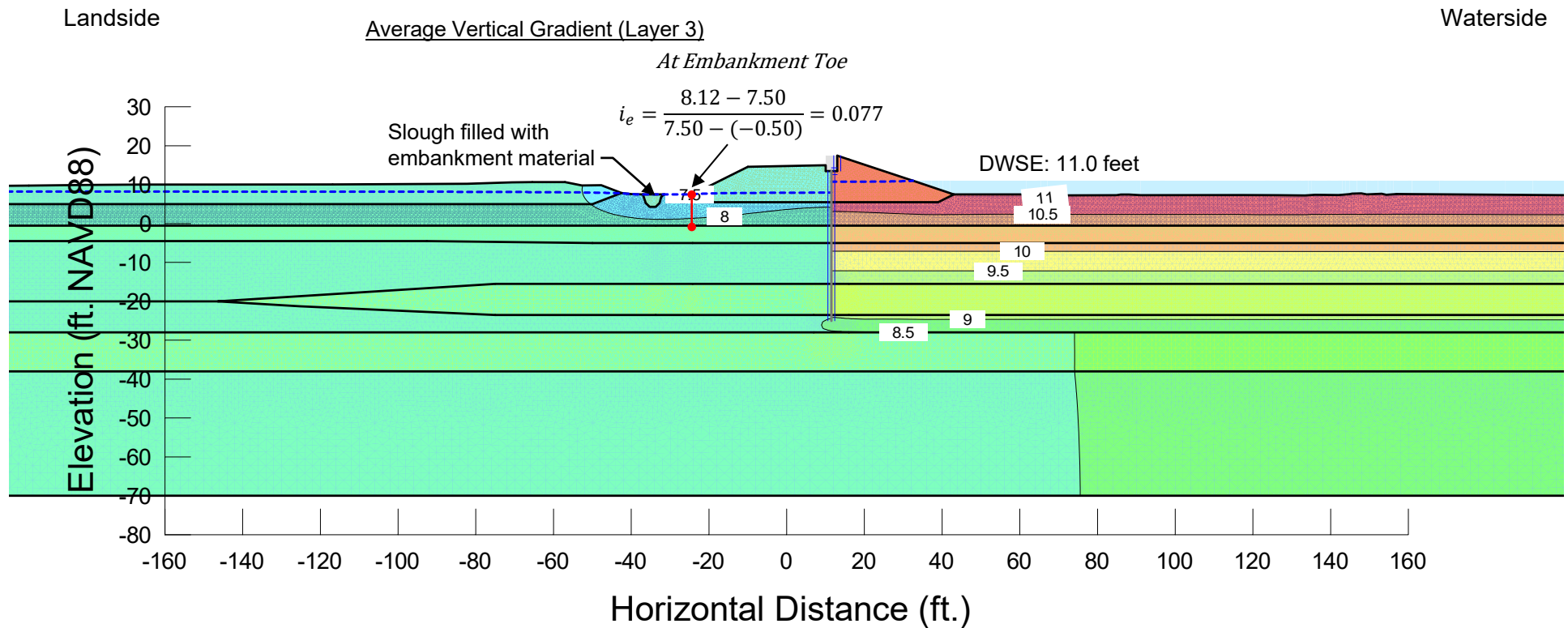
Average blanket unit weight = 100 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{100 - 62.4}{62.4} = 0.60$$

Required FOS = 2.0

$$FOS = \frac{i_c}{i_e} = 7.74 > 2.0$$



CROSS SECTION 4 (STATION 37+65)
DWSE 11.0 FEET WITH WALL TO EL -25 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.13

Factor of Safety for Underseepage

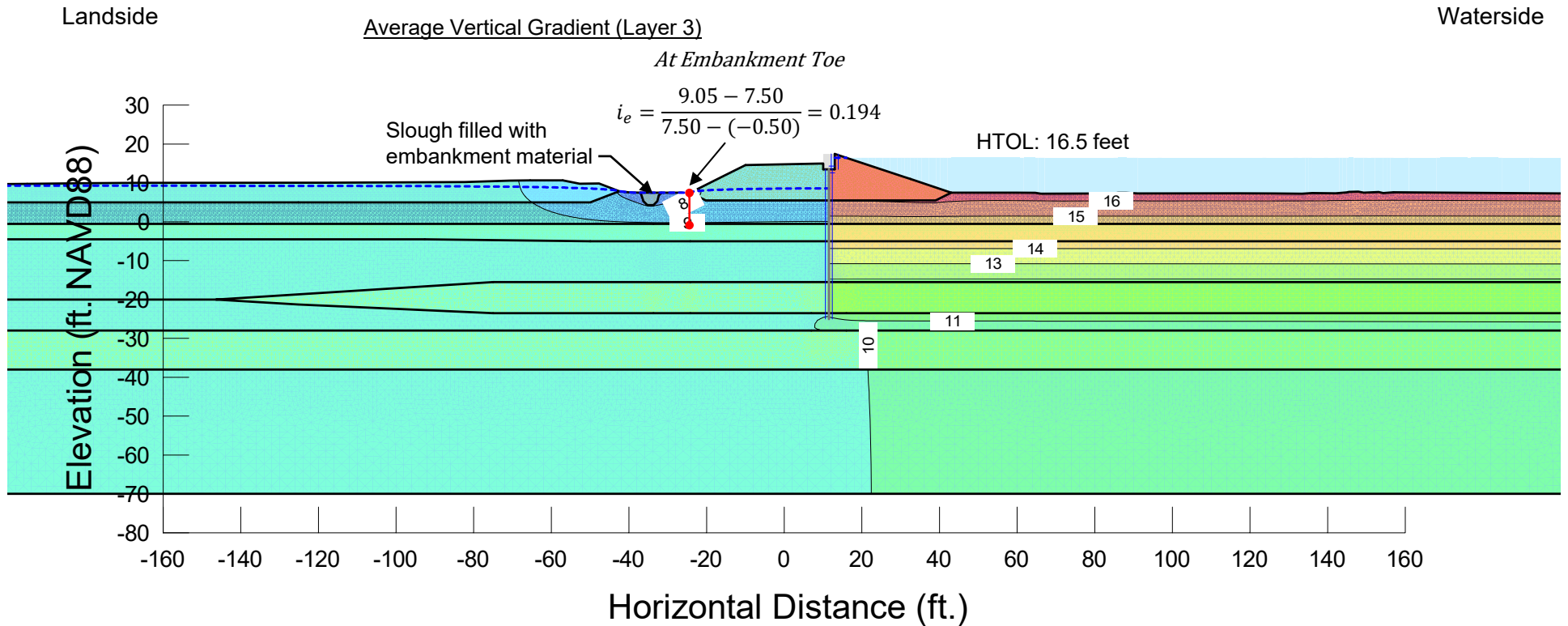
Average blanket unit weight = 100 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{100 - 62.4}{62.4} = 0.60$$

Required FOS = 1.6

$$FOS = \frac{i_c}{i_e} = 3.10 > 1.6$$



CROSS SECTION 4 (STATION 37+65)
HTOL 16.5 FEET WITH WALL TO EL -25 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.14

SENSITIVITY ANALYSIS:

Slough to the landside of the embankment is not filled in with engineered fill (otherwise model is unchanged from the base case).

Factor of Safety for Underseepage

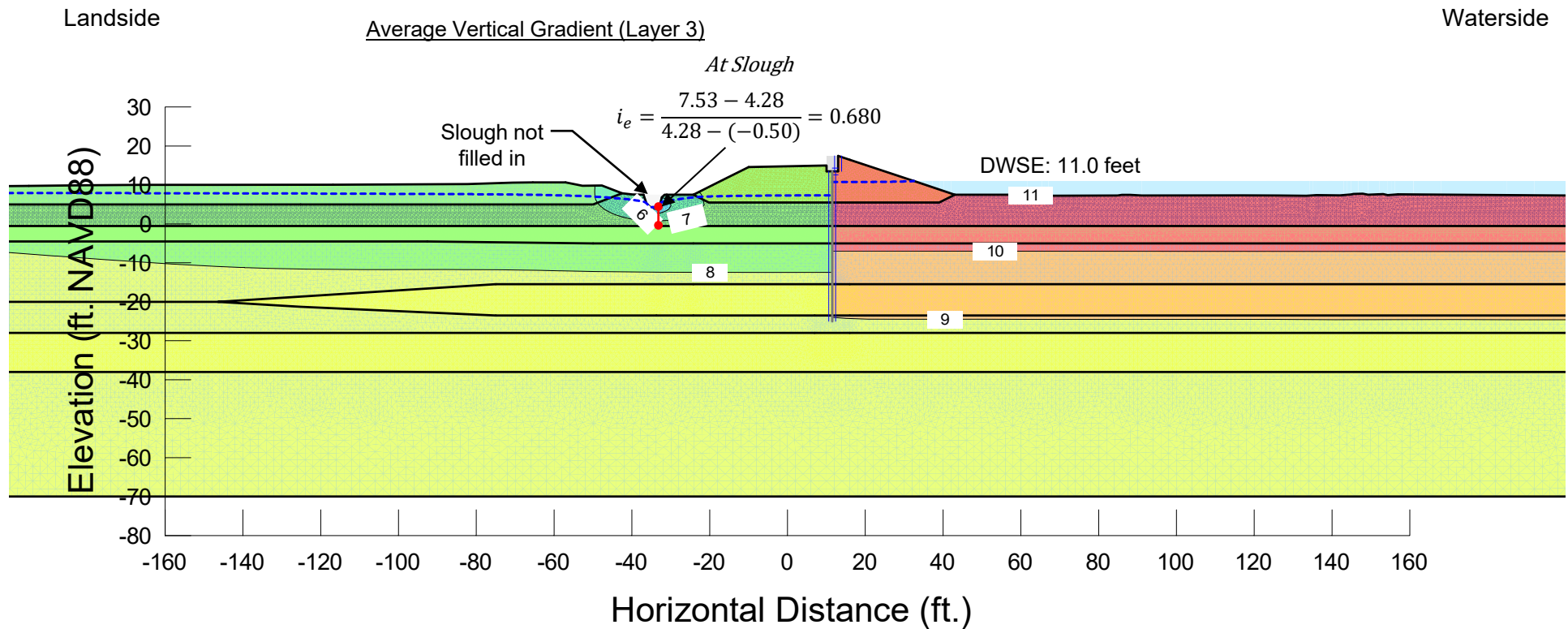
Average blanket unit weight = 100 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{100 - 62.4}{62.4} = 0.60$$

Required FOS = 2.0

$$FOS = \frac{i_c}{i_e} = 0.88 < 2.0 \quad (\text{Does not meet required FOS criterion})$$



CROSS SECTION 4 (STATION 37+65)
SENSITIVITY ANALYSIS: SLOUGH NOT FILLED IN (DWSE)
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.15

SENSITIVITY ANALYSIS:

Slough to the landside of the embankment is not filled in with engineered fill (otherwise model is unchanged from the base case).

Factor of Safety for Underseepage

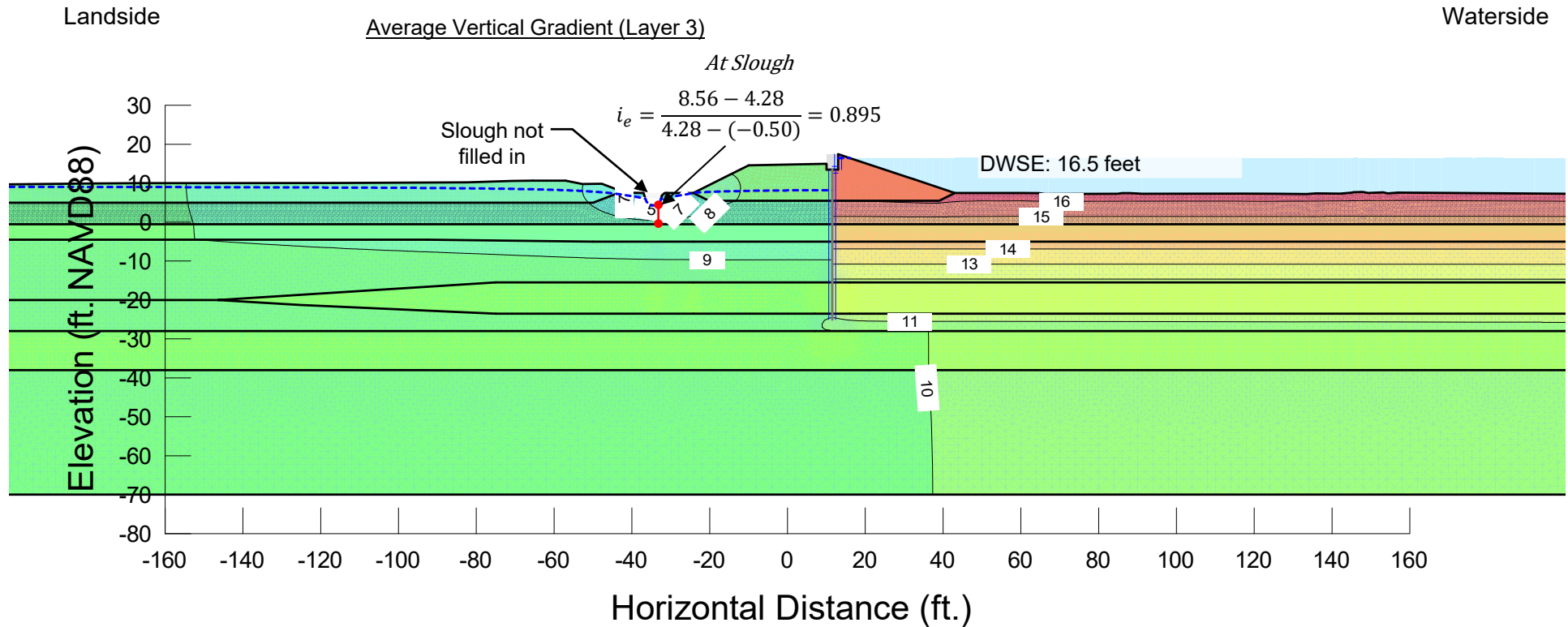
Average blanket unit weight = 100 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{100 - 62.4}{62.4} = 0.60$$

Required FOS = 1.6

$$FOS = \frac{i_c}{i_e} = 0.67 < 1.6 \text{ (Does not meet required FOS criterion)}$$



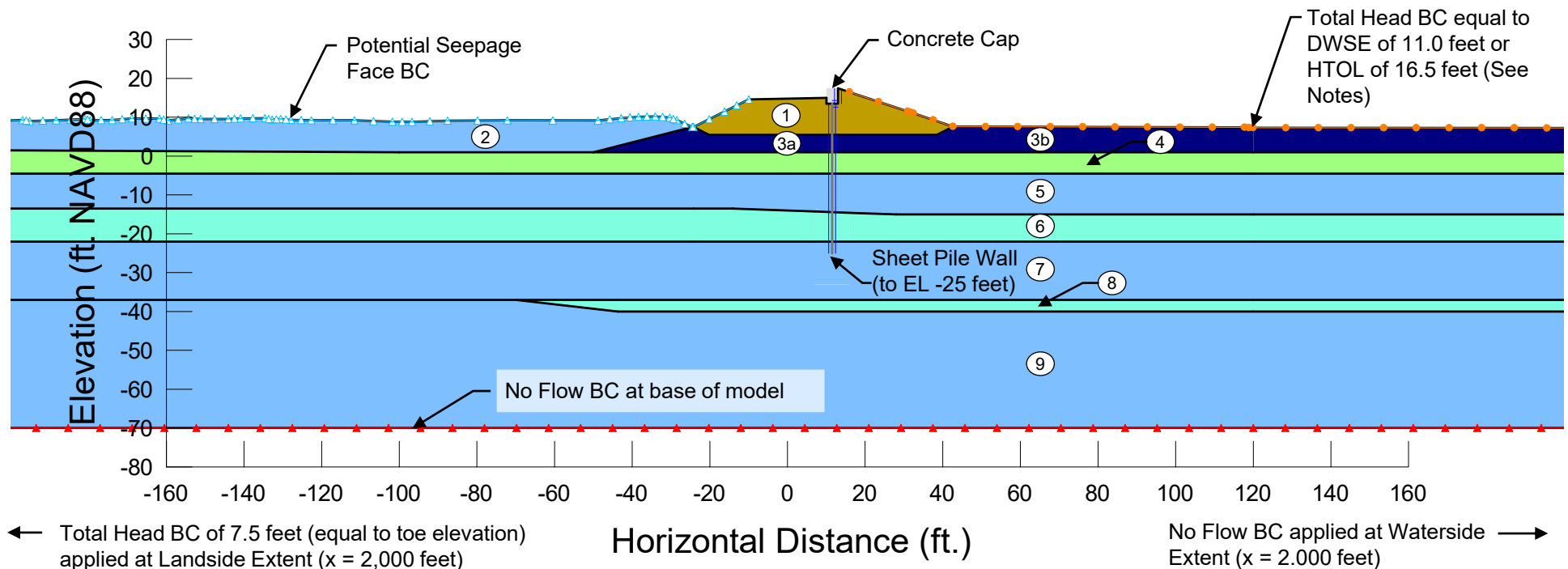
CROSS SECTION 4 (STATION 37+65)
SENSITIVITY ANALYSIS: SLOUGH NOT FILLED IN (HTOL)
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.16

Layer Number	Layer Name	k_h	k_v	k_h/k_v
		(cm/sec)	(cm/sec)	(-)
1	CL/SC - EMBANKMENT FILL	4.0E-06	1.0E-06	0.25
2	CL/SC - EXISTING FILL	4.0E-06	1.0E-06	0.25
3	CH/OH/CL - YBM	1.0E-06	2.5E-07	0.25
4	SM/SC-SM/ML - ALLUVIUM	1.0E-04	2.5E-05	0.25
5	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
6	SC - ALLUVIUM	1.0E-04	2.5E-05	0.25
7	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25
8	SC - ALLUVIUM	1.0E-04	2.5E-05	0.25
9	CL - ALLUVIUM	1.0E-06	2.5E-07	0.25



Note:

1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise).
2. The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
3. The sheet pile wall is modeled as an impermeable boundary. See discussion in Section 5.4.1 of the report text.



CROSS SECTION 5 (STATION 44+00)
 SEEPAGE ANALYSIS
 MODEL SETUP AND MATERIAL PARAMETERS
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 D.17

Factor of Safety for Underseepage

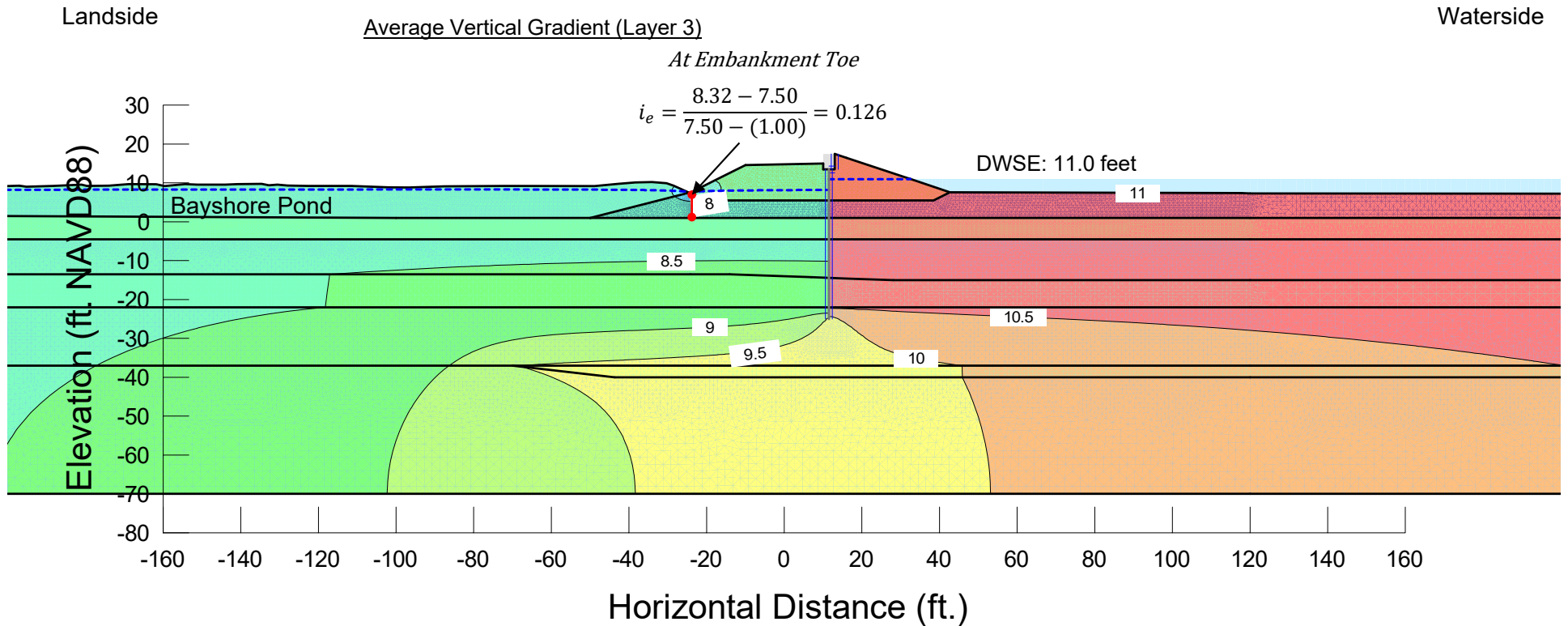
Average blanket unit weight = 100 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{100 - 62.4}{62.4} = 0.60$$

Required FOS = 2.0

$$FOS = \frac{i_c}{i_e} = 4.76 > 2.0$$



CROSS SECTION 5 (STATION 44+00)
DWSE 11.0 FEET WITH WALL TO EL -25 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
D.18

Factor of Safety for Underseepage

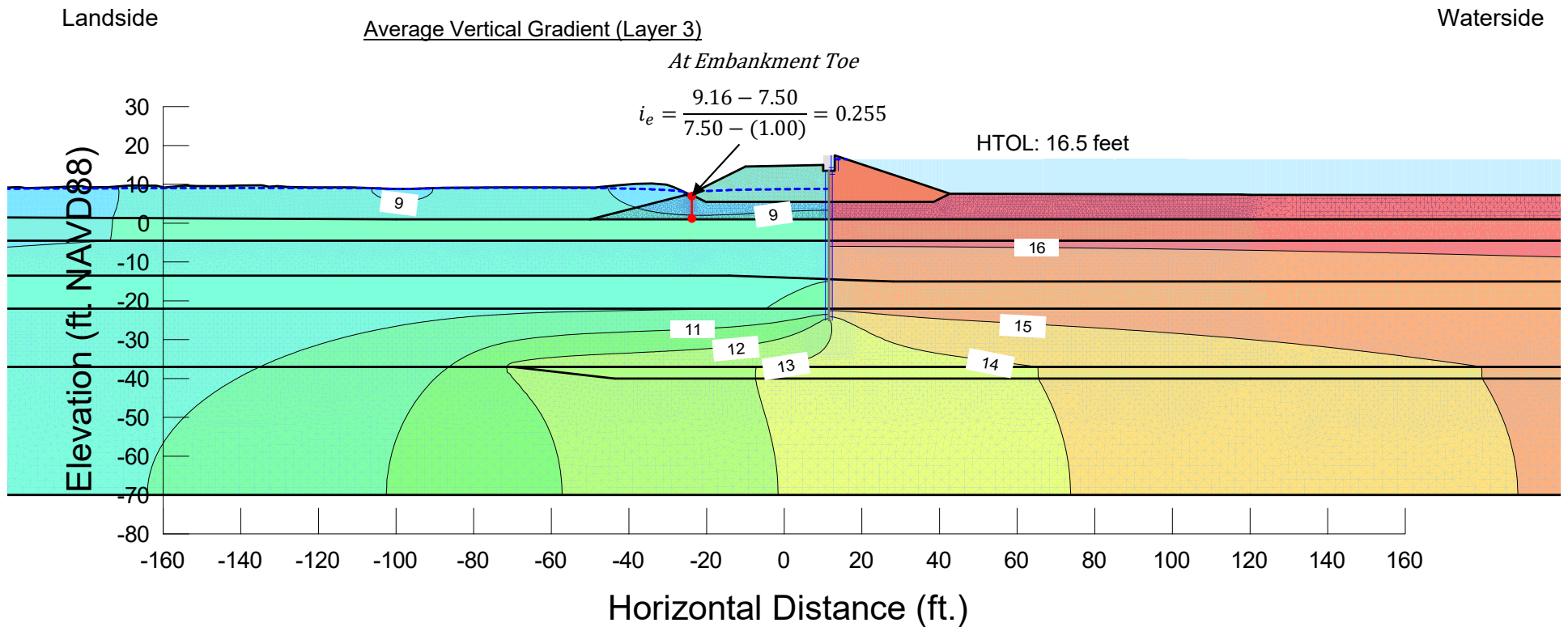
Average blanket unit weight = 100 pcf

(max. 112.5 pcf for i_c)

$$i_c = \frac{100 - 62.4}{62.4} = 0.60$$

Required FOS = 1.6

$$FOS = \frac{i_c}{i_e} = 2.35 > 1.6$$



CROSS SECTION 5 (STATION 44+00)
HTOL 16.5 FEET WITH WALL TO EL -25 FEET
STEADY STATE SEEPAGE RESULTS

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

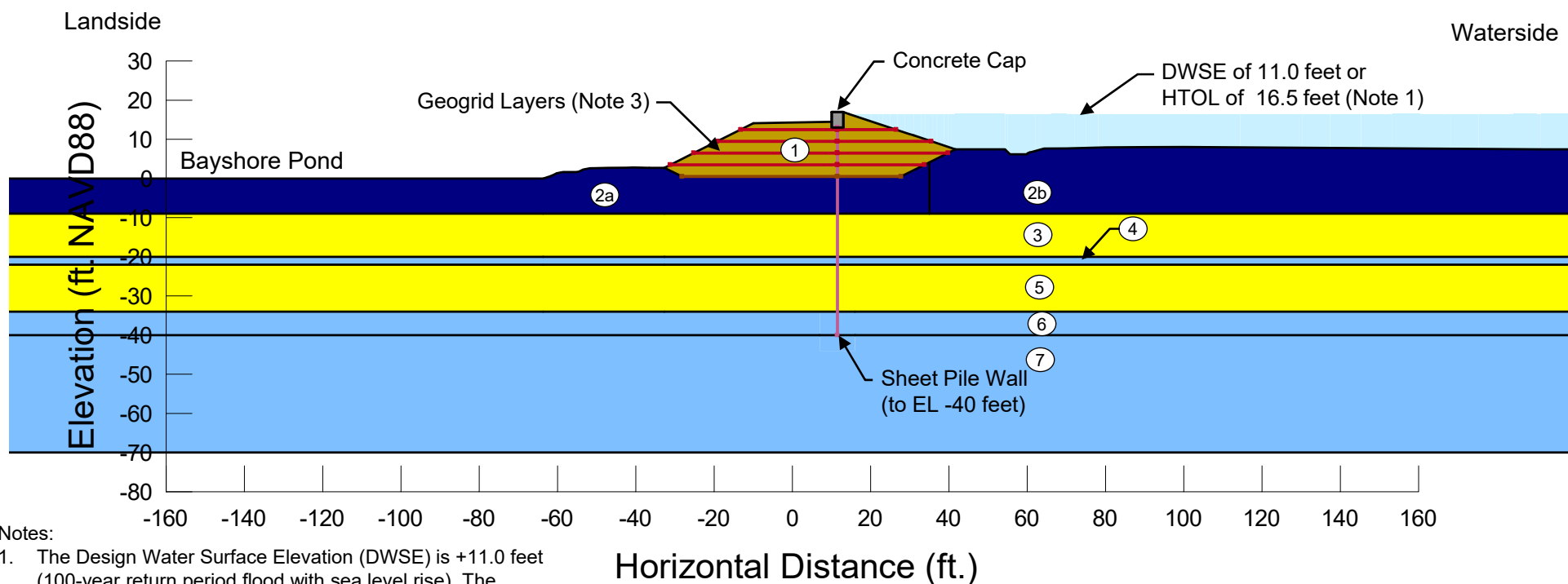
Date
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Figure
D.19

Appendix E. Stability Analysis

DRAFT

Layer Number	Layer Name	Saturated Unit Weight (pcf)	Drained Parameters		Undrained Parameters (Note 2)		
			ϕ' (deg.)	c' (psf)	ϕ_R (deg.)	c_R (psf)	S_u (psf)
1	CL/SC - Embankment FILL	125	30	75	0	750	750
2a	CH/OH/CL - YBM	110	29	0	0	300	300 – 425
2b	CH/OH/CL - YBM (MARSH)	100	29	0	0	225	200 – 250
3	SP - ALLUVIUM	125	36	0	--	--	--
4	CL - ALLUVIUM	120	30	50	0	900	900
5	SP - ALLUVIUM	125	36	0	--	--	--
6	CL/ML - ALLUVIUM	120	30	50	0	1200	1200
7	CL - ALLUVIUM	120	30	50	0	1200	1200



Notes:

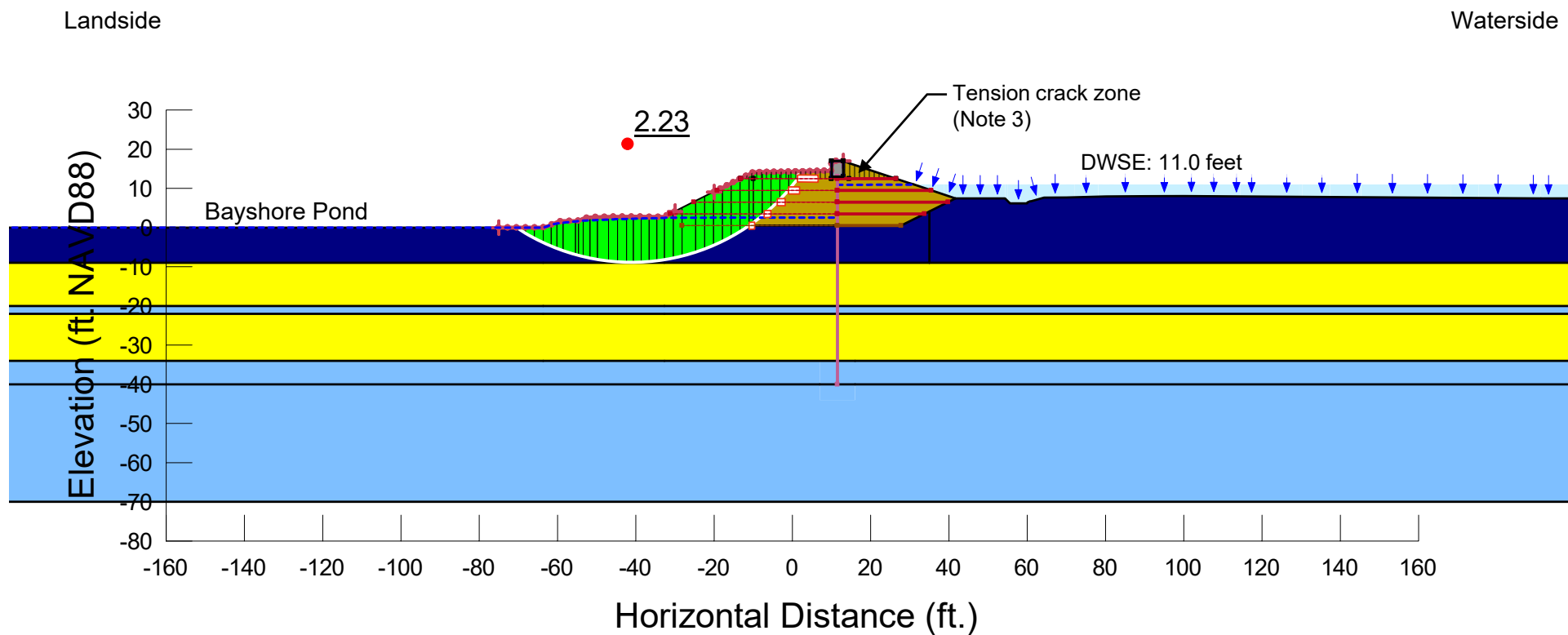
1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise). The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
2. Total strength parameters c_R and ϕ_R are used for waterside rapid drawdown (RDD) analyses. Undrained strength (S_u) is used to end of construction (EOC) and seismic stability analyses.
3. Geogrid layers are spaced at 3 feet vertically starting from the based on the embankment. Layers on each side of the sheet pile wall are modeled as separate (discrete) layers.



CROSS SECTION 1 (STATION 5+30)
 STABILITY ANALYSIS
 MODEL SETUP AND MATERIAL PARAMETERS
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.1



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

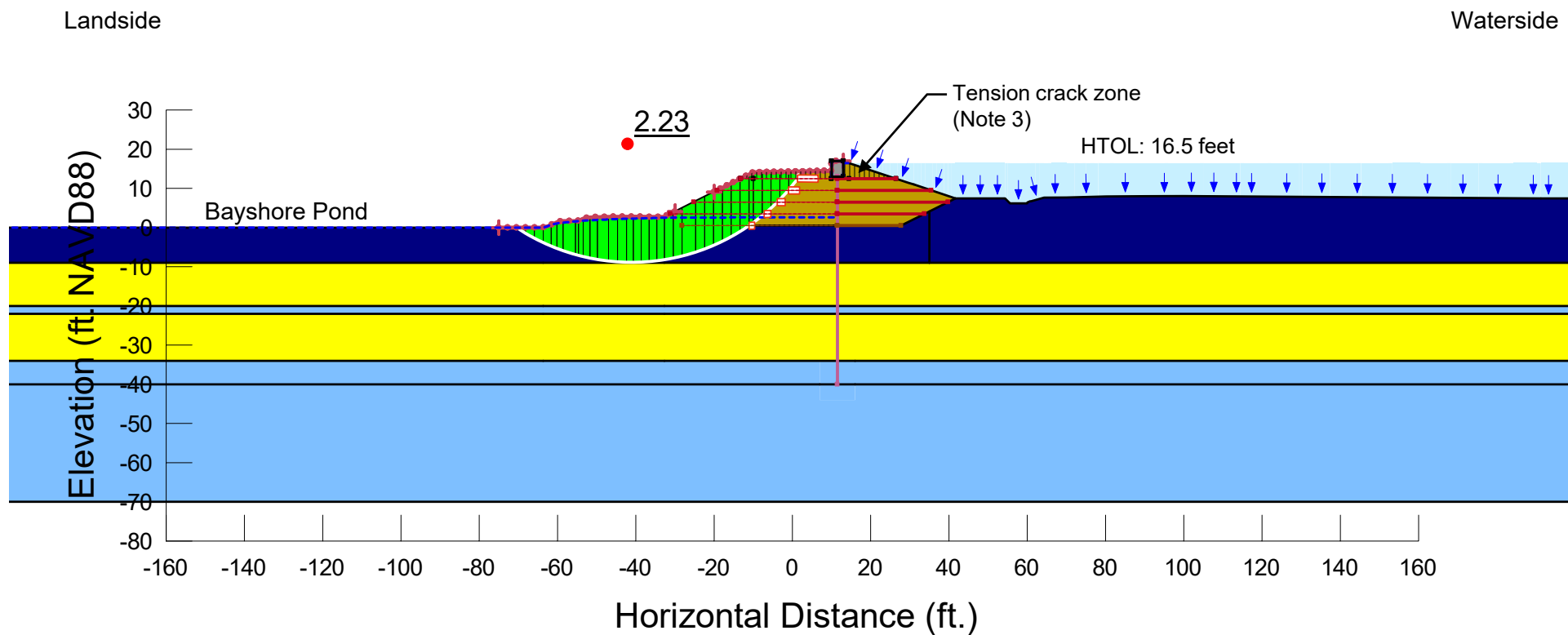


CROSS SECTION 1 (STATION 5+30)
 DWSE (11.0 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.2



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the HTOL of +16.5 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

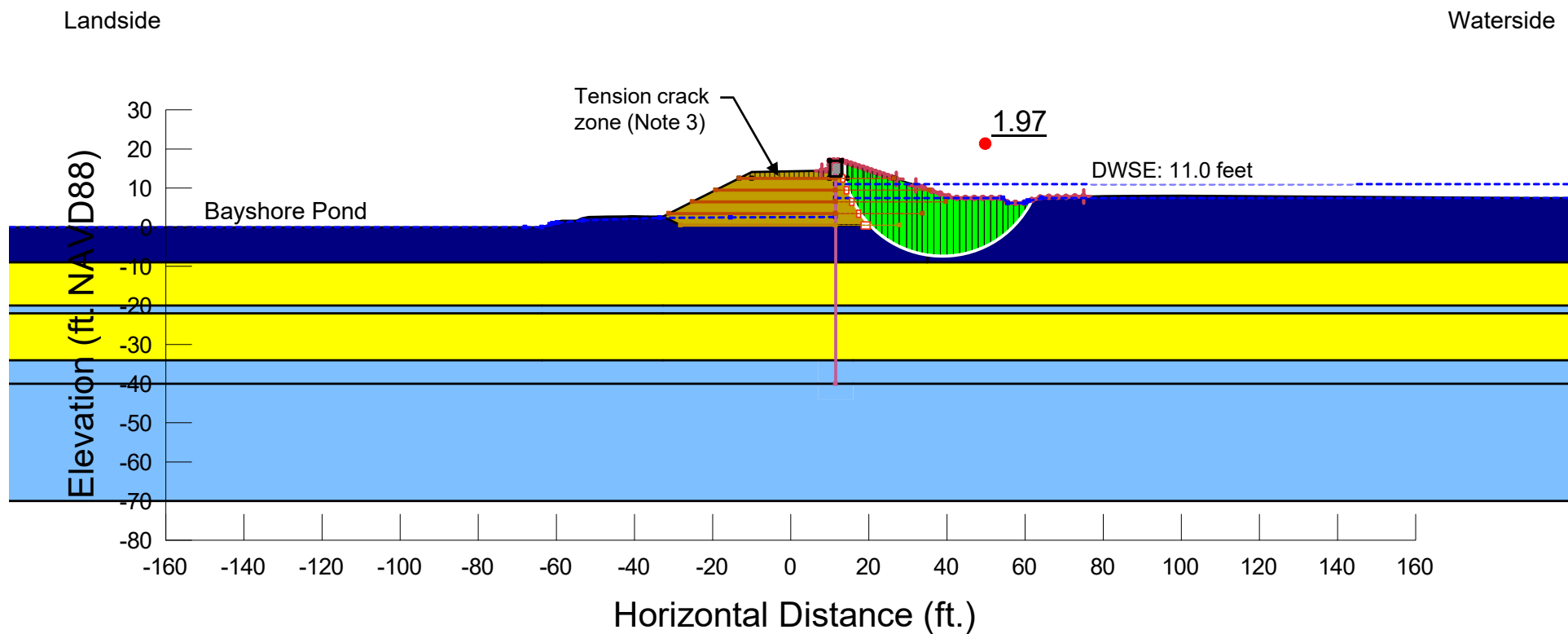


CROSS SECTION 1 (STATION 5+30)
HTOL (16.5 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
LANDSIDE STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.3



Notes:

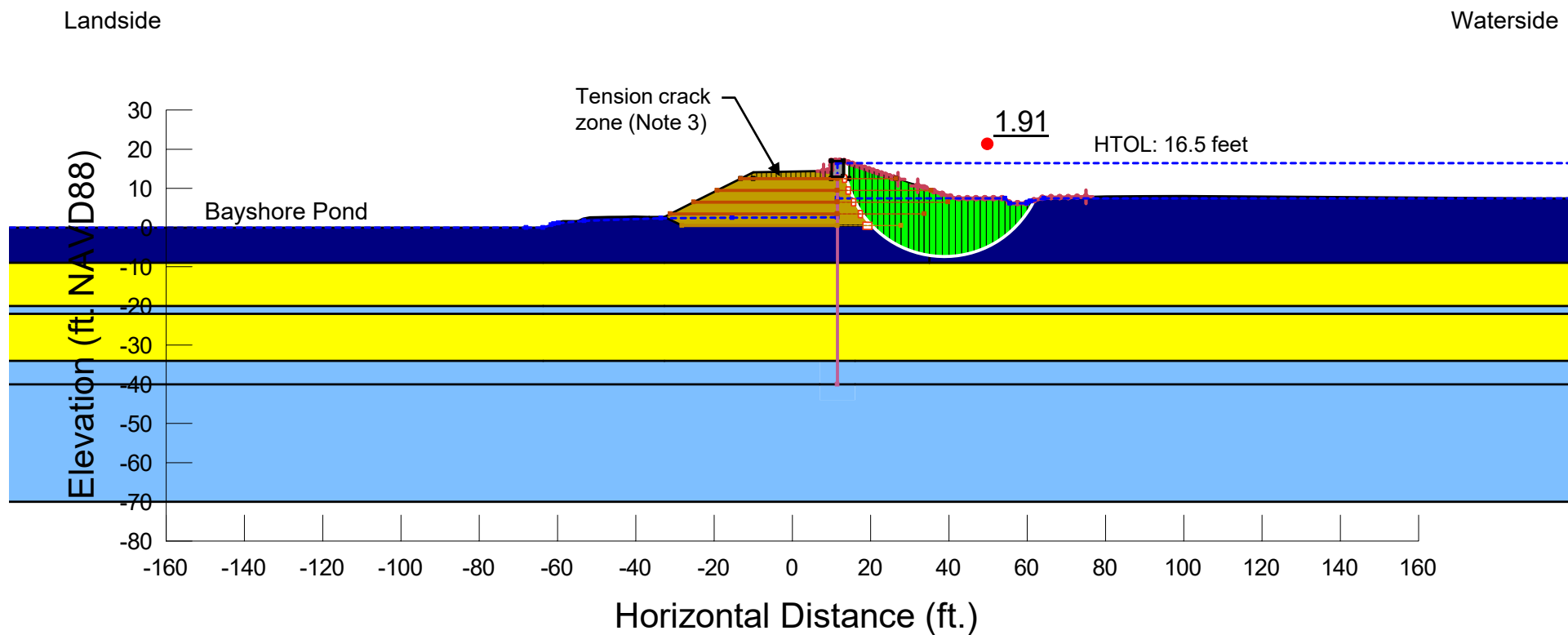
1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 1 (STATION 5+30)
 DWSE (11.0 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.4



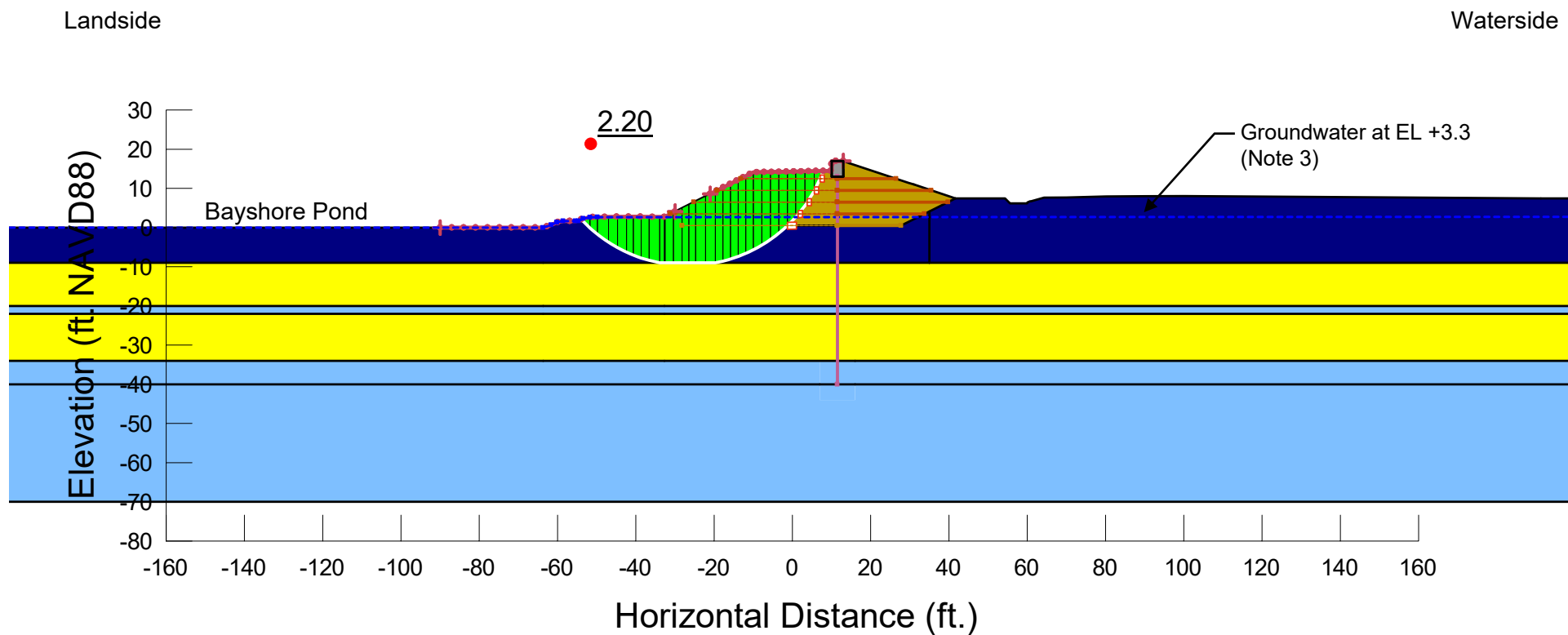
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 1 (STATION 5+30)
 HTOL (16.5 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date	JUNE 2024
Figure	E.5



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. End of construction (EOC) stability is shown only on the more critical side of the embankment.
3. The groundwater table for end of construction stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. Tension cracks are not applied for end of construction stability analysis.



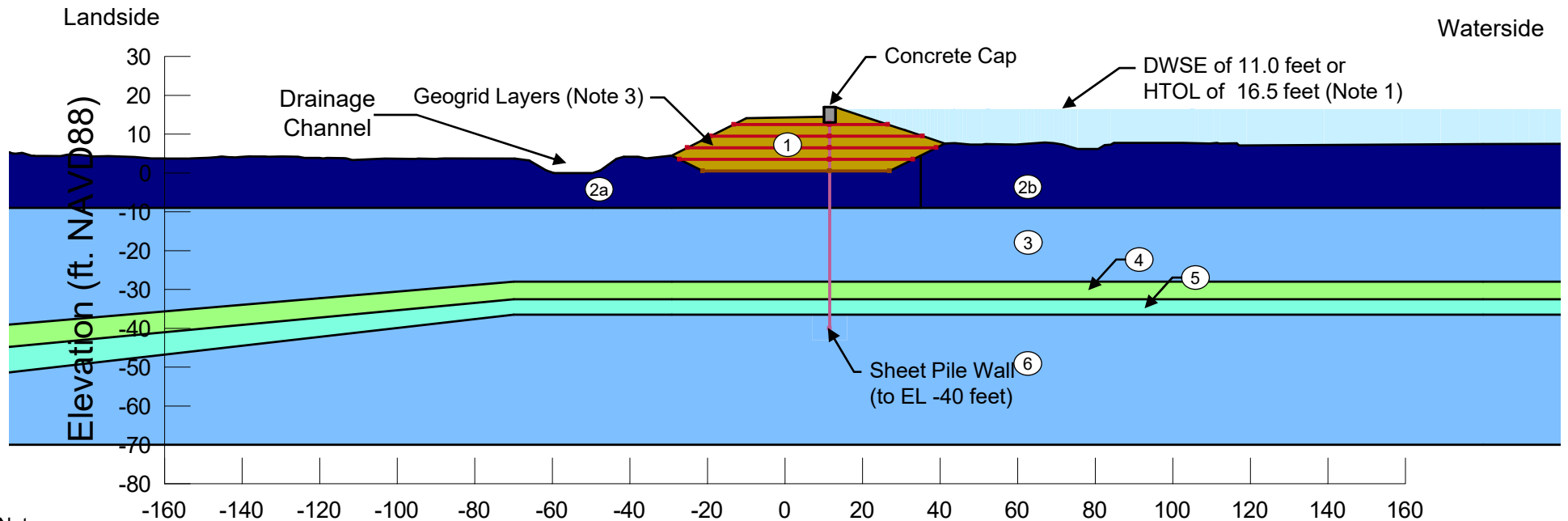
CROSS SECTION 1 (STATION 5+30)
CUTOFF WALL TO EL -40 FT, WITH GEOGRID
END OF CONSTRUCTION STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.6

Layer Number	Layer Name	Saturated Unit Weight (pcf)	Drained Parameters		Undrained Parameters (Note 2)		
			ϕ' (deg.)	c' (psf)	ϕ_R (deg.)	c_R (psf)	S_u (psf)
1	CL/SC - Embankment FILL	125	30	75	0	750	750
2a	CH/OH/CL - YBM	110	29	0	0	300	250 – 400
2b	CH/OH/CL - YBM (MARSH)	100	29	0	0	225	200 – 300
3	CL - ALLUVIUM	120	30	50	0	700	700
4	SW-SC/SC - ALLUVIUM	125	36	0	--	--	--
5	ML - ALLUVIUM	120	30	50	0	1200	1200
6	CL - ALLUVIUM	120	30	50	0	1200	1200



Notes:

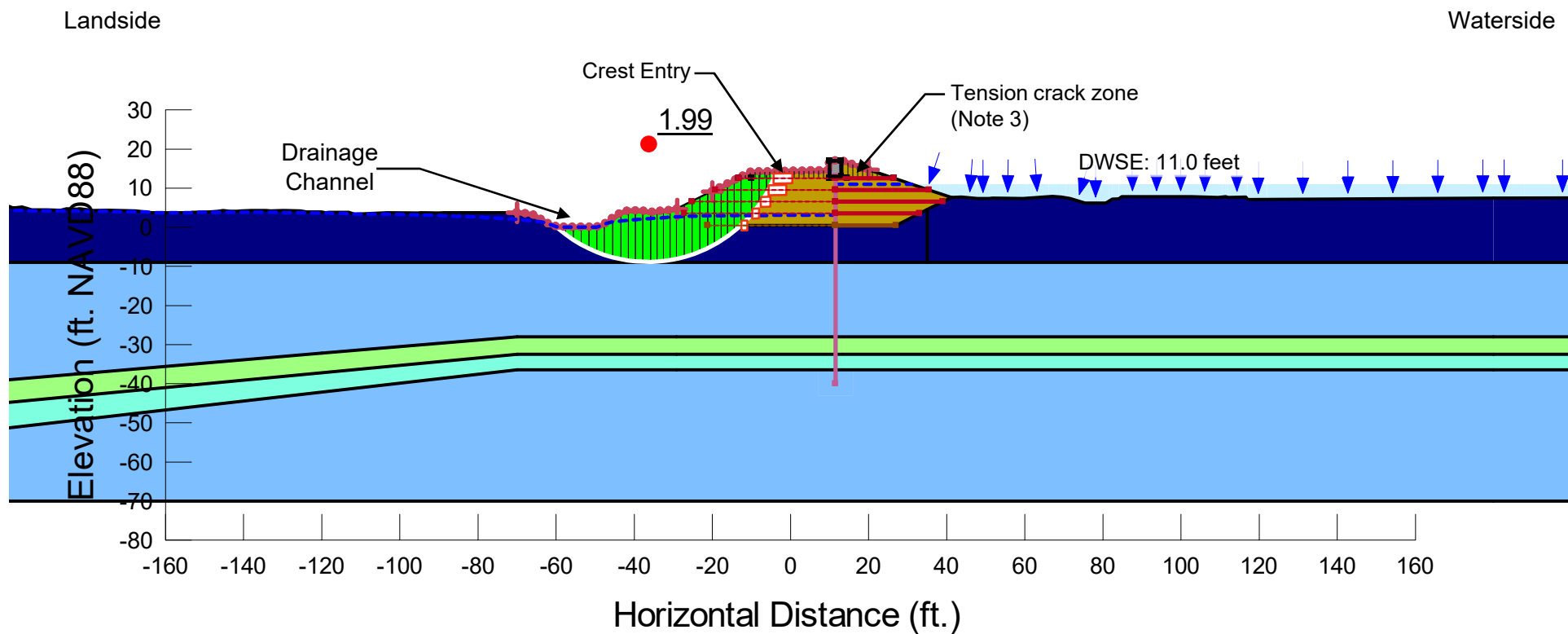
1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise). The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
2. Total strength parameters c_R and ϕ_R are used for waterside rapid drawdown (RDD) analyses. Undrained strength (S_u) is used to end of construction (EOC) and seismic stability analyses.
3. Geogrid layers are spaced at 3 feet vertically starting from the based on the embankment. Layers on each side of the sheet pile wall are modeled as separate (discrete) layers.



Horizontal Distance (ft.)

CROSS SECTION 2 (STATION 16+40)
 STABILITY ANALYSIS
 MODEL SETUP AND MATERIAL PARAMETERS
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 E.7



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

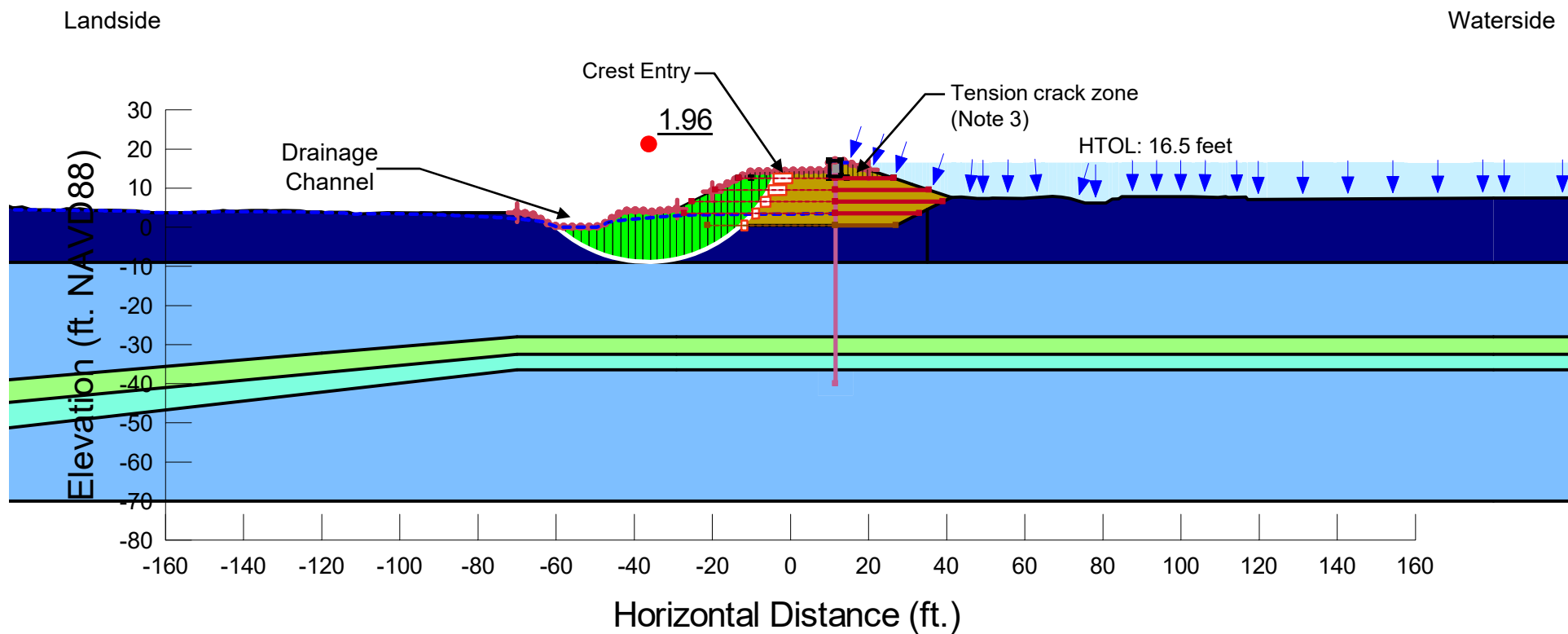


CROSS SECTION 2 (STATION 16+40)
 DWSE (11.0 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.8



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

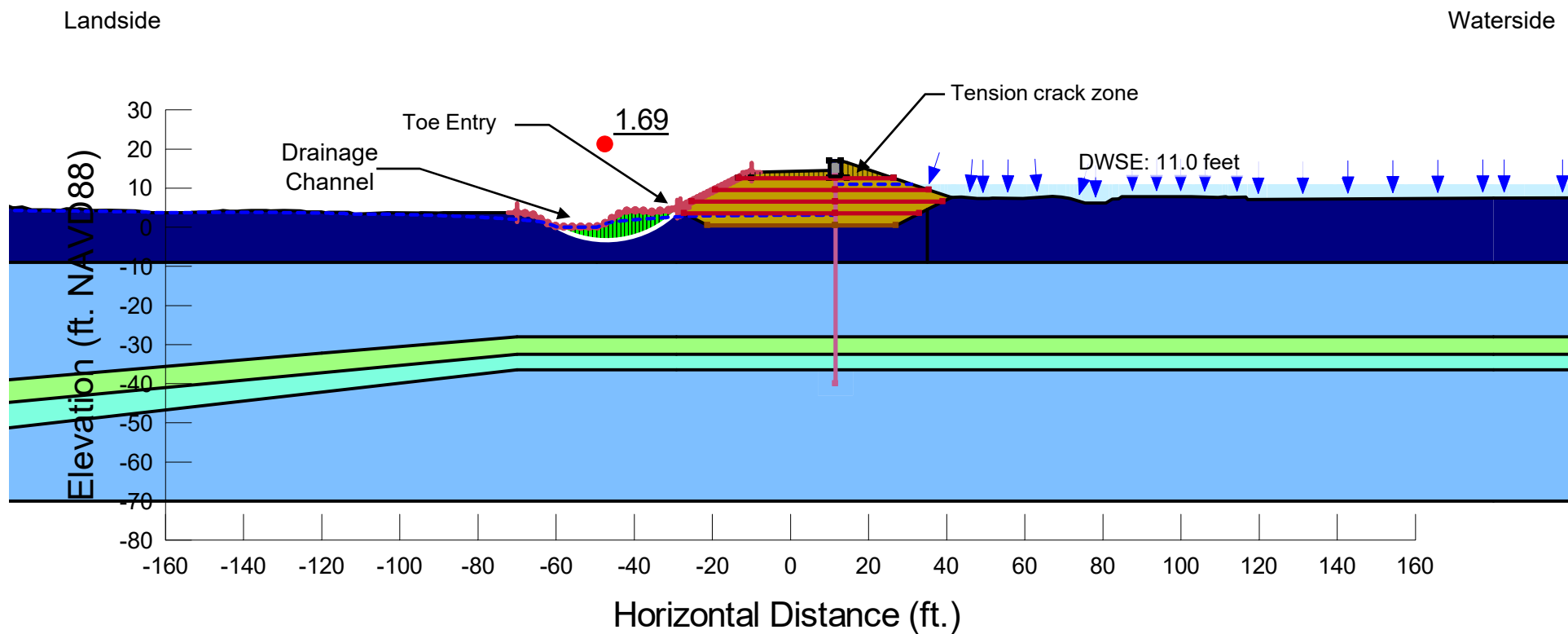


CROSS SECTION 2 (STATION 16+40)
 HTOL (16.5 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.9



Notes:

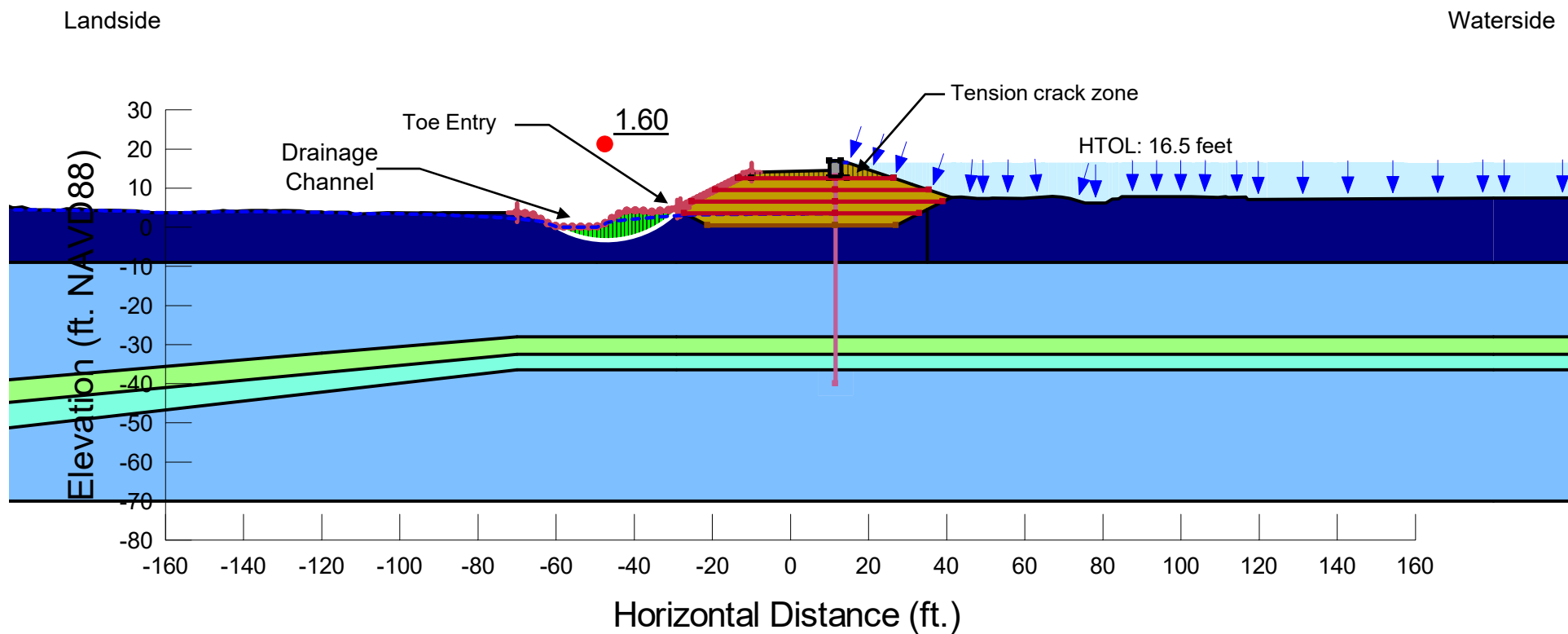
1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.



