APPENDIX A: GEOTECHNICAL REPORT & MEMORANDUMS

The geotechnical parameters shall be based on recommendations provided in the geotechnical reports and memorandums prepared by ENGEO including the following:

DRAFT



BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

GEOTECHNICAL REPORT

SUBMITTED TO
Mr. James Connolly
COWI
555 12th Street, Suite 1700
Oakland, CA 94601

PREPARED BY
ENGEO Incorporated

December 16, 2024
Latest Revision December 12, 2025

PROJECT NO.
25022.000.001

Copyright © 2025 by ENGEO Incorporated. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without the express written consent of ENGEO Incorporated.

ENGEO
Expect Excellence

Project No.
25022.000.001

December 16, 2024
Latest Revision December 12, 2025

Mr. James Connolly
COWI
555 12th Street, Suite 1700
Oakland, CA 94601

Subject: Berkeley Water Transportation Pier Ferry
Berkeley Marina
Berkeley, California

GEOTECHNICAL REPORT

Dear Mr. Connolly:

We prepared this geotechnical report for COWI as outlined in our agreement dated August 5, 2024. Our services comprised preparing a geotechnical report based on our review of previous geotechnical data, published geologic maps, historical aerial photographs, and conceptual plans for proposed development as well as a project-specific subsurface exploration and laboratory testing program.

From a geotechnical engineering viewpoint, the site is suitable for the proposed project, provided the geotechnical recommendations in this report are incorporated into the design and implemented during construction. The main geotechnical considerations for the planned project include the presence of non-engineered fill, soft compressible clay, liquefiable soil, seismically induced lateral spreading and slope instability, and shallow groundwater. We present our conclusions and recommendations related to the planned project in this report.

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to review the project plans and specifications and provide geotechnical testing and observation services during construction. If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated



Vlad Zasmolin, PE



Jeff Fippin, GE

vz/jaf/ca

TABLE OF CONTENTS

LETTER OF TRANSMITTAL

1.0 INTRODUCTION 1

1.1 PURPOSE AND SCOPE 1
1.2 PROJECT LOCATION 2
1.3 PROPOSED PROJECT 2
1.4 BERKELEY MARINA AND PIER HISTORY 3
1.5 PREVIOUS REPORTS 7

2.0 FINDINGS 7

2.1 GEOLOGY AND SEISMICITY 7

2.1.1 Regional Geologic Setting 7
2.1.2 Regional Seismic Setting 8
2.1.3 Local Geologic Conditions Geology 8

2.2 FIELD EXPLORATION 9

2.2.1 Pavement and Subgrade Exploration 10
2.2.2 Landside Cone Penetration Tests 10
2.2.3 Landside Borings 11
2.2.4 Offshore Exploration 12
2.2.5 Sonic Borings 13

2.3 LABORATORY TESTING 13
2.4 SURFACE CONDITIONS 14
2.5 SUBSURFACE CONDITIONS 14

2.5.1 Artificial Fill (Qaf) 14
2.5.2 Recent Bay Deposits/Young Bay Mud (Qybm) 15
2.5.3 San Antonio Formation (Qal 1) 16
2.5.4 Old Bay Clay (OBC) 16
2.5.5 Upper Alameda Formation (OBC 2 to 4 and Qal 2 to 4) 16

2.6 GROUNDWATER CONDITIONS 16

3.0 DISCUSSIONS AND CONCLUSIONS 17

3.1 NON-ENGINEERED FILL 18
3.2 SHALLOW GROUNDWATER 18
3.3 CONSOLIDATION SETTLEMENT OF YOUNG BAY MUD 18
3.4 SEISMIC INPUT FOR ANALYSES 19

3.4.1 Shear-Wave Velocity 19
3.4.2 Pier Structure Seismic Design Criteria 19
3.4.3 Pier Structure Site-Specific Seismic-Hazard Analysis 20
3.4.4 2022 CBC Seismic Design Parameters 21

3.5 SEISMIC HAZARDS 22

3.5.1 Ground Rupture 22
3.5.2 Ground Shaking 22
3.5.3 Soil Liquefaction 22

3.6 SHORELINE DEFORMATION ANALYSIS STABILITY 25

3.6.1 Geometry and Idealized Soil Profiles 25
3.6.2 Soil Strength Parameters 25

TABLE OF CONTENTS (Continued)

3.6.3 Method of Analysis 26
3.6.4 Results of Slope Deformation Analysis 28
3.7 SOIL CORROSION POTENTIAL 28
4.0 CONCEPTUAL SHORELINE STABILIZATION MITIGATIONS 29
4.1 DSM 29
4.2 RETAINING WALL 30
5.0 EARTHWORK RECOMMENDATIONS 30
5.1 GENERAL DEMOLITION AND SITE CLEARING 30
5.2 NON-ENGINEERED FILL 31
5.3 OVER-OPTIMUM SOIL MOISTURE CONDITIONS AND UTILITY EXCAVATION 31
5.4 ACCEPTABLE FILL 31
5.5 FILL COMPACTION 32
5.5.1 Grading in Structural Areas 32
5.5.2 Underground Utility Backfill 32
5.5.3 Landscape Fill 32
5.6 CUTOFF CURBS 32
5.7 SITE SURFACE DRAINAGE 33
5.8 STORMWATER BIORETENTION AREAS 33
5.9 CONSOLIDATION MITIGATION 33
5.9.1 Lightweight Cellular Concrete 34
5.9.2 Surcharging 34
6.0 FOUNDATION RECOMMENDATIONS 34
6.1 DRIVEN PILES SUPPORTING PIER 34
6.1.1 Vertical Capacity 36
6.1.2 Lateral Capacity 36
6.2 FOUNDATION FOR MINOR STRUCTURES 37
6.2.1 Structurally Reinforced Mat Foundation 37
6.2.2 Spread Footings 37
6.2.3 Shallow Foundation Settlements 38
6.2.4 Shallow Foundation Lateral Resistance 38
6.2.5 Slab Moisture Vapor Protection 38
6.2.6 Drilled Piers 39
7.0 RETAINING WALLS 39
7.1 ABOVE-GRADE RETAINING WALLS 39
7.1.1 Retaining Wall Drainage 40
7.1.2 Backfill 40
7.2 PIER ABUTMENT AND MECHANICALLY STABILIZED EARTH WALL 41
8.0 CONSTRUCTION MONITORING 41
9.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS 41
SELECTED REFERENCES
FIGURES

TABLE OF CONTENTS (Continued)

APPENDIX A – Cone Penetration Test Logs

APPENDIX B – Cone Penetration Liquefaction Calculation

APPENDIX C – Boring Logs

APPENDIX D – Laboratory Test Results

APPENDIX E – Corrosion Laboratory Testing (CERCO Analytical)

APPENDIX F – Discussion of Site-Specific Seismic Hazard Analysis

APPENDIX G.1 – Slope Stability Analyses – Existing Slope

APPENDIX G.2 – Slope Stability Analyses – Deep Soil Mixing

APPENDIX G.3 – Slope Stability Analyses – Retaining Wall

APPENDIX H – p-y springs

APPENDIX I – t-z and q-w springs

APPENDIX J – Pier Plaza Settlement Mitigation

APPENDIX K – Pier Abutment Lateral Earth Pressure Recommendations

APPENDIX L – Precast Panel Mechanically Stabilized Earth Seawall Submittal

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

We prepared this geotechnical report for the Berkeley Water Transportation Pier Ferry project at the Berkeley Marina in Berkeley, California. Our scope of services is outlined in our agreement dated August 5, 2024, and includes the following.

- Review of published maps, previous reports, and historical information
- Review of aerial images
- Exploration of subsurface conditions
- Laboratory testing of soil samples
- Analysis of data
- Development of conclusions
- Preparation of this report

For our use, we received numerous as-built construction drawings and engineering reports. For the purposes of our report, we used the following select documents.

Construction Drawings

- The Golden Gate Ferry Company. 1926. General Pile Plan, Ferry Terminal, Berkeley, California. August 24, 1926. Sheet 1.
- City of Berkeley Department of Public Works. 1632. Yacht Harbor. Berkeley, California. August 4, 1936. Plan No. 1632.
- City of Berkeley Department of Public Works. 1952. University Avenue Extension to Berkeley Harbor, Berkeley, California. September 12, 1952. Plan 302-A-88.
- City of Berkeley Department of Public Works. 1965. Grading Plan for South Sailing Basin. Berkeley, California. March 1, 1965. Plan 4084.

Consultant Reports

- Earl and Wright Consulting Engineers. 1960. Berkeley Pier, Berkeley, California. June 6, 1960.
- A3GEO. 2013. South Cove Public Dock and Parking Lot Renovation Project Berkeley Marina, Berkeley, California. February 12, 2013. Project No. 1118-1A.
- IDA Structural Engineers. 2015. Berkeley Pier Load Evaluation, Berkeley, California. June 25, 2015. Project No. 13113.07.
- GHD. 2023. Feasibility Study Ferry Facility at Berkeley Municipal Pier, Berkeley, California. June 2022; Revised June 30, 2023. Project No. 11125268.

We prepared this report for the exclusive use of COWI and their consultants for the design of this project. If any changes are made in the character, design, or layout of the development, we must be contacted to review the conclusions and recommendations contained in this report to evaluate whether modifications are recommended. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.2 PROJECT LOCATION

The existing Berkeley Municipal Pier (Pier) is located at the Berkeley Marina (Marina) on the western edge of University Avenue as shown in Figure 1. The Marina is an irregularly shaped peninsula that consists of manmade fill situated on the eastern end of the San Francisco Bay. The proposed project includes reconstruction of 1,080 feet of the Pier extending west of the intersection of Seawall Drive and University Avenue. The associated Marina landside improvements will be constructed in the area between University Avenue, Seawall Drive, the Bay Trail, and former HS Lordships Parking Lot.

1.3 PROPOSED PROJECT

The Response to Qualifications (RFQ) document prepared by the City of Berkeley, dated December 15, 2023, outlines that the project will include demolishing and replacing 1,080 linear feet (lf) of the existing Municipal Berkeley Pier with a new “sword” shaped Pier and breakwater as shown in Exhibit 1.3-1.

EXHIBIT 1.3-1: Renderings of Proposed New Pier and Associated Marina Developments

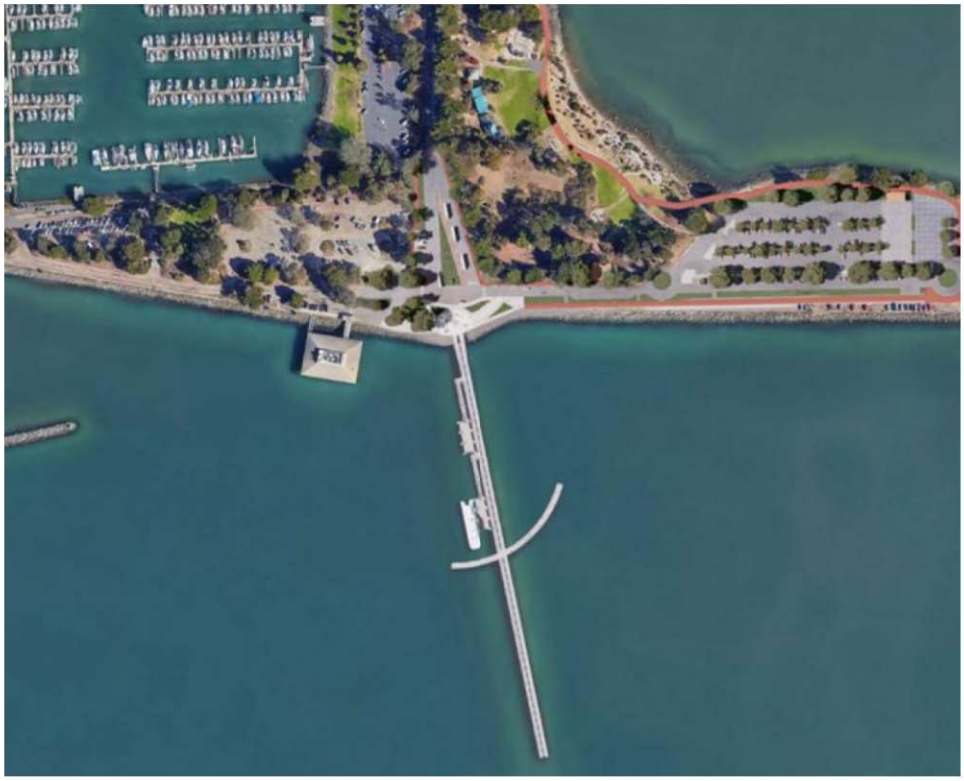


Exhibit 1.3-1 shows the planned offshore elements, which will include:

- A 580 lf ferry boarding pier segment extending westward from Seawall Drive. Two connecting gangways and berthing floats will be added on the northern end of the Pier to facilitate ferry access. The Pier and berthing floats will be supported by 24-inch plumb octagonal precast, prestressed concrete piles and 36-inch steel pipe piles, respectively.

- A 400 lf breakwater perpendicular to the pier providing wave and wind protection for the ferry boarding region. The breakwater will be constructed using 4-foot by 2-inch or 4-foot by 14-inch precast, prestressed concrete sheet piles laterally supported by 24-inch battered octagonal prestressed precast piles.
- A 500 lf recreational pier segment extending westward past the breakwater for recreational public access. This portion of the pier will be supported by 24-inch plumb octagonal precast, prestressed concrete piles.

The newly built pier will classify as an essential faciality and require ongoing access during and following seismic events and other disasters.

In addition, the project includes the redevelopment of landside lots adjacent to the Pier within the South Cove Sailing Basin. The associated improvements will include:

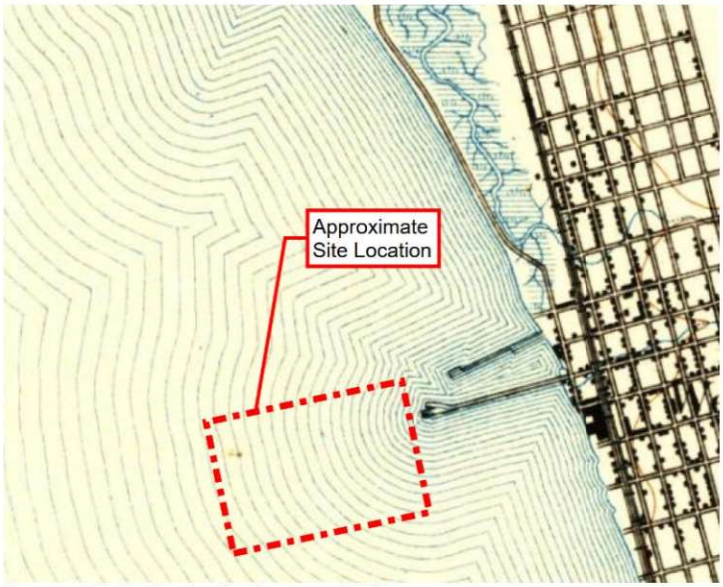
- Street, parking lot, and sidewalk renovations on Seawall Drive, University Avenue, HS Lordships Parking Lot, and Bay Trail.
- Grading of the pier entrance plaza area.
- Minor structures (restroom, light poles, canopies etc.).
- Renovation of sidewalks and pedestrian pathways.
- New underground utilities.

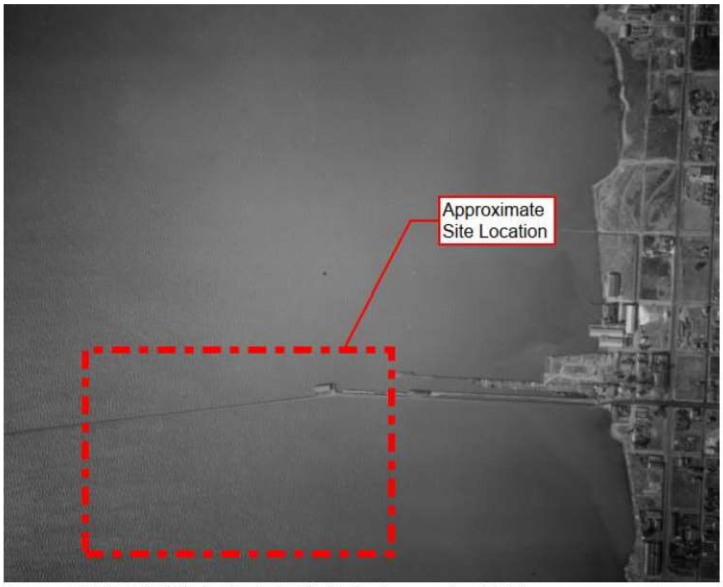
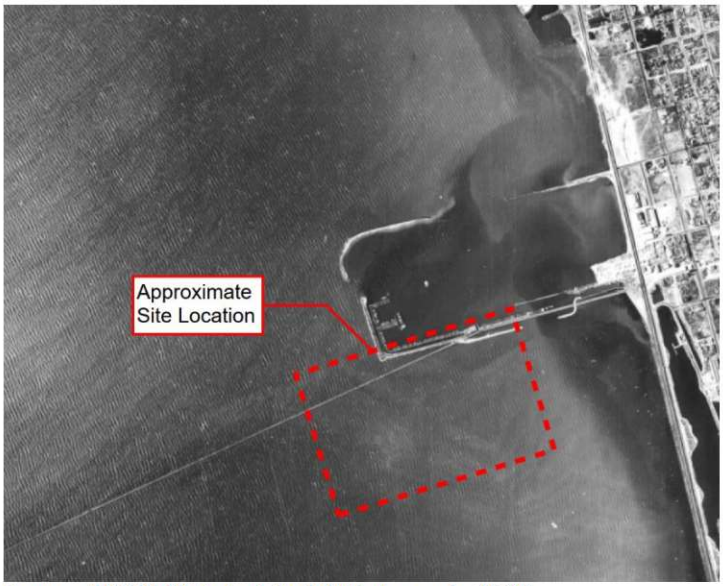
The elevation datum for this project is the City of Berkeley Mean Lower Low Water tidal datum (City of Berkeley, MLLW). The figures and data presented in this report reference elevations based on this datum. The City of Berkeley MLLW datum is equal to NAVD88 plus 0.07 foot. At this time, we understand the proposed finished grade at the pier entrance plaza will be Elevation 16½ feet. To achieve the proposed grade at this location, the site will need to be raised approximately 5½ feet. Grading at the rest of the site will be on the order of 1 to 2 feet.

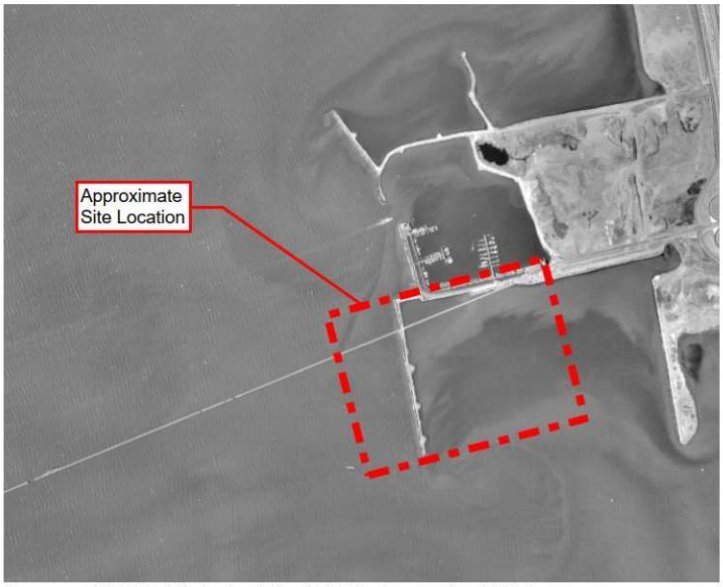
1.4 BERKELEY MARINA AND PIER HISTORY

The area encompassing the Berkeley Marina was historically part of the San Francisco Bay beyond the natural shoreline of Berkeley prior to development. The predevelopment shoreline in 1895 was located adjacent to the current day Interstate 80 (I-80). Table 1.4-1 presents a brief overview and timeline of development-related activities at the Berkeley Marina Site.

TABLE 1.4-1: Site History

 Source: U.S. Geologic Survey, 1895	1850s to early 1900s – The site was approximately 4,500 feet offshore the Berkeley shoreline and completely submerged. Adjacent to the site there were two wharves owned by The Standard Soap Company and Jacobs and Heywood Lumber yard extending 2,700 feet west of University Avenue and 2,000 feet west of Delaware Street, respectively. We presume both were used for bulk cargo shipping.
 Source: U.S. Geologic Survey, 1915	Early 1900s to 1926 – In 1915, it appears the Standard Soap Company pier was replaced with a municipal pier built by the City of Berkeley to serve as a commuter ferry and freight pier. The pier extended approximately 5,000 feet west of University Avenue.

 Source: USCB Historical Aerial Photograph, 1931	1926 to 1936 – In 1926, the Golden Gate Ferry Company constructed the existing Berkeley Pier by extending the municipal wharf. The Pier functioned as an automobile ferry service to San Francisco. It spanned 18,500 feet westward from the foot of University Avenue to the Northern end of Treasure Island; extending to water deep enough to accommodate a deeper ferry draft than the prior pier.
 Source: USCB Historical Aerial Photograph, 1939	1936 to 1957 – Ten years following the construction of the Berkeley Pier, the Bay Bridge was built, rendering ferry services from Berkeley to San Francisco obsolete. As such, in 1937, the ferry was shut down and the Pier was acquired by the City of Berkeley to operate as a recreational Pier. Furthermore, in 1936, the Berkeley Yacht Harbor was developed, including the construction of several small docking piers and three rock dikes acting as breakwaters.

 Source: USCB Historical Aerial Photograph, 1957	1957 to 1966 – In 1957, land reclamation began with the construction of perimeter dikes bordering current day McLaughlin Eastshore Park and Cesar Chavez Park. The areas became a landfill with soil and municipal waste being placed within the perimeter dikes. In addition, a rock breakwater was placed along the western perimeter of the current South Cove Sailing Basin shoreline. Around this time, the Pier appeared to show signs of significant deterioration with observable gaps in the decking (Earl and Wright, 1960).
 Source: Historical Aerial Photograph Viewer, 1968	1960s to 1970s – In 1966, the South Cove Sailing Basin area was filled using a combination of hydraulically placed dredge spoils from the surrounding San Francsico Bay and non-engineered general fill (City of Berkeley, 1967). The area was predominantly used for recreational purposes.



Source: Google Earth, 2002

1970s to Present – Following land reclamation, development in the area included commercial and office structures, restaurants, parks, and small piers. Additionally, in approximately 1991, the landfill located at McLaughlin Eastshore Park and Cezar Chavez Park was closed and capped with a clay liner. The Pier remained operational until 2015 when it was closed indefinitely following a structural assessment by IDA (2015).

1.5 PREVIOUS REPORTS

We reviewed past geotechnical reports that we and other geotechnical consultants prepared for projects in the Berkeley Marina and surrounding proximity. These reports include:

- ENGEO. 2018. Geotechnical Recommendations for Courtyard Redesign of DoubleTree Hotel. July 20, 2018. Project No. 15201.000.000.
- ENGEO. 2018. Brickyard Phase I Improvements. Geotechnical Exploration. Berkeley, California. June 11, 2018. Project No. 15007.000.000.
- ENGEO. 2016. Cezar Chavez Park. Berkeley, California. October 6, 2016. Project No. 12860.000.000.
- A3GEO. 2013. South Cove Public Dock and Parking Lot Renovation Project. Berkeley, California. February 12, 2013. Project No. 1118-1A.
- ENGEO. 2011. Lawrence Berkeley National Laboratory Second Campus; Golden Gate Field Site. Albany, California. July 28, 2011. Project No. 9289.000.000.

2.0 FINDINGS

2.1 GEOLOGY AND SEISMICITY

2.1.1 Regional Geologic Setting

The Site is located on the eastern margin of the San Francisco Bay, in the Coast Ranges geomorphic province of California. The Coast Ranges comprise a system of northwest-trending, fault-bounded mountain ranges, and intervening valleys that trend approximately parallel to the right-lateral transform boundary between the North American and Pacific Plates. The present geology of the Coast Ranges is the result of deformation and deposition along this tectonic boundary. Plate boundary fault movements are largely concentrated along the well-known fault

zones, which in the San Francisco Bay Area include the San Andreas, Hayward, and Calaveras Faults, as well as other lesser-order faults.

2.1.2 Regional Seismic Setting

The site is located in a seismically active area that contains numerous faults. Small earthquakes occur every year in the San Francisco Bay Area and larger earthquakes have been recorded and can be expected to occur in the future. Active faults are cataloged and mapped by the United Sates Geologic Survey (USGS) in the Quaternary Fault and Fold Database of the United States. An active fault is defined by the California Geologic Survey as one that experienced surface displacement within Holocene time (about the last, 11,700 years) (CGS, 2018). Figure 3 shows the approximate locations of known active faults, along with other Quaternary faults based on the USGS Quaternary Fault and Fold Database, as well as significant historical earthquakes recorded within the San Francisco Bay Area region.

To identify nearby faults that are capable of generating strong seismic ground shaking at the Site, we utilized the USGS Earthquake Hazard Toolbox and the 2018 National Seismic Hazard Model (NSHM) to perform a disaggregation of the seismic hazard at the peak ground acceleration (PGA) and at spectral periods up to 5 seconds for a return period of 2,475 years. The resulting faults are listed in Table 2.1.2-1.

TABLE 2.1.2-1: Faults Considered Capable of Producing Strong Ground Shaking at the Site*

SOURCE NAME	RUPTURE DISTANCE, R_{RUP} (mi)	MOMENT MAGNITUDE, M_W
Hayward (North) (2)	3.9	7.4
San Andreas (Peninsula) (13)	15.5	8.0
Hayward (North) (3)	4	7.1
Hayward (North) (1)	4.5	6.8
San Gregorio (North) (3)	17.6	7.8

*Based on USGS Earthquake Hazard Toolbox: NSHM Conterminous U.S. 2018

These results represent known fault sources contributing at least 1 percent to the seismic hazard at the site based on the disaggregation discussed above. The rupture distances (R_{RUP}) and mean moment magnitudes (M_W) 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 NSHM. Note that the above fault table is not an exhaustive list and other faults in the region may generate seismic shaking at the project site.

2.1.3 Local Geologic Conditions Geology

Quaternary geology along the Bay margins is typically defined by periods of deposition and erosion correlated to worldwide glaciations, and their associated changes in sea level. Glacial episodes are associated with a fall in sea level, due to more of the Earth's water being stored in glaciers and ice caps. During the last glaciation between approximately 70,000 and 12,000 years ago, the sea level was as much as 300 feet below modern levels (Atwater, et al. 1977). Depositional environments during low stands of sea level are governed by eolian deposits along the shoreline, erosional processes, and high-energy stream channel deposits.

By contrast, interglacial periods are defined by higher sea levels and reduced ice cap cover. Soil deposited during these episodes typically consists of estuarine and low-energy shallow marine sediments allowed to settle to the sea floor.

During the Late Quaternary period, the San Francisco Bay experienced several episodes of sea level rise and fall related to these glaciations. According to Atwater, et al. (1977), samples recovered from foundation explorations at the Bay Bridge encountered marine estuary deposits that formed during the Sangamon interglacial period (100,000 years ago) and post-Wisconsin interglacial period (less than 10,000 years ago), during stands of higher sea level. These deposits are typical of Bay margin stratigraphy and are commonly referred to as Old Bay Clay (OBC) and Young Bay Mud (YBM), respectively.

The cyclical fluctuations in sea level have resulted in interbedded alluvial and marine soil deposits, each with distinctive colors. Alluvial deposits exhibit a yellowish-brown color because of their exposure to oxygen during terrestrial deposition, whereas marine deposits appear gray and olive because they did not oxidize while inundated. These alternating layers continue past the uppermost Old Bay Clay to form the Upper Alameda Formation.

As shown in Figure 4, mapping by Graymer (2000) indicates the site is capped by artificial fill placed east of the Berkeley shoreline. The fill is a combination of imported soil and dredge spoils from the San Francsico Bay that was placed between perimeter rock dikes. Our experience indicates that the quality and consistency of fill placed in this era can vary considerably. Some fill is quite dense, while other, especially older fill, was not compacted during placement is typically relatively loose.

Based on cross sections along the San Francisco Bay presented by Roger and Figures (1992) and our interpretation of the geologic units, the general stratigraphy of the site is summarized in Table 2.1.3-1 and discussed in detail in Section 2.5.

TABLE 2.1.3-1: Stratigraphic Units at the Berkeley Pier

UNIT NAME	SYMBOL	GEOLOGIC TIME PERIOD	DESCRIPTION
Artificial Fill	Qaf	Recent	Heterogeneous sandy and clayey fill mixed with debris
Young Bay Mud	Qybm	Holocene (Interglacial)	Soft to medium stiff marine silt and clay interbedded with marine sand
San Antonio Formation	Qal 1	Pleistocene (Wisconsin Glacial)	Stiff clay interbedded with layers of medium dense to dense sand.
Old Bay Clay	OBC	Pleistocene (Sangamon Interglacial)	Overconsolidated, stiff to very stiff marine clay with few sandy interbeds
Alameda Formation	Qal 2-4	Late Pleistocene (Glacial)	Very stiff to hard alluvial clay varying in sand content.
	Qobc 2-4	Late Pleistocene (Interglacial)	Overconsolidated, stiff to very stiff marine clay.

2.2 FIELD EXPLORATION

Prior to conducting our field exploration, we notified Underground Service Alert and retained the services of a private utility locator to clear the exploratory locations of existing utilities. Additionally, we obtained drilling and engineering permits from the City of Berkeley. The approximate exploration locations can be found in Figure 2.

2.2.1 Pavement and Subgrade Exploration

Prior to drilling, we retained the services of Penhall and West Coast Exploration to core through the existing pavement at select boring and cone penetration test (CPT) locations along University Avenue, Seawall Drive, Bay Trail, and the former HS Lordships parking lot. Coring was complete using an 8-inch-diameter, diamond-bit core drill. We identified pavement thickness, aggregate base thickness, and depth to any pavement fabric encountered. We delivered the pavement core samples to NCE's Point Richmond storage unit. Photographs of the asphalt cores are shown in Figure 5A through 5C.

We drilled Borings 1-C1 through 1-C8 after coring using a solid flight auger to a depth of 3½ to 6 feet below the ground surface (bgs) and collected bulk samples for lab testing. A summary of our in-situ measurements and laboratory testing is provided in Table 2.2.1-1. The logs of the borings are included in Appendix C.

TABLE 2.2.1-1- Summary from Pavement Exploration

LOCATION	THICKNESS OF ASPHALT CONCRETE (AC) (inches)	THICKNESS OF AGGREGATE BASE (AB) (inches)	DEPTH TO PAVEMENT FABRIC* (inches)	SUBGRADE LABORATORY TESTING		
				MOISTURE CONTENT (%)	PLASTICITY INDEX	R-VALUE
1-C1	12	12	4¼	12.2	25	10
1-C2	9¼	12	2½	-	-	-
1-C3	4¼	12	2	14.3	20	9
1-C4	2	8	None	10.9	17	-
1-C5	3	6½	None	-	-	-
1-C6	2½	9	None	-	18	17
1-C7/1-B4	10½	6	None	-	-	-
1-C8	4½	3	None	14.3	17	12
1-C9	4¼	-	2½	-	-	-
1-CPT1/1-B2	4¼	5	None	-	-	-
1-CPT2	4¼	6	2¼	17.2	22	-
1-CPT3	5	7	2¾	-	-	-
1-CPT4	2	9	None	-	-	-
1-B2	4¼	5	None	-	-	-
1-B3	5	7	2¼	-	24	9
1-B5	3½	7	None	-	-	-

* below ground surface

2.2.2 Landside Cone Penetration Tests

Between August 27, 2024, and August 29, 2024, we retained the services of ConeTec to perform CPTs to a maximum depth of 134 feet bgs (Elevation -125 feet), in general accordance with ASTM D5778. Measurements include the tip resistance to penetration of the cone (Qc), the resistance of the surface sleeve (Fs), and pore pressure (U) (Robertson and Campanella, 1988). We encountered shallow refusal at 5 to 8 feet bgs in 1-CPT1, 1-CPT2, and 1-CPT3 due to the presence of debris and coarse gravel. We used a solid flight auger to drill out the impeding material and subsequently resumed the CPT. We performed shear-wave velocity measurements

in one of the CPTs in accordance with ASTM D7400. CPT logs are presented in Appendix A. Photographs of the operation can be seen in Exhibits 2.2.2-1a and 2.2.2-1b.

EXHIBIT 2.2.2-1a: CPT Drilling Operations at 1-CPT2



EXHIBIT 2.2.2-1b: CPT Drilling Operations at 1-CPT4



2.2.3 Landside Borings

Between August 28, 2024, and September 5, 2024, we retained the services of Pitcher Services LLC to advance borings up to a depth of 106½ feet bgs (Elevation -89 feet) using mud-rotary wash methods with a 3⅞-inch tricone drill bit. A representative of our firm observed the drilling and logged the subsurface conditions. At locations 1-B2 and 1-B5 we encountered difficult drilling conditions due to the presence of very dense coarse-grained gravel and cobbles that we presume are associated with a perimeter rock dike placed between 1952 to 1957. Photographs of the operations can be seen in Exhibits 2.2.3-1a and 2.2.3-1b.

We collected soil samples at frequent depth intervals using either a 3-inch outside-diameter (O.D.) California-type split-spoon sampler fitted with 6-inch-long brass liners, or a 2-inch O.D. standard penetration test (SPT) split-spoon sampler. We advanced the samplers with a 140-pound hammer with a 30-inch drop, employing an automatic-trip hammer system. We recorded the penetration of the sampler as the number of blows needed to drive the sampler 18 inches in 6-inch increments. The boring log shows the number of blows required for the last foot of penetration, or the number of blows per depth of penetration for samples that met driving refusal. We did not convert the blow counts depicted on the boring log using any correction factors. In areas of soft fine-grained soil, we advanced thin-walled Shelby tubes, at select locations. The logs of the borings are included in Appendix C.

EXHIBIT 2.2.3-1a: Mud Rotary Drilling Operations at Location 1-B1



EXHIBIT 2.2.3-1b: Mud Rotary Drilling Operations at Location 1-B2



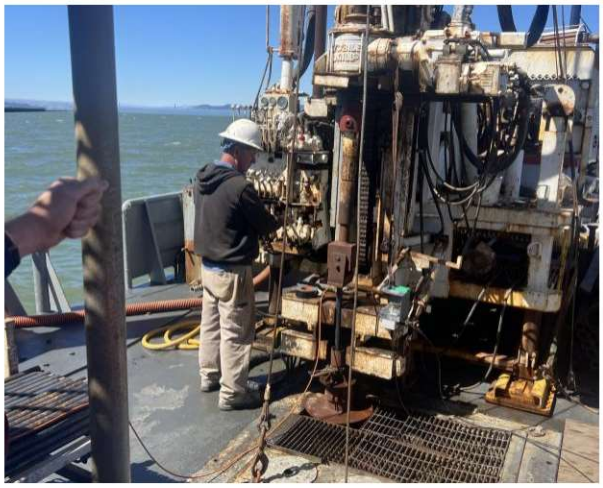
2.2.4 Offshore Exploration

Between September 4, 2024, and September 18, 2024, we retained the services of Gregg Drilling LLC to advance six mud-rotary borings and three CPTs up to a depth of 151½ feet below the mudline (Elevation -157½ feet) from the Quin Delta Research Vessel (Quin Delta). The drilling and sampling methodologies resemble those presented in Section 2.2.2 and 2.2.3. For CPTs, the Quin Delta has a decreased pushing capacity in contrast to a landside rig due to (1) longer unsupported rod length and (2) frictional losses of pushing capacity to the sides of casing. As such, we encountered CPT refusal in medium dense and dense sand, prompting us to switch to rotary wash drilling and sampling in these units. Upon encountering clay, we resumed the CPTs. The locations and elevations of the explorations are approximate and we estimated them by use of differential GPS onboard the Quin Delta and show them in Figure 2. The logs of the borings and CPTs are included in Appendices A and C, respectively.

EXHIBIT 2.2.4-1a: Quin Delta Research Vessel Stationed adjacent to the Berkeley Municipal Pier



EXHIBIT 2.2.4-1b: Drilling Operations on the Quin Delta Research Vessel



2.2.5 Sonic Borings

We mobilized a sonic drill rig on February 7, 2025, to evaluate the extents (vertical and lateral) of the perimeter rock dike. We drilled up to about 30 feet bgs (Elevation -20 feet) using a 6½-inch-diameter sonic core barrel. A representative of our firm observed the drilling and logged the subsurface conditions. Sonic drilling employs a high-frequency oscillator that generates resonant vibrations along the drill string while it cuts through the subgrade soil. The substantial energy transferred to the drill bit enables penetration through very dense soil. We retrieved bulk samples every 5 vertical feet during drilling, allowing for continuous characterization of the subsurface conditions. Exhibits 2.2.5-1 and 2.2.5-2 show photographs of our drilling operations. The logs of the borings are included in Appendix C.

EXHIBIT 2.2.5-1a: Sonic Drilling Operations at Location 2-B4



EXHIBIT 2.2.5-1b: Sonic Drilling Operations at Location 2-B7



2.3 LABORATORY TESTING

We performed laboratory testing on samples recovered during borehole drilling in accordance with Table 2.3-1 to determine various soil characteristics.

TABLE 2.3-1: Laboratory Testing

TEST	DESIGNATION	NUMBER OF TESTS PERFORMED
Natural Unit Weight and Moisture Content	ASTM D7263	18
Natural Moisture Content	ASTM D2216	21
Atterberg Limits	ASTM D4318	19
Grain Size Distribution	ASTM D6913	5
Passing No.200 Sieve	ASTM D1140	14
Consolidation – Constant Rate of Strain	ASTM D4186	3
Unconsolidated Undrained Triaxial Compression Test	ASTM D2850	48
Unconfined Undrained Triaxial Compression Test	ASTM D2166	3
Lab miniature Vane Shear	ASTM D4648	2
Corrosivity Testing (Redox, pH, Resistivity, Chloride, Sulfate, Sulfide)	ASTM D1498, D4972, G57, D4658M, D4327	2
R -value Testing	ASTM D2844	5

2.4 SURFACE CONDITIONS

The landside portion of the site is predominantly occupied by paved roads, parking lots, sidewalks, walking trails, and landscaped areas. Small one-story structures associated with Shorebird Park, Cal Sailing Club, Skates on The Bay Restaurant, and former HS Lordships Restaurant are located throughout the site boundary. Paved roads appear to be in poor condition along Seawall Drive and the former HS Lordships restaurant parking lot relative to those on University Avenue. In addition, the HS Lordships parking is bisected by a fence that appears to have previously bounded a construction staging area located on the southern portion of the parking lot until recently.

Based on our review of the landside topographic survey provided by NCE, the ground surface within the majority of the site boundary range between Elevation 12 feet and Elevation 19 feet with a generally gradual slope. However, there are outstanding topographic features on the site. The Pier entrance plaza is at a topographic low at Elevation 11½ feet that slopes up to Elevation 15 feet at approximately 7.5:1 (horizontal:vertical) inland. In addition, shorebird park contains manmade hills sloped at a 4:1 wedged between Seawall Drive and University Avenue with topographic highs up to Elevation 30 feet.

The existing Pier begins immediately to the west of the intersection of University Avenue and Seawall Drive. The Pier extends 3,000 feet to the west of the shoreline before the wooden decking terminates and only pile remnants remain. Based on our review of the Bathymetric and LiDAR survey completed by eTrac, the shoreline slopes at approximately 2:1 to 3:1 to the mudline at Elevation -6 feet. The mudline elevation remains relatively constant along the pier throughout the site extents.

2.5 SUBSURFACE CONDITIONS

Our exploration locations are presented in the Site Plan, Figure 2, and the specific stratigraphy for each CPT and boring is depicted on the exploration logs in Appendix A and Appendix C. The logs contain the soil type, color, consistency, and visual classification in general accordance with the Unified Soil Classification System. The logs graphically depict the subsurface conditions encountered at the time of the exploration. We present idealized subsurface cross-sections in Figure 6. The cross-sections are based on interpolation between surface explorations and are provided for reference only. Local variation should be expected.

2.5.1 Artificial Fill (Qaf)

We encountered up to 23 feet of artificial fill. Our research indicates this fill was placed on the South Cove Sailing Basin land during reclamation between 1966 to 1968. City of Berkeley (1965) indicates that the fill was placed directly on native marine sediment underlying the site. There is no documentation of engineering compaction and due the type of fill placement and era, it is unlikely the soil was compacted. In general, the fill we encountered consists of 4 to 10 feet of soft to stiff lean clay over loose to dense clean and clayey sand and gravel with varying amounts of debris.

2.5.1.1 Perimeter Rock Dike

During the geotechnical investigation that we performed between August 27, 2024, and September 18, 2024, we encountered dense to very dense sand and gravel material on the western shoreline of the Marina in exploration locations 1-B2, 1-CPT1, and 1-B5 at approximately 6 feet bgs. As shown in historical aerial photographs presented in Section 1.4, this material

appears to be associated with a rock breakwater placed on the western perimeter of the South Cove Sailing Basin between 1952 and 1957. Based on our historical aerial photograph review, review of construction plans, and exploration, we opine that this breakwater was used as a rock dike behind which fill was placed when land reclamation occurred. At Boring 1-B1, we encountered YBM immediately below the rock. At Boring 1-B5, the rock appears to be intermixed with fill and YBM at 16 feet bgs.

On February 7, 2025, we performed a supplemental geotechnical investigation that included seven sonic borings. We drilled the borings in an approximately parallel line from the pier entrance to the end of Seawall Drive to identify the extent of the rock dike at the proposed Pier Plaza. We encountered the rock dike in 2-B1 through 2-B4 beginning at approximately Elevation 5 feet and extending down to Elevation -9½ feet. The dike comprises light to dark gray well-graded gravel with sand, clayey gravel with sand, clayey sand with gravel, and silty sand with cobble up to 4½ inches in diameter. The clay we encountered with the gravel appears to be recent Bay deposits that accreted on top of the backside of the rock dike when it was in use as a breakwater. Immediately below the gravel, we encountered YBM in every exploration.

In 2-B5 and 2-B6, we encountered a dark gray silty gravel with sand at a similar depth as the top of the rock dike. However, in comparison to the dike, the fill contained finer gravel, fewer cobbles, seams of soft clay, and was easier to drill through. These borings were performed at least 10 feet beyond where aerial photographs indicate the backside of the rock dike was located. This layer was likely used to bridge YBM and accredited Bay sediment behind the dike to support fill placement. In 2-B7, the fill became more clay-like and similar in consistency to soil encountered at 1-B3.

2.5.2 Recent Bay Deposits/Young Bay Mud (Qybm)

Recent marine deposits along the bay margins often consist of soft fat clay deposited in a low-energy, estuarine environment during the current interglacial period, beginning approximately 8,000 years ago. This material is often referred to as Young Bay Mud (YBM). Locally, YBM can also contain thin, sandy interbeds. We encountered the top of YBM between Elevation 0 feet to Elevation -9½ feet throughout the site; however, its characteristics varied significantly landside and offshore.

We encountered two layers of offshore YBM. The upper layer consisted of a very soft gray fine-grained material with an abundant amount of shells directly below the mudline. Laboratory testing and CPT data indicate that this soil has undrained shear strengths of less than 100 pounds per square foot (psf). This unit is primarily recent sediments and for the purposes of this report, we refer to it as Recent Bay Deposits. Below the Recent Bay Deposits, we encountered soft to medium stiff YBM intermixed with sand.

The YBM we encountered in the landside explorations consisted of gray and black (with hues of blue and green) normally consolidated soft to medium-stiff lean and fat clay with abundant shells and minor organics. The YBM ranged in thickness between 4 to 16 feet, with the thinnest layer encountered below the rock dike and thicker deposits in the eastern and southern portions of the site. Triaxial strength and mini laboratory vane shear testing from samples of this YBM indicate shear strengths ranging from 300 to 750 psf. CPT tests corroborate the shear strength values, with undrained shear strength ranging from 500 to 800 psf, based on a cone factor (N_{kt}) of 14 (a conservative estimate). Additionally, we measured natural water contents in the unit varying between 27.6 to 86.7 percent; suggesting the presence of a fluctuating sand and shell content. The stiffer YBM on the landside is attributable to the overburden fill placed on the marine deposits

60 years ago. In addition, the landside YBM has experienced all primary consolidation resulting from land reclamation due to the time since fill placement.

2.5.3 San Antonio Formation (Qal 1)

The San Antonio Formation consists of estuarine and alluvial sediments lying between the OBC and YBM layers. The material was deposited in a complex ever-changing depositional environment ranging from alluvial fans to flood plains ranging old broad channels infilled with stiff sandy clay underlain by sandy channel fill.

The San Antonio Formation we encountered in our explorations consisted of yellowish brown, reddish brown, and reddish orange stiff clay with discontinuous lenses of medium dense to dense silt sand and clayey sand. Triaxial strength and mini laboratory vane shear testing of stiff clay samples collected in Modified California and Shelby Tube samplers indicate shear strengths ranging from 1,450 to 2,250 psf.

2.5.4 Old Bay Clay (OBC)

The San Antonio Formation is underlain by another interglacial marine deposit, colloquially named Old Bay Clay (OBC), and labelled as such in this report. This unit was deposited during the Sangamon interglacial period approximately 125,000 to 75,000 years ago. In general, OBC is typically described as moderately over-consolidated stiff clay with a characteristic greenish-blue hue, moderate plasticity and minor sand. Laboratory testing of one relatively undisturbed sample of OBC indicated an overconsolidation ratio (OCR) of approximately 1.5. Triaxial strength testing from samples collected in Modified California and Shelby Tube samplers indicate shear strengths ranging from 730 to 4,000 psf.

The OBC encountered in our borings consisted of gray, greenish gray and olive lean and fat clay with varying amounts of sand. In addition, there were lenses of gravel and sand interbedded in the OBC.

2.5.5 Upper Alameda Formation (OBC 2 to 4 and Qal 2 to 4)

Below the Sangamon Old Bay Clay lies the late Pleistocene Alameda Formation that was deposited 1,000,000 to 500,000 years ago. This formation has spanned a number of interglacial periods of sea level rise, as well as the intervening glacial ages. As such, much of the unit is highly interbedded marine bay mud and terrestrial alluvium deposits corresponding to the cyclic glaciation. These deposits share similar attributes to the younger OBC and San Antonio formation units encountered at shallower depth; however, they typically increase in shear strength due their age and depth.

2.6 GROUNDWATER CONDITIONS

We encountered groundwater in all of the sonic borings and one of our shallow borings during drilling. In addition, we performed pore pressure dissipation testing in our CPTs to approximate the groundwater levels. Table 2.6-1 summarizes our groundwater observations and interpretation of the pore pressure dissipation test. The groundwater encountered in 1-C7 was significantly shallower than other measured groundwater levels, indicating there may have been water perched on less permeable clay below.

TABLE 2.6-1: Groundwater Observations

SOURCE	APPROXIMATE DEPTH TO GROUNDWATER (feet)	ELEVATION (City of Berkeley MLLW)
1-C7	5	9
1-CPT2	13.4	5½
1-CPT3	11.4	3½
1-CPT4	11.1	5½
2-B1	7	4
2-B2	8	3
2-B3	8	3
2-B4	7	4
2-B5	13	3
2-B6	12	4
2-B7	13	3

The mean tide fluctuates between approximately Elevation 6.27 feet to 0 foot each day according to modelling completed by AECOM and documented in the San Francisco Bay Tidal Datums and Extreme Tides Study (2016). Due to the proximity of the site to the Bay, the groundwater level is likely heavily influenced by the tidal level. It is reasonable to assume, for construction planning, that the groundwater could be as shallow as Elevation 6.5 and fluctuating throughout the day.

The Ocean Protection Council (2024) presented sea level rise projections of 2.2 feet as an intermediate-high evaluation for the 2070-time horizon. Consequently, the mean sea level could be at approximately Elevation 5 feet owing to sea level rise within this timeframe. For the purposes of long-term design, including seismic evaluation, a groundwater table corresponding to the projected mean sea level is an appropriate assumption; while the groundwater could be shallower than this depth, due to fluctuating water table, the soil above the mean sea level is unlikely to be saturated which is a requirement of soil to be liquefiable.

Fluctuations in the level of groundwater may occur due to variations in rainfall, irrigation practice, tidal influence, and other factors not evident at the time measurements were made. Perched groundwater may also result in locally shallower groundwater conditions.

3.0 DISCUSSIONS AND CONCLUSIONS

From a geotechnical viewpoint, the site is suitable for the proposed project, provided the geotechnical recommendations in this report are properly incorporated into the design plans and specifications. The geotechnical considerations for the Site are as follows.

- Non-engineered fill
- High seismic shaking and liquefiable soil
- Shoreline stability
- Soft compressible soil
- Shallow groundwater table

We discuss the above considerations, and the risks associated with these and other hazards with respect to the planned project in the following sections of this report.

3.1 NON-ENGINEERED FILL

As discussed in Section 2.5.1, we encountered up to 23 feet of artificial fill in the Marina. Common construction methods used during land reclamation activities in 1960s and prior did not employ engineering compaction during fill placement. Furthermore, our exploration encountered abundant debris within the fill. Therefore, the artificial fill at the site should be considered a non-engineered fill. The non-engineered fill is highly variable in soil type; the loose to medium dense clean sand and gravel that we encountered may exhibit a high potential for deformation during a seismic event. Our assessment of the liquefaction of saturated fill and the resulting potential post liquefaction reconsolidation settlement is discussed further in Section 3.5.3.

Additionally, the presence of non-engineered fill may lead to inconsistent bearing support and excessive foundation settlement of structures. We provide recommendations for fill improvement underneath building footprints in Section 5.2.

3.2 SHALLOW GROUNDWATER

Based on groundwater levels previously discussed in Section 2.6, we anticipate that the groundwater is likely tidally influenced. We also encountered shallow perched groundwater in 1-C7 at an elevation several feet above high tide. Shallow groundwater should be anticipated for excavations for underground construction that extend below about Elevation 6.5 feet and areas of shallower water perched on clay in the fill should also be anticipated. Regional dewatering operations should be avoided due to the presence of compressible soil below most of the site. Where necessary, dewatering should be limited to pumping from sumps within the trench, if possible. We recommend that the contractor constructing the subsurface utilities plan to perform some localized potholing prior to construction to assess if the groundwater will affect their improvements. Moreover, we provide recommendations in Section 5.3 to mitigate excessively wet ground at the base of excavations, if encountered.

3.3 CONSOLIDATION SETTLEMENT OF YOUNG BAY MUD

We encountered soft to medium stiff highly compressible YBM deposits below the artificial fill at the site. The thickness of the YBM that we encountered varied between 4 to 16 feet throughout the project improvement area. These deposits are normally consolidated or lightly over consolidated and will experience consolidation and creep settlement when subjected to new loading. Our study of historical aerials photographs indicates that the reclamation of the site was conducted more than 50 years ago. Primary consolidation settlement due to reclamation has completed, though long-term creep (secondary consolidation) of the site may be ongoing. Future loading from placement of fill or structural loads from buildings and site improvements will trigger additional long-term settlement. The amount of settlement depends on the proposed loads, thickness of the YBM, and the previous load experienced by the deposit. Based on our conversations with you, generally grades will be raised between 1 to 5½ feet within the site.

To estimate potential consolidation settlement under planned fill loads we performed consolidation analysis using the Settle 3D software program. Settle 3D is a three-dimensional analytical program that is primarily used for consolidation settlement analysis. We selected material properties, including unit weights, stress history, compression indices, coefficient of consolidation, etc., based on laboratory tests data, field measurements and our considerable experience with YBM in the San Francsico Bay Area. We provide an estimate of long-term consolidation in Table 3.3-1

TABLE 3.3-1: Summary of Consolidation Analyses

CIVIL FILL (feet)	SETTLEMENT (inches)
1 to 2	< 2
3 to 5½	2½ to 5

If mitigation measures are not implemented, we anticipate that approximately 75 percent of the settlement will occur within 3 months of fill placement and consolidation could continue for up to 5 years, slowing with time. The YBM will also experience creep; this settlement will occur for decades and will be approximately 1 inch over a 50-year time period. We provide mitigation recommendations for long-term settlement in settlement sensitive areas in Section 5.9.

3.4 SEISMIC INPUT FOR ANALYSES

3.4.1 Shear-Wave Velocity

As described in Section 2.2.1, we measured the shear-wave velocity (V_S) to a depth of 100 feet bgs during performance of 1-CPT1. We additionally considered the CPT-Vs correlation by Robertson (2009) to estimate the V_S of offshore bay deposits and a portion of the deeper Alameda Formation. Based on measured and correlated Vs Profiles, we classified the site as Site Class D in accordance with Chapter 20 of ASCE 7-16. While there are minor differences in the landside and offshore stratigraphy, it has a nominal impact on the time-averaged shear-wave velocity over the top 100 feet or 30 meters (V_{S30}).

3.4.2 Pier Structure Seismic Design Criteria

We developed seismic-design response spectra for the pier structure in accordance with the guidelines presented in the 2014 ASCE/COPRI 61 Standard: Seismic Design of Piers and Wharves (ASCE 61-14) with following amendments.

1. Based on our discussions with you, we understand the Ferry Pier will be designed as an "Essential" facility and the breakwater as a "Moderate" facility; ASCE 61-14 does not consider performance criteria for an Essential facility, so COWI developed performance criteria for this classification based on prior project experience. ASCE 61-14 incorporates, by reference, the seismic site classification and site-specific ground motion procedures described in the 2005 ASCE/SEI 7 Standard (ASCE 7-05).

2. In our evaluation, we found that the Contingency Level Earthquake (CLE) response spectra generally exceeded the Design Earthquake (DE) response spectrum in our period range of interests, creating incoherence in the seismic performance requirements presented in the code. Based on discussions on this topic, the team we opted to use a site-specific MCE response spectrum to assess the Design Earthquake performance levels.

The seismic hazard and performance levels that we considered are listed in Table 3.4.2-1.

TABLE 3.4.2-1: Seismic Hazard and Performance Levels

PERFORMANCE LEVEL	SEISMIC HAZARD LEVEL FOR "ESSENTIAL"	SEISMIC HAZARD LEVEL FOR "MODERATE"
Operating Level Earthquake (OLE)	50 percent in 50 years (72-year return period)	N/A
Contingency Level Earthquake (CLE)	10 percent in 50 years (475-year return period)	20 percent in 50 years (225-year return period)
Design Earthquake (DE)	Site Specific MCE Earthquake per ASCE 7*	Site Specific MCE Earthquake per ASCE 7*

*Amended from ASCE 61-14

It should be noted that the Design Earthquake (DE) is defined as two-thirds of the Maximum Considered Earthquake (MCE) which is defined in ASCE 7.

3.4.3 Pier Structure Site-Specific Seismic-Hazard Analysis

We performed a site-specific seismic-hazard analysis in accordance with ASCE 61-14 and ASCE 7-05 to develop response spectra for the seismic hazard and performance levels discussed in Section 3.4.2. The procedure for performing this analysis is discussed in Appendix F. We present the site-specific OLE, CLE, DE, and MCE response spectra in Table 3.4.3-1.

TABLE 3.4.3-1: Site-Specific OLE, CLE DE, and MCE Response Spectra

PERIOD (seconds)	PSEUDO-SPECTRAL ACCELERATION (g)				
	OLE (72-year)	CLE (225-year)	CLE (475-year)	DE (ASCE7-05)	MCE (ASCE 7-05)
0.01	0.25	0.41	0.54	0.57	0.85
0.02	0.24	0.41	0.53	0.57	0.85
0.03	0.25	0.41	0.53	0.56	0.85
0.05	0.27	0.45	0.58	0.62	0.93
0.08	0.34	0.55	0.72	0.77	1.16
0.10	0.41	0.66	0.85	0.91	1.36
0.12	0.46	0.73	0.93	0.98	1.47
0.15	0.52	0.82	1.05	1.00	1.50
0.20	0.58	0.93	1.18	1.00	1.50
0.25	0.62	1.00	1.28	1.00	1.50
0.30	0.63	1.05	1.35	1.00	1.50
0.40	0.60	1.04	1.38	1.00	1.50
0.50	0.57	1.01	1.35	1.00	1.50
0.60	0.51	0.93	1.25	1.00	1.50
0.75	0.43	0.81	1.13	0.80	1.20
1.00	0.35	0.70	1.00	0.60	0.90
1.50	0.24	0.51	0.75	0.42	0.63
2.00	0.18	0.40	0.60	0.32	0.47
3.00	0.11	0.26	0.40	0.20	0.30
4.00	0.07	0.18	0.29	0.15	0.23
5.00	0.05	0.13	0.21	0.12	0.18
7.50	0.03	0.07	0.11	0.08	0.12
8.00	0.02	0.06	0.10	0.08	0.11
10.00	0.02	0.04	0.06	0.06	0.09

We estimated the site-specific MCE peak ground acceleration (PGA) to be 0.85 g. The PGA is a median component (RotD50) value and probabilistically controlled.

3.4.4 2022 CBC Seismic Design Parameters

For landside improvements and structures, the 2022 CBC seismic parameters should be used for design. The 2022 CBC utilizes seismic design criteria established in the ASCE/SEI Standard "Minimum Design Loads and Associated Criteria for Buildings and Other Structures," (ASCE 7-16). The 2022 CBC requires that a classification of Site Class F be assigned to any site that is considered liquefiable. However, based on our experience with structures of this size, we anticipate the structural period will be less than 0.5 second, which allows classification as Site Class D per the exception in Section 20.3.1 of ASCE 7-16.

ASCE 7-16 requires a site-specific seismic-hazard analysis for Site Class D sites with a mapped S_1 value greater than or equal to 0.2; however, Section 11.4.8 of ASCE 7-16 and Supplement No. 3 provide an exception to this requirement. A site-specific seismic-hazard analysis is not required when the value of the parameter S_{M1} determined by Equation 11.4-2 and shown in Table 3.4.4-1 is increased by 50 percent for developing the mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) spectral response, calculating S_{D1}, and evaluating C_s in accordance with Chapter 12 of ASCE 7-16.

In Table 3.4.4-1 below, we provide the CBC seismic parameters based on the United States Geological Survey's (USGS') Seismic Design Maps for your use. When using this table, considerations should be given to exceptions in Section 11.4.8 of ASCE 7-16, as described previously.

TABLE 3.4.4-1: 2022 CBC Seismic Design Parameters Latitude: 37.8629 Longitude: -122.3176

PARAMETER	VALUE
Site Class	D
Mapped MCE_R Spectral Response Acceleration at Short Periods, S_S (g)	1.72
Mapped MCE_R Spectral Response Acceleration at 1-second Period, S_1 (g)	0.65
Site Coefficient, F_a	1
Site Coefficient, F_v	1.7*
MCE_R Spectral Response Acceleration at Short Periods, S_{MS} (g)	1.72
MCE_R Spectral Response Acceleration at 1-second Period, S_{M1} (g)	1.11*
Design Spectral Response Acceleration at Short Periods, S_{DS} (g)	1.15
Design Spectral Response Acceleration at 1-second Period, S_{D1} (g)	0.74*

*The parameters above should only be used for calculation of T_s, determination of Seismic Design Category, and, when taking the exceptions under Items 1 and 2 of ASCE 7-16 Section 11.4.8. (Supplement Number 3 https://ascelibrary.org/doi/epdf/10.1061/9780784414248.sup3).

We recommend that we collaborate with your design team to further evaluate the effects of implementing the exception in the structural design and identify if there is a need for performing a site-specific seismic-hazard analysis. We can prepare a proposal for a site-specific seismic-hazard analysis, if requested.

3.5 SEISMIC HAZARDS

3.5.1 Ground Rupture

The site is not located within a State of California Earthquake Fault Hazard Zone and no known faults cross it; therefore, ground rupture is unlikely.

3.5.2 Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay Area could cause considerable ground shaking at the Site, similar to that which has occurred in the past. To mitigate the shaking effects, structures should be designed using sound engineering judgment and the guidelines provided in ASCE 61-14, as a minimum. Seismic design provisions of current codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead and live loads. The code-prescribed lateral forces are generally considered to be substantially smaller than the comparable forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage, but with some non-structural damage, and (3) resist major earthquakes without collapse but with some structural, as well as non-structural damage. Conformance to the code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

3.5.3 Soil Liquefaction

As shown in Figure 7, the site is mapped in a State of California Seismic Hazard Zone (CGS, 2006) for areas that may be susceptible to liquefaction. Soil considered most susceptible to liquefaction is clean, loose, saturated, uniformly graded fine sand below the groundwater table. Empirical evidence indicates that loose silty sand is also potentially liquefiable. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess pore-water pressures to develop. If excess pore-water pressures exceed the effective confining stress from the overlying soil, the sand is said to have liquefied, and if the liquefied sand consolidates or vents to the surface, ground settlement and surface deformation may occur.

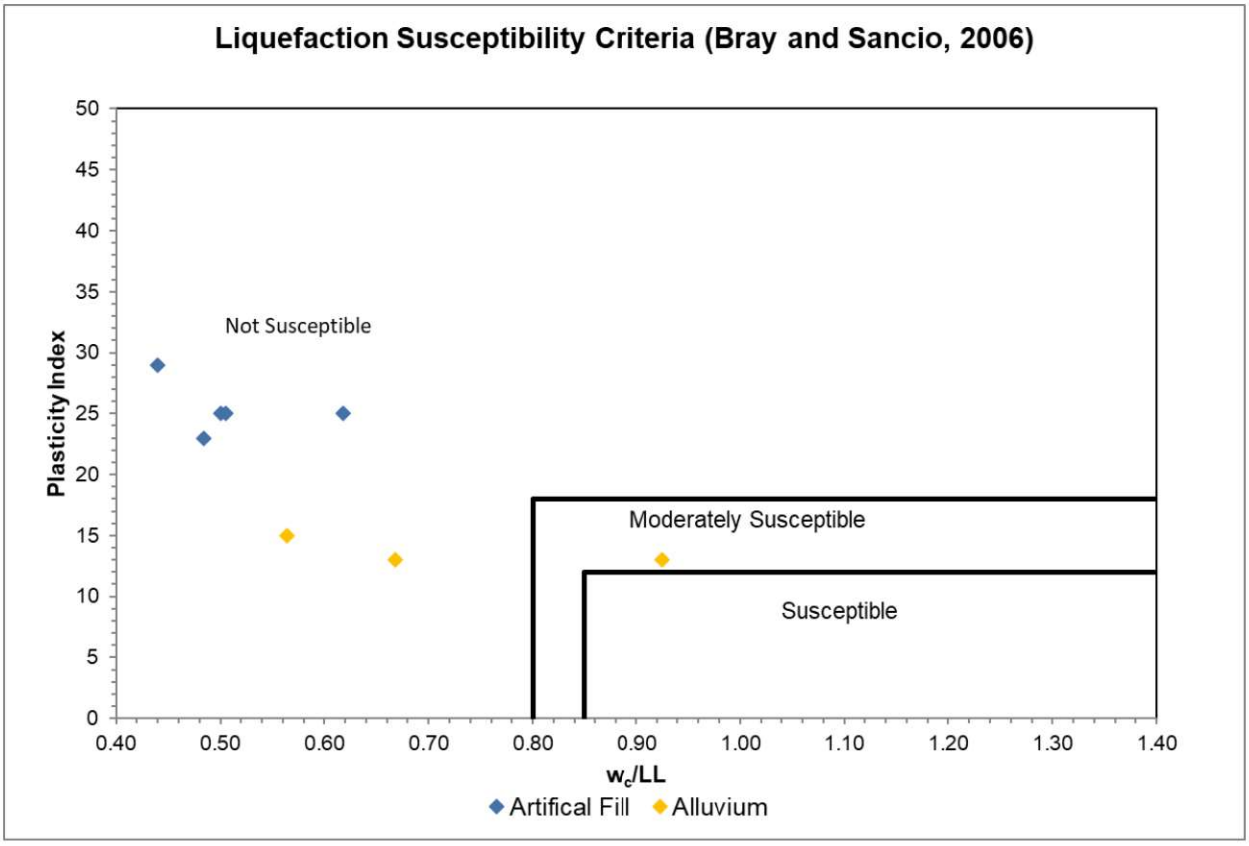
3.5.3.1 Liquefaction Susceptibility Screening of Soil Samples.

To identify an appropriate soil behavior type index (I_c) cutoff for the subsequent liquefaction analysis in Section 3.5.3.2, we sampled potential transitional soil (soil that appears to be on the border between clay-like and sand-like) that may pose a risk of liquefaction in our borings. We identified transitional material at various depths in the artificial fill and between Elevation -10 feet and -20 feet in the San Antonio Formation. We considered the criteria presented by Bray and Sancio (2006) to assess the potential for liquefaction triggering based on the on the index testing on the collected samples.

Bray and Sancio observed that soil with a plasticity index (PI) less than 12 and a water content (w_c) to liquid limit (LL) ratio of more than 0.85 are susceptible to liquefaction/cyclic softening. Soil with a PI greater than 18 and/or w_c/LL less than 0.8 were deemed to be not susceptible to liquefaction because they are too plastic and/or their water contents are too low.

We plotted this data on Exhibit 3.5.3.1-1. An additional sample in 1-B2 at Elevation -18.5 feet yielded a PI of 22; while we did not perform a moisture content test for the sample, it would plot in the "Not Susceptible" region based on the PI. Based on these results, we opine that the soil logged as sandy lean clay and clayey sand in the at this site is not susceptible to liquefaction.

EXHIBIT 3.5.3.1-1: Liquefaction Susceptibility Testing



3.5.3.2 CPT-Based Liquefaction Analysis

The data presented in Section 3.5.3.1 as 'Not Susceptible' to liquefaction generally has an I_c of 2.5 or greater. Based on this screening, we established an I_c cutoff value of 2.5 when performing our liquefaction analysis; this means that soil with an I_c above 2.5 is excluded from liquefaction triggering in our calculations.

We performed liquefaction analyses on the landside CPTs based on analysis methods by Idriss and Boulanger (2014) to estimate potential liquefaction triggering and volumetric liquefaction settlement. We estimated the cyclic stress ratio (CSR) for a geometric mean peak ground acceleration (PGA) of 0.85 based on the site-specific seismic hazard analysis for the MCE and a Moment Magnitude (M_w) 8.1 based on a San Andreas Fault rupture scenario. As discussed in Section 2.6, we assumed a groundwater table at Elevation 5 feet. Our results indicate there are discontinuous layers of liquefiable soil within the artificial fill. Soil in the San Antonio formation may experience a nominal amount of liquefaction.

We estimated settlement of liquefiable soil in each of our CPTs based on the method by Idriss and Boulanger (2014). Our analysis indicates that the ground could experience settlement up to the amounts shown in Table 3.5.3.2-1.

TABLE 3.5.3.2-1: Estimated Liquefaction Induced Volumetric Settlement.

CPT	VOLUMETRIC LIQUEFACTION INDUCED SETTLEMENT (inches)
1-CPT1	2½
1-CPT2	1¾
1-CPT3	1
1-CPT4	Nominal

We pushed 1-CPT1 through the rock dike; it took us several attempts to complete this CPT as we encountered shallow refusal and relocated the CPT several feet each time. The eventual breakthrough likely indicated a weaker zone within the dike. As such, we do not believe liquefaction in 1-CPT1 is persistent throughout the plaza area.

3.5.3.3 Liquefaction Ejecta

In addition to the previously described liquefaction analysis, we also evaluated the capping effect of the non-liquefiable soil above the liquefied layer. Based on empirical evidence, liquefaction-induced ejecta can occur if the pore-water pressure generated within the liquefied strata exerts a force sufficient to break through the overlying soil and vent to the surface resulting in sand boils or fissures. The loss of subsurface material beneath the building footprint could result in undermining the foundation, localized reduction in bearing capacity, and unpredictable settlements.

Hutabarat and Bray (2022) present a method for evaluating the severity of liquefaction-induced ejecta based on CPT data. The method considers the liquefaction ejecta demand from the liquefiable soil and the resistance to ejecta provided by the non-liquefiable soil above. We performed an analysis using this method assuming that 5 feet of engineered fill will be placed above the existing ground surface at the Pier entrance plaza and 2 feet in other regions of the site, to achieve planned finished grades. Based on our analysis, the site has a liquefaction-induced ejecta severity risk of “nominal” in 1-CPT1,1-CPT3, and 1-CPT4; and “moderate” in 1-CPT2. The moderate risk of liquefaction ejecta in 1-CPT2 is due to a clean sand layer situated between Elevation 8 feet to Elevation -2 feet. We opine that the lack of lateral continuity of this sand throughout the site and presence of moderately plastic lean clay and clayey sand capping the upper 9 feet throughout the site will inhibit significant amounts of ejecta.

TABLE 3.5.3.3-1: Estimated Liquefaction Induced Ejecta Severity

CPT	EJECTA SEVERITY
1-CPT1	Nominal
1-CPT2	Moderate
1-CPT3	Nominal
1-CPT4	Nominal

3.5.3.4 Lateral Spreading and Seismic Slope Stability

Lateral spreading is a seismically induced failure within a soil zone (typically due to liquefaction) that causes the overlying soil mass to move toward a free face or down a gentle slope. We distinguish this phenomenon from seismic slope stability, which is a failure of soft soil due to an imparted seismic loading. The effects of both pose a risk to lateral movement on the western end of the shoreline, at the pier entrance plaza, due to the presence of non-engineered fill and YBM. We performed a seismic slope deformation analysis and present our methodology and results in Section 3.6.

3.6 SHORELINE DEFORMATION ANALYSIS STABILITY

3.6.1 Geometry and Idealized Soil Profiles

We developed a geologic cross section using exploration data from our field exploration, regional geologic maps and the LiDAR and bathymetric survey data provided by eTrac. We also reviewed historical construction documents regarding Pier construction and filling of the South Cove Sailing Basin. Since we did not have as-built documents outlining the existing rock dike along Seawall Drive, we estimated the extents by evaluating our sonic boring exploration, reviewing the South Cove Sailing Basin grading plans (City of Berkeley, 1965), and georeferencing historical aerial imagery to the current shoreline. We performed our analysis based on the idealized stratigraphy of Cross-Section A-A' shown in Figure 2 and Figure 6.

3.6.2 Soil Strength Parameters

Prior to performing slope stability analyses, we evaluated the strength of the soil profile based on laboratory testing, CPT data, and various field correlations.

Laboratory testing of the YBM showed significant variation in water content and undrained shear strength. Consequently, we relied on continuous CPT data, using an N_{kt} of 14, to estimate shear strength values and corroborated our estimated values with existing literature. We also recognize that the seismic deformations in the YBM are likely to occur parallel with the layer; representative of a direct simple shear test (DSS), in contrast to CPT and UU failure modes. As such, we reduced our CPT undrained shear strength estimates by 20 percent. We assigned a static undrained shear strength ratio (vertical strength ratio) of 0.27 to the YBM.

Additionally, we modelled YBM as having a dynamic shear strength 30 percent greater than the corresponding static shear strength. We based this increase on studies showing that the undrained shear strength of YBM experiences a roughly 10 percent increase per log cycle increase in the rate of shear strain (Serna et al. 2019) under shear strains less than 3 percent.

As previously presented, our liquefaction analysis of the artificial fill indicates that approximately half of it may experience liquefaction or cyclic softening in discontinuous layers. We estimate that the liquefied fill will have a residual vertical strength ratio of 0.1 during a seismic event, while clayey non-liquefiable soil will retain a shear strength of 500psf. We averaged the material strengths to develop our estimate of shear strength.

The strength parameters that we used in our analyses are summarized in Table 3.6.2-1.

TABLE 3.6.2-1 Slope Stability Analysis Material Properties

SOIL LAYER	UNIT WEIGHT, γ (pcf)	COHESION STATIC (SEISMIC), c (psf)	FRICTION ANGLE, ϕ (deg)
Sandy Fill	120	-	30
Clayey Fill	120	500	-
Liquefied Fill	120	-/290	-
Qybm under Dike	95	540 (700)	-
Qybm	95	415 (540)	-
Offshore Qybm	80	100	-
Rock Dike/Riprap	135	-	45
DSM	135	4,320	-
Qal 1	125	1,700	-
Qobc 1	120	1,900	-
Qal 2	125	2,750	-
Qobc 2	120	3,000	-
Qal 3	125	3,000	-
Qobc 3	120	2,000	-
Qal 4	125	4,000	-

3.6.3 Method of Analysis

We performed a simplified deformation analysis using the computer program SLIDE (Version 9.035), which is a limit equilibrium program that allows the user various search routines to locate the minimum factor of safety and critical slip surface. We used circular and non-circular searching methods and the Spencer's Method of Slices (Spencer, 1973) for our analyses. We used a design groundwater level of Elevation 5 feet, corresponding to mean sea level and spectral ordinates corresponding to CLE and MCE response spectra.

In evaluating the stability of slopes at the site under seismic conditions, we used the pseudo-static method of analysis. The pseudo-static method models the effects of transient earthquake loading on a potential slide mass by using an equivalent sustained horizontal force determined as the product of a seismic coefficient and the weight of the potential slide mass. We used a staged pseudo-static strength for the calculation of effective stresses; this method estimates the strength of the soil based on effective stresses in a static condition then applies the external pseudo-static horizontal loading in a second step to estimate slope stability.

To estimate potential displacement of the shoreline, we used the methodologies from the National Cooperative Highway Research Program (NCHRP) Report 611 (2008) and the Bray and Macedo (2019) Simplified Procedure for Estimating Seismic Slope Displacement. These methods require estimation of the yield coefficient (k_y) which is the pseudo-static coefficient that results in a factor of safety of 1.0. The k_y and other characteristics about the seismic spectra are then used to estimate a lateral deformation. The value of estimated displacement resulting from these methods is a mean value of displacement based on a regression analysis and as such should be considered an index of potential displacement and not an exact amount of displacement. The following table shows our estimate of potential seismic deformation of the shoreline of Section A-A' based on both of these methods. We show the results of this analysis in Appendix G-1.

TABLE 3.6.3-1: Estimate of Potential Seismic Deformation

CASE	FACTOR OF SAFETY		YIELD ACCELERATION (g)		WALL PRESSURES (ksf)		POTENTIAL SEISMIC SLOPE DISPLACEMENT (inches)	
	Circular	Block	Circular	Block	CLE	MCE	CLE	MCE
Existing – Static	2.5	3.6	-	-	-	-	-	-
Existing – Psuedostatic	-	-	0.26	0.23	-	-	4 to 8	13 to 21

We assume that these magnitudes of deformation are unacceptable for accessibility to the pier as well as kinematic loading on the pier foundation elements at the shoreline. We developed two alternative mitigation systems to reduce displacements.

1. Buttressing the shoreline with Deep Soil Mix (DSM) Ground Improvement: DSM is a method of in situ ground improvement where soil is mechanically mixed with a cementitious binder to significantly increase its strength. The DSM would be accomplished to create a series of overlapping vertical columns forming shear panels oriented perpendicular to the shoreline.
2. Sheet Pile Wall – this wall would be oriented parallel to the shoreline and extend deep enough into the stable soil below the site to restrain the soil from moving laterally in an earthquake.

We discuss ground improvement methods further in Section 4.

We evaluated the minimum DSM dimensions and strength using the same pseudo-static analysis as previously presented and the shear strength shown in Table 3.6.2-1. The DSM shear strength is based on an assumed compressive strength of DSM of 200 pounds per square inch (psi) and an area replacement ratio of 0.3; we assumed that the shear strength is approximately one-half the compressive strength. Based on experience, we assumed a displacement of no more than 6 inches was acceptable for shoreline stability which results in a k_h of 0.33g to 0.37g for the MCE event. We then evaluated slope displacements behind (to the east) and in front (to the west) of the DSM; modifying the depth and width of the DSM until achieving a factor of safety of at least 1.0. We show the results of this analysis in Appendix G-2. While our results indicate 5 to 7 inches of displacement during the MCE; the values are based on simplified pseudo-static procedures and should be interpreted as an index of movement rather than prescriptive values. As such, we opine that the displacement is consistent with a criteria of approximately ½ foot of displacement, and the project will be able to maintain ingress and egress to the pier following an MCE level event.

To develop active and earthquake loads on the sheet pile wall, we performed a limit equilibrium analysis using a force to represent the bulkhead capacity; this approach is discussed in NCHRP 611 and is referred to as the GLE method. We applied k_h values ranging between 0.45g to 0.54g, which is consistent with 2 inches of wall deflection for an MCE event. We changed the value of the externally applied force until we calculated a factor of safety of at least 1. We show the results of this analysis in Appendix G-3.

Our experience and more rigorous numerical modeling we performed of similar sites indicates that the lateral movement may have a shape similar to the failure surfaces shown in Appendix F and have deformations that are larger at the shoreline and decrease with distance inland. However, the pseudo-static method of analysis is not able to accurately capture this deformation distribution, and it often indicates low factors of safety farther away from the shoreline due to the increased mass above the slide plane. Based on our judgement and our work on many other

bayfront sites in the area, we expect that the deformation during a seismic event will be limited to approximately 135 feet from the shoreline.

3.6.4 Results of Slope Deformation Analysis

Table 3.6.4-1 shows the results of our analyses of the two mitigations evaluated. The results show a range since we evaluated the displacement using two methods and considered both circular and non-circular surfaces.

TABLE 3.6.4-1 Results of Displacement Analyses

CASE	FACTOR OF SAFETY		YIELD ACCELERATION (g)		WALL EQUIVALENT FLUID PRESSURES (pcf)		POTENTIAL SEISMIC SLOPE DISPLACEMENT (inches)	
	Circular	Block	Circular	Block	CLE	MCE	CLE	MCE
Improved DSM (Front)	-	-	0.52	0.36	-	-	Nominal to 3	5 to 7
Improved DSM (Behind)	-	-	0.55	0.46	-	-	Nominal to 2	2 to 3
Sheet Pile Wall	-	-	-	-	170	340	2	2

For the evaluation of DSM, we estimate the location of the rock dike based on exploration, historical aerial photographs review, and review of construction plans. The presence of rock will make performing DSM difficult and more expensive as the equipment is not compatible with material of cobble size or greater. We assumed DSM would be performed to avoid the rock dike. There may not be enough space to perform the DSM mitigation in front of the rock dike; the limited space assumed results in a lower performance than the behind rock option. The estimated range of displacement presented in Table 3.6.4-1 includes slope displacement both in front and behind the area to receive DSM.

The values of pressure shown for the sheet pile wall option are the active plus earthquake pressure down to the bottom of the YBM at Elevation -15 feet. The magnitude of the seismic-induced pressure and height of cantilever of the sheet piles may necessitate either addition of tiebacks or bracing piles to provide additional support.