CROSS SECTION 2 (STATION 16+40)
 DWSE (11.0 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 DRAINAGE CHANNEL STEADY STATE STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.10



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the HTOL of +16.5 feet.



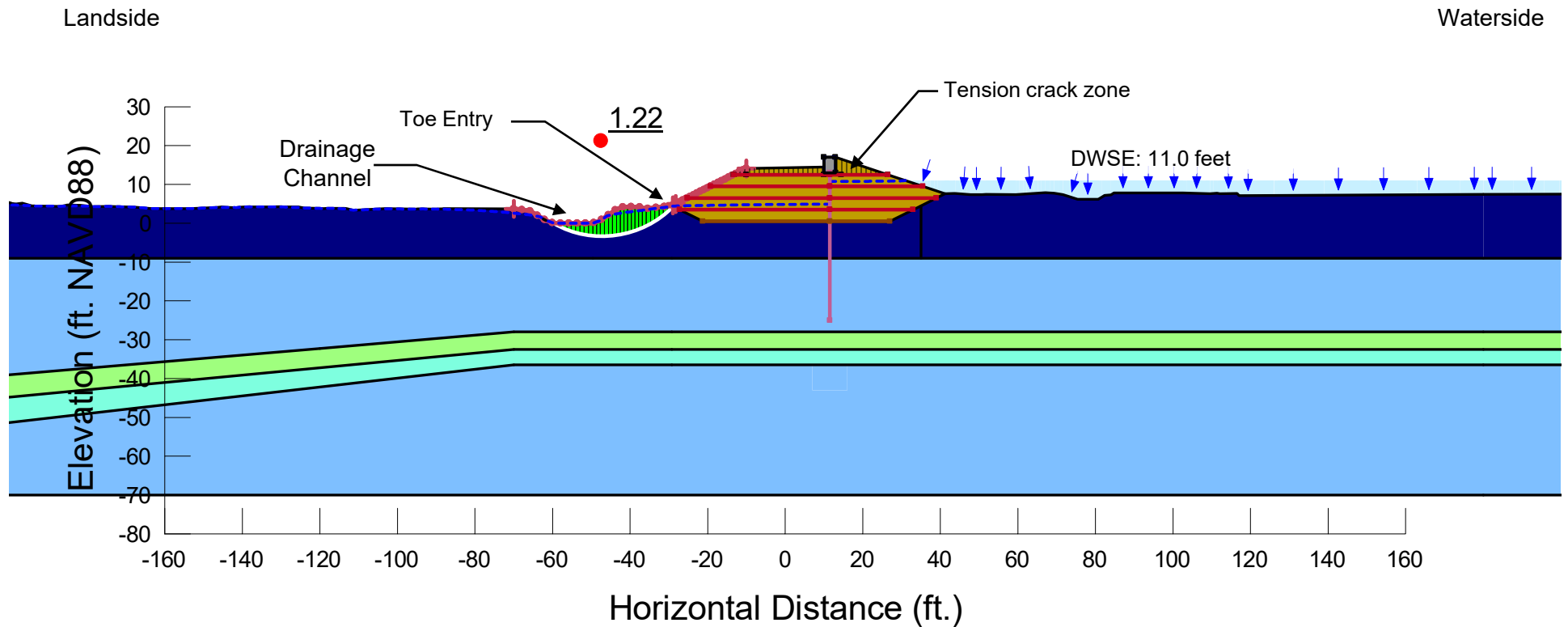
CROSS SECTION 2 (STATION 16+40)
 HTOL (16.5 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 DRAINAGE CHANNEL STEADY STATE STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.11

SENSITIVITY ANALYSIS:

Sheet pile wall installed to EL -25 feet (otherwise model is unchanged from the base case). See Figure E.10 for base case analysis result.



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.



CROSS SECTION 2 (STATION 16+40)
SENSITIVITY ANALYSIS: WALL TO EL -25 FEET (DWSE)
DRAINAGE CHANNEL STEADY STATE STABILITY

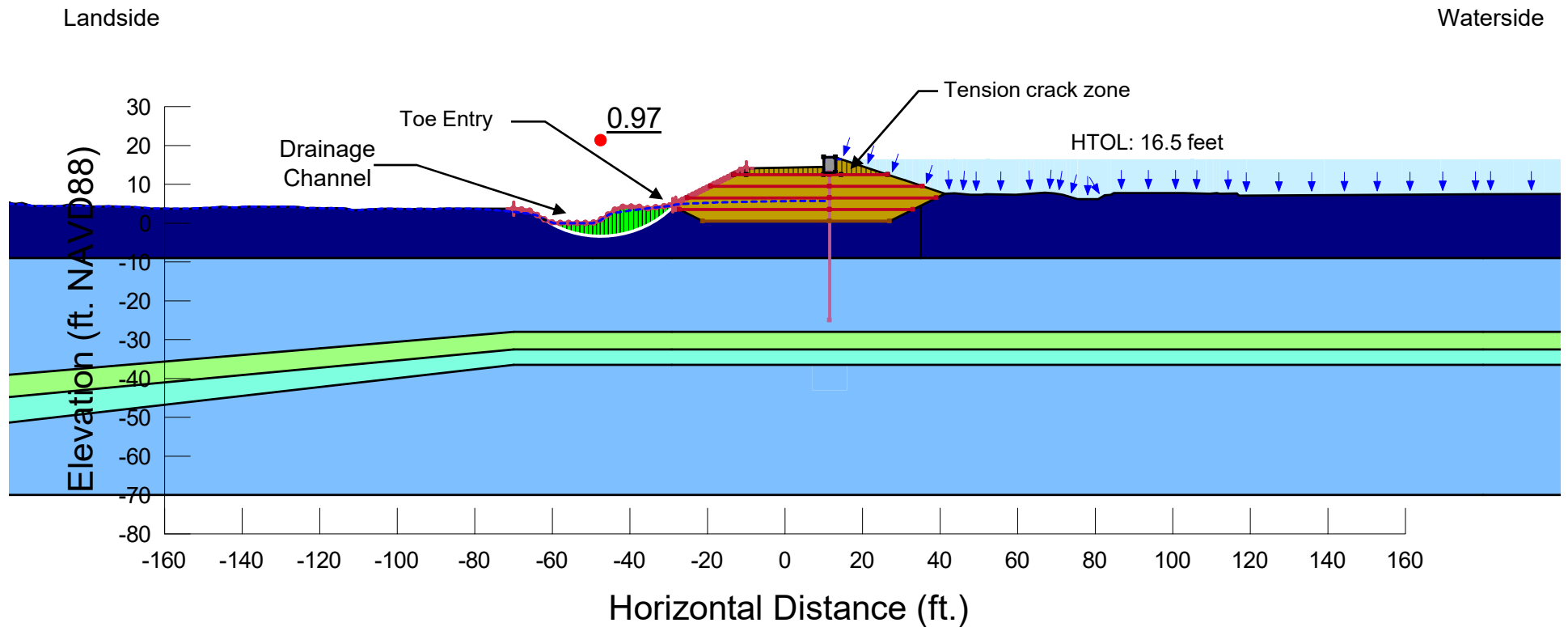
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.12

SENSITIVITY ANALYSIS:

Sheet pile wall installed to EL -25 feet (otherwise model is unchanged from the base case). See Figure E.11 for base case analysis result.



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the HTOL of +16.5 feet.

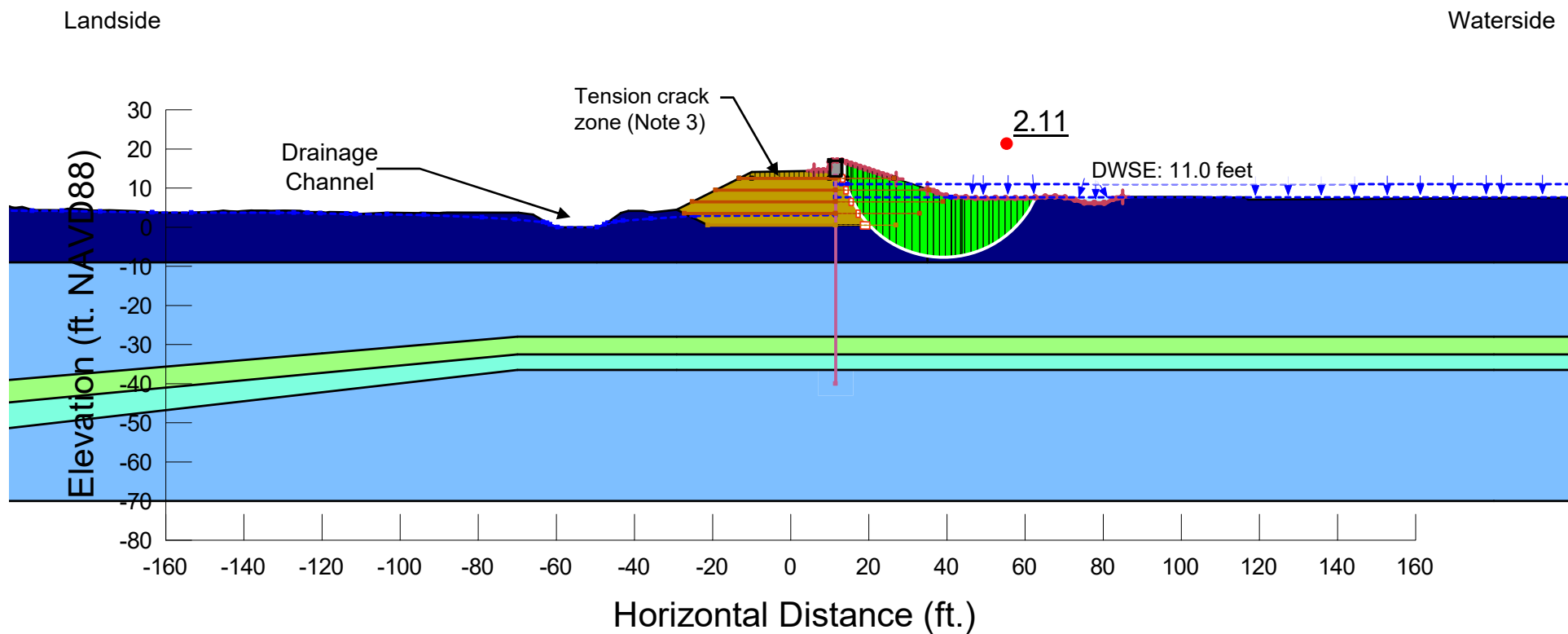


CROSS SECTION 2 (STATION 16+40)
SENSITIVITY ANALYSIS: WALL TO EL -25 FEET (HTOL)
DRAINAGE CHANNEL STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.13



Notes:

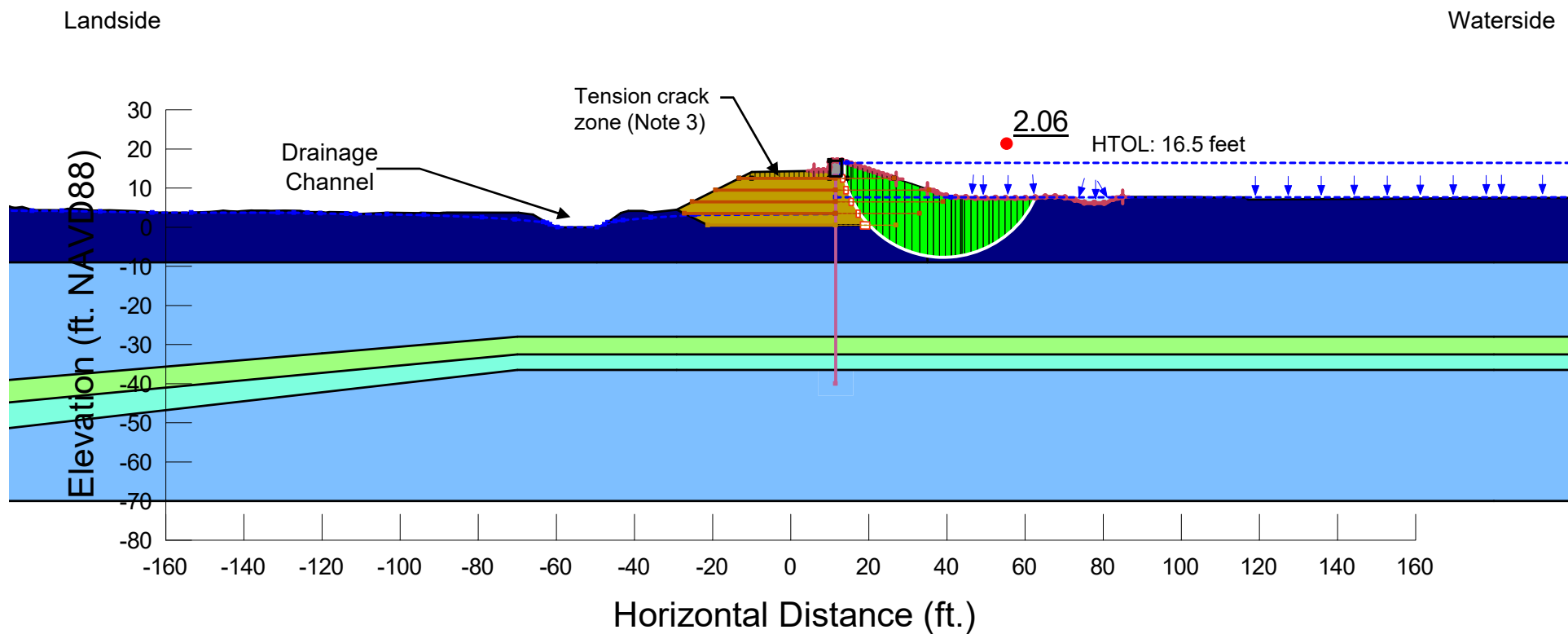
1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 2 (STATION 16+40)
 DWSE (11.0 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.14



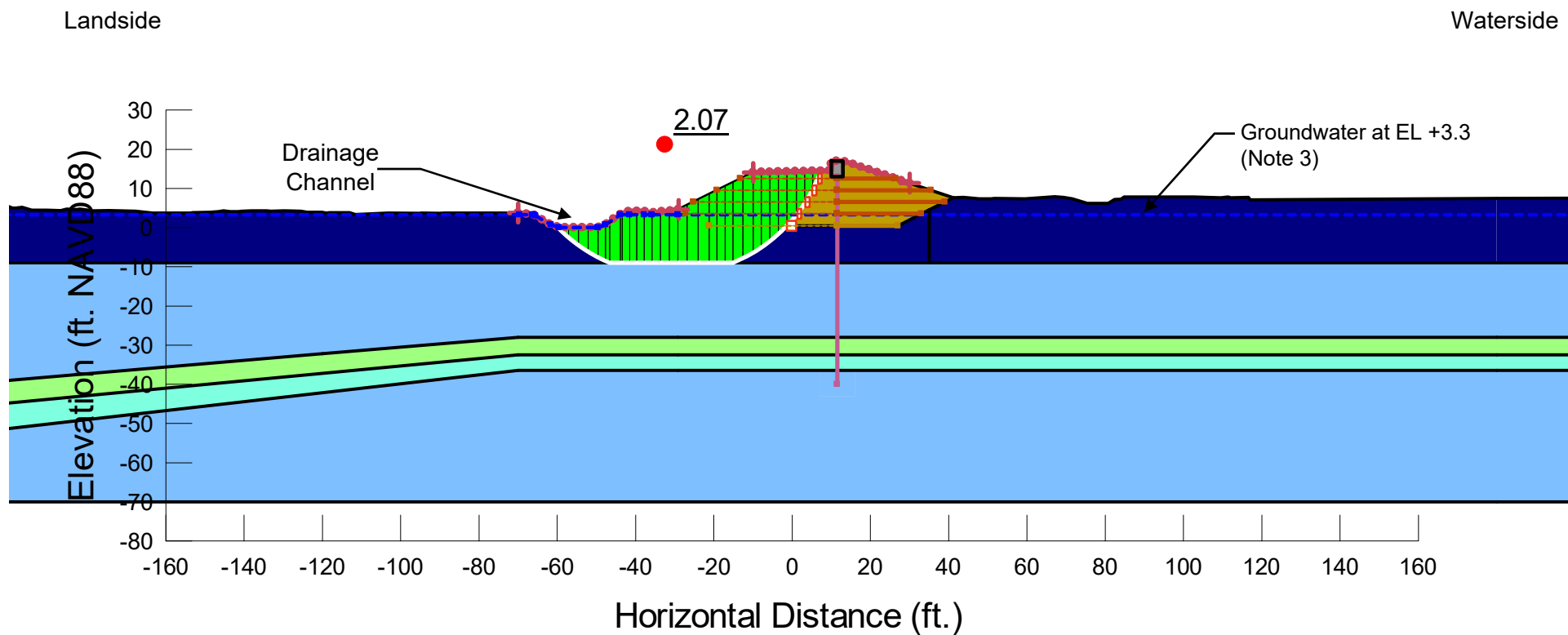
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 2 (STATION 16+40)
 HTOL (16.5 FT), CUTOFF WALL TO EL -40 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 E.15



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. End of construction (EOC) stability is shown only on the more critical side of the embankment.
3. The groundwater table for end of construction stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. Tension cracks are not applied for end of construction stability analysis.



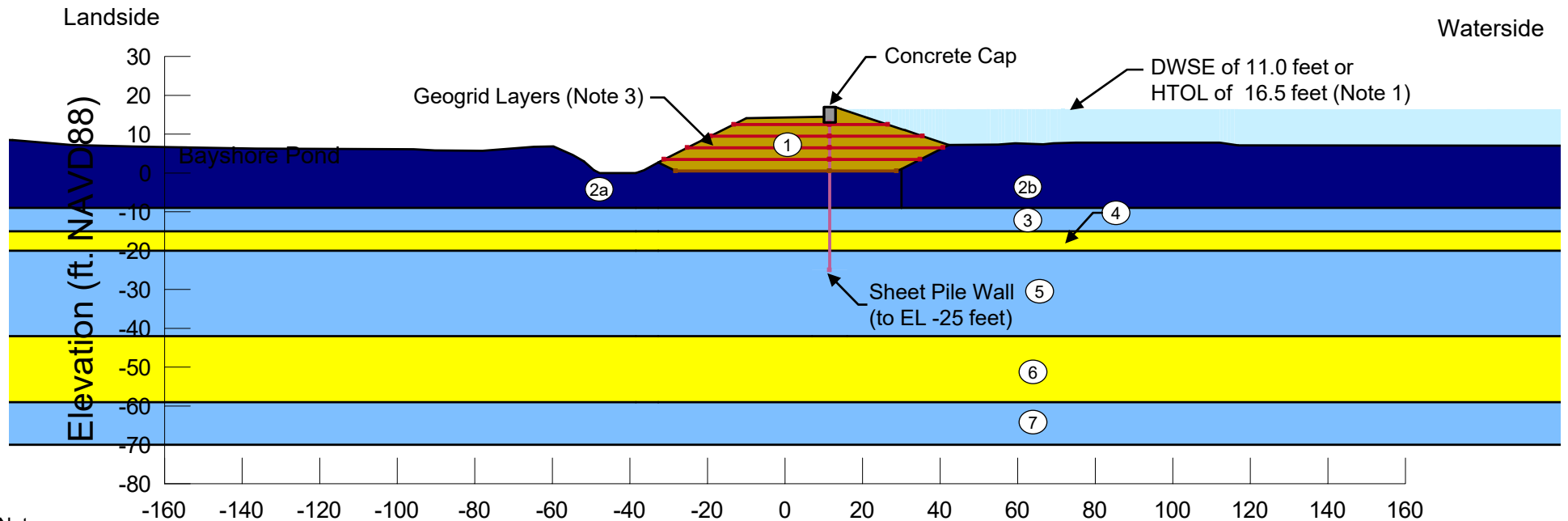
CROSS SECTION 2 (STATION 16+40)
CUTOFF WALL TO EL -40 FT, WITH GEOGRID
END OF CONSTRUCTION STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.16

Layer Number	Layer Name	Saturated Unit Weight (pcf)	Drained Parameters		Undrained Parameters (Note 2)		
			ϕ' (deg.)	c' (psf)	ϕ_R (deg.)	c_R (psf)	S_u (psf)
1	CL/SC - Embankment FILL	125	30	75	0	750	750
2a	CH/OH/CL - YBM	110	29	0	0	300	250-400
2b	CH/OH/CL - YBM (MARSH)	100	29	0	0	225	200 – 250
3	CL - ALLUVIUM	120	30	50	0	700	700
4	SP - ALLUVIUM	125	36	0	--	--	--
5	CL - ALLUVIUM	120	30	50	0	1200	1200
6	SP - ALLUVIUM	125	36	0	--	--	--
7	CL - ALLUVIUM	120	30	50	0	1200	1200



Notes:

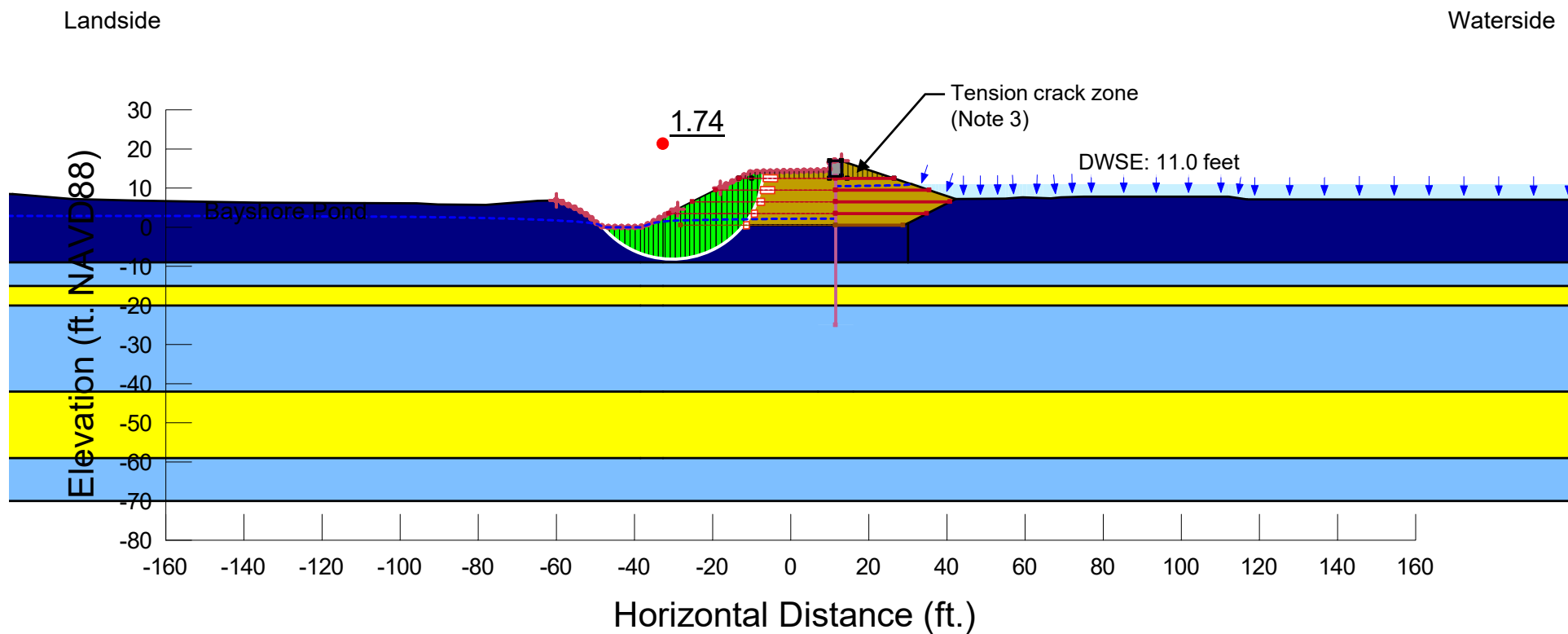
1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise). The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
2. Total strength parameters c_R and ϕ_R are used for waterside rapid drawdown (RDD) analyses. Undrained strength (S_u) is used to end of construction (EOC) and seismic stability analyses.
3. Geogrid layers are spaced at 3 feet vertically starting from the based on the embankment. Layers on each side of the sheet pile wall are modeled as separate (discrete) layers.



Horizontal Distance (ft.)

CROSS SECTION 3 (STATION 26+00)
 STABILITY ANALYSIS
 MODEL SETUP AND MATERIAL PARAMETERS
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 E.17



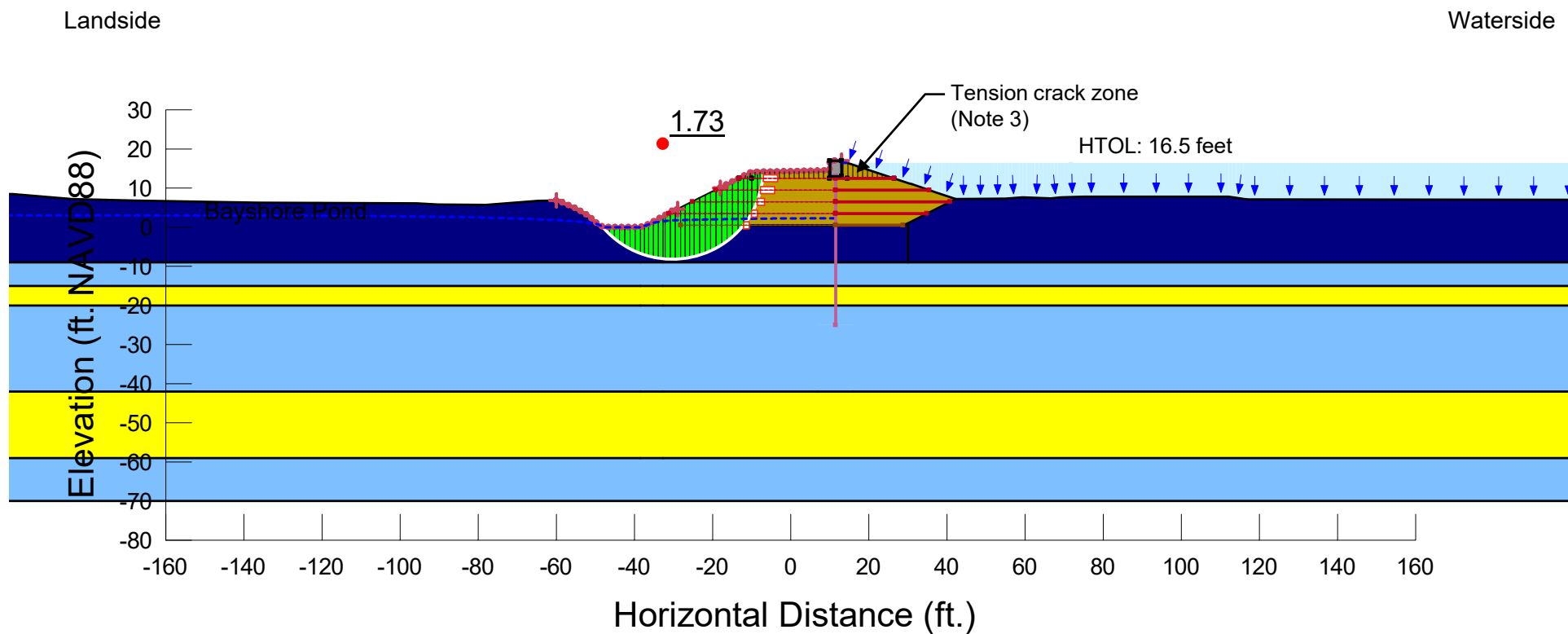
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 3 (STATION 26+00)
 DWSE (11.0 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
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 Figure
 E.18



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the HTOL of +16.5 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

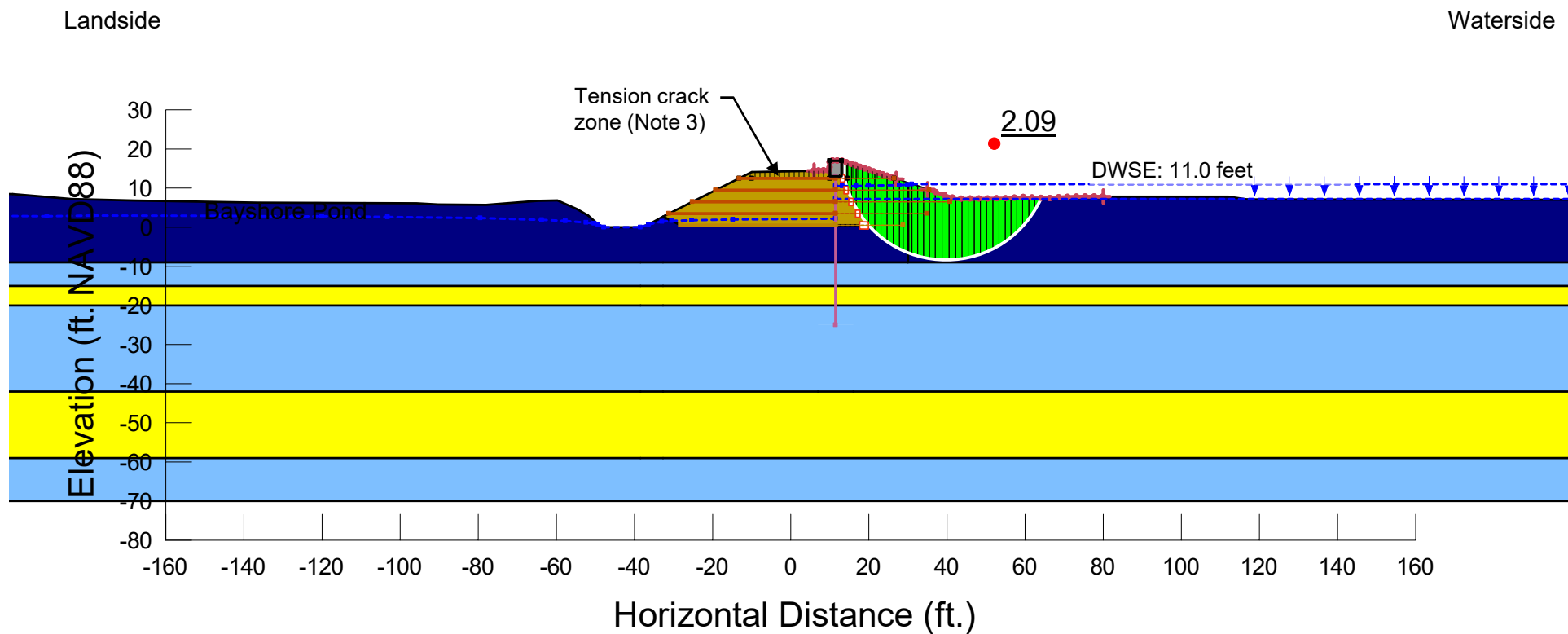


CROSS SECTION 3 (STATION 26+00)
 HTOL (16.5 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.19



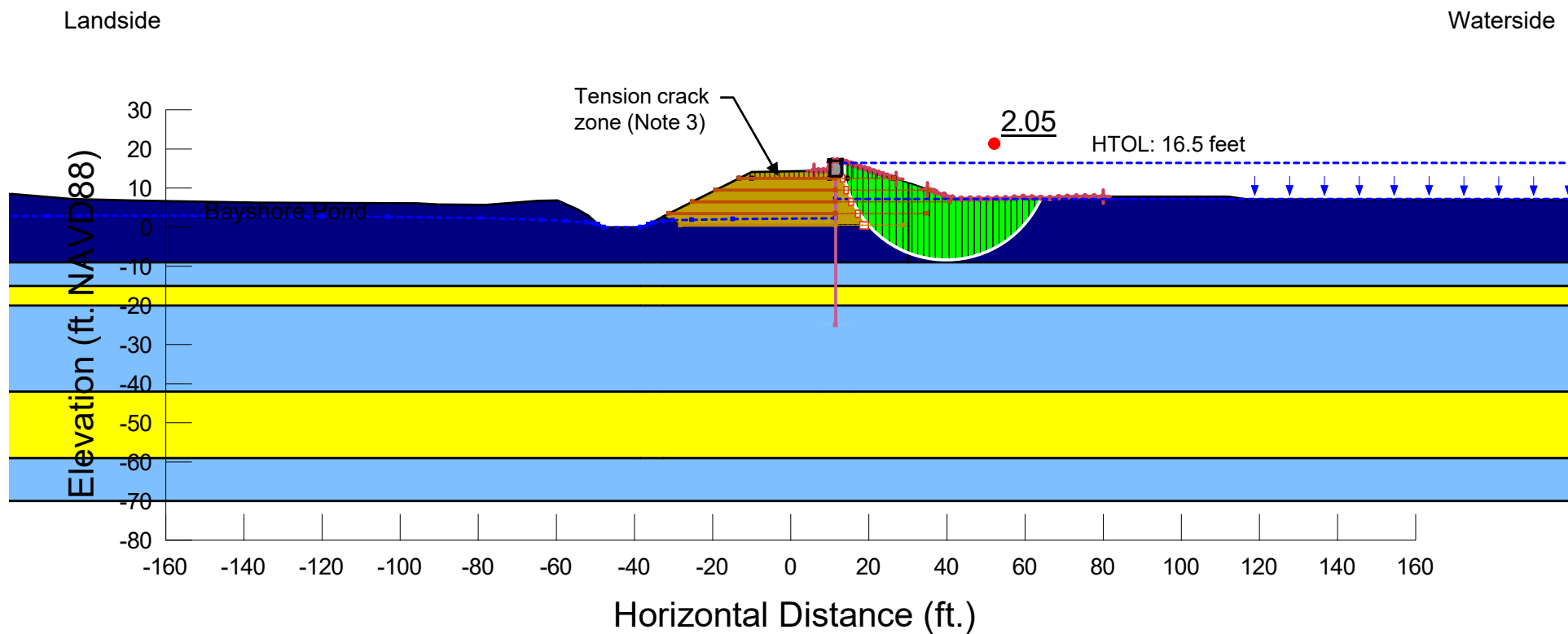
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 3 (STATION 26+00)
 DWSE (11.0 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date	JUNE 2024
Figure	E.20



Notes:

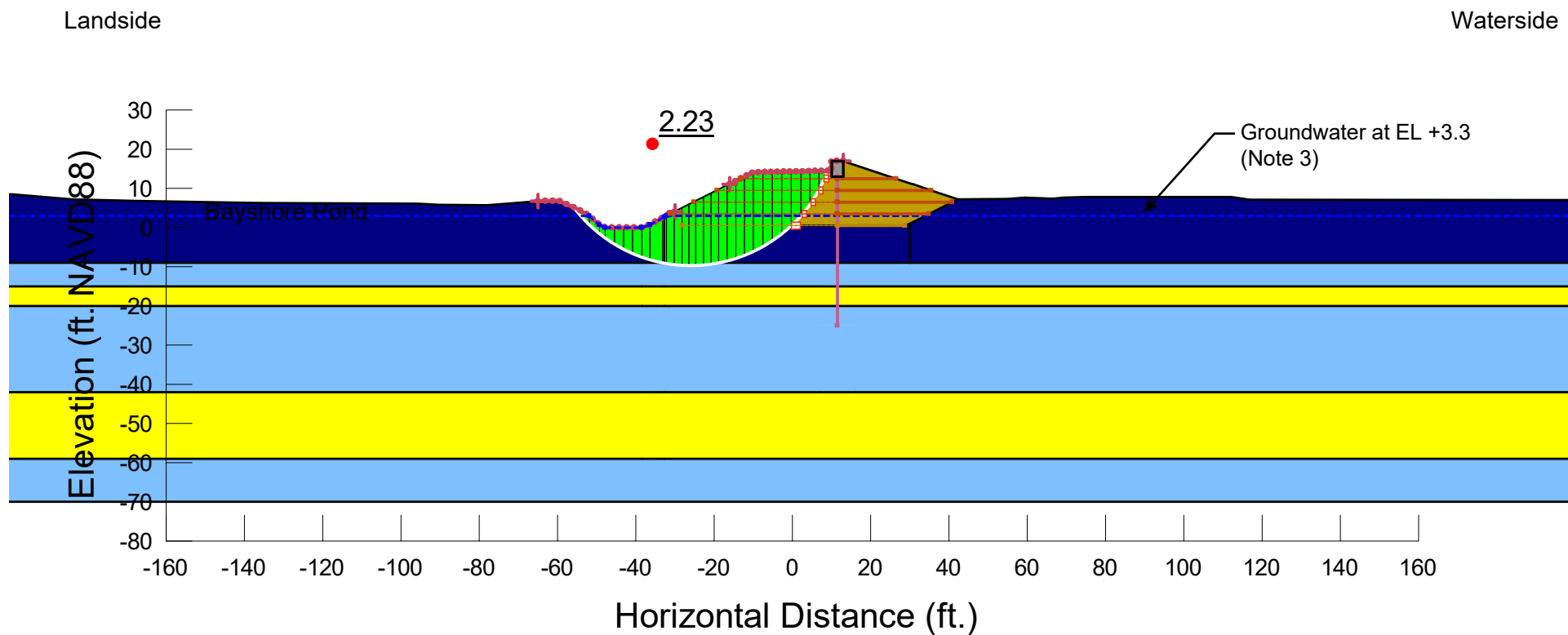
1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 3 (STATION 26+00)
 HTOL (16.5 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.21



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. End of construction (EOC) stability is shown only on the more critical side of the embankment.
3. The groundwater table for end of construction stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. Tension cracks are not applied for end of construction stability analysis.



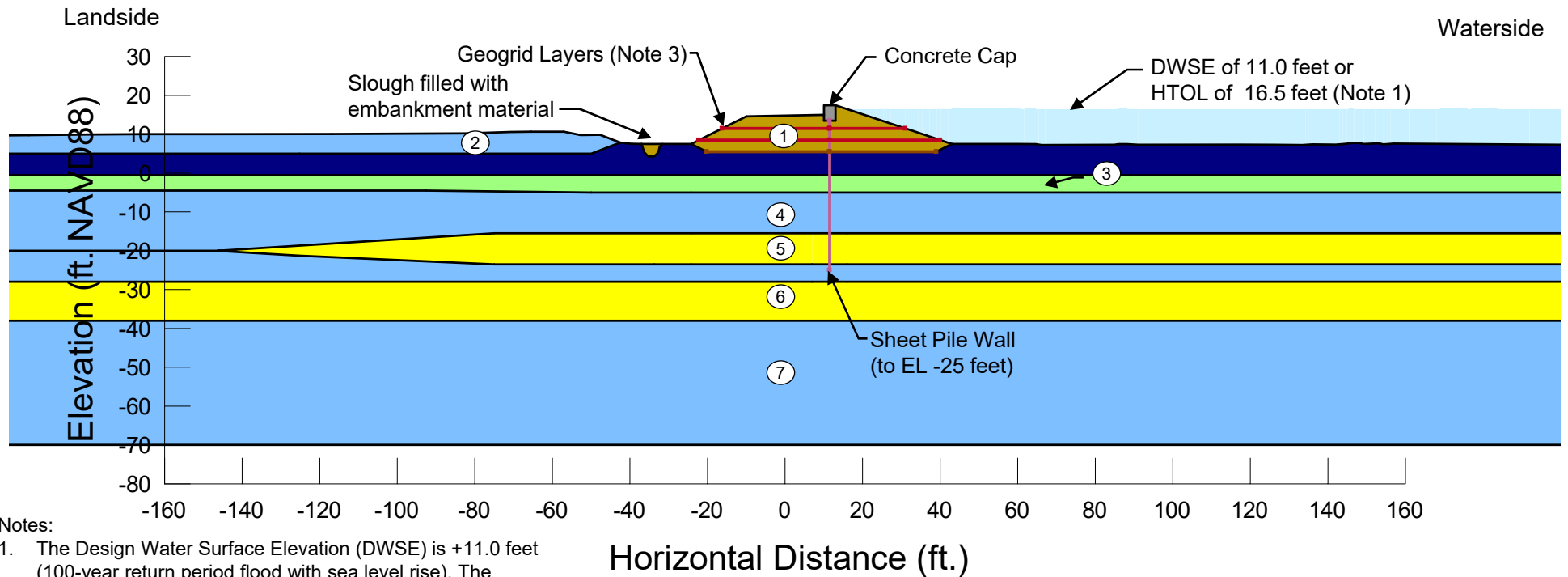
CROSS SECTION 3 (STATION 26+00)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
END OF CONSTRUCTION STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.22

Layer Number	Layer Name	Saturated Unit Weight (pcf)	Drained Parameters		Undrained Parameters (Note 2)		
			ϕ' (deg.)	c' (psf)	ϕ_R (deg.)	c_R (psf)	S_u (psf)
1	CL/SC - Embankment FILL	125	30	75	0	750	750
2	CL/SC - EXISTING FILL	120	30	25	0	500	500
3	CH/OH/CL - YBM (MARSH)	100	29	0	0	225	200 – 250
4	SM/SC-SM/ML - ALLUVIUM	120	32	0	--	90	--
5	CL - ALLUVIUM	120	30	50	0	600	600
6	SP - ALLUVIUM	125	36	0	--	--	--
7	CL - ALLUVIUM	120	30	50	0	800	800
8	SP - ALLUVIUM	125	36	0	--	--	--
9	CL - ALLUVIUM	120	30	50	0	1200	1200



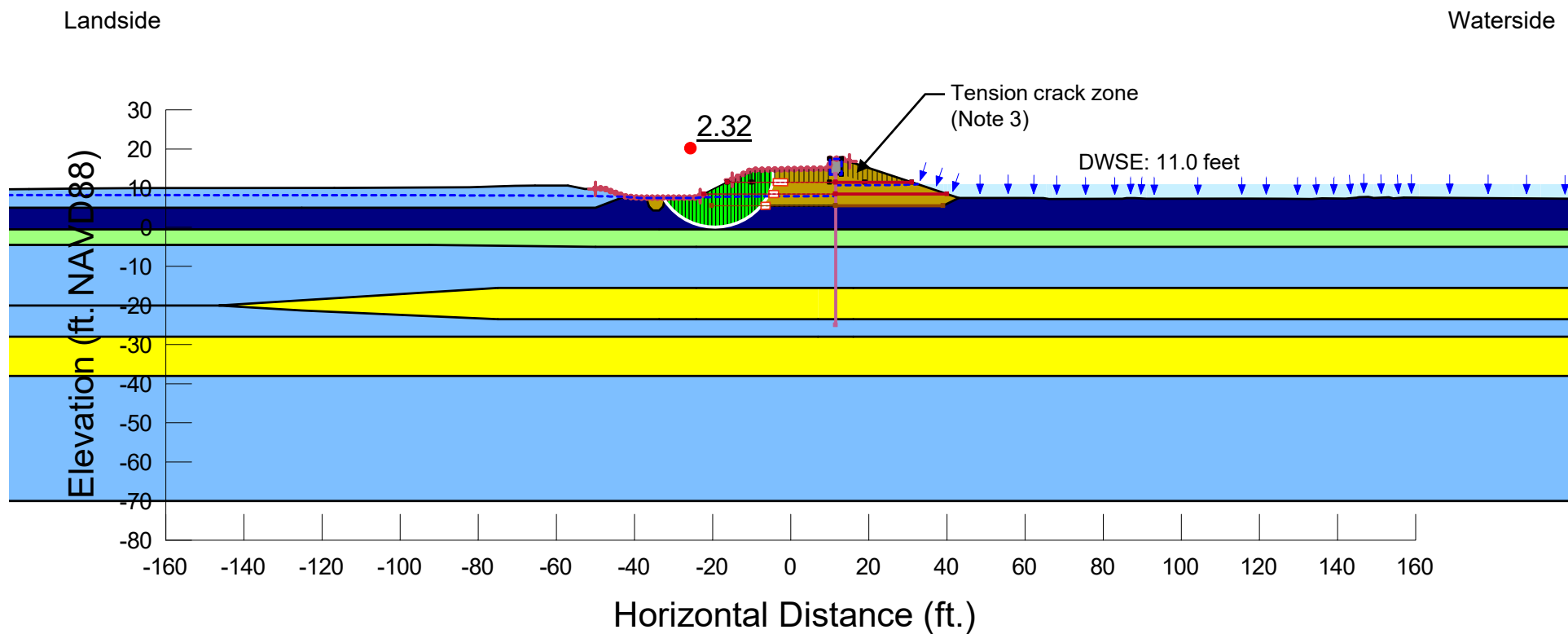
Notes:

1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise). The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
2. Total strength parameters c_R and ϕ_R are used for waterside rapid drawdown (RDD) analyses. Undrained strength (S_u) is used to end of construction (EOC) and seismic stability analyses.
3. Geogrid layers are spaced at 3 feet vertically starting from the based on the embankment. Layers on each side of the sheet pile wall are modeled as separate (discrete) layers.



CROSS SECTION 4 (STATION 37+65)
 STABILITY ANALYSIS
 MODEL SETUP AND MATERIAL PARAMETERS
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 E.23



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

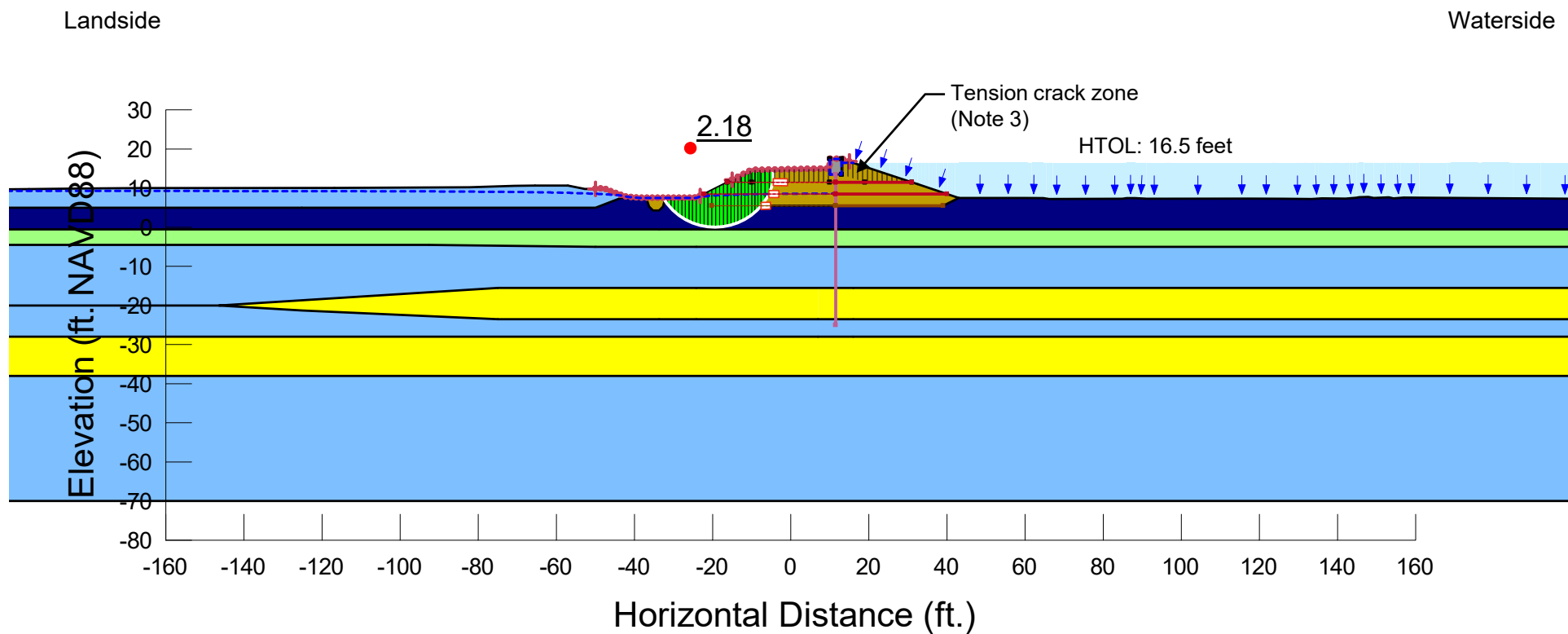


CROSS SECTION 4 (STATION 37+65)
 DWSE (11.0 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.24



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the HTOL of +16.5 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 4 (STATION 37+65)
 HTOL (16.5 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY

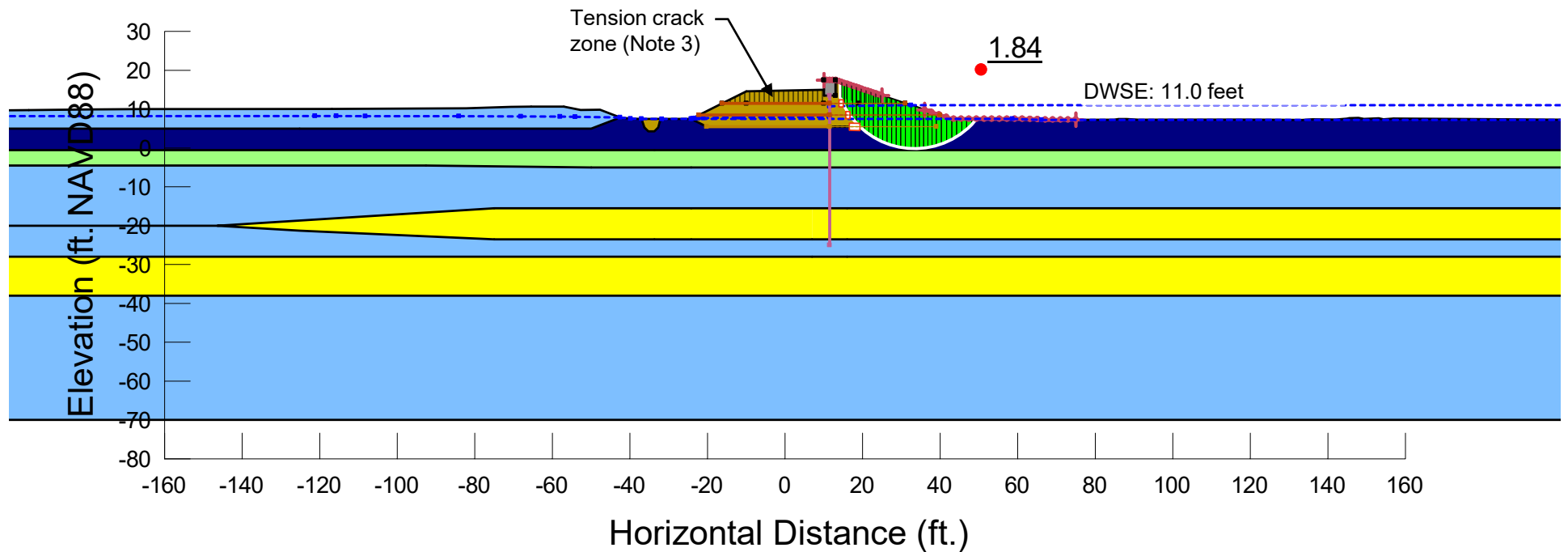
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
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Figure
 E.25

Landside

Waterside



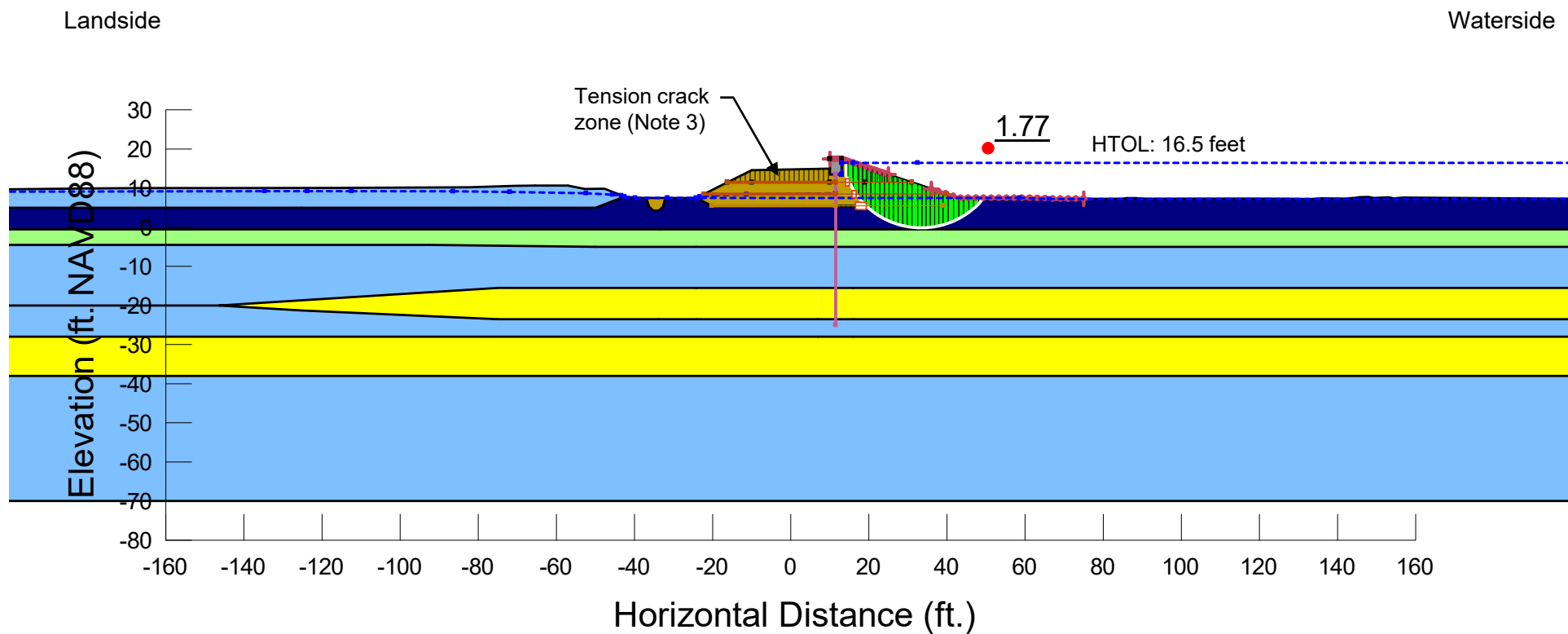
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 4 (STATION 37+65)
 DWSE (11.0 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024
Figure
E.26



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

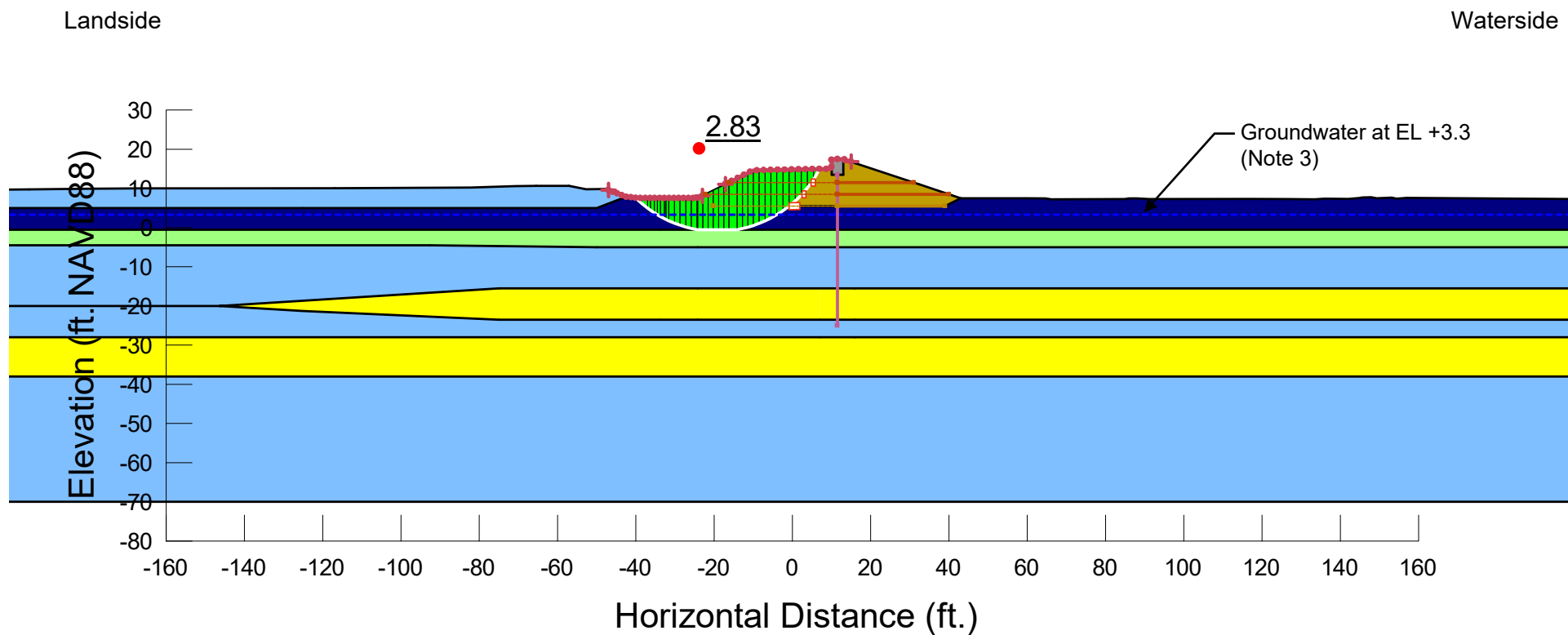


CROSS SECTION 4 (STATION 37+65)
 HTOL (16.5 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024

Figure
 E.27



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. End of construction (EOC) stability is shown only on the more critical side of the embankment.
3. The groundwater table for end of construction stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. Tension cracks are not applied for end of construction stability analysis.



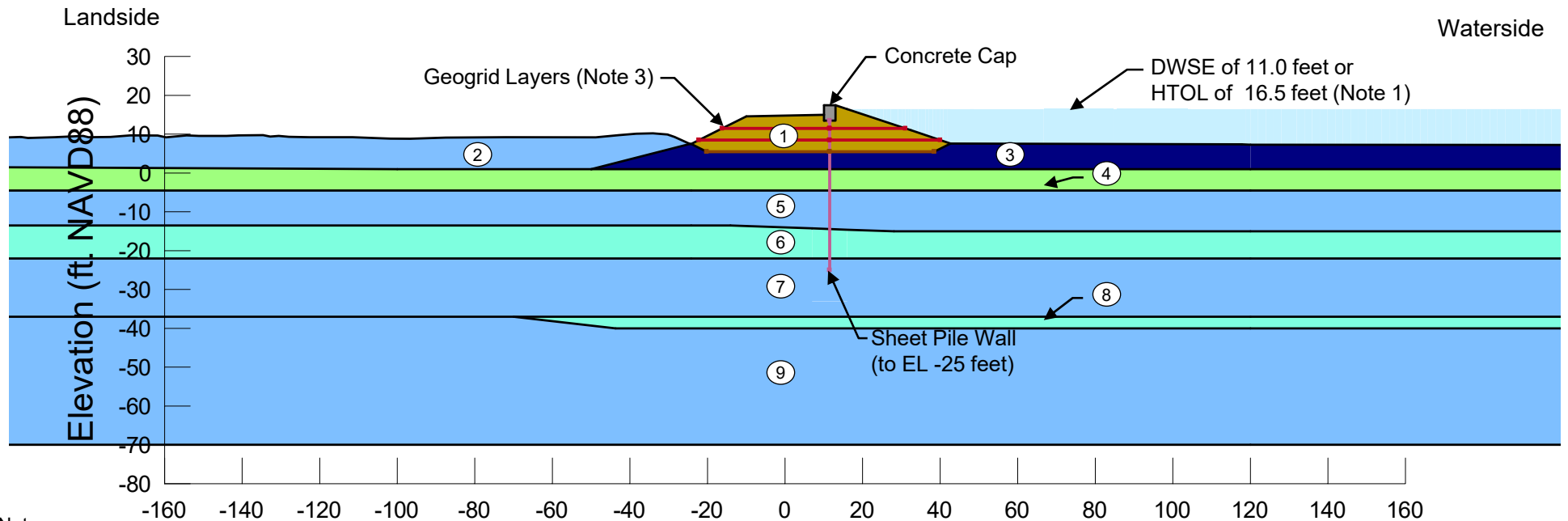
CROSS SECTION 4 (STATION 37+65)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
END OF CONSTRUCTION STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.28

Layer Number	Layer Name	Saturated Unit Weight (pcf)	Drained Parameters		Undrained Parameters (Note 2)		
			ϕ' (deg.)	c' (psf)	ϕ_R (deg.)	c_R (psf)	S_u (psf)
1	CL/SC - Embankment FILL	125	30	75	0	750	750
2	CL/SC - EXISTING FILL	120	30	25	0	500	500
3	CH/OH/CL - YBM (MARSH)	100	29	0	0	225	200 – 300
4	SM/SC-SM/ML - ALLUVIUM	120	32	0	--	90	--
5	CL - ALLUVIUM	120	30	50	0	600	600
6	SC - ALLUVIUM	125	36	0	--	--	--
7	CL - ALLUVIUM	120	30	50	0	800	800
8	SC - ALLUVIUM	125	36	0	--	--	--
9	CL - ALLUVIUM	120	30	50	0	1200	1200



Notes:

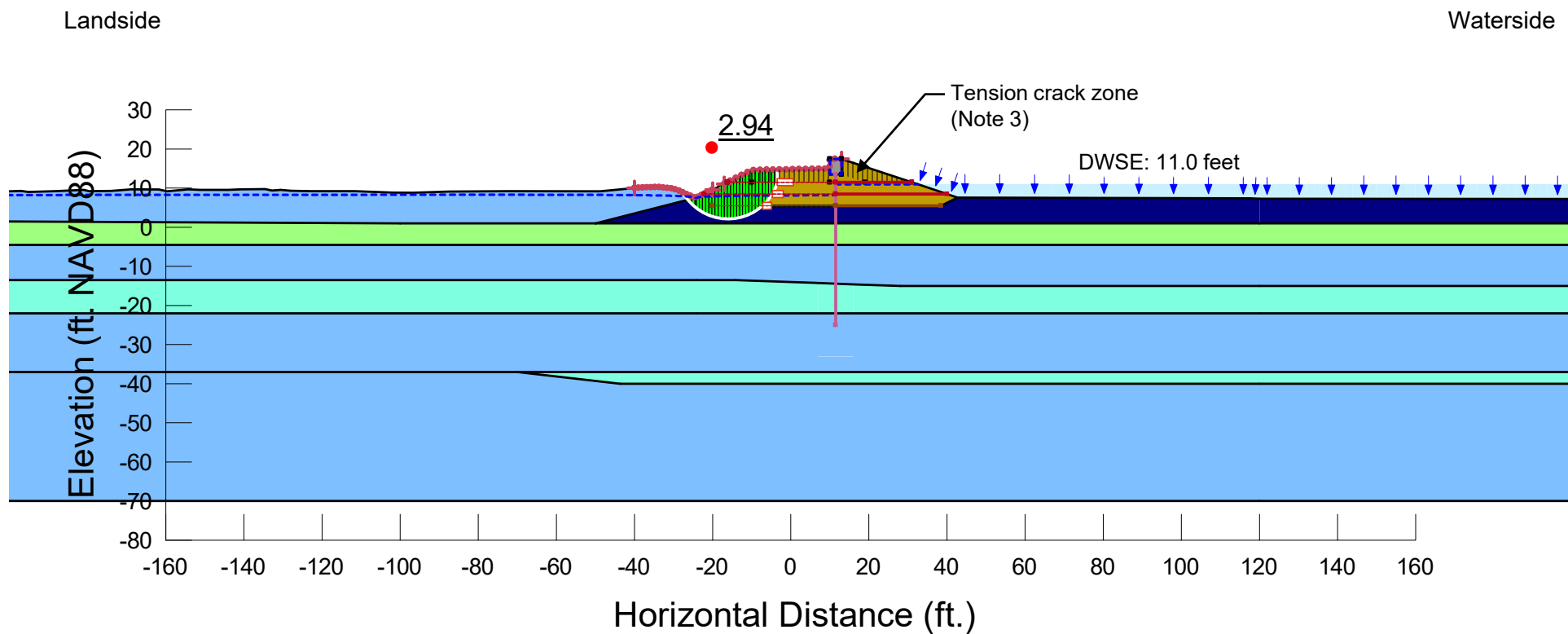
1. The Design Water Surface Elevation (DWSE) is +11.0 feet (100-year return period flood with sea level rise). The Hydraulic Top of Levee (HTOL) WSE is set at the nominal top of wall elevation of +16.5 feet (not including overbuild height).
2. Total strength parameters c_R and ϕ_R are used for waterside rapid drawdown (RDD) analyses. Undrained strength (S_u) is used to end of construction (EOC) and seismic stability analyses.
3. Geogrid layers are spaced at 3 feet vertically starting from the based on the embankment. Layers on each side of the sheet pile wall are modeled as separate (discrete) layers.