3.7 SOIL CORROSION POTENTIAL

We performed corrosion tests on two samples of soil from our borings. We transported the samples under the chain-of-custody to CERCO Analytical to evaluate the corrosion potential of the subsurface materials towards ferrous metals and concrete. The tests included minimum resistivity, pH, chloride content, and sulfate content. Test results are included in Appendix D. A summary of the results is presented below.

TABLE 3.7-1: Corrosivity Test Results (CERCO, 2024)

SAMPLE LOCATION	DEPTH (FEET)	REDOX (MV) [a]	PH[b]	MINIMUM RESISTIVITY[c] (OHMS-CM)	CHLORIDE[d] (MG/KG)	SULFATE[e] (MG/KG)	CORROSIVITY
1-B2	4.5-5	270	6.86	360	570	97	Severely Corrosive
1-B3	5.5-6	200	8	760	N.D.	17	Corrosive

a. ASTM D1498
b. ASTM D4972
c. ASTM G57
d. ASTM D4327

Based on the resistivity measurements and chloride ion concentration from our collected samples, we classified the soil as severely corrosive to buried metal and concrete. YBM and marine environments are known to be corrosive to metal and concrete. The site conditions present a risk to embedded pipes, walls, concrete structures, and piles. Sacrificial steel thickness or cathodic protection should be employed for steel elements and special consideration should be given to the concrete mix design. We recommend a corrosion consultant be retained to evaluate the specific corrosion recommendations for the project.

4.0 CONCEPTUAL SHORELINE STABILIZATION MITIGATIONS

Based on our discussion with you, to achieve the desired seismic performance for the pier we recommend implementation of a mitigation of the effects of seismic slope instability. This section provides additional detail regarding proposed shoreline stabilization presented in Section 3.6. We considered a range of stabilization methods as potential mitigation alternatives and recommend the use of DSM ground improvement and/or tied-back retaining walls.

4.1 DSM

DSM will increase the strength of the YBM, significantly reducing the potential for soil movement within and behind the improvement area. The DSM buttress would likely consist of several shear panels oriented perpendicular to the shoreline and Seawall Drive that are created by overlapping vertical DSM columns that will likely be between 3 and 5 feet in diameter. Various specialty DSM contractors utilize different equipment, and the exact size of the DSM columns, spacing of DSM columns, size of the panels, and spacing of the panels will depend on the contractor selected. The DSM will need to extend to the bottom of the YBM and approximately 1 diameter into the alluvium below. We show our recommendation of the lateral extent of the DSM in Figure 8; the length of the area to receive DSM is approximately 110 lf to protect the Pier and 260 lf to protect the plaza region. The soil directly below the rock dike cannot efficiently be improved using DSM due to the very dense nature and the presence of large cobbles in the rock dike.

Our experience indicates that the DSM panels should have a minimum depth to width ratio of 1:¾; additional design evaluation should be performed to verify that the panels are wide enough to not experience plunging of the toe or tension in the trailing elements if this mitigation is advanced. An additional benefit of the DSM buttress is that it generates spoils that amount to approximately 40 to 50 percent of the volume mixed; once they are allowed to cure, the spoils can be used as engineered fill at the site with enhanced engineering properties.

The location of any existing utilities that will remain within the planned DSM footprint will need to be accommodated in the final DSM design. They may need to be relocated or the DSM designed to have an opening around existing utility lines. All utilities within 25 feet of DSM should be located from potholing to reduce the risk of damage from DSM construction activities. Ideally new utilities can be kept in the fill above the top of the DSM. If new utilities need to extend into the DSM depth, they should be backfilled with controlled density fill with a shear strength at least equal to the DSM.

4.2 RETAINING WALL

A reinforced cast-in-place concrete (on a footing or deep foundation), soldier pile with shotcrete facing, or reinforced sheet pile wall may be used as an alternative to or in conjunction with the DSM for shoreline stability if it is designed to accommodate additional seismic and soil loads. To accomplish this, the wall should be installed with tie backs or braces and extended below the YBM. Refusal or bending of sheet or solider piles is expected if they are driven. As such, pile locations should pre-drilled or spudded prior to installation and backfilled over top to meet the appropriate grade.

Table 3.6.4-1 shows our estimated range of pressures for active and earthquake loading assuming a 2-inch deformation is tolerable for the wall. For the purpose of design, we recommend using an equivalent fluid pressure of 170 pounds per cubic foot (pcf) for a CLE-level event and 340 pcf for a MCE-level event (averages between selected methods). Figure 9 shows the distribution of these pressures as well as our recommendations for active pressure below the potential deformation surface and passive resistance for sheet pile design.

5.0 EARTHWORK RECOMMENDATIONS

As used in this report, relative compaction refers to the in-place dry unit weight of soil expressed as a percentage of the maximum dry unit weight of the same soil, as determined by the ASTM D1557 laboratory compaction test procedure, latest edition. Compacted soil is not acceptable if it is unstable; it should exhibit only minimal flexing or pumping, as observed by our field representative. The term “moisture condition” refers to adjusting the moisture content of the soil by either drying if too wet or adding water if too dry.

Structural areas are defined as regions where constructed elements transfer loads to the subgrade, such as pavement and buildings. These elements rely on an unyielding subsurface to maintain their integrity.

5.1 GENERAL DEMOLITION AND SITE CLEARING

After demolition of the Pier and associated improvements, the Site should be cleared of all obstructions, including existing foundations and debris. Any existing underground utilities that are not to remain in service after construction within the site should be identified and removed entirely, including pipes and their backfill. Depressions resulting from the removal of underground obstructions extending below the proposed finished grades should be cleared and backfilled with suitable material compacted to the recommendations presented in Section 5.5.

5.2 NON-ENGINEERED FILL

As described previously, we identified the presence of non-engineered fill. The planned structures other than the Pier will generally be lightly loaded. We recommend the existing fill be removed and recompacted to a depth of 3 feet within the building pad and extend a minimum of 5 feet laterally beyond the footprint of proposed minor structures.

5.3 OVER-OPTIMUM SOIL MOISTURE CONDITIONS AND UTILITY EXCAVATION

The contractor should anticipate encountering excessively over-optimum (wet) soil moisture conditions during winter or spring grading, or during or following periods of rain. Additionally, it is common to encounter overly wet soil in the subgrade of existing pavement areas when they are reconstructed. Wet soil should also be anticipated during utility excavation and other underground construction due to shallow groundwater. Wet soil can make proper compaction difficult or impossible. Wet soil conditions can be mitigated by:

1. Frequent spreading and mixing during warm dry weather,
2. Mixing with drier materials,
3. Mixing with a lime, lime-fly ash, or cement product; or
4. Overexcavating unstable soil and replacing with a geotextile stabilization fabric such as Mirafi 500x placed below the layer Class 2 Aggregate Base.

We should be allowed to evaluate Options 3 and 4 prior to implementation.

Due to the sandy and loose artificial fill and shallow groundwater at the site, shoring will likely be required for any excavation in an area that cannot be sloped. Temporary sheet piles or a shield or continuous hydraulic skeleton shoring should be anticipated for utility excavations that extend below a depth of about 5 feet.

5.4 ACCEPTABLE FILL

From a geotechnical perspective, the existing fill at the site soil is suitable for use as engineered fill, provided they are processed to remove concentrations of YBM, organic material, any shells, debris, and particles greater than 6 inches in maximum dimension. Unsuitable materials and debris and particles larger than 6 inches should be removed from the project site. If a soil mixing ground improvement is implemented, the cement-rich spoils generated from ground improvement may also be used as fill. The use of spoils as fill will cause adverse effects on planted vegetation within the grading area.

Imported fill material should meet the above requirements and have a plasticity index less than 25 and at least 20 percent passing the No. 200 sieve. Import materials should be submitted to us for approval prior to delivery to the site. The contractor should allow us to sample, and test proposed imported fill materials at least 72 hours prior to delivery to the Site.

5.5 FILL COMPACTION

5.5.1 Grading in Structural Areas

Areas to receive fill should be excavated to a firm unyielding surface, scarified to a depth of 8 inches, moisture conditioned, and recompacted to provide adequate bonding with the initial lift of fill. All fill should be placed in loose lifts that do not exceed 12 inches or the depth of penetration of the compaction equipment used, whichever is less. We recommend the following compaction and moisture content requirements for the placement and compaction of engineered fill.

TABLE 5.5.1-1: Fill Compaction and Moisture Content Recommendations

FILL LOCATION	MINIMUM RELATIVE COMPACTION (%)	MINIMUM MOISTURE CONTENT (percentage points above optimum moisture content)
General Fill	90	2
Pavement Subgrade (top 12 inches)	95	0
Caltrans Class 2 Aggregate Base	95	0

Pavement subgrade soil should be in a stable, non-pumping condition at the time aggregate base is placed and compacted. Proof-rolling with a heavy wheel-loaded piece of construction equipment should be implemented. Yielding materials should be appropriately mitigated, with suitable mitigation measures developed in coordination with the client, contractor, and our representative.

5.5.2 Underground Utility Backfill

Project consultants involved in utility design should specify pipe bedding materials. We recommend that utility trench backfilling be done under our observation. Trench backfill in structural areas should be placed and compacted in accordance with Table 5.5.1-1. If uniformly graded gravel is used, we recommend that it be encapsulated in 6-ounce filter fabric.

Jetting of backfill is not an acceptable means of compaction. Controlled density fill is also suitable for pipe zone and trench zone backfill.

5.5.3 Landscape Fill

We recommend processing, placing, and compacting fill in landscaped areas in accordance with the “General Fill” material in Table 5.5.1-1, except it should be compacted to at least 85 percent relative compaction.

5.6 CUTOFF CURBS

Overly wet pavement subgrade or aggregate base can cause premature failure or increased maintenance of the pavement section. This condition often occurs where landscape areas directly abut and drain toward streets. Cutoff barriers are not required by City of Berkeley standards, but they can be implemented to reduce the impacts of landscaping directly adjacent to pavement. If desired to install cutoff barriers, they should be considered where pavement areas lie downslope of any landscape areas that are to be irrigated, and should extend to a depth of at least 6 inches below the base rock layer. Cutoff barriers may consist of deepened concrete curbs or deep-root moisture barriers.

5.7 SITE SURFACE DRAINAGE

The project civil engineer is responsible for designing surface drainage improvements. With regard to geotechnical engineering issues, we recommend that finished grades be sloped away from buildings and pavements to the maximum extent practical. The latest California Building Code Section 1804.4 specifies minimum slopes of 5 percent for pervious surfaces within 10 feet of foundations. Where lot lines or surface improvements restrict meeting this slope requirement, we recommend that specific drainage requirements be developed. We also recommend infiltration be restricted to prevent introducing collected runoff to subgrade with low permeability and to limit excessive sheet flow. As a minimum, we recommend the following.

1. Roof downspouts should discharge into closed conduits that are directed away from foundations to appropriate drainage devices.
2. Water should not be allowed to pond near foundations, pavements, or exterior flatwork.

5.8 STORMWATER BIORETENTION AREAS

Infiltration testing was not included in our scope as part of this geotechnical exploration. Based on Site soil and the groundwater table encountered, infiltration rate of 0.05 inches/hour may be possible at the ground surface; however, the presence of the shallow groundwater should be considered in design of infiltration.

If bioretention areas are planned at grade, we recommend that, when practical, they be placed a minimum of 5 feet away from the building and other structural Site improvements, such as streets, retaining walls, and sidewalks/driveways. When this is not practical, bioretention areas located within 5 feet of structural site improvements can either:

1. Be constructed with structural side walls capable of withstanding the loads from the adjacent improvements, or
2. Incorporate filter material compacted in accordance with Section 5.5.1 and a waterproofing system designed to reduce the potential for moisture transmission into the subgrade soil beneath the adjacent improvement.

In addition, site improvements located adjacent to bioretention areas that are underlain by base rock, sand, or other imported granular materials, should be designed with a deepened edge that extends to the bottom of the imported material underlying the improvement. Where adjacent site improvements include streets steeper than 3 percent or design elements that will experience lateral loads (such as from impact or traffic), additional design considerations may be required. In addition, although not recommended, if trees are to be planted within bioretention areas, HDPE Tree Boxes that extend below the bottom of the bioretention system should be installed to reduce potential impact to subdrain systems that may be part of the bioretention area design. For this condition, the waterproofing system should be connected to the HPDE Tree Box with a waterproof seal.

5.9 CONSOLIDATION MITIGATION

If the amount of potential settlement discussed in Section 3.3 is inconsistent with anticipated long-term performance, it can be mitigated by placing lightweight fill, pre-loading the area with compacted soil before construction, or a combination of both. We provide a general description

of both methods below and specific recommendations pertaining to settlement mitigation at the Pier Plaza area in Appendix J.

5.9.1 Lightweight Cellular Concrete

The most cost-effective type of lightweight fill for this site appears to be cellular concrete. Cellular concrete is a mixture of cement, water, and a proprietary foaming agent. The proportion of foaming agent added can reduce the weight of the cellular concrete to as little as 17 pounds per cubic foot (pcf). For this project, we assume that cellular concrete of 30 pcf will be used.

Cellular concrete will weigh approximately one quarter the weight of soil fill. If a "net zero" pressure balance is required, a foot of existing fill can be removed and replaced with cellular concrete for each 3 feet of cellular concrete placed above existing grade. Where soil, aggregate base, asphalt concrete or Portland Cement concrete are included in the fill section, at least 1½ feet of existing fill should be removed and replaced with cellular concrete for each foot of these materials placed.

Cellular concrete is lighter than water, where cellular concrete is placed the area should be pumped dry and kept dry until the cellular concrete is completely placed and cured. To address long-term buoyancy and considerations for sea level rise, we recommend considering permeable cellular concrete which will experience very little, if any buoyancy effects.

Cellular concrete, while robust and an appropriately strong backfill material, is subject to erosion from both tracked and rubber tired equipment. We recommend that cellular concrete be protected with a layer of aggregate or soil once placement is complete to reduce the risk of generating concrete dust from surface erosion caused by equipment traffic.

5.9.2 Surcharging

A surcharge program would involve temporarily blanketing the settlement sensitive area with temporary fill until the YBM is practically complete with settlement under the weight of the surcharge. Subsequently, the surcharge may be cut to final subgrade and construction of settlement sensitive infrastructure can be built. The settlement during the surcharge should be monitored with settlement plates placed at the base of the fill. We estimate that surcharge will take on the order of 2 to 3 months; however, the actual time before surcharge removal will depend on the results of the monitoring. The surcharge can be removed once approximately 75 percent of the settlement under the surcharge load is achieved.

6.0 FOUNDATION RECOMMENDATIONS

6.1 DRIVEN PILES SUPPORTING PIER

Based on our discussion with you, we understand that the proposed pier will have a finished deck at approximately Elevation 16 feet and include the construction of the following piles.

- 24-inch plumb octagonal precast prestressed concrete piles to support the pier
- 24-inch battered octagonal precast prestressed concrete piles to support the breakwater
- 4-foot-by-14-inch or 4-foot-by-12-inch concrete sheetpile breakwater
- 36-inch-diameter plumb steel pipe piles for berthing floats
- 24-inch-diameter steel pipe piles for concrete abutment

During installation, pile driving should be continuous, as interruptions for extended periods of time may allow the pile to set up and result in harder pile driving resistance to reach design tip elevations. High driving resistance may be encountered as the pile advances through the alluvial deposits where dense sands were encountered. The landside piles may require spudding or predrilling through the rock dike. Jetting may be necessary to drive piles through dense sand layers. If piles for pier support are jetted for installation, they should be driven at least an additional 10 feet.

The contractor should submit a pile driving program for our review and approval. At a minimum, the pile driving submittal should include an analysis of the pile driving system to be used by the contractor. This analysis should indicate the hammer type and an approximate blow count that would represent refusal conditions for the soil type, piles, and driving system.

To develop estimates of vertical pile lateral capacity and lateral pile performance, we used an idealized soil profile with soil properties matching those used in our slope stability analysis in Section 3.6. We present the generalized stratigraphy used in analysis for offshore piles in Table 6.1-1 and for piles driven through the rock dike in Table 6.1-2.

TABLE 6.1-1: Generalized Offshore Pile Stratigraphy and Soil Properties

GEOLOGIC UNIT	ELEVATION TOP (feet)	ELEVATION BOTTOM (feet)	UNIT WEIGHT, γ (pcf)	COHESION, c (psf)	FRICTION ANGLE, ϕ (deg)
Offshore Qybm	-6	-13	80	100	-
Qal 1 (Clay)	-13	-19	125	1700	-
Qal 1 (Sand)	-19	-23	125	-	34
Qal 1 (Clay)	-23	-29	125	1700	-
Qobc 1	-29	-86	120	1900	-
Qal 2	-86	-99	125	2750	-
Qobc 2	-99	-104	120	3000	-
Qal 3	-104	-112	125	3000	-
Qobc 3	-112	-133	120	2000	-
Qal 4	-133	-152	125	4000	-

TABLE 6.1-2: Generalized Landward Pile Stratigraphy and Soil Properties

GEOLOGIC UNIT	ELEVATION TOP (feet)	ELEVATION BOTTOM (feet)	UNIT WEIGHT, γ (pcf)	COHESION, c (psf)	FRICTION ANGLE, ϕ (deg)
Rock Dike	Varies	-9	135	-	40
Qybm	-9	-14	95		
Qal 1 (Clay)	-14	-19	125	1700	-
Qal 1 (Sand)	-19	-23	125	-	34
Qal 1 (Clay)	-23	-29	125	1700	-
Qobc 1	-29	-86	120	1900	-
Qal 2	-86	-99	125	2750	-
Qobc 2	-99	-104	120	3000	-
Qal 3	-104	-112	125	3000	-
Qobc 3	-112	-133	120	2000	-
Qal 4	-133	-152	125	4000	-

6.1.1 Vertical Capacity

We developed estimates of the ultimate compression and tension capacity for the octagonal piles and sheet pile walls and present them in Figure 10 and Figure 11, respectively. During pile installation, we recommend performing high-strain dynamic testing using a pile driving analyzer (PDA) to verify the pile capacities and monitor driving stresses.

TABLE 6.1.1-1: Recommended Factor of Safety for ASD and Resistance Factor for LRFD Pile Design

DESIGN METHOD	LOAD CONDITION/LIMIT STATE	PILE CAPACITY COMPONENT	FACTOR OF SAFETY/RESISTANCE FACTOR
ASD (Factor of Safety)	Static	Compression and Tension	2.0
	Seismic		1.5
Load Resistance Factor Desing* (Resistance Factor, ϕ)	Strength Limit	Compression and Tension	0.7
	Extreme Limit	Compression	1.0
		Tension	0.8

*The values of resistance factor assume PDA testing is performed to confirm ultimate capacity

Due to the substantial tip area of the breakwater, the strain necessary to develop end bearing is considerably incompatible with the strain required to develop skin friction. Therefore, for the concrete sheet pile wall, we derived capacity solely from skin friction.

We also developed t-z curves (skin friction load-deflection springs) for the battered octagonal piles and sheet piles to represent the mobilization of the soil side friction from static loading (settlement from initial loading of the pile not including the elastic settlement of the soil from overall loading) using the computer program Apile v2023.10.4 by Ensoft Inc. We developed a spring at the top and bottom of each soil layer and every 5 feet through the Old Bay Clay. In addition, we developed q-w curves (end bearing load-deflection springs) at select depths for the battered concrete octagonal pile, where partial mobilization of tip resistance is anticipated. For evaluation of mobilized side friction of piles at depths between the spring depths, linear interpolation may be performed. A summary of the t-z and q-w springs may be found in Appendix F.

6.1.2 Lateral Capacity

For the purposes of estimating soil reaction to lateral loads, we developed lateral soil-structure load-deflection curves (p-y springs). We developed the springs for octagonal and steel pipe piles using the computer software LPile v2022.12.01 by Ensoft Inc. For the sheet pile wall, we used the NCHRP 611 (2008) method to develop p_w-y springs. We developed a spring at the top and bottom of each soil layer and every 5 feet through the OBC, until the spring stiffness stopped increasing with depth. For evaluation of soil resistance to lateral pile loads at depths between the spring depths, linear interpolation may be performed. We recommend using the best estimate spring models to evaluate kinematic pile loading due to slope deformation.

We utilized the Matlock model for Soft Clay for the YBM, the Stiff Clay without Free Water model by Reese for the stiff alluvial clay and OBC; the Reese sand model for interbedded sand in the San Antonio Formation and the rock dike. P-y springs can be found in Appendix G.

6.2 FOUNDATION FOR MINOR STRUCTURES

In this section we provide recommendations for foundations of lightly loaded, non-occupied, minor ancillary structures such as restroom facilities, landscape arbors, seating facilities, and monuments.

6.2.1 Structurally Reinforced Mat Foundation

Structures may be supported on a structurally reinforced mat foundation designed to impose an average allowable bearing pressure of at most 750 pounds per square foot (psf) for dead-plus live loads. Areas of concentrated loading may be designed using a maximum allowable bearing capacity of 1,000 psf for dead plus live loading. These values may be increased by one-third for transient loads such as wind or seismic.

6.2.2 Spread Footings

Structures can alternatively be supported on continuous and isolated spread footings with a maximum allowable bearing capacity of 1,000 psf. The footings should be designed with minimum footing dimensions in Table 6.2.2-1

TABLE 6.2.2-1: Typical Footing Dimensions

FOOTING TYPE	*MINIMUM DEPTH (inches)	MINIMUM WIDTH (inches)
Isolated	24	24
Continuous	24	12

* below lowest adjacent pad grade

The minimum footing depths shown above are taken from lowest adjacent pad grade.

The maximum allowable bearing pressure is a net value; the weight of the footing may be neglected for design purposes. Footings located adjacent to utility trenches should have their bearing surfaces below an imaginary 1:1 (horizontal:vertical) plane projected upward from the bottom edge of the trench to the footing.

6.2.2.1 Slabs-On-Grade/Interior Concrete Floor Slabs

We recommend the following minimum design for slab-on-grade floors.

1. A minimum concrete thickness of 5 inches.
2. Minimum steel reinforcing of No. 3 rebar on 18-inch centers each way placed within the middle third of the slab to help control the width of shrinkage cracking that inherently occurs as concrete cures.

6.2.2.2 Waterstop

If a two-pour system is used for footings and slab, the cold joint between the exterior footing and slab-on-grade should be located at least 4 inches above adjacent finish exterior grade. If this is not done, then we recommend the addition of a waterstop between the two pours to reduce moisture penetration through the cold joint and migration under the slab. Use of a monolithic pour would eliminate the need for the waterstop.

6.2.3 Shallow Foundation Settlements

Provided our report recommendations are followed; we estimate total static foundation settlements of up to 1 inch with a similar amount of differential settlement over a lateral distance of 50 feet. Due to liquefaction in the artificial fill, we expect differential settlement will be on the order of 1½ inches over a lateral distance of 50 feet.

6.2.4 Shallow Foundation Lateral Resistance

Lateral loads may be resisted by friction along the base and by passive resistance along the sides of foundations. The passive pressure is based on an equivalent fluid pressure in pounds per cubic foot (pcf). We recommend the following ultimate values for design.

- Passive Lateral Resistance: 250 pcf
- Coefficient of Friction: 0.30

The values above are unfactored and an appropriate factor of safety should be implemented based on the load combination considered and the method of analysis. These two resistances can be combined; however, due to incompatibility of strain to peak value, one of the two values should be reduced by half if they are combined.

Passive lateral pressure should not be used for footings on or above slopes.

6.2.5 Slab Moisture Vapor Protection

When structures are constructed with concrete slab-on-grade floors or structural mat foundations, water vapor from beneath the slab will migrate through the slab and into the building. This water vapor can be reduced but not stopped. Vapor transmission can negatively affect floor coverings and lead to increased moisture within a building. When water vapor migrating through the slab would be undesirable, we recommend the following to reduce, but not stop, water vapor transmission upward through the slab-on-grade.

- A vapor retarder membrane should be placed directly beneath the slab or mat. The vapor retarder membrane should be sealed at all seams and pipe penetrations. Vapor retarders should conform to Class A vapor retarder in accordance with ASTM E1745-97 “Standard Specification for Plastic Water Vapor Retarders used in Contact with Soil or Granular Fill under Concrete Slabs.”
- For non-structural slab-on-grade floors, a 4-inch-thick layer of ¾-inch clean crushed rock should be placed below the vapor retarder membrane to act as a capillary break.
- Concrete should have a concrete water-cement ratio of no more than 0.50.
- Inspection and testing should be performed during concrete placement to check that the proper concrete and water-cement ratio are used.
- Slabs should be moist cured for a minimum of 3 days or other equivalent curing should be specified by the structural engineer.

6.2.6 Drilled Piers

Appropriate structures may be supported on drilled, cast-in-place, straight-shaft friction piers. The following design criteria should be incorporated into the structural design for the proposed light pole foundation. The piers should have a minimum diameter of 12 inches and extend to a depth of at least 6 feet below the existing ground surface. Piers should be designed for an allowable skin friction of 250 psf plus the weight the pier for combined dead-plus-live loads with a one-third increase allowed for either transient wind or seismic loading.

Resistance to uplift loads is developed in friction along the pier shafts. We recommend that an allowable uplift frictional resistance of 200 psf be used for tension resistance.

Lateral loads exerted on drilled piers and may be resisted by a passive resistance based on an equivalent fluid pressure of 250 pounds per cubic foot acting against the projected area of the individual pier shafts below grade.

The bottoms of pier excavations should be dry, reasonably clean, and free of loose soil before reinforcing steel is installed and concrete is placed. We recommend that the excavation of piers be performed under our direct observation to establish that the piers are founded in suitable materials and constructed in accordance with the recommendations presented in this letter.

Due to the potential for caving, each shaft may need to be cased. If groundwater is encountered, remove it from excavations prior to concrete placement. If groundwater cannot be removed from excavations prior to concrete placement, then we recommend that concrete be placed by tremie pipe. The concrete should be tremied to the bottom of the hole keeping the tremie pipe below the surface of the concrete to avoid entrapment of water in the concrete. As concrete is poured, water is displaced out of the hole.

7.0 RETAINING WALLS

7.1 ABOVE-GRADE RETAINING WALLS

Unrestrained walls constructed on the Site on level and sloped foregrounds should be designed for active lateral fluid pressure as provided below.

TABLE 7.0-1: Active Earth Pressure (Drained)

BACKFILL SLOPE CONDITION	ACTIVE PRESSURE (pcf)
Level	40
3:1	45
2:1	50

Passive pressures acting on foundations and shear keys may be assumed as 250 pcf, provided that the area in front of the retaining wall is level for a distance of at least 10 feet or three times the depth of foundation and keyway, whichever is greater. The upper 1 foot of soil should be excluded from passive pressure computations unless it is confined by pavement or a concrete slab. The friction factor for sliding resistance may be assumed as 0.30. On a preliminary basis, the retaining wall footings may be planned using an allowable bearing pressure of 1,000 psf on firm recompacted pads. The footings should be at least 24 inches below lowest adjacent grades.

The above lateral earth pressures assume sufficient drainage behind the walls to prevent any build-up of hydrostatic pressures from surface water infiltration and/or a rise in the groundwater level. If adequate drainage is not provided, we recommend that an additional equivalent fluid pressure of 40 pcf be added to the values recommended. Damp-proofing of the walls should be included in areas where wall moisture would be problematic.

Under seismic conditions, the active incremental seismic force along the wall should be added to the static active pressure and can be calculated as follows.

$$\Delta P = 10 \times H^2$$

Where H is the design height of the wall (in feet) and ΔP is the active incremental seismic force in pounds per foot length of wall. Since seismic loading requires soil movement, evaluation of the seismic case should consist of adding the seismic increment to the active soil pressure for all wall types. The resultant seismic force should be applied at $^1/_3$H from the base of the wall, indicative of a triangular pressure distribution.

7.1.1 Retaining Wall Drainage

Either graded rock drains or geosynthetic drainage composites should be constructed behind the retaining walls to reduce hydrostatic lateral forces. For rock drain construction, we recommend two types of rock drain alternatives.

1. A minimum 12-inch-thick layer of Class 2 Permeable Filter Material (Caltrans Specification 68-2.02F) placed directly behind the wall, or
2. A minimum 12-inch-thick layer of washed, crushed rock with 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 sieve. Envelop rock in a minimum 6-ounce, non-woven geotextile filter fabric.

For both types of rock drains:

1. The rock drain should be placed directly behind the walls of the structure.
2. The rock drains should extend from the wall base to within 12 inches of the top of the wall.
3. A minimum of 4-inch-diameter perforated pipe (glued joints and end caps) should be placed at the base of the wall, inside the rock drain and fabric, with perforations placed down.
4. The pipe should be placed at a gradient at least 1 percent to direct water away from the wall by gravity to a drainage facility.

We should review and approve geosynthetic composite drainage systems prior to use.

7.1.2 Backfill

Backfill behind the retaining walls should be placed and compacted in accordance with Section 5.5 as general site fill. Light compaction equipment should be used within 5 feet of the wall face. If heavy compaction equipment is used, the walls should be temporarily braced to avoid excessive wall movement.

7.2 PIER ABUTMENT AND MECHANICALLY STABILIZED EARTH WALL

Fill placed at the pier plaza will be retained by both the pier abutment and a mechanically stabilized earth (MSE) seawall (Retaining Wall) with a precast panel facing. We provide design recommendations for the pier abutment in Appendix K and our complete design submittal for the MSE Retaining wall in Appendix L.

8.0 CONSTRUCTION MONITORING

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to:

1. Review the final grading and foundation plans and specifications prior to construction to evaluate whether our recommendations have been implemented, and to provide additional or modified recommendations, as needed. This also allows us to check if any changes have occurred in the nature, design, or location of the proposed improvements and provides the opportunity to prepare a written response with updated recommendations.

   Perform construction monitoring to check the validity of the assumptions we made to prepare this report. Earthwork and ground improvement operations should be performed under the observation of our representative to check that the Site is properly prepared, the selected fill materials are satisfactory, and that placement and compaction of the fill has been performed in accordance with our recommendations and the project specifications. Sufficient notification to us prior to earthwork is important.
   If we are not retained to perform the services described above, then we are not responsible for any party's interpretation of our report (and subsequent addenda, letters, and verbal discussions).

9.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents geotechnical recommendations for design of the improvements of Berkeley Water Transportation Pier project located in Berkeley, California. If changes occur in the nature or design of the project, we should be allowed to review this report and provide additional recommendations, if any. It is the responsibility of the owner to transmit the information and recommendations of this report to the appropriate organizations or people involved in design of the project, including but not limited to developers, owners, buyers, architects, engineers, and designers. The preliminary conclusions and recommendations contained in this report are solely professional opinions and are valid for a period of no more than 2 years from the date of report issuance.

We strive to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is provided, express or implied. There are risks of earth movement and property damages inherent in building on or with earth materials. We are unable to eliminate all risks; therefore, we are unable to guarantee or warrant the results of our services.

This report is based upon field and other conditions discovered at the time of report preparation. We developed this report with limited subsurface exploration data. We assumed that our subsurface exploration data is representative of the actual subsurface conditions across the Site. Considering possible underground variability of soil, rock, stockpiled material, and groundwater,

additional costs may be required to complete the project. We recommend that the owner establish a contingency fund to cover such costs. If unexpected conditions are encountered, we should be notified immediately to review these conditions and provide additional and/or modified recommendations, as necessary.

Our services did not include excavation sloping or shoring, soil volume change factors, flood potential, or a geohazard exploration. In addition, our geotechnical exploration did not include work to assess the existence of possible hazardous materials. If any hazardous materials are encountered during construction, notify the proper regulatory officials immediately.

This document must not be subject to unauthorized reuse, that is, reusing without our written authorization. Such authorization is essential because it requires us to evaluate the document's applicability given new circumstances, not the least of which is passage of time.

Actual field or other conditions will necessitate clarifications, adjustments, modifications, or other changes to our documents. Therefore, we must be engaged to prepare the necessary clarifications, adjustments, modifications, or other changes before construction activities commence or further activity proceeds. If our scope of services does not include on-site construction observation, or if other persons or entities are retained to provide such services, we cannot be held responsible for any or all claims arising from or resulting from the performance of such services by other persons or entities, and from any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies, or other changes necessary to reflect changed field or other conditions.

SELECTED REFERENCES

A3GEO. 2013. South Cove Public Dock and Parking Lot Renovation Project Berkeley Marina Berkeley, California. February 12, 2013. Project No. 1118-1A.

Abrahamson, N. 2000. Effects of rupture directivity on probabilistic seismic-hazard analysis, 6th Int. Conf. on Seismic Zonation, Proceedings: Earthq. Eng. Res. Inst. CD-2000-01.

Abrahamson, N. A., Silva, W. J., & Kamai, R. 2014. Summary of the ASK14 Ground Motion Relation for Active Crustal Regions. Earthquake Spectra, 30(3), 1025-1055.

AECOM. 2016. San Francisco Bay Tidal Datums and Extreme Tides Study. SF Bay Tidal Datums (2016).

Ancheta, T., Darragh, R., Stewart, J., Seyhan, E., Silva, W., Chiou, B., Wooddell, K., Graves, R., Kottke, A., Boore, D., Kishida, T., and Donahue, J. 2014. NGA-West2 database, Earthquake Spectra, Vol. 30, pp. 989-1005.

American Society of Civil Engineers. 2016. ASCE 7-16, Minimum Design Loads for Buildings and Other Structures.

Atwater, B. F., Hedel, C. W., & Helley, E. J. 1977. Late Quaternary depositional history, Holocene sea-level changes, and vertical crust movement, Southern San Francisco Bay, California (Professional Paper 1014). USGS. https://pubs.usgs.gov/pp/1014/

Bray, J. D. and Macedo, J. 2019. Procedure for Estimating Shear-Induced Seismic Slope Displacement for Shallow Crustal Earthquakes. American Society of Civil Engineers Journal of Geotechnical and Geoenvironmental Engineering.

Bray, J.D. and Sancio, R.B. 2006. “Assessment of the liquefaction susceptibility of fine-grained soils,” Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 132, No. 9, pp. 1165-1177.

Boore, D. M., Stewart, J. P., Seyhan, E., & Atkinson, G. M. 2014. NGA-West2 equations for predicting PGA, PGV, and 5% damped PSA for shallow crustal earthquakes. Earthquake Spectra, 30(3), 1057-1085.

California Geological Surbey. 2003. Seismic Hazard Zone Report for the Oakland West 7.5 Minute Quadrangle, Alameda County, California.

California Building Code. 2022.

Campbell, K. W., & Bozorgnia, Y. 2014. NGA-West2 ground motion model for the average horizontal components of PGA, PGV, and 5% damped linear acceleration response spectra. Earthquake Spectra, 30(3), 1087-1115.

Chiou, Brian S-J., and Robert R. Youngs. 2014. Update of the Chiou and Youngs NGA model for the average horizontal component of peak ground motion and response spectra. Earthquake Spectra, 30(3), 1117-1153.

SELECTED REFERENCES (Continued)

City of Berkeley Department of Public Works. 1936. Yacht Harbor. August 4, 1936. Berkeley, California.

City of Berkeley Department of Public Works. 1952. University Avenue Extension to Berkeley Harbor. September 12, 1952. Berkeley, California.

City of Berkeley Department of Public Works. 1965. Grading Plan for South Sailing Basin. March 1, 1965. Berkeley, California.

City of Berkeley. 2023. Response to Qualification (RFQ) For the Berkeley Water Transportation Pier Ferry Project, Berkeley, California. December 15, 2023.

Earl and Wright Consulting Engineers. 1960. Berkeley Pier. June 6, 1960. Berkeley, California.

IDA Structural Engineers. 2015. Berkeley Pier Load Evaluation. Berkeley, California. June 25, 2015. Project No. 13113.07.

The Golden Gate Ferry Company. 1926. General Pile Plan for Ferry Terminal at Berkeley, California. August 24, 1926. Berkeley, California.

ENGEO. 2018. Geotechnical Recommendations for Courtyard Redesign of DoubleTree Hotel. July 20, 2018. Project No. 15201.000.000.

ENGEO. 2018. Brickyard Phase I Improvements. Geotechnical Exploration. Berkeley, California. June 11, 2018. Project No. 15007.000.000.

ENGEO. 2016. Cezar Chavez Park. Berkeley, California. October 6, 2016. Project No. 12860.000.000.

ENGEO. 2011. Lawrence Berkeley National Laboratory Second Campus; Golden Gate Field Site. Albany, California. July 28, 2011. Project No. 9289.000.000.

Field, E.H., Biasi, G.P., Bird, P., Dawson, T.E., Felzer, K.R., Jackson, D.D., Johnson, K.M., Jordan, T.H., Madden, C., Michael, A.J., Milner, K.R., Page, M.T., Parsons, T., Powers, P.M., Shaw, B.E., Thatcher, W.R., Weldon, R.J., II, and Zeng, Y. 2013. Uniform California earthquake rupture forecast, version 3 (UCERF3)—The time-independent model: U.S. Geological Survey Open-File Report 2013–1165, 97 p., California Geological Survey Special Report 228, and Southern California Earthquake Center Publication 1792, http://pubs.usgs.gov/of/2013/1165/.

Google Earth v7.3.6.9796.

GHD. 2023. Feasibility Study Ferry Facility at Berkeley Municipal Pier. June 30, 2023.

Graymer R.W. 2000. Geologic map and map database of the Oakland metropolitan area, Alameda, Contra Costa, and San Francisco Counties, California: U.S. Geologic Survey. Miscellaneous Field Studies Map MF-2342, scale 1:50,000.

Historic Aerials by Netronline, https://www.historicaerials.com/

SELECTED REFERENCES (Continued)

Idriss and Boulanger. 2014. Soil Liquefaction during Earthquakes, EERI.

Mikola, R.G., Candia, G., and Sitar, N. 2013. Seismic Earth Pressures on Retaining Structures and Basement Walls. 10th U.S. National Conference on Earthquake Geotechnical Engineering, Anchorage, Alaska.

National Coorperative Highway Research Program Report 611. 2008. Seismic Analysis and Design of Retaining Walls, Buried Structures, Slopes, and Embankments.

Robertson, P.K. 2009. Interpretation of cone penetration tests - a unified approach, Canadian Geotechnical Journal 2009, vol. 46, pp. 1337-1355.

Rogers J.D., and Figuers S.H. 1991. Engineering Geologic Site Characterization of the Greater Oakland-Alameda Area; Alameda and San Francisco Counties, California. December 30, 1991.

Serna, B., Dickenson, S. E., Rudolph, R. W., & Chang, K. E. 2019. Influence of Dynamic Behavior of Soft Clay on Seismic Pier Response at the Port of San Francisco. In Ports 2019: Port Engineering (pp. 261-272). Reston, VA: American Society of Civil Engineers.

Silvia Mazzoni, Linda Al Atik, Nick Gregor, Yousef Bozorgnia. 2023. Directivity-Based PSHA Interactive Tool. The B. John Garrick Institute for the Risk Sciences. Dataset. https://doi.org/10.34948/N34S39 (https://doi.org/10.34948/N34S39).

Sitar et al. 2013. Seismically Induced Lateral Earth Pressures on Retaining Structures and Basement Walls. GeoCongress 2012, Oakland, California, United States. DOI: 10.1061/9780784412138.0013

Ocean Protection Council. 2024. State of California Sea Level Rise Guidance.

Somerville, P. G., Smith, N. F., Graves, R. W., & Abrahamson, N. A. 1997. Modification of empirical strong ground motion attenuation relations to include the amplitude and duration effects of rupture directivity. Seismological research letters, 68(1), 199-222.

U.S. Geological Survey, San Francisco [map], 1:62500, Topographic Quadrangle Map, San Francisco, California. 1895.