Horizontal Distance (ft.)

CROSS SECTION 5 (STATION 44+00)
 STABILITY ANALYSIS
 MODEL SETUP AND MATERIAL PARAMETERS
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
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 Figure
 E.29



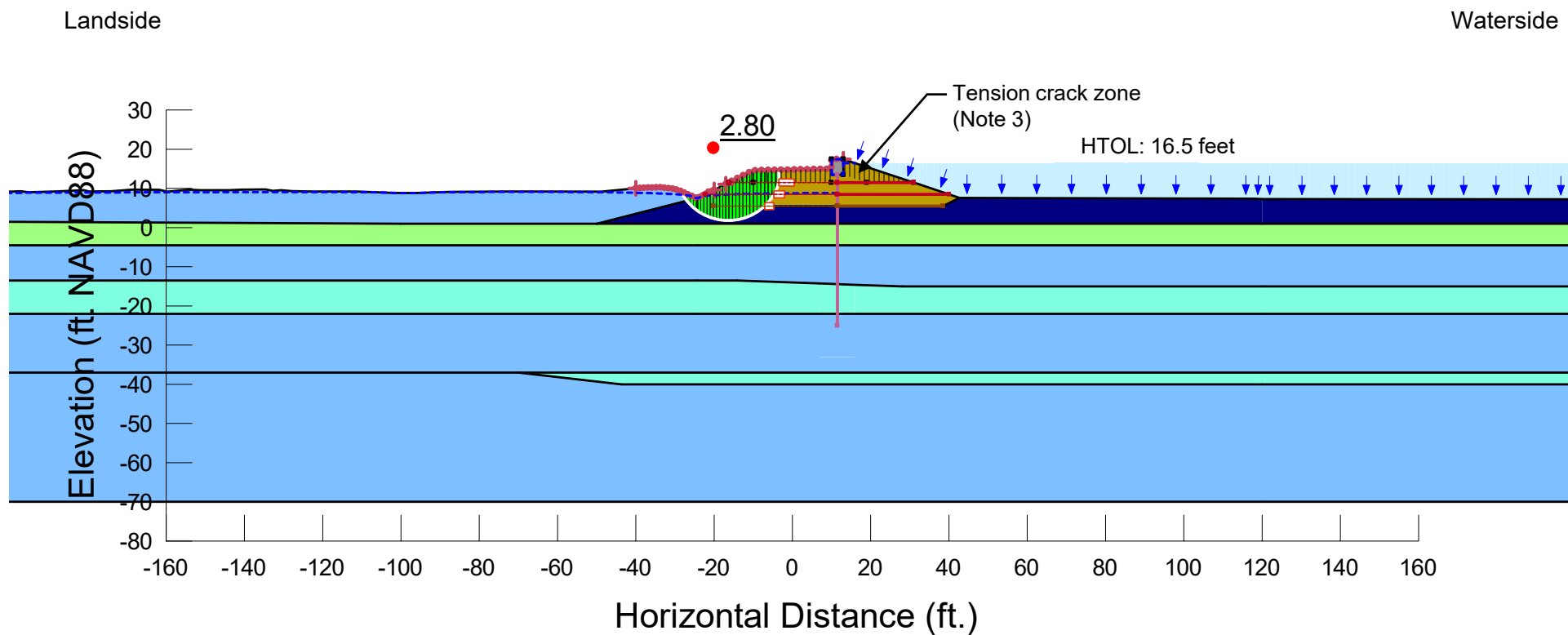
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the DWSE of +11.0 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 5 (STATION 44+00)
 DWSE (11.0 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 LANDSIDE STEADY STATE STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 E.30



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Pore pressures are calculated from the steady-state seepage model and water at the HTOL of +16.5 feet.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.

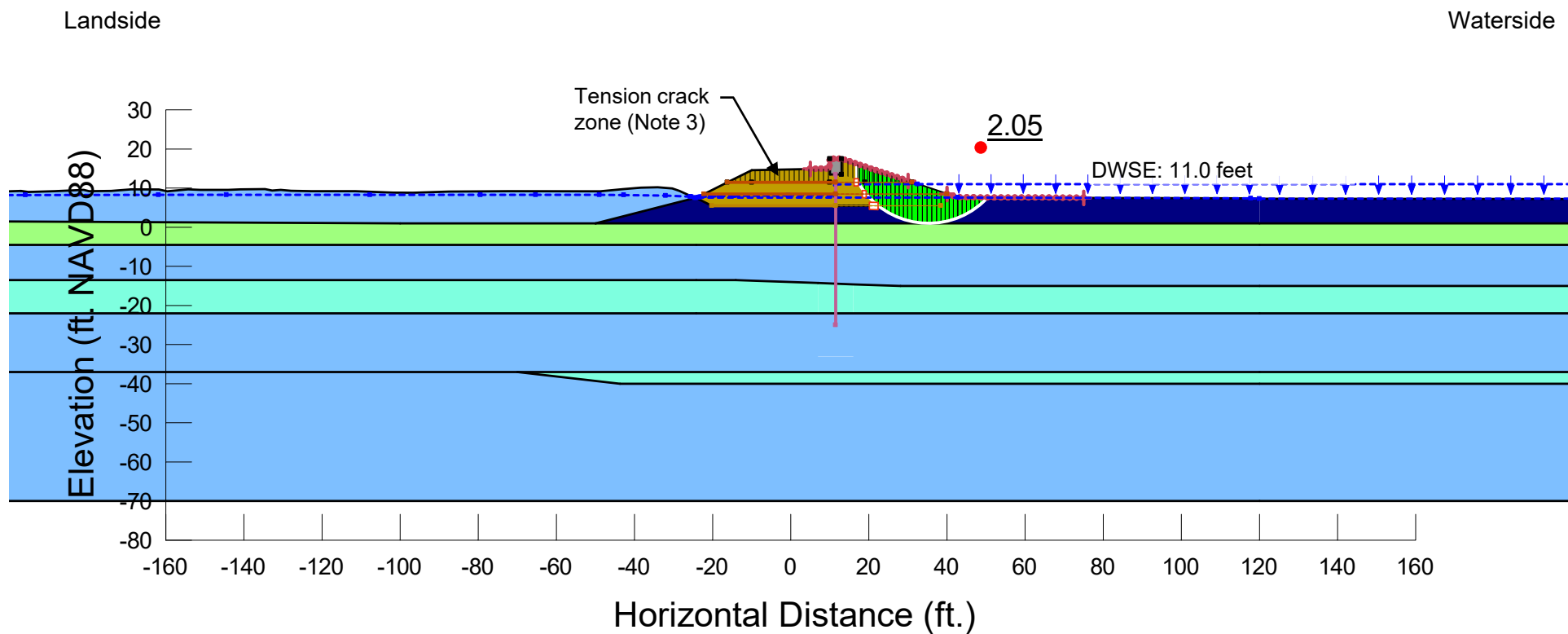


CROSS SECTION 5 (STATION 44+00)
HTOL (16.5 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
LANDSIDE STEADY STATE STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

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Figure
E.31



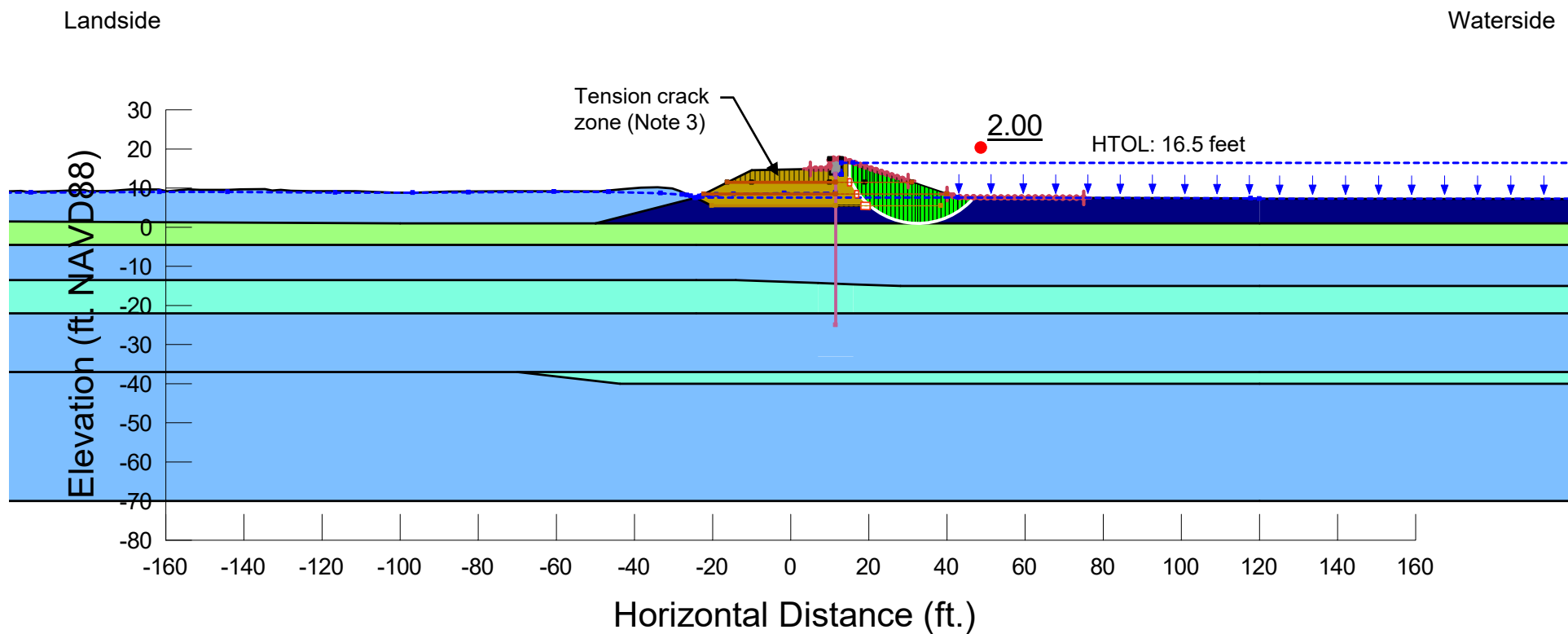
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 5 (STATION 44+00)
 DWSE (11.0 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
 WATERSIDE RAPID DRAWDOWN STABILITY
 SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
 SAN MATEO COUNTY, CALIFORNIA

Date
 JUNE 2024
 Figure
 E.32



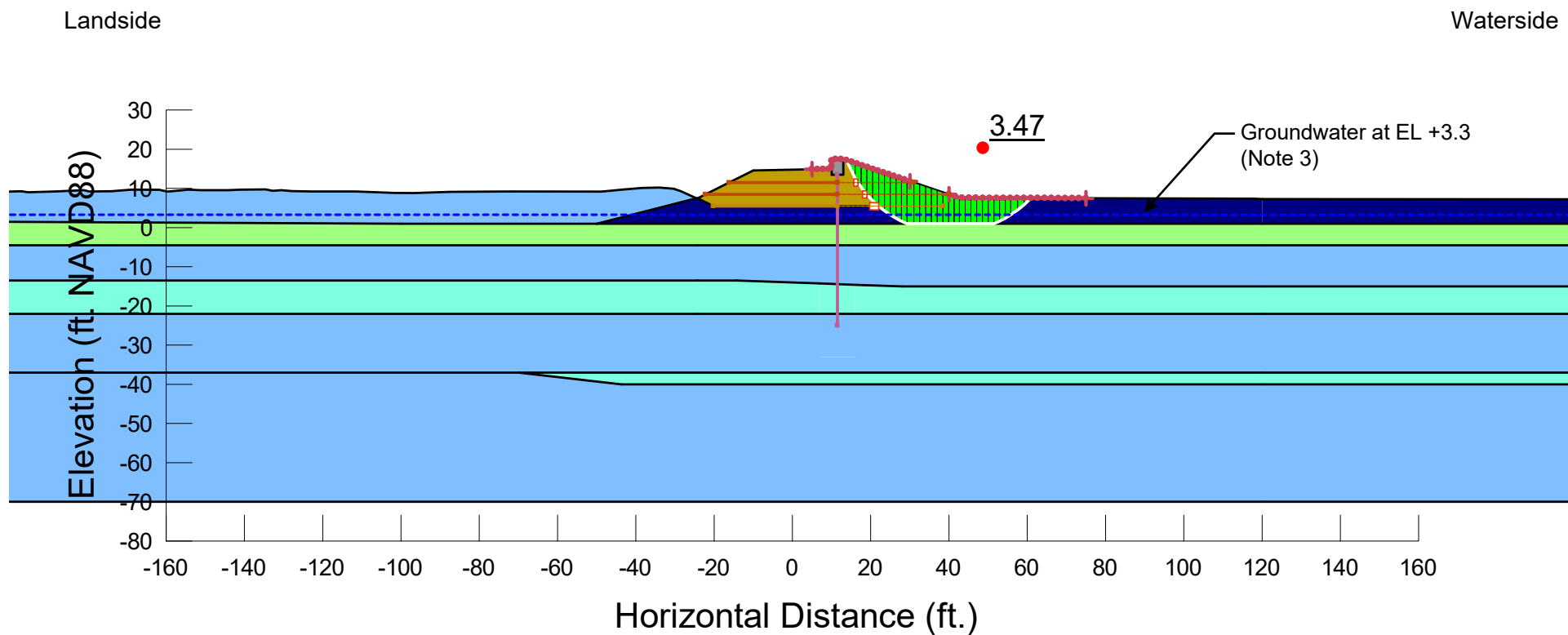
Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Instantaneous drawdown from the flood elevation to the waterside ground surface is assumed.
3. A tension crack zone is assigned along the crest to depth of 4 feet or the upper geogrid layer, whichever is shallower. Tension cracks are modeled as filled with water.



CROSS SECTION 5 (STATION 44+00)
HTOL (16.5 FT), CUTOFF WALL TO EL -25 FT, WITH GEOGRID
WATERSIDE RAPID DRAWDOWN STABILITY
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date	JUNE 2024
Figure	E.33



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. End of construction (EOC) stability is shown only on the more critical side of the embankment.
3. The groundwater table for end of construction stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. Tension cracks are not applied for end of construction stability analysis.



CROSS SECTION 5 (STATION 44+00)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
END OF CONSTRUCTION STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
E.34

Appendix F. Liquefaction Analysis

DRAFT

LIQUEFACTION ANALYSIS REPORT

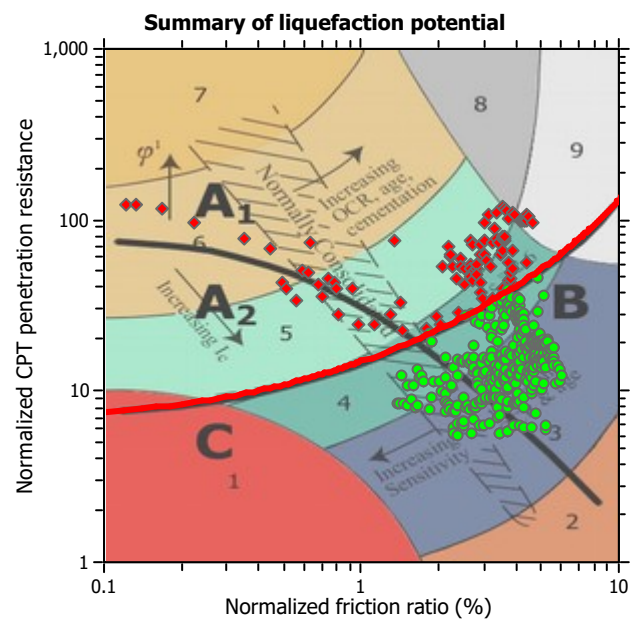
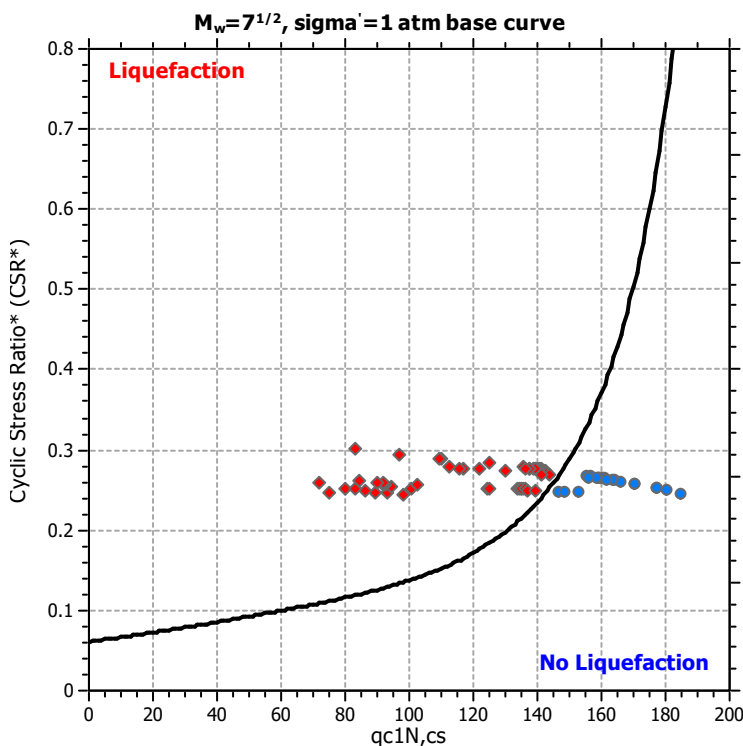
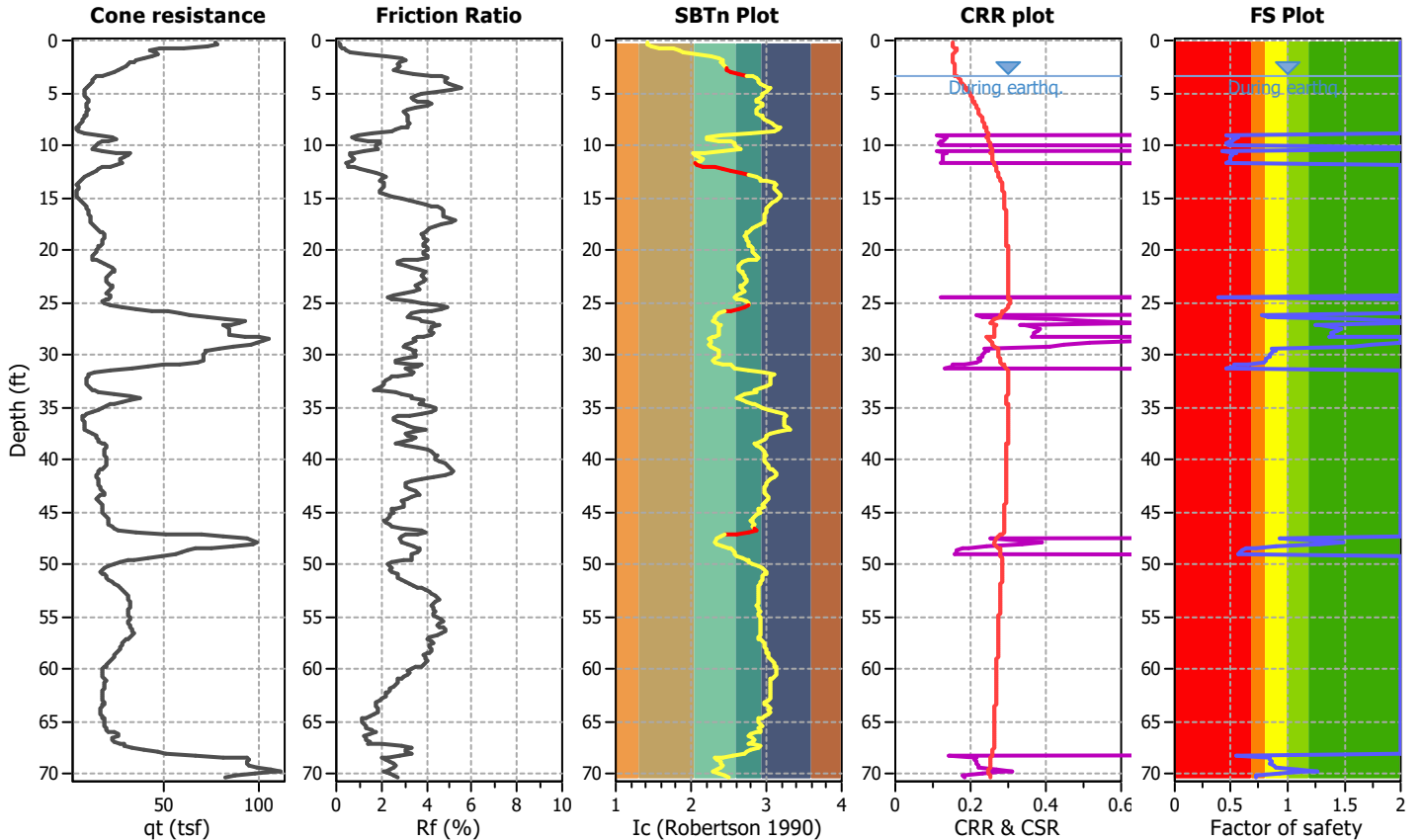
Project title :

Location :

CPT file : C-104

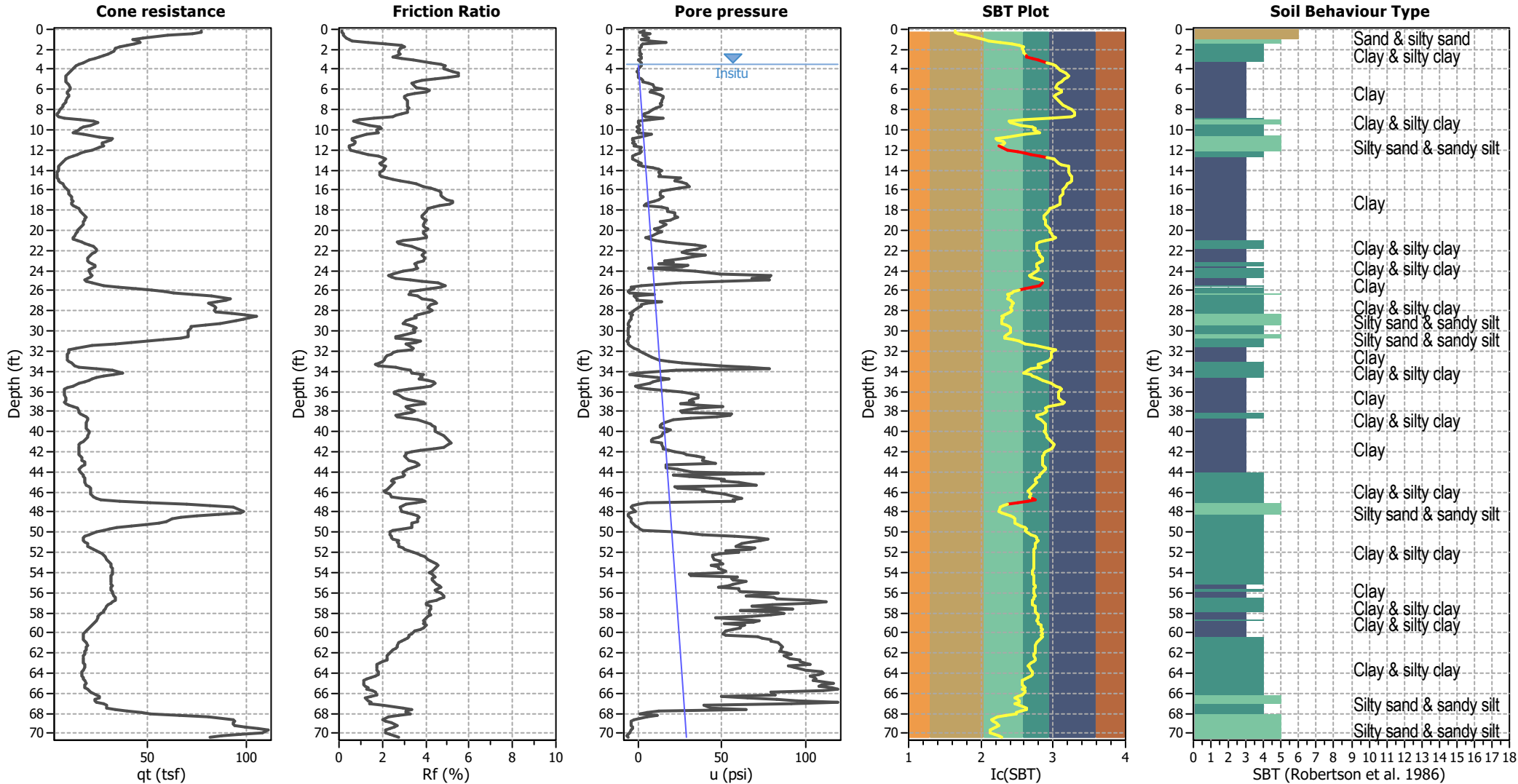
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



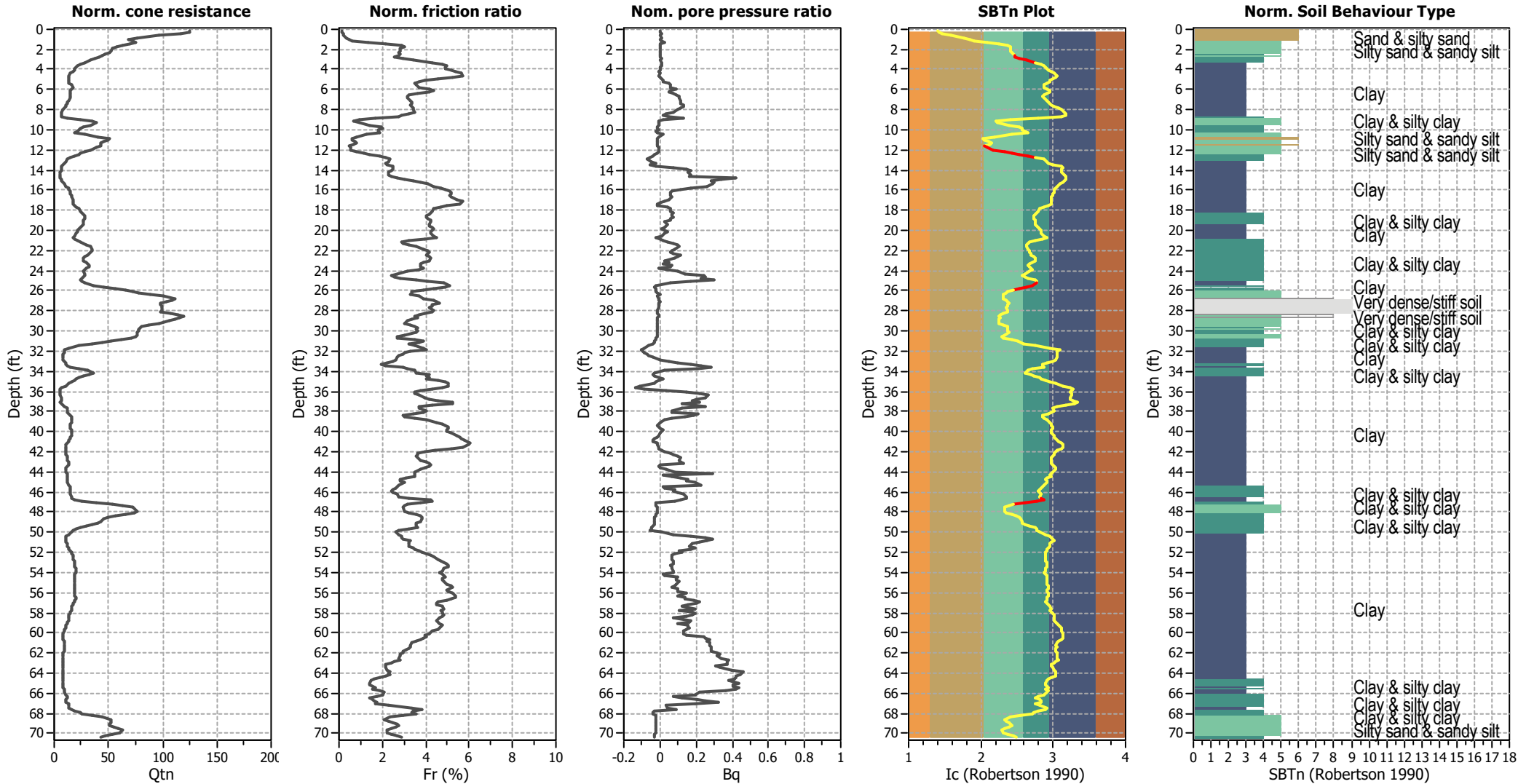
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



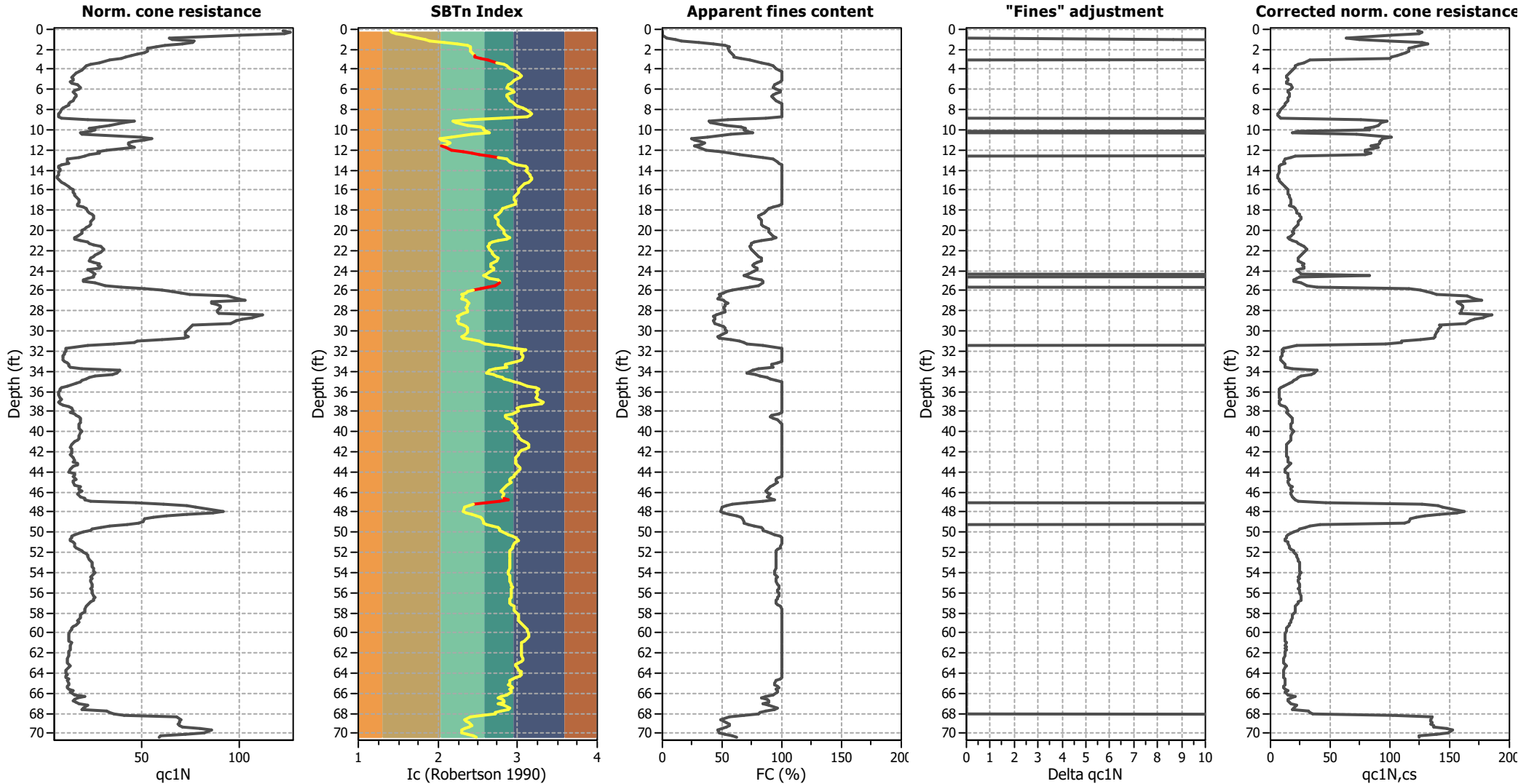
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

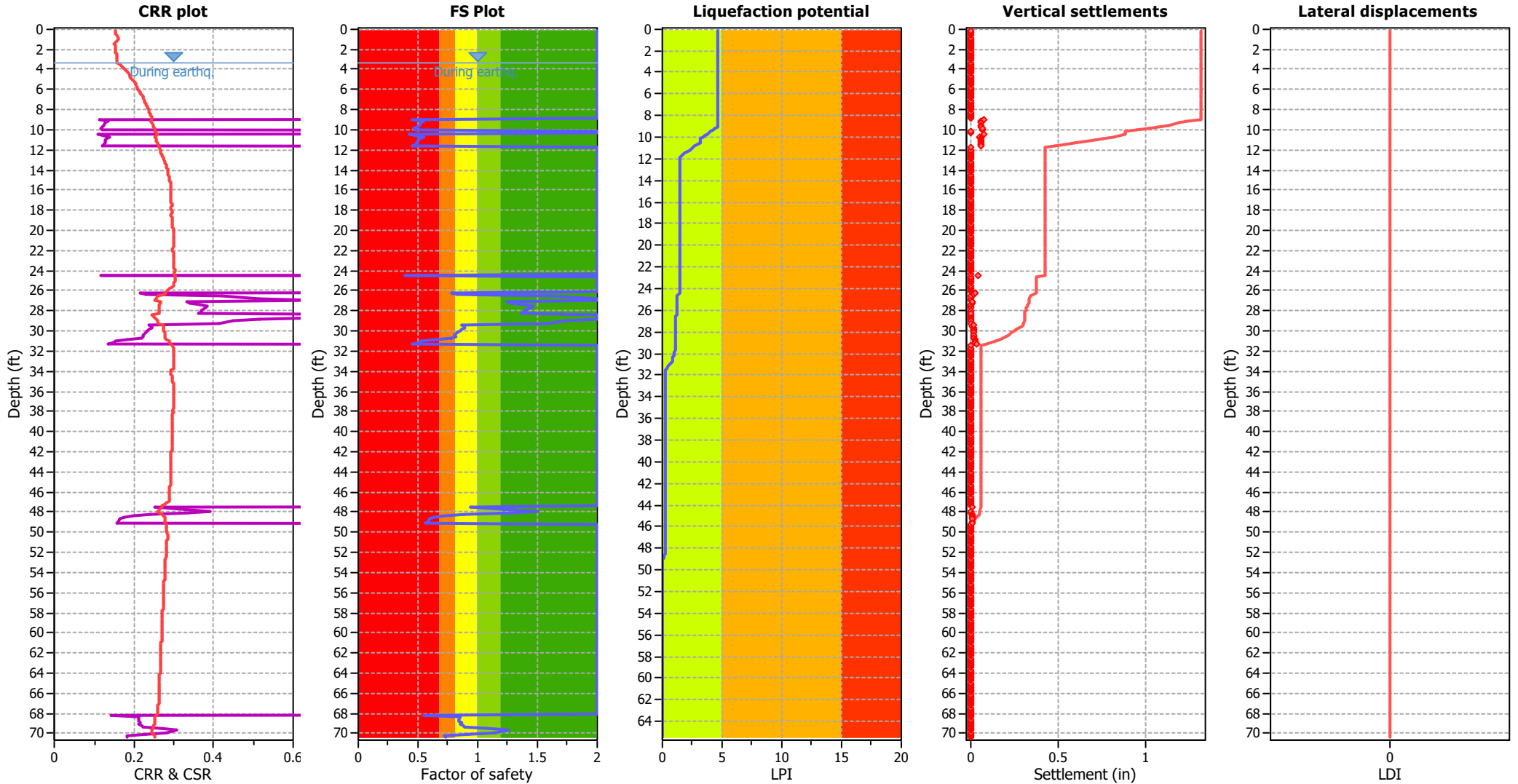
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

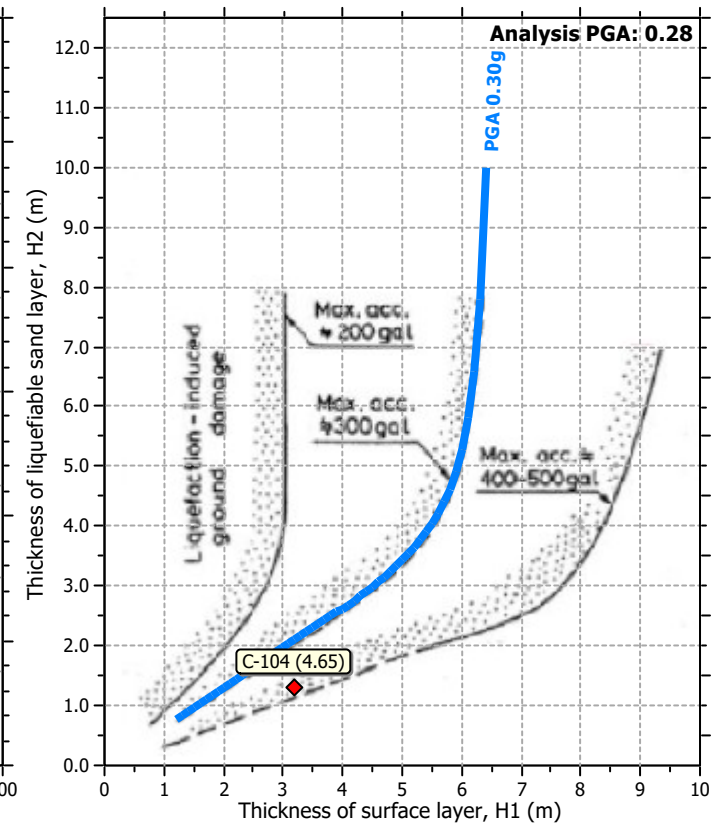
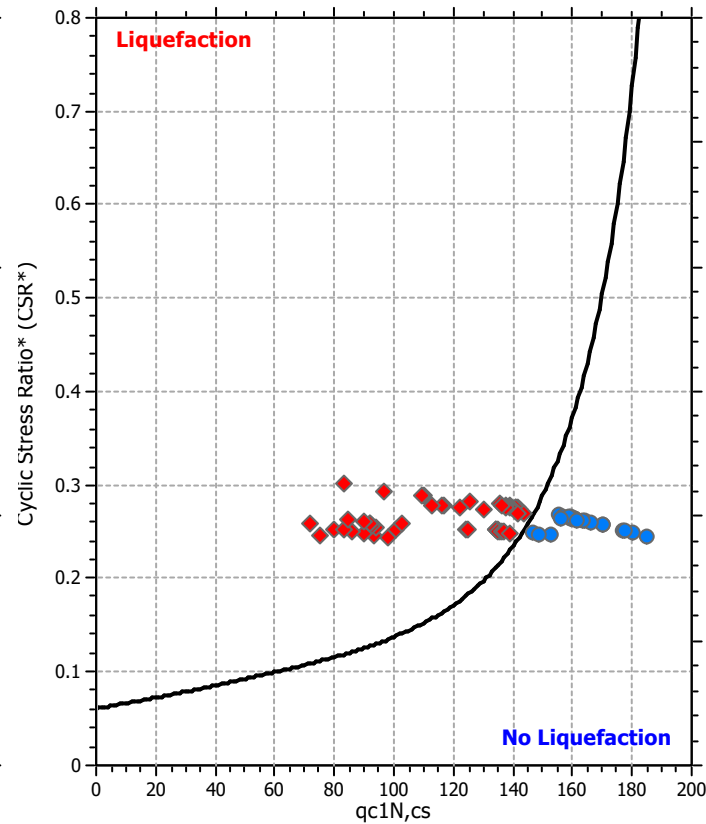
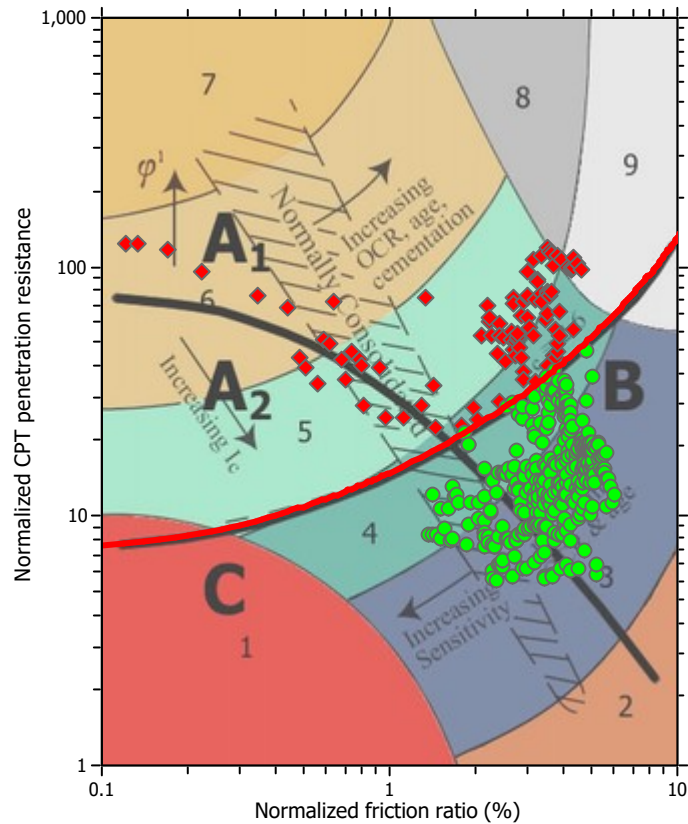
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

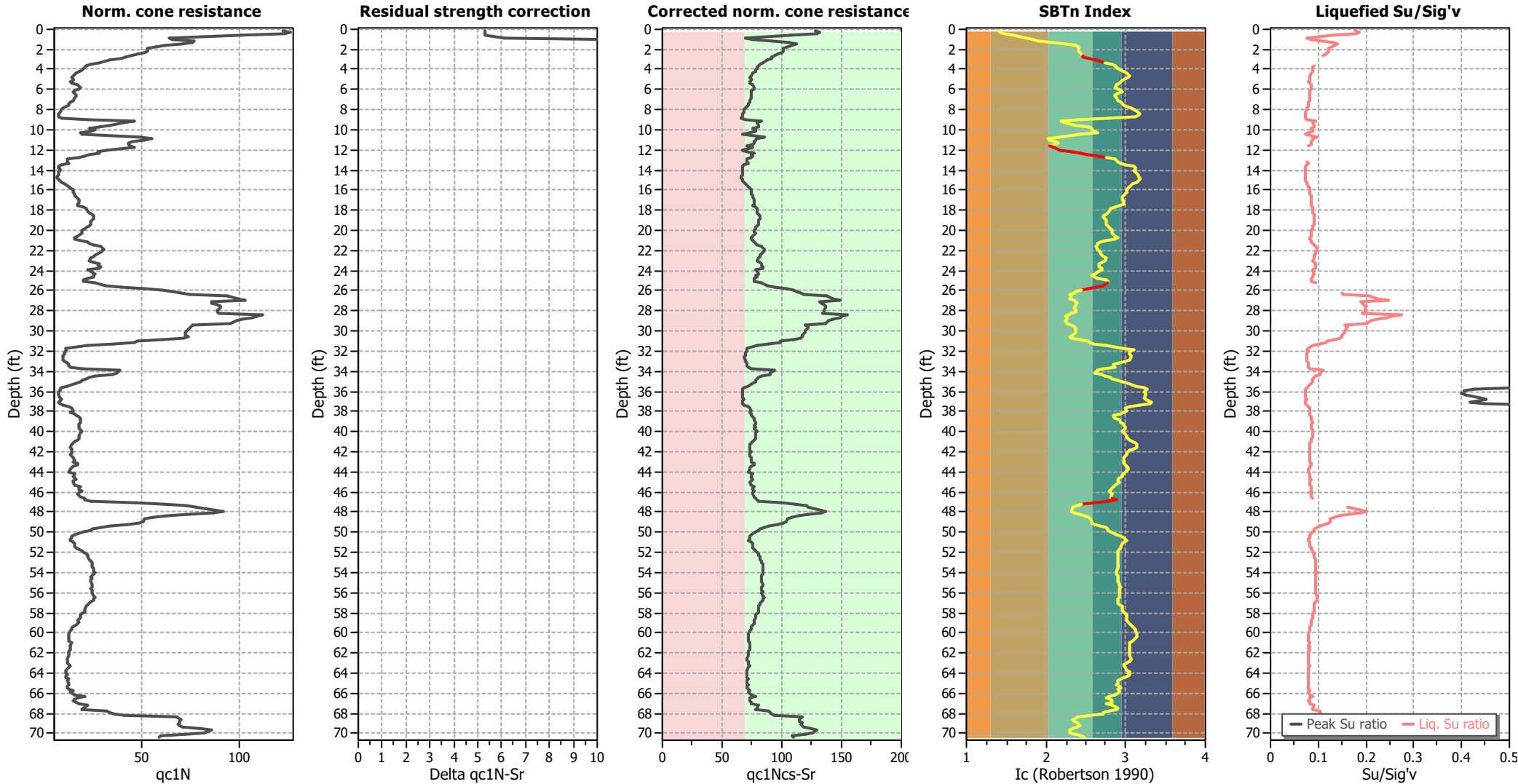
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

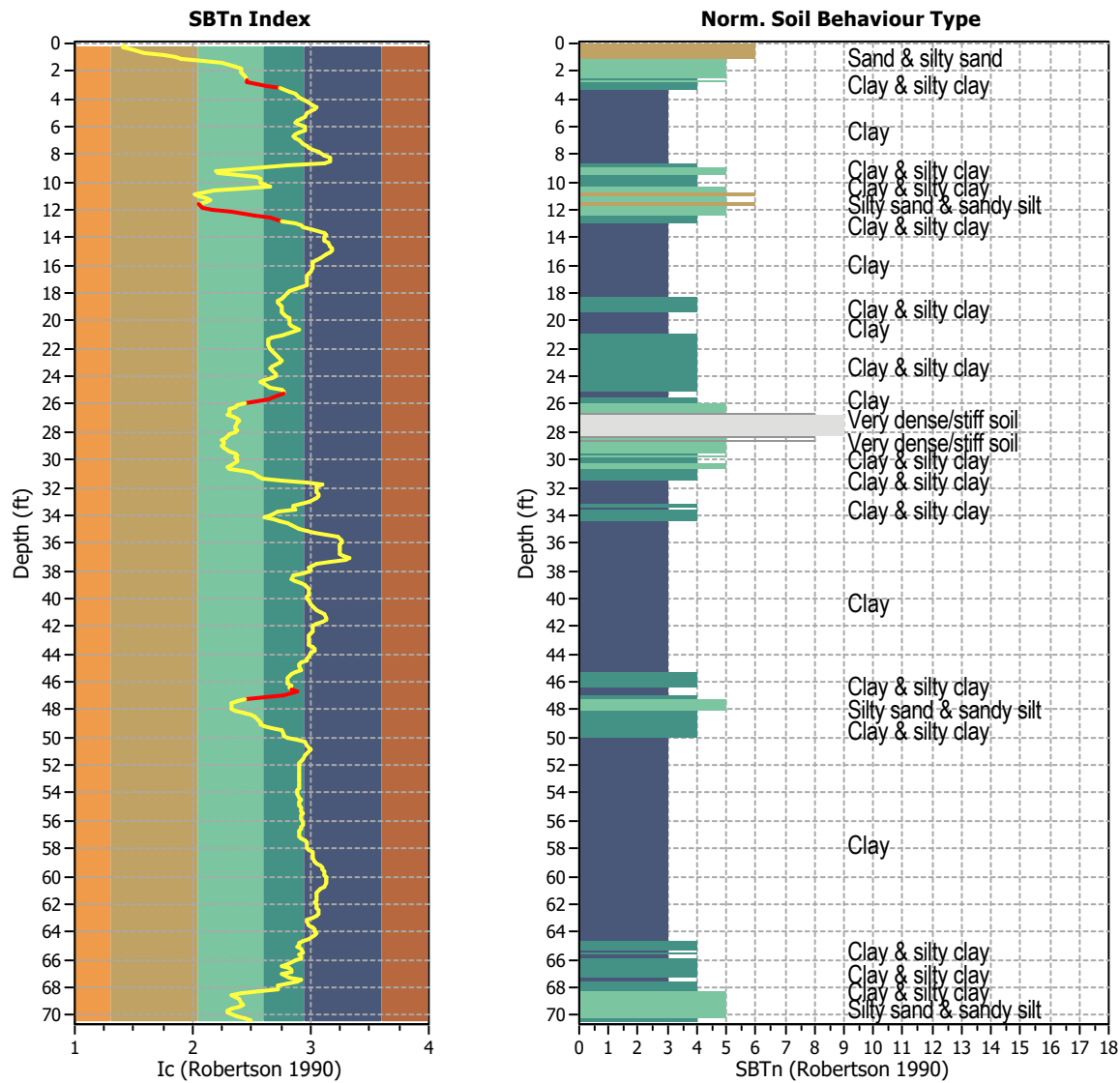
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vice-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties

I_c minimum check value:

2.00

I_c maximum check value:

3.00

I_c change ratio value:

0.0300

Minimum number of points in layer:

5

General statistics

Total points in CPT file:

428

Total points excluded:

23

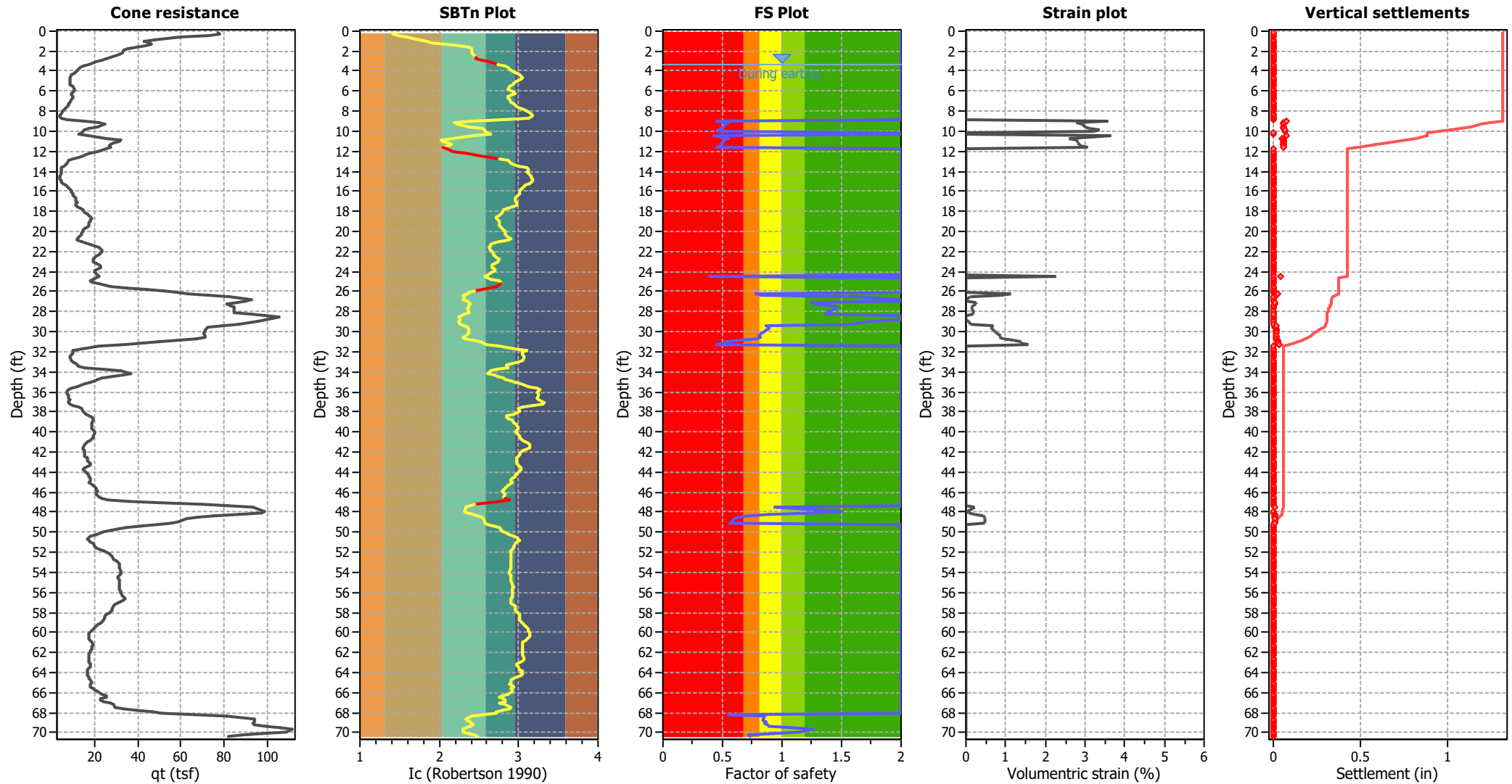
Exclusion percentage:

5.37%

Number of layers detected:

4

Estimation of post-earthquake settlements



Abbreviations

q_c : Total cone resistance (cone resistance q_c corrected for pore water effects)
 I_c : Soil Behaviour Type Index
 FS: Calculated Factor of Safety against liquefaction
 Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

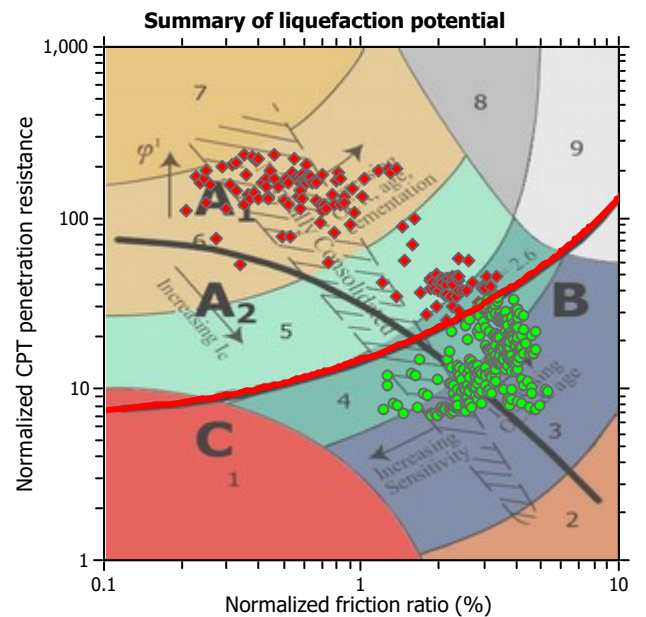
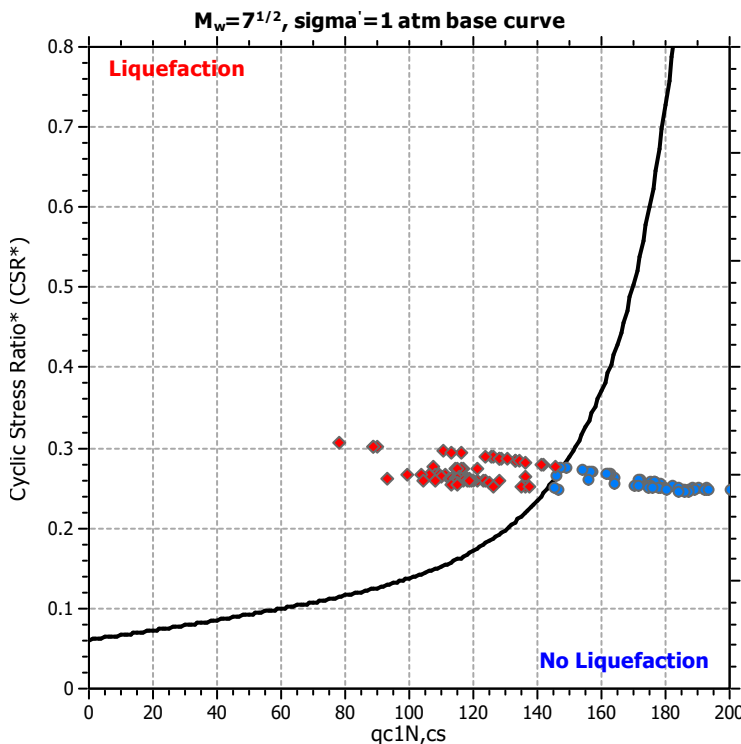
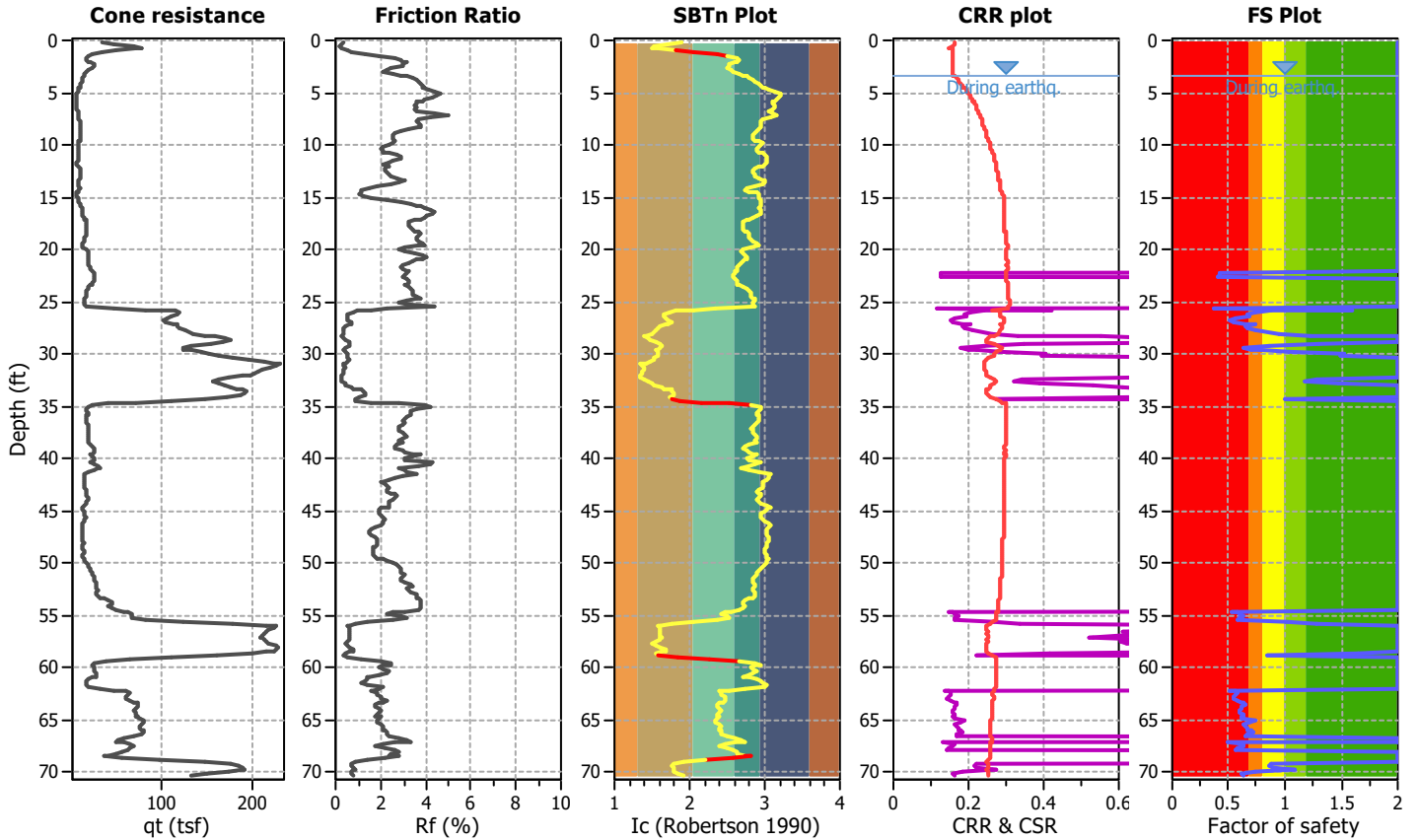
Project title :

Location :