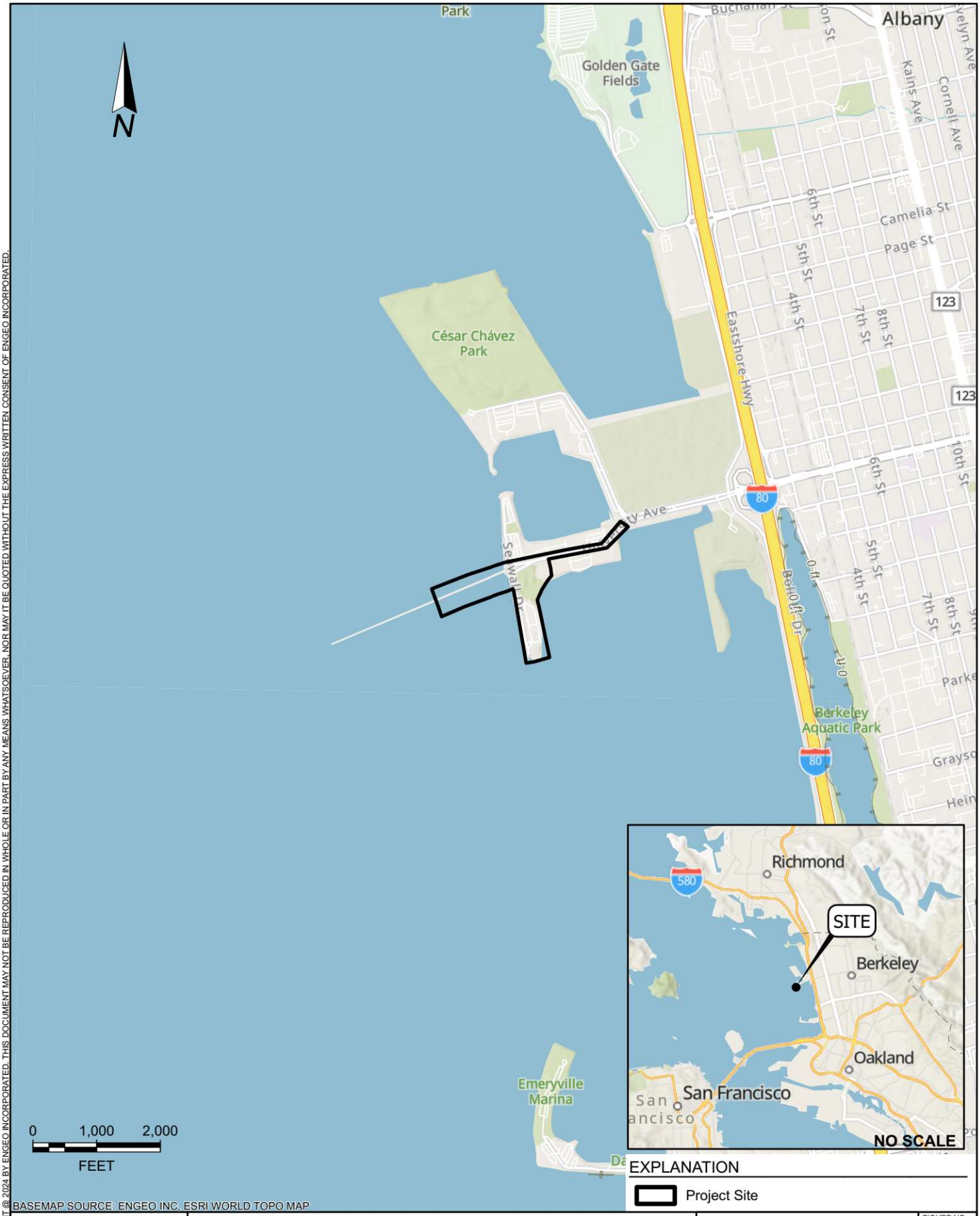
U.S. Geological Survey, San Francisco [map], 1:62500, Topographic Quadrangle Map, San Francisco, California. 1915.

UCSB Aerial Photography Library. FrameFinder



FIGURES

FIGURE 1: Vicinity Map
FIGURE 2: Site Plan
FIGURE 3: Regional Faulting and Seismicity Map
FIGURE 4: Geologic Map
FIGURES 5A THROUGH 5C: Asphalt Core Photographs
FIGURE 6: Cross Sections A-A' and B-B'
FIGURE 7: Seismic Hazard Zone Map
FIGURE 8: Ground Improvement and Retaining Wall Extents
FIGURE 9: Lateral Pressure Diagram for Retaining Wall
FIGURE 10: Ultimate Pile Compression Capacity
FIGURE 11: Ultimate Pile Tension Capacity



EXPLANATION

Project Site

BASEMAP SOURCE: ENGEO INC, ESRI WORLD TOPO MAP

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

ENGEO
Expect Excellence

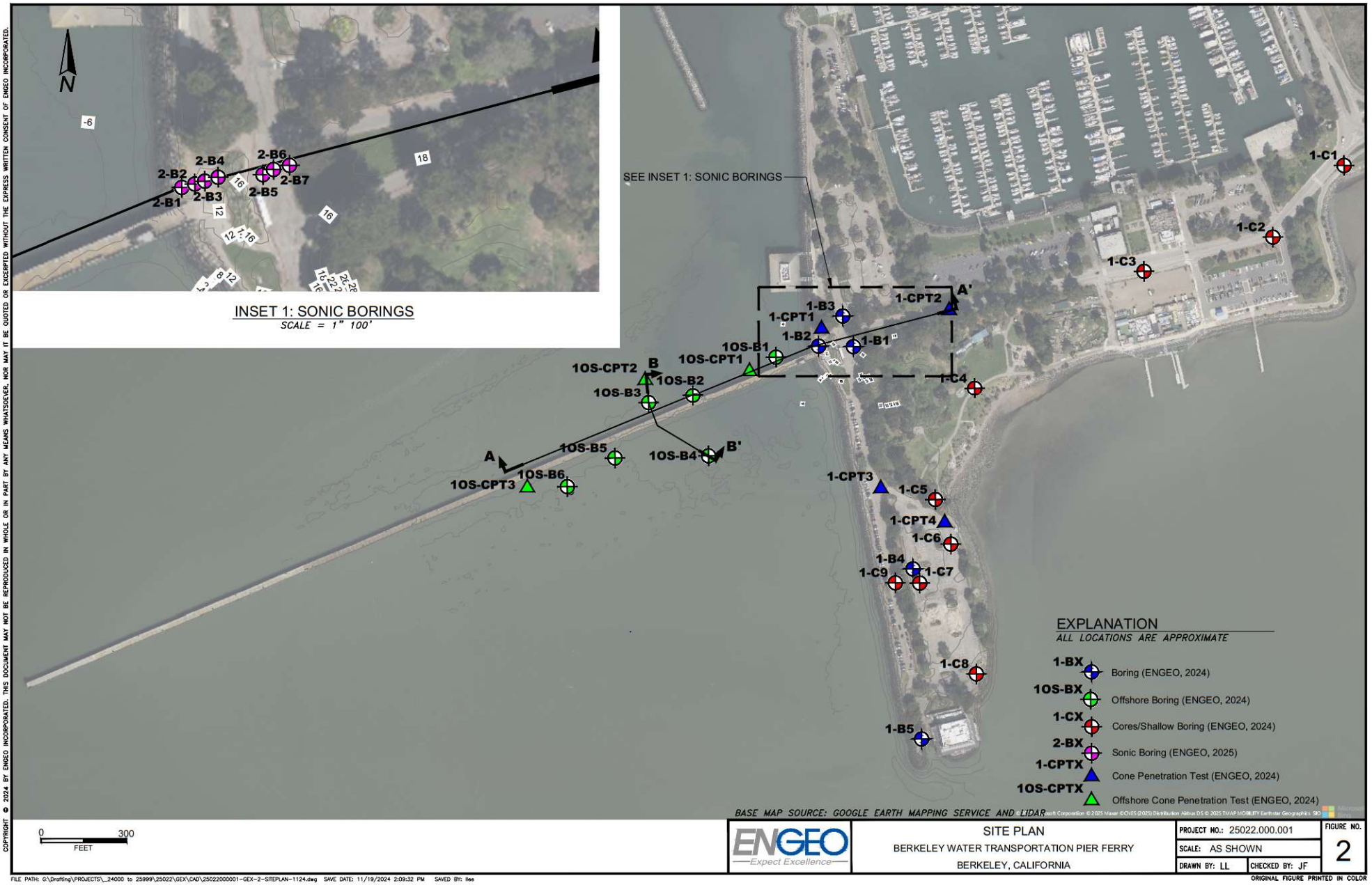
VICINITY MAP

BERKELEY WATER TRANSPORTATION PIER FERRY

BERKELEY, CALIFORNIA

PROJECT NO. : 25022.000.001		FIGURE NO. 1
SCALE: AS SHOWN		
DRAWN BY: VZ	CHECKED BY: JF	

ORIGINAL FIGURE PRINTED IN COLOR



COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

ENGEO
Expect Excellence

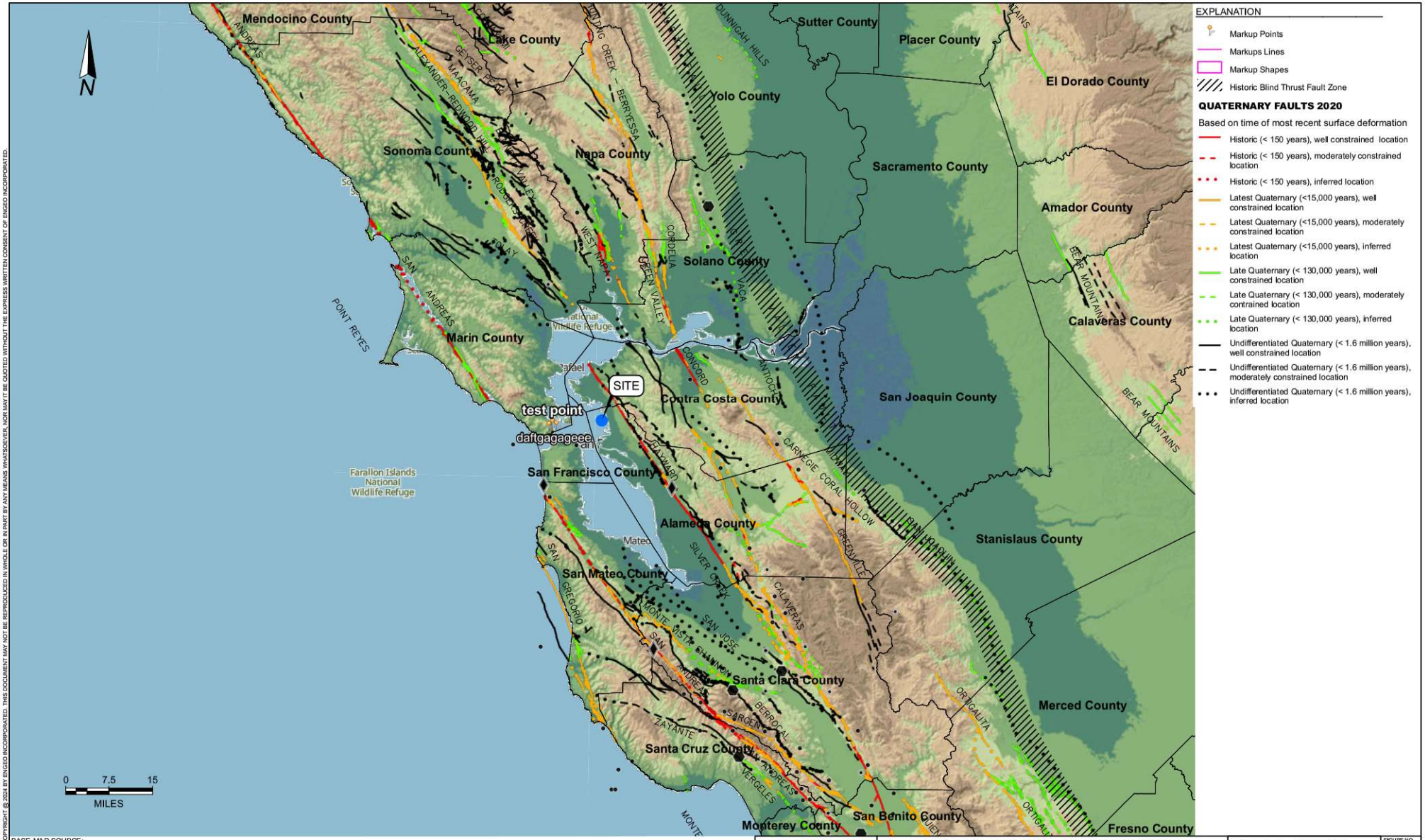
SITE PLAN
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NO.: 25022.000.001
SCALE: AS SHOWN
DRAWN BY: LL
CHECKED BY: JF

FIGURE NO. 2

ORIGINAL FIGURE PRINTED IN COLOR

FILE PATH: G:\Drafting\PROJECTS_24000 to 25999\25022\GEX\CAD\25022000001-GEX-2-SITEPLAN-1124.dwg SAVE DATE: 11/19/2024 2:09:32 PM SAVED BY: llee



EXPLANATION

- Markup Points
- Markups Lines
- Markup Shapes
- Historic Blind Thrust Fault Zone

QUATERNARY FAULTS 2020

Based on time of most recent surface deformation

- Historic (< 150 years), well constrained location
- Historic (< 150 years), moderately constrained location
- Historic (< 150 years), inferred location
- Latest Quaternary (<15,000 years), well constrained location
- Latest Quaternary (<15,000 years), moderately constrained location
- Latest Quaternary (<15,000 years), inferred location
- Late Quaternary (< 130,000 years), well constrained location
- Late Quaternary (< 130,000 years), moderately contrained location
- Late Quaternary (< 130,000 years), inferred location
- Undifferentiated Quaternary (< 1.6 million years), well constrained location
- Undifferentiated Quaternary (< 1.6 million years), moderately constrained location
- Undifferentiated Quaternary (< 1.6 million years), inferred location

COPYRIGHT @ 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED, WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

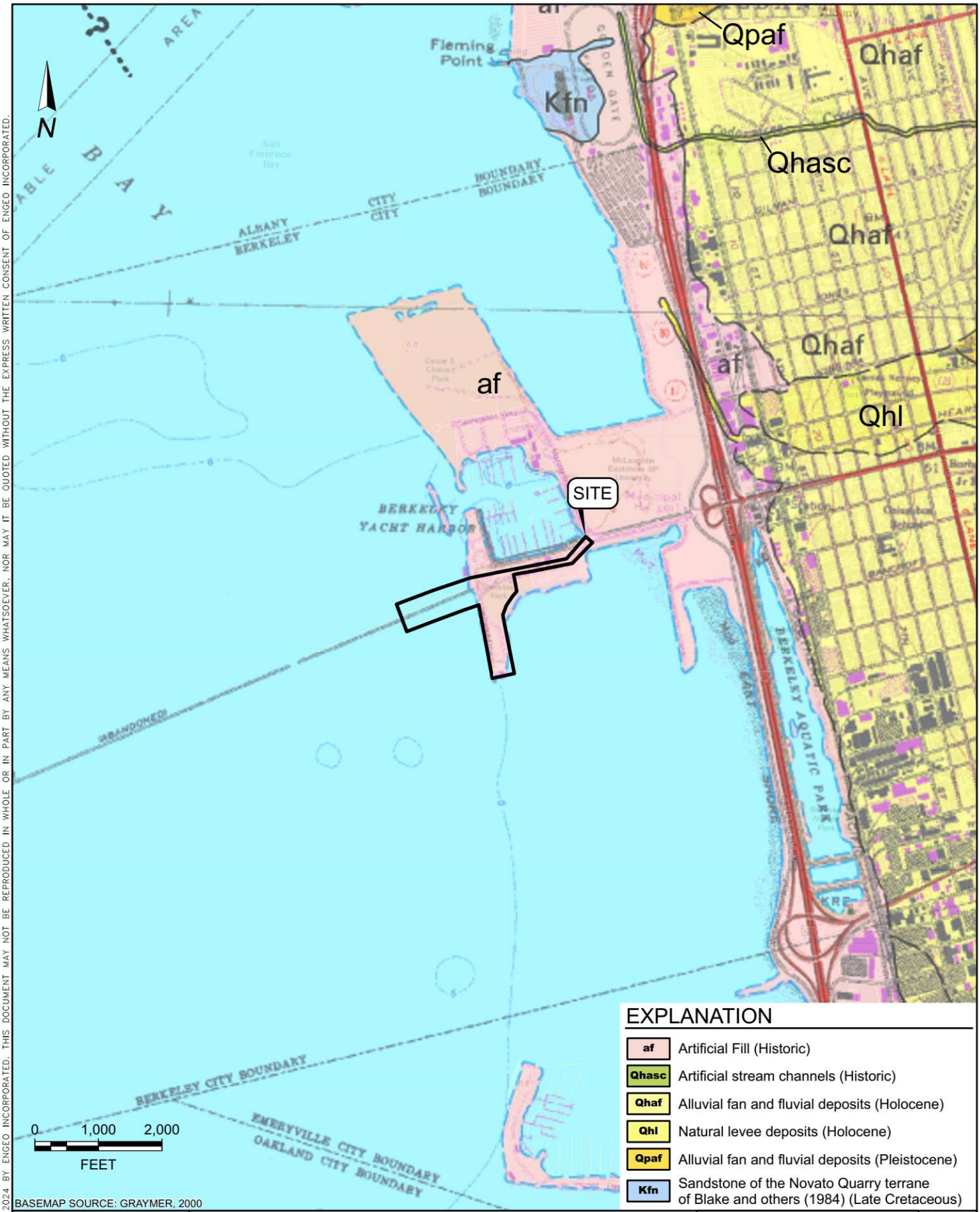
BASE MAP SOURCE:
ENGEO
COLOR HILLSHADE IMAGE BASED ON THE NATIONAL ELEVATION DATA SET (NED) AT 30 METER RESOLUTION
U.S.G.S. QUATERNARY FAULT DATABASE, 2020
C.G.S. HISTORIC EARTHQUAKE DATABASE

ENGEO
Expect Excellence

REGIONAL FAULTING AND SEISMICITY MAP
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NO. :	25022.000.001	FIGURE NO. 3
SCALE:	AS SHOWN	
DRAWN BY: VZ	CHECKED BY: JF	

ORIGINAL FIGURE PRINTED IN COLOR



BASEMAP SOURCE: GRAYMER, 2000

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

ENGEO Expect Excellence

GEOLOGIC MAP

BERKELEY WATER TRANSPORTATION PIER FERRY

BERKELEY, CALIFORNIA

PROJECT NO. :	25022.000.001
SCALE:	AS SHOWN
DRAWN BY: NWC	CHECKED BY: JF

FIGURE NO. 4

PATH: G:\DRAFTING\PROJECTS_24000 TO 25999\25022\GEX\25022000001_BERKELEYWATERTRANSPORTATIONPIERFERRY – GEX.APRX
LAYOUT: 03. GEOLOGIC 8.5 X 11 PORTRAIT USER: NCLOUGH

ORIGINAL FIGURE PRINTED IN COLOR



1-B2



1-B3



1-B5



1-C1



1-C2



1-C3

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

ENGEO Expect Excellence

ASPHALT CORE PHOTOGRAPHS

BERKELEY WATER TRANSPORTATION PIER FERRY

BERKELEY, CALIFORNIA

PROJECT NUMBER: **25022.000.001**		FIGURE NO. **5A**
SCALE: **NO SCALE**		
DRAWN BY: **NWC**	CHECKED BY: **JF**	



1-C4



1-C5



1-C6



1-C7



1-C8



1-C9

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

ENGEO Expect Excellence

ASPHALT CORE PHOTOGRAPHS

BERKELEY WATER TRANSPORTATION PIER FERRY

BERKELEY, CALIFORNIA

PROJECT NUMBER: **25022.000.001**		FIGURE NO. **5B**
SCALE: **NO SCALE**		
DRAWN BY: **NWC**	CHECKED BY: **JF**	



1-CPT2



1-CPT3



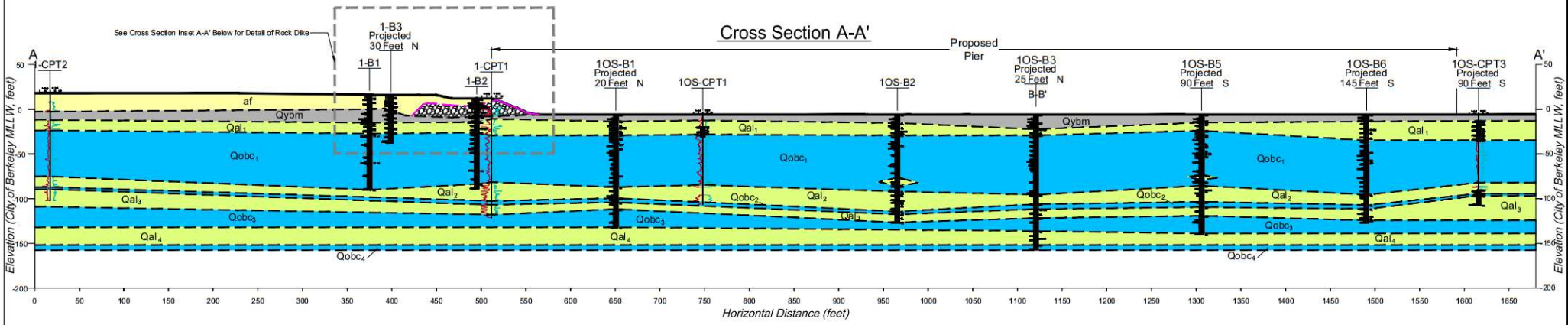
1-CPT4

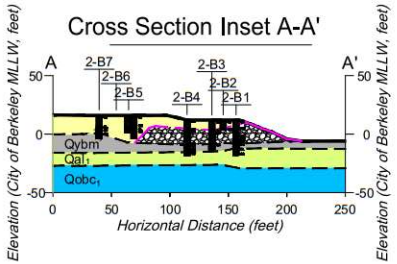
COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

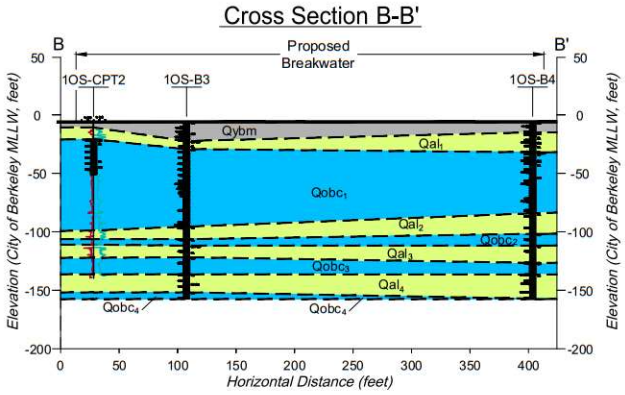
ENGEO Expect Excellence

ASPHALT CORE PHOTOGRAPHS
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NUMBER: **25022.000.001**		FIGURE NO. **5C**
SCALE: **NO SCALE**		
DRAWN BY: **NWC**	CHECKED BY: **JF**	







Legend

af	Artificial Fill
Qybm	Young Bay Mud (Holocene)
Qal	Alluvium (Pleistocene and/or Holocene), Number Indicates Layer Order
Qobc	Old Bay Clay/Old Bay Deposits (Pleistocene), Number Indicates Layer Order
1-BX	Boring (ENGEO, 2024)
1OS-BX	Off-Shore Boring (ENGEO, 2024)
1-CPTX	Cone Penetration Test (ENGEO, 2024)
1OS-CPTX	Off Shore Cone Penetration Test (ENGEO, 2024)
2-BX	Boring (ENGEO, 2025)

Existing Ground Surface

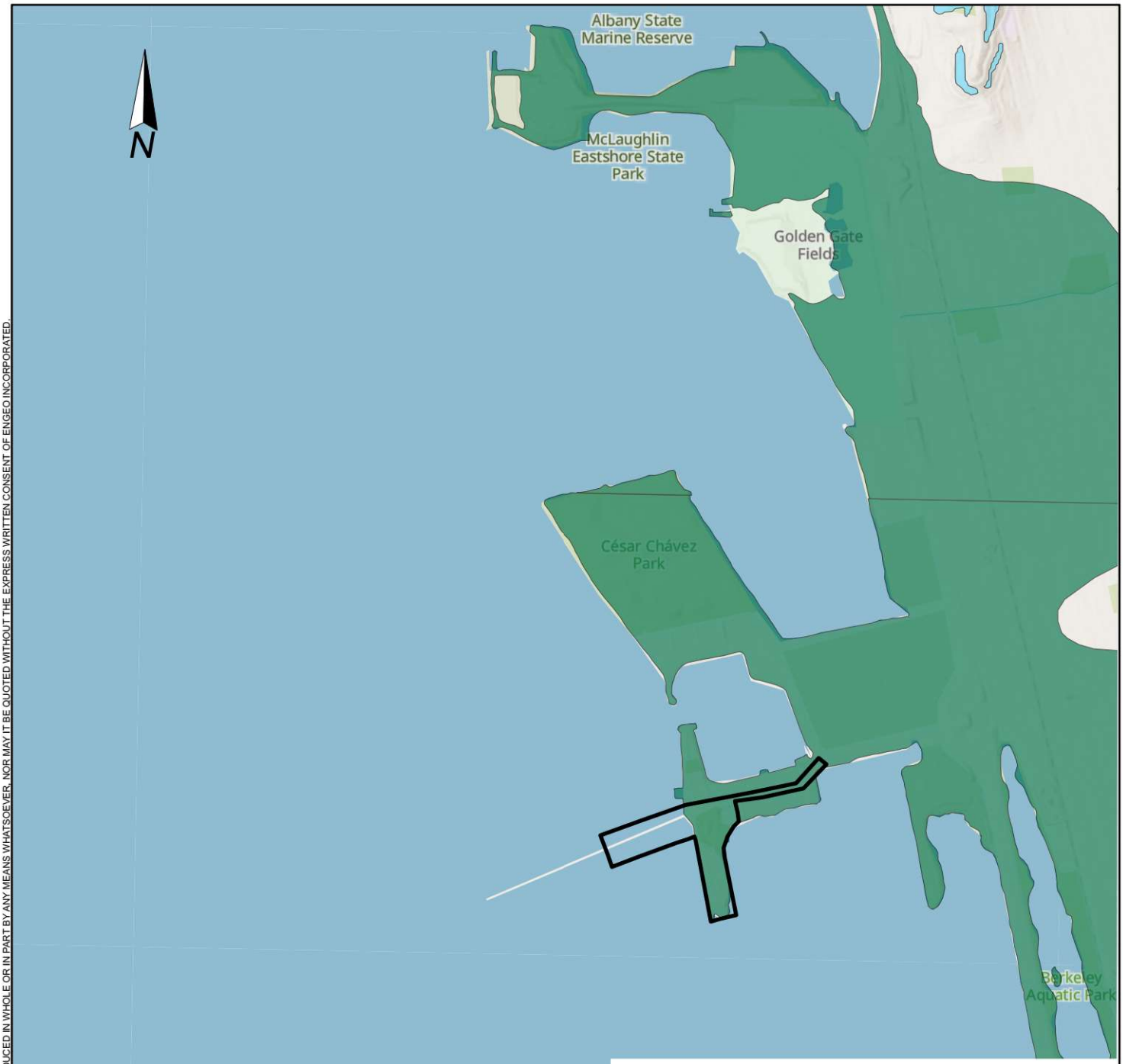
Geologic Contact, dashed where approximate queried where inferred

Rock Dike

Disclaimer: Cross Section Is For Illustration Purposes Only. The Transition Between Materials May Be Abrupt Or Gradual. Variations Should Be Expected.

CROSS SECTIONS A-A' AND B-B'
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NO.: 25022.000.001
SCALE: AS SHOWN
DRAWN BY: LL CHECKED BY: JF



EXPLANATION

- Project Site
- Liquefaction Zones
  Areas Where The Historical Occurrence Of Liquefaction, Or Local Geological, Geotechnical And Groundwater Conditions Indicate A Potential For Permanent Ground Displacements Such That Mitigation As Defined In Public Resources Code Section 2693(C) Would Be Required
- Earthquake-Induced Landslide Zones
  Areas Where The Previous Occurrence Of Landslide Movement, Or Local Topographic, Geological, Geotechnical And Subsurface Water Conditions Indicate A Potential For Permanent Ground Displacements Such That Mitigation As Defined In Public Resources Code Section 2693(C) Would Be Required.

BASEMAP SOURCE: ESRI MAPPING SERVICE
CALIFORNIA DEPARTMENT OF CONSERVATION, CALIFORNIA GEOLOGICAL SURVEY

COPYRIGHT @ 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

ENGEO
Expect Excellence

SEISMIC HAZARD ZONE MAP

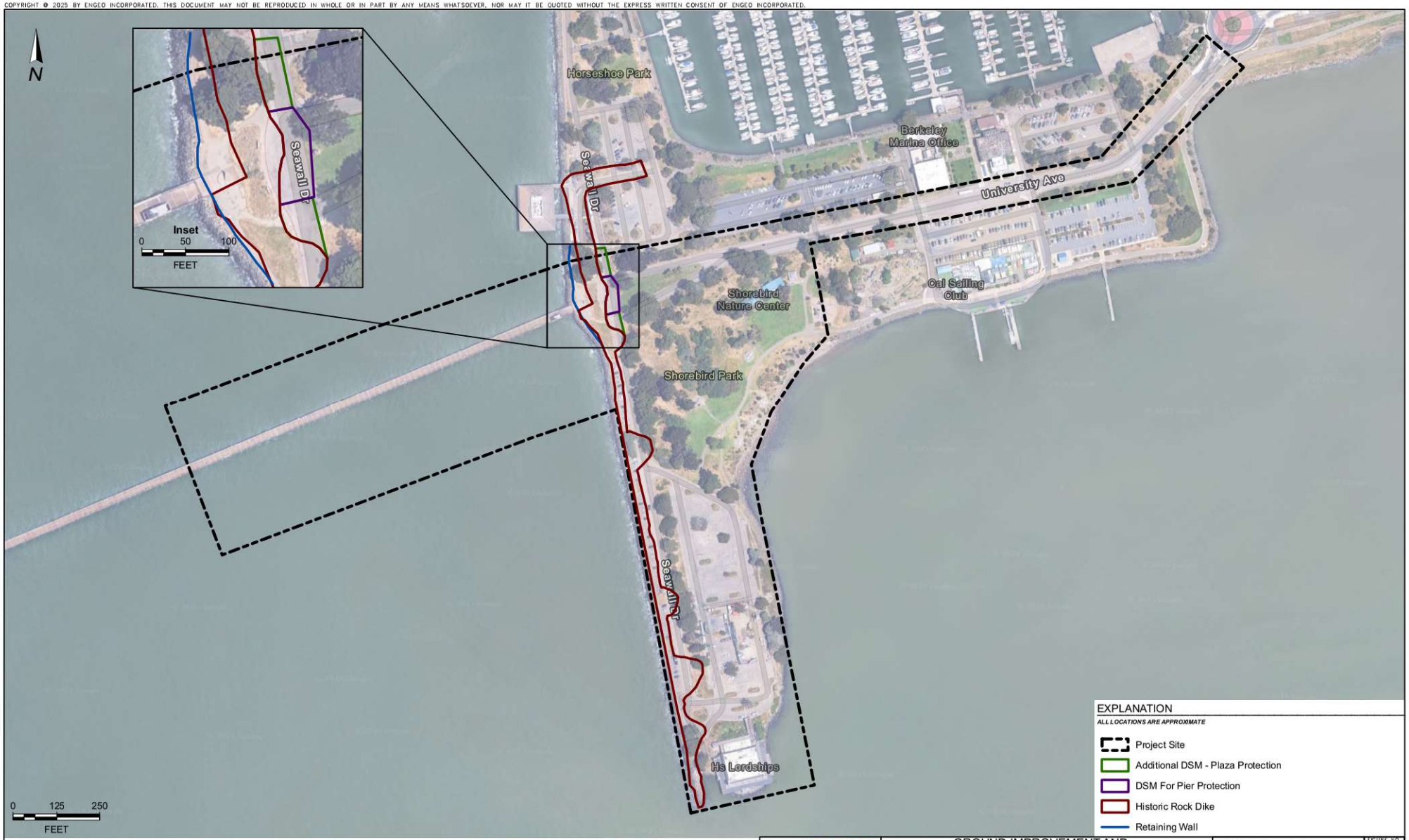
BERKELEY WATER TRANSPORTATION PIER FERRY

BERKELEY, CALIFORNIA

PROJECT NO. : 25022.000.001		FIGURE NO. 7
SCALE: AS SHOWN		
DRAWN BY: VZ	CHECKED BY: JF	

ORIGINAL FIGURE PRINTED IN COLOR

COPYRIGHT © 2025 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.



BASEMAP SOURCE: GOOGLE EARTH MAPPING SERVICE 2022

ENGEO Expect Excellence

GROUND IMPROVEMENT AND RETAINING WALL EXTENTS
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

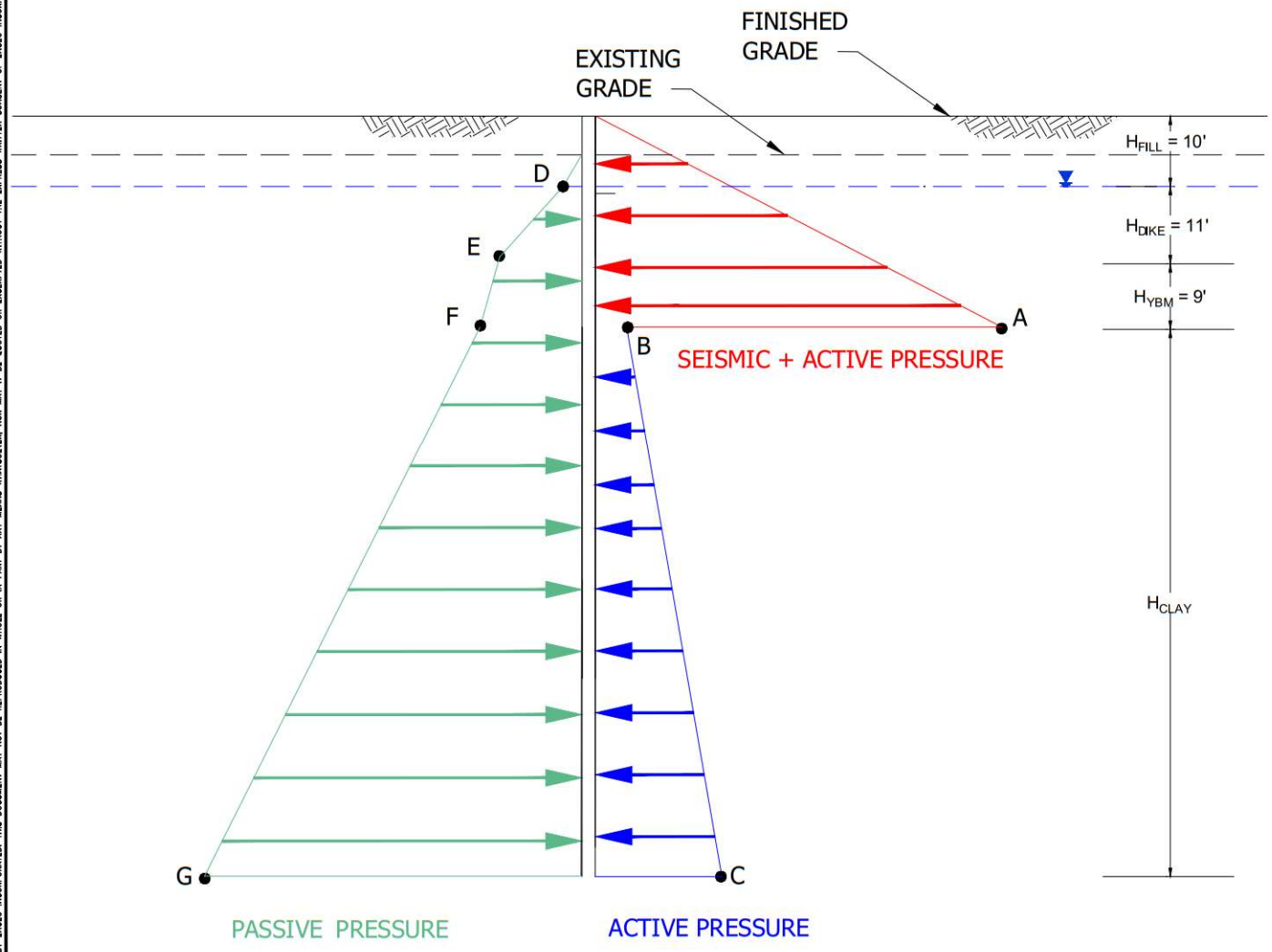
PROJECT NO. :	25022.000.001
SCALE:	AS SHOWN
DRAWN BY: NWC	CHECKED BY: JF

FIGURE NO. 8

ORIGINAL FIGURE PRINTED IN COLOR

PATH: G:\DRAFTING\PROJECTS_24000 TO 25999\25022\GEX\25022000001_BERKELEYWATERTRANSPORTATIONPIERFERRY - GEX.APRX
LAYOUT: 08. EXTENTS OF GROUND IMPROVEMENT 11 X 17 LANDSCAPE USER: NLAMOTTEKERR

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.



NOTES:

1. LATERAL EARTH PRESSURES SHOWN ARE FOR SEISMIC LOADING CONDITIONS ON THE RESTRAINED WALL.
2. PRESSURE DIAGRAM CONSIDERS HYDROSTATIC CONDITIONS, AND DOES NOT INCLUDE ADDITIONAL INFLUENCE OF CONFINED OR PARTIALLY CONFINED AQUIFERS THAT MAY BE PRESENT ON-SITE.
3. DEPTH TO GROUNDWATER IS 10 FEET BELOW FINISHED GRADE.
4. PASSIVE PRESSURE OF FILL AND DIKE IS DERIVED ASSUMING SLOPED CONDITIONS ALONG THE SHORELINE.

LATERAL EARTH PRESSURE PARAMETERS			
Layer	SEISMIC + ACTIVE EFPs [CLE/MCE] (pcf)	ACTIVE EFP_a (pcf)	PASSIVE EFP_p (pcf)
Fill	170 / 340	N/A	95
Dike	170 / 340	N/A	145
Young Bay Mud (YBM)	170 / 340	N/A	55
Clay	N/A	30	140

PRESSURE POINT CALCULATION (PSF)

Point A: $\sigma_A = 30 * EFP_s$

Point B: $\sigma_B = 850$

Point C: $\sigma_c = \sigma_B + (H_{CLAY} * EFP_{a,clay})$

Point D: $\sigma_D = 475$

Point E: $\sigma_E = 2000$

Point F: $\sigma_F = 2500$

Point G: $\sigma_G = \sigma_F + [(H_{CLAY}) * EFP_{p,clay})]$

ENGEO Expect Excellence

LATERAL PRESSURE DIAGRAM
FOR RETAINING WALL
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

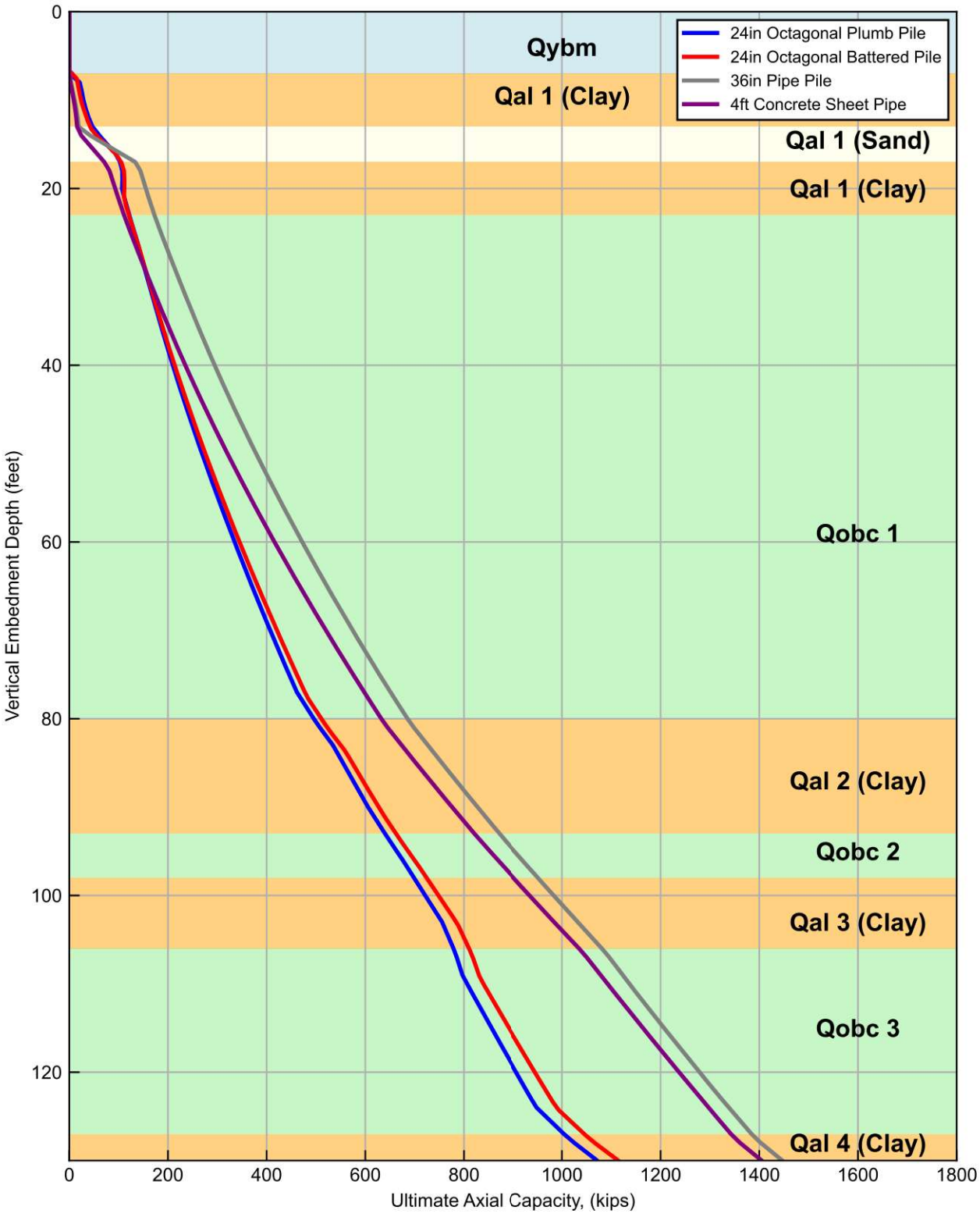
PROJECT NO.: 25022.000.001
SCALE: NO SCALE
DRAWN BY: VZ
CHECKED BY: JF

FIGURE NO. 9

ORIGINAL FIGURE PRINTED IN COLOR

FILE PATH: G:\Drafting_STAFF DRAFTING_2024\25022\EARTHPRESSURE-DIAGRAM.dwg SAVE DATE: 12/15/2024 8:02:20 PM SAVED BY: vzasmolin

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

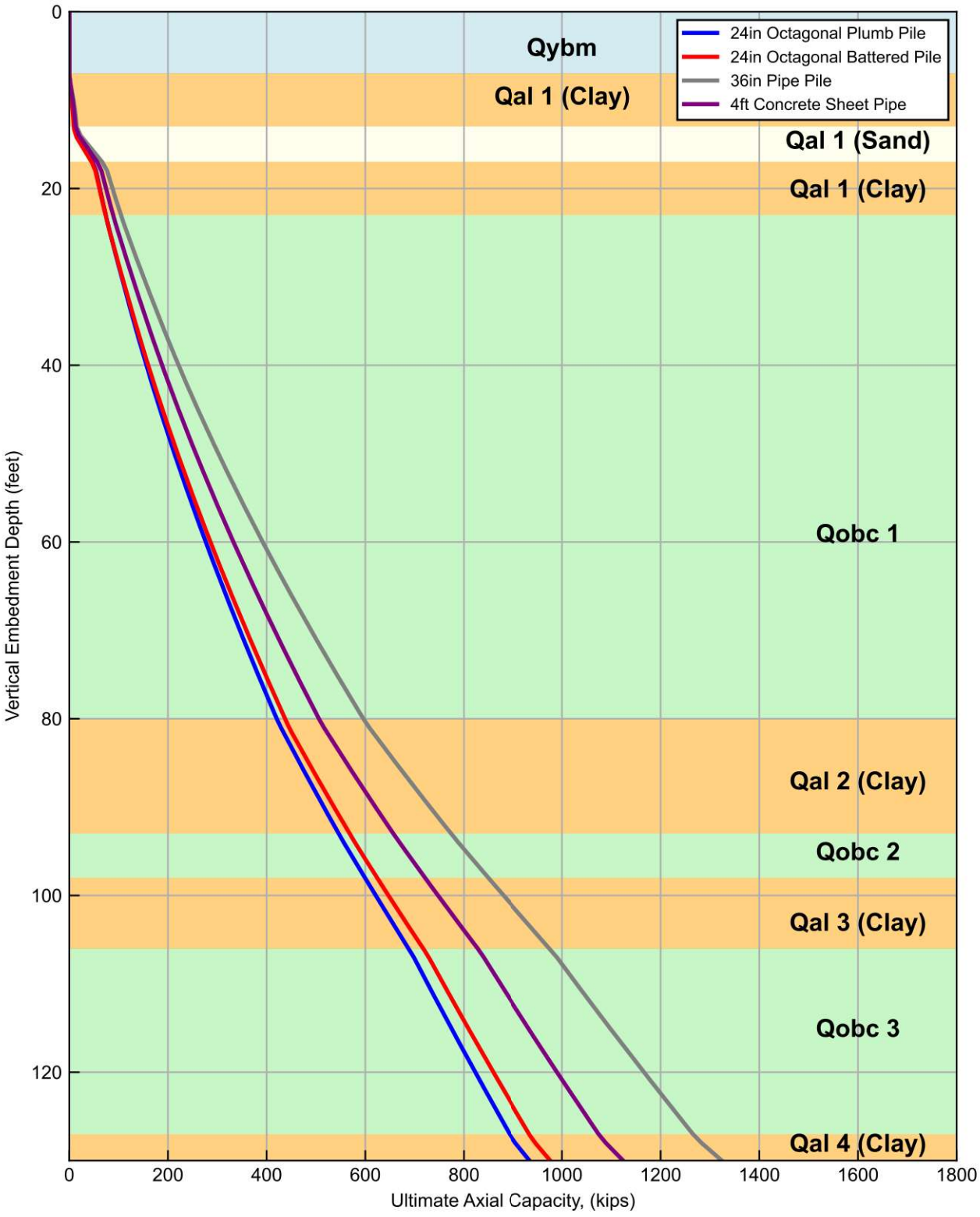


ENGEO Expect Excellence

Ultimate Pile Compression Capacity
Berkeley Water Transportation Pier Ferry
BERKELEY, CALIFORNIA

PROJECT NO: 25022.000.001			FIGURE NO. 10
SCALE: AS SHOWN			
DRAWN BY: VZ	CHECKED BY: JF		

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.



ENGEO Expect Excellence

Ultimate Pile Tension Capacity
Berkeley Water Transportation Pier Ferry
BERKELEY, CALIFORNIA

PROJECT NO: 25022.000.001		FIGURE NO. 11
SCALE: AS SHOWN		
DRAWN BY: VZ	CHECKED BY: JF	



APPENDIX A

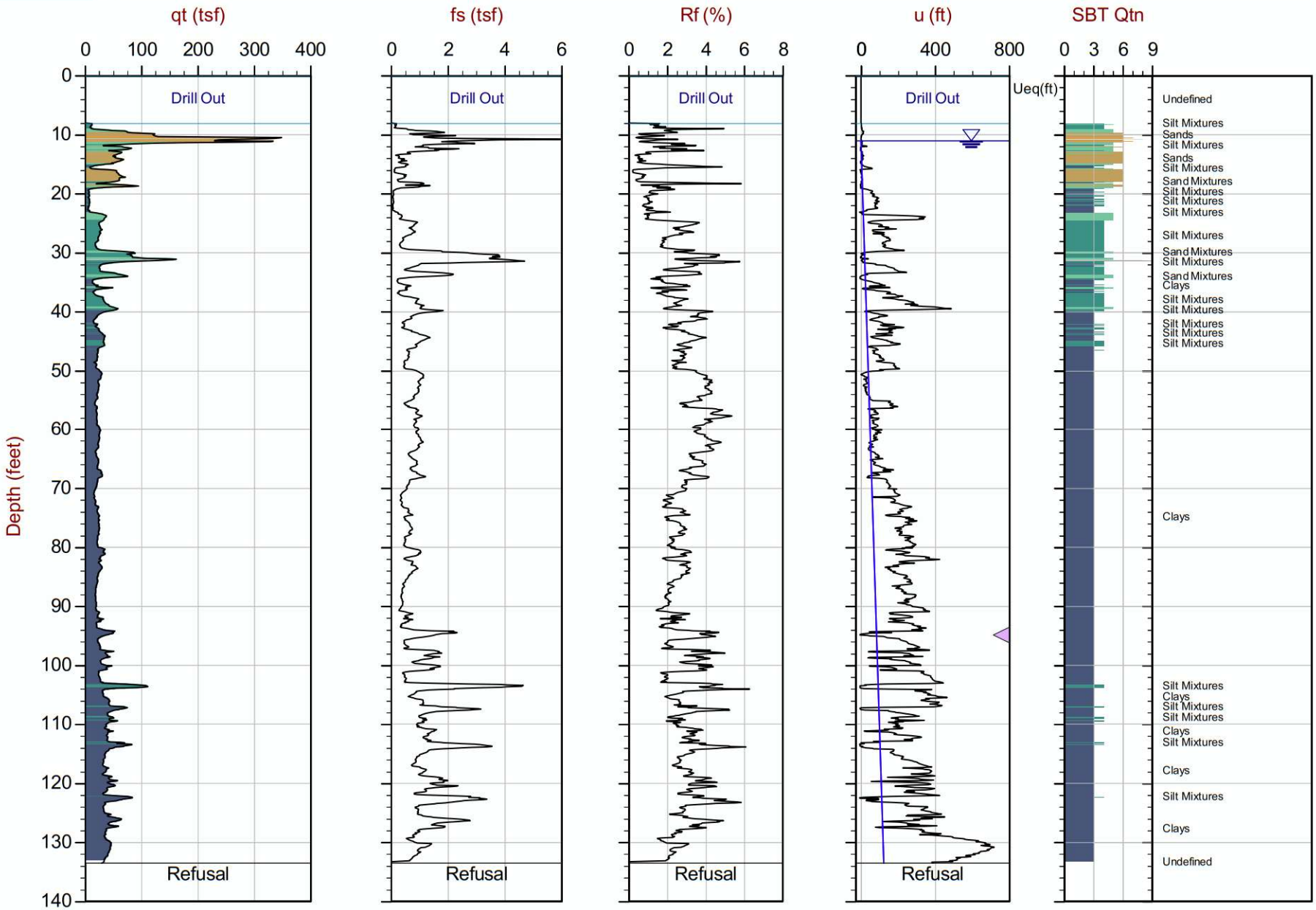
CONE PENETRATION TEST LOGS

CONETEC

ENGEO, Inc.

Job No: 24-56-28254
Date: 2024-08-27 15:22
Site: Berkeley Marina

Sounding: 1-CPT01
Cone: 813:T1500F15U35 Area=15 cm²



Max Depth: 40.700 m / 133.53 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 24-56-28254_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: (UTM Zone 10 North) N: 4190831m E: 560023m

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

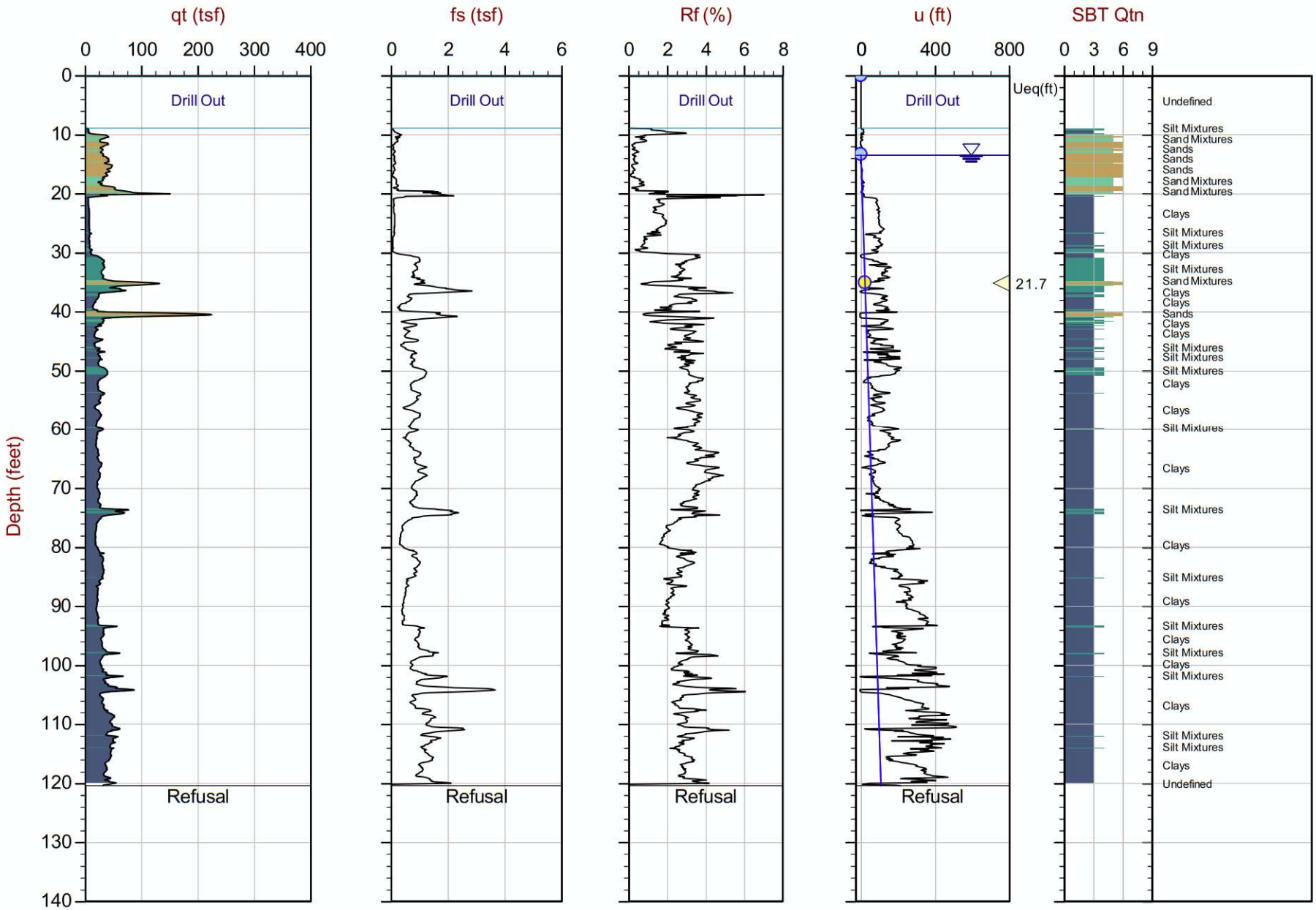
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

ENGEO, Inc.

Job No: 24-56-28254
Date: 2024-08-27 13:42
Site: Berkeley Marina

Sounding: 1-CPT02
Cone: 813:T1500F15U35 Area=15 cm²



Max Depth: 36.700 m / 120.41 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 24-56-28254_CP02B.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: (UTM Zone 10 North) N: 4190873m E: 560133m

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

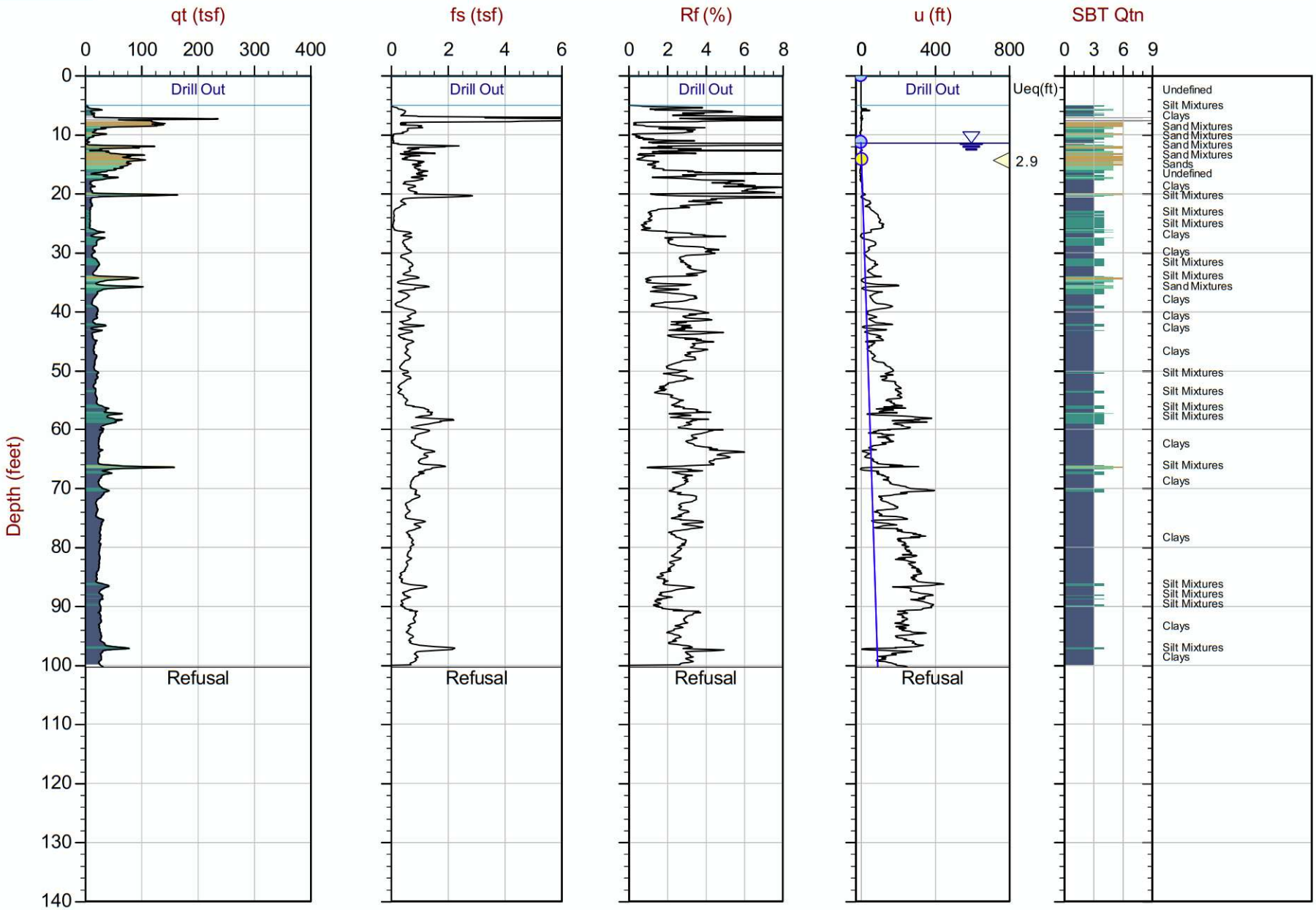
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

ENGEO, Inc.

Job No: 24-56-28254
Date: 2024-08-27 09:00
Site: Berkeley Marina

Sounding: 1-CPT03
Cone: 813:T1500F15U35 Area=15 cm²



Max Depth: 30.575 m / 100.31 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 24-56-28254_CP03.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: (UTM Zone 10 North) N: 4190667m E: 560090m

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | Hydrostatic Line

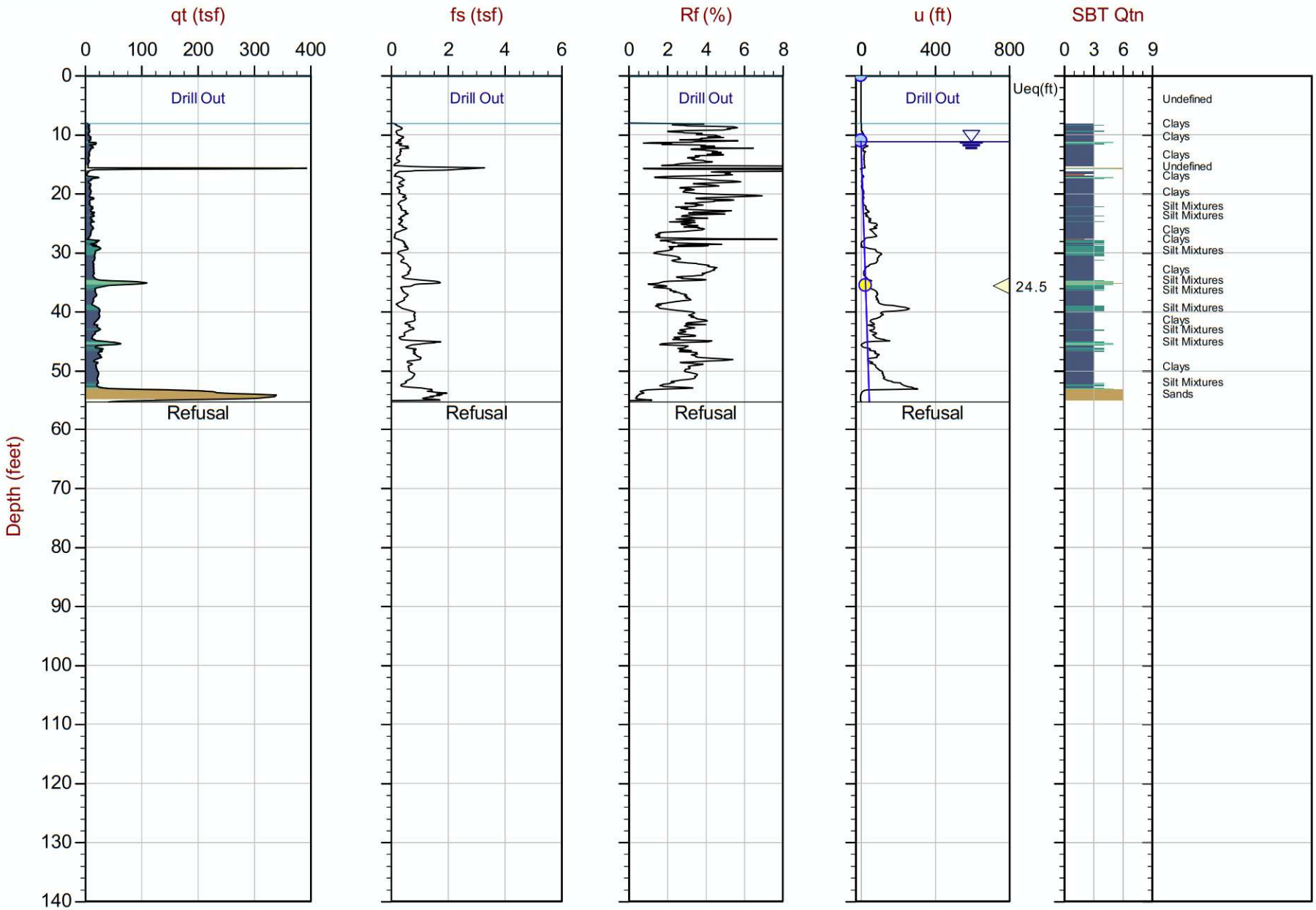
The reported coordinates were acquired from consumer grade GPS equipment and are only approximate locations. The coordinates should not be used for design purposes.

CONETEC

ENGEO, Inc.

Job No: 24-56-28254
Date: 2024-08-29 10:54
Site: Berkeley Marina

Sounding: 1-CPT4
Cone: 813:T1500F15U35 Area=15 cm²



Max Depth: 16.850 m / 55.28 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 24-56-28254_CP04.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: (UTM Zone 10 North) N: 4190842m E: 560337m

Overplot Item: Ueq, Assumed Ueq, Dissipation, Ueq achieved, Dissipation, Ueq not achieved, Dissipation, Ueq assumed, 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.

GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

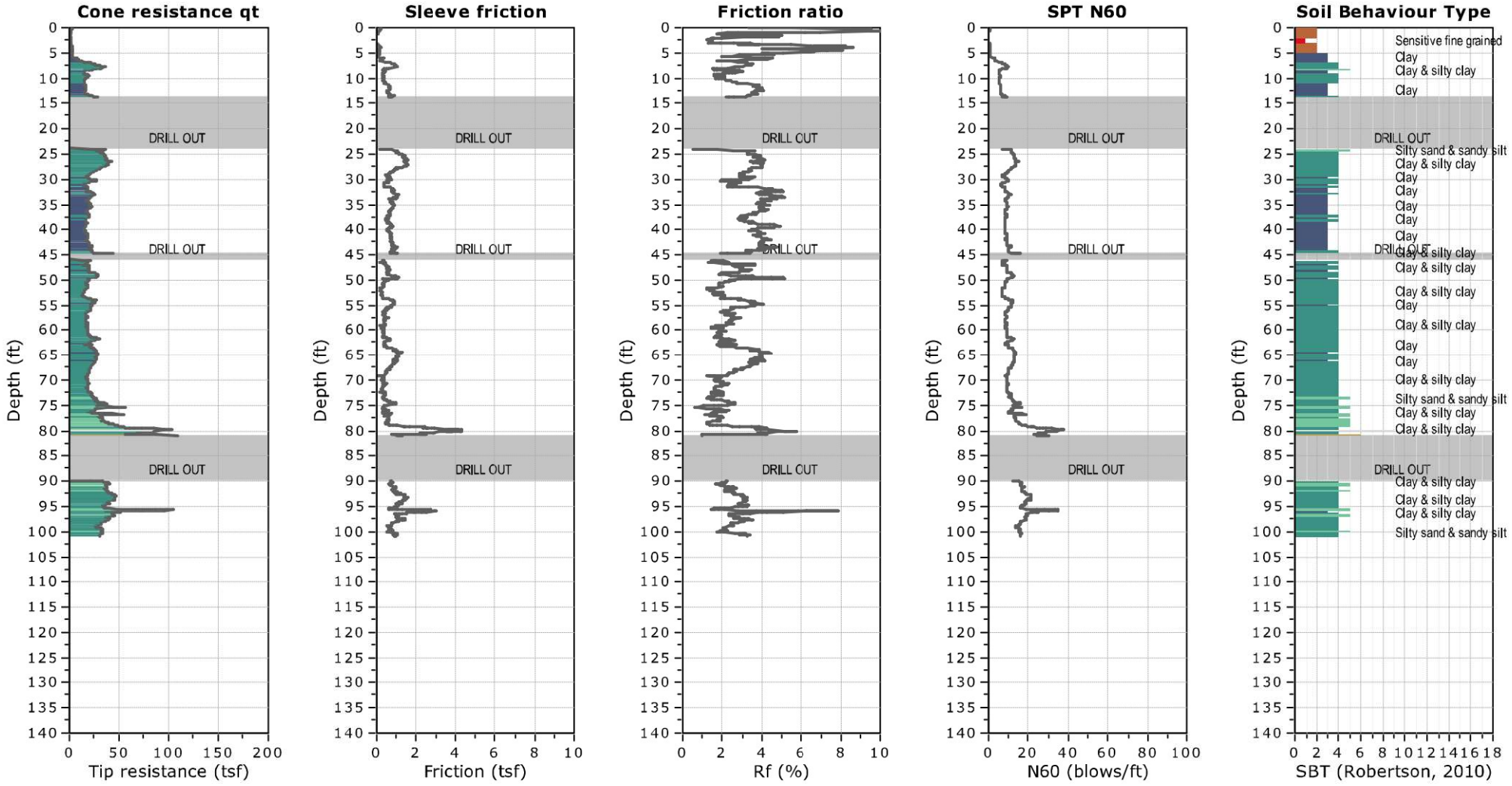
CPT: 1OS-CPT1

FIELD REP: Vlad Z
Cone ID: 231229

CLIENT: ENGEO

SITE: BERKELEY PIER, BERKELEY, CA

Total depth: 100.92 ft, Date: 9/09/2024



GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

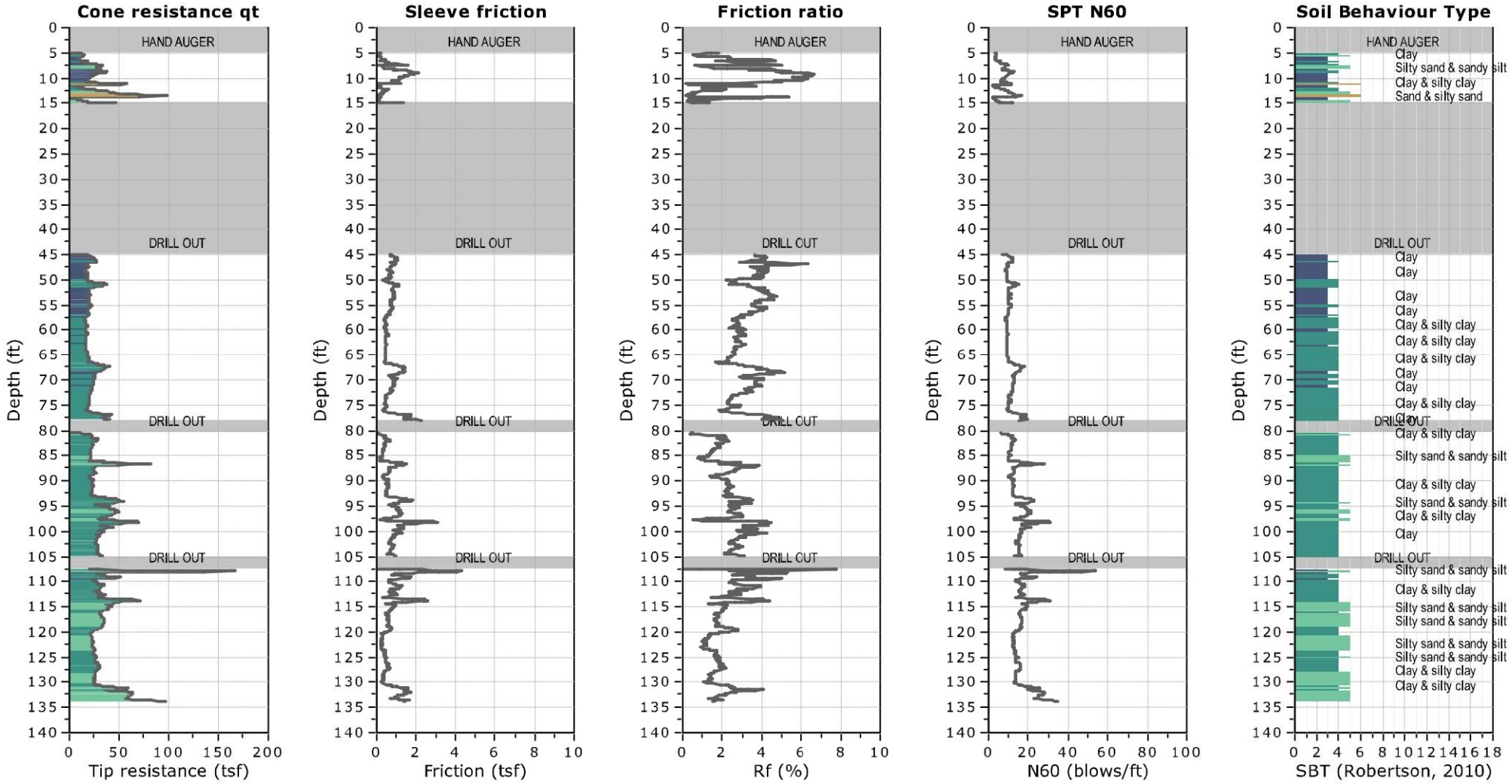
CPT: 1OS-CPT2

CLIENT: ENGEO

SITE: BERKELEY PIER, BERKELEY, CA

FIELD REP: Vlad Z
Cone ID: 231229

Total depth: 133.66 ft, Date: 9/05/2024



GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

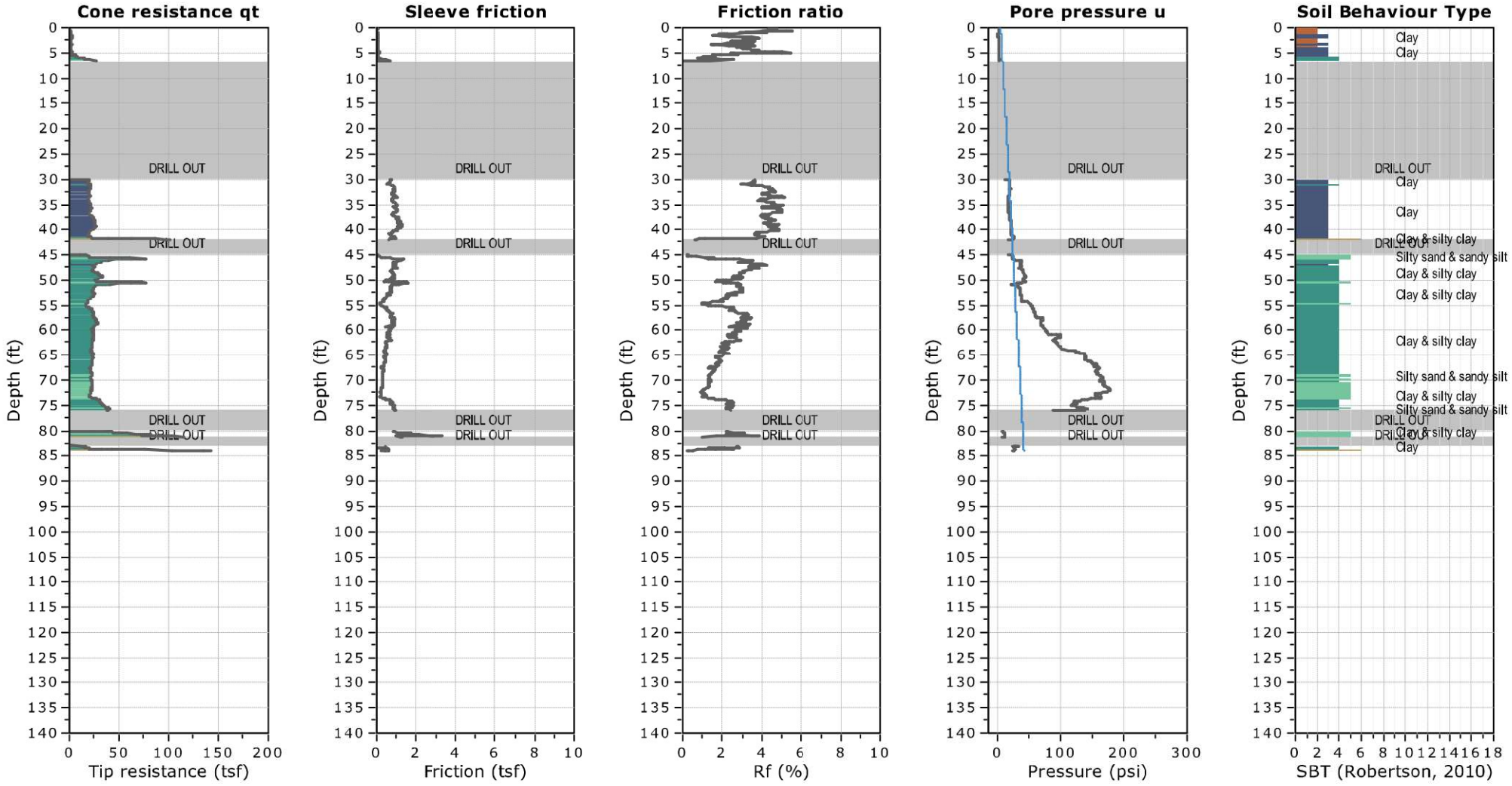
CPT: 1OS-CPT3

CLIENT: ENGEO

SITE: BERKELEY PIER, BERKELEY, CA

FIELD REP: Vlad Z
Cone ID: 231229

Total depth: 83.99 ft, Date: 9/10/2024

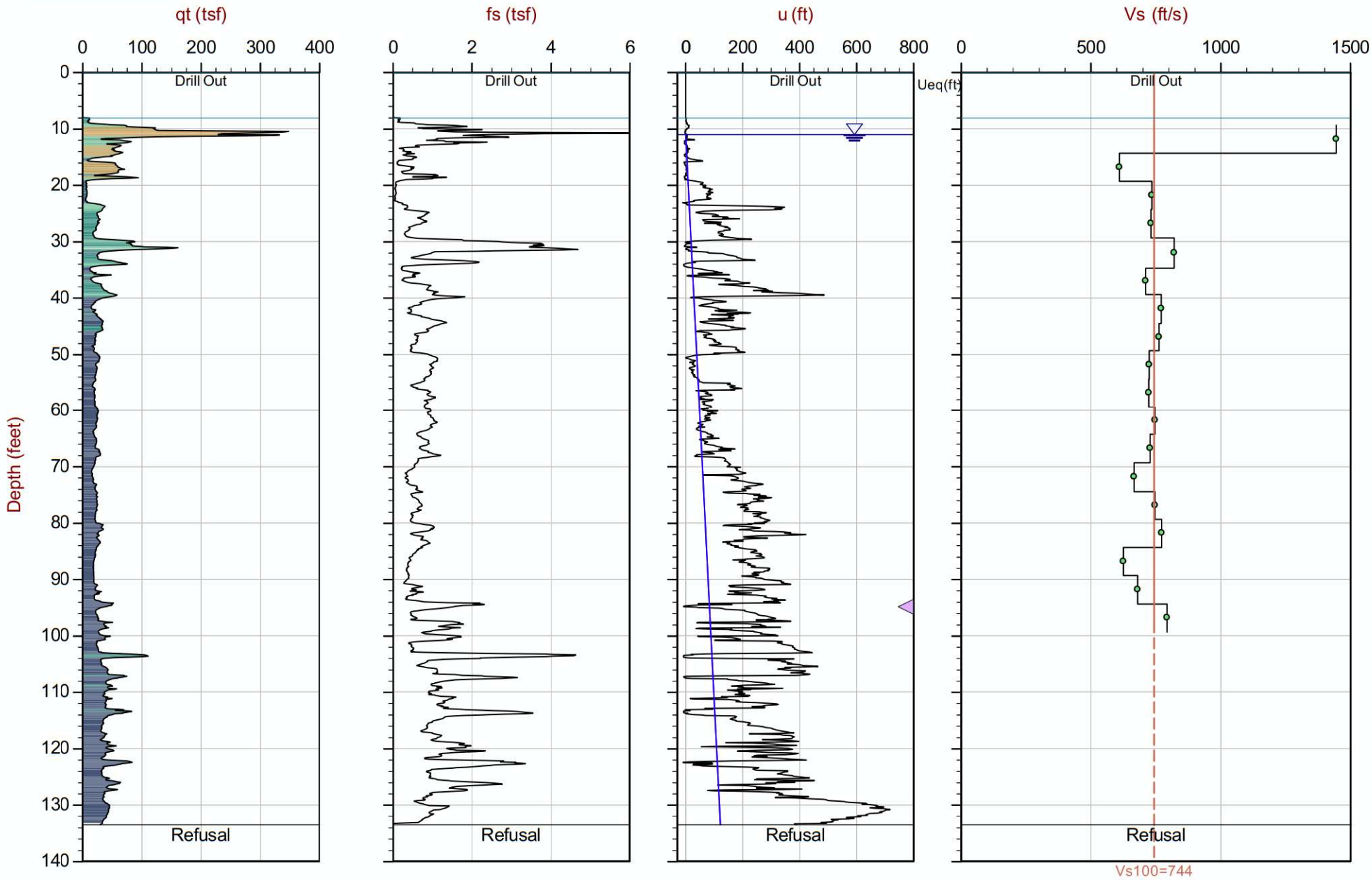


CONETEC

ENGEO, Inc.