CPT file : C-105

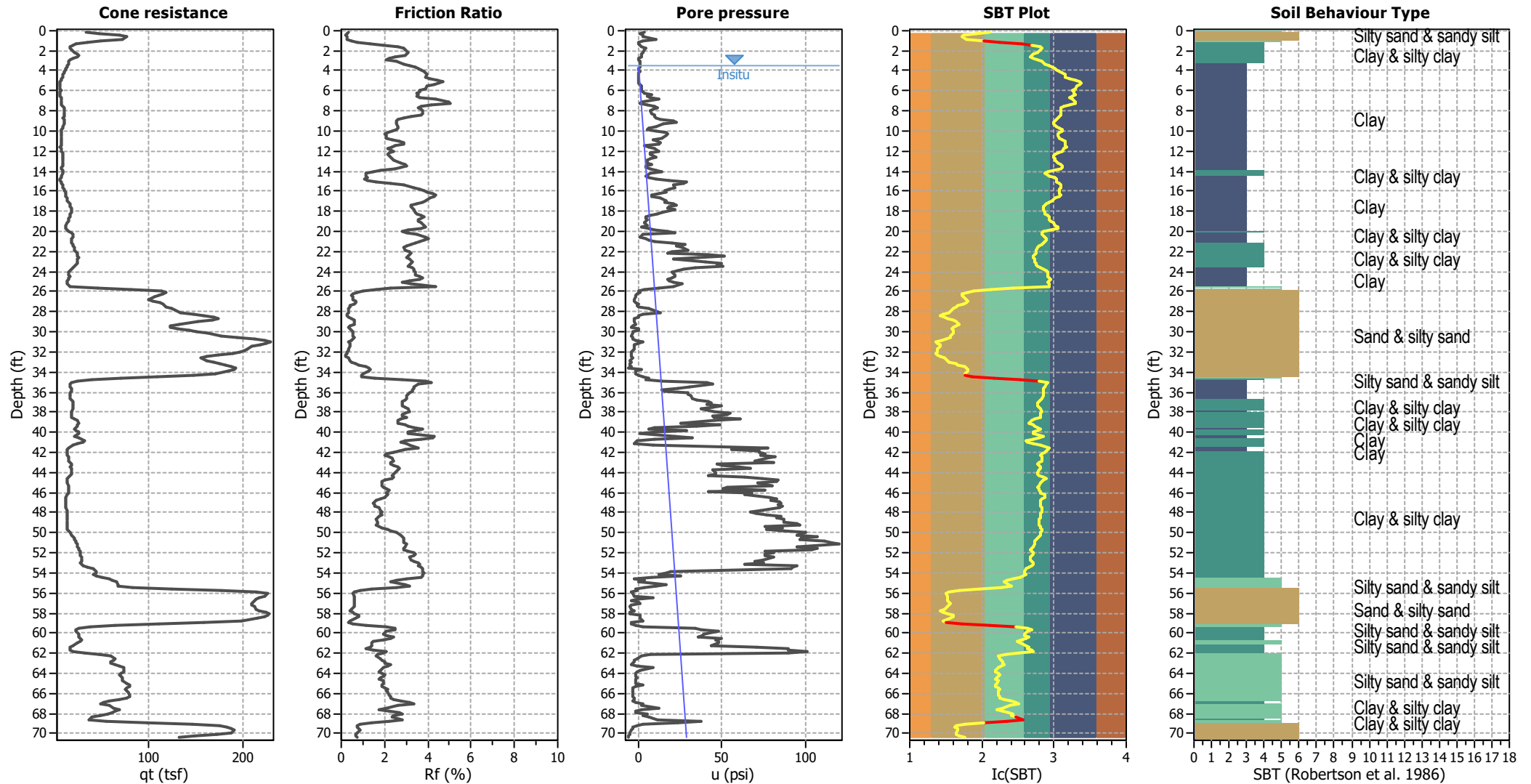
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



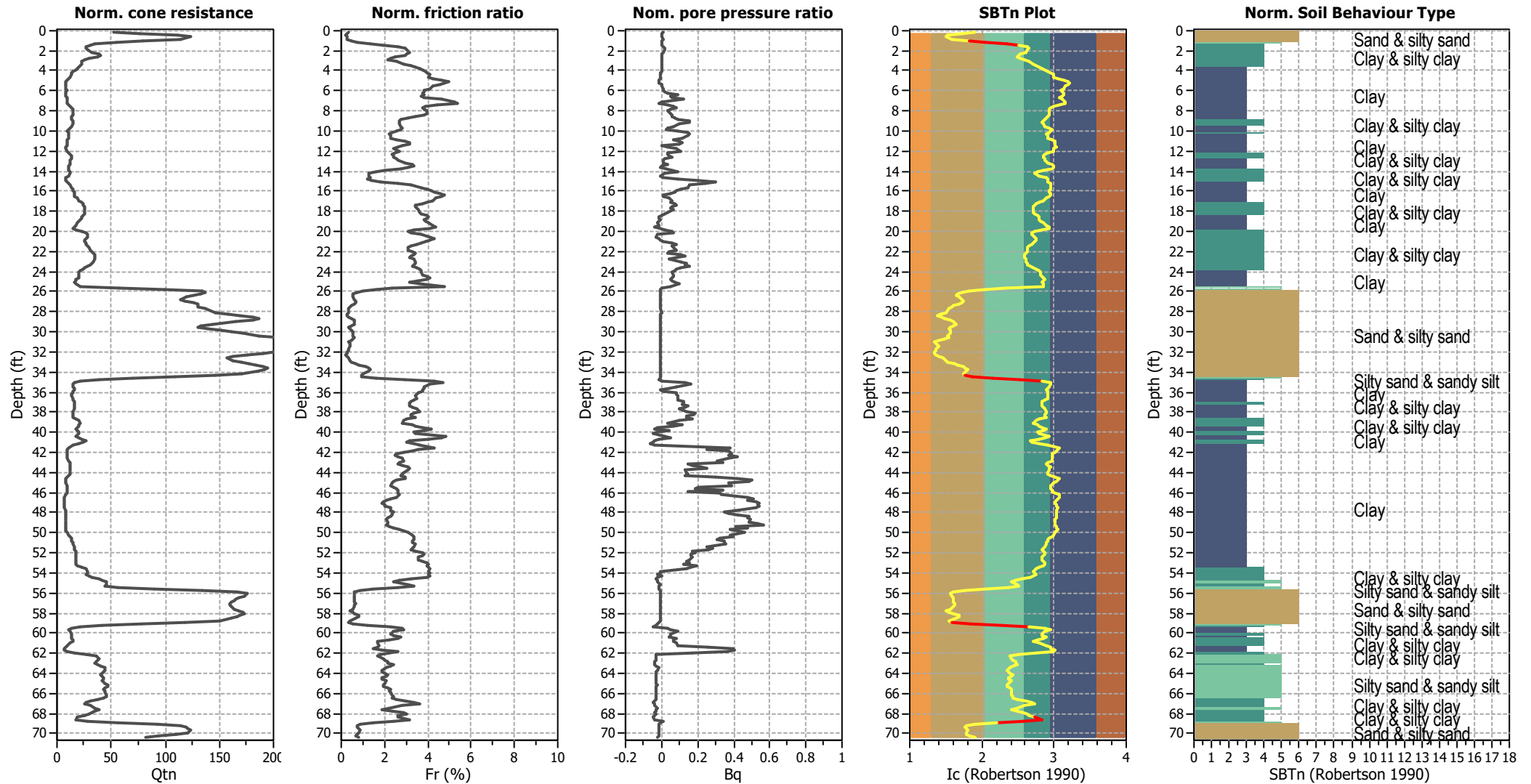
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



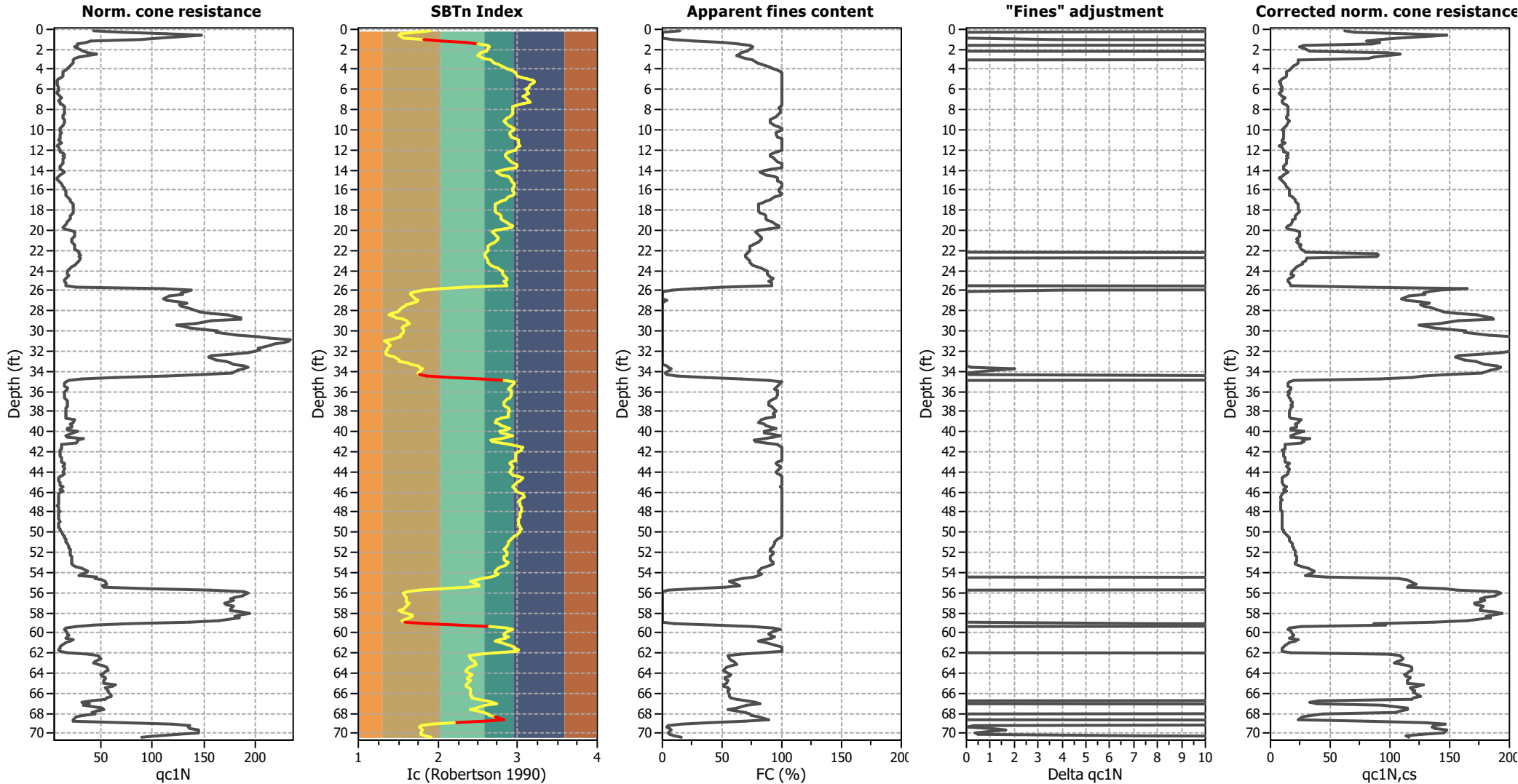
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

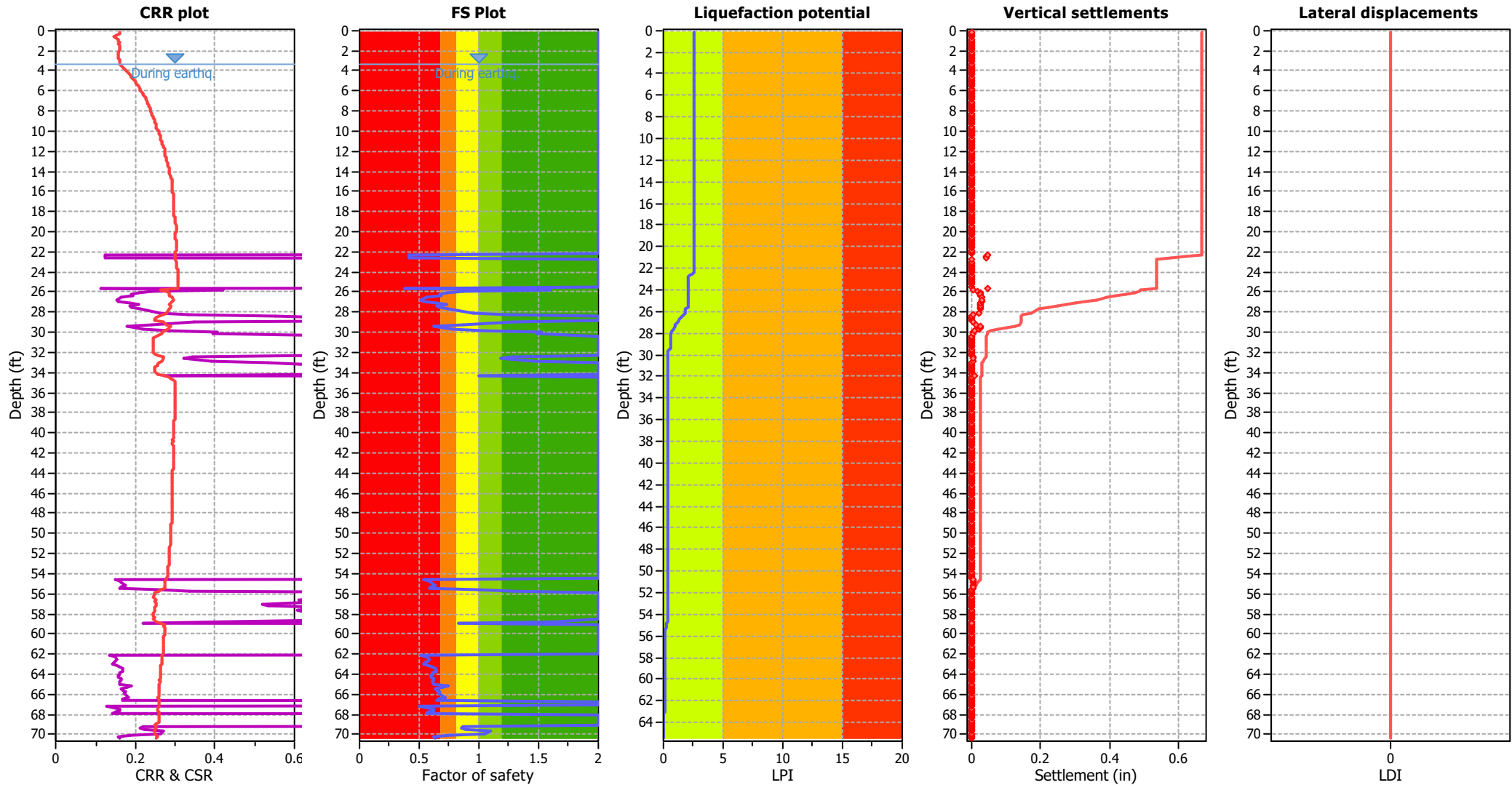
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

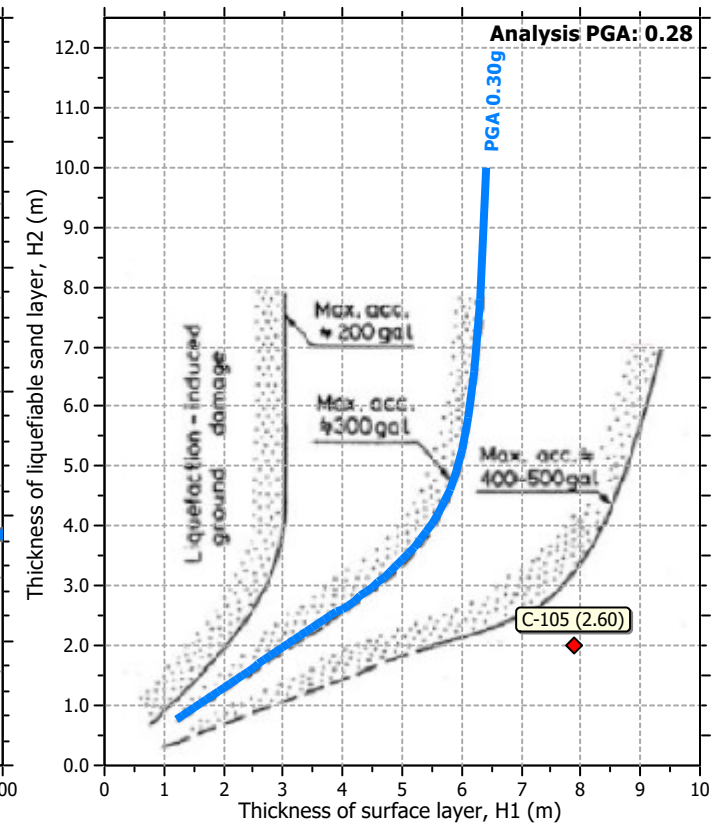
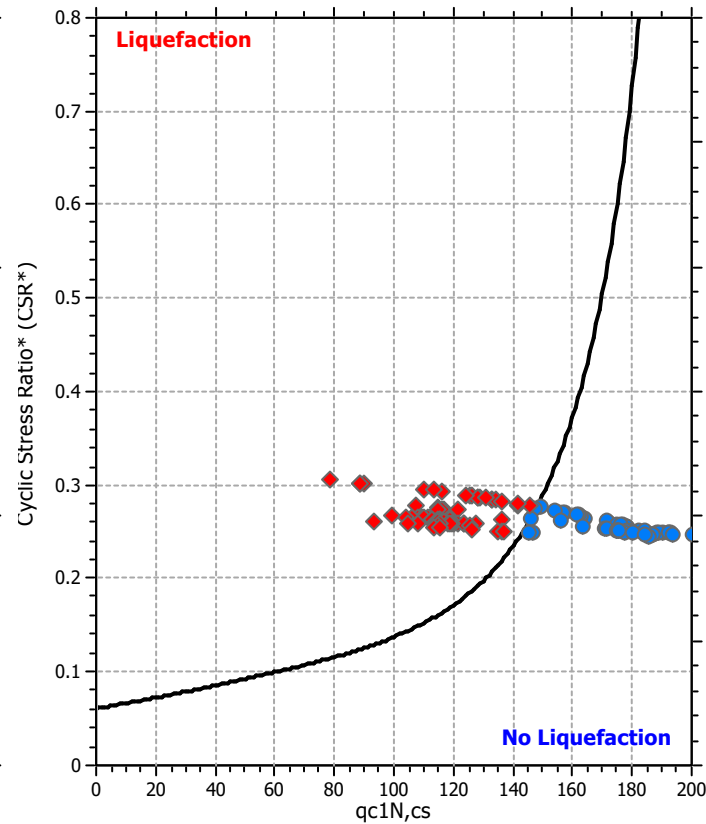
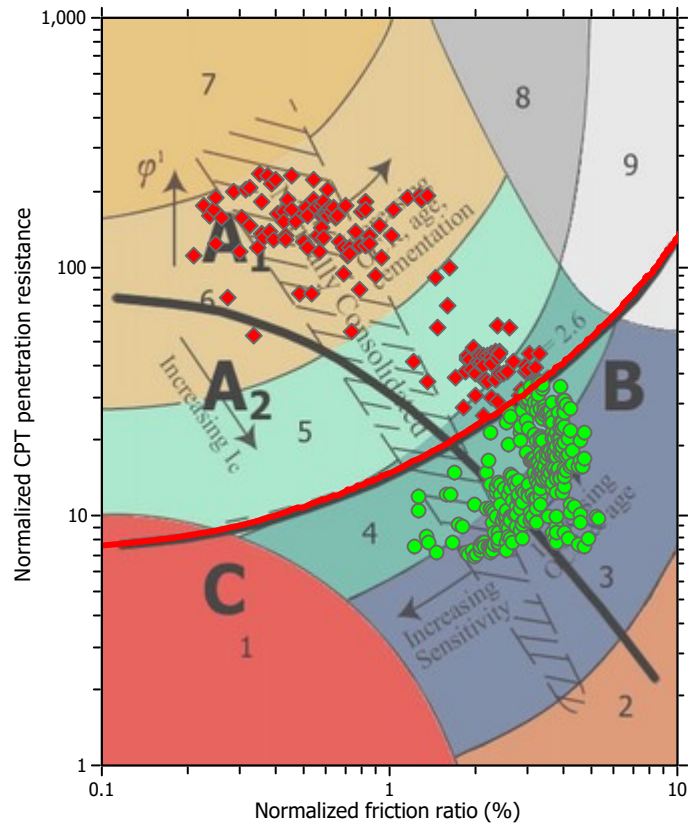
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

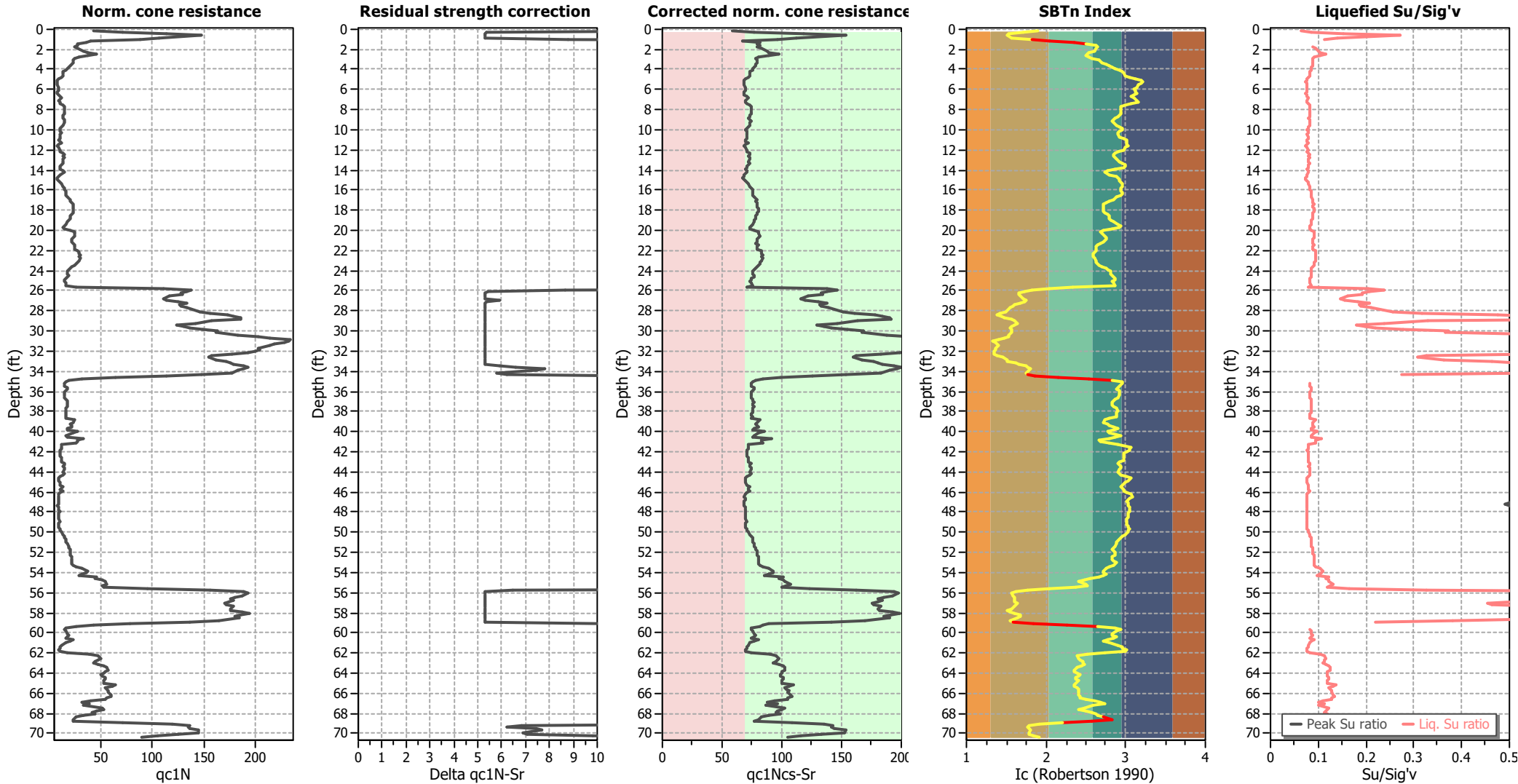
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

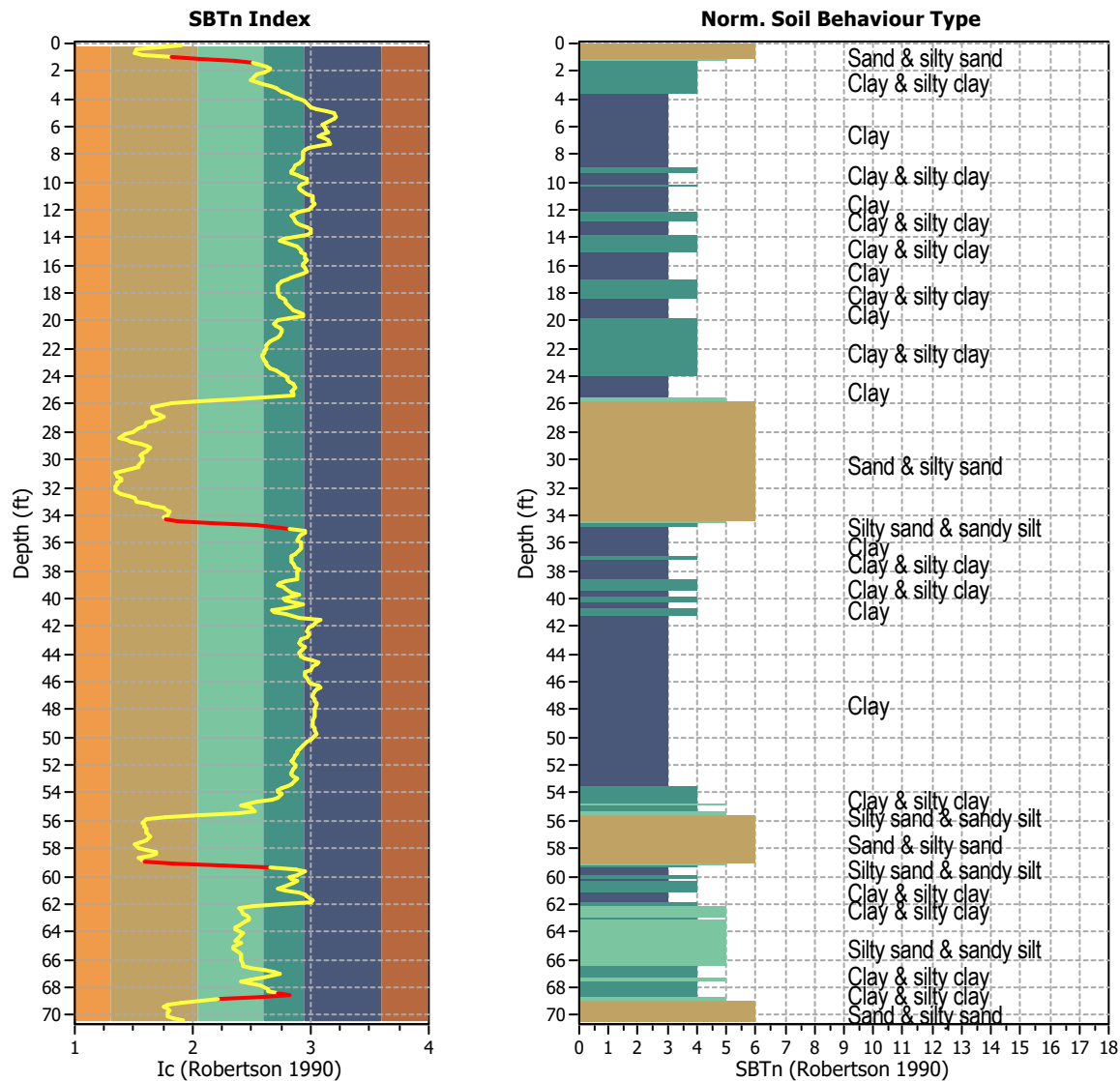
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



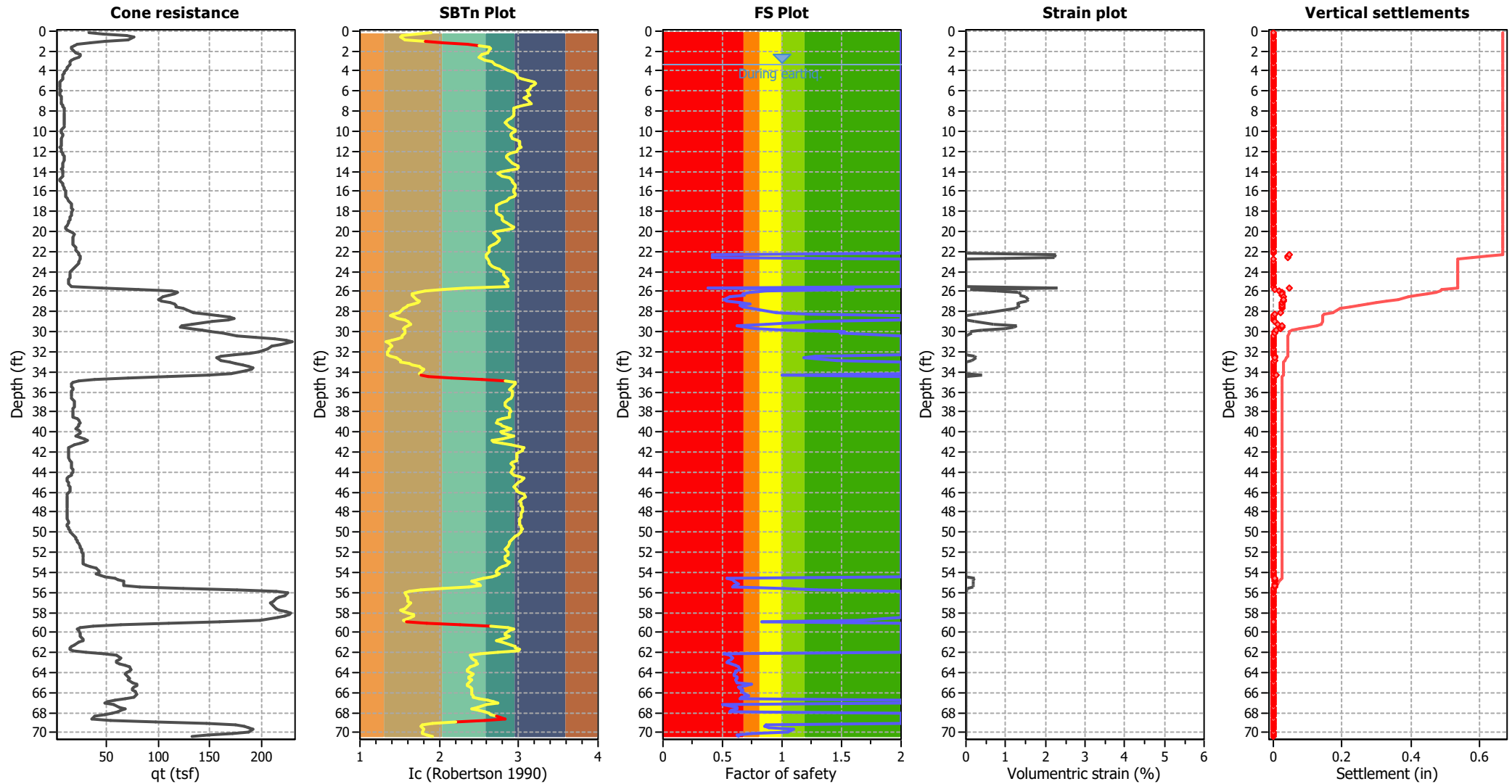
Transition layer algorithm properties

I_c minimum check value: 1.83
 I_c maximum check value: 3.00
 I_c change ratio value: 0.0600
Minimum number of points in layer: 4

General statistics

Total points in CPT file: 428
Total points excluded: 17
Exclusion percentage: 3.97%
Number of layers detected: 4

Estimation of post-earthquake settlements



Abbreviations

q_c : Total cone resistance (cone resistance q_c corrected for pore water effects)
 I_c : Soil Behaviour Type Index
 FS: Calculated Factor of Safety against liquefaction
 Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

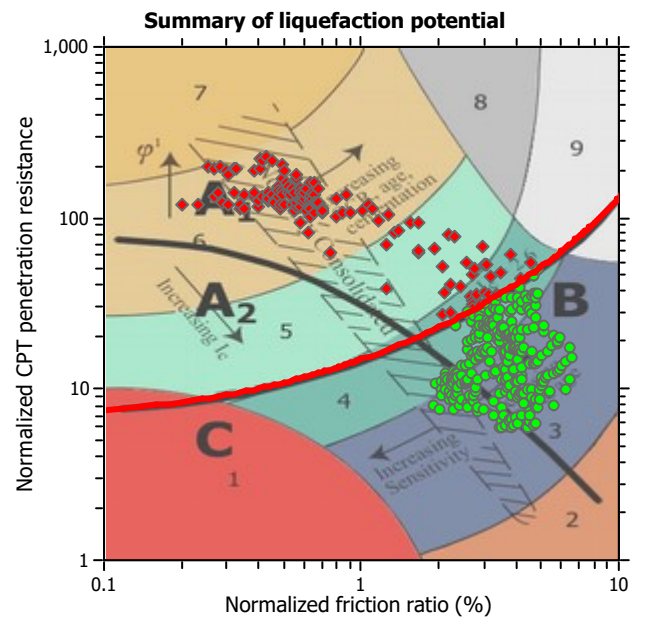
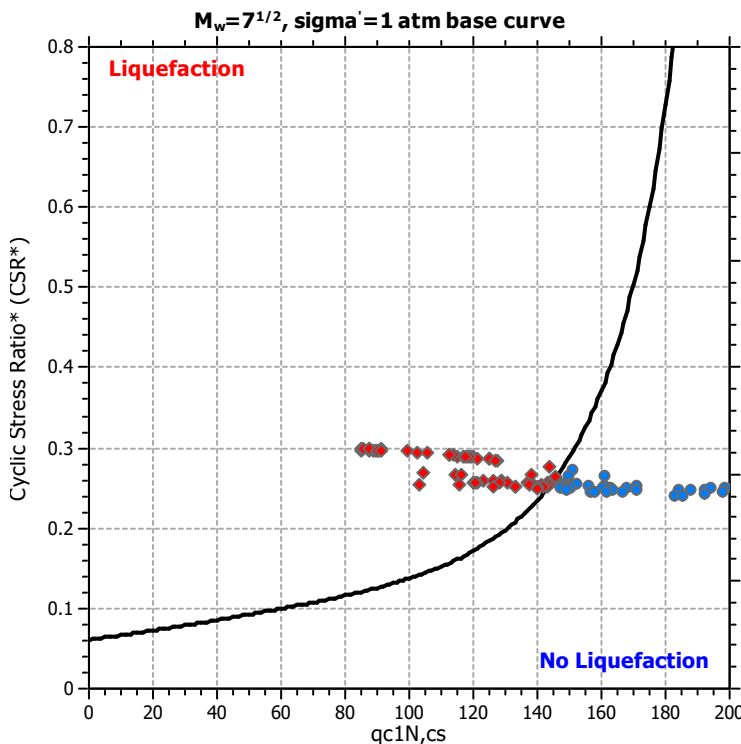
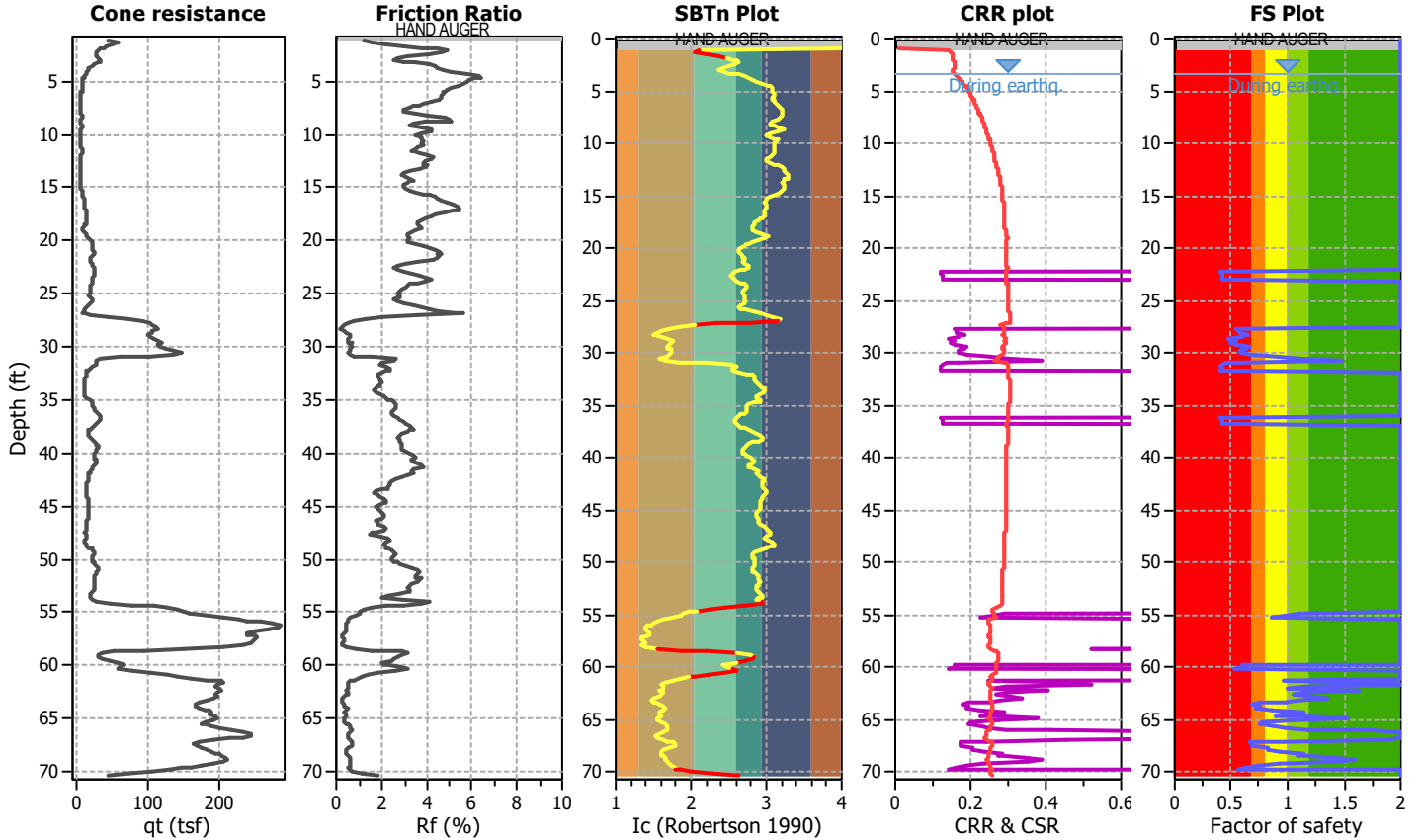
Project title :

Location :

CPT file : C-106

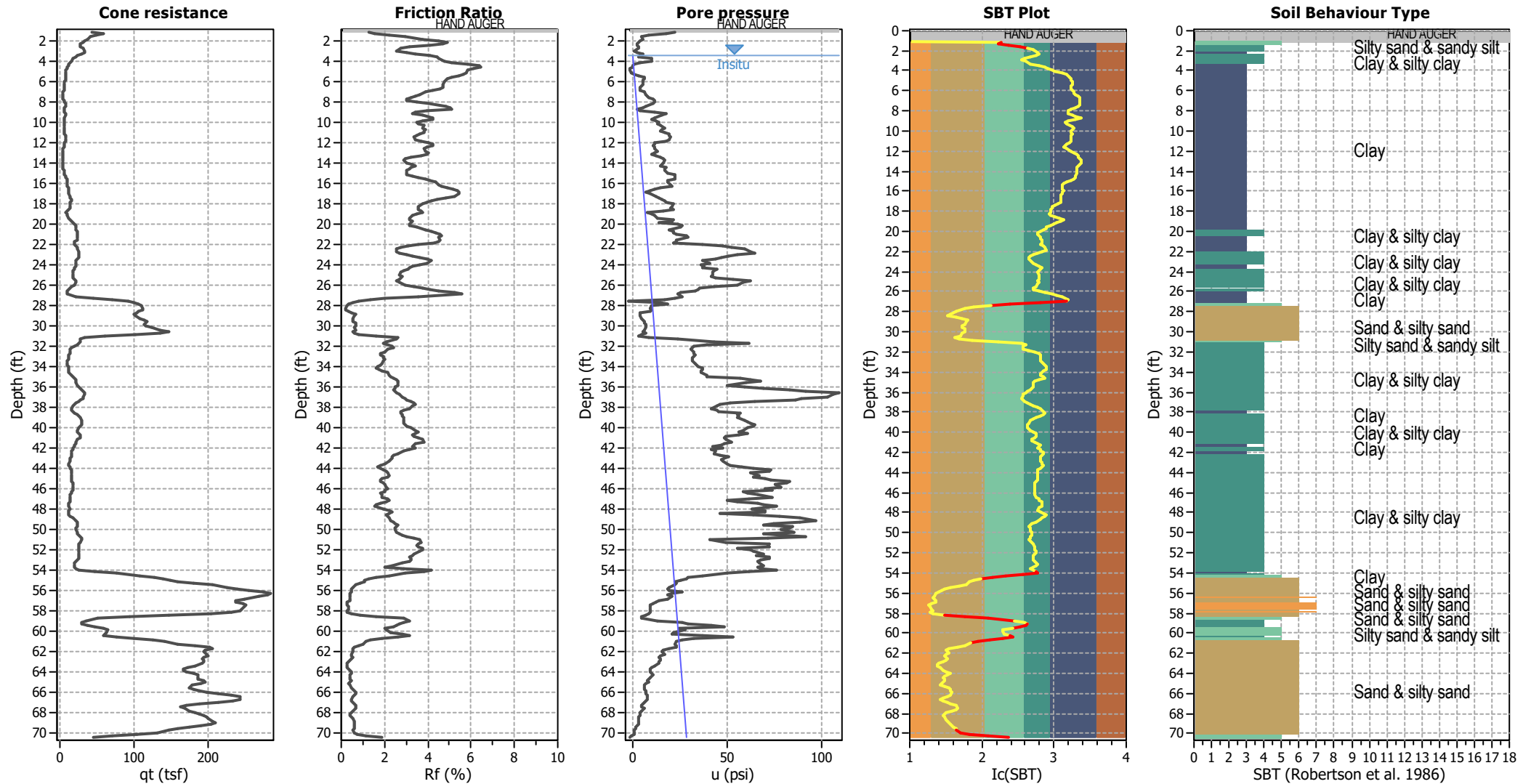
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	MSF method:	N/A
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



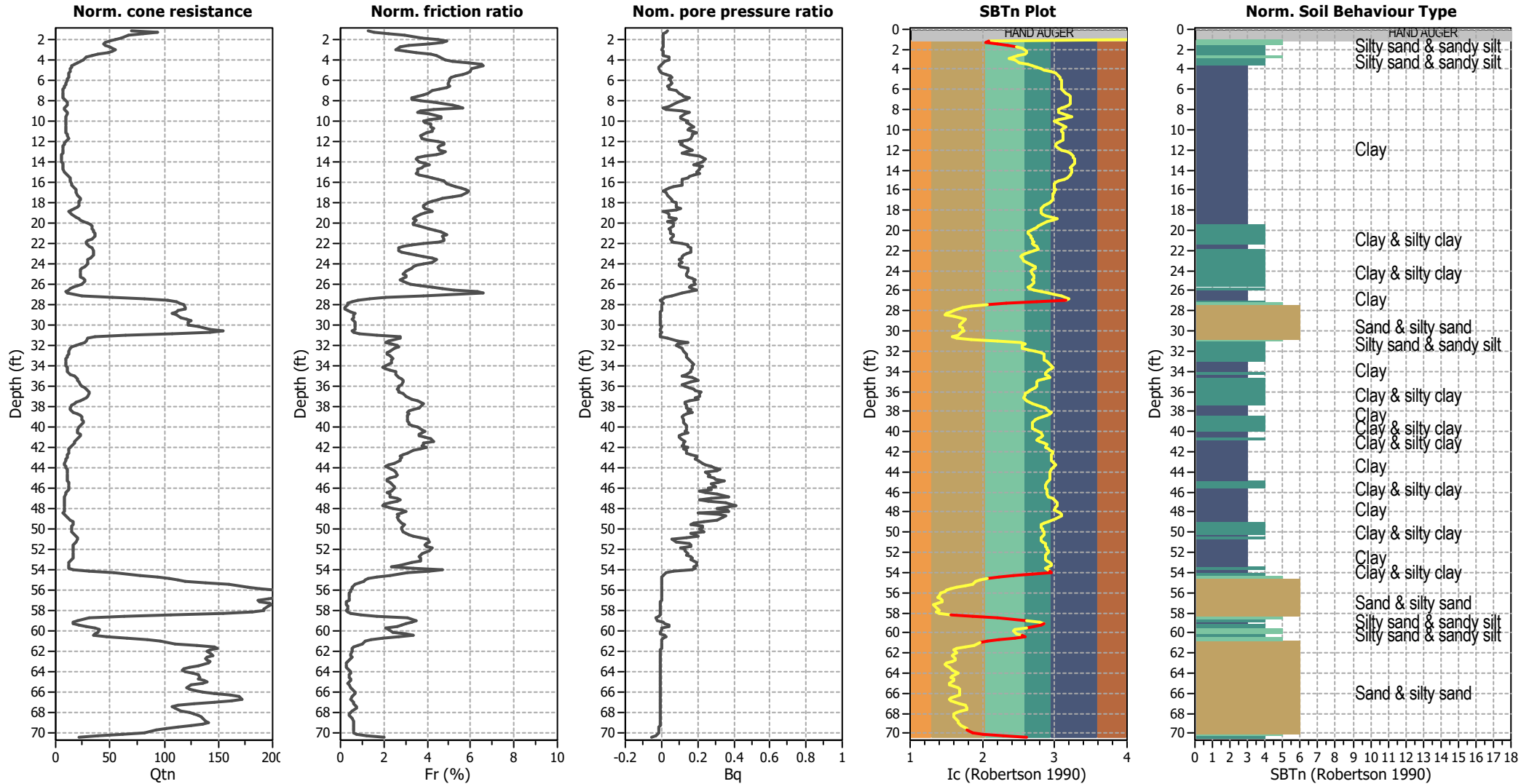
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



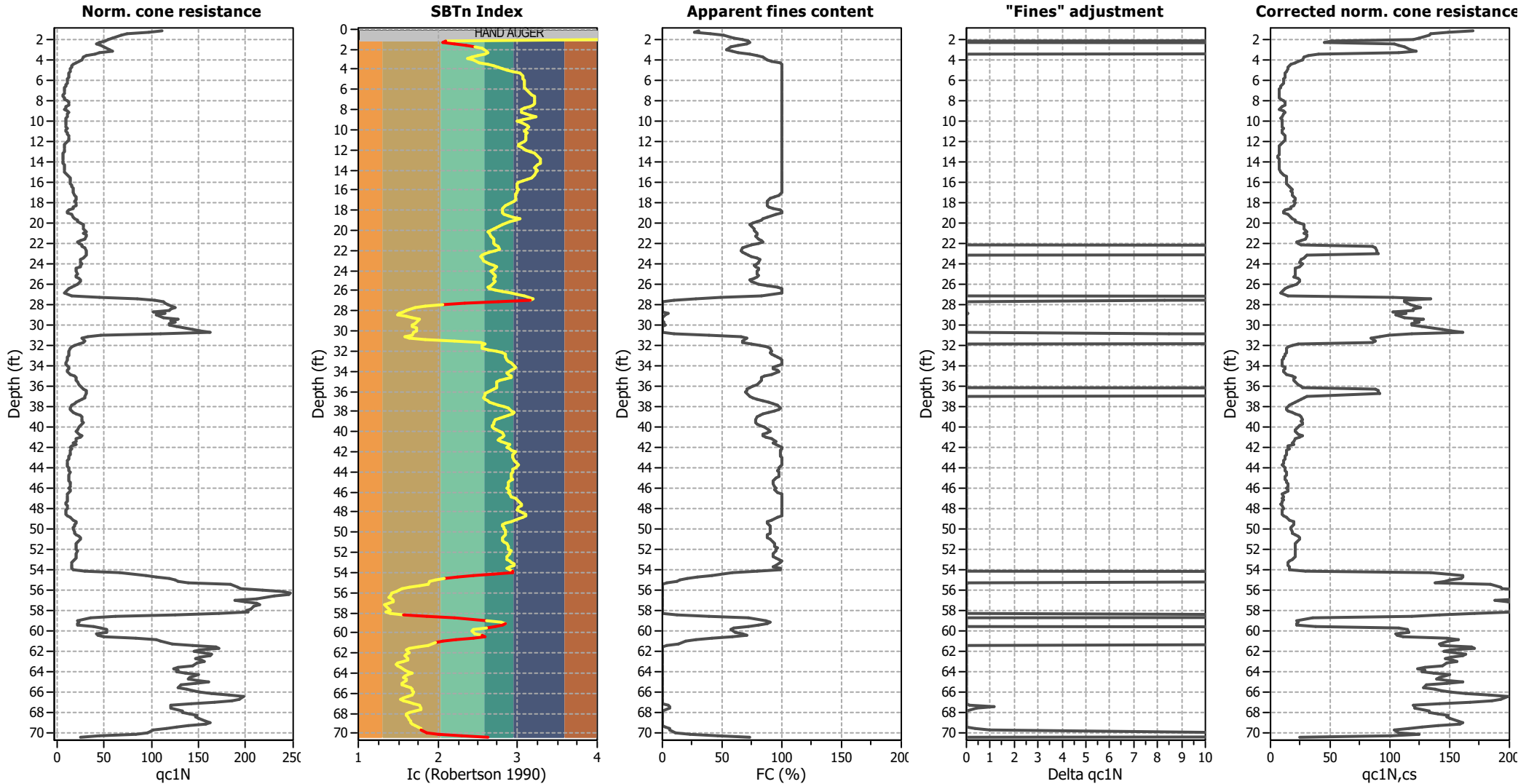
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

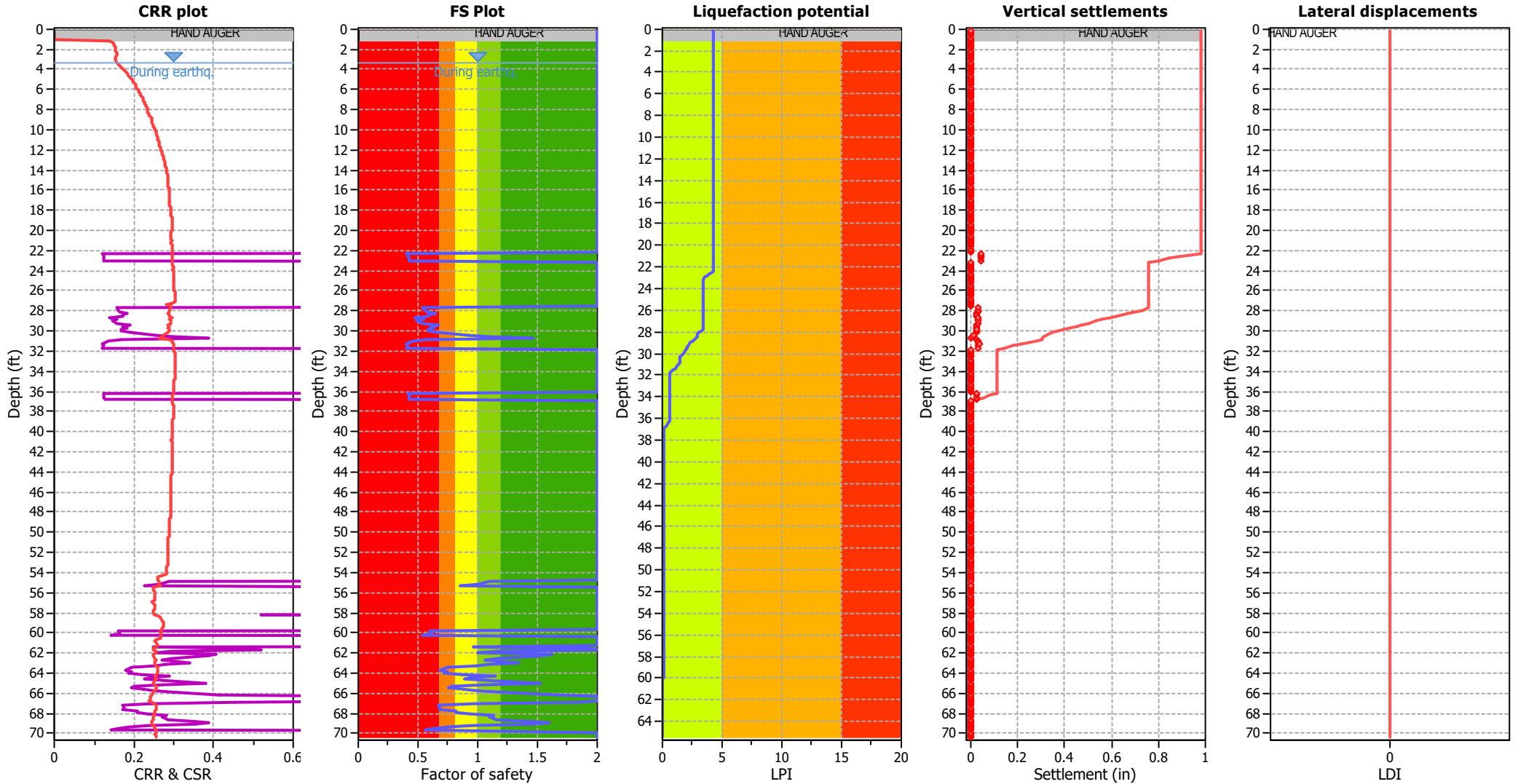
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

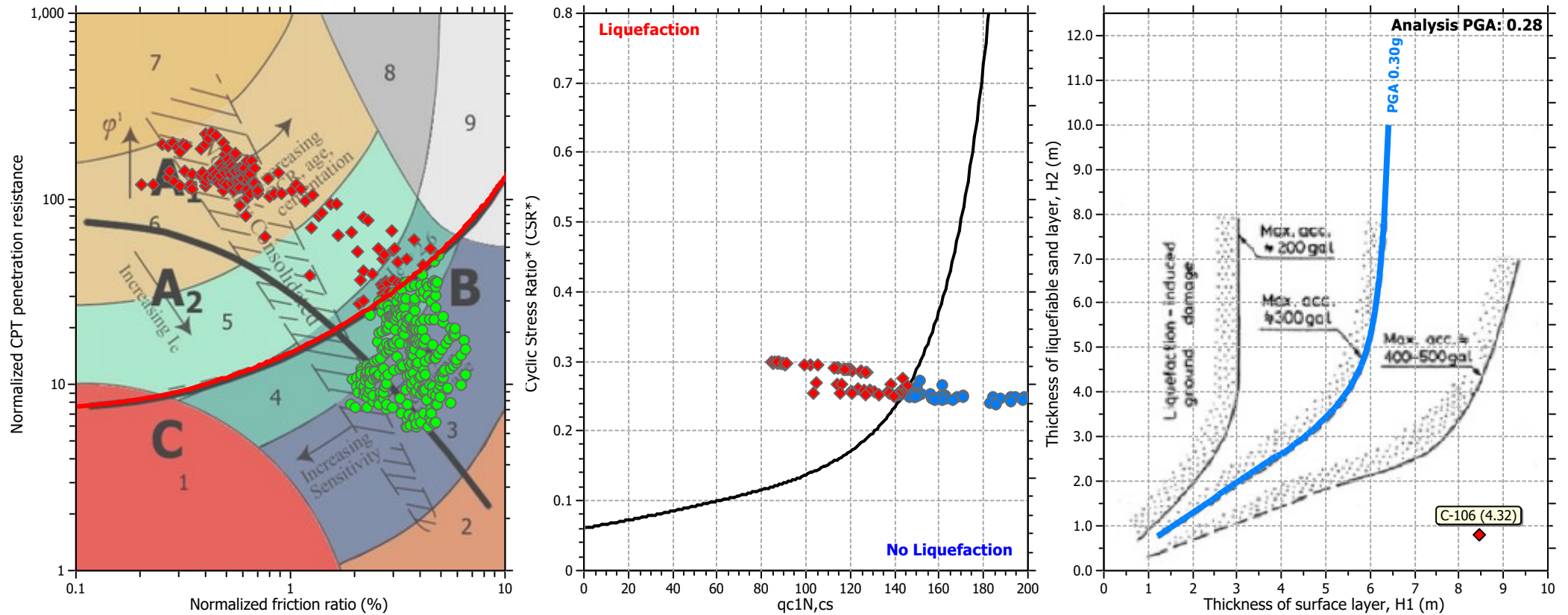
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

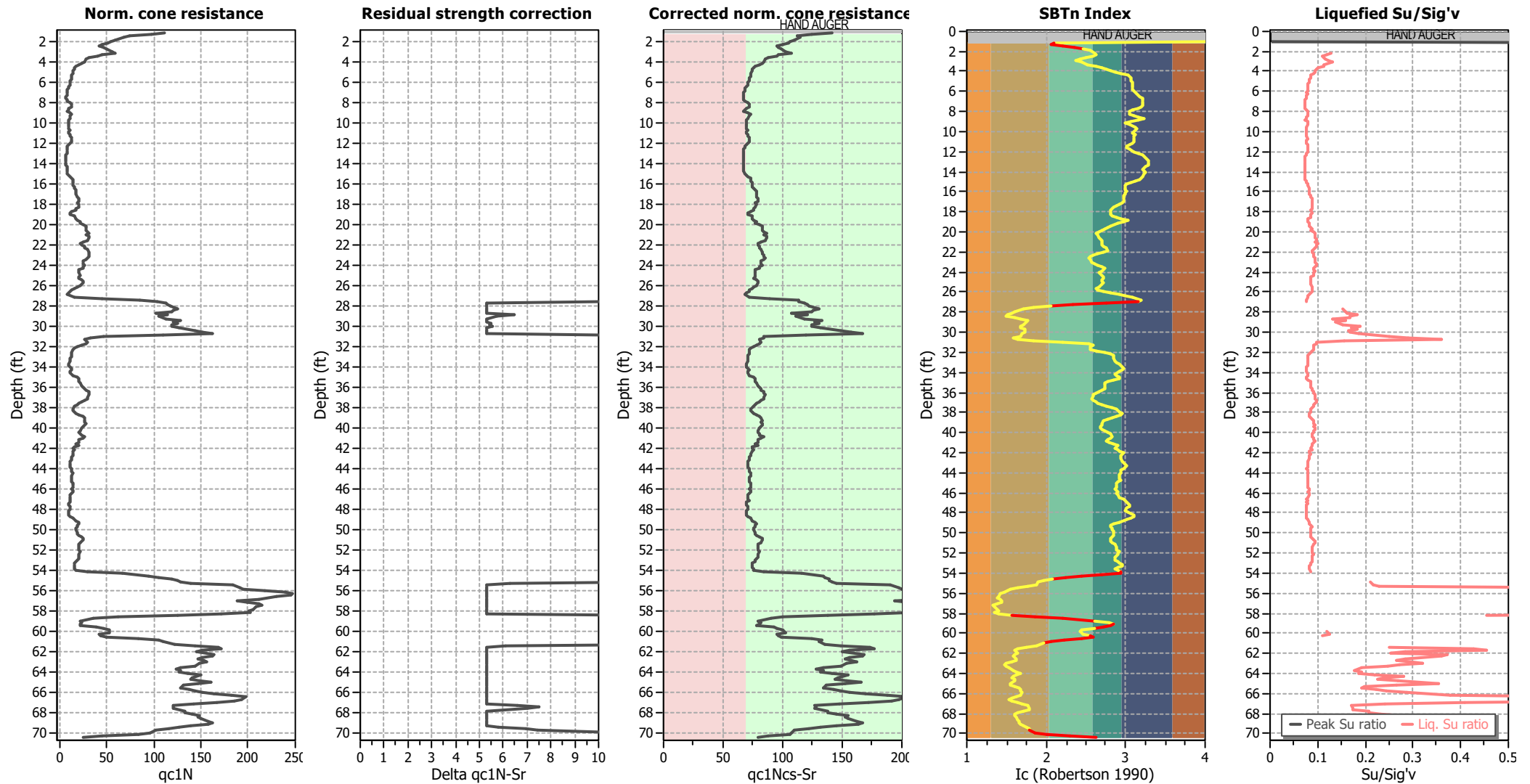
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