Job No: 24-56-28254
Date: 2024-08-27 15:22
Site: Berkeley Marina

Sounding: 1-CPT-01
Cone: 813:T1500F15U35 Area=15 cm²



Max Depth: 40.700 m / 133.53 ft
Depth Inc: 0.025 m / 0.082 ft
Avg Int: Every Point

File: 24-56-28254_SP01.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: (UTM Zone 10 North) N: 4190831m E: 560023m

Overplot Item: Ueq | Assumed Ueq | Dissipation, Ueq achieved | Dissipation, Ueq not achieved | Dissipation, Ueq assumed | 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.



APPENDIX B

CONE PENETRATION LIQUEFACTION CALCULATION

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

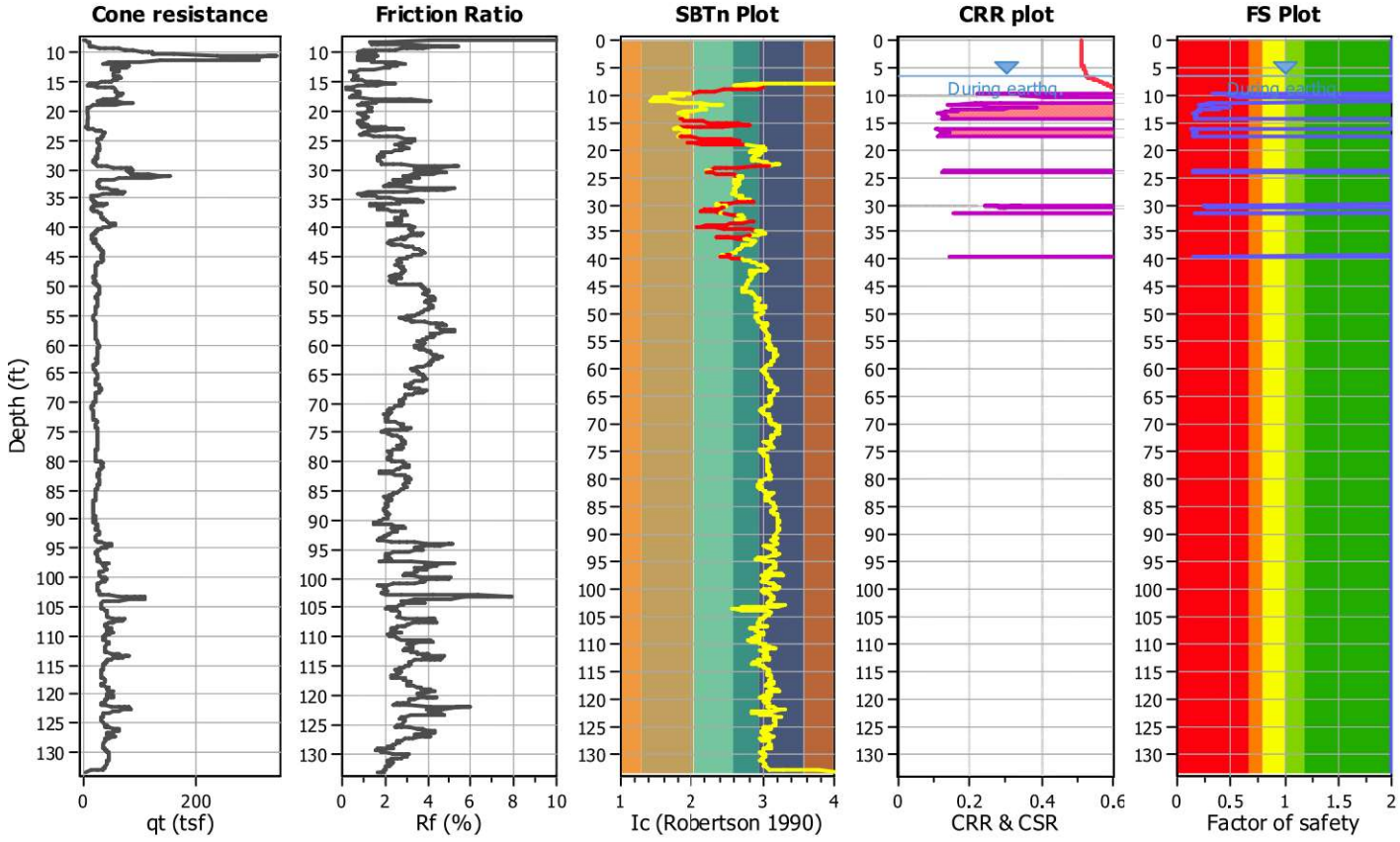
LIQUEFACTION ANALYSIS REPORT

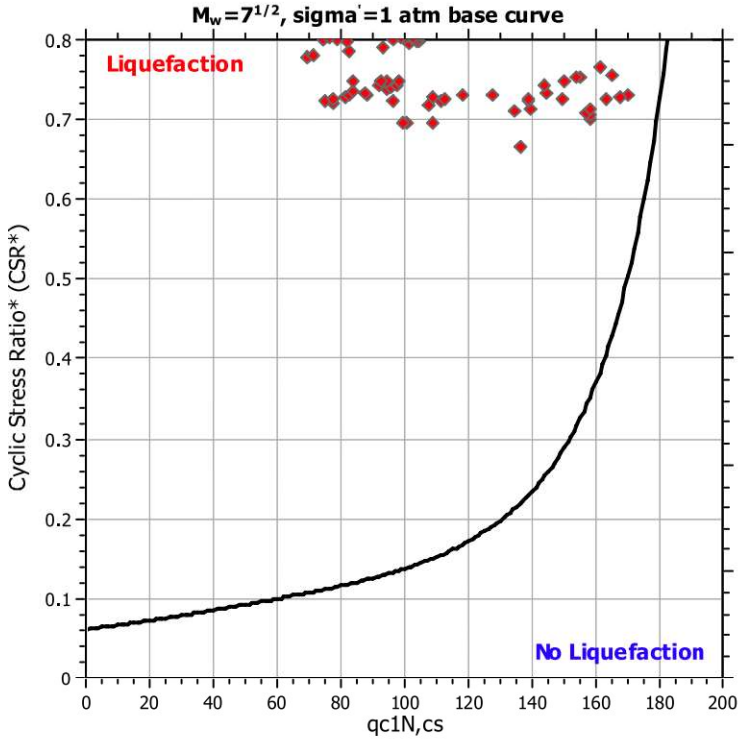
Project title : **Location :**

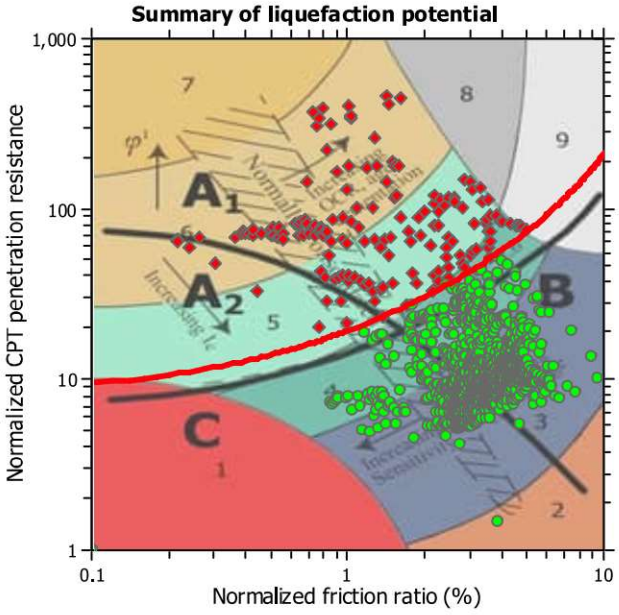
CPT file : 1-CPT1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.60 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.60 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	8.10	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: 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

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

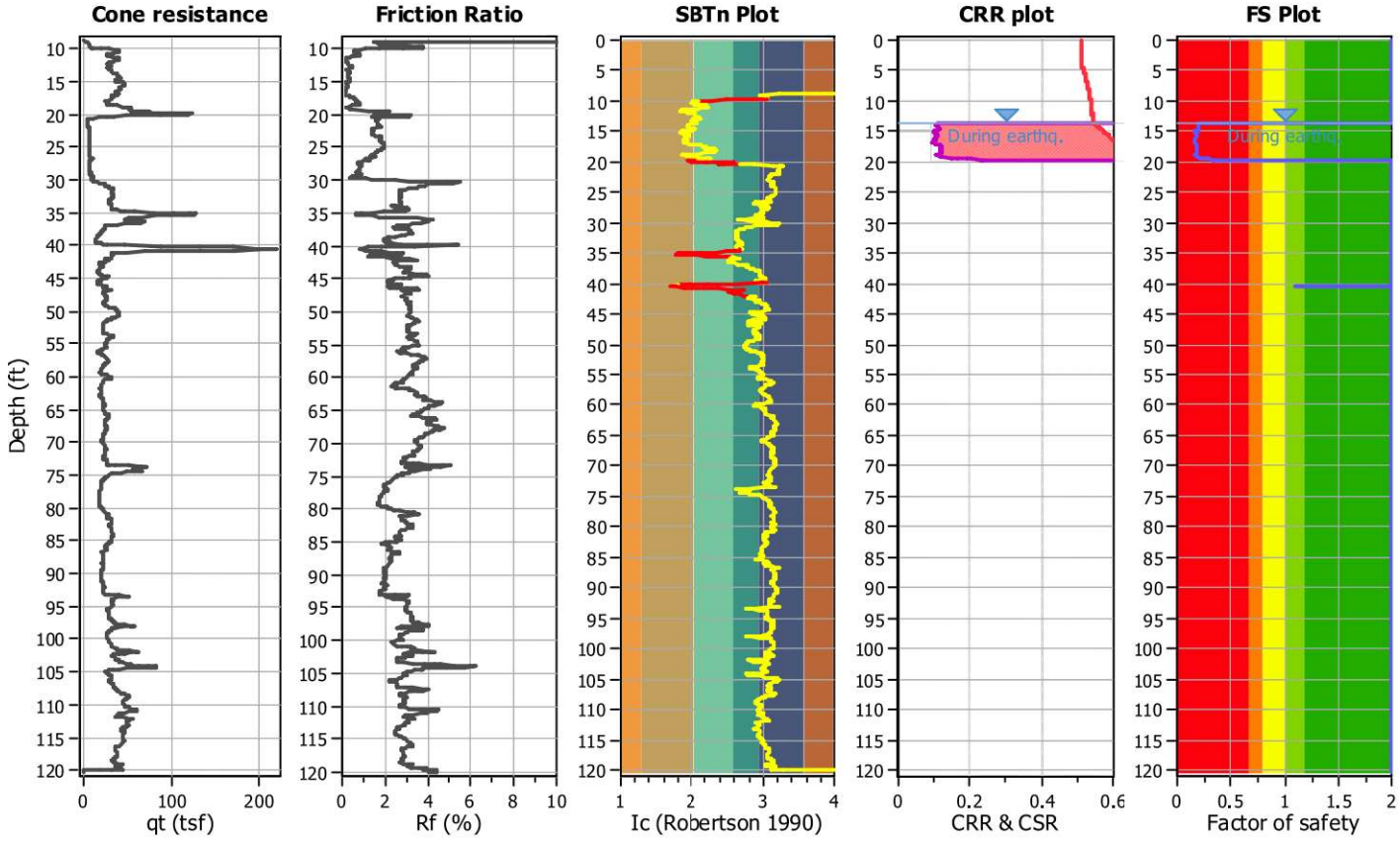
LIQUEFACTION ANALYSIS REPORT

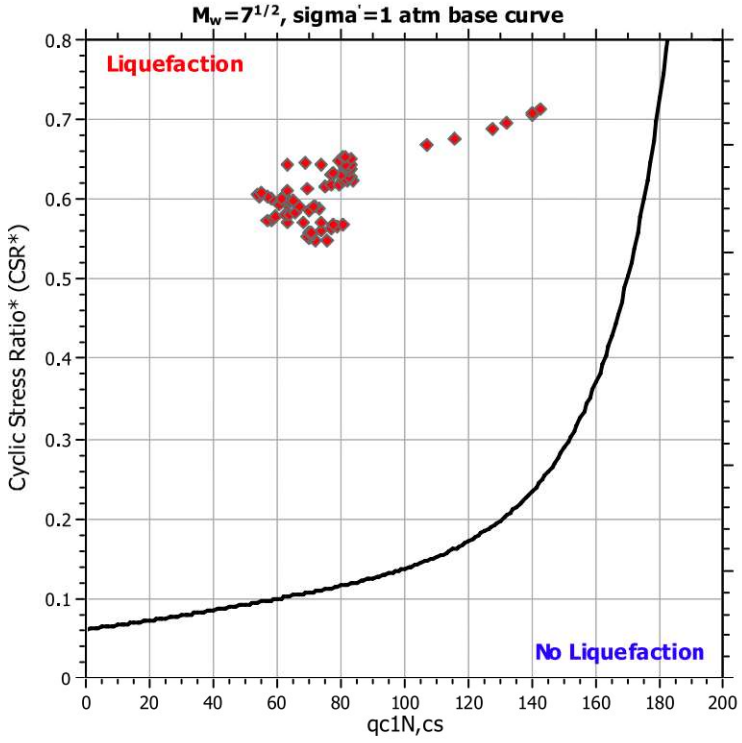
Project title : **Location :**

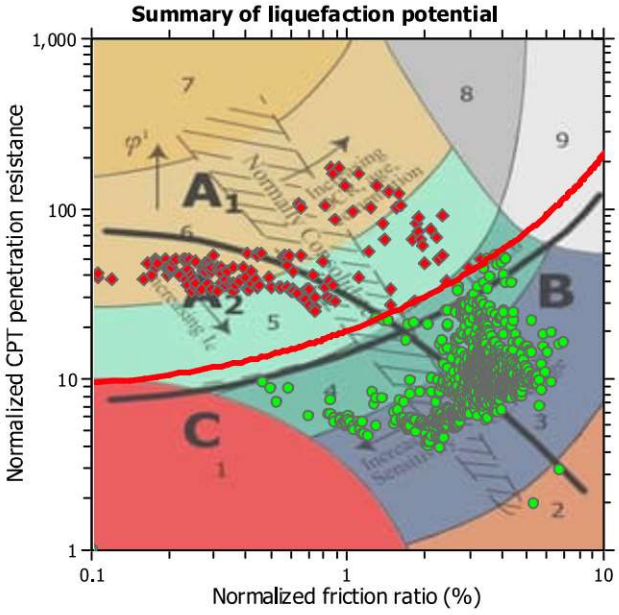
CPT file : 1-CPT2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	13.70 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	13.70 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	8.10	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: 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

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

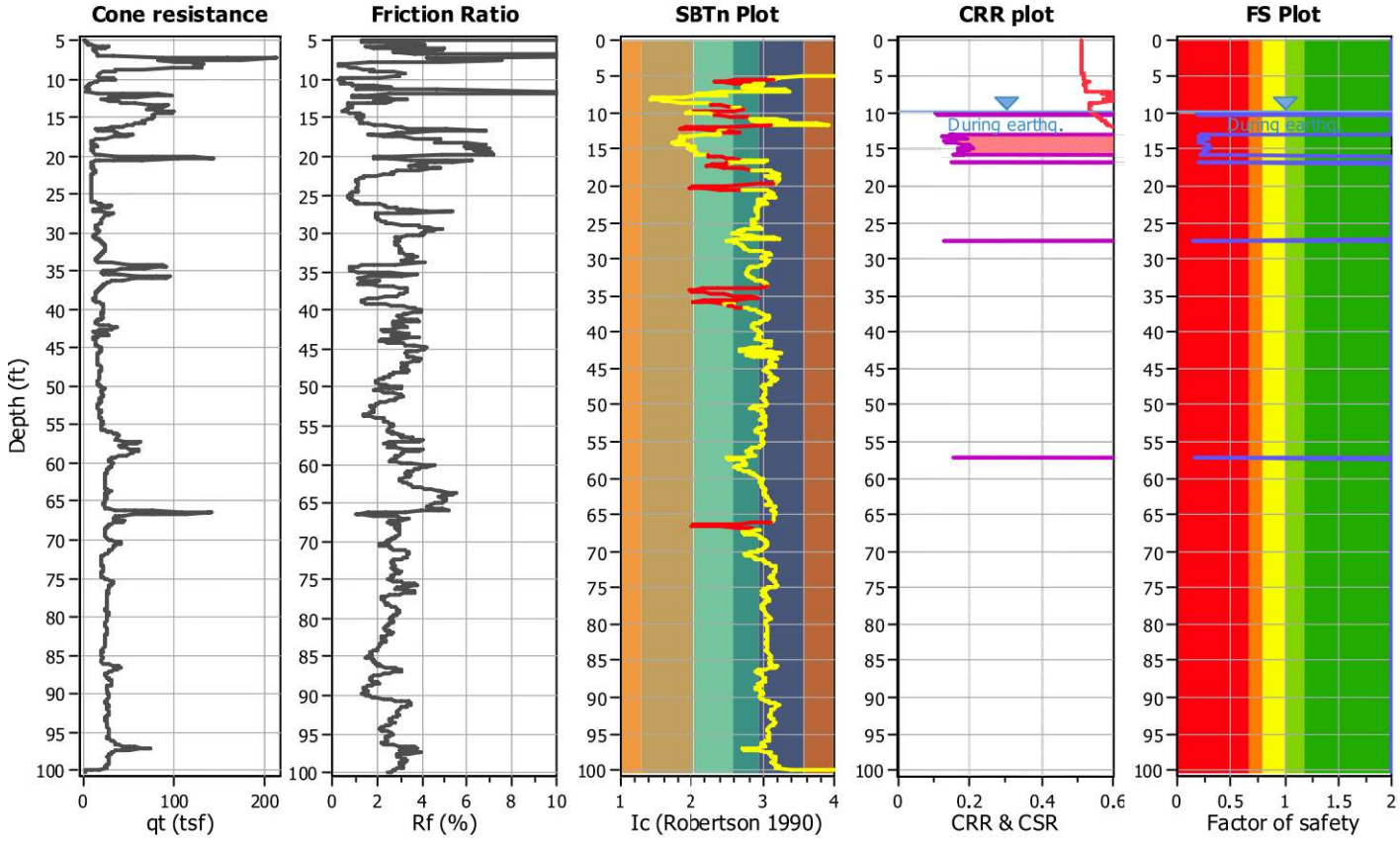
LIQUEFACTION ANALYSIS REPORT

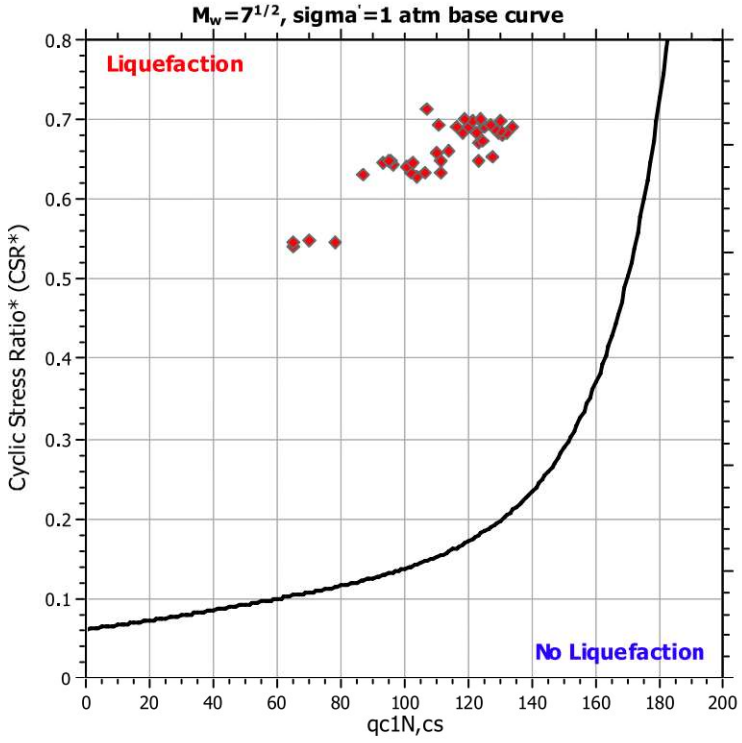
Project title : **Location :**

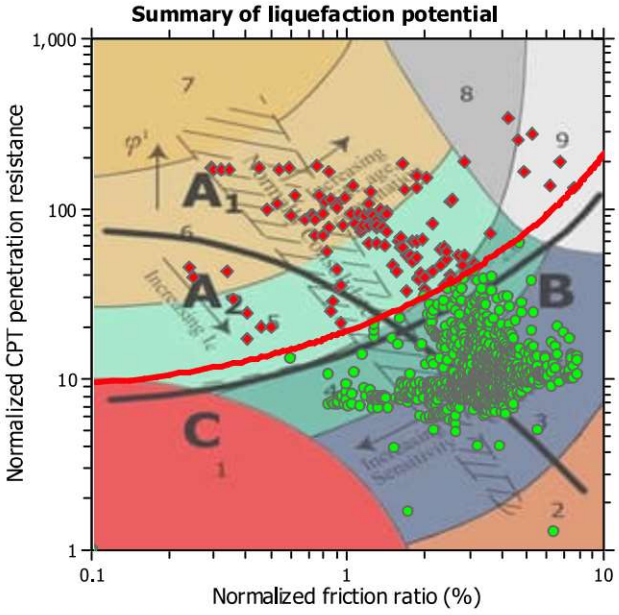
CPT file : 1-CPT3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	9.80 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	9.80 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	8.10	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: 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

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

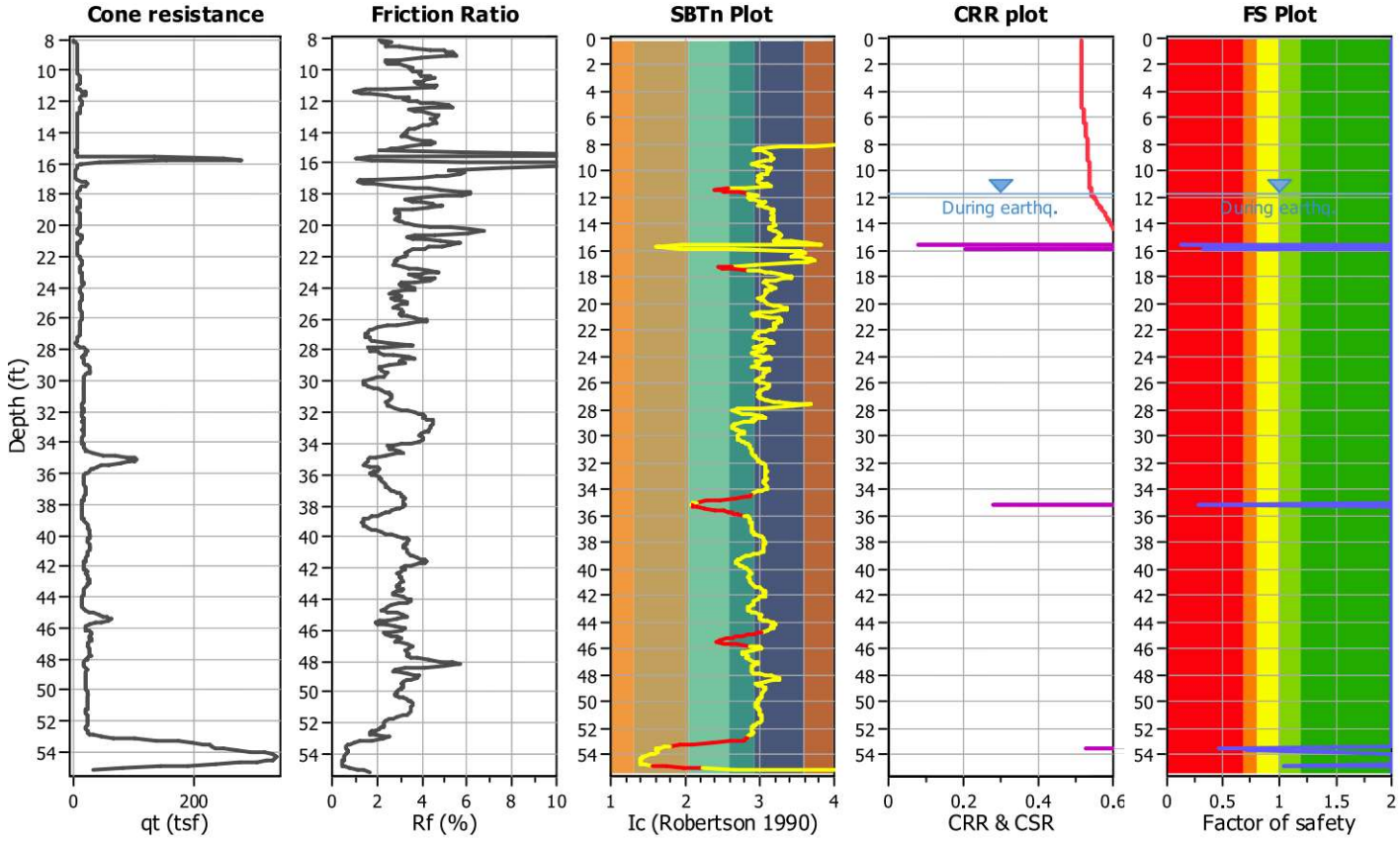
LIQUEFACTION ANALYSIS REPORT

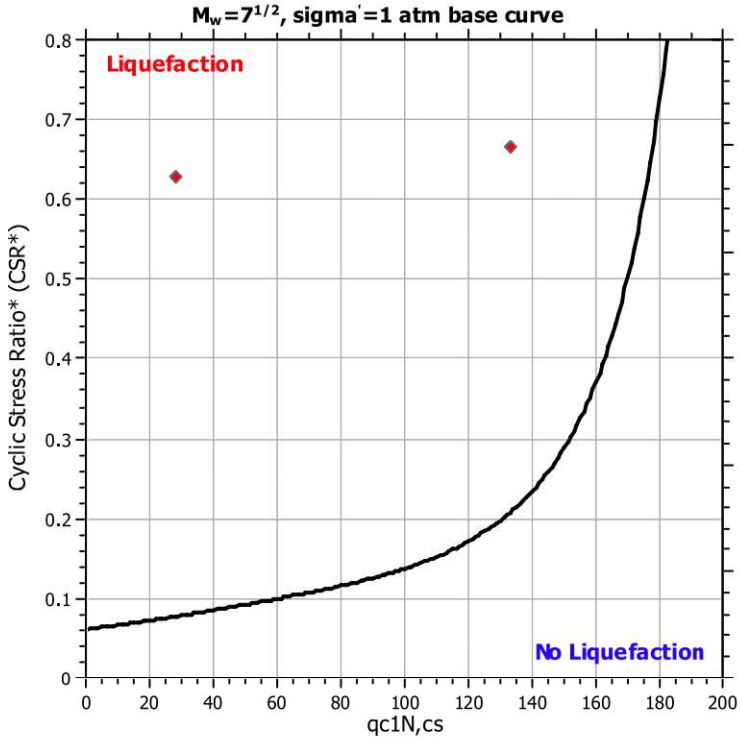
Project title : **Location :**

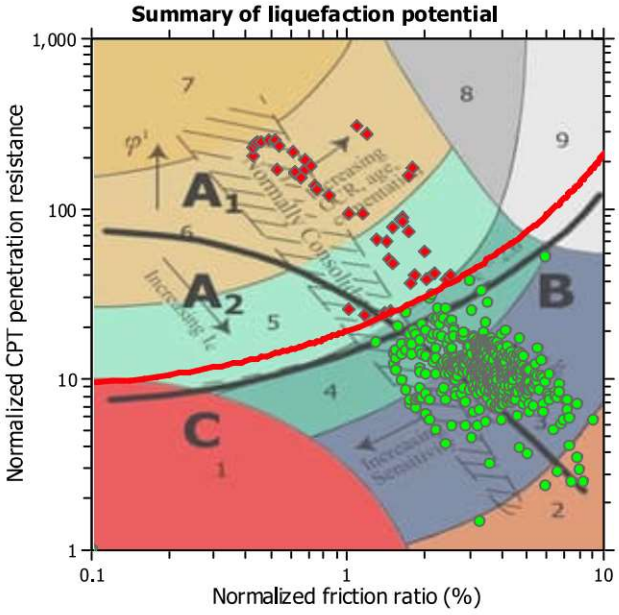
CPT file : 1-CPT4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	11.70 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	11.70 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	8.10	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: 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

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

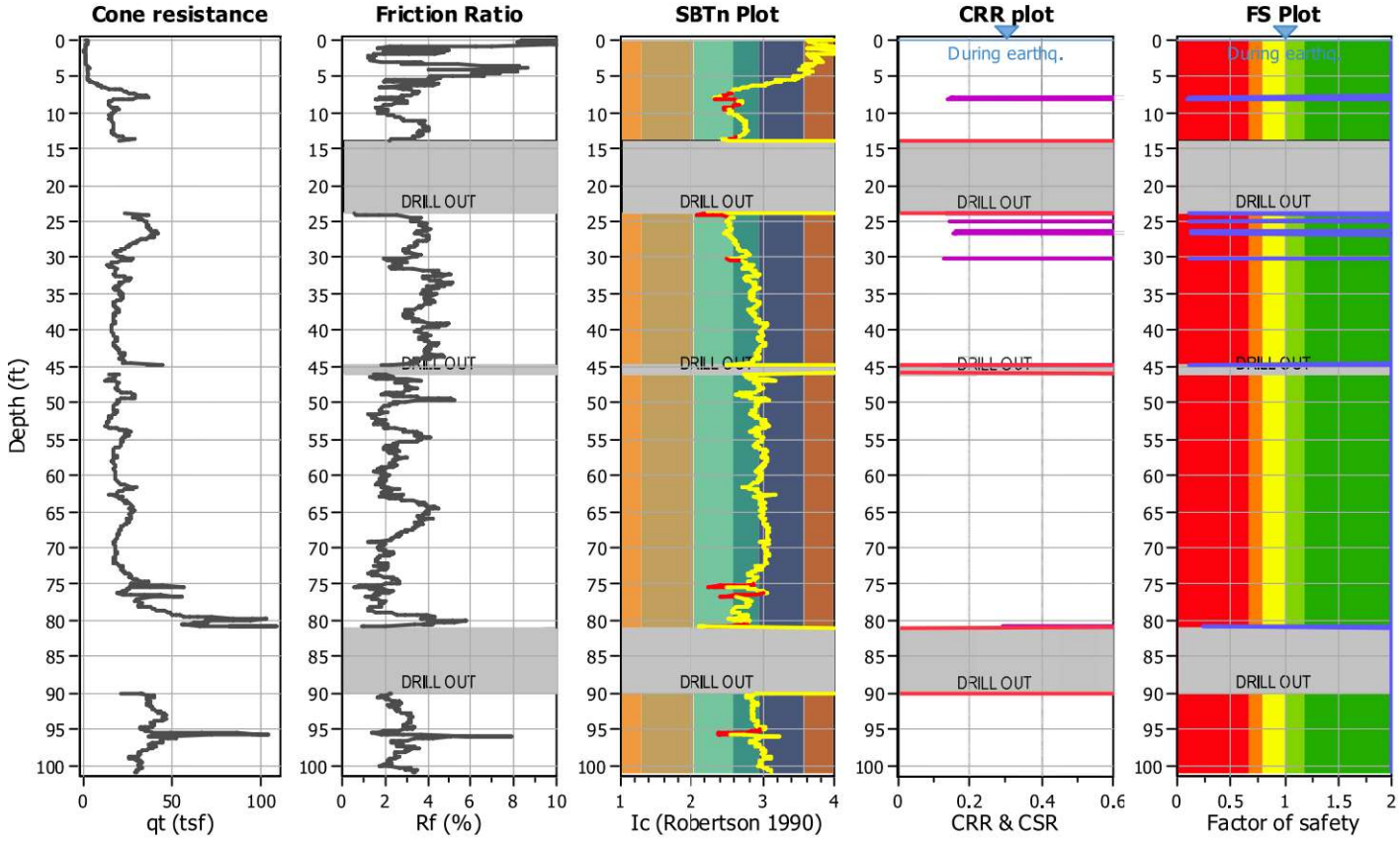
LIQUEFACTION ANALYSIS REPORT

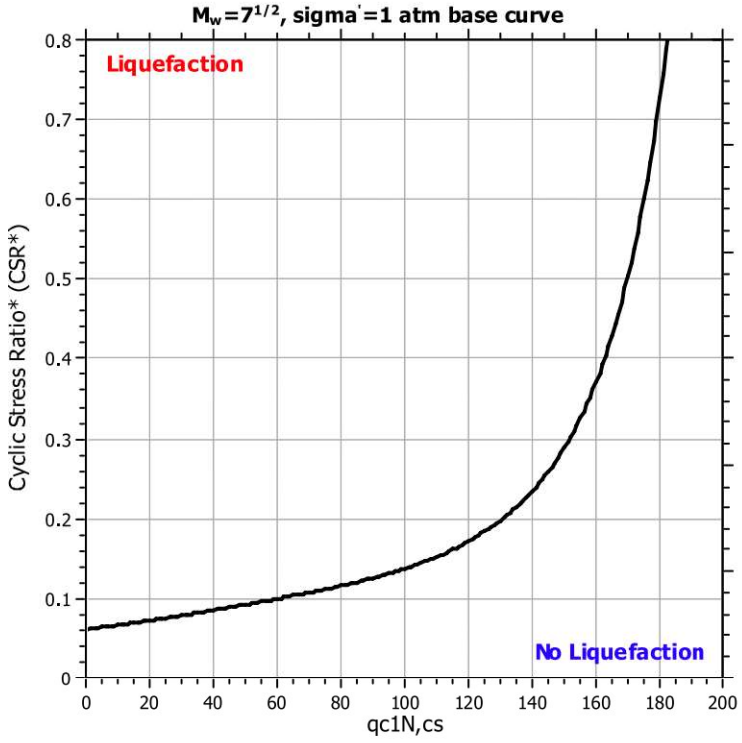
Project title : **Location :**

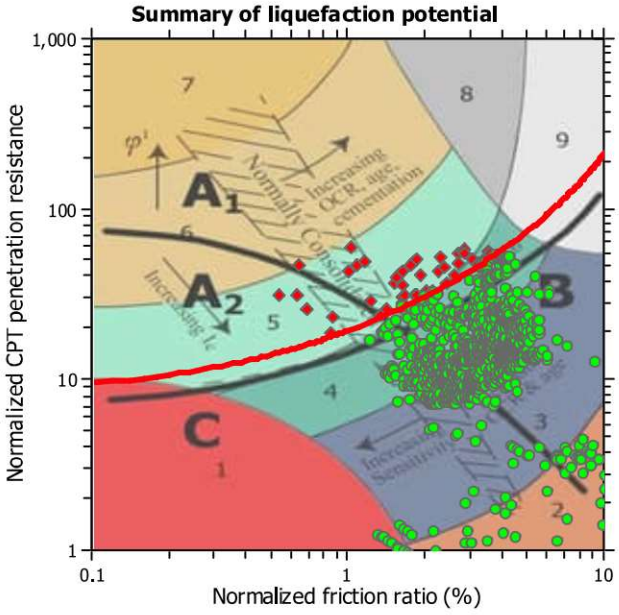
CPT file : 1OS-CPT1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	8.10	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: 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