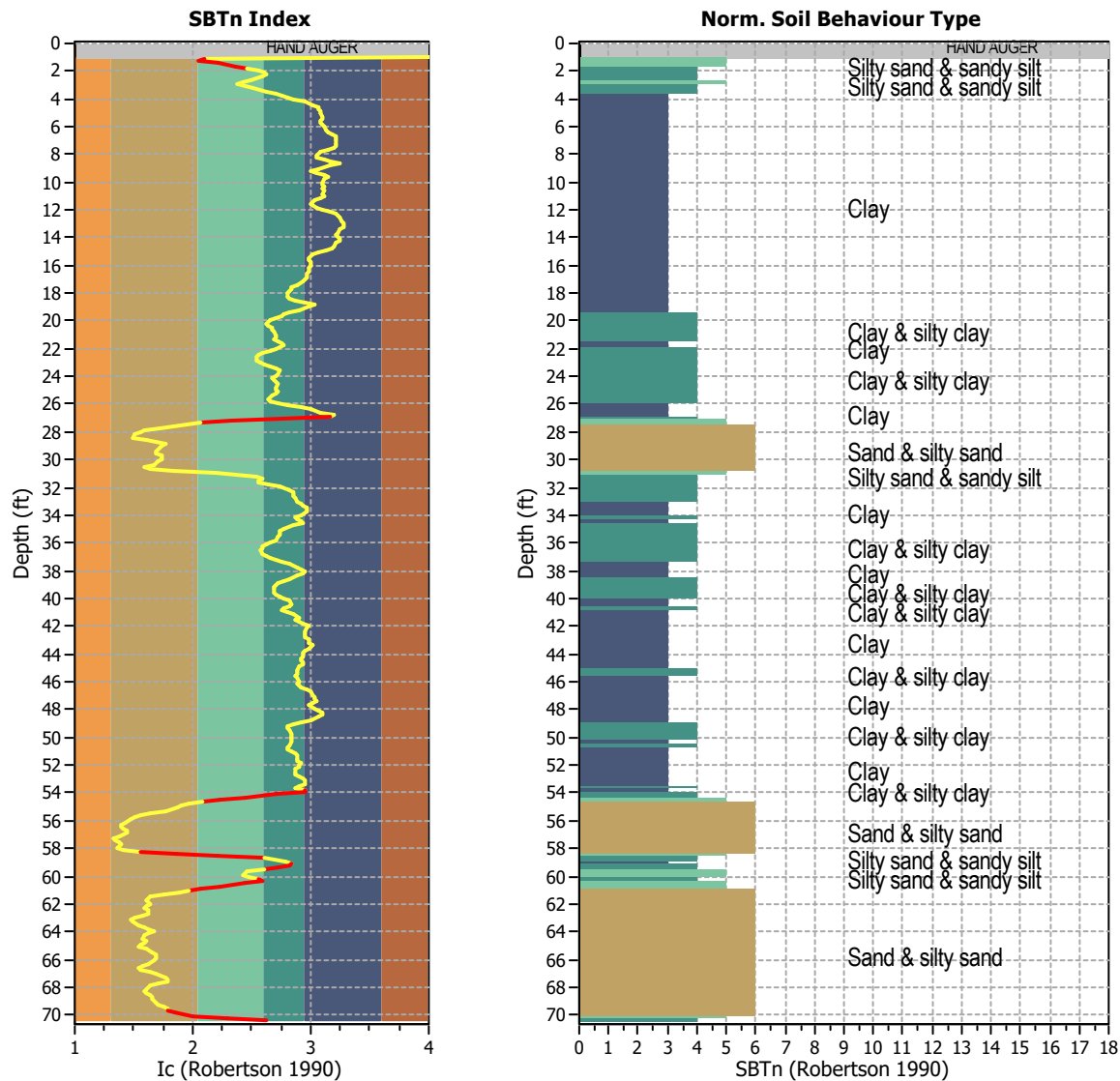
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties

I_c minimum check value:

1.78

I_c maximum check value:

3.00

I_c change ratio value:

0.0350

Minimum number of points in layer:

4

General statistics

Total points in CPT file:

429

Total points excluded:

33

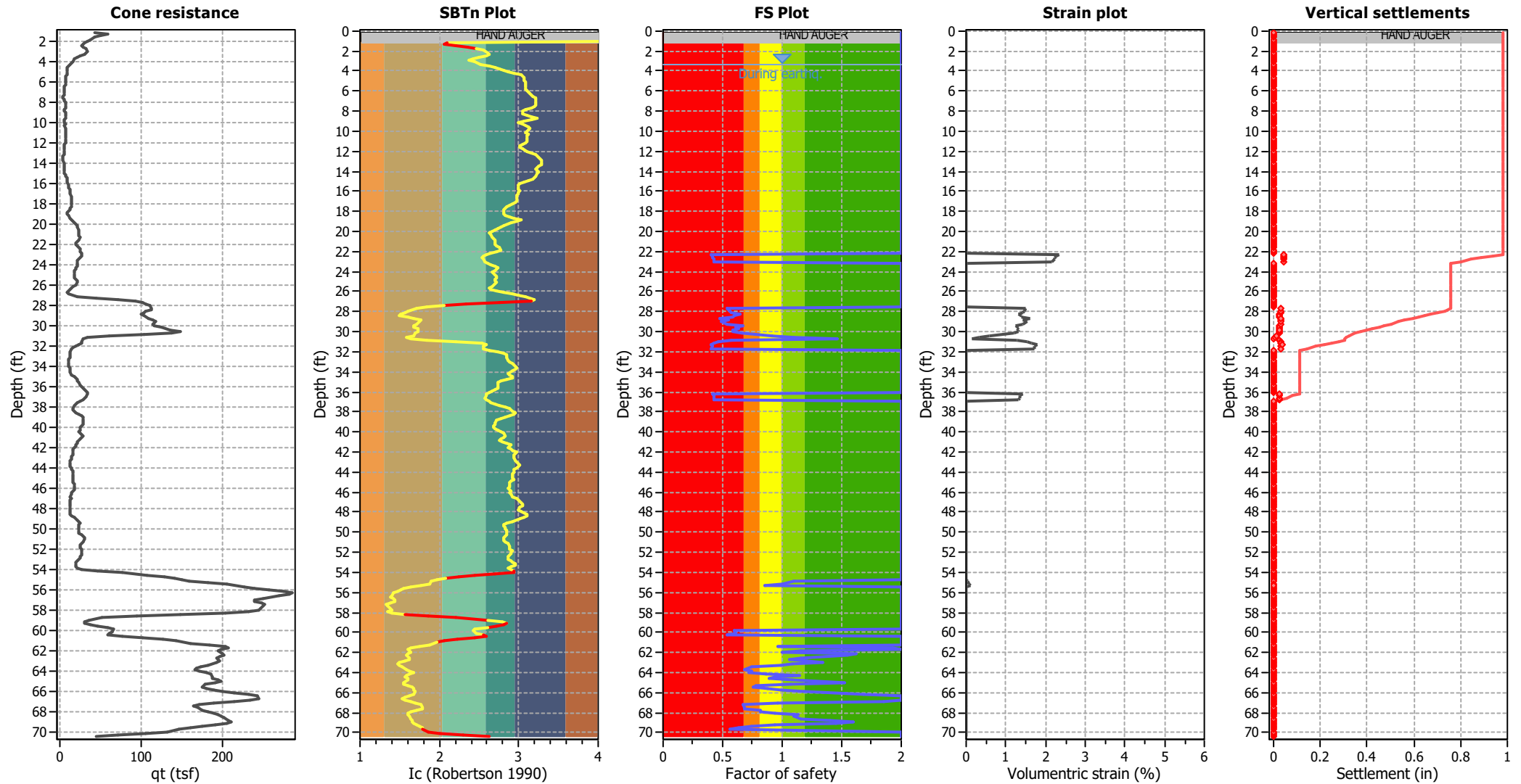
Exclusion percentage:

7.69%

Number of layers detected:

7

Estimation of post-earthquake settlements



Abbreviations

q_t : Total cone resistance (cone resistance q_c corrected for pore water effects)
 I_c : Soil Behaviour Type Index
 FS: Calculated Factor of Safety against liquefaction
 Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

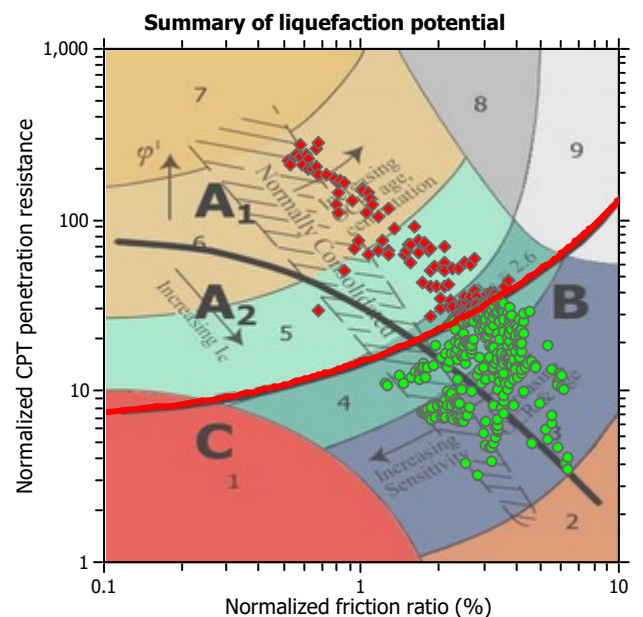
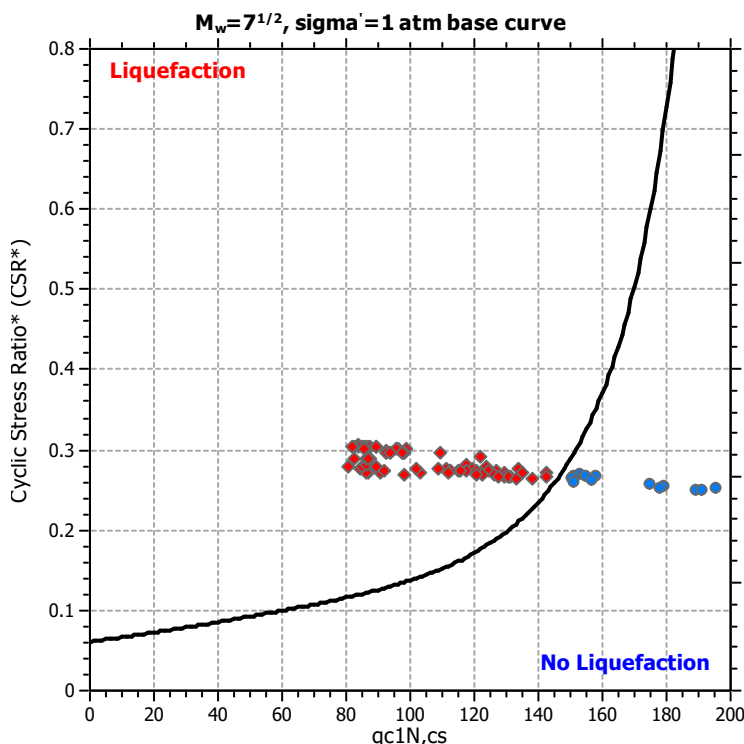
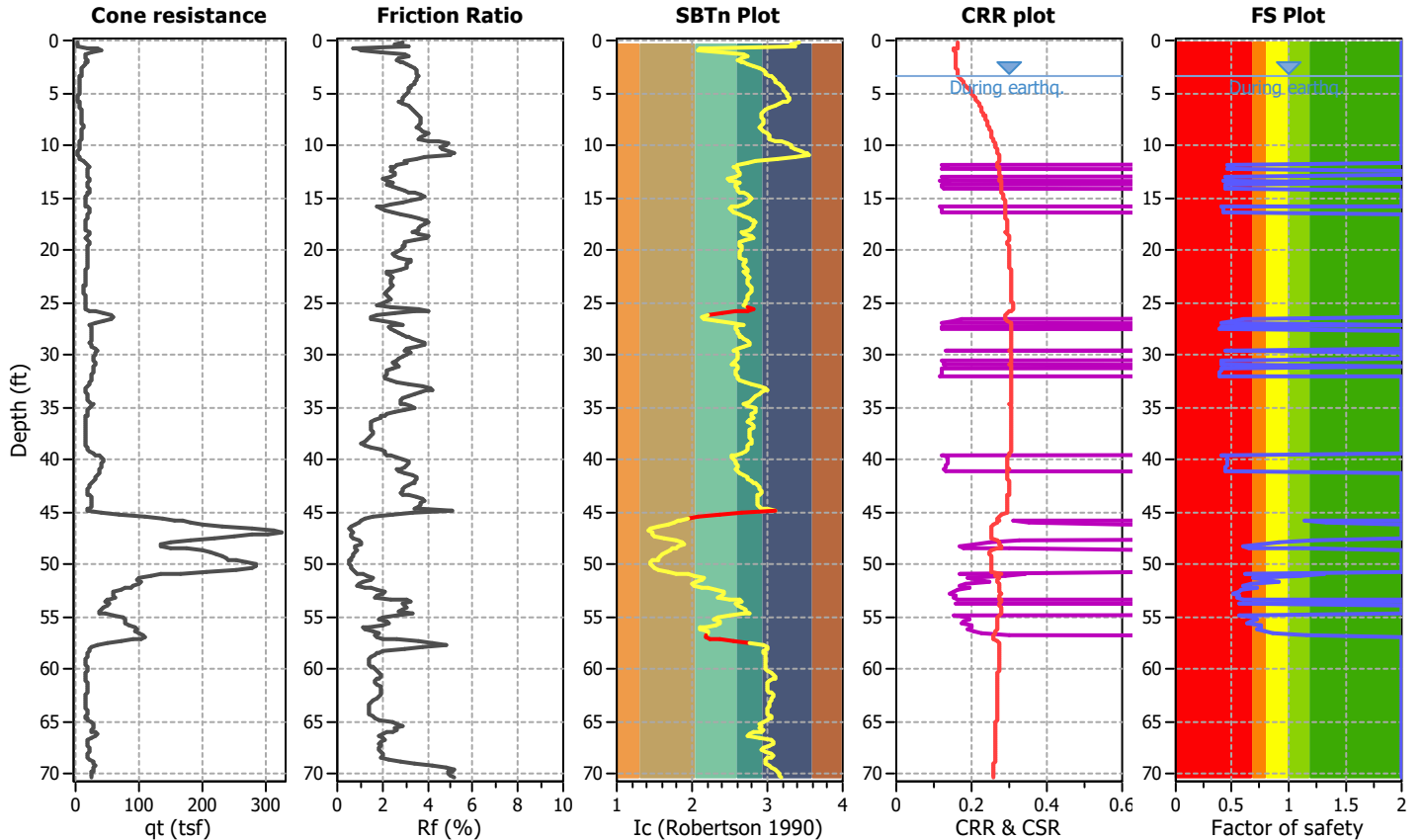
Project title :

Location :

CPT file : C-107

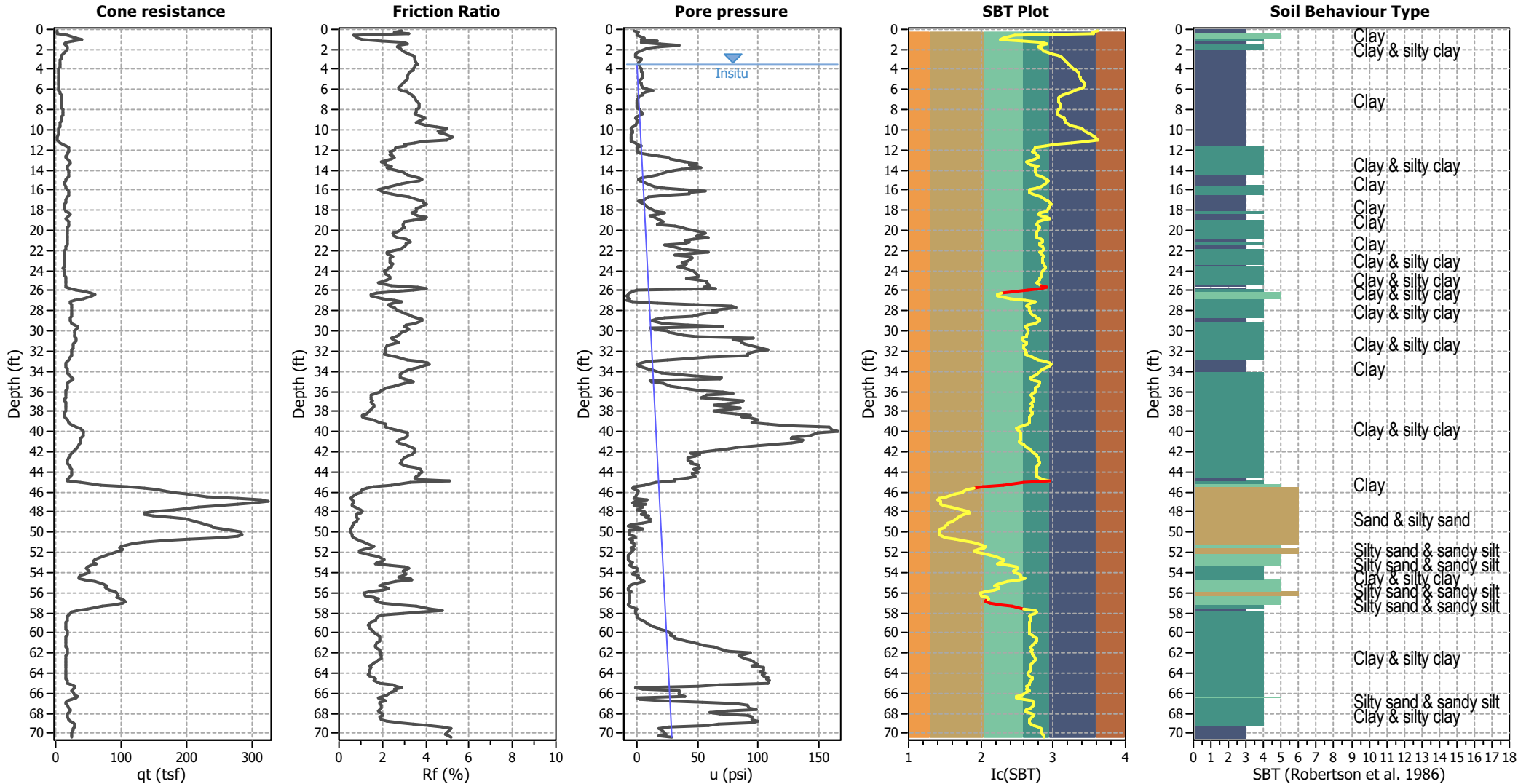
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	MSF method:	N/A
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
 Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
 Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
 Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



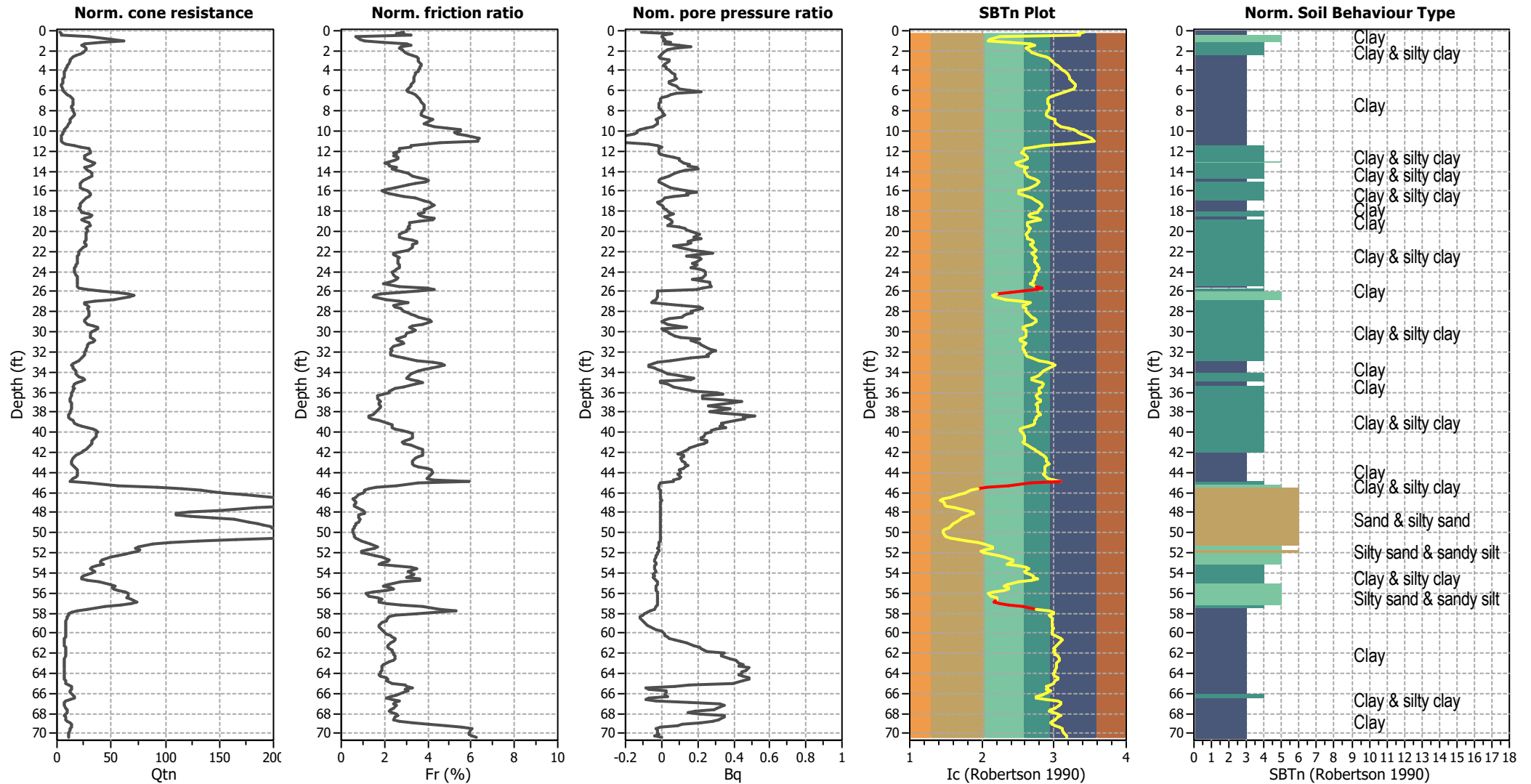
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



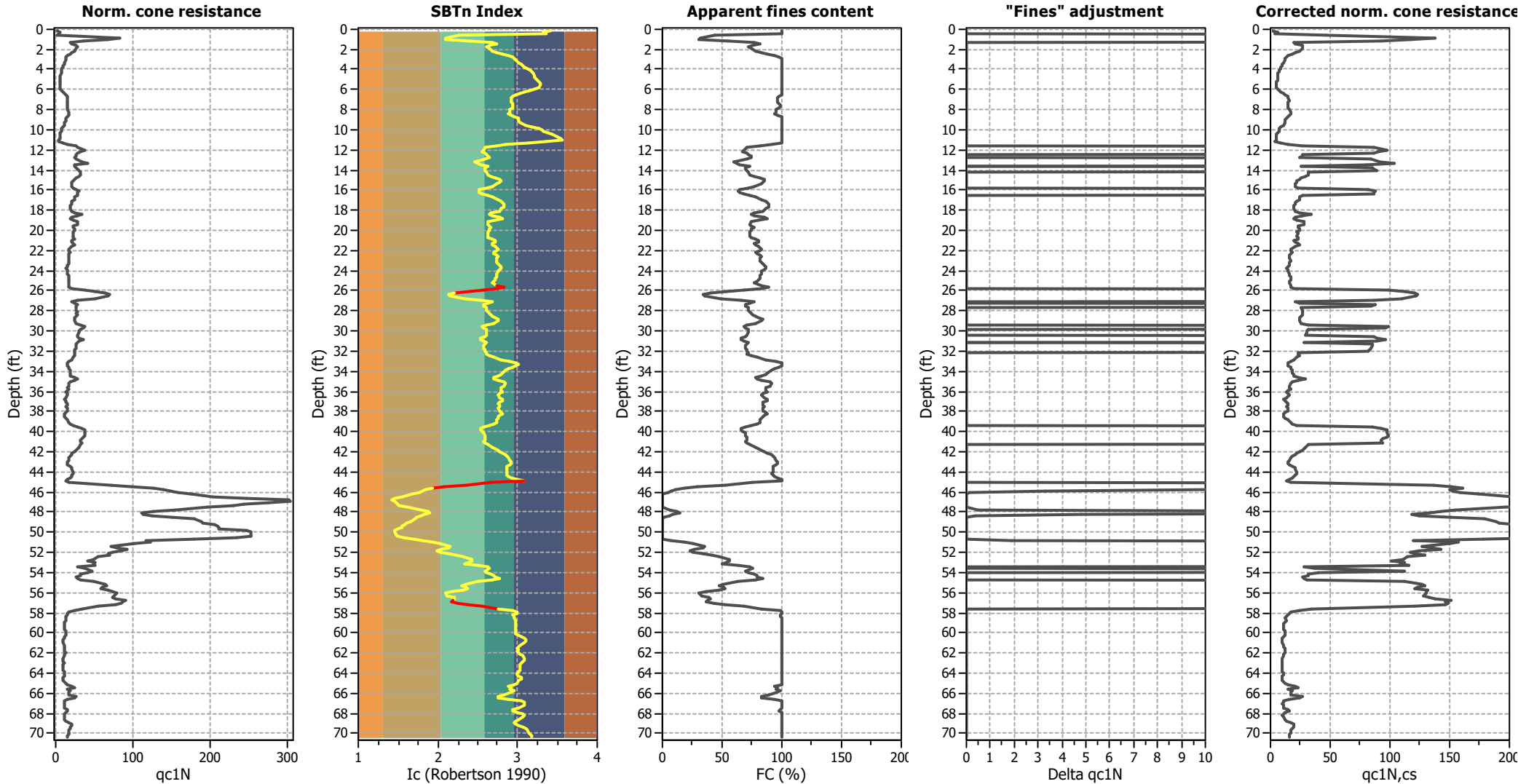
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

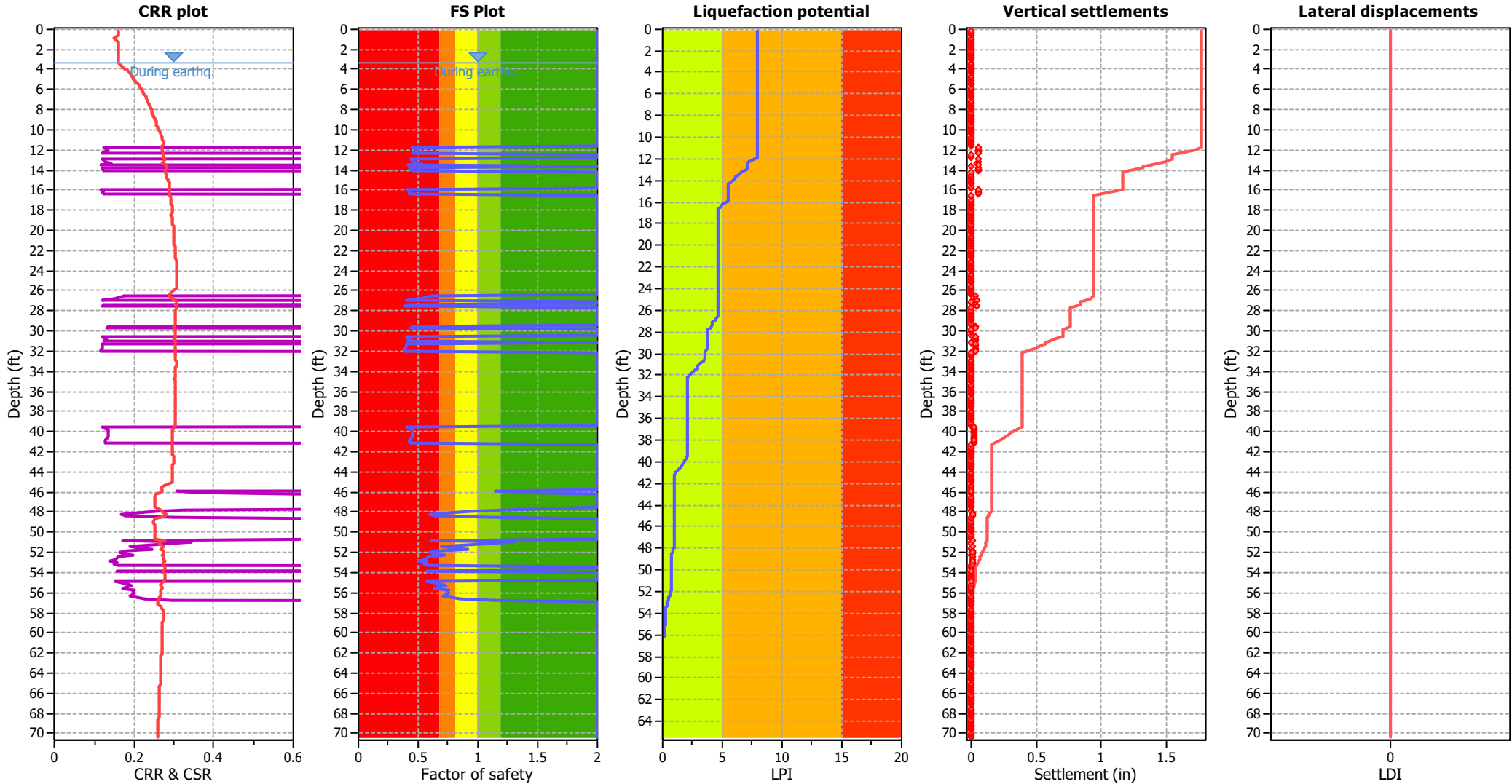
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

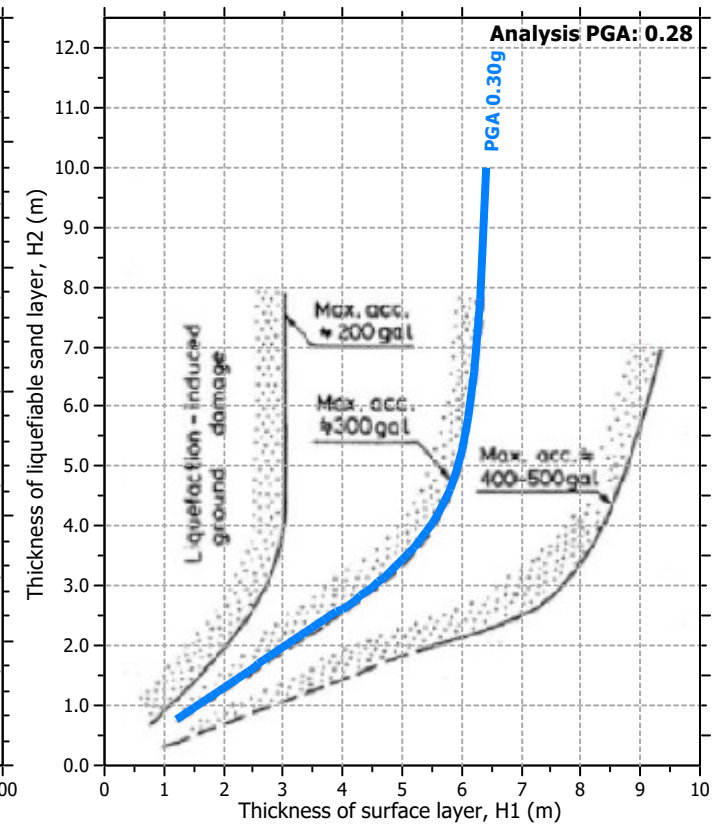
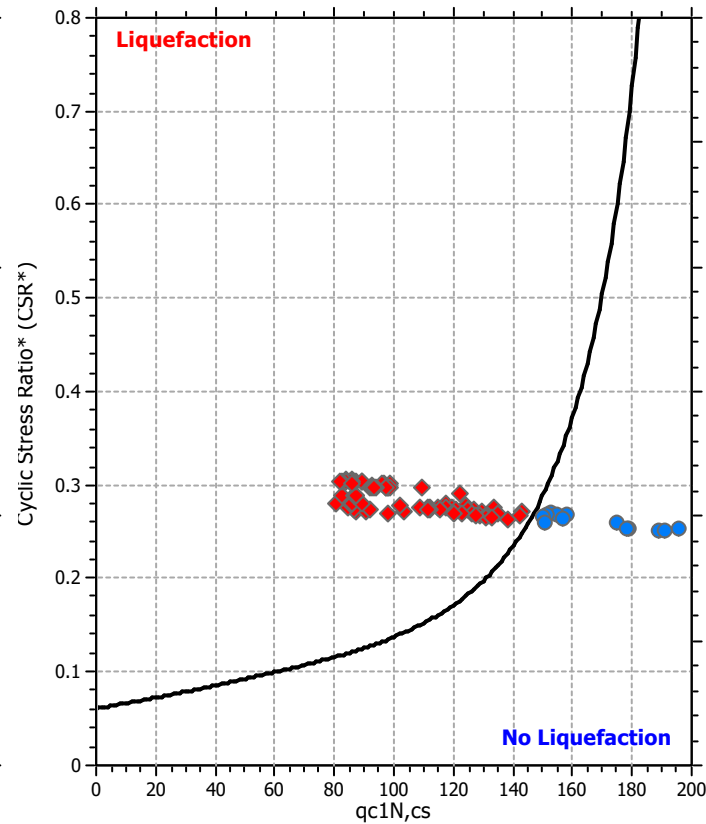
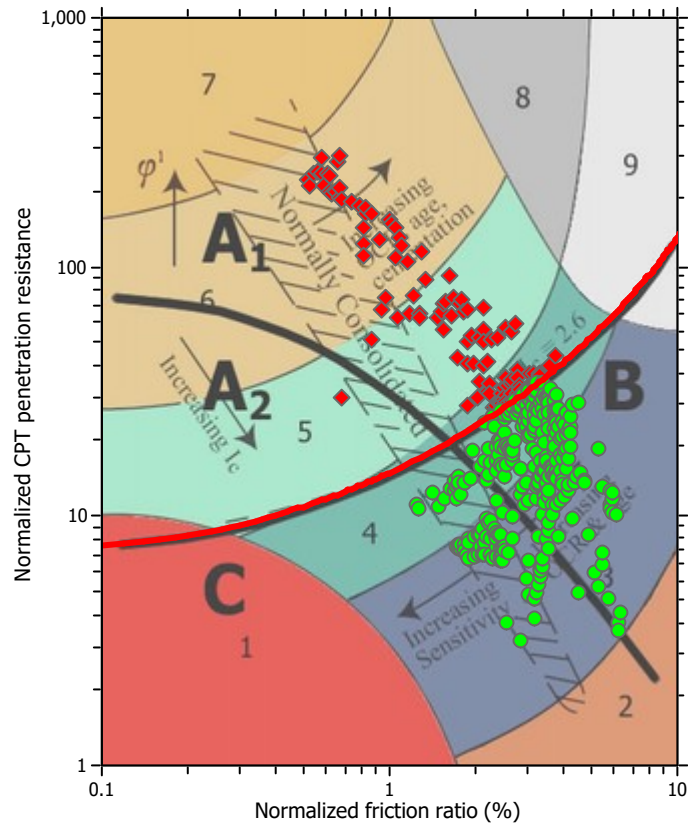
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

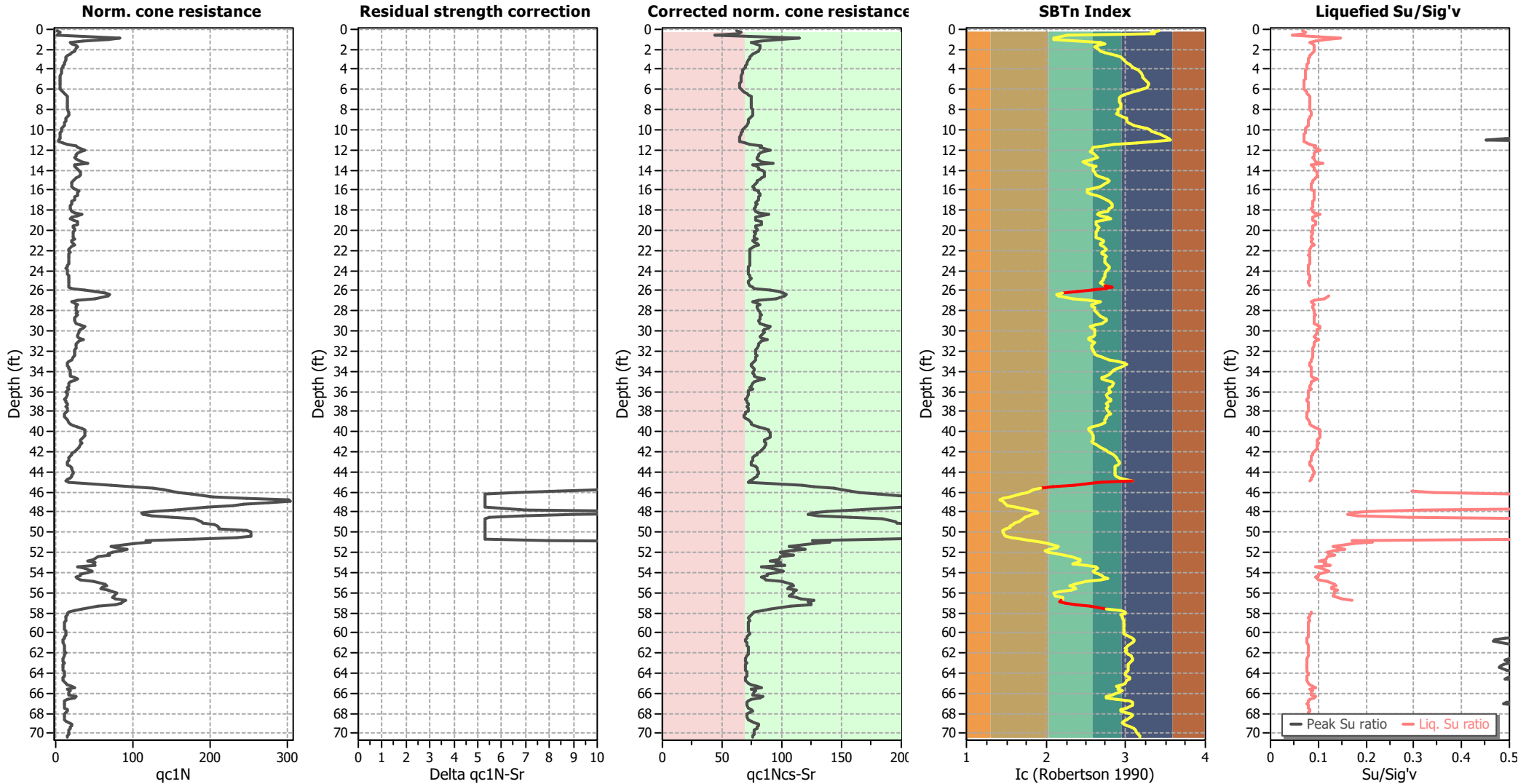
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

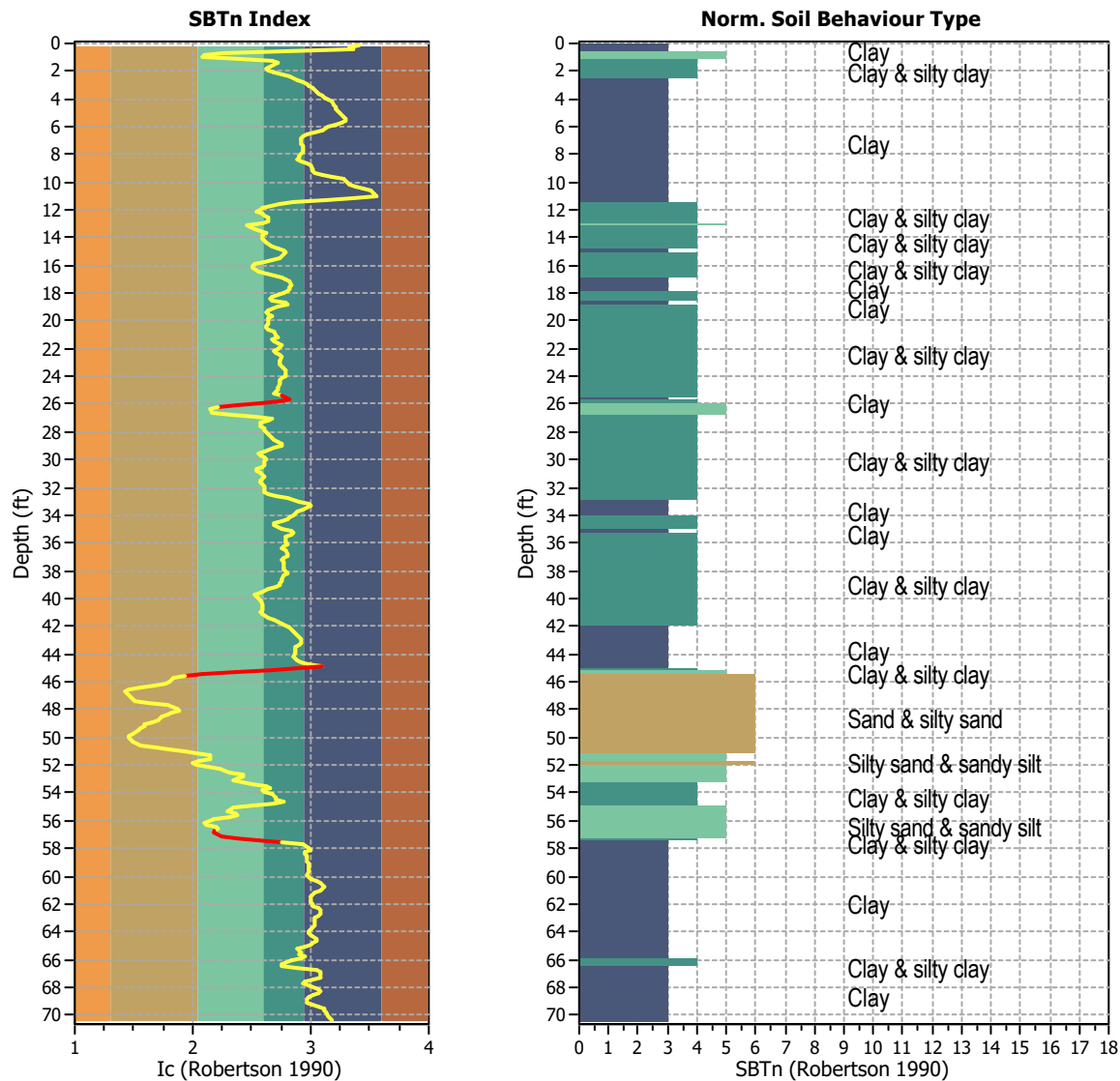
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



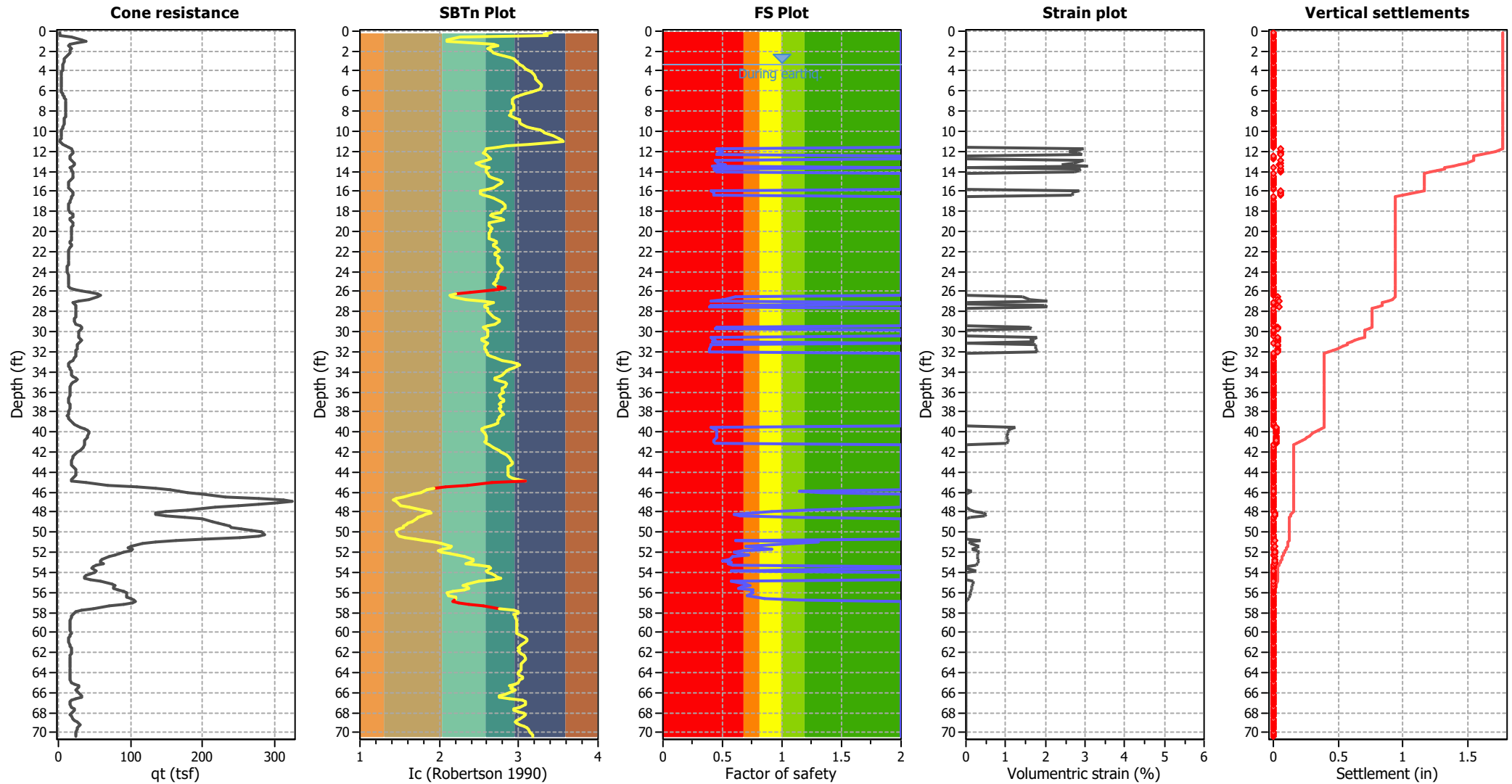
Transition layer algorithm properties

I_c minimum check value: 1.81
 I_c maximum check value: 3.00
 I_c change ratio value: 0.0350
Minimum number of points in layer: 5

General statistics

Total points in CPT file: 429
Total points excluded: 17
Exclusion percentage: 3.96%
Number of layers detected: 3

Estimation of post-earthquake settlements



Abbreviations

q_c : Total cone resistance (cone resistance q_c corrected for pore water effects)
 I_c : Soil Behaviour Type Index
 FS: Calculated Factor of Safety against liquefaction
 Volumetric strain: Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

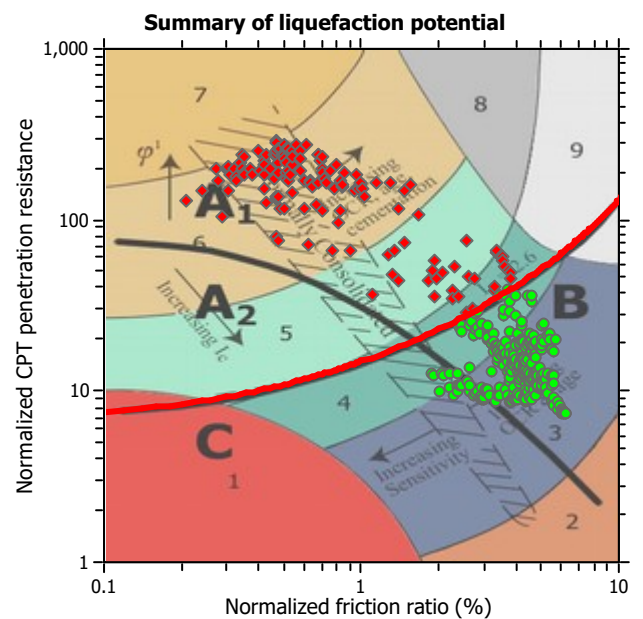
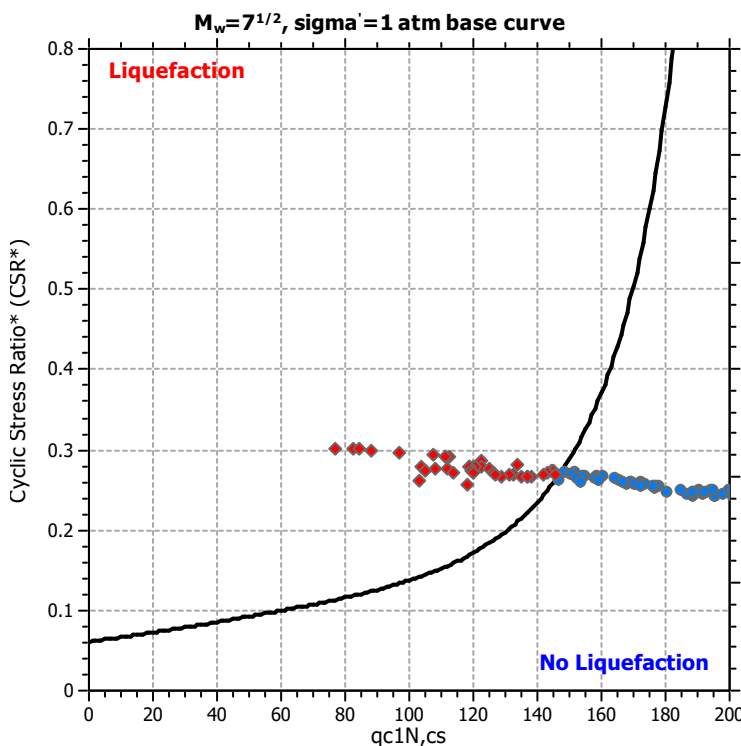
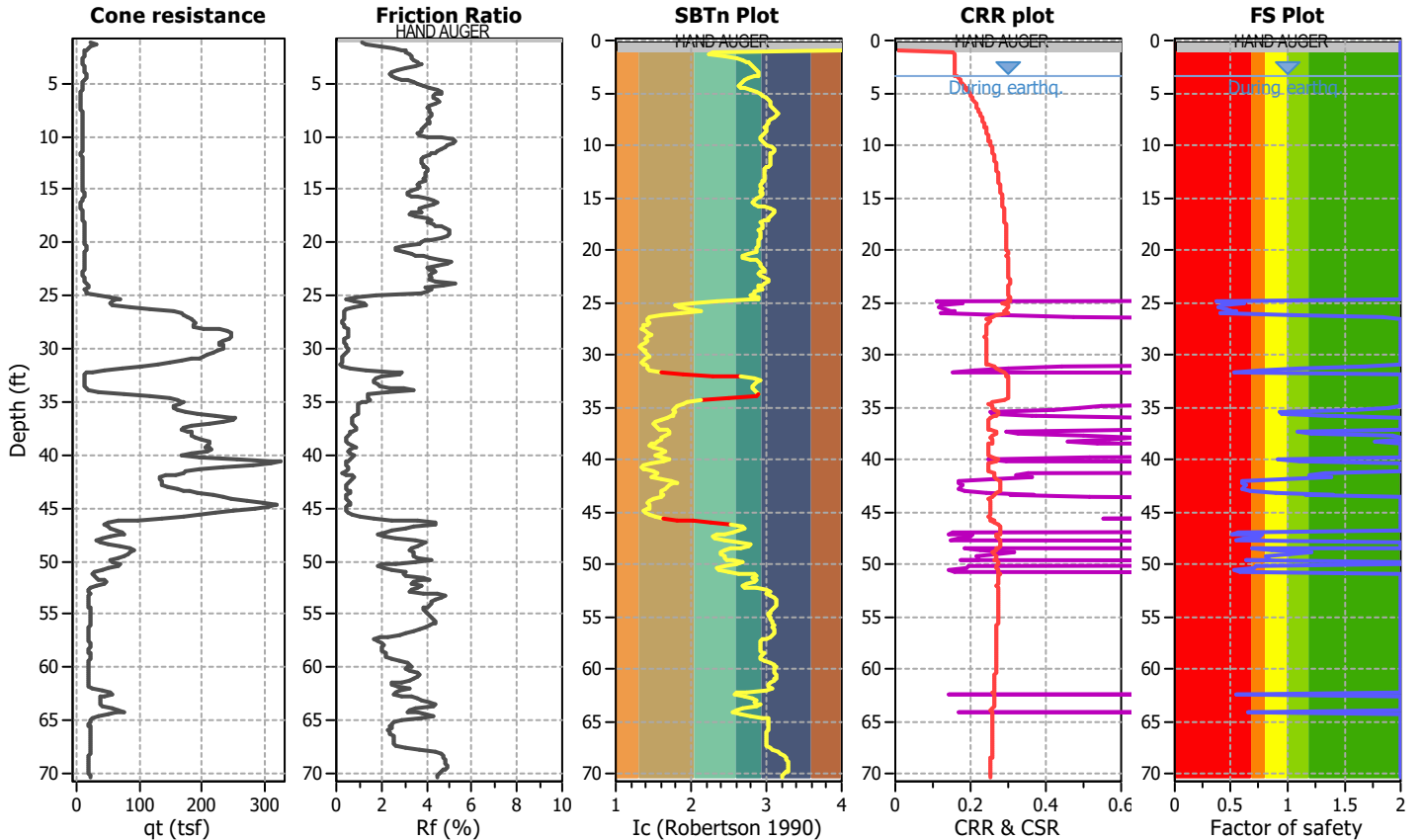
Project title :

Location :

CPT file : C-108

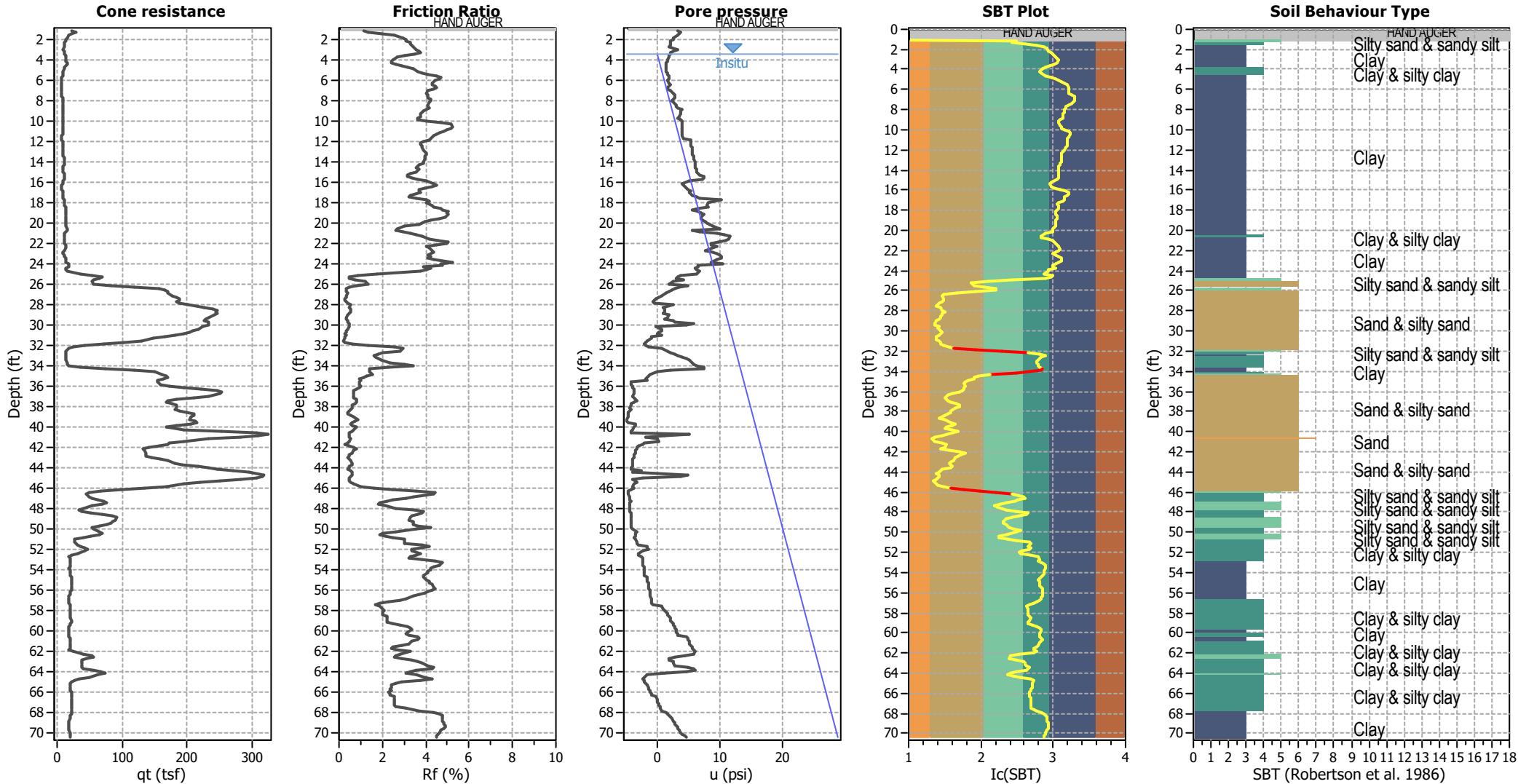
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



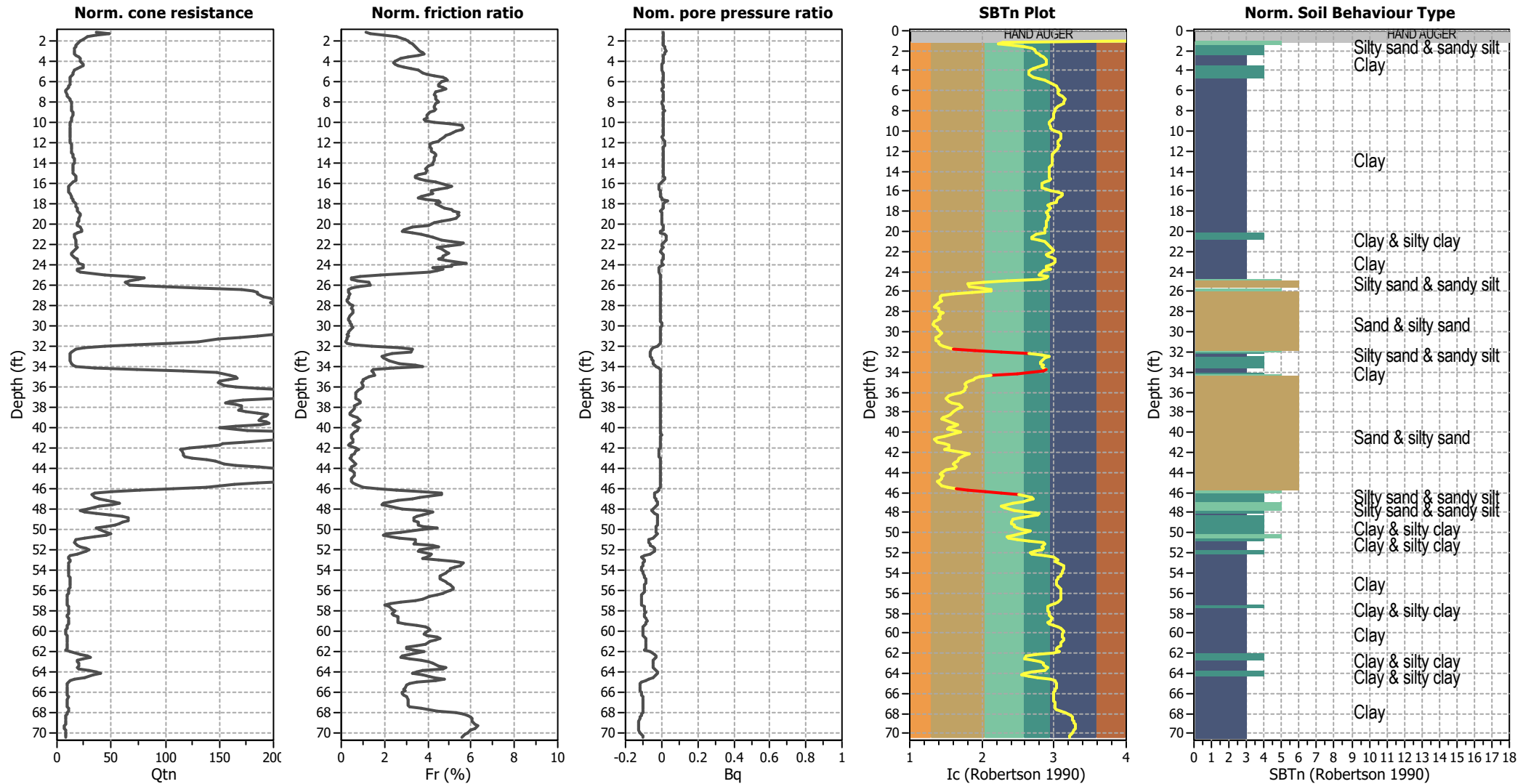
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



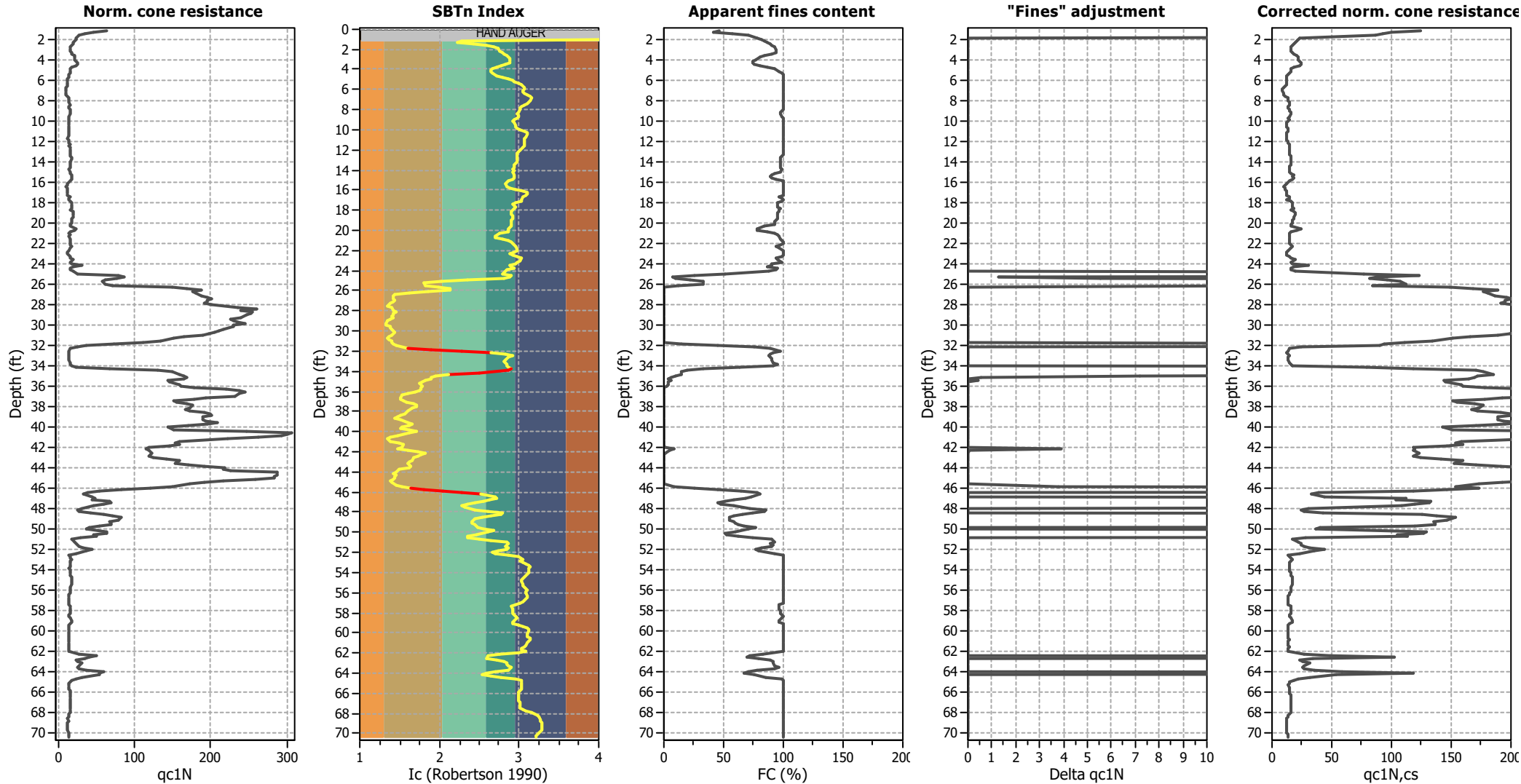
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