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

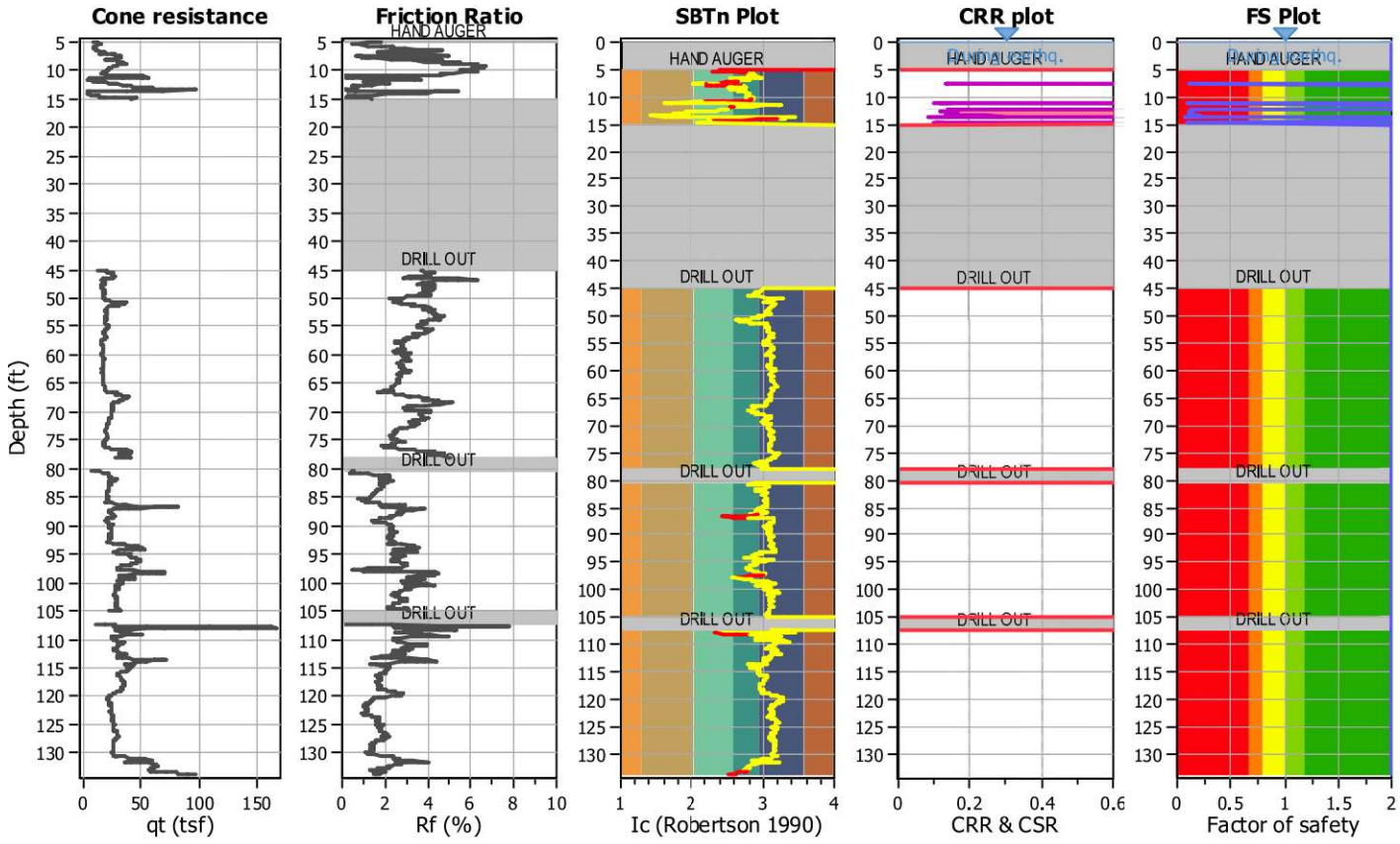
LIQUEFACTION ANALYSIS REPORT

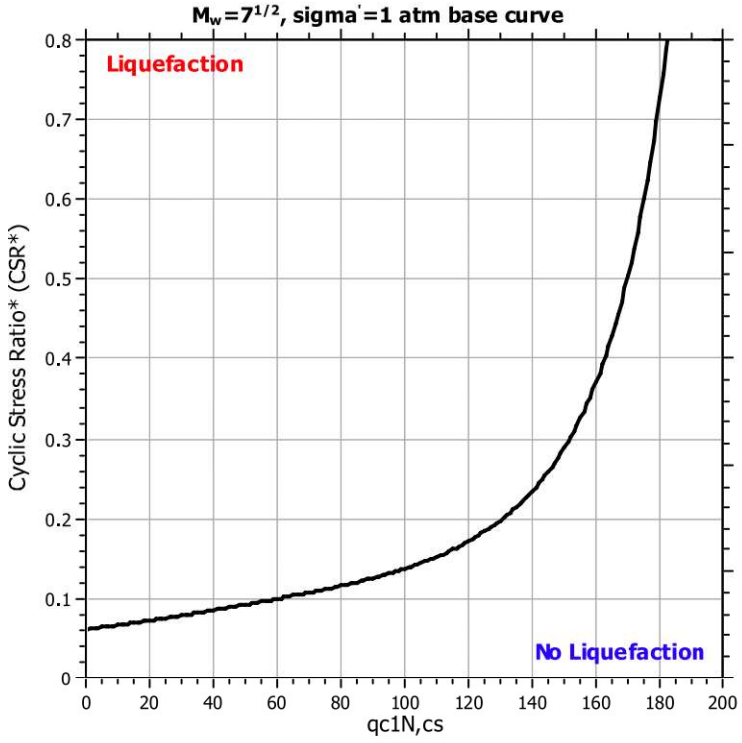
Project title : **Location :**

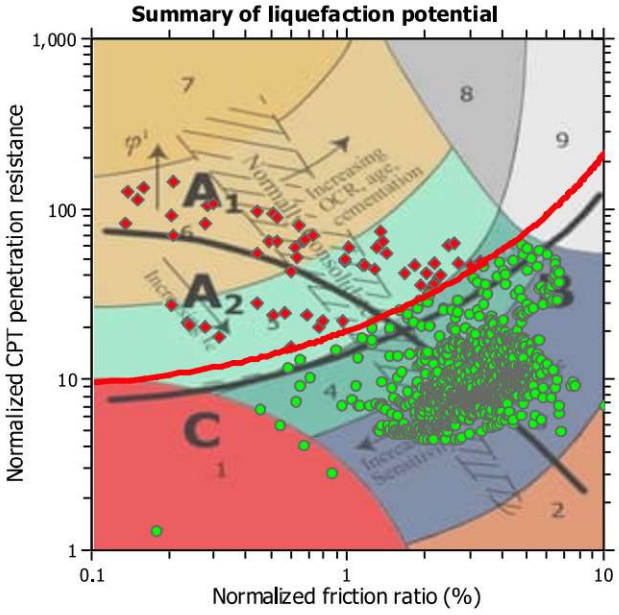
CPT file : 1OS-CPT2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	8.10	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: 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

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

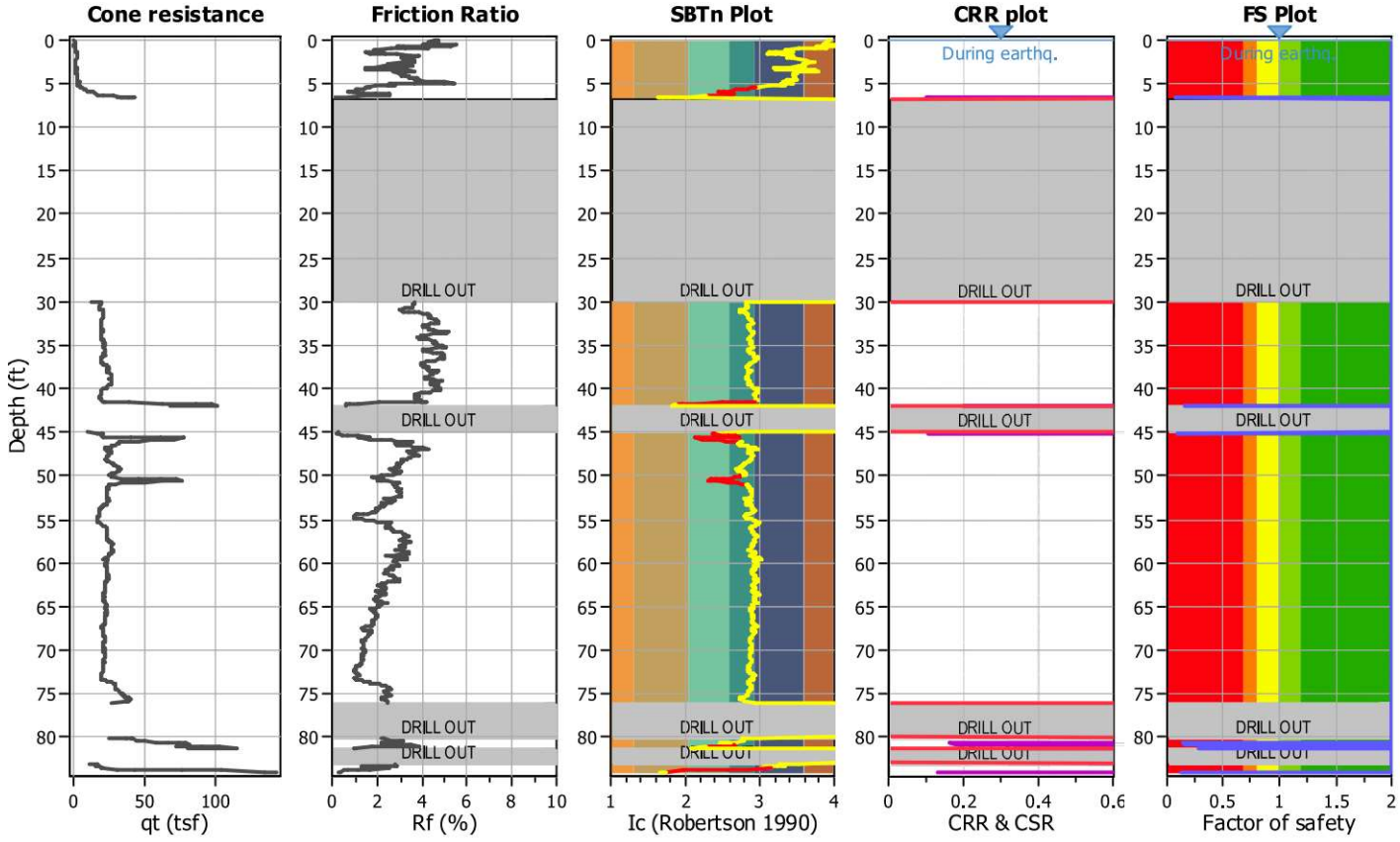
LIQUEFACTION ANALYSIS REPORT

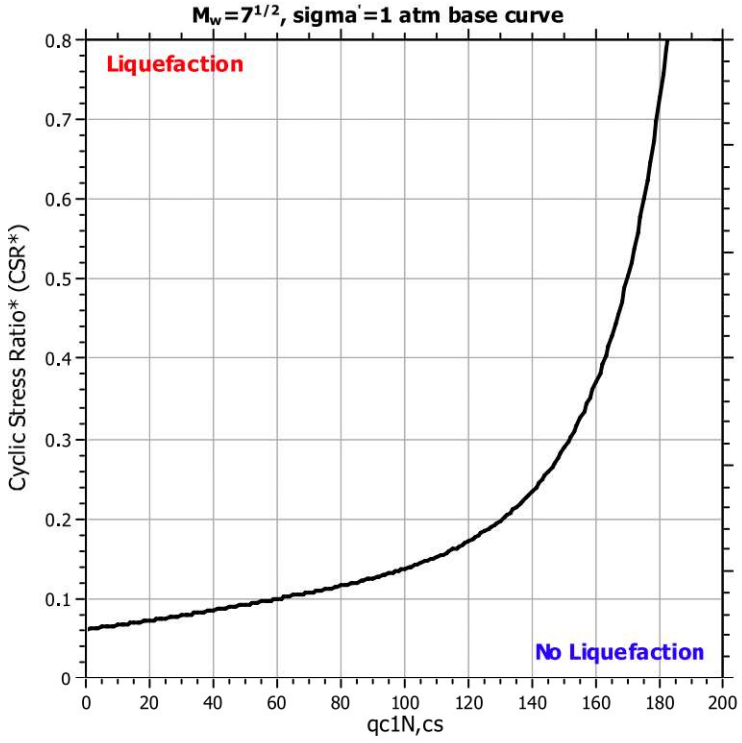
Project title : **Location :**

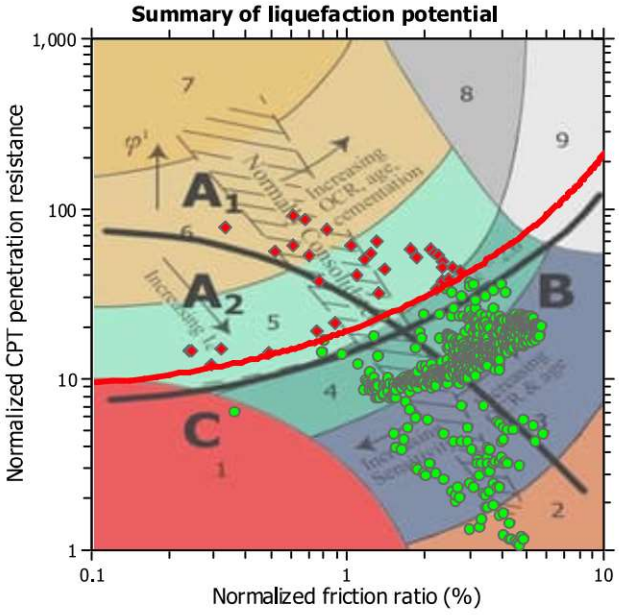
CPT file : 1OS-CPT3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	8.10	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: 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



APPENDIX C

KEY TO BORING LOGS
BORING LOGS

KEY TO BORING LOGS

MAJOR TYPES			DESCRIPTION
COARSE-GRAINED SOILS MORE THAN HALF OF MAT'L LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW - Well graded gravels or gravel-sand mixtures GP - Poorly graded gravels or gravel-sand mixtures
		GRAVELS WITH OVER 12 % FINES	GM - Silty gravels, gravel-sand and silt mixtures GC - Clayey gravels, gravel-sand and clay mixtures
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES	SW - Well graded sands, or gravelly sand mixtures SP - Poorly graded sands or gravelly sand mixtures
		SANDS WITH OVER 12 % FINES	SM - Silty sand, sand-silt mixtures SC - Clayey sand, sand-clay mixtures
FINE-GRAINED SOILS MORE THAN HALF OF MAT'L SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50 % OR LESS		ML - Inorganic silt with low to medium plasticity CL - Inorganic clay with low to medium plasticity OL - Low plasticity organic silts and clays
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 %		MH - Elastic silt with high plasticity CH - Fat clay with high plasticity OH - Highly plastic organic silts and clays
	HIGHLY ORGANIC SOILS		PT - Peat and other highly organic soils

For fine-grained soils with 15 to 29% retained on the #200 sieve, the words "with sand" or "with gravel" (whichever is predominant) are added to the group name.

For fine-grained soil with >30% retained on the #200 sieve, the words "sandy" or "gravelly" (whichever is predominant) are added to the group name.

GRAIN SIZES

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

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS/FOOT (S.P.T.)
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH*
VERY SOFT	0-1/4
SOFT	1/4-1/2
MEDIUM STIFF	1/2-1
STIFF	1-2
VERY STIFF	2-4
HARD	OVER 4

SAMPLER SYMBOLS

- Modified California (3" O.D.) sampler
- California (2.5" O.D.) sampler
- S.P.T. - Split spoon sampler
- Shelby Tube
- Dames and Moore Piston
- Continuous Core
- Bag Samples
- Grab Samples
- NR No Recovery

MOISTURE CONDITION

DRY	Dusty, dry to touch
MOIST	Damp but no visible water
WET	Visible freewater

LINE TYPES

- ———— Solid - Layer Break
- – – – – – Dashed - Gradational or approximate layer break

GROUNDWATER SYMBOLS

- Groundwater level during drilling
- Stabilized groundwater level

(S.P.T.) Number of blows of 140 lb. hammer falling 30" to drive a 2-inch O.D. (1-3/8 inch I.D.) sampler

* Unconfined compressive strength in tons/sq. ft., asterisk on log means determined by pocket penetrometer

ENGEO
Expect Excellence

ENGEO
Expect Excellence

SOIL BORING 1-B1

LATITUDE: 37.8629 LONGITUDE: -122.3171

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/04/2024
HOLE DEPTH: 106.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 17 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	15		**SANDY LEAN CLAY WITH GRAVEL** (**CL**), dark yellowish brown, dry, ~30% fine-grained sand, ~15% subangular fine to coarse gravel, rootlets, wood [FILL]											
5	10		**CLAYEY GRAVEL** (**GC**), dark reddish brown, medium dense, dry, angular fine to coarse gravel, some fine- to coarse-grained sand, rootlets [FILL]			31	35	24	12	7.3	110.5		408	
10	5		**CLAYEY SAND WITH GRAVEL** (**SC**), dark yellowish brown, loose, moist, fine-grained sand, some subangular fine gravel [FILL]			12	45	29	45	19.8	94.7		299.2	
15	0		**FAT CLAY** (**CH**), bluish black, soft, wet, shells [YOUNG BAY MUD]											

ENGEO
Expect Excellence

SOIL BORING 1-B1

LATITUDE: 37.8629 LONGITUDE: -122.3171

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/04/2024
HOLE DEPTH: 106.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 17 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			very soft			WOH								
25	-5													
	-10					50psi								
30						WOH								
	-15		**SANDY LEAN CLAY** (**CL**), olive gray, medium stiff, wet, ~30% fine-grained sand [ALLUVIUM]			WOH 400psi								
35			**SANDY LEAN CLAY** (**CL**), light yellowish brown, medium stiff, moist, ~45% fine-grained sand [ALLUVIUM]			9								
	-20		**SILTY SAND** (**SM**), light yellowish brown, medium dense, moist, fine- to medium-grained sand, iron oxide staining [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1-B1

LATITUDE: 37.8629 LONGITUDE: -122.3171

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/04/2024
HOLE DEPTH: 106.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 17 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						20			16					
	-25													
			FAT CLAY (**CH**), olive gray, stiff, moist [OLD BAY CLAY]											
45														
	-30					175psi 350psi								
50														
	-35													
55			Light gray, very stiff, 15% fine-grained sand			WOH				22.7 20.7	102.0 103.8		1986	
	-40													

ENGEO
Expect Excellence

SOIL BORING 1-B1

LATITUDE: 37.8629 LONGITUDE: -122.3171

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/04/2024
HOLE DEPTH: 106.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 17 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
65	-45													
70	-50		Dark greenish gray, no sand			14								
75	-55		Stiff			150psi								
	-60													

ENGEO
Expect Excellence

SOIL BORING 1-B1

LATITUDE: 37.8629 LONGITUDE: -122.3171

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/04/2024
HOLE DEPTH: 106.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 17 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
85	-65													
90	-70		Grayish green, very stiff, shells			16				23.2	99.6		458.3	
95	-75													
	-80													

ENGEO
Expect Excellence

SOIL BORING 1-B1

LATITUDE: 37.8629 LONGITUDE: -122.3171

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/04/2024
HOLE DEPTH: 106.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 17 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
	-85													
105			Stiff, ~15% fine-grained sand, shells			22								
			ALLUVIUM LEAN CLAY (**CL**), yellowish brown, stiff, moist, ~15% fine-grained sand [ALLUVIUM]											

End of boring at approximately 106½ feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 1-B2

LATITUDE: 37.8630 LONGITUDE: -122.3176

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/03/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 11.6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 4¼-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 5-inch Aggregate Base											
	10		**LEAN CLAY WITH SAND** (**CL**), light yellowish brown, moist, ~15% fine- to coarse-grained sand, trace fine gravel [FILL]											
			~25% fine to coarse gravel											
5			**CLAYEY SAND** (**SC**), light yellowish brown, medium dense, wet, fine- to medium-grained sand [FILL]			41	42	25	44	21.0	107.8		662	
	5		**CLAYEY SAND WITH GRAVEL** (**SC**), dark gray, very dense, moist, fine- to coarse-grained sand, some fine to coarse angular gravel [ROCK DIKE]			65			18	15.6				
			Wet				38	18	13	13.6				
10			**WELL-GRADED SAND WITH SILT AND GRAVEL** (**SW-SM**), dark gray, dense, moist, fine- to coarse-grained sand, some angular fine to coarse gravel [ROCK DIKE]			29			5	8.2				
	0													
15			wet hard drilling			81			2	14.9				
	-5													
			FAT CLAY (**CH**), bluish black, soft, wet, shells [YOUNG BAY MUD]											

ENGEO
Expect Excellence

SOIL BORING 1-B2

LATITUDE: 37.8630 LONGITUDE: -122.3176

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/03/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 11.6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
	-10					WOH				27.6	96.8		724	
										27.3	97.0			
25														
	-15		**CLAYEY SAND** (**SC**), light yellowish brown, very stiff, wet, fine- to coarse-grained sand [ALLUVIUM]			WOH 300psi								
30			Pale olive to brown, moist, trace subrounded fine gravel			13	35	22	44					
	-20													
			WELL-GRADED SAND WITH SILT (**SW-SM**), brown, medium dense, wet, fine- to medium-grained sand, trace subrounded fine gravel, ~10% fines [ALLUVIUM]											
35						16								
	-25		Dark gray							25.8	100.1			
			FAT CLAY WITH SAND (**CH**), olive gray to grayish green, very stiff, moist, ~15% fine-grained sand [OLD BAY CLAY]											

ENGEO
Expect Excellence

SOIL BORING 1-B2

LATITUDE: 37.8630 LONGITUDE: -122.3176

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/03/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 11.6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Olive			32				21.4	107.0			
	-30													
45			Gray to olive gray, trace fine-grained sand and subrounded fine gravel			31				23.2	103.9		2959	
	-35													
50			Medium stiff, no sand or gravel			26								
	-40													
55			Olive, stiff, wet			WOH 50psi								
	-45													

ENGEO
Expect Excellence

SOIL BORING 1-B2

LATITUDE: 37.8630 LONGITUDE: -122.3176

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/03/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 11.6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Gray to olive gray, moist, trace subrounded fine gravel			22								
	-50													
65														
	-55													
70			Greenish gray, medium stiff, no sand or gravel, brown mottling			14				35.6	84.3			
	-60													
75														
	-65													

ENGEO
Expect Excellence

SOIL BORING 1-B2

LATITUDE: 37.8630 LONGITUDE: -122.3176

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/03/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 11.6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Olive gray to greenish gray, stiff, wet, shells			WOH								
	-70													
85														
	-75													
90			~15% fine-grained sand, brown mottling			4							1056	
	-80													
95														
	-85		**SANDY LEAN CLAY** (**CL**), brown, very stiff, moist to wet, ~40% fine-grained sand [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1-B2

LATITUDE: 37.8630 LONGITUDE: -122.3176

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/03/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 11.6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						29								

End of boring at approximately 101½ feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 1-B3

LATITUDE: 37.8632 LONGITUDE: -122.3173

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/29/2024
HOLE DEPTH: 52.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 15 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sample Graphic	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blows/Foot	Atterberg Limits (LL-PL-PI)	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Shear Strength (psf)	Compressive Strength (psf)	Pocket Penetrometer (tsf)	Torvane (psf)
			ASPHALT (**AC**), 5-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 7-inch Aggregate Base											
			LEAN CLAY WITH SAND (**CL**), brown, medium stiff, moist, ~20% fine-grained sand, ~10% angular fine gravel [FILL]				41-17-24			17.20				
			reddish orange mottling, dark gray and pale olive staining											
5	10					8							2	1000
			Light yellowish brown, very stiff, with trace fine-grained sand				38-13-25		23.5	100.2	784			
			CLAYEY SAND (**SC**), light yellowish brown, loose, moist, fine- to coarse-grained sand, maganese staining [FILL]			8		17						
10	5		Dark gray, wet, some fine- to coarse- grained sand and angular fine gravel, brick fragments, olive and yellowish brown staining			4								
			WELL-GRADED GRAVEL WITH SILT AND SAND (**GW**), dark gray, loose, wet, angular fine gravel, ~10% fine- to coarse-grained sand, ~10% fines [FILL]						22.1					
			CLAYEY SAND (**SC**), gray, loose, moist, fine- to coarse-grained sand, ~45% fines, yellow-brown staining [FILL]											
15	0					6	39-14-25		19.7					
			CLAYEY SAND WITH GRAVEL (**SC**), gray, soft, moist, ~40% fines, ~15% angular fine gravel [FILL]											
			FAT CLAY (**CH**), dark gray, very stiff, wet, organic odor [YOUNG BAY MUD]											

ENGEO
Expect Excellence

SOIL BORING 1-B3

LATITUDE: 37.8632 LONGITUDE: -122.3173

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/29/2024
HOLE DEPTH: 52.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 15 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sample Graphic	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blows/Foot	Atterberg Limits (LL-PL-PI)	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Shear Strength (psf)	Compressive Strength (psf)	Pocket Penetrometer (tsf)	Torvane (psf)
						WOH			74.4 86.7	56.0 49.2	300		2.5	
25	-10		**SANDY LEAN CLAY** (**CL**), gray, medium stiff, moist, ~35% fine-grained sand [YOUNG BAY MUD]			3	32-19-13		29.6		498		0.5	200
30	-15		**SANDY LEAN CLAY** (**CL**), yellowish brown, very stiff, moist, ~30% fine-grained sand, ~10% subangular fine gravel [ALLUVIUM]			11							3.5	
35	-20		Shells **SILTY SAND** (**SM**), yellowish brown, dense, moist, fine- to coarse-grained sand, ~20% fines [ALLUVIUM]			55							1.5	

ENGEO
Expect Excellence

SOIL BORING 1-B3

LATITUDE: 37.8632 LONGITUDE: -122.3173

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/29/2024
HOLE DEPTH: 52.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 15 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sample Graphic	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blows/Foot	Atterberg Limits (LL-PL-PI)	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Shear Strength (psf)	Compressive Strength (psf)	Pocket Penetrometer (tsf)	Torvane (psf)
			LEAN CLAY (**CL**), olive brown, very stiff, moist, trace fine-grained sand [ALLUVIUM]			16							2	500
45	-30					25							2	1000
50	-35		~35% fine-grained sand			WOH 400psi							3.5	

End of boring at approximately 52½ feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 1-B4

LATITUDE: 37.86184 LONGITUDE: -122.31905

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 52.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 14.2 ft (MLLW)
LOGGED BY / REVIEWED BY: QP / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	10		**ASPHALT** (**AC**), 10½-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 6-inch Aggregate base											
			SANDY LEAN CLAY WITH GRAVEL (**CL**), dark bluish gray, soft, moist, ~30% fine- to coarse-grained sand, ~25% subangular fine gravel, yellowish red staining [FILL]											
5	5					4								
10	0		brown, stiff, ~20% fine- to coarse-grained sand, less gravel			WOH	45	23		21.8	105.1		506	
15	-5		~25% fine- to coarse-grained sand, ~10% subangular fine gravel			5								
			FAT CLAY (**CH**), bluish black, medium stiff, wet, ~10% fine- to coarse-grained sand, organic odor [YOUNG BAY MUD]											

ENGEO
Expect Excellence

SOIL BORING 1-B4

LATITUDE: 37.86184 LONGITUDE: -122.31905

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 52.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 14.2 ft (MLLW)
LOGGED BY / REVIEWED BY: QP / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						WOH								
						600psi								
			CLAYEY GRAVEL WITH SAND (**GC**), reddish brown, medium dense, moist, angular fine gravel, some fine- to coarse-grained sand [ALLUVIUM]			22			40					
	-10													
25			**LEAN CLAY** (**CL**), reddish brown, very stiff, moist, trace fine-grained sand [ALLUVIUM]											
			light yellowish brown											
	-15					100psi				33.3	89.7		781	
30														
	-20													
35			yellowish red			12								
	-25													

ENGEO
Expect Excellence

SOIL BORING 1-B4

LATITUDE: 37.86184 LONGITUDE: -122.31905

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 52.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 14.2 ft (MLLW)
LOGGED BY / REVIEWED BY: QP / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
45	-30		~10% fine to medium grained sand			24								
	-35		**SILT WITH SAND** (**ML**), reddish brown, very stiff, moist, ~25% fine-grained sand [ALLUVIUM]											
50						50psi								
			LEAN CLAY WITH SAND (**CL**), reddish brown, very stiff, moist, ~20% medium-grained sand, trace subrounded fine gravel [ALLUVIUM]			50psi WOH							2596	
			End of boring at approximately 52½ feet below ground surface. Groundwater was not measured due to drilling method.											
55	-40													
	-45													

ENGEO
Expect Excellence

SOIL BORING 1-B5

LATITUDE: 37.8594 LONGITUDE: -122.3163

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 51.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 15 ft

LOGGED BY / REVIEWED BY: QP / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 3½-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 7-inch Aggregate Base											
			SANDY LEAN CLAY (**CL**), dark brown, moist, ~20% fine- to coarse-grained sand, yellowish red mottling [FILL]											
5	10					50/3"			39	16.2 15.7	104.8 105.3			
			CLAYEY GRAVEL WITH SAND (**GC**), gray, very dense, moist, angular [ROCK DIKE]											
10	5													
15	0													
			GRAVELLY LEAN CLAY WITH SAND (**CL**), bluish black to reddish brown, medium dense, moist [ROCK DIKE]			21			54	21.60 9.80				

SOIL BORING 1-B5

LATITUDE: 37.8594 LONGITUDE: -122.3163

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 51.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 15 ft

LOGGED BY / REVIEWED BY: QP / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						30								
			FAT CLAY (**CH**), bluish black, very soft, wet, trace organics and shells [YOUNG BAY MUD]			1								
25	-10									19.4	112.2		312	
						WOH								
30	-15													
						100psi								
			LEAN CLAY (**CL**), yellowish red, yellowish red, moist [ALLUVIUM]											
35	-20													
						200psi								
										31.1	89.1		1630	

ENGEO
Expect Excellence

SOIL BORING 1-B5

LATITUDE: 37.8594 LONGITUDE: -122.3163

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 51.5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 15 ft

LOGGED BY / REVIEWED BY: QP / JF
DRILLING CONTRACTOR: Pitcher Services LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Reddish brown, hard, ~30% fine-grained sand, bluish gray mottling			48								
			End of boring at approximately 41½ feet below ground surface. Groundwater was not measured due to drilling method.											
45	-30													
50	-35													
55	-40													

SOIL BORING 1-C1

LATITUDE: 37.8647 LONGITUDE: -122.3114

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/28/2024
HOLE DEPTH: 6 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 12.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 12-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 12-inch Aggregate Base											
	10		**SANDY LEAN CLAY** (**CL**), dark gray, moist, ~30% fine- to coarse-grained sand, ~15% subangular fine gravel [FILL]				44	25		12.2				
5														

End of boring at approximately 6 feet below ground surface. Groundwater was not encountered during drilling.

ENGEO
Expect Excellence

SOIL BORING 1-C2

LATITUDE: 37.8641 LONGITUDE: -122.3121

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/28/2024
HOLE DEPTH: 5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 13 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 9¼-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 12-inch Aggregate Base											
			SANDY LEAN CLAY (**CL**), dark gray, moist, ~40% fine- to coarse-grained sand, ~5% fine gravel [FILL]											
10														
5			End of boring at approximately 5 feet below ground surface. Groundwater was not encountered during drilling.											

ENGEO
Expect Excellence

SOIL BORING 1-C3

LATITUDE: 37.8637 LONGITUDE: -122.3135

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/28/2024
HOLE DEPTH: 6 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 14 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 4¼-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 12-inch Aggregate Base											
			SANDY LEAN CLAY (**CL**), yellowish brown, moist, ~35% fine- to coarse-grained sand, ~5% subangular fine gravel [FILL]				36	20		14.3				
10														
5			**LEAN CLAY WITH SAND** (**CL**), dark gray, moist, ~15% fine-grained sand [FILL]											

End of boring at approximately 6 feet below ground surface. Groundwater was not encountered during drilling.

ENGEO
Expect Excellence

SOIL BORING 1-C4

LATITUDE: 37.8627 LONGITUDE: -122.3153

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/28/2024
HOLE DEPTH: 3.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 14.8 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 2-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 8-inch Aggregate Base											
			GRAVELLY LEAN CLAY WITH SAND (**CL**), brown, moist, ~20% subangular fine gravel, ~15% fine- to medium-grained sand [FILL]				33	17		10.9				
			POORLY GRADED SAND (**SP**), dark gray, dry, angular coarse-grained sand [FILL]											

End of boring at approximately 3½ feet below ground surface. Groundwater was not encountered during drilling.

SOIL BORING 1-C5

LATITUDE: 37.8615 LONGITUDE: -122.3163

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/28/2024
HOLE DEPTH: 4 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 17.4 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			3-inch Asphalt Concrete 6½-inch Aggregate Base **SILTY SAND WITH GRAVEL** (**SM**), yellowish brown, dry to moist, ~20% fines, ~20% fine gravel [FILL]											
	15													

End of boring at approximately 4 feet below ground surface. Groundwater was not encountered during drilling.

SOIL BORING 1-C6

LATITUDE: 37.8610 LONGITUDE: -122.3160

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/28/2024
HOLE DEPTH: 5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 16.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	15		**ASPHALT** (**AC**), 2½-inch Asphalt Concrete **AGGREGATE BASE** (**AB**), 9-inch Aggregate Base **SANDY LEAN CLAY** (**CL**), yellow-brown, moist, ~30% fine-grained sand, ~5% subangular fine gravel [FILL]				38	18						
5			**LEAN CLAY WITH SAND** (**CL**), olive brown, moist, ~30% fine-grained sand [FILL]											

End of boring at approximately 5 feet below ground surface. Groundwater was not encountered during drilling.

ENGEO
Expect Excellence

SOIL BORING 1-C7

LATITUDE: 37.8607 LONGITUDE: -122.3164

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/28/2024
HOLE DEPTH: 5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 14.2 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0			**ASPHALT** (**AC**), 10½-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 6-inch Aggregate Base											
			LEAN CLAY (**CL**), dark brown, moist, ~30% fine-grained sand, ~15% subangular fine gravel [FILL]											
	10													
5			End of boring at approximately 5 feet below ground surface. Groundwater was encountered at 5 feet below ground surface.											

SOIL BORING 1-C8

LATITUDE: 37.86297 LONGITUDE: -122.31758

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 08/28/2024
HOLE DEPTH: 6 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: 13.3 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: West Coast Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0			**ASPHALT** (**AC**), 4½-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 3-inch Aggregate Base											
			GRAVELLY LEAN CLAY WITH SAND (**CL**), bluish black, moist, ~20% fine- to coarse-grained sand [FILL]				39	17		14.3				
	10													
5			End of boring at approximately 5 feet below ground surface. Groundwater was not encountered during drilling.											

ENGEO
Expect Excellence

SOIL BORING 1-CPT2

LATITUDE: 37.8632 LONGITUDE: -122.3163

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/29/2024
HOLE DEPTH: 5 ft
HOLE DIAMETER: 4 in
SURFACE ELEV.: 18.7 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: ConeTec
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 4¼-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 6-inch Aggregate Base											
			SANDY LEAN CLAY (**CL**), yellowish brown, moist, ~30% fine- to medium-grained sand [FILL]				40	22		17.2				
			Brick											
	15		**CLAYEY GRAVEL** (**GC**), dark gray, moist, ~20% fines, ~10% fine- to coarse-grained sand [FILL]											
5			End of boring at approximately 5 feet below ground surface. Groundwater was not encountered during drilling.											

ENGEO
Expect Excellence

SOIL BORING 1-CPT3

LATITUDE: 37.86297 LONGITUDE: -122.31758

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/29/2024
HOLE DEPTH: 5 ft
HOLE DIAMETER: 4.5 in
SURFACE ELEV.: 14.8 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: ConeTec
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	10		**ASPHALT** (**AC**), 5" Asphalt Concrete											
			AGGREGATE BASE (**AB**), 7" Aggregate Base											
			CLAYEY GRAVEL WITH SAND (**GC**), dark brown, moist to wet, ~30% fines, ~20% fine- to medium grained sand [FILL]											
			WELL-GRADED SAND WITH CLAY AND GRAVEL (**SW**), dark gray, moist, ~20% fines, ~30% subangular fine gravel [FILL]											
5			End of boring at approximately 5 feet below ground surface. Groundwater was not encountered during drilling.											

ENGEO
Expect Excellence

SOIL BORING 1-CPT4

LATITUDE: 37.8630 LONGITUDE: -122.3176

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/29/2024
HOLE DEPTH: 6 ft
HOLE DIAMETER: 4.5 in
SURFACE ELEV.: 16.7 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: ConeTec
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	15		**ASPHALT** (**AC**), 2-inch Asphalt Concrete **AGGREGATE BASE** (**AB**), 9-inch Aggregate Base **SANDY LEAN CLAY** (**CL**), yellowish brown, moist, ~30% fine- to medium-grained sand [FILL]											
5														

End of boring at approximately 6 feet below ground surface. Groundwater was not encountered during drilling.

ENGEO
Expect Excellence

SOIL BORING 1OS-B1

LATITUDE: 37.86286 LONGITUDE: -122.31808

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 127 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			FAT CLAY (**CH**), bluish black, very soft, wet, shells [YOUNG BAY MUD]											
	-10					WOH				22.1	108.8		747.2	
5			**LEAN CLAY** (**CL**), greenish gray, medium stiff, moist [YOUNG BAY MUD]											
	-15		**CLAYEY GRAVEL WITH SAND** (**GC**), yellowish brown, medium dense, moist, subrounded fine gravel, some fine-grained sand [ALLUVIUM]			21	33	15	48	18.3				
10						17								
			LEAN CLAY (**CL**), yellowish brown, medium dense, moist, ~45% fine-grained sand [ALLUVIUM]			WOH	35	18					2245	
	-20													
15			**WELL-GRADED SAND WITH SILT** (**SW-SM**), yellowish brown to dark gray, medium dense, wet, fine- to medium-grained sand [ALLUVIUM]			24			9.8	19.4	113.1			
						24								
	-25		**LEAN CLAY** (**CL**), yellowish brown, stiff, moist, ~20% fine-grained sand [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1OS-B1

LATITUDE: 37.86286 LONGITUDE: -122.31808

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 127 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			FAT CLAY (**CH**), dark gray, stiff, moist [OLD BAY CLAY]			16				32.9	92.5			
			SILTY SAND (**SM**), dark gray, medium dense, moist, ~20% fines [OLD BAY CLAY]			11								
	-30		**SANDY LEAN CLAY** (**CL**), greenish gray, very stiff, moist, ~30% fine-grained sand [OLD BAY CLAY]											
25						34								
			FAT CLAY (**CH**), dark greenish gray, very stiff, moist, light gray mottling [OLD BAY CLAY]			26								
	-35													
30			no mottling			18								
	-40		**WELL-GRADED GRAVEL WITH SAND** (**GW**), dark gray, dense, wet, subrounded fine gravel, ~15% fine- to medium-grained sand, shells [OLD BAY DEPOSITS]											
35						500psi								
	-45		**FAT CLAY** (**CH**), dark gray, stiff, moist, ~25% fine-grained sand [OLD BAY CLAY]											

ENGEO
Expect Excellence

SOIL BORING 1OS-B1

LATITUDE: 37.86286 LONGITUDE: -122.31808

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 127 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						16								
						400psi								
	-50													
45						22				30.4	94.4			
	-55													
50			~15% fine-grained sand			16								
	-60													
55			Medium stiff											
	-65													

ENGEO
Expect Excellence

SOIL BORING 1OS-B1

LATITUDE: 37.86286 LONGITUDE: -122.31808

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 127 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Bluish gray, stiff, wet, shells			9								
	-70													
65										43.1	78.6		1655	
	-75		**FAT CLAY** (**CH**), pale olive, very stiff, moist, fine-grained sand, ~15%, reddish yellow mottling [OLD BAY CLAY]											
70						26								
	-80													
75			Stiff			12								
	-85													

ENGEO
Expect Excellence

SOIL BORING 1OS-B1

LATITUDE: 37.86286 LONGITUDE: -122.31808

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 127 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						300psi								
			LEAN CLAY (**CL**), yellowish red, very stiff, moist [ALLUVIUM]											
	-90													
85			Brown, sand lense @ 85'			27								
	-95													
90			very stiff			200psi				23.6	102.6		2590	
	-100		**FAT CLAY WITH SAND** (**CH**), light olive gray, very stiff, moist, ~10% fine-grained sand [OLD BAY CLAY]											
95						34				47.8	86.7			
	-105		**SANDY LEAN CLAY** (**CL**), brown, very stiff, moist, ~35% fine- to coarse-grained sand [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1OS-B1

LATITUDE: 37.86286 LONGITUDE: -122.31808

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 127 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						35				20.2	108.6			
	-110													
105			**FAT CLAY WITH SAND** (**CH**), bluish gray, medium stiff to very stiff, moist, ~20% fine-grained sand, reddish brown mottling [OLD BAY CLAY]											
	-115													
110						37				27.5	96.40		3300	
	-120													
115														
	-125													

ENGEO
Expect Excellence

SOIL BORING 1OS-B1

LATITUDE: 37.86286 LONGITUDE: -122.31808

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 127 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: AC / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Dark Gray, stiff, no sand			30								
	-130													
125			**LEAN CLAY** (**CL**), brown, very stiff, moist [ALLUVIUM]			400psi							4166	

End of boring at approximately 127 feet below ground surface.