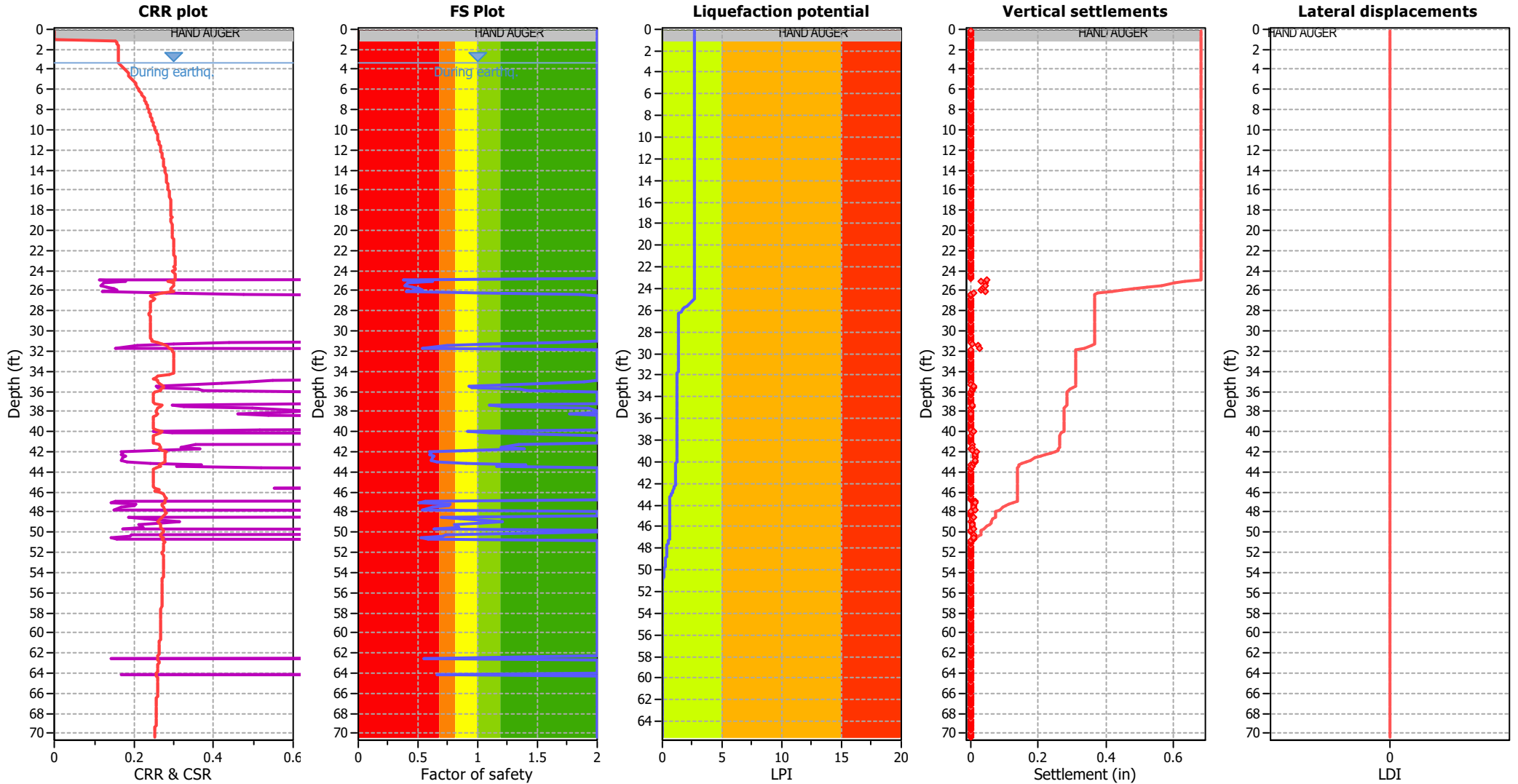
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

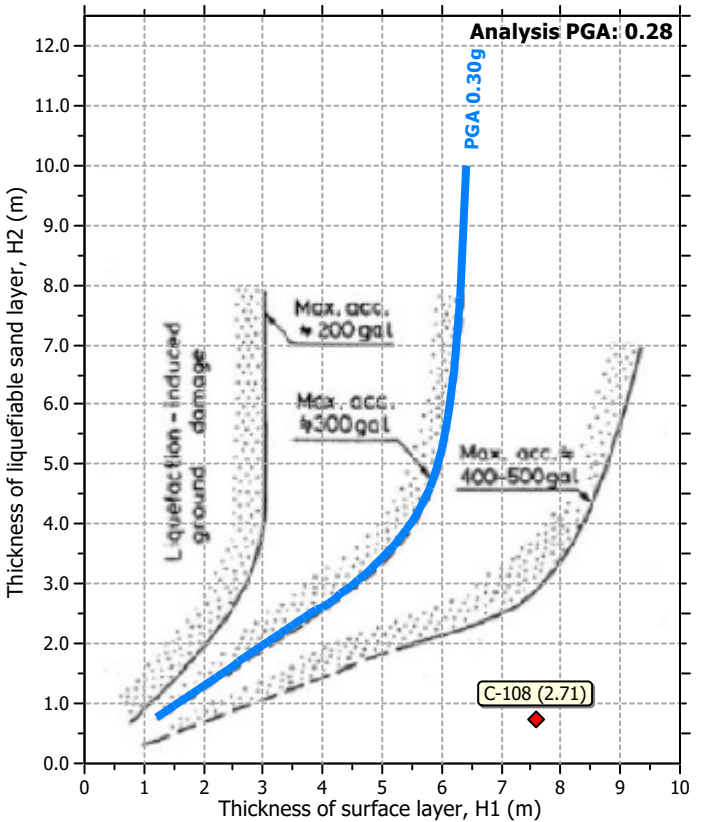
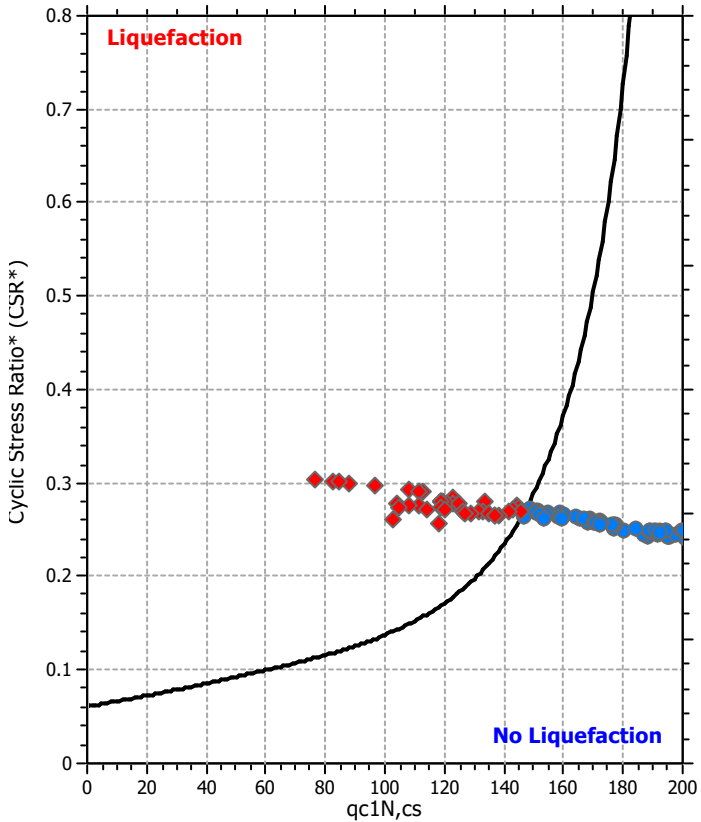
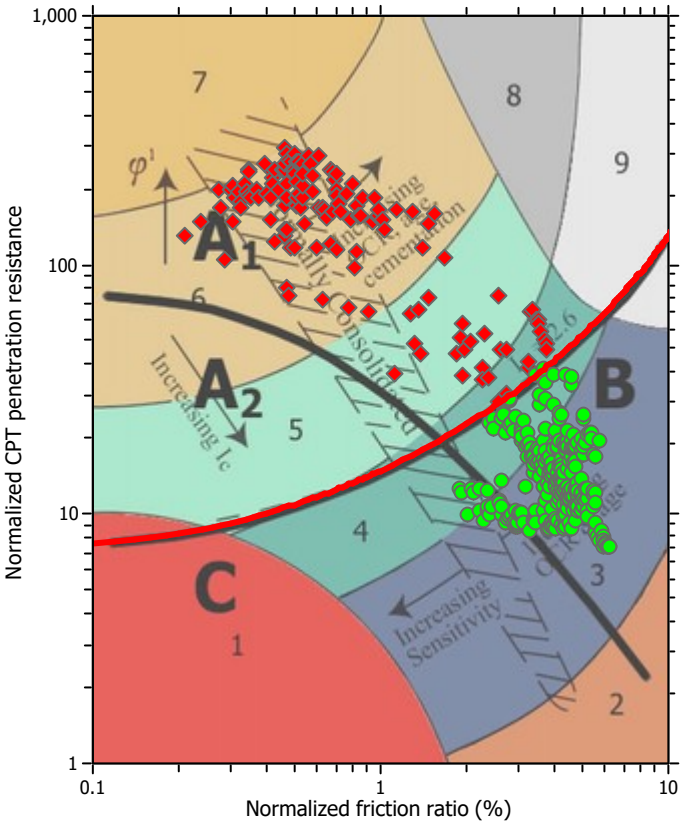
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

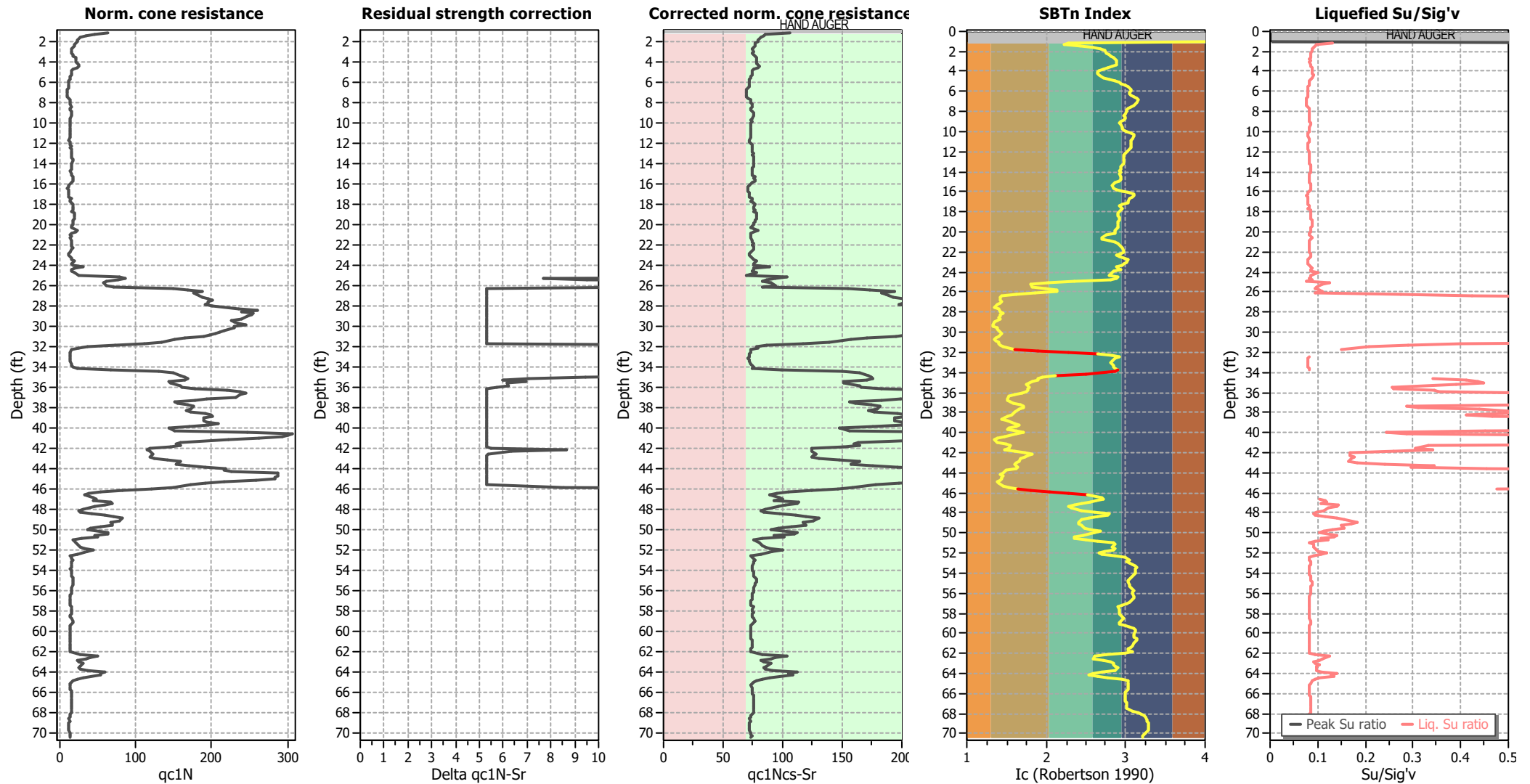
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_{ϕ} applied:	Yes
Earthquake magnitude M_w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

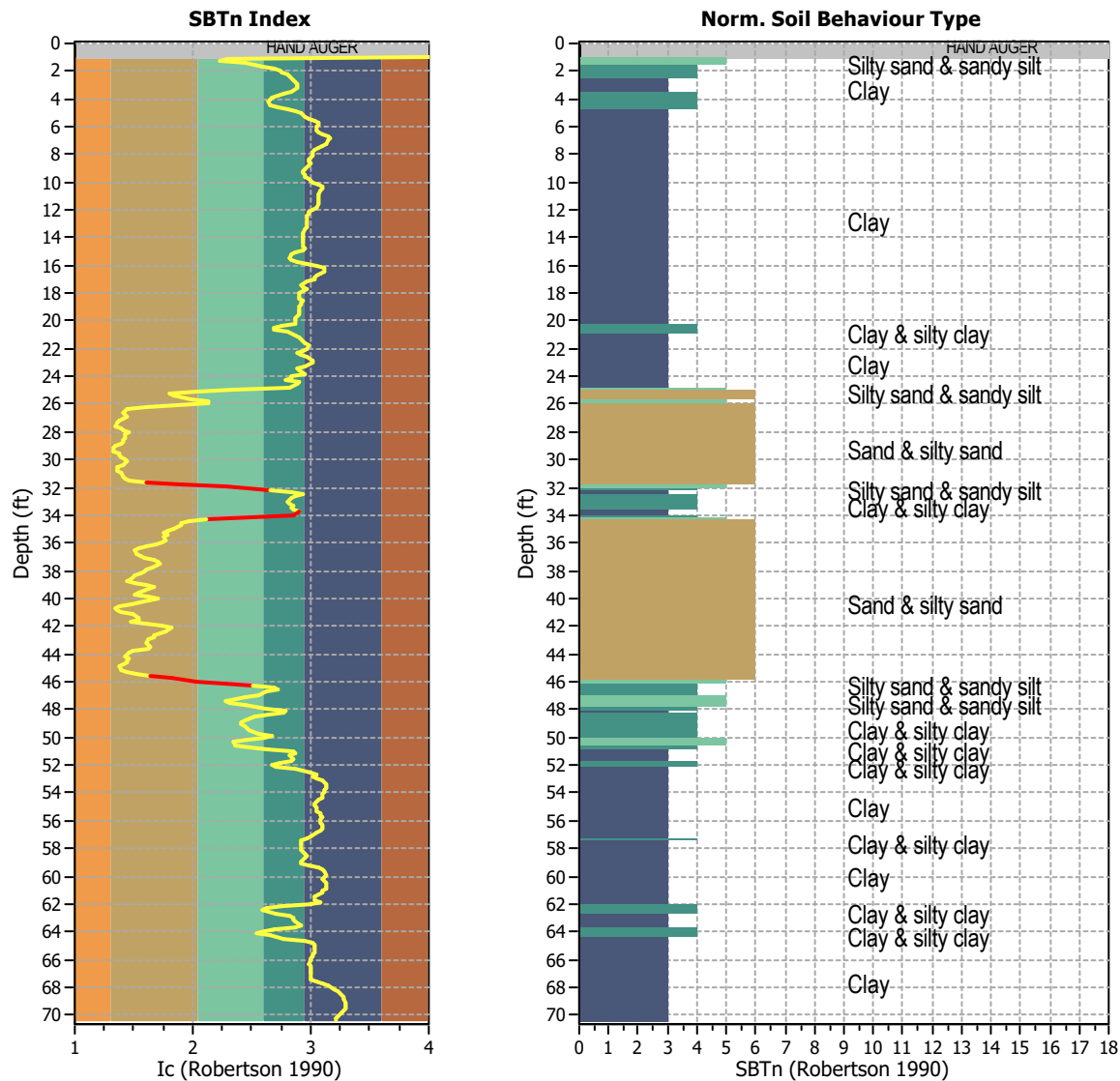
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties

I_c minimum check value:

1.80

I_c maximum check value:

3.00

I_c change ratio value:

0.0750

Minimum number of points in layer:

4

General statistics

Total points in CPT file:

429

Total points excluded:

13

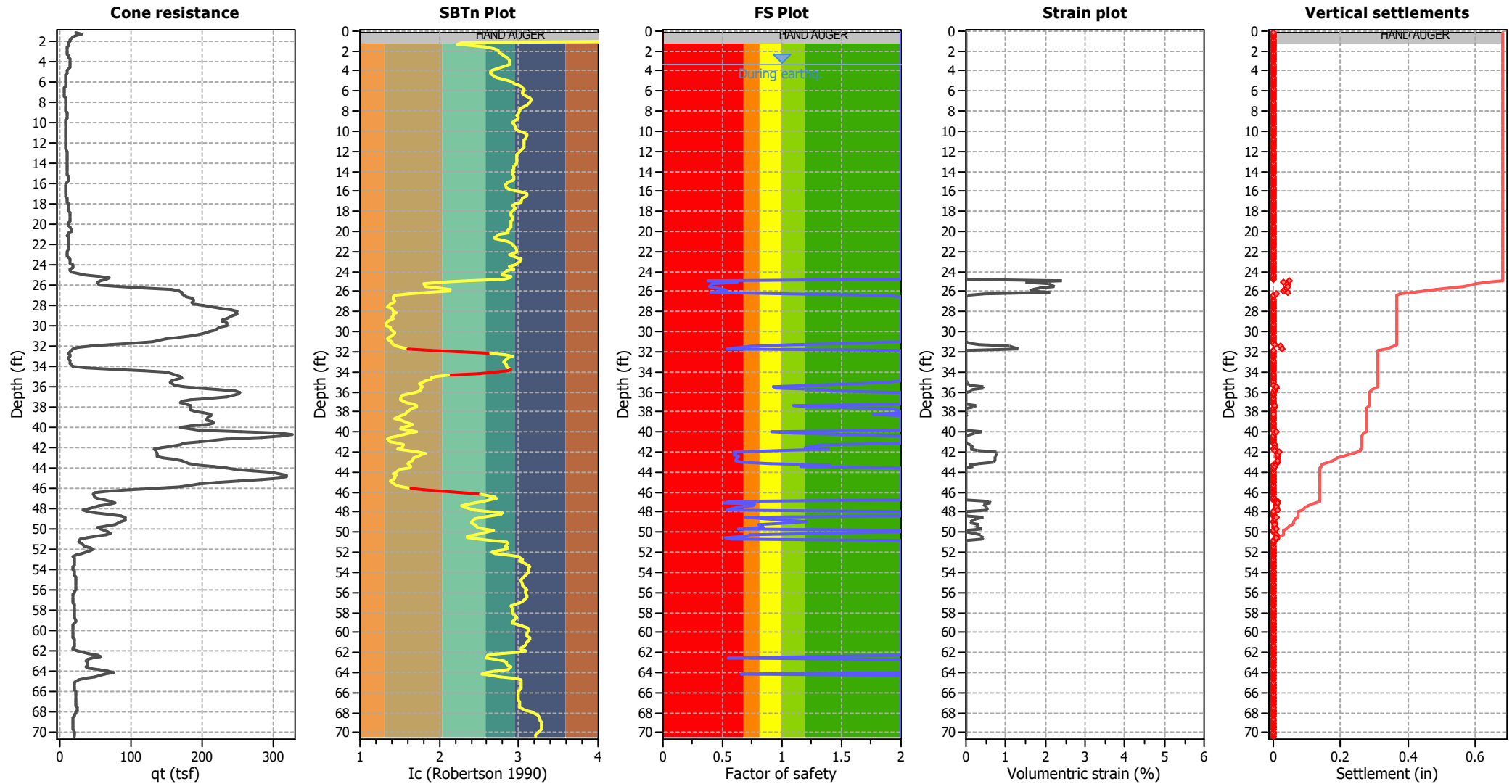
Exclusion percentage:

3.03%

Number of layers detected:

3

Estimation of post-earthquake settlements



Abbreviations

q_c : Total cone resistance (cone resistance q_c corrected for pore water effects)
 I_c : Soil Behaviour Type Index
 FS: Calculated Factor of Safety against liquefaction
 Volumetric strain: Post-liquefaction volumetric strain



LIQUEFACTION ANALYSIS REPORT

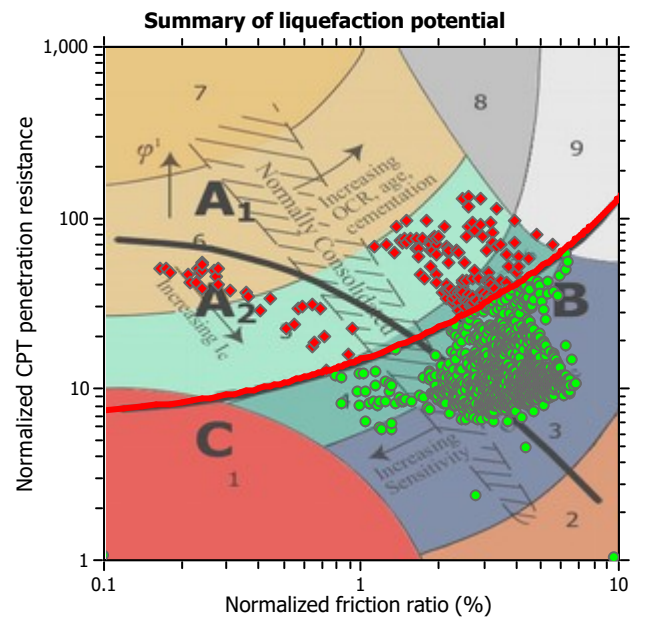
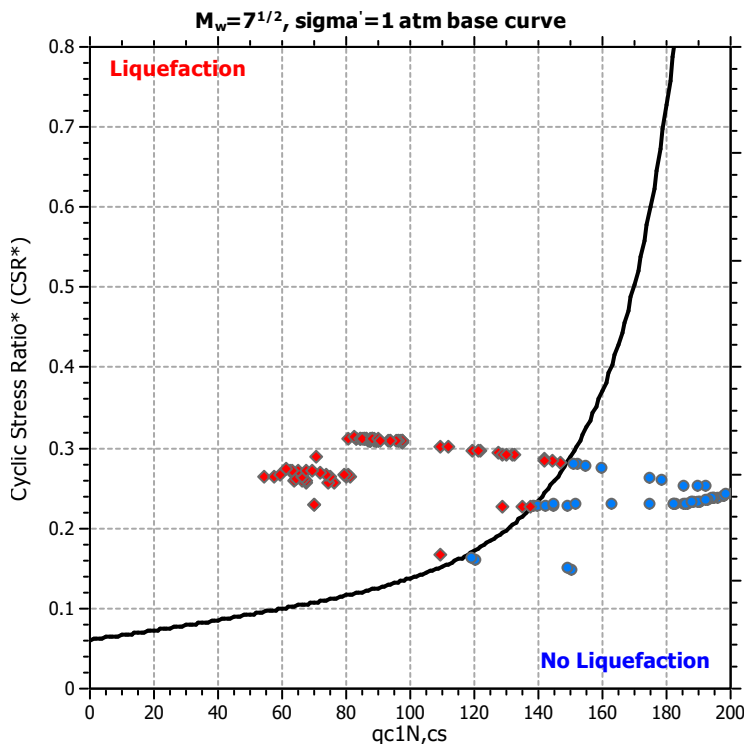
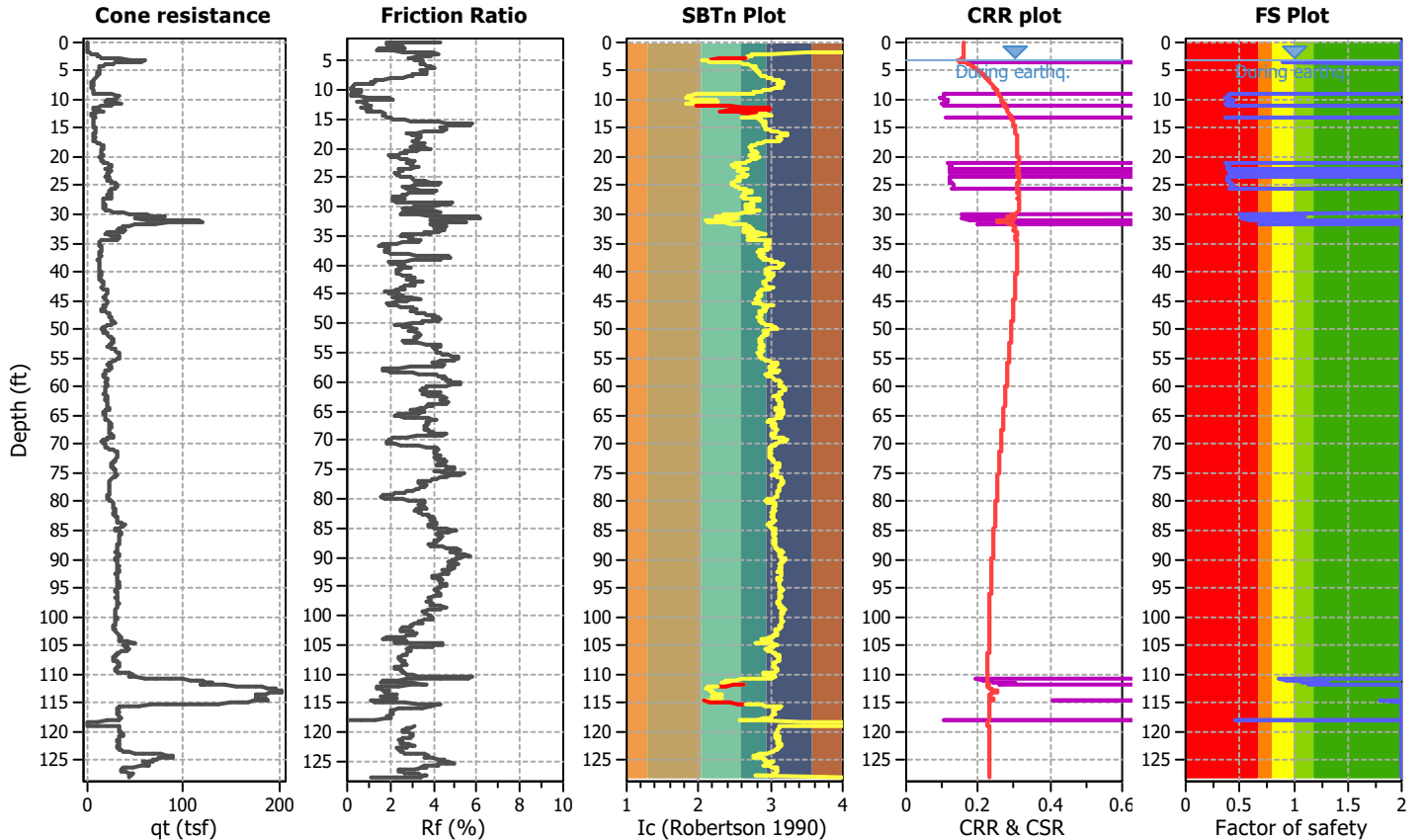
Project title :

Location :

CPT file : A-CPT2

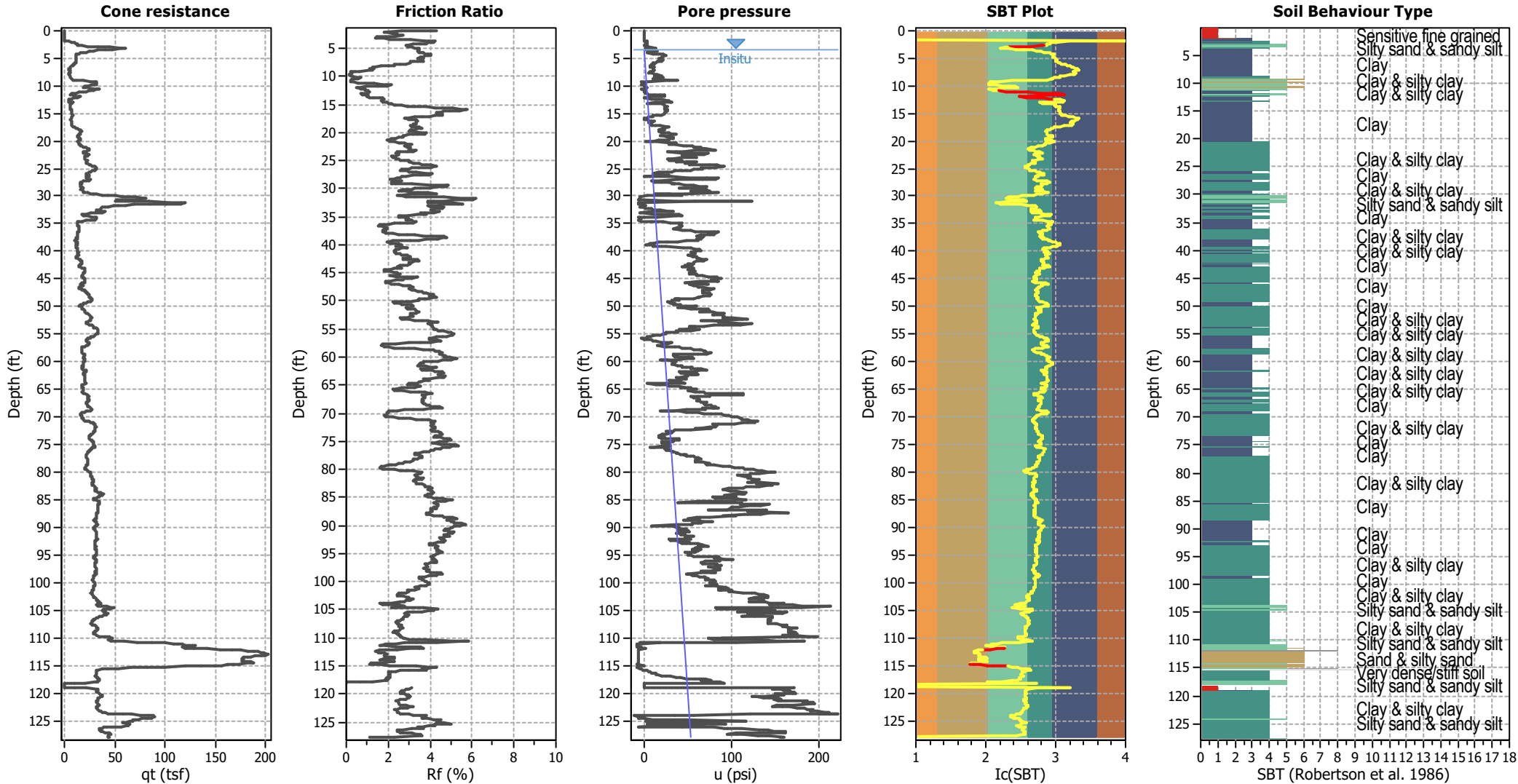
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



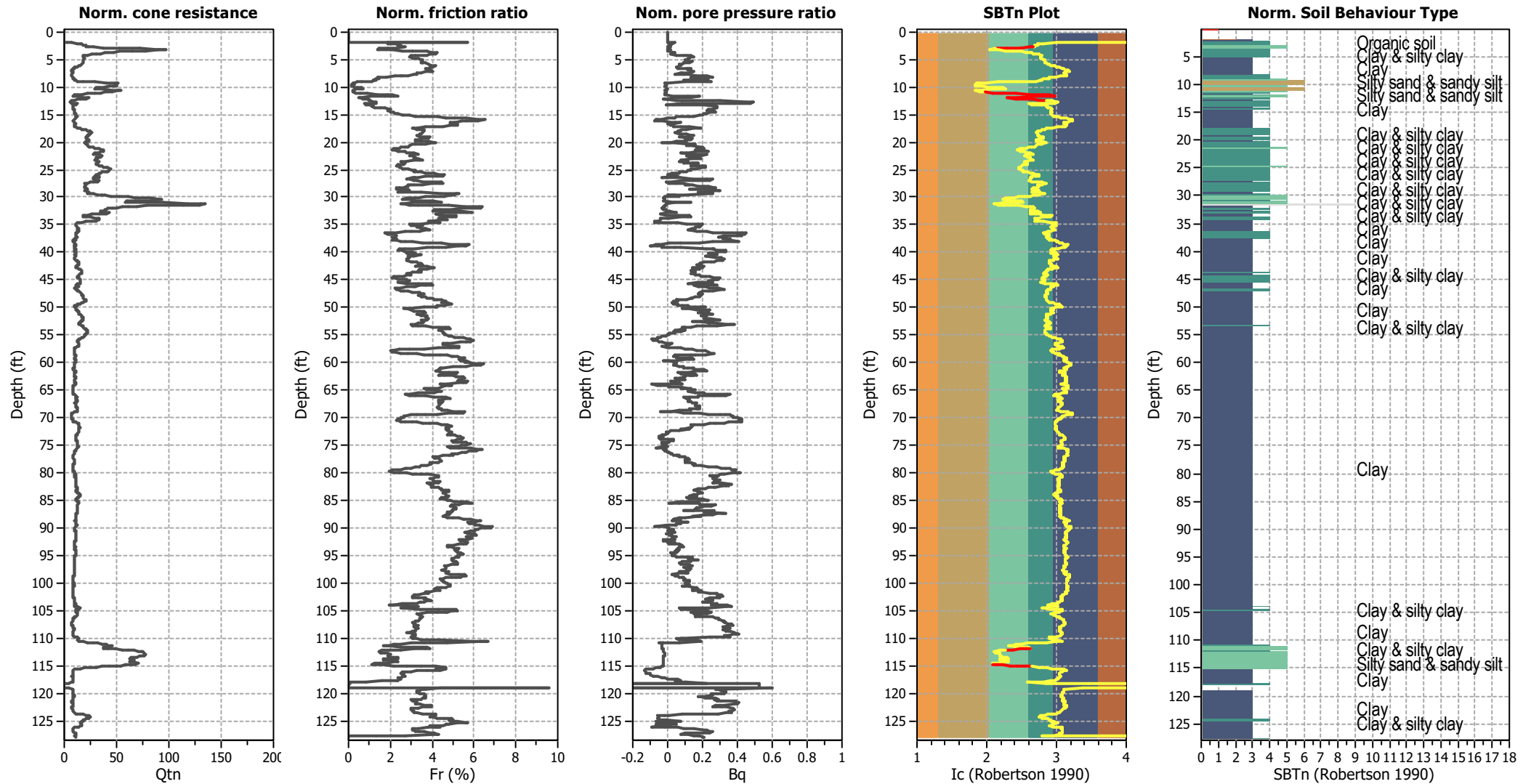
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



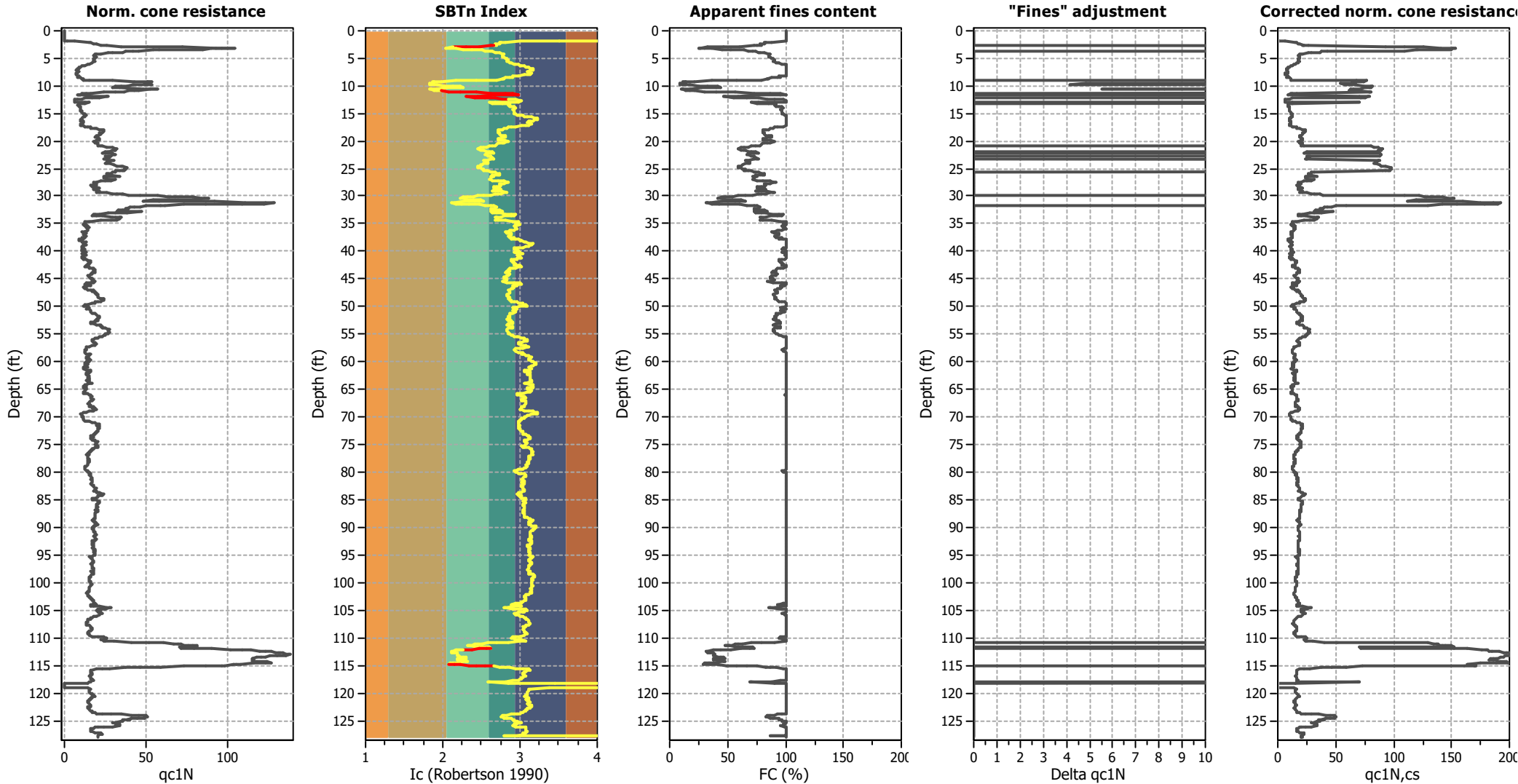
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- | | | | | | |
|---|---------------------------|---|-----------------------------|---|----------------------------|
|  | 1. Sensitive fine grained |  | 4. Clayey silt to silty |  | 7. Gravely sand to sand |
|  | 2. Organic material |  | 5. Silty sand to sandy silt |  | 8. Very stiff sand to |
|  | 3. Clay to silty clay |  | 6. Clean sand to silty sand |  | 9. Very stiff fine grained |

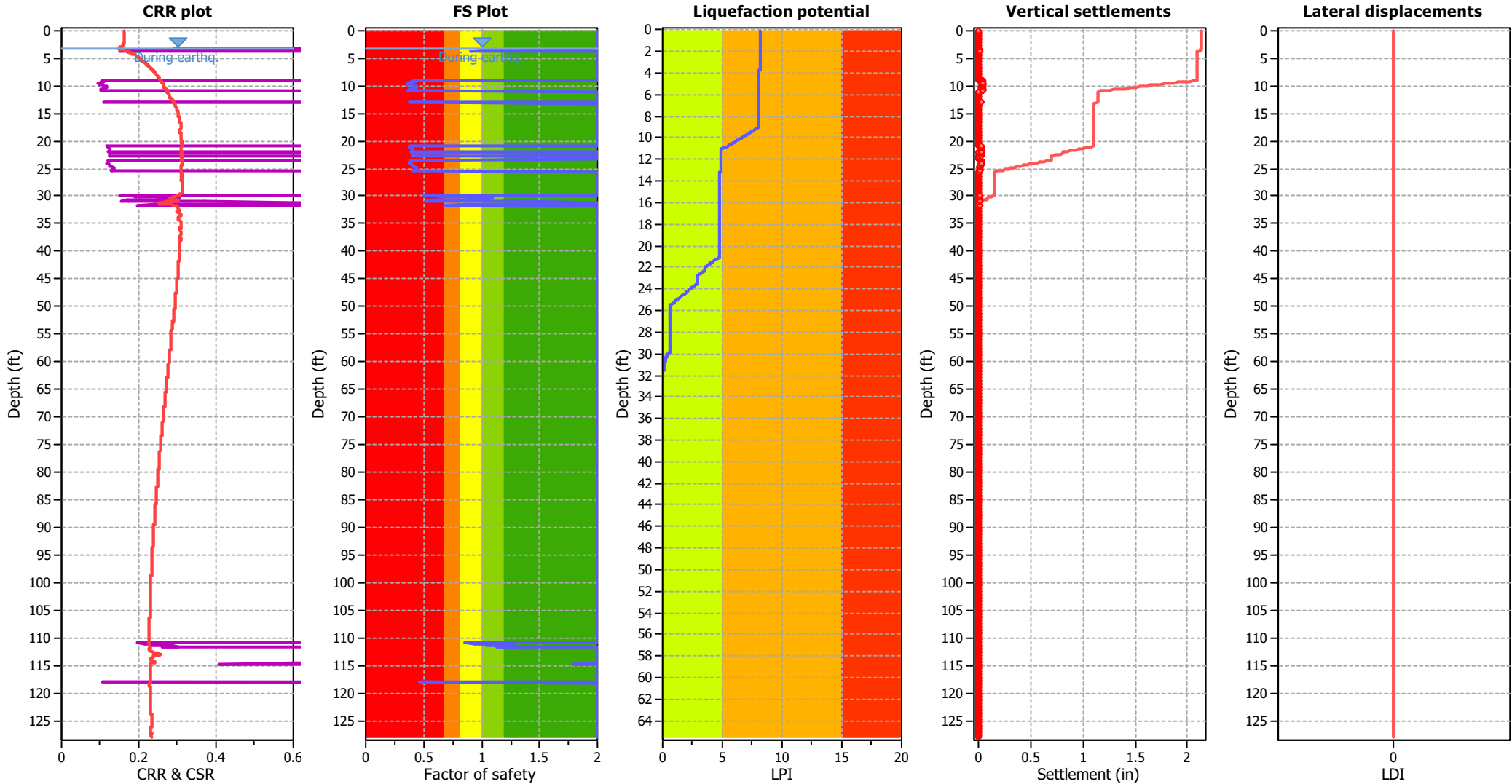
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _σ applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

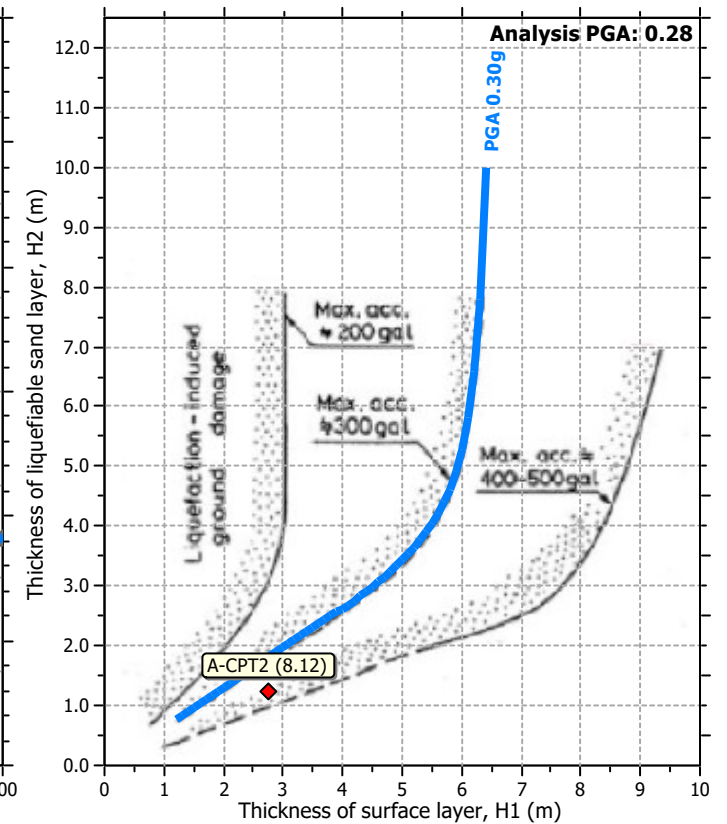
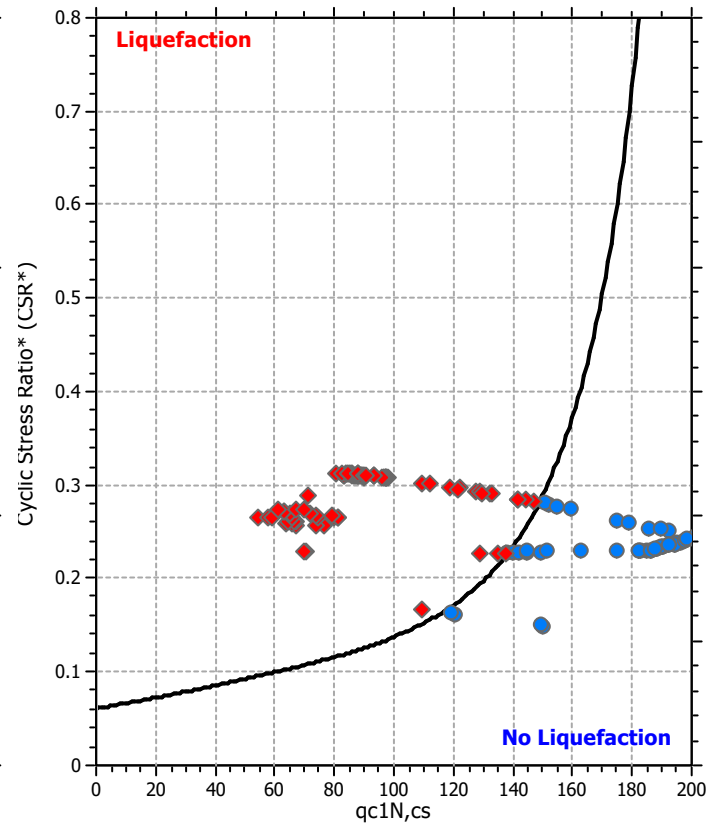
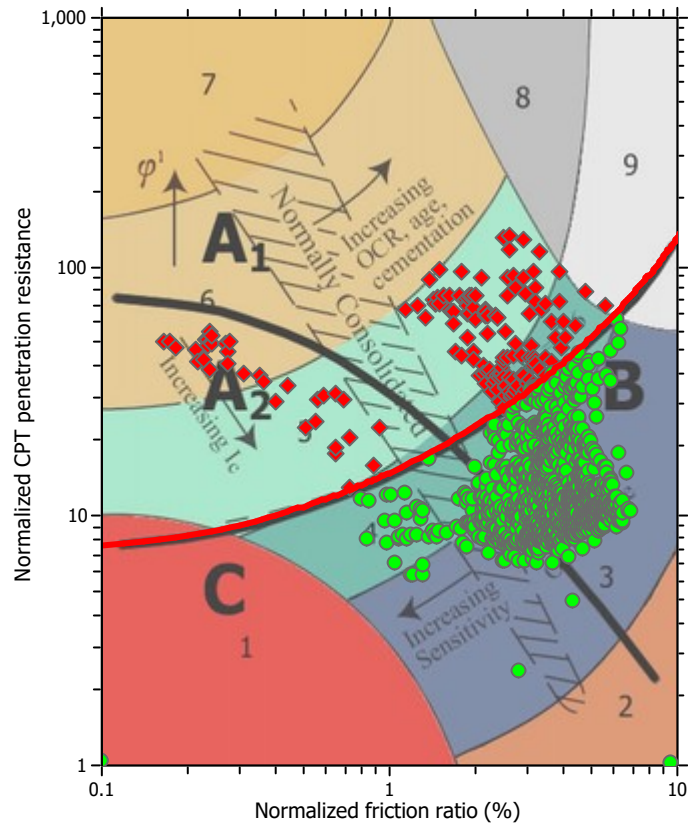
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

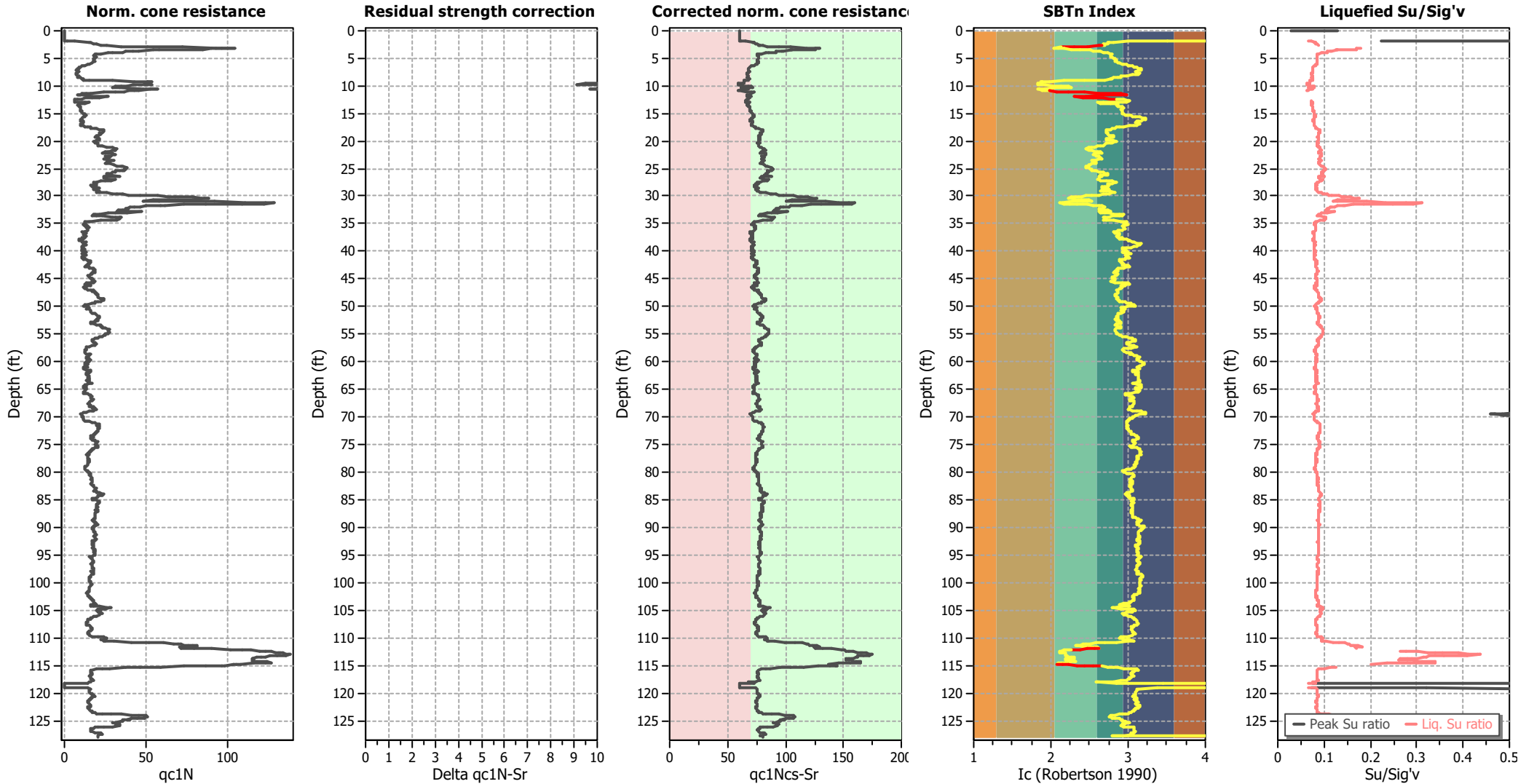
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

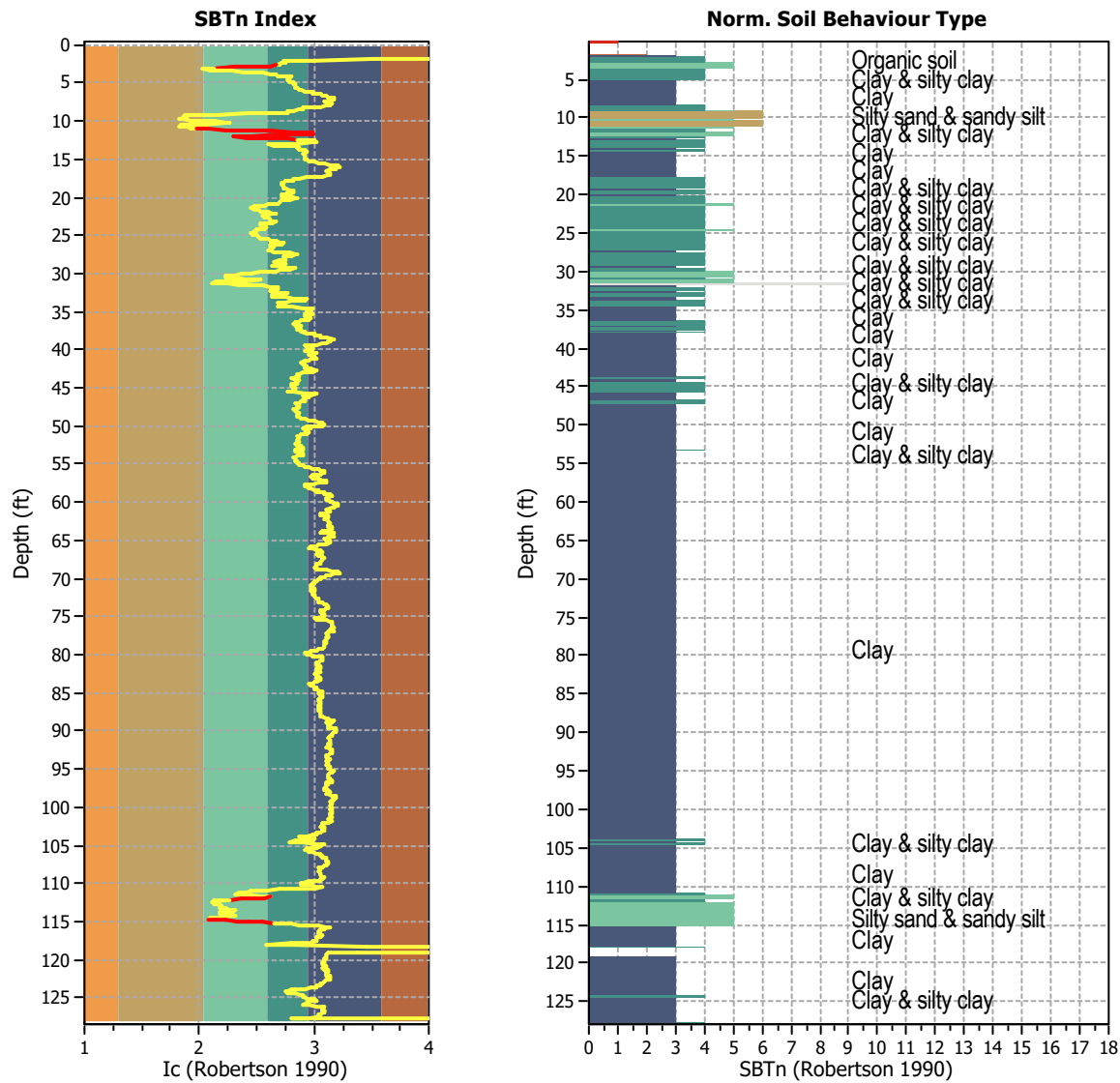
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties

I_c minimum check value:

2.00

I_c maximum check value:

3.00

I_c change ratio value:

0.0750

Minimum number of points in layer:

5

General statistics

Total points in CPT file:

1560

Total points excluded:

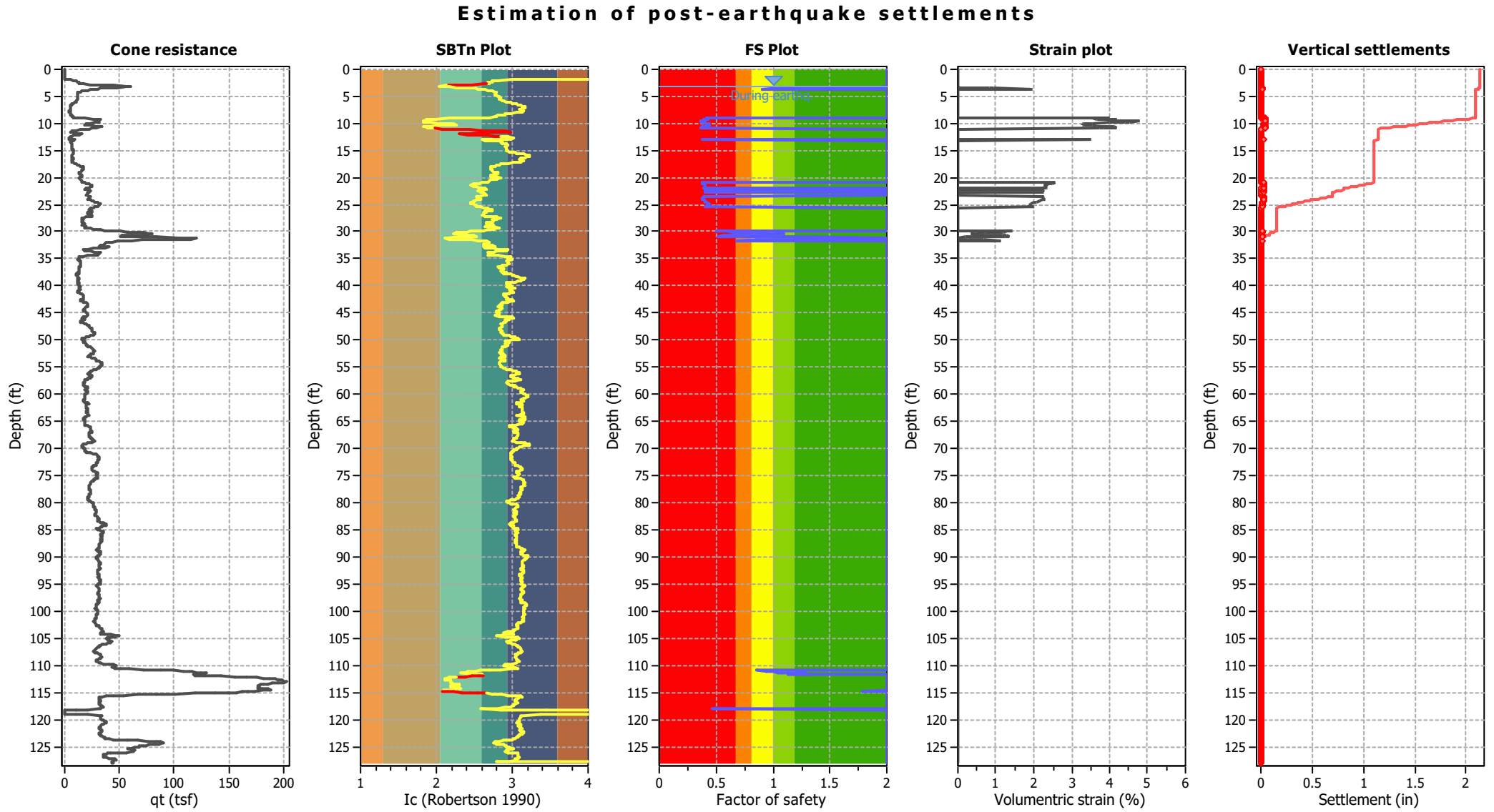
36

Exclusion percentage:

2.31%

Number of layers detected:

6



Abbreviations

- q_c:
- Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c:
- Soil Behaviour Type Index
- FS:
- Calculated Factor of Safety against liquefaction
- Volumetric strain:
- Post-liquefaction volumetric strain

LIQUEFACTION ANALYSIS REPORT

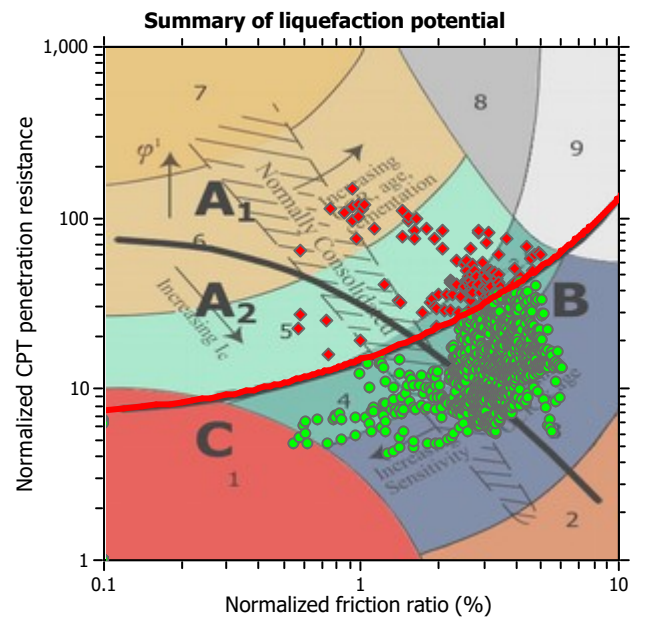
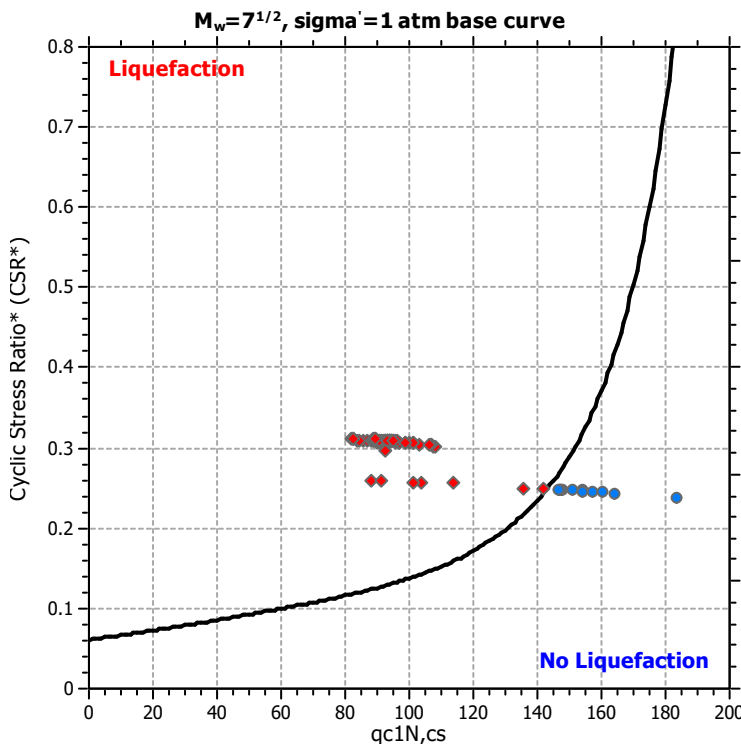
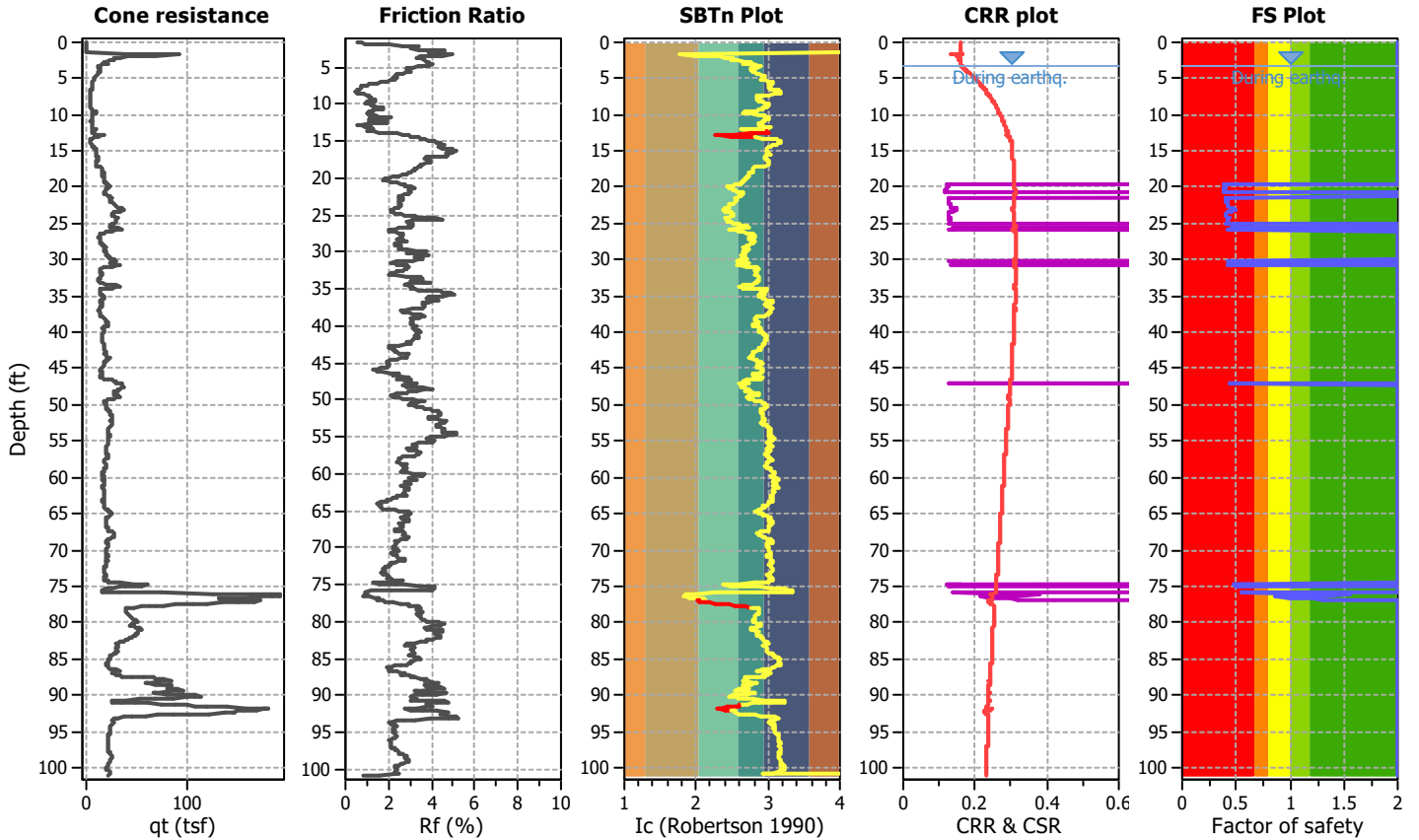
Project title :

Location :

CPT file : A-CPT3

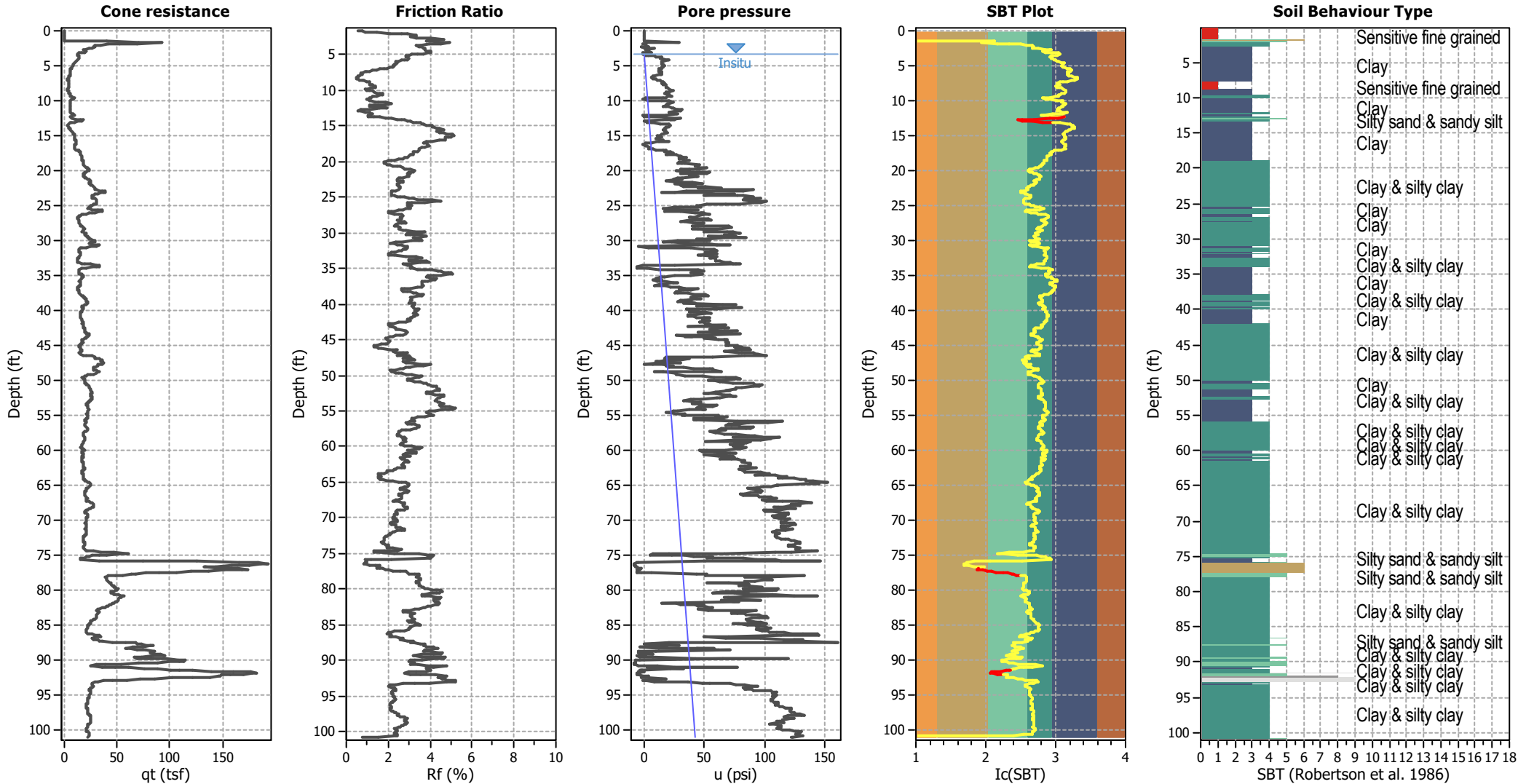
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	Yes
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	Limit depth:	80.00 ft
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



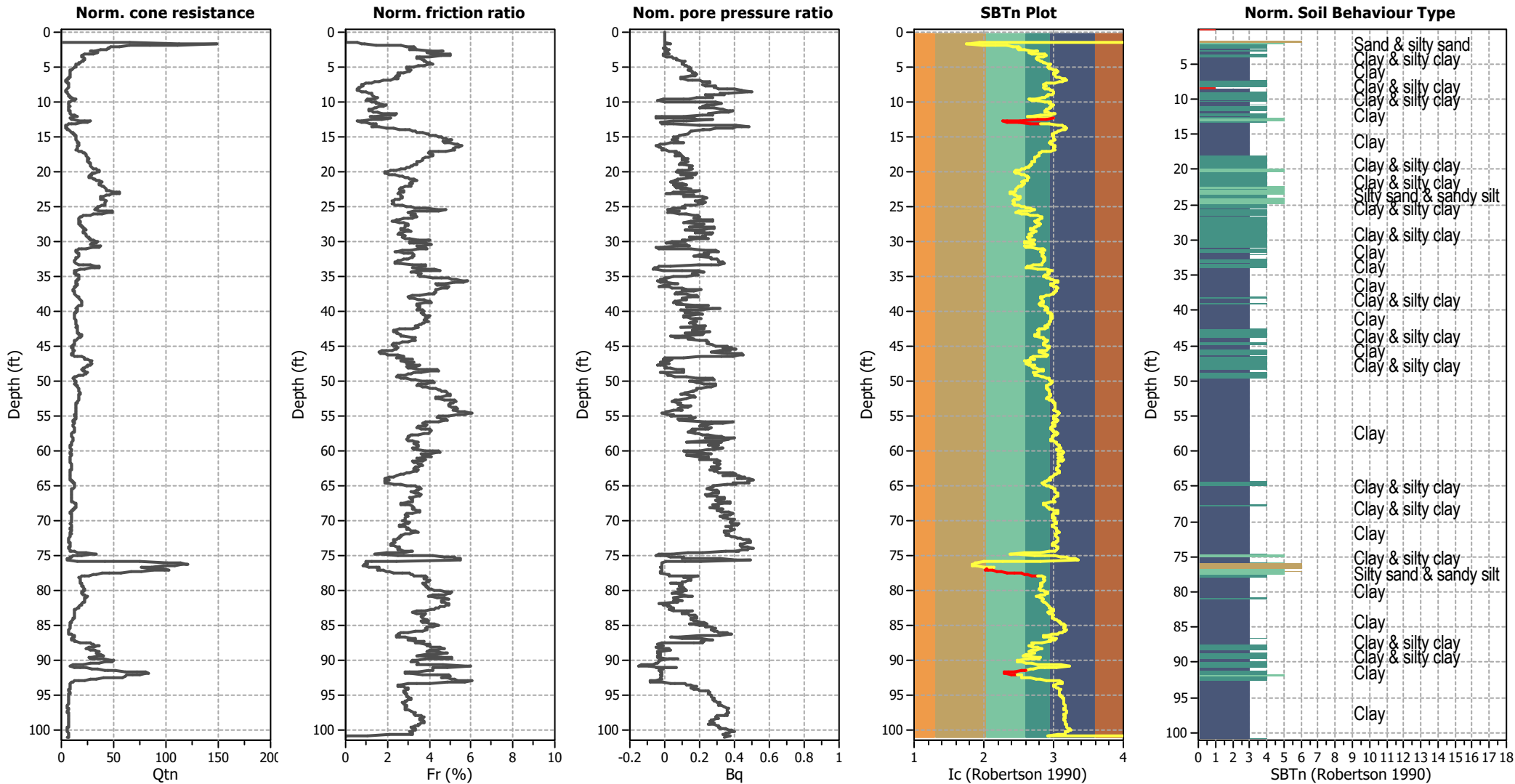
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	80.00 ft

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

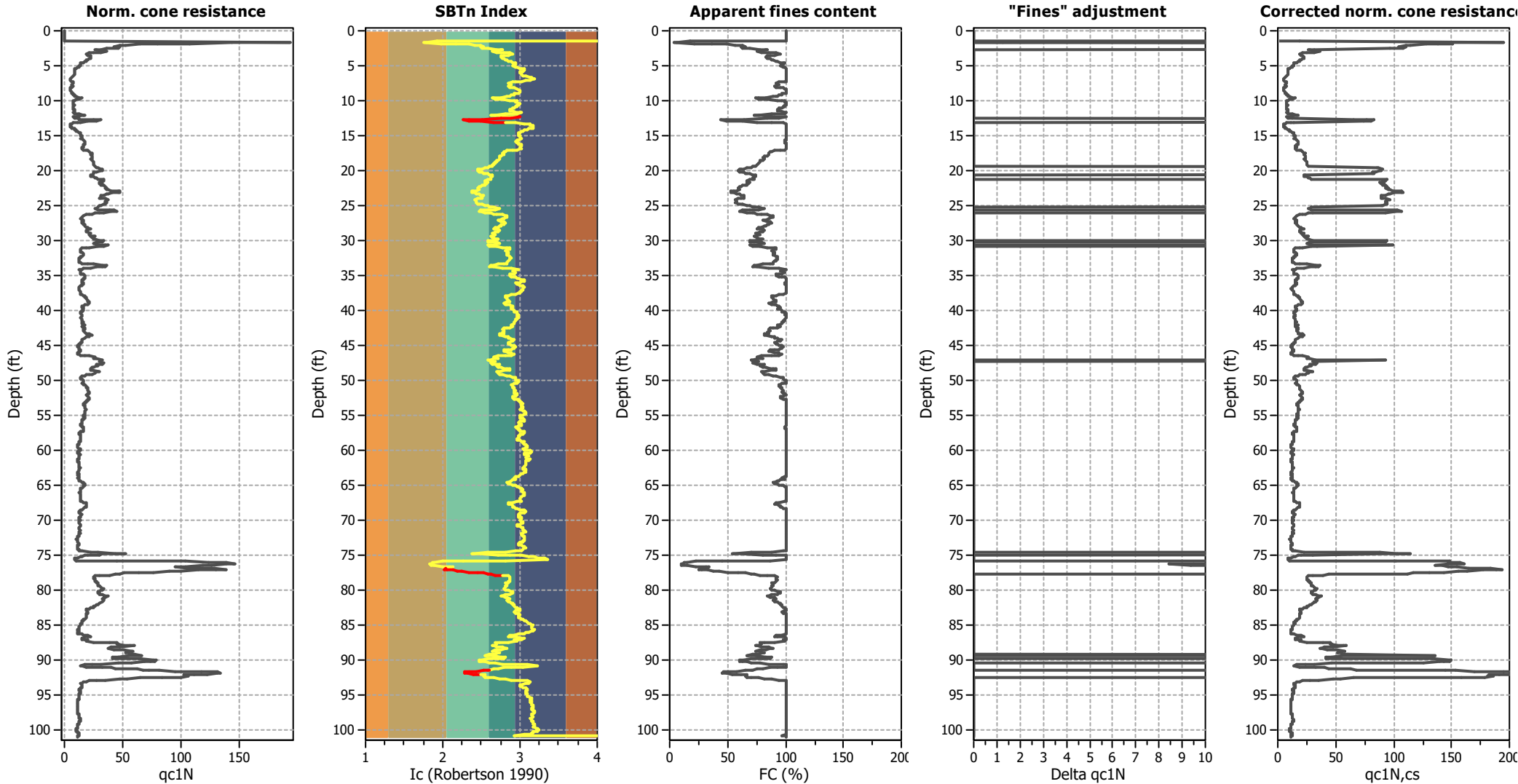
CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	80.00 ft

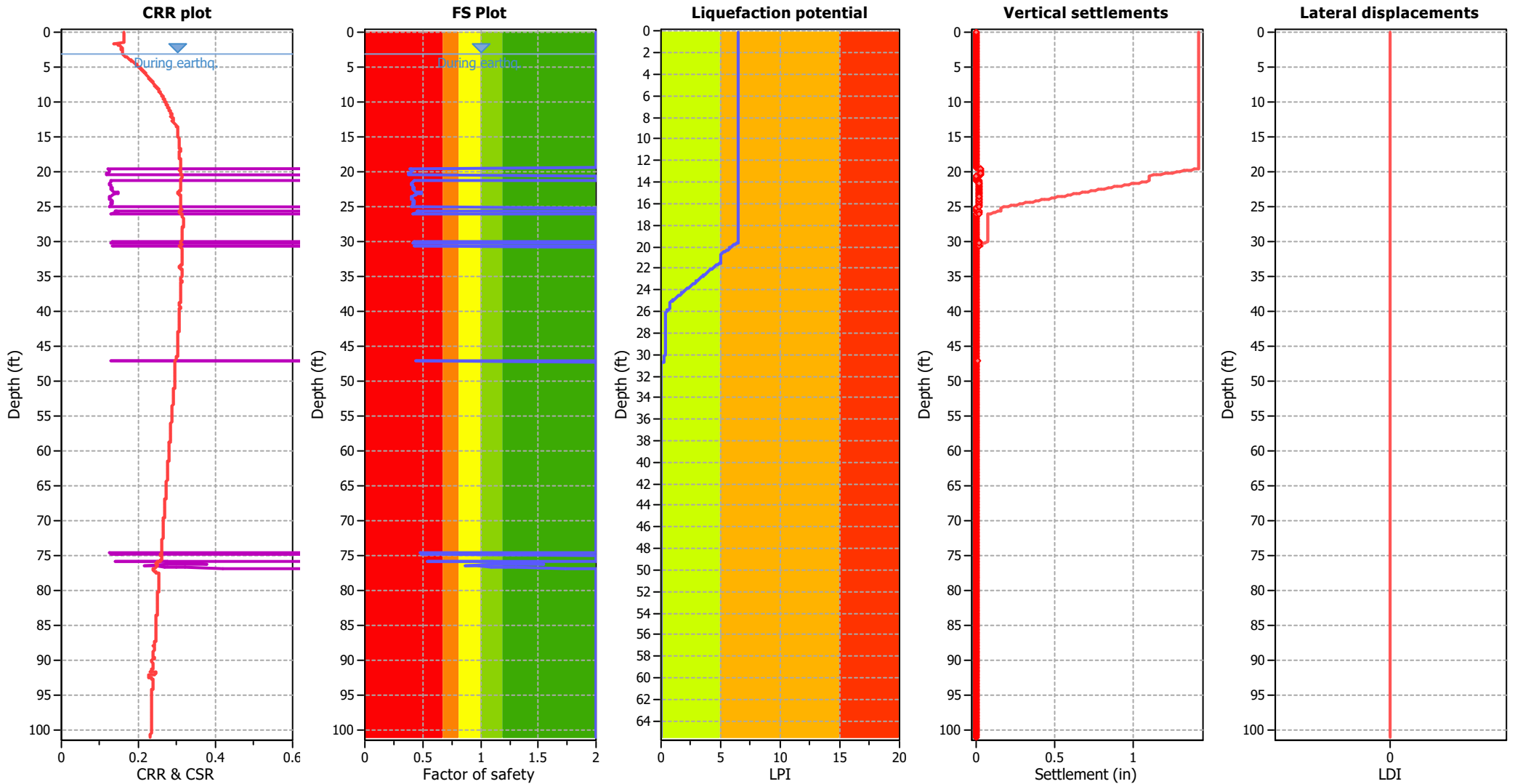
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_o applied:	Yes
Earthquake magnitude M_w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	80.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _s applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	80.00 ft

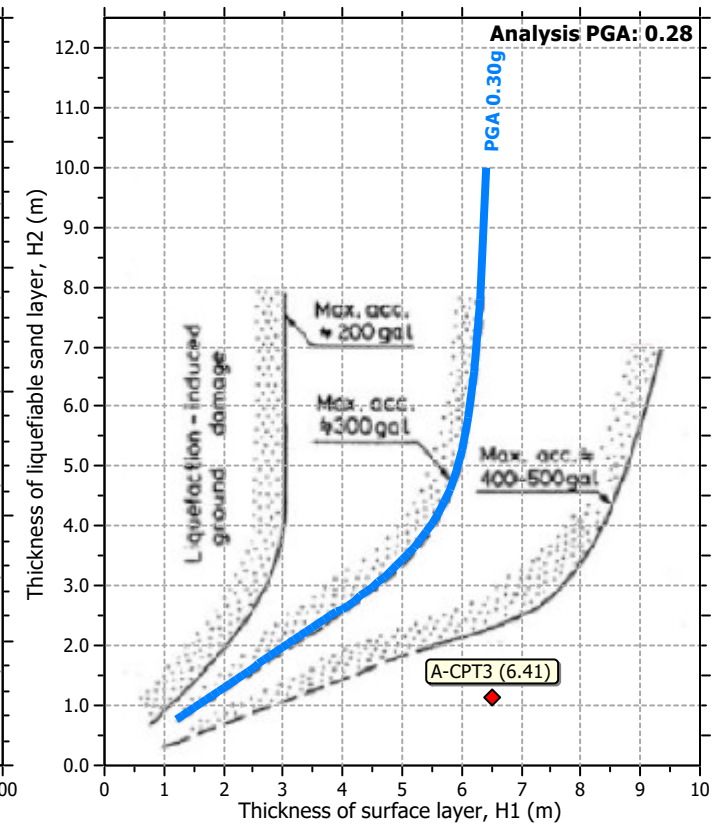
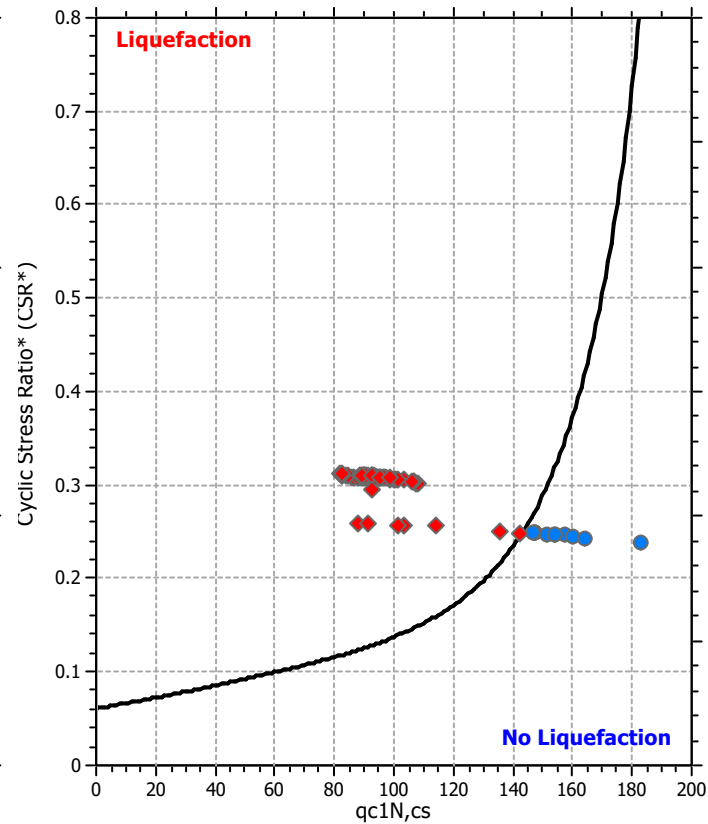
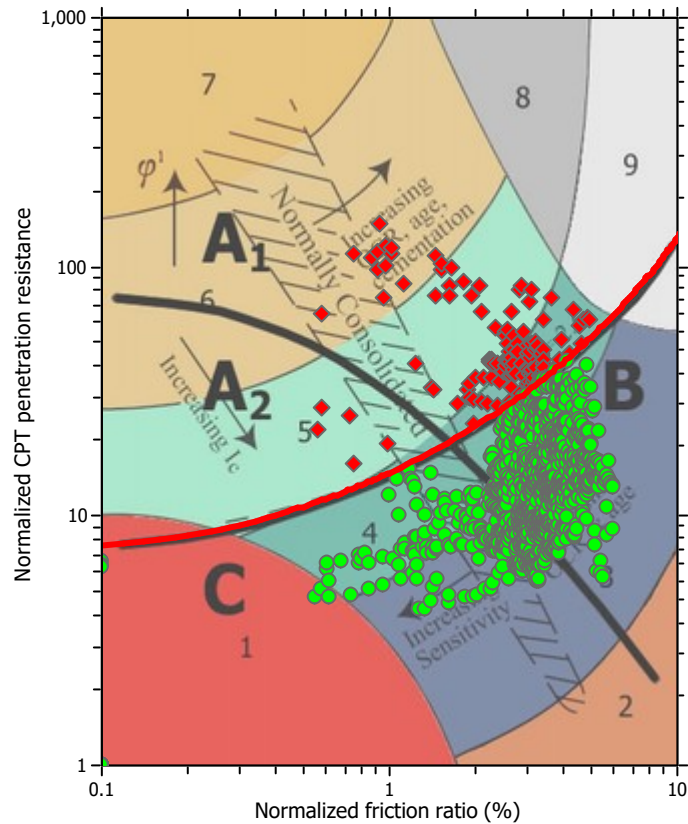
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

Red	Very high risk
Orange	High risk
Yellow	Low risk

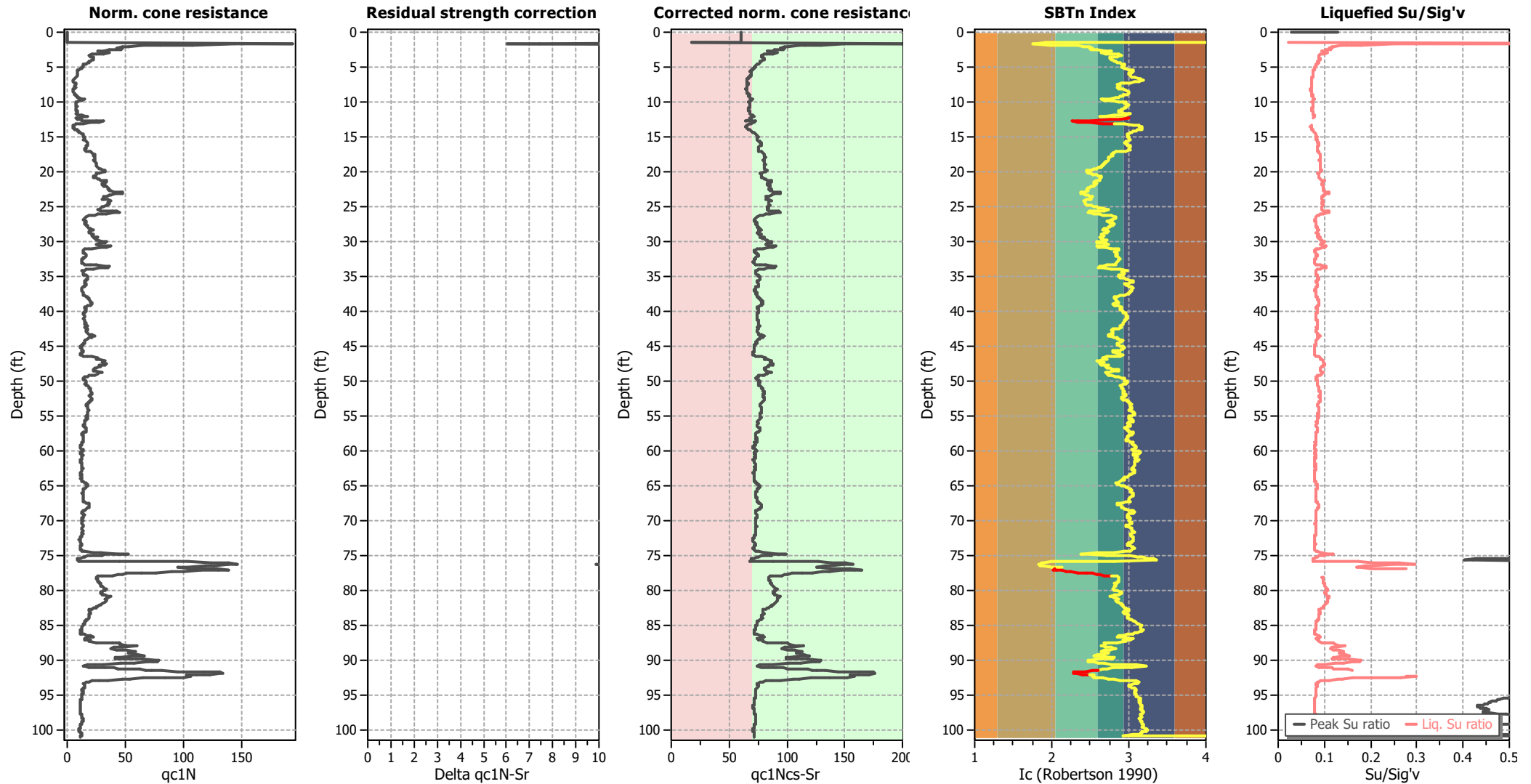
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	80.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	80.00 ft

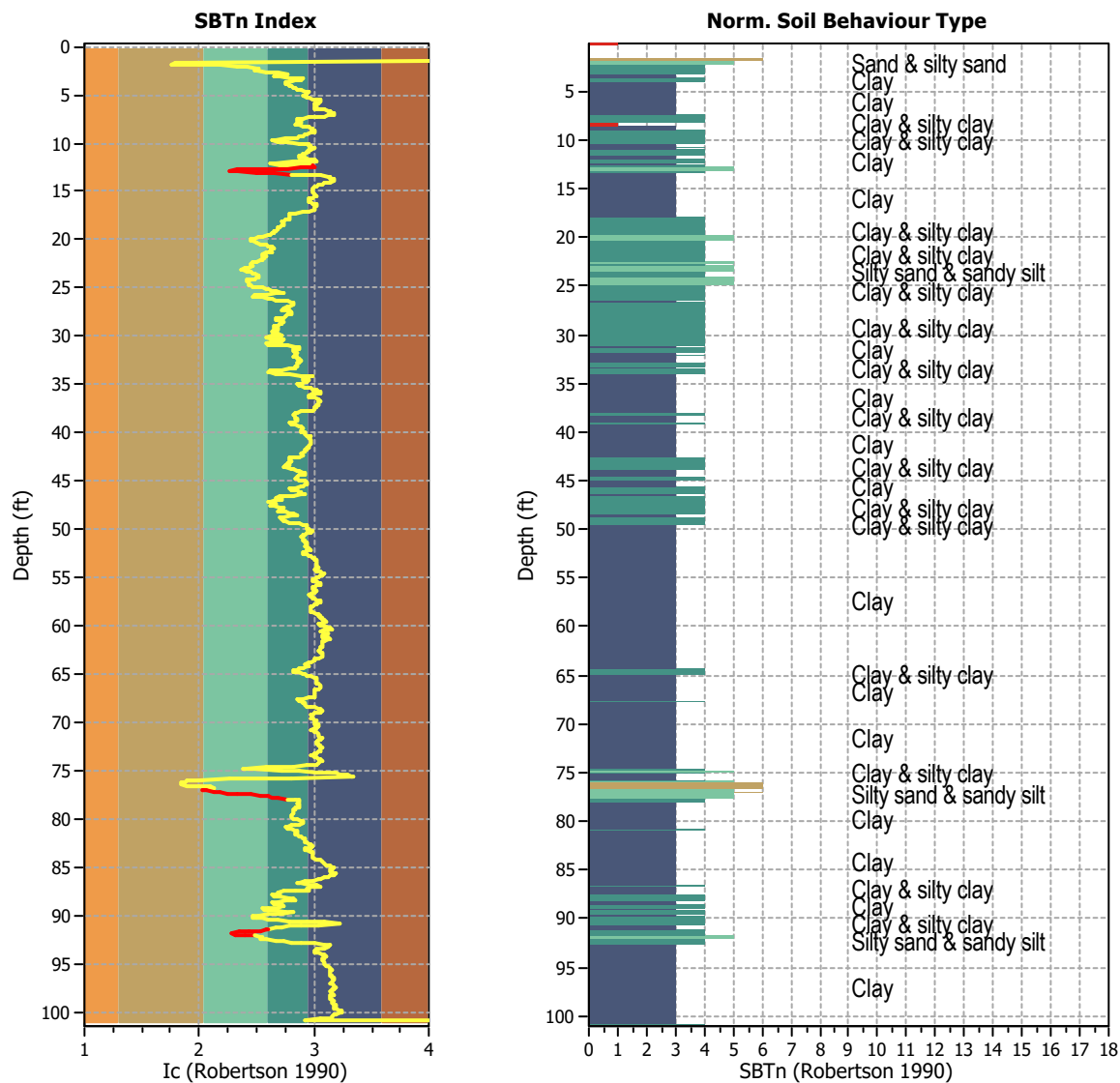
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



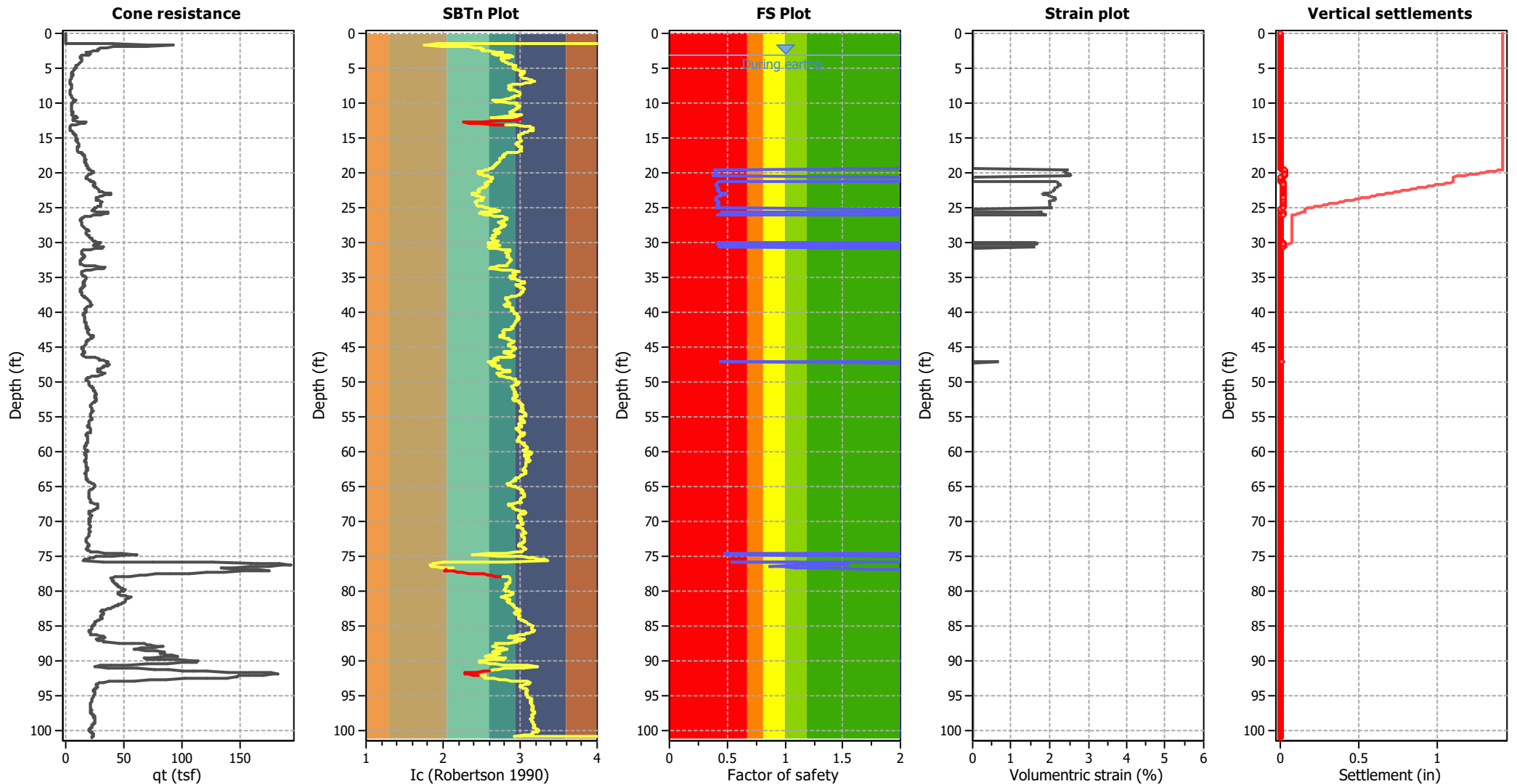
Transition layer algorithm properties

I_c minimum check value: 2.00
 I_c maximum check value: 3.00
 I_c change ratio value: 0.0300
Minimum number of points in layer: 5

General statistics

Total points in CPT file: 1232
Total points excluded: 35
Exclusion percentage: 2.84%
Number of layers detected: 5

Estimation of post-earthquake settlements



Abbreviations

- q_c : Total cone resistance (cone resistance q_c corrected for pore water effects)
- I_c : Soil Behaviour Type Index
- FS: Calculated Factor of Safety against liquefaction
- Volumetric strain: Post-liquefaction volumetric strain



LIQUEFACTION ANALYSIS REPORT

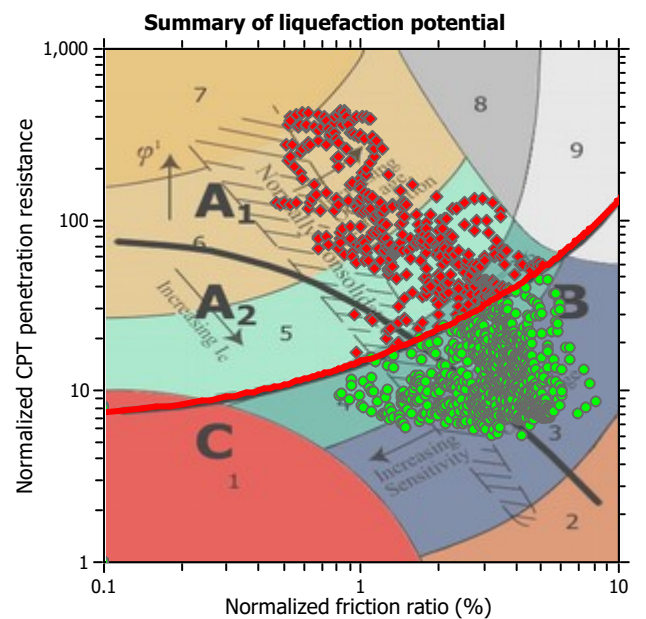
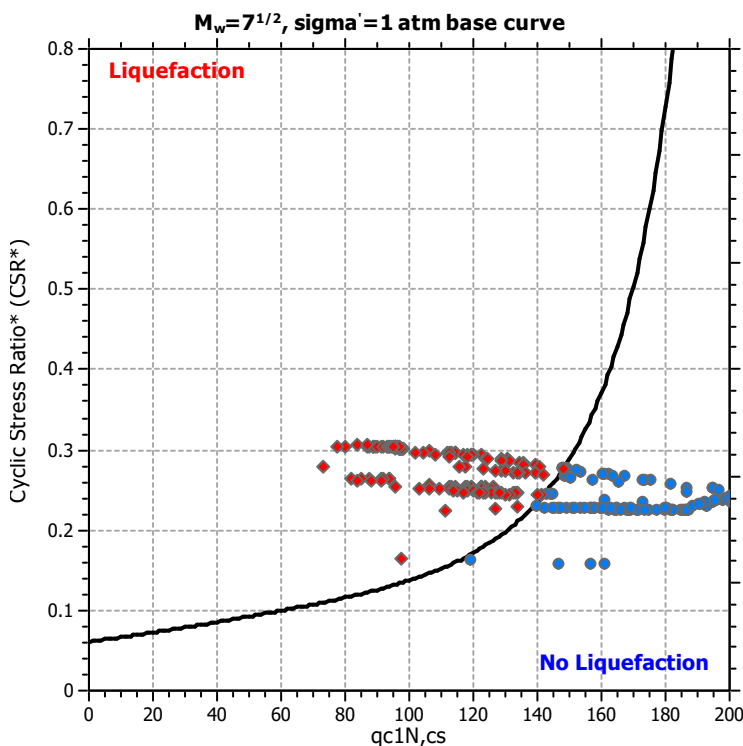
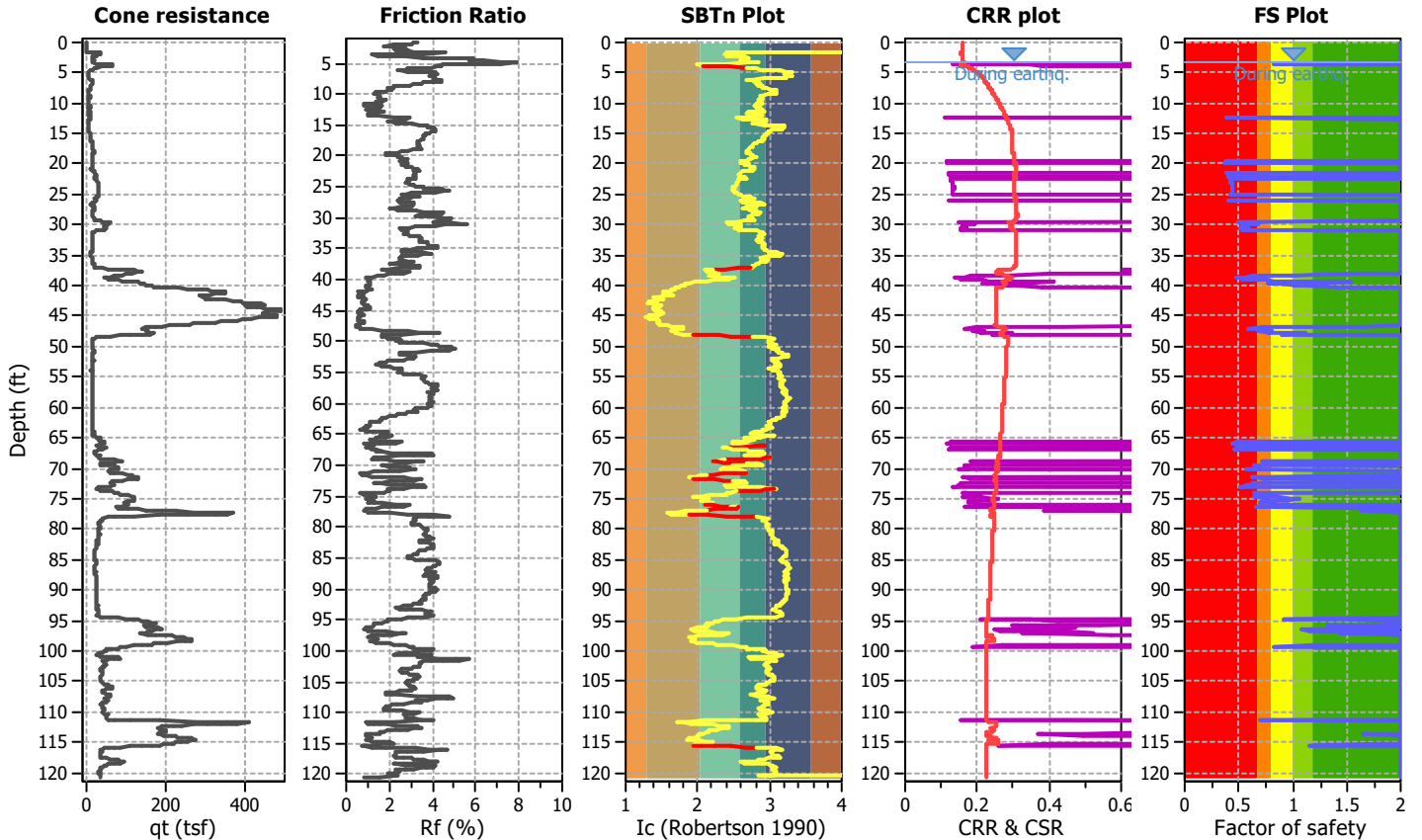
Project title :

Location :

CPT file : A-SCPT4

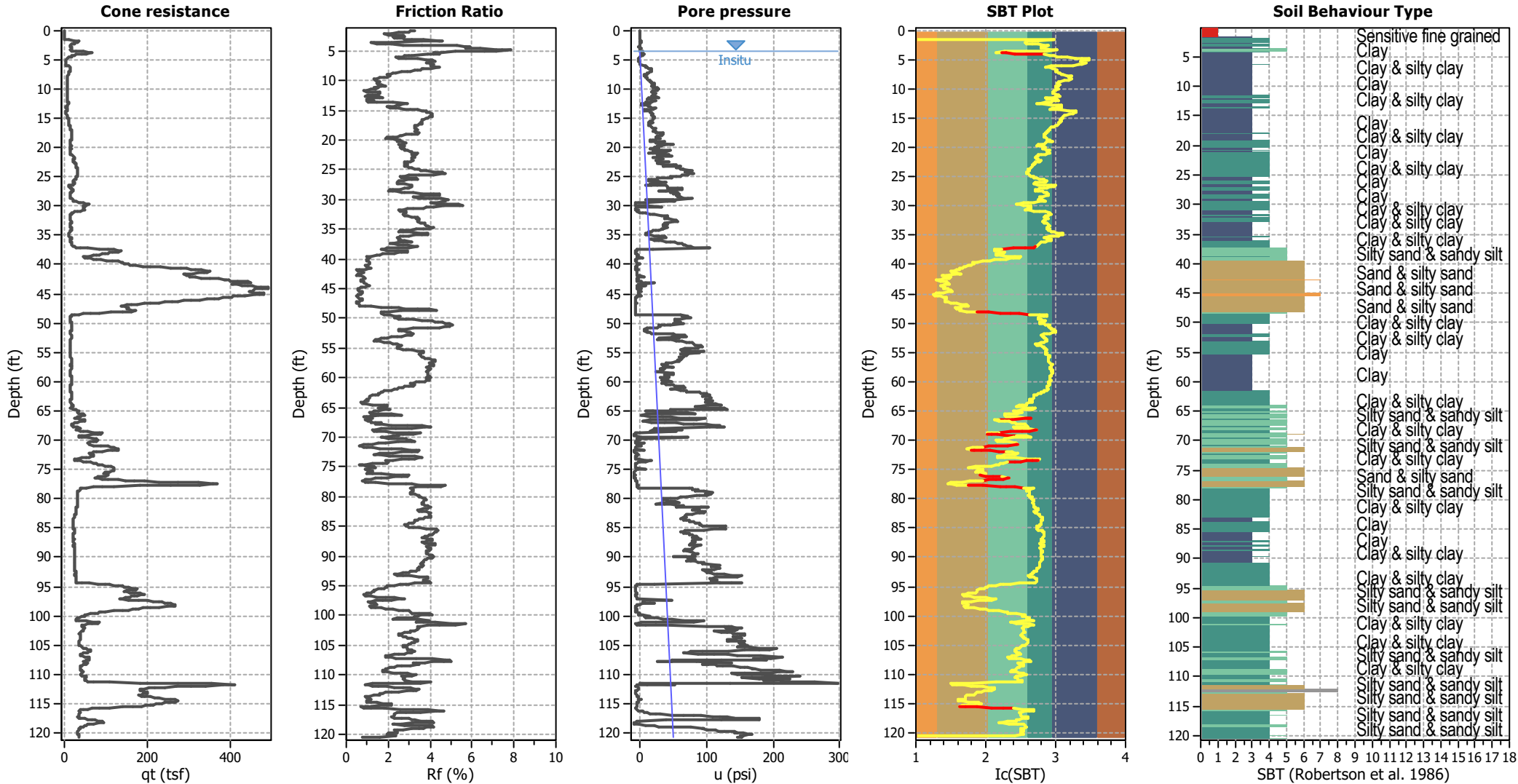
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.30 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	MSF method:	N/A
Earthquake magnitude M_w :	6.96	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.28	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



Zone A₁: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A₂: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



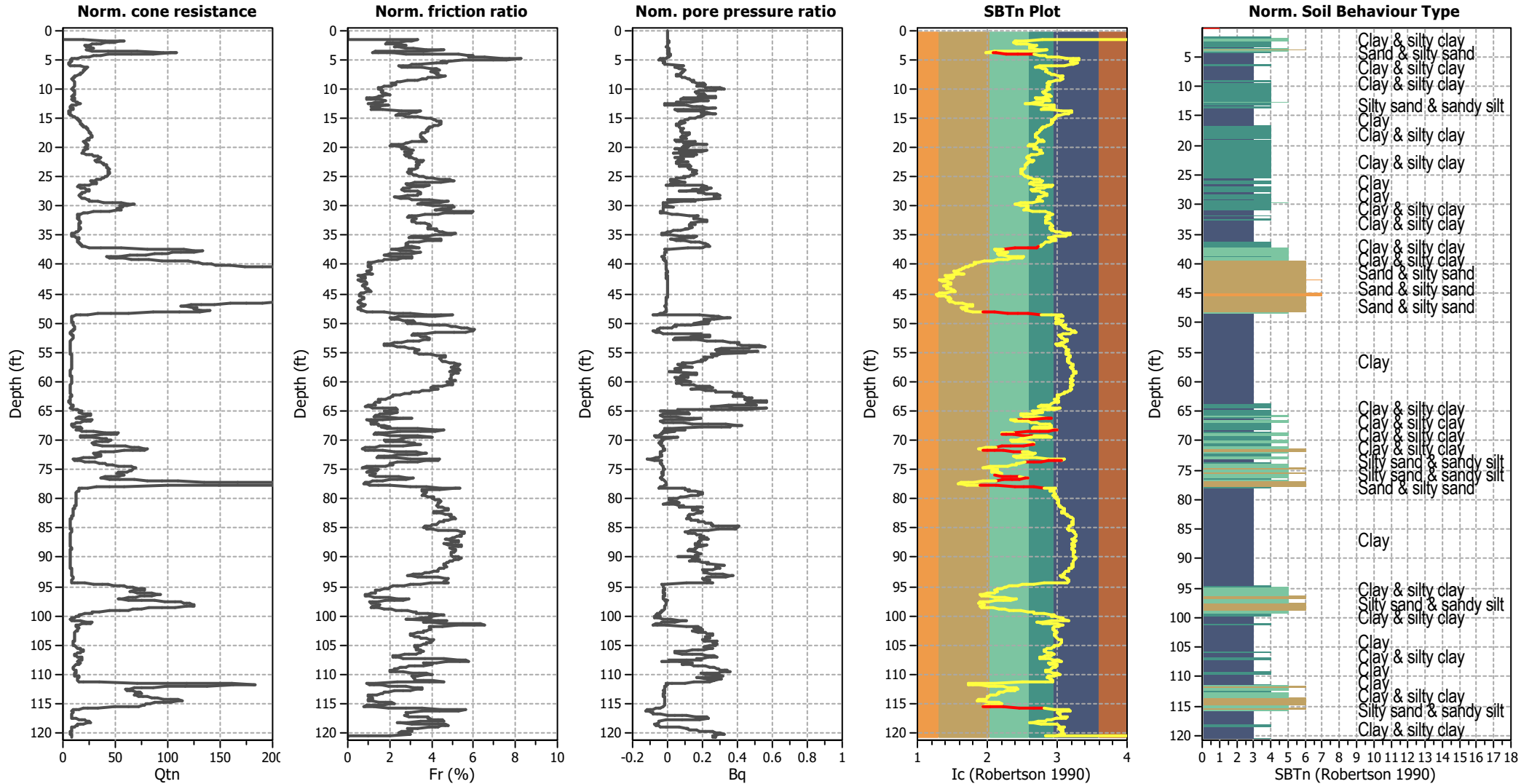
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



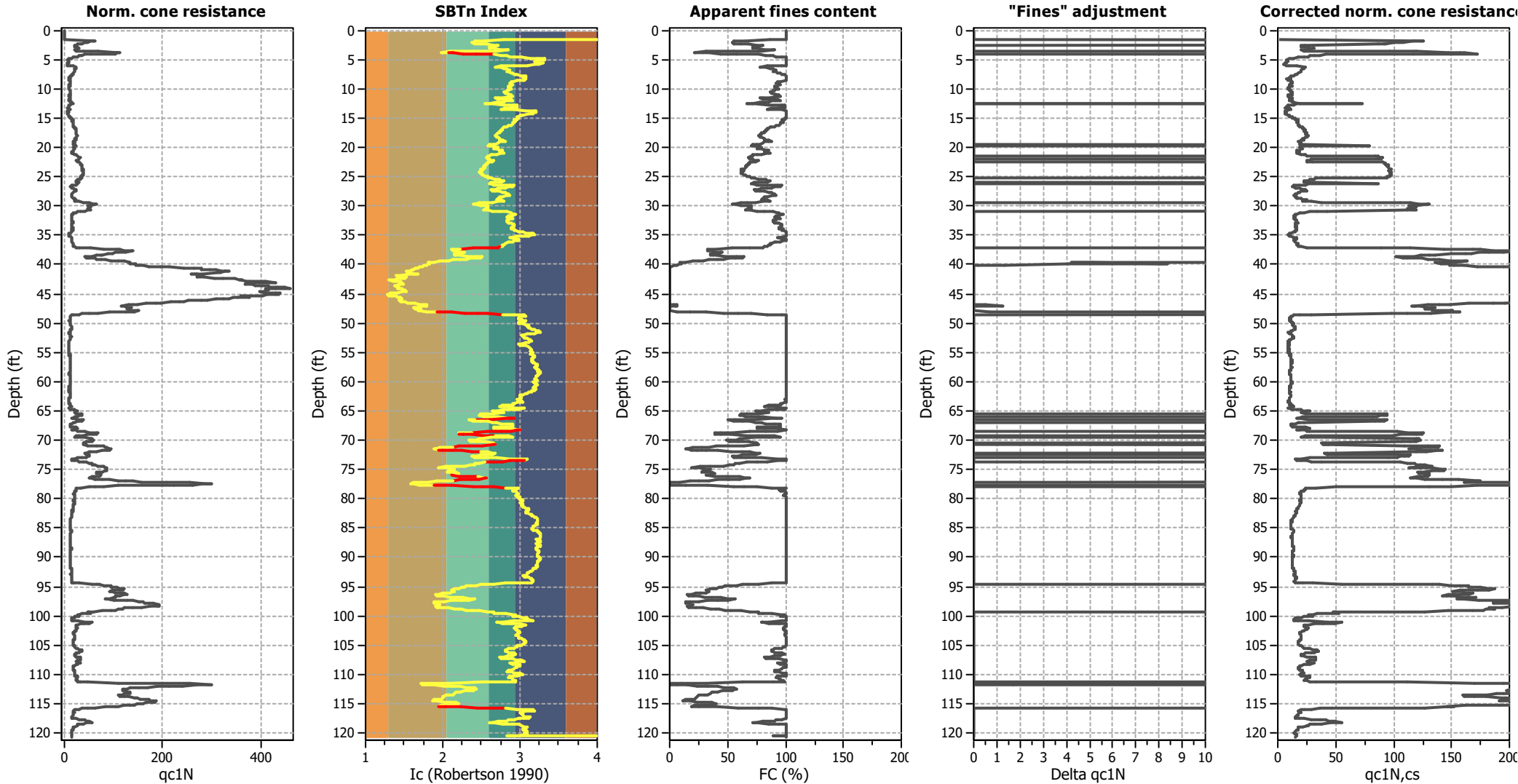
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

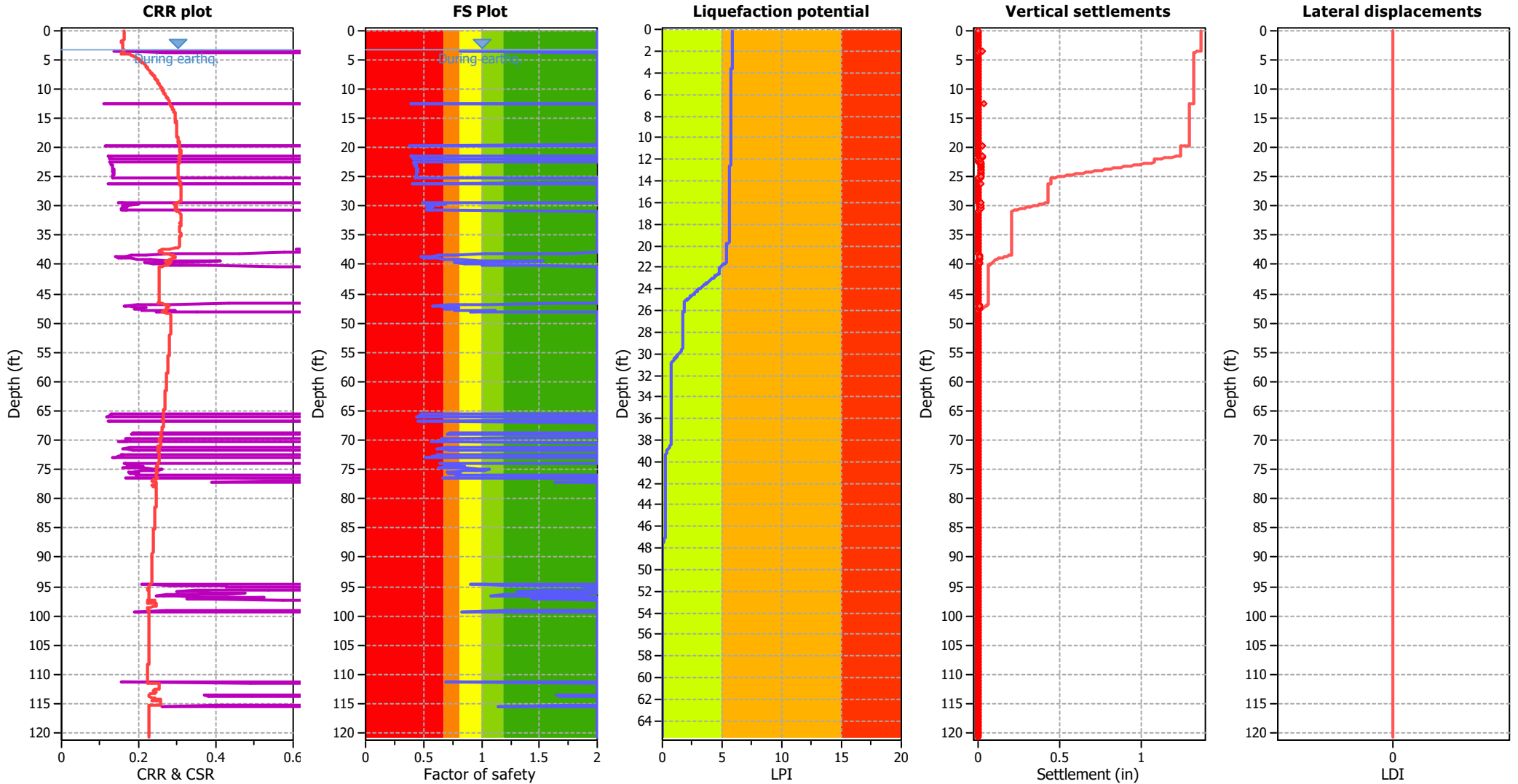
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LPI color scheme

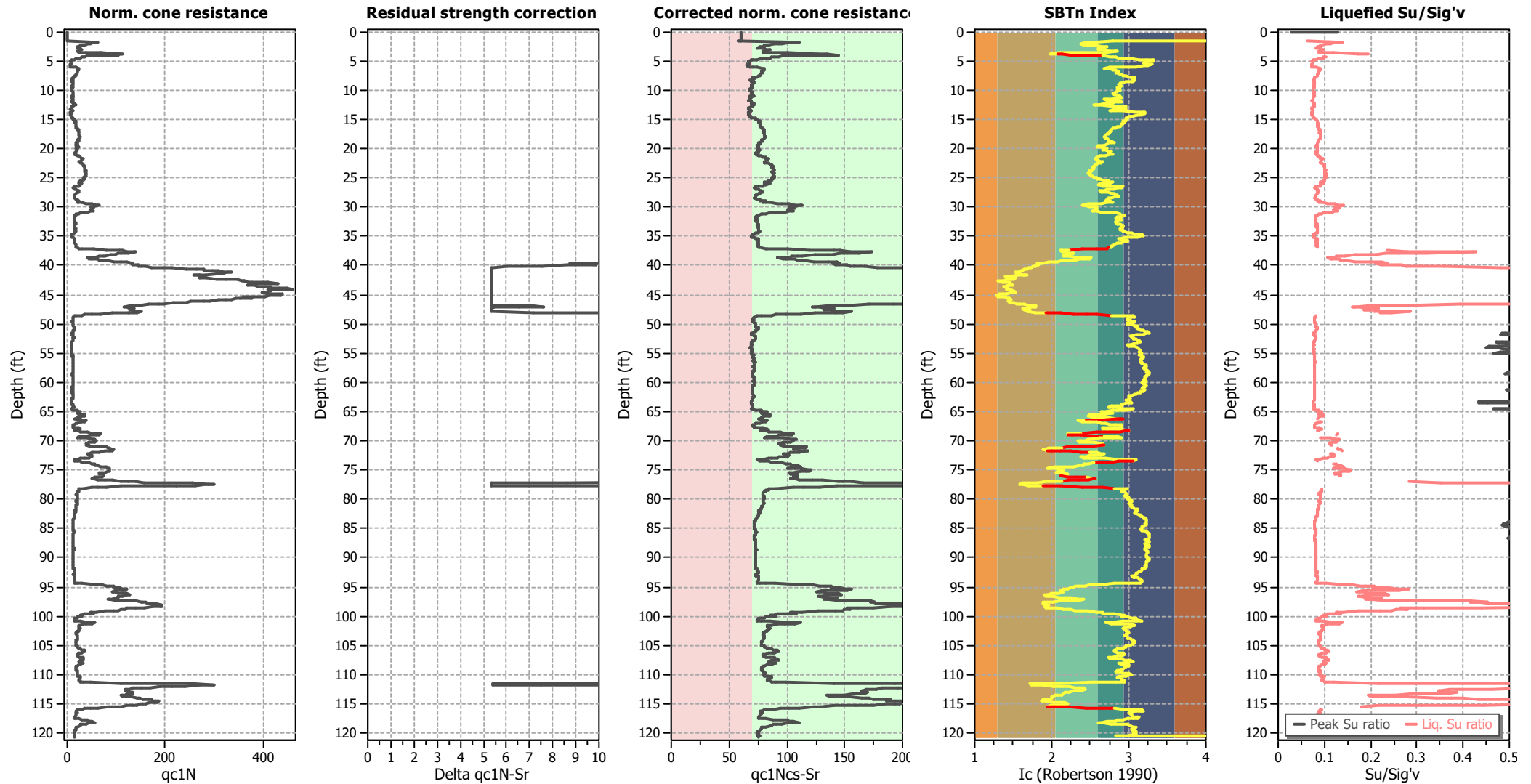
Red	Very high risk
Orange	High risk
Yellow	Low risk

The figure consists of three subplots:

- Left Plot:** A log-log scatter plot showing Normalized CPT penetration resistance (y-axis, 1 to 1000) versus Normalized friction ratio (%) (x-axis, 0.1 to 10). The plot is divided into several regions labeled 1 through 9. Regions 1, 2, and 3 are shaded red, orange, and blue respectively. Region 4 is a green band. Regions 5, 6, 7, 8, and 9 are various shades of grey and white. Arrows indicate trends: "Increasing ϕ' " (upwards), "Normally Consolidation" (diagonally down-right), "Increasing I_c " (downwards), and "Increasing Sensitivity" (diagonally up-left).
- Middle Plot:** A semi-log plot showing Cyclic Stress Ratio* (CSR*) (y-axis, 0 to 0.8) versus $qc_{1N,cs}$ (x-axis, 0 to 200). Red diamonds represent data points where liquefaction occurred, clustered between CSR* values of 0.2 and 0.3. Blue circles represent data points where no liquefaction occurred, mostly below CSR* = 0.2. A black curve shows the boundary between the two states.
- Right Plot:** A linear plot showing the thickness of the liquefiable sand layer, H_2 (m) (y-axis, 0.0 to 12.0) versus the thickness of the surface layer, H_1 (m) (x-axis, 0 to 10). A thick blue line represents the analysis results for PGA = 0.30g. Shaded regions indicate different levels of maximum acceleration: Max. acc. = 200gal (lightest), Max. acc. = 400gal (medium), and Max. acc. = 400-500gal (darkest). A label "Liquefaction-induced ground damage" points to the shaded area. A specific point is labeled "A-SCPT4 (5.80)".

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.30 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _o applied:	Yes
Earthquake magnitude M _w :	6.96	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.28	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	N/A

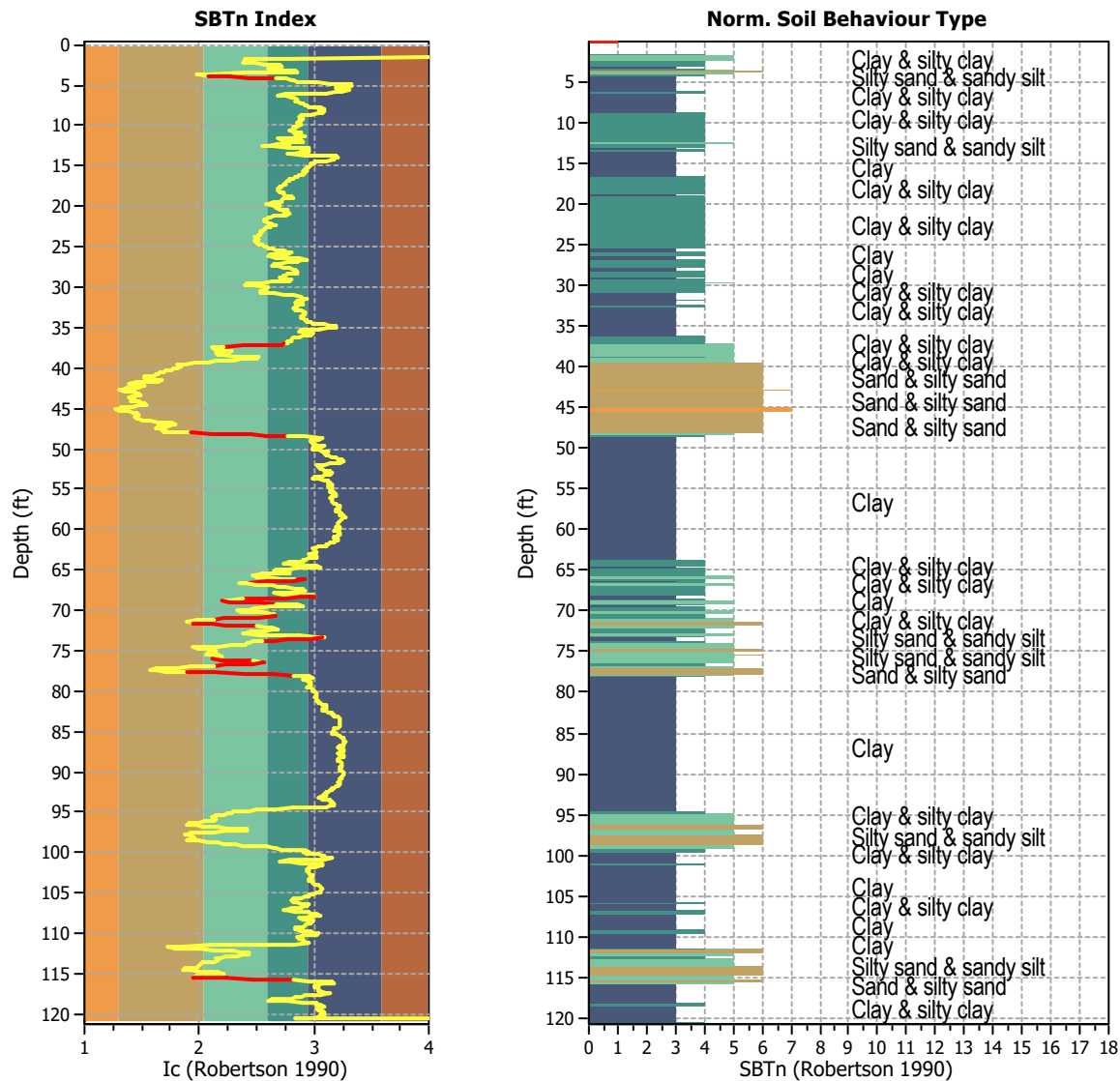
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c . Transitions typically occur when the rate of change of I_c is fast (i.e. ΔI_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



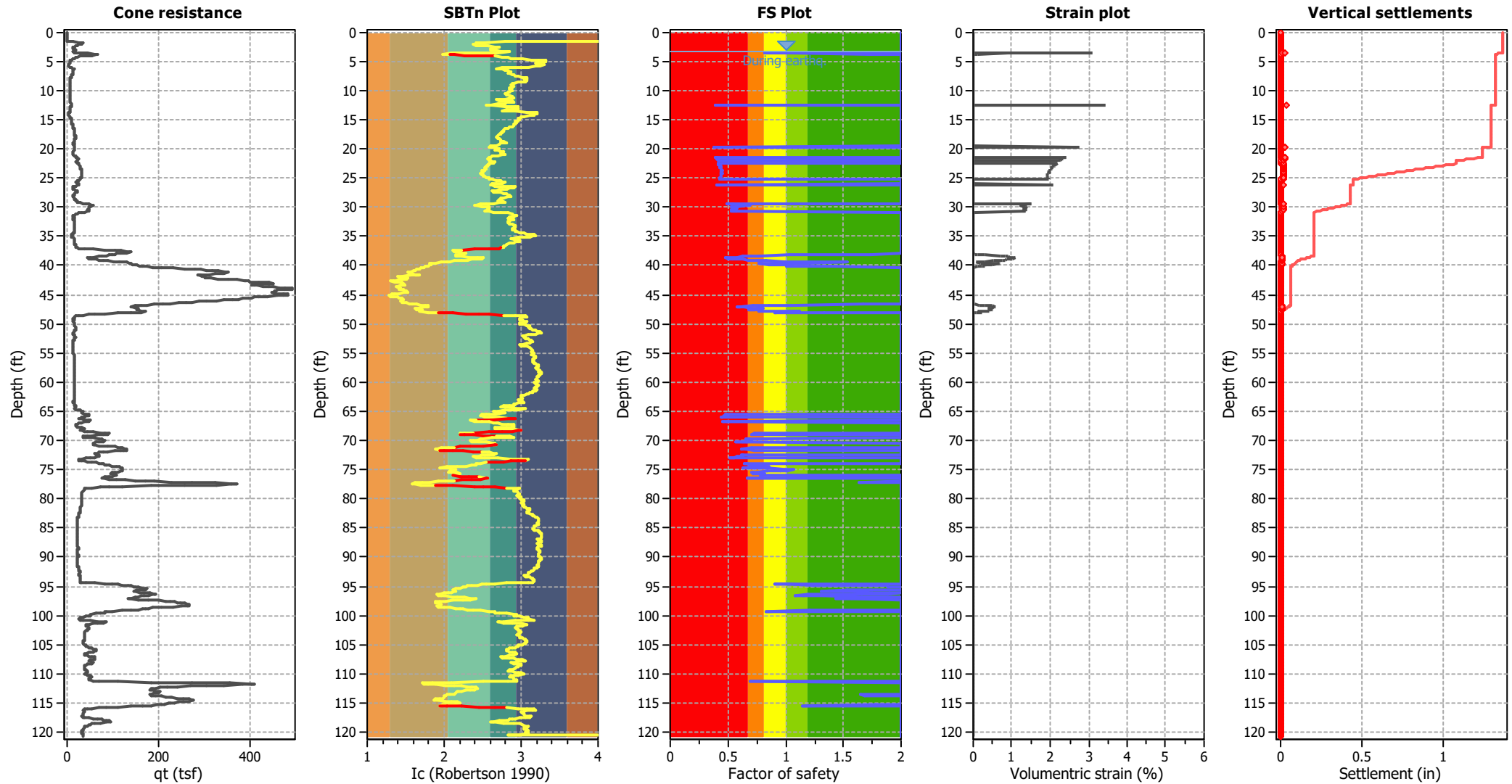
Transition layer algorithm properties

I_c minimum check value: 2.00
 I_c maximum check value: 3.00
 I_c change ratio value: 0.0700
Minimum number of points in layer: 5

General statistics

Total points in CPT file: 1472
Total points excluded: 73
Exclusion percentage: 4.96%
Number of layers detected: 13

Estimation of post-earthquake settlements



Abbreviations

q_c : Total cone resistance (cone resistance q_c corrected for pore water effects)
 I_c : Soil Behaviour Type Index
 FS: Calculated Factor of Safety against liquefaction
 Volumetric strain: Post-liquefaction volumetric strain



SPT BASED LIQUEFACTION ANALYSIS REPORT

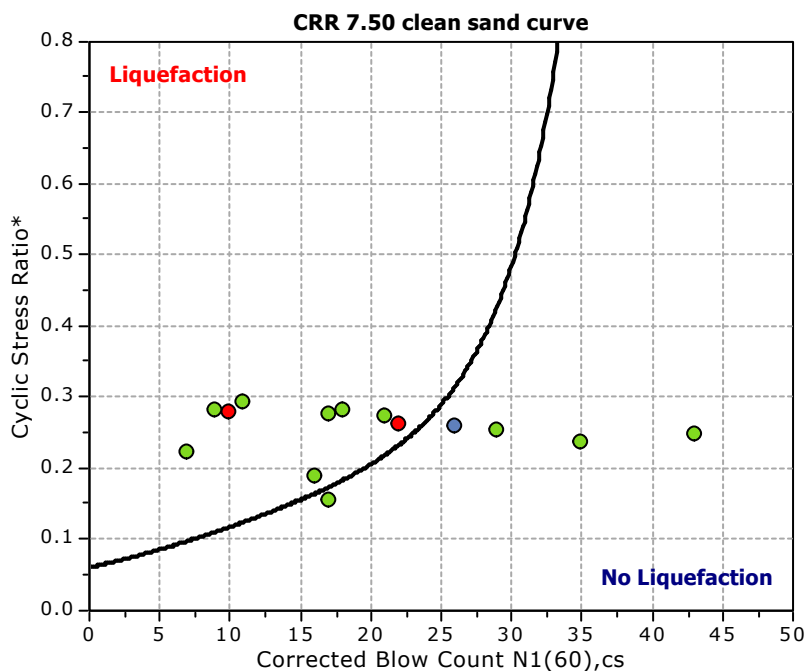
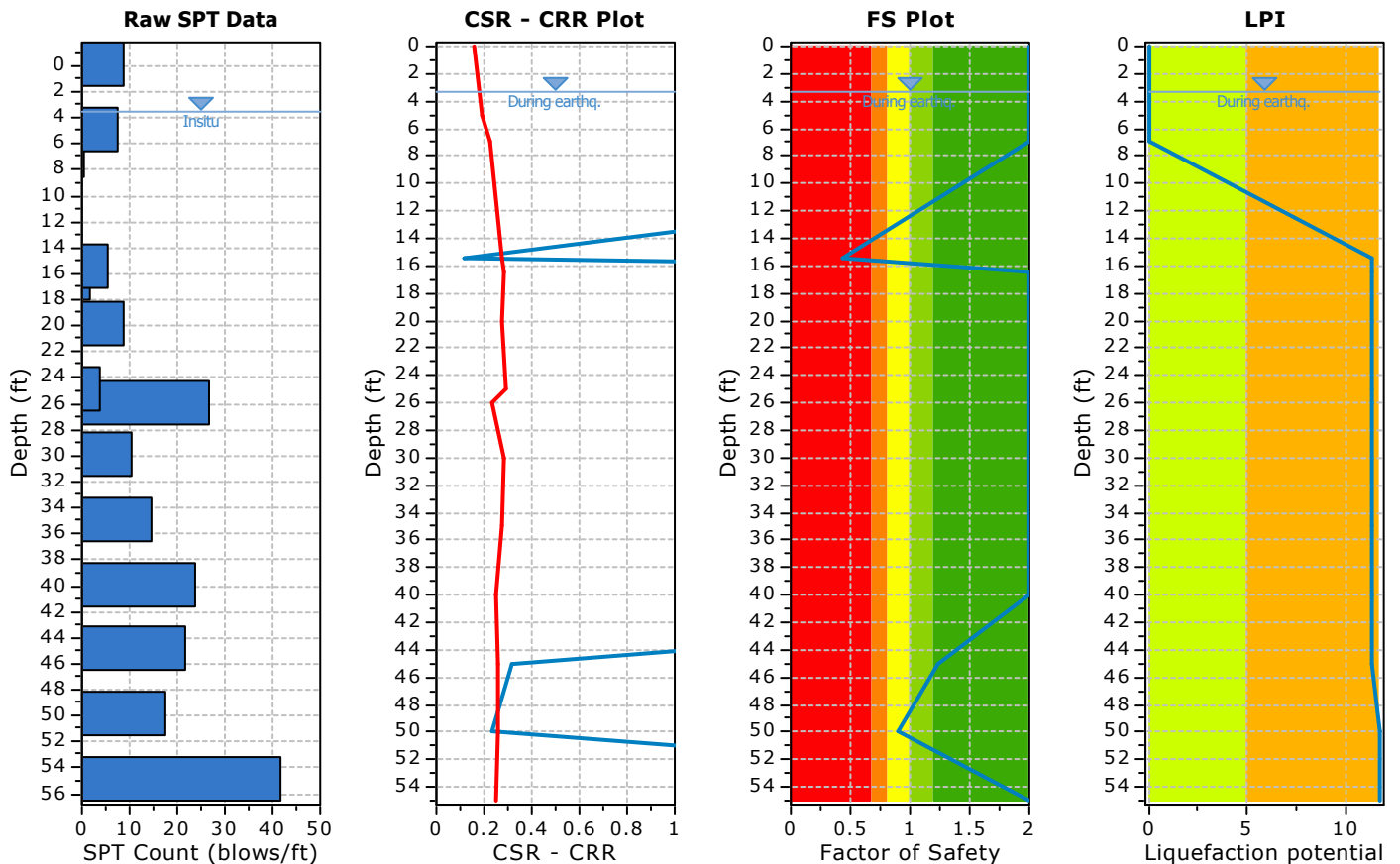
Project title : Safer Bay

SPT Name: B-107

Location : Palo Alto, California

:: Input parameters and analysis properties ::

Analysis method:	Boulanger & Idriss, 2014	G.W.T. (in-situ):	3.50 ft
Fines correction method:	Boulanger & Idriss, 2014	G.W.T. (earthq.):	3.30 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w :	6.96
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.28 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.00		



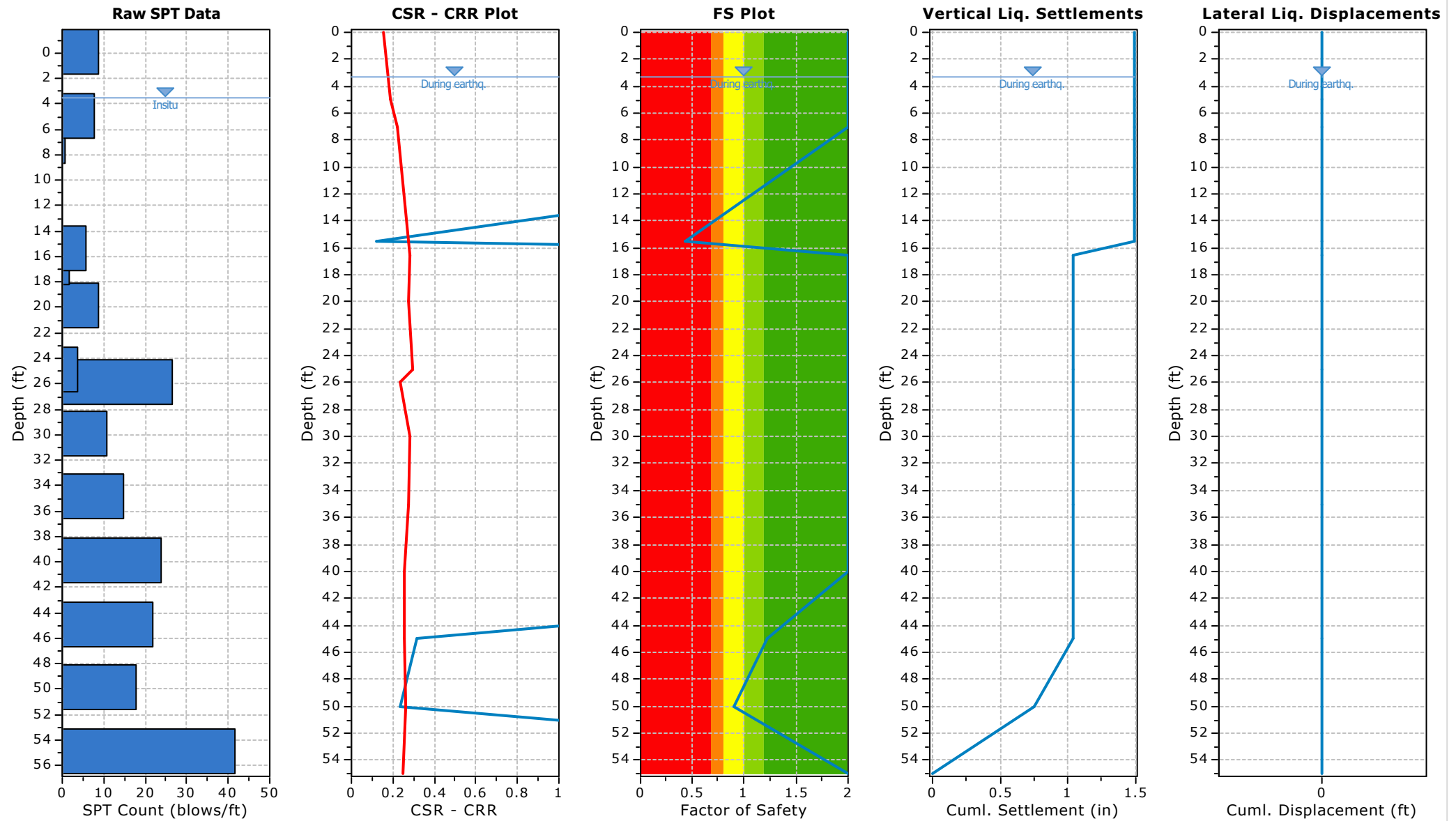
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::					
Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
0.01	9	50.00	115.00	5.00	Yes
5.00	8	85.00	115.00	2.00	No
7.00	1	70.00	110.00	8.50	No
15.50	6	12.00	110.00	1.00	Yes
16.50	2	85.00	115.00	3.50	No
20.00	9	85.00	115.00	5.00	No
25.00	4	85.00	113.00	1.00	No
26.00	27	70.00	125.00	4.00	No
30.00	11	70.00	122.00	5.00	No
35.00	15	70.00	125.00	5.00	No
40.00	24	70.00	125.00	5.00	No
45.00	22	42.00	120.00	5.00	Yes
50.00	18	42.00	120.00	5.00	Yes
55.00	42	42.00	120.00	7.00	Yes

Abbreviations

Depth:	Depth at which test was performed (ft)
SPT Field Value:	Number of blows per foot
Fines Content:	Fines content at test depth (%)
Unit Weight:	Unit weight at test depth (pcf)
Infl. Thickness:	Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy:	User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::																
Depth (ft)	SPT Field Value	Unit Weight (pcf)	α_v (tsf)	u_0 (tsf)	σ'_{vo} (tsf)	m	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	FC (%)	$\Delta(N_1)_{60}$	$(N_1)_{60cs}$	$CRR_{7.5}$
0.01	9	115.00	0.00	0.00	0.00	0.43	1.70	1.00	1.00	0.75	1.00	11	50.00	5.61	17	4.000
5.00	8	115.00	0.29	0.05	0.24	0.44	1.70	1.00	1.00	0.75	1.00	10	85.00	5.53	16	4.000
7.00	1	110.00	0.40	0.11	0.29	0.53	1.70	1.00	1.00	0.80	1.00	1	70.00	5.57	7	4.000
15.50	6	110.00	0.86	0.37	0.49	0.53	1.50	1.00	1.00	0.85	1.00	8	12.00	2.07	10	0.118
16.50	2	115.00	0.92	0.41	0.52	0.53	1.46	1.00	1.00	0.95	1.00	3	85.00	5.53	9	4.000
20.00	9	115.00	1.12	0.51	0.61	0.46	1.29	1.00	1.00	0.95	1.00	11	85.00	5.53	17	4.000
25.00	4	113.00	1.41	0.67	0.74	0.53	1.21	1.00	1.00	0.95	1.00	5	85.00	5.53	11	4.000
26.00	27	125.00	1.47	0.70	0.77	0.33	1.11	1.00	1.00	0.95	1.00	29	70.00	5.57	35	4.000
30.00	11	122.00	1.71	0.83	0.89	0.46	1.08	1.00	1.00	1.00	1.00	12	70.00	5.57	18	4.000
35.00	15	125.00	2.03	0.98	1.04	0.43	1.01	1.00	1.00	1.00	1.00	15	70.00	5.57	21	4.000
40.00	24	125.00	2.34	1.14	1.20	0.38	0.95	1.00	1.00	1.00	1.00	23	70.00	5.57	29	4.000
45.00	22	120.00	2.64	1.29	1.34	0.40	0.91	1.00	1.00	1.00	1.00	20	42.00	5.59	26	0.316
50.00	18	120.00	2.94	1.45	1.49	0.44	0.86	1.00	1.00	1.00	1.00	16	42.00	5.59	22	0.233
55.00	42	120.00	3.24	1.61	1.63	0.29	0.88	1.00	1.00	1.00	1.00	37	42.00	5.59	43	4.000

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_0 (tsf)	σ'_{vo} (tsf)	m	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	FC (%)	$\Delta(N_1)_{60}$	$(N_1)_{60cs}$	CRR _{7.5}
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Abbreviations

σ_v : Total stress during SPT test (tsf)
 u_0 : Water pore pressure during SPT test (tsf)
 σ'_{vo} : Effective overburden pressure during SPT test (tsf)
m: Stress exponent normalization factor
 C_N : Overburden correction factor
 C_E : Energy correction factor
 C_B : Borehole diameter correction factor
 C_R : Rod length correction factor
 C_S : Liner correction factor
 $N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
 $\Delta(N_1)_{60}$: Equivalent clean sand adjustment
 $N_{1(60)cs}$: Corrected $N_{1(60)}$ value for fines content
CRR_{7.5}: Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF_{max}	$(N_1)_{60cs}$	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR*	FS	
0.01	115.00	0.00	0.00	0.00	1.01	1.00	0.183	1.38	17	1.07	0.171	1.10	0.155	2.000	🟢
5.00	115.00	0.29	0.05	0.23	0.99	1.00	0.221	1.35	16	1.07	0.207	1.10	0.189	2.000	🟢
7.00	110.00	0.40	0.12	0.28	0.98	1.00	0.253	1.14	7	1.03	0.246	1.10	0.224	2.000	🟢
15.50	110.00	0.86	0.38	0.48	0.95	1.00	0.309	1.19	10	1.04	0.298	1.07	0.278	0.425	🔴
16.50	115.00	0.92	0.41	0.51	0.94	1.00	0.311	1.17	9	1.03	0.301	1.06	0.282	2.000	🟢
20.00	115.00	1.12	0.52	0.60	0.93	1.00	0.315	1.38	17	1.07	0.293	1.07	0.275	2.000	🟢
25.00	113.00	1.41	0.68	0.73	0.90	1.00	0.317	1.21	11	1.04	0.304	1.04	0.294	2.000	🟢
26.00	125.00	1.47	0.71	0.76	0.90	1.00	0.315	2.20	35	1.23	0.256	1.09	0.236	2.000	🟢
30.00	122.00	1.71	0.83	0.88	0.88	1.00	0.310	1.42	18	1.08	0.287	1.02	0.281	2.000	🟢
35.00	125.00	2.03	0.99	1.04	0.85	1.00	0.302	1.53	21	1.10	0.274	1.00	0.273	2.000	🟢
40.00	125.00	2.34	1.15	1.19	0.82	1.00	0.292	1.94	29	1.18	0.248	0.98	0.254	2.000	🟢
45.00	120.00	2.64	1.30	1.34	0.79	1.00	0.284	1.77	26	1.15	0.248	0.96	0.258	1.225	🟢
50.00	120.00	2.94	1.46	1.48	0.76	1.00	0.276	1.58	22	1.11	0.248	0.95	0.261	0.894	🔴
55.00	120.00	3.24	1.61	1.62	0.74	1.00	0.267	2.20	43	1.23	0.217	0.87	0.249	2.000	🟢

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
 $u_{0,eq}$: Water pressure at test point, during earthquake (tsf)
 $\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
 r_d : Nonlinear shear mass factor
 α : Improvement factor due to stone columns
CSR: Cyclic Stress Ratio
MSF: Magnitude Scaling Factor
CSR_{eq,M=7.5}: CSR adjusted for M=7.5
 K_{sigma} : Effective overburden stress factor
CSR*: CSR fully adjusted (user FS applied)***
FS: Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
0.01	2.000	0.00	10.00	4.99	0.00
5.00	2.000	0.00	9.24	4.99	0.00
7.00	2.000	0.00	8.93	2.00	0.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I _L
15.50	0.425	0.57	7.64	8.50	11.38
16.50	2.000	0.00	7.49	1.00	0.00
20.00	2.000	0.00	6.95	3.50	0.00
25.00	2.000	0.00	6.19	5.00	0.00
26.00	2.000	0.00	6.04	1.00	0.00
30.00	2.000	0.00	5.43	4.00	0.00
35.00	2.000	0.00	4.67	5.00	0.00
40.00	2.000	0.00	3.90	5.00	0.00
45.00	1.225	0.00	3.14	5.00	0.00
50.00	0.894	0.11	2.38	5.00	0.39
55.00	2.000	0.00	1.62	5.00	0.00

Overall potential I_L : 11.76I_L = 0.00 - No liquefactionI_L between 0.00 and 5 - Liquefaction not probableI_L between 5 and 15 - Liquefaction probableI_L > 15 - Liquefaction certain**:: Vertical & Lateral displacements estimation for saturated sands ::**

Depth (ft)	(N ₁) _{60cs}	γ _{lim} (%)	F _a	FS _{liq}	γ _{max} (%)	e _v weight factor	e _v (%)	dz (ft)	S _{v-1D} (in)	LDI (ft)
5.00	16	0.00	0.00	2.000	0.00	0.00	0.00	2.00	0.000	0.00
7.00	7	0.00	0.00	2.000	0.00	0.00	0.00	8.50	0.000	0.00
15.50	10	47.32	0.91	0.425	47.32	1.00	3.74	1.00	0.448	0.00
16.50	9	0.00	0.00	2.000	0.00	0.00	0.00	3.50	0.000	0.00
20.00	17	0.00	0.00	2.000	0.00	0.00	0.00	5.00	0.000	0.00
25.00	11	0.00	0.00	2.000	0.00	0.00	0.00	1.00	0.000	0.00
26.00	35	0.00	0.00	2.000	0.00	0.00	0.00	4.00	0.000	0.00
30.00	18	0.00	0.00	2.000	0.00	0.00	0.00	5.00	0.000	0.00
35.00	21	0.00	0.00	2.000	0.00	0.00	0.00	5.00	0.000	0.00
40.00	29	0.00	0.00	2.000	0.00	0.00	0.00	5.00	0.000	0.00
45.00	26	7.85	0.17	1.225	2.13	1.00	0.49	5.00	0.293	0.00
50.00	22	12.67	0.41	0.894	4.72	1.00	1.25	5.00	0.752	0.00
55.00	43	0.44	-1.03	2.000	0.00	1.00	0.00	7.00	0.000	0.00

Cumulative settlements: 1.493 0.00**Abbreviations**

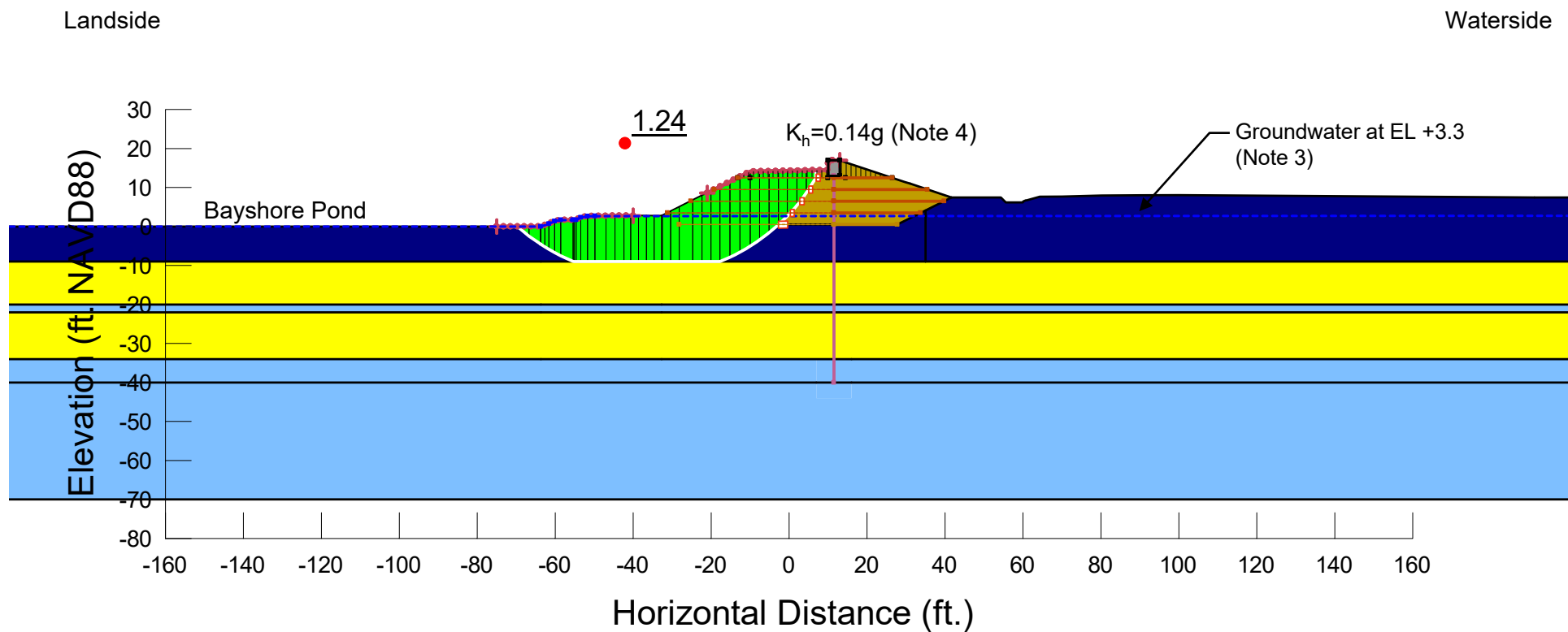
γ_{lim}: Limiting shear strain (%)
 F_a/N: Maximum shear strain factor
 γ_{max}: Maximum shear strain (%)
 e_v: Post liquefaction volumetric strain (%)
 S_{v-1D}: Estimated vertical settlement (in)
 LDI: Estimated lateral displacement (ft)

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Appendix G. Seismic Stability Analysis

DRAFT



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. The pseudo-static seismic coefficient (k_h) is taken as half of the 100-year return period PGA.

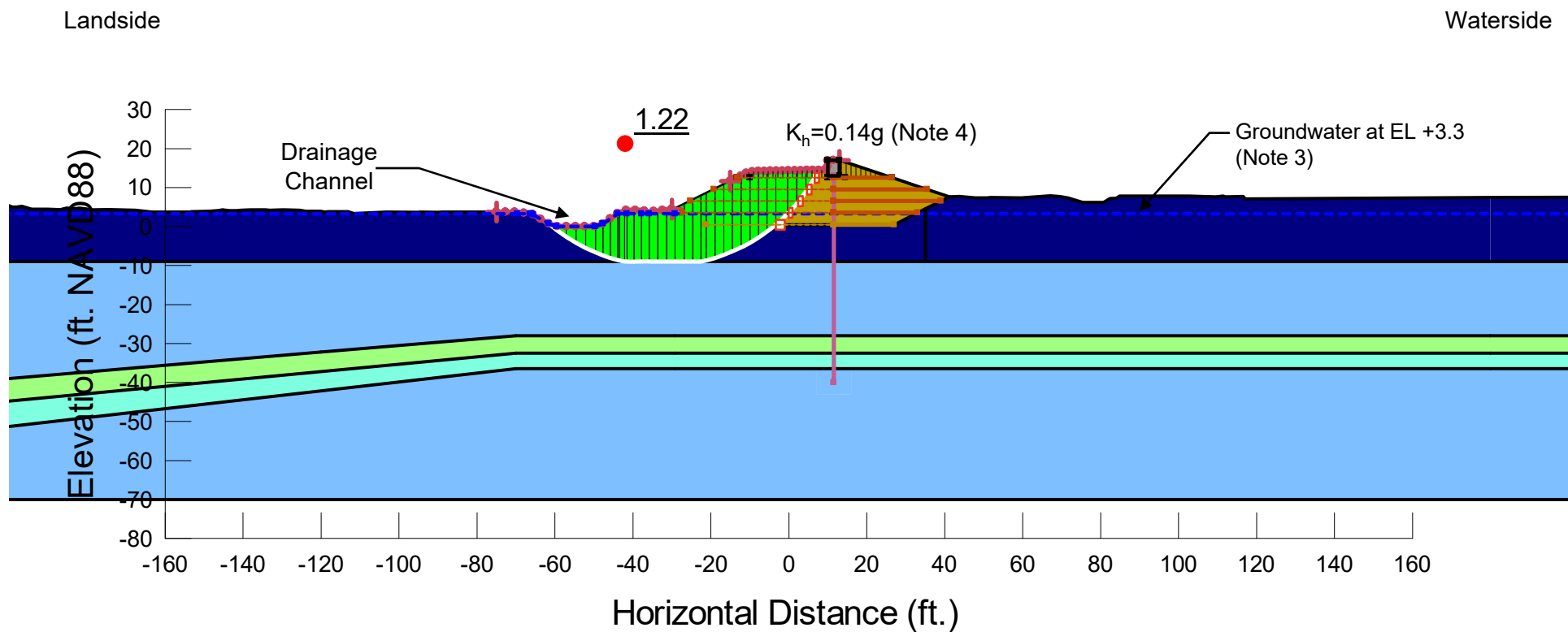


CROSS SECTION 1 (STATION 5+30)
CUTOFF WALL TO EL -40 FT, WITH GEOGRID
PSEUDO-STATIC SEISMIC STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
G.1



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. The pseudo-static seismic coefficient (k_h) is taken as half of the 100-year return period PGA.

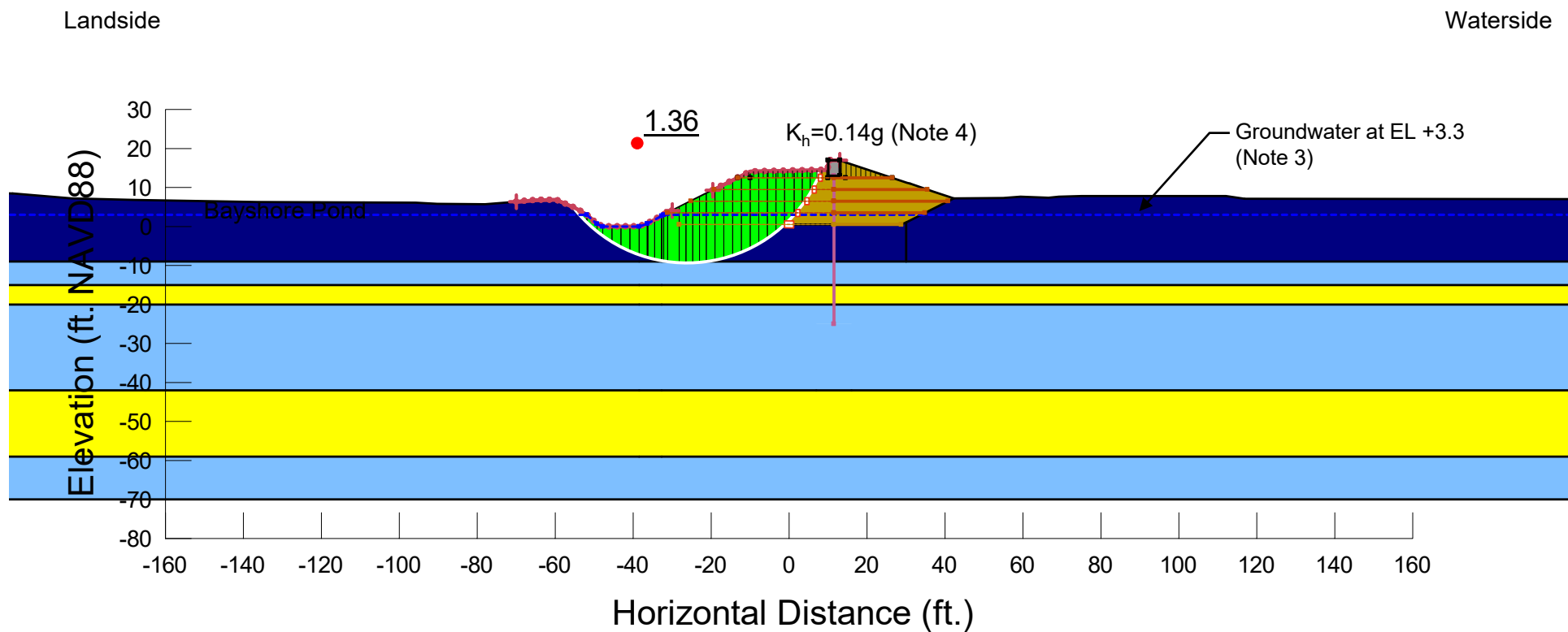


CROSS SECTION 2 (STATION 16+40)
CUTOFF WALL TO EL -40 FT, WITH GEOGRID
PSEUDO-STATIC SEISMIC STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
G.2



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. The pseudo-static seismic coefficient (k_h) is taken as half of the 100-year return period PGA.



CROSS SECTION 3 (STATION 26+00)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
PSEUDO-STATIC SEISMIC STABILITY

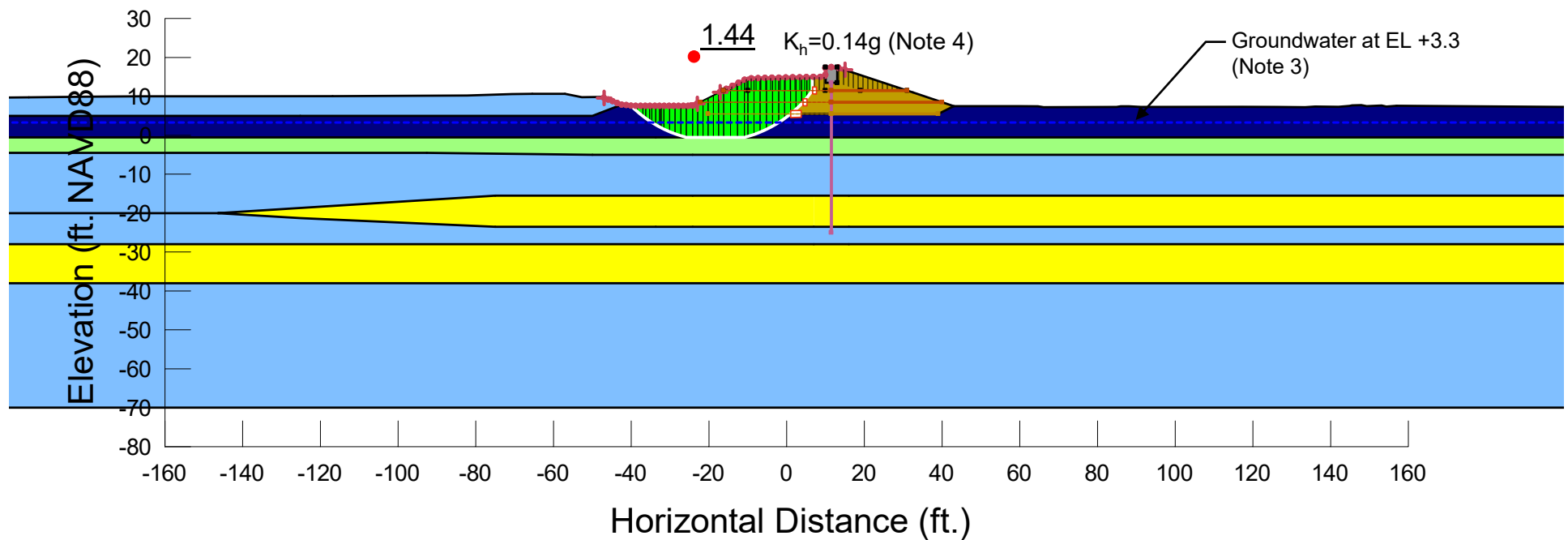
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
G.3

Landside

Waterside



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. The pseudo-static seismic coefficient (k_h) is taken as half of the 100-year return period PGA.



CROSS SECTION 4 (STATION 37+65)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
PSEUDO-STATIC SEISMIC STABILITY

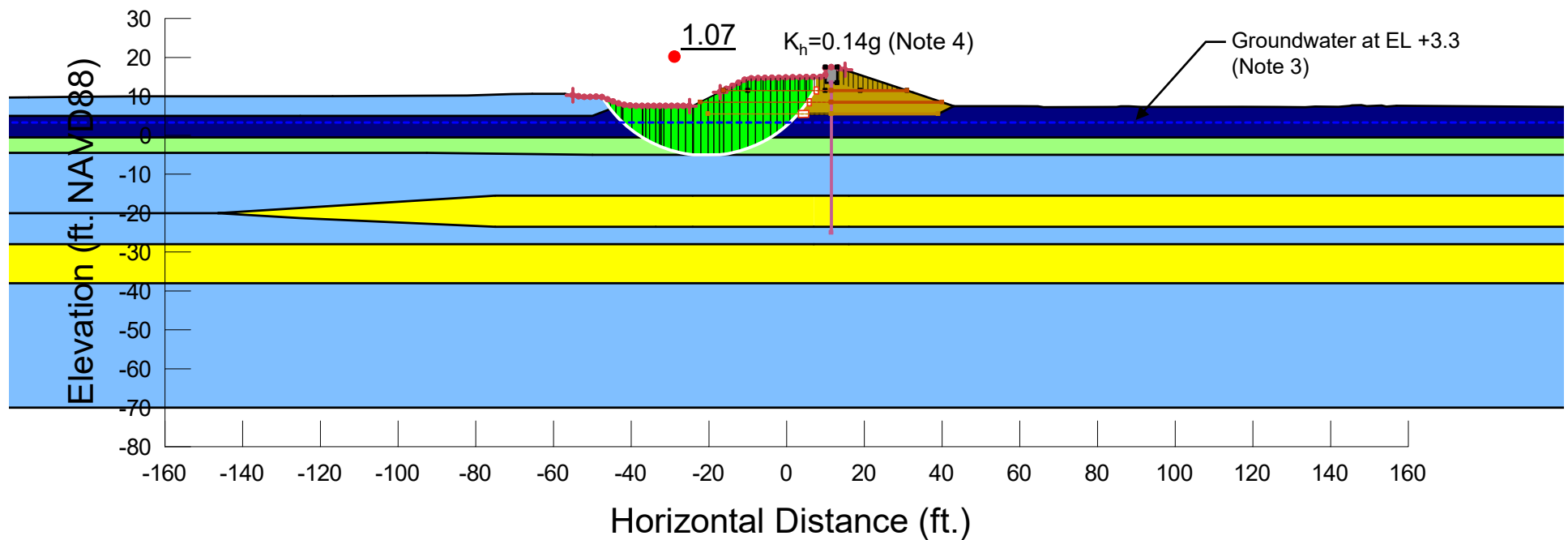
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
G.4

Landside

Waterside



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. The pseudo-static seismic coefficient (k_h) is taken as half of the 100-year return period PGA.

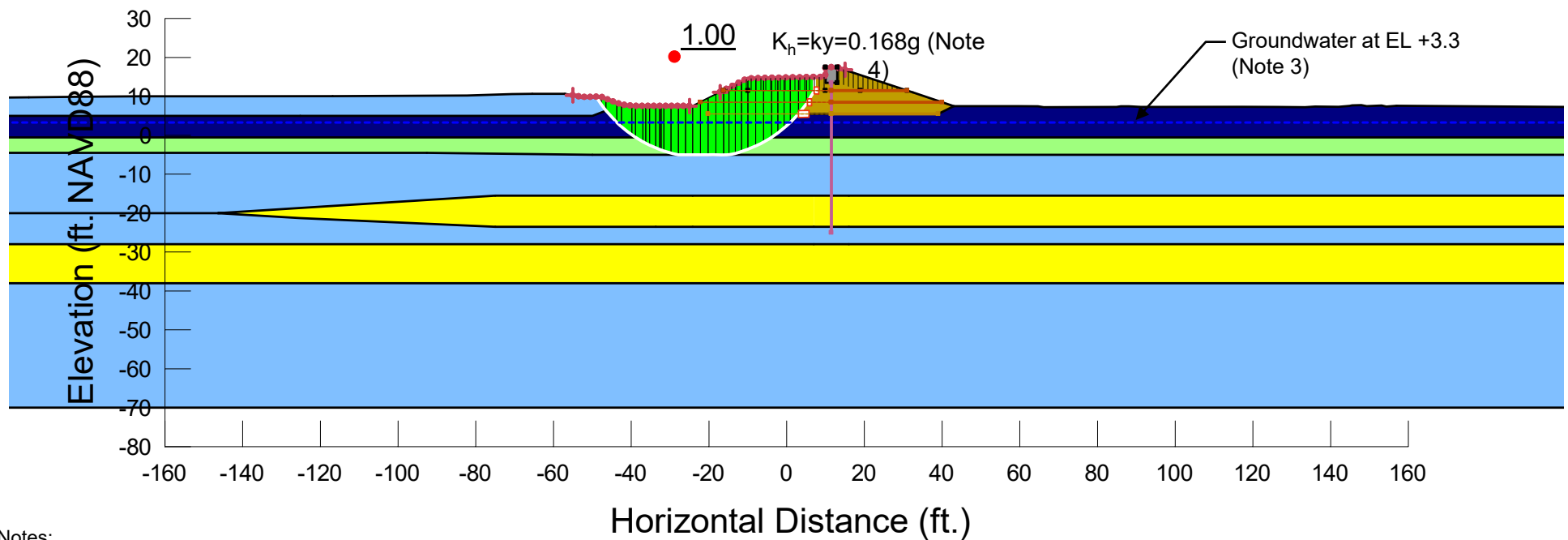


CROSS SECTION 4 (STATION 37+65)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
POST-LIQUEFACTION PSEUDO-STATIC SEISMIC STABILITY
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date	JUNE 2024
Figure	G.5

Landside

Waterside



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. Yield coefficient (k_y) is the pseudo-static seismic coefficient (K_h) that results in FOS equal to 1.



CROSS SECTION 4 (STATION 37+65)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
POST-LIQUEFACTION YIELD COEFFICIENT

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024
Figure
G.6

SEISMIC SLOPE STABILITY ANALYSIS

PROBABLISTIC SEISMIC DISPLACEMENT FOR K=0.168

Input Parameters

EQ Level	16% Prob. Of Exceedance	50% Prob. Of Exceedance	For a 100-year Return Period UHS and $k = k_y$, Probability of Exceeding Seismic Displacement
D_a (in)	2.9	1.4	Probabilistic Seismic Displacement for $k=0.168$ (inches)
D_a (cm)	7.4	3.5	Probabilistic Seismic Displacement for $k=0.168$ (cm)
V_s (ft/sec)	500	500	Shear wave velocity of slide mass
H (feet)	15.0	15.0	Average Height of slide mass
T_s (s)	0.12	0.12	Initial fundamental period of slide mass ($4H/V_s$)
$1.3T_s$ (s)	0.16	0.16	Degraded Period of Slide Mass
$S_a(1.3T_s)$ (g)	0.60	0.60	Spectral acceleration at $1.3T_s$ (5% damping) at the base of the slide mass.
M_w	6.96	6.96	Moment Magnitude
e	0.74	0	Normally distribution with zero mean and standard deviation of 0.74
P	16	50	Probability of exceedence level for Allowable Seismic Displacement (D_a)

e = -0.74 for D_a at the 84% probability of exceedence level; e = 0 for D_a at the median (i.e. 50% probability of exceedence) level; or e = +0.74 for D_a at the 16% probability of exceedence level.

Intermediate Parameters

EQ Level	16% Prob. Of Exceedance	50% Prob. Of Exceedance
x_1	0.490	0.490 constant
a	2.668	2.668 Eq. 12b
x_2	3.983	3.976 value in parenthesis in Eq. 12c
b	3.218	3.224 Eq. 12c
x_3	-1.785	-1.782 value in parenthesis in Eq. 12a

Yield Coefficient (k_y) is the Pseudo-static Seismic Coefficient (k) Resulting in Factor of Safety of 1.0

Seismic Coefficient, $k =$ Yield Coefficient, k_y			See "Note" Below
EQ Level	16% Prob. Of Exceedance	50% Prob. Of Exceedance	
k =	0.168	0.168	

Note: The yield coefficient (k_y) is the horizontal seismic coefficient (k) that results in a pseudostatic stability FOS of 1.0

Pseudostatic Stability FOS

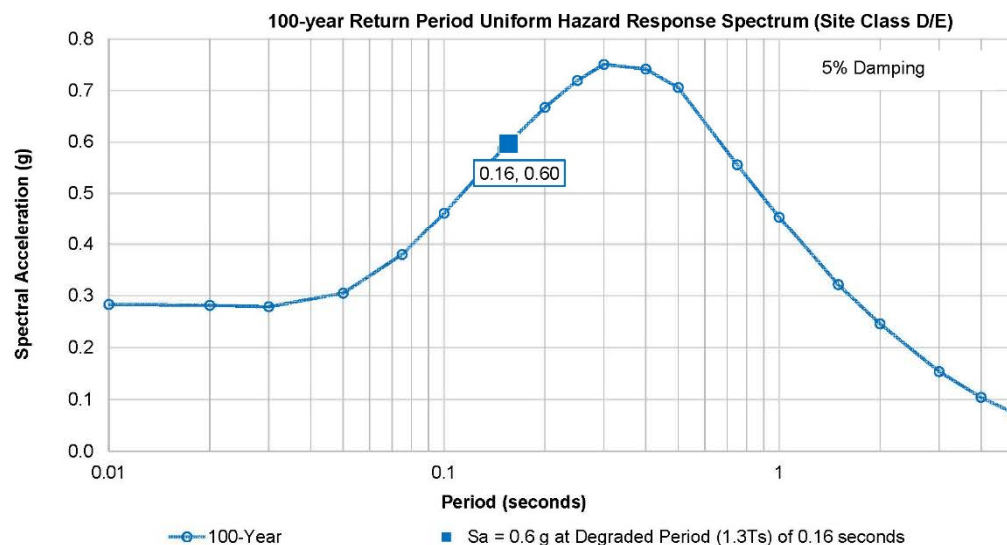
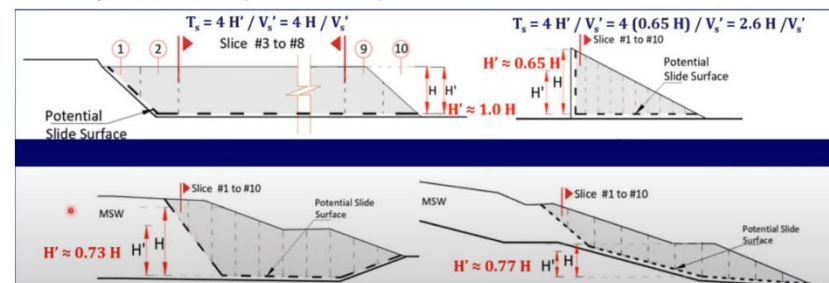
Seismic Coefficient, $k =$ Yield Coefficient, k_y	
EQ Level	FOS
Figure	1.00
	G.6

References:

- 1 Procedure for Estimating Shear-Induced Seismic Slope Displacement for Shallow Crustal Earthquakes," ASCE JGGE, 2019, 145(12), doi: 10.1061/(ASCE)GT.1943-5606.0002143
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Initial fundamental period of slide mass

From Bray & Macedo 2021 (Reference No. 3)



PROBABLISTIC SEISMIC DISPLACEMENT ANALYSIS FOR
CROSS SECTION 4 (STATION 37+65) WITH LIQUEFACTION
USING BRAY AND MACEDO (2019)

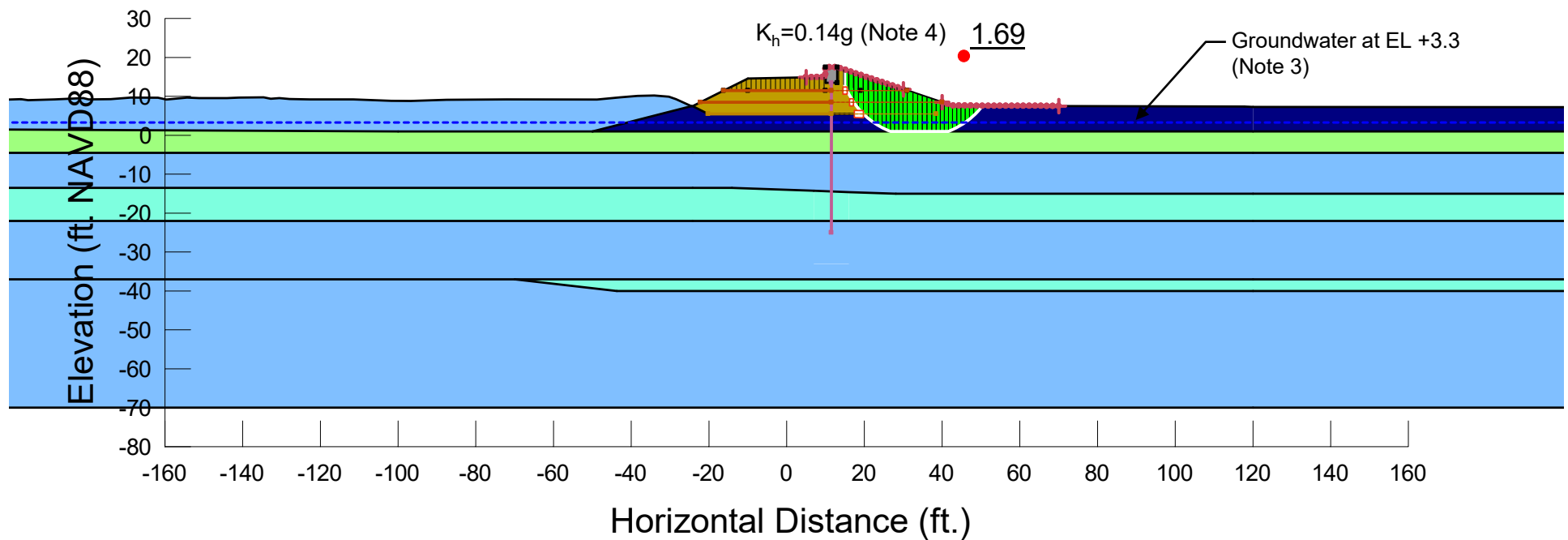
SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
G.7

Landside

Waterside



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. The pseudo-static seismic coefficient (k_h) is taken as half of the 100-year return period PGA.

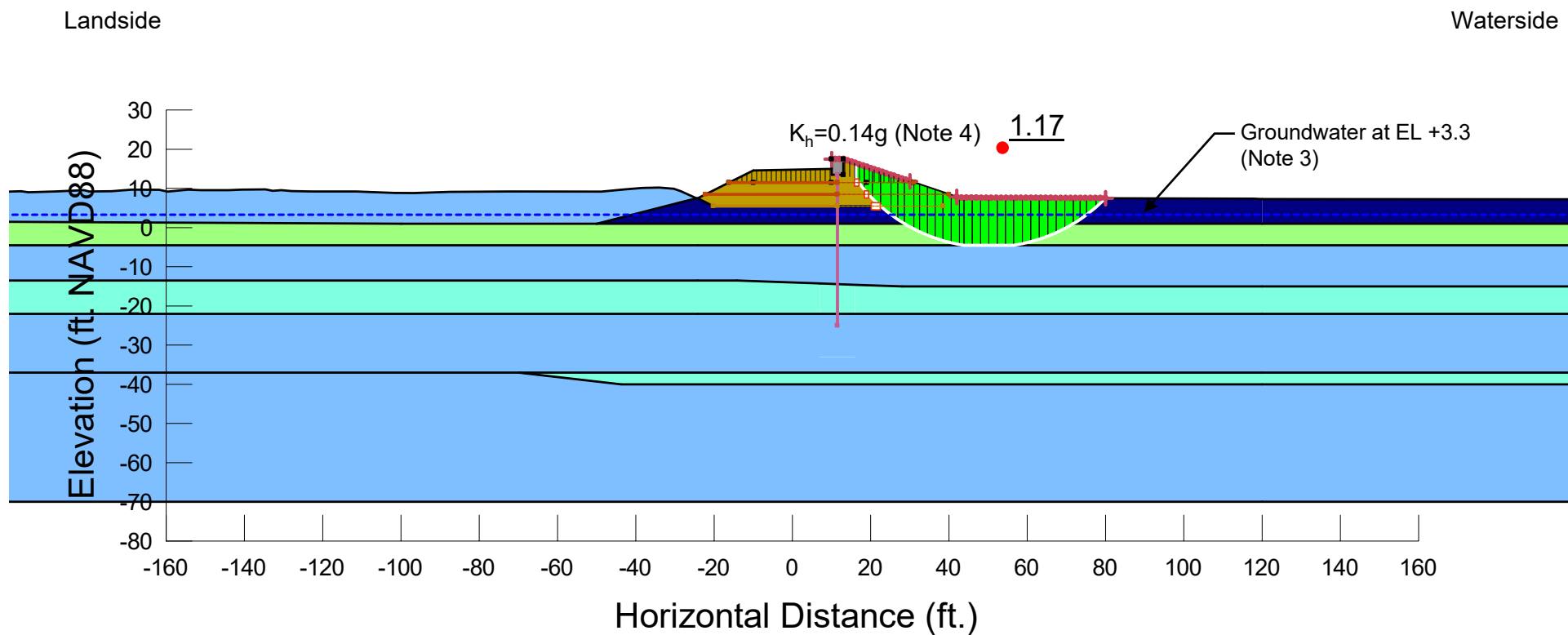


CROSS SECTION 5 (STATION 44+00)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
PSEUDO-STATIC SEISMIC STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
G.8



Notes:

1. The Factor of Safety (FOS) value shown is for the critical failure surface.
2. Seismic slope stability is shown only on the more critical side of the embankment.
3. The groundwater table for seismic stability analysis is set at Elevation +3.3 feet or the ground surface, whichever is lower. See report for discussion.
4. The pseudo-static seismic coefficient (k_h) is taken as half of the 100-year return period PGA.



CROSS SECTION 5 (STATION 44+00)
CUTOFF WALL TO EL -25 FT, WITH GEOGRID
POST-LIQUEFACTION PSEUDO-STATIC SEISMIC STABILITY

SAFER BAY – SOUTH OF BAY ROAD (30% DESIGN)
SAN MATEO COUNTY, CALIFORNIA

Date
JUNE 2024

Figure
G.9