ENGEO
Expect Excellence

SOIL BORING 1OS-B2

LATITUDE: 37.86246 LONGITUDE: -122.31908

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/18/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			FAT CLAY (**CH**), dark gray, very soft, wet, shells [YOUNG BAY MUD]											
	-10					WOH								
5														
						2								
	-15													
			SANDY LEAN CLAY (**CL**), gray, soft, moist, ~30% fine-grained sand [YOUNG BAY MUD]											
10			Stiff, pale olive staining, reddish orange mottling shells			7								
						200psi				18.7	111.5		1482	
	-20													
			LEAN CLAY (**CL**), light yellowish brown, very stiff, moist, ~30% fine-grained sand, maganese staining [ALLUVIUM]											
15						19								
										17.9	114.0		1875	
	-25		**POORLY GRADED SAND WITH SILT** (**SP-SM**), olive, medium dense, wet, fine-grained sand, ~5% fines [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1OS-B2

LATITUDE: 37.86246 LONGITUDE: -122.31908

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/18/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			LEAN CLAY (**CL**), reddish orange, very stiff, moist, trace fine-grained sand [ALLUVIUM]			15								
			SILTY SAND (**SM**), light yellowish brown, medium dense, wet, ~20% fines [ALLUVIUM]											
	-30		**SANDY LEAN CLAY** (**CL**), olive-brown, stiff, moist, ~30% fine- to medium-grained sand [ALLUVIUM]											
25						8								
			grades yellowish brown											
	-35													
30			Olive-brown, very stiff, ~20% fine-grained sand			10								
						200psi								
	-40									23.0	102.5		1799	
35			**FAT CLAY WITH SAND** (**CH**), olive, very stiff, moist, ~20% fine-grained sand [OLD BAY CLAY]			18				30.4	100.0			
						300psi								
	-45													

ENGEO
Expect Excellence

SOIL BORING 1OS-B2

LATITUDE: 37.86246 LONGITUDE: -122.31908

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/18/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
45	-50		Gray, wet, trace fine-grained sand, yellowish brown mottling			19								
50	-55													
55	-60		Greenish gray			24								
	-65					400psi				29.0	94.4		2345	

ENGEO
Expect Excellence

SOIL BORING 1OS-B2

LATITUDE: 37.86246 LONGITUDE: -122.31908

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/18/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
	-70													
65			Reddish orange stains			13								
	-75													
70			**LEAN CLAY** (**CL**), yellowish brown, very stiff, moist, ~10% fine- to medium-grained sand [ALLUVIUM]											
	-80													
75						12				32.5	100.0			
						5								
	-85													

SOIL BORING 1OS-B2

LATITUDE: 37.86246 LONGITUDE: -122.31908

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/18/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			FAT CLAY (**CH**), olive, stiff to very stiff, moist, trace fine-grained sand, iron oxide staining [OLD BAY CLAY]			13								
			Bluish gray, dark gray staining											
			Olive, no staining											
	-90													
85			Bluish gray			WOH								
						300psi								
			LEAN CLAY (**CL**), yellowish brown, very stiff, moist, trace fine-grained sand [ALLUVIUM]											
	-95		**POORLY GRADED SAND** (**SP**), olive brown, medium dense, wet, medium- to coarse-grained sand, shells [ALLUVIUM]											
90			**LEAN CLAY** (**CL**), reddish orange, very stiff, moist [ALLUVIUM]			19				31.7	92.5		1815	
	-100													
95						40								
			SILTY SAND (**SM**), yellowish brown, dense, moist, ~30% fines [ALLUVIUM]											
			SANDY LEAN CLAY (**CL**), yellowish brown, hard, moist, ~30% fine- to medium-grained sand [ALLUVIUM]											
			Light yellowish brown, dense, wet											
	-105		Yellowish brown, hard, moist, reddish orange, olive, and white staining			44								
			CLAYEY SAND (**SC**), yellowish brown, dense, wet,											

ENGEO
Expect Excellence

SOIL BORING 1OS-B2

LATITUDE: 37.86246 LONGITUDE: -122.31908

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/18/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			fine- to coarse-grained sand, standstone fragments, reddish orange staining [ALLUVIUM]											
			LEAN CLAY WITH SAND (**CL**), yellowish brown, very stiff, moist, ~15% fine-grained sand [ALLUVIUM]											
	-110													
105						38								
	-115		**LEAN CLAY WITH SAND** (**CL**), olive, very stiff, moist, ~25% fine- to medium-grained sand [OLD BAY CLAY]											
110						37								
			CLAYEY SAND (**SC**), yellowish brown, wet, fine- to coarse-grained sand, ~40% fines, trace subangular fine gravel [ALLUVIUM]											
	-120													
115														
			LEAN CLAY (**CL**), yellowish brown, ~10% fine-grained sand, maganese staining [ALLUVIUM]											
	-125													

SOIL BORING 1OS-B2

LATITUDE: 37.86246 LONGITUDE: -122.31908

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/18/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			FAT CLAY (**CH**), gray, very stiff, moist, trace fine-grained sand [OLD BAY CLAY]			21								

End of boring at approximately 121.5 feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			SILT (**ML**), dark gray, very soft, wet, shells [YOUNG BAY MUD]											
	-10					WOH								
5														
						WOH								
	-15		Greenish black, soft, ~40% medium-grained sand											
10			**FAT CLAY** (**CH**), greenish gray, stiff, wet [YOUNG BAY MUD]			8								
						100psi				20.4	109.7		1653	
	-20													
15						35								
			WELL-GRADED SAND WITH SILT (**SW-SM**), greenish gray, medium dense, wet, medium-grained sand, ~10% fines [ALLUVIUM]											
	-25													

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			LEAN CLAY WITH SAND (**CL**), yellowish brown, stiff, wet, ~15% fine-grained sand [ALLUVIUM]			8								
	-30		**FAT CLAY** (**CH**), olive gray, hard, moist, ~10% fine-grained sand [OLD BAY CLAY]											
25						32				24.8	102.3		4033	
	-35													
30			Very stiff			19								
	-40													
35			Greenish gray			23				23.4	104.5		2304	
	-45													

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Olive to olive gray, very stiff,~10% fine-grained sand			26								
	-50													
45			stiff			19								
	-55													
50			greenish gray, vertical sand vein			17								
						400psi								
	-60													
55						18								
			sand lense			N/A								
	-65													

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						12								
	-70									44.6	76.5		1551	
65														
	-75													
70														
	-80													
75			reddish yellow mottling, very stiff, ~25% fine-grained sand			30								
	-85													

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
85	-90		Olive, ~30% fine-grained sand			34								
						200psi				25.3	99.0		3108	
90	-95		**SANDY LEAN CLAY** (**CL**), yellowish brown, stiff, moist, maganese staining [ALLUVIUM]			23								
			olive gray											
95	-100													
	-105													

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			GRAVELLY LEAN CLAY WITH SAND (CL), grayish green, hard, moist, ~30% rounded fine gravel, ~10% medium-grained sand [OLD BAY CLAY]			47				22.7	106.4		3401	
	-110													
105														
			WELL-GRADED GRAVEL WITH SILT (GW-GM), pale olive, dense, moist, rounded fine gravel, ~25% fine-grained sand, ~10% fines [ALLUVIUM]											
	-115													
110						40								
			LEAN CLAY WITH SAND (CL), yellowish brown, very stiff, moist, ~25% fine-grained sand, iron oxide mottling [ALLUVIUM]											
	-120													
115														
			FAT CLAY (CH), greenish gray, stiff, moist [OLD BAY CLAY]											
	-125													

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						23				39.8	81.4		1289.4	
	-130													
125														
	-135													
130			**SANDY LEAN CLAY** (**CL**), olive, very stiff to hard, moist, ~25% fine-grained sand [OLD BAY CLAY]			53								
	-140													
135			very stiff, reddish yellow mottling			48				19.1	112.0		2374	
	-145		**POORLY GRADED SAND WITH SILT** (**SP-SM**), yellowish brown, very dense, moist, fine- to medium-grained sand [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1OS-B3

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/16/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						78								
	-150													
145			**SANDY LEAN CLAY** (**CL**), greenish gray, very stiff, moist, ~45% medium-grained sand, iron oxide mottling [OLD BAY CLAY]											
	-155													
150						30								

End of boring at approximately 151½ feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0			**SANDY SILT** (**ML**), gray, very soft, wet, shells [YOUNG BAY MUD]											
	-10					WOH				38.2	83.3		69	
5														
	-15					12								
			SILTY SAND (**SM**), olive, medium dense, moist, fine-grained sand, ~20% fines [YOUNG BAY MUD]											
10			more clayey			24				15.50				
	-20		**LEAN CLAY WITH SAND** (**CL**), yellowish brown, stiff, moist, ~20% fine-grained sand, pale olive staining [ALLUVIUM]											
15			hard			16				26.0	99.8			
						500psi								
	-25		**SILTY SAND** (**SM**), yellowish brown, medium dense, wet, fine-grained sand, ~30% fines [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			LEAN CLAY (**CL**), yellowish brown, hard, moist, iron oxide staining [ALLUVIUM]			19								
	-30													
25			**SAND SILT** (**ML**), gray, moist, ~40% fine-grained sand [OLD BAY CLAY]			500psi				24.7				
			POORLY GRADED SAND WITH SILT (**SP-SM**), olive, medium dense, wet, fine- to medium-grained sand, ~10% fines, pale olive staining [OLD BAY CLAY]			20								
	-35		**LEAN CLAY WITH SAND** (**CL**), olive, very stiff, moist, ~15% fine-grained sand, pale olive staining [OLD BAY CLAY]											
30			reddish orange staining			22				25.3	100.7			
	-40		**SILTY SAND** (**SM**), olive gray, medium dense, wet, fine-grained sand, ~15% fines [OLD BAY CLAY]			200psi								
35						29								
			LEAN CLAY (**CL**), olive, very stiff, moist, ~10% fine-grained sand, iron oxide staining [OLD BAY CLAY]											
	-45													

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						32								
						400psi				29.6	92.0		1477	
	-50													
45														
			FAT CLAY (**CH**), greenish gray, very stiff, moist, trace fine-grained sand, reddish orange and pale olive staining [OLD BAY CLAY]											
	-55													
50						26								
						200psi								
	-60									28.6	94.7		3005	
55														
	-65													

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
	-70													
65			Olive staining			19								
			Shells			200psi								
	-75													
70			Hard											
	-80													
75			Very stiff, iron oxide mottling			23				42.6	80.0		738	
	-85		**SANDY LEAN CLAY** (**CL**), yellowish brown, hard, moist, ~30% fine-grained sand [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			iron oxide staining ~15% fine-grained sand			30								
	-90													
85														
	-95													
90			~30% fine- to coarse-grained sand, 10% subangular fine gravel			34								
	-100													
95			**LEAN CLAY WITH SAND** (**CL**), olive, very stiff to hard, moist, ~20% fine-grained sand [OLD BAY CLAY]											
	-105													

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
105	-110		Hard, trace fine-grained sand, manganese staining, iron oxide and olive staining ~20% fine-grained sand			38								
110	-115		**LEAN CLAY** (**CL**), olive, very stiff to hard, moist, ~20% fine-grained sand [OLD BAY CLAY]			48				27.9	96.4			
115	-120													
	-125													

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			FAT CLAY (**CH**), gray, very stiff, moist, trace fine-grained sand [OLD BAY CLAY]			30								
	-130													
125														
	-135													
130			iron oxide mottling **LEAN CLAY WITH SAND** (**CL**), yellowish brown, hard, moist, ~25% fine-grained sand [ALLUVIUM]			75								
	-140													
135						26								
	-145					500psi				19.2	110.8			

ENGEO
Expect Excellence

SOIL BORING 1OS-B4

LATITUDE: 37.86237 LONGITUDE: -122.31962

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/13/2024
HOLE DEPTH: 151.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
145	-150		olive and iron oxide mottling			72								
150	-155					53								

End of boring at approximately 151½ feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 1OS-B5

LATITUDE: 37.86187 LONGITUDE: -122.31995

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/12/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			SANDY SILT (**ML**), gray, very soft, wet, ~30% fine-grained sand [YOUNG BAY MUD]											
	-10					WOH				35.1	78.3		91	
5														
			SILTY SAND (**SM**), gray, medium dense, wet, fine-grained sand, ~40% fines [YOUNG BAY MUD]											
	-15					200psi								
			SILTY SAND (**SM**), olive brown to yellow brown, medium dense, wet, fine-grained sand, 25% fines [ALLUVIUM]											
10														
			LEAN CLAY (**CL**), yellowish brown, stiff to very stiff, moist, ~10% fine-grained sand, maganese and pale olive staining [ALLUVIUM]											
						11								
	-20													
15														
						300psi								
			SILTY SAND (**SM**), olive brown, medium dense, moist, ~20% fines, shells, iron oxide staining [ALLUVIUM]											
	-25					14			31	23.0				

ENGEO
Expect Excellence

SOIL BORING 1OS-B5

LATITUDE: 37.86187 LONGITUDE: -122.31995

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/12/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						14			31	23.0				
			SANDY LEAN CLAY (**CL**), yellowish brown, very stiff, moist, ~30% fine-grained sand [ALLUVIUM]			28								
	-30		**SILTY SAND** (**SM**), yellowish brown, medium dense, moist, fine-grained sand, ~20% fines [ALLUVIUM]											
25			**FAT CLAY WITH SAND** (**CH**), olive gray, stiff to very stiff, moist, ~20% fine-grained sand [OLD BAY CLAY]			31								
			Olive, stiff, shells											
	-35					400psi				25.9	96.8		1986	
30														
			SANDY LEAN CLAY (**CL**), olive-brown, stiff, moist, ~35% fine-grained sand [ALLUVIUM]			23								
	-40													
35			**FAT CLAY** (**CH**), gray, very stiff, moist, ~10% fine-grained sand, maganese staining [OLD BAY CLAY]											
										26.2	99.2		1405	
						15								
	-45		no sand											

ENGEO
Expect Excellence

SOIL BORING 1OS-B5

LATITUDE: 37.86187 LONGITUDE: -122.31995

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/12/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			SANDY LEAN CLAY (**CL**), olive, meidum stiff, wet, ~40% fine- to medium-grained sand [OLD BAY CLAY]											
	-50		**POORLY GRADED SAND WITH SILT** (**SP-SM**), olive, dense, wet, ~10% fines [OLD BAY CLAY]			500psi								
45						35								
			FAT CLAY (**CH**), greenish gray, very stiff, moist, maganese staining [OLD BAY CLAY]			26								
	-55													
50														
						300psi								
	-60													
55														
	-65													

ENGEO
Expect Excellence

SOIL BORING 1OS-B5

LATITUDE: 37.86187 LONGITUDE: -122.31995

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/12/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						100psi				47.1	74.3		1483	
65	-70													
			shells **SANDY LEAN CLAY** (**CL**), yellowish brown, very stiff, moist, ~30% fine- to medium-grained sand [ALLUVIUM]			29								
70	-75		no sand, iron oxide mottling											
			olive-brown and yellow brown mottling			25				40.2	80.7			
75	-80													
			FAT CLAY (**CH**), olive, stiff, moist, yellowish brown mottling [OLD BAY CLAY]			300psi								
	-85													
			LEAN CLAY (**CL**), yellowish brown, stiff, moist,											

ENGEO
Expect Excellence

SOIL BORING 1OS-B5

LATITUDE: 37.86187 LONGITUDE: -122.31995

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/12/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			~10% fine-grained sand, maganese staining [ALLUVIUM]											
			wet			38								
	-90		**WELL-GRADED SAND WITH SILT** (**SW-SM**), yellowish brown, moist, fine- to medium-grained sand, ~10% fines [ALLUVIUM]											
85			**LEAN CLAY WITH SAND** (**CL**), yellowish brown, very stiff, moist, ~15% fine-grained sand, maganese staining [ALLUVIUM]											
						30								
	-95													
90										19.8	105.9		3813	
	-100													
95														
			SILT WITH SAND (**ML**), olive, hard, moist, ~20% fine-grained sand, sandstone fragments [OLD BA CLAY]			59								
	-105													

ENGEO
Expect Excellence

SOIL BORING 1OS-B5

LATITUDE: 37.86187 LONGITUDE: -122.31995

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/12/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			LEAN CLAY (**CL**), yellowish brown, very stiff, moist, trace fine-grained sand, trace sand [ALLUVIUM]											
	-110													
105														
						53				20.5	108.8		2649	
	-115		~20% fine-grained sand											
110														
			FAT CLAY (**CH**), greenish gray, very stiff, moist [OLD BAY CLAY]											
	-120													
115														
			yellowish brown staining			25								
	-125		gray, no staining											
						200psi								

ENGEO
Expect Excellence

SOIL BORING 1OS-B5

LATITUDE: 37.86187 LONGITUDE: -122.31995

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/12/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						200psi				46.0	74.9		2246	
	-130													
125														
	-135													
130														
	-140		**LEAN CLAY WITH SAND** (**CL**), yellowish brown, very stiff, moist, ~20% fine-grained sand [ALLUVIUM]			35								

End of boring at approximately 134 feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 1OS-B6

LATITUDE: 37.86152 LONGITUDE: -122.3205

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/11/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0			**FAT CLAY WITH SAND (CH)**, gray, very soft, wet, ~25% fine-grained sand, shells [YOUNG BAY MUD			WOH								
	-10													
5						WOH								
	-15		**SILTY SAND (SM)**, gray, loose, wet, fine-grained sand, ~40% fines [YOUNG BAY MUD]											
10			Olive gray, medium dense			9								
	-20													
15						47			8.1	17.6	117.3			
			POORLY GRADED SAND WITH SILT (SP-SM), olive brown, dense, wet, fine-grained sand, ~10% fines [YOUNG BAY MUD]											
	-25													

ENGEO
Expect Excellence

SOIL BORING 1OS-B6

LATITUDE: 37.86152 LONGITUDE: -122.3205

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/11/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			SANDY LEAN CLAY (CL), olive brown to yellowish brown, very stiff, moist, ~35% fine-grained sand, maganese and iron oxide staining [ALLUVIUM]			24								
			2" sand lense											
	-30													
25			yellowish brown			20	28	14						
			2" sand lense											
			LEAN CLAY (CL), yellowish brown, very stiff, moist, ~10% fine-grained sand, maganese staining [ALLUVIUM]											
	-35													
30						31								
	-40													
35						19				28.2	96.0			
	-45													

ENGEO
Expect Excellence

SOIL BORING 1OS-B6

LATITUDE: 37.86152 LONGITUDE: -122.3205

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/11/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						21								
			FAT CLAY WITH SAND (**CH**), olive gray, stiff, moist, ~15% fine-grained sand [OLD BAY CLAY]											
						17								
	-50													
45			trace sand											
						200psi								
	-55													
50														
			CLAYEY SAND (**SC**), gray, medium dense, wet, fine-grained sand, ~20% fines [OLD BAY DEPOSITS]			500psi								
	-60		**FAT CLAY** (**CH**), greenish gray, very stiff, moist [OLD BAY CLAY]											
55						29				20.9	107.8			
	-65													

ENGEO
Expect Excellence

SOIL BORING 1OS-B6

LATITUDE: 37.86152 LONGITUDE: -122.3205

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/11/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Shells			300psi								
	-70													
65														
	-75													
70						200psi				44.5	77.2		2036	
	-80													
75			Olive-gray, iron staining			23								
	-85													

ENGEO
Expect Excellence

SOIL BORING 1OS-B6

LATITUDE: 37.86152 LONGITUDE: -122.3205

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/11/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Pale olive staining			36								
	-90													
85			Fragments of sandstone and claystone, reddish orange staining			29								
	-95													
90			**LEAN CLAY** (**CL**), yellowish brown, stiff, moist, maganese staining, trace sands [ALLUVIUM]			48								
						14								
	-100													
95														
	-105													

ENGEO
Expect Excellence

SOIL BORING 1OS-B6

LATITUDE: 37.86152 LONGITUDE: -122.3205

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/11/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			trace angular gravel			500psi								
			SANDY LEAN CLAY (**CL**), olive, stiff, wet, ~25% medium- to coarse-grained sand, yellowish brown staining [OLD BAY CLAY]											
	-110													
105			**LEAN CLAY** (**CL**), yellowish brown, very stiff, moist, ~5% fine-grained sand, claystone fragments, reddish orange and pale olive staining [ALLUVIUM]			28								
			sand lense											
	-115													
110						400psi								
	-120		**SILTY SAND** (**SM**), yellowish brown, dense, wet, fine-grained sand, ~25% fines [ALLUVIUM]											
115						26								
			SANDY LEAN CLAY (**CL**), yellowish brown, very stiff, moist, ~35% fine-grained sand, iron oxide and maganese staining [ALLUVIUM]											
	-125		**FAT CLAY** (**CH**), greenish gray, stiff, moist, iron oxide staining [OLD BAY CLAY]											

SOIL BORING 1OS-B6

LATITUDE: 37.86152 LONGITUDE: -122.3205

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/11/2024
HOLE DEPTH: 121.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						13								

End of boring at approximately 121½ feet below ground surface.

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT1

LATITUDE: 37.86271 LONGITUDE: -122.31836

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/09/2024
HOLE DEPTH: 101 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Pushed CPT											
	-10													
5														
	-15													
10														
	-20		**CLAYEY SAND** (**SC**), yellowish brown, medium dense, wet, fine- to medium-grained sand, maganese staining [ALLUVIUM]			12	28	13	45.1	18.70				
15			**LEAN CLAY** (**CL**), yellowish brown, medium stiff, wet, maganese staining [ALLUVIUM]											
	-25					6								

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT1

LATITUDE: 37.86271 LONGITUDE: -122.31836

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/09/2024
HOLE DEPTH: 101 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			LEAN CLAY WITH SAND (**CL**), olive brown to olive gray, stiff, moist, ~15% fine-grained sand [OLD BAY CLAY]			6								
			Greenish gray, very stiff			34								
	-30		Pushed CPT											

SOIL BORING 1OS-CPT2

LATITUDE: 37.8626 LONGITUDE: -122.31967

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			Pushed CPT											
	-10													
5														
	-15													
10														
	-20													
15			**SILTY SAND** (**SM**), yellowish brown, medium dense, wet, ~35% fines [ALLUVIUM]			17								
	-25		**LEAN CLAY WITH SAND** (**CL**), yellowish brown, very stiff, wet, ~30% fine-grained sand [ALLUVIUM]											

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT2

LATITUDE: 37.8626 LONGITUDE: -122.31967

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						17								
	-30													
25			~15% fine-grained sand			12								
	-35													
30						18				28.1	96.4			
	-40		**LEAN CLAY WITH SAND** (**CL**), olive-brown, hard, moist, ~15% fine-grained sand [ALLUVIUM]											
35						23								
	-45		**FAT CLAY** (**CH**), greenish gray, stiff, moist [OLD BAY CLAY]											

SOIL BORING 1OS-CPT2

LATITUDE: 37.8626 LONGITUDE: -122.31967

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/05/2024
HOLE DEPTH: 134 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
-45	-50		Pushed CPT			17								

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT3

LATITUDE: 37.86153 LONGITUDE: -122.32103

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/10/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			CPT											
	-10		**SILTY SAND** (**SM**), gray, loose, wet, fine-grained sand, ~30% fines, shells [YOUNG BAY MUD]											
5						31								
	-15		**SANDY LEAN CLAY** (**CL**), olive brown, very stiff, moist, ~40% fine-grained sand [ALLUVIUM]											
10			**SILTY SAND** (**SM**), olive brown, medium dense, wet, fines, reddish orange mottling, gray staining [ALLUVIUM]											
	-20					26			26	16.1				
15			**SANDY LEAN CLAY** (**CL**), yellowish brown, stiff, moist, ~35% fine-grained sand [ALLUVIUM]											
	-25		**SILTY SAND** (**SM**), yellowish brown, medium dense, moist, fine-grained sand, ~30% fines [ALLUVIUM]			27								

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT3

LATITUDE: 37.86153 LONGITUDE: -122.32103

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/10/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			POORLY GRADED SAND (**SP**), yellowish brown, medium dense, wet, fine-grained sand, trace fines [ALLUVIUM]											
			SILTY SAND (**SM**), yellowish brown, dense, moist, fine-grained sand, ~25% fines [ALLUVIUM]			56								
	-30													
25			**LEAN CLAY WITH SAND** (**CL**), yellowish brown, very stiff, moist, ~25% fine-grained sand, reddish orange staining [ALLUVIUM]											
						23								
	-35		**LEAN CLAY WITH SAND** (**CL**), olive-gray, very stiff, moist, ~15% fine-grained sand [OLD BAY CLAY]											
30			CPT											
	-40													
35														
	-45													

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT3

LATITUDE: 37.86153 LONGITUDE: -122.32103

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/10/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
45	-50													
50	-55													
55	-60													
	-65													

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT3

LATITUDE: 37.86153 LONGITUDE: -122.32103

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/10/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
65	-70													
70	-75													
75	-80													
	-85													

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT3

LATITUDE: 37.86153 LONGITUDE: -122.32103

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/10/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
85	-90		**WELL-GRADED SAND** (**SW**), bluish gray, medium dense to dense, wet, medium- to coarse-grained sand, ~10% subrounded fine gravel [OLD BAY CLAY]			29				18.5				
			claystone fragments											
90	-95		**FAT CLAY WITH SAND** (**CH**), greenish gray, very stiff, moist [OLD BAY CLAY]											
			LEAN CLAY WITH SAND (**CL**), yellowish brown, very stiff to hard, moist, ~15% fine- to medium-grained sand [ALLUVIUM]			44								
95	-100													
	-105													

ENGEO
Expect Excellence

SOIL BORING 1OS-CPT3

LATITUDE: 37.86153 LONGITUDE: -122.32103

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 09/10/2024
HOLE DEPTH: 101.5 ft
HOLE DIAMETER: 6 in
SURFACE ELEV.: -6 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
						78				16.8				
			SANDY SILT (**ML**), yellowish brown, hard, moist, reddish orange staining [ALLUVIUM]											

End of boring at approximately 101½ feet below ground surface. Groundwater was not measured due to drilling method.

ENGEO
Expect Excellence

SOIL BORING 2-B1

LATITUDE: 37.862953 LONGITUDE: -122.317585

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/07/2025 LOGGED BY / REVIEWED BY: VZ /
HOLE DEPTH: 30 ft DRILLING CONTRACTOR: Gregg Drilling LLC
HOLE DIAMETER: 6.5 in DRILLING METHOD: Sonic
SURFACE ELEV.: 11 ft (MLLW) HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 3-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 3-inch Aggregate Base											
	10		**GRAVELLY LEAN CLAY WITH SAND** (**CL**), light yellowish brown, very stiff, moist, ≈25% subangular to subrounded fine to coarse gravel, ≈15% fine- to medium-grained sand [FILL]											
5			brick fragments											
	5		grades more gravel											
			WELL-GRADED GRAVEL WITH SAND (**GW**), light yellowish brown, dry, subangular to subrounded fine to coarse gravel, ≈35% fine- to coarse-grained sand, rebar piece [ROCK DIKE]											
10	0		**CLAYEY GRAVEL WITH SAND** (**GC**), gray to pale olive, wet, subangular to subrounded fine to coarse gravel, ≈30% fine- to coarse-grained sand, ≈25% fines [ROCK DIKE]											
15	-5		**WELL-GRADED GRAVEL WITH SAND** (**GW**), light gray, dry, subangular to subrounded fine to coarse gravel, ≈30% fine- to coarse-grained sand [ROCK DIKE]											
			CLAYEY SAND WITH GRAVEL (**SC**), dark gray, dry to moist, fine- to coarse-grained sand, ≈30% subrounded fine to coarse gravel, ≈20% fines [ROCK DIKE]											
			6-inch seam of dry, coarse rounded gravel, up to 4-inch diameter clasts											

ENGEO
Expect Excellence

SOIL BORING 2-B1

LATITUDE: 37.862953 LONGITUDE: -122.317585

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/07/2025
HOLE DEPTH: 30 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 11 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ /
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
	-10		**FAT CLAY WITH SAND** (**CH**), gray, soft to medium stiff, moist, ≈25% shells, ≈20% fine-grained sand [YOUNG BAY MUD]											
25	-15		**LEAN CLAY WITH SAND** (**CL**), light yellowish brown, hard, moist, ≈15% fine- to medium-grained sand, maganese staining [ALLUVIUM]											
			CLAYEY SAND (**SC**), light yellowish brown, moist, fine-grained sand, ≈40% fines [ALLUVIUM]											
30			End of boring at approximately 30 feet below ground surface. Groundwater was encountered at 7 feet below ground surface.											

SOIL BORING 2-B2

LATITUDE: 37.862961 LONGITUDE: -122.317568

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 8 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 11.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: N/A

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
	10		**ASPHALT** (**AC**), 3-inch Asphalt Concrete **AGGREGATE BASE** (**AB**), 3-inch Aggregate Base **LEAN CLAY WITH SAND** (**CL**), light yellowish brown, stiff, wet, ≈20% fine- to medium-grained sand, ≈10% subangular fine to coarse gravel [FILL]											
5	5		**WELL-GRADED GRAVEL WITH SAND** (**GW**), light gray, moist, fine to coarse gravel, ≈35% fine- to coarse grained sand, up to 4-inch gravel clasts [ROCK DIKE]											

End of boring at approximately 8 feet below ground surface. Groundwater was encountered at approximately 8 feet below ground surface.

ENGEO
Expect Excellence

SOIL BORING 2-B3

LATITUDE: 37.862968 LONGITUDE: -122.317538

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 25 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 11.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: N/A

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	10		**ASPHALT** (**AC**), 3-inch Asphalt Concrete, **AGGREGATE BASE** (**AB**), 3-inch Aggregate Base, **SANDY LEAN CLAY WITH GRAVEL** (**CL**), light yellowish brown, stiff, wet, ≈30% fine- to medium-grained sand, ≈15% subangular to subrounded fine to coarse gravel, [FILL]											
5	5		**SANDY LEAN CLAY WITH GRAVEL** (**CL**), dark gray, moist, fine- to coarse-grained sand, ≈20% fine- to medium-grained sand, ≈15% subangular to subrounded fine gravel [FILL]											
10	0		**SILTY SAND WITH GRAVEL** (**SM**), dark gray, fine- to coarse-grained sand, ≈35% subangular to angular fine to coarse gravel, ≈15% fines [ROCK DIKE]											
15	-5													

SOIL BORING 2-B3

LATITUDE: 37.862968 LONGITUDE: -122.317538

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 25 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 11.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: N/A

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
	-10		**FAT CLAY WITH SAND (CH)**, gray, soft, moist, ≈20% fine-grained sand [YOUNG BAY MUD]											
-25			End of boring at approximately 25 feet below ground surface. Groundwater was encountered at approximately 8 feet below ground surface.											

ENGEO
Expect Excellence

SOIL BORING 2-B4

LATITUDE: 37.86298 LONGITUDE: -122.317497

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 30 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 11.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: N/A

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	10		**GRAVELLY LEAN CLAY WITH SAND** (**CL**), light yellowish brown, stiff, moist to wet, ≈25% subangular to subrounded fine to coarse gravel, ≈15% fine- to medium-grained sand, [FILL]											
5	5		**POORLY GRADED GRAVEL WITH SAND** (**GP**), gray, dry, subangular to subrounded fine to coarse gravel, up to 4½-inch clasts, [ROCK DIKE]											
10	0		**CLAYEY GRAVEL WITH SAND** (**GC**), dark yellowish brown to dark gray, wet, subangular to subrounded fine to coarse gravel, ≈45% fines, ≈15% fine- to coarse-grained sand, up to 4½ inch clasts, light gray staining [ROCK DIKE] No recovery from 10 to 13½ feet below existing ground surface											
15	-5		becomes dark yellowish brown, ≈35% fine- to coarse-grained sand, becomes dark gray becomes gray, presence of fibrous rootlets											
			CLAYEY SAND WITH GRAVEL (**SC**), dark gray, moist, fine- to coarse-grained sand, ≈25% fines, ≈25% subrounded fine to coarse gravel [ROCK DIKE]											

ENGEO
Expect Excellence

SOIL BORING 2-B4

LATITUDE: 37.86298 LONGITUDE: -122.317497

Berkeley Water
Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 30 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 11.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: N/A

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			≈25% subrounded fine to coarse gravel [ROCK DIKE]											
	-10		**FAT CLAY** (**CH**), gray, soft, moist, ≈10% fine- to medium-grained sand, ≈10% shells [YOUNG BAY MUD]											
			CLAYEY SAND (**SC**), gray, moist, fine- to coarse-grained sand, ≈30% fines [YOUNG BAY MUD]											
25			**FAT CLAY** (**CH**), gray, soft, moist, ≈10% fine- to medium-grained sand, ≈10% shells [YOUNG BAY MUD]											
	-15		**SANDY LEAN CLAY** (**CL**), light yellowish brown, stiff, moist, ≈35% fine- to coarse-grained sand [ALLUVIUM]											
			CLAYEY SAND (**SC**), light yellowish brown, wet, fine- to coarse-grained sand, ≈35% fines, ≈10% subrounded fine to coarse gravel [ALLUVIUM]											
30			End of boring at approximately 30 feet below ground surface. Groundwater was encountered at approximately 7 feet below ground surface.											

ENGEO
Expect Excellence

SOIL BORING 2-B5

LATITUDE: 37.863006 LONGITUDE: -122.31733

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 20 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 14.5 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: -

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	10		**ASPHALT** (**AC**), 4½-inch Asphalt Concrete **AGGREGATE BASE** (**AB**), 5-inch Aggregate Base **LEAN CLAY WITH SAND** (**CL**), yellowish brown, moist, ≈25% fine- to coarse-grained sand, brick fragments [FILL]											
5														
10	5		**SILTY GRAVEL WITH SAND** (**GM**), dark gray, wet, subangular to subrounded fine gravel, ≈35% fine- to coarse-grained sand, ≈20% fines [FILL] 3½-inch subangular cobble											
			SANDY LEAN CLAY (**CL**), pale olive, moist, ≈40% fine-grained sand [FILL]											
15	0		**SILTY GRAVEL** (**GM**), dark gray, wet, subangular to subrounded fine to coarse gravel, ≈20% fines [FILL]											
	-5													

SOIL BORING 2-B6

LATITUDE: 37.863009 LONGITUDE: -122.317313

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 15 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 14.5 ft (MLLW)

LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: N/A

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
0	10		**ASPHALT** (**AC**), 4½-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 6-inch Aggregate Base											
			LEAN CLAY WITH SAND (**CL**), dark yellowish brown, moist, ≈20% fine- to medium-grained sand, dark gray stains, concrete and brick fragments [FILL]											
5	5													
10	0		**SILTY GRAVEL WITH SAND** (**GM**), dark gray, wet, angular to subrounded fine to coarse gravel, ≈35% fine- to coarse-grained sand, ≈20% fines, up to 1½ inch clasts [FILL]											
15			End of boring at approximately 15 feet below ground surface. Groundwater was encountered at approximately 12 feet below ground surface.											

ENGEO
Expect Excellence

SOIL BORING 2-B7

LATITUDE: 37.863027 LONGITUDE: -122.317221

Berkeley Water Transportation Pier Ferry
Berkeley, CA
25022.000.001

DATE DRILLED: 02/08/2025
HOLE DEPTH: 20 ft
HOLE DIAMETER: 6.5 in
SURFACE ELEV.: 15 ft (MLLW)
LOGGED BY / REVIEWED BY: VZ / JF
DRILLING CONTRACTOR: Gregg Drilling LLC
DRILLING METHOD: Sonic
HAMMER TYPE: N/A

Depth (ft)	Elevation (ft)	Sampler Type	MATERIAL DESCRIPTION	Graphic Log	Water Levels	Blow Count (blows/ft) or Penetration Resistance	Liquid Limit	Plasticity Index	Fines (%)	Moisture Content (%)	Dry Density (pcf)	Compressive Strength (psf) *Field Approximation (tsf)	Shear Strength (psf) *Field Approximation (tsf)	Strength Test Type
			ASPHALT (**AC**), 4½-inch Asphalt Concrete											
			AGGREGATE BASE (**AB**), 6-inch Aggregate Base											
			LEAN CLAY WITH SAND (**CL**), dark yellowish brown, stiff, wet, ≈20% fine- to medium-grained sand, textile fragments, dark gray stains [FILL]											
5	10													
			GRAVELLY LEAN CLAY (**CL**), dark yellowish brown, stiff, wet, ≈30% angular to subrounded fine gravel, fiborous roots [FILL]											
10	5		**SANDY FAT CLAY WITH GRAVEL** (**CH**), dark yellowish brown, soft, wet, ≈30% fine angular to subrounded fine gravel [FILL]											
			CLAYEY SAND WITH GRAVEL (**SC**), dark yellowish brown, moist, ≈40% fines, ≈20% subangular fine gravel, fiborous roots [FILL]											
15	0		**FAT CLAY** (**CH**), black, very soft, wet, organic odor [YOUNG BAY MUD]											

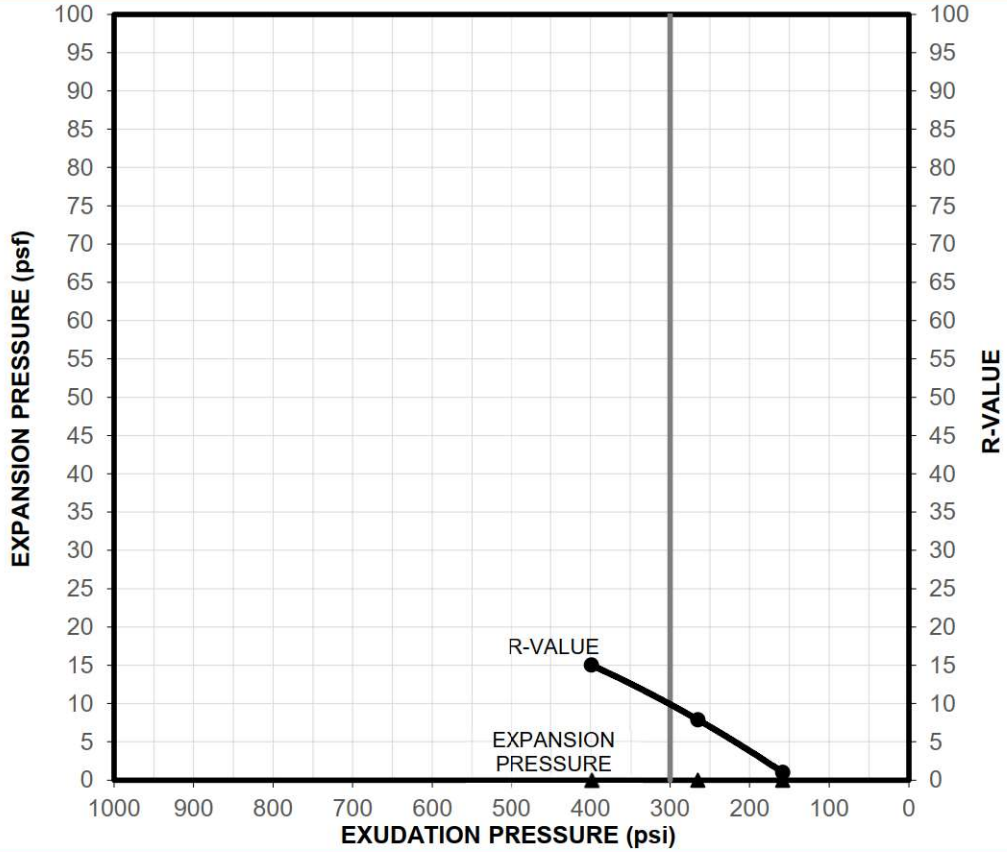


APPENDIX D

LABORATORY TEST RESULTS

R-VALUE TEST REPORT

CTM 301



SAMPLE ID	MATERIAL DESCRIPTION	SAMPLE LOCATION
1-C1@0-5	See exploration logs	1-C1 at 0 to 5 feet

SPECIMENS	1	2	3
EXUDATION PRESSURE (psi)	399	265	158
EXPANSION PRESSURE (psf)	0	0	0
R-VALUE	15	8	1
MOISTURE CONTENT (%)	15.1	17.3	19.1
DRY DENSITY (pcf)	116.1	112.7	108.3
EXPANSION PRESSURE (psf) AT EXUDATION PRESSURE OF 300 psi		0	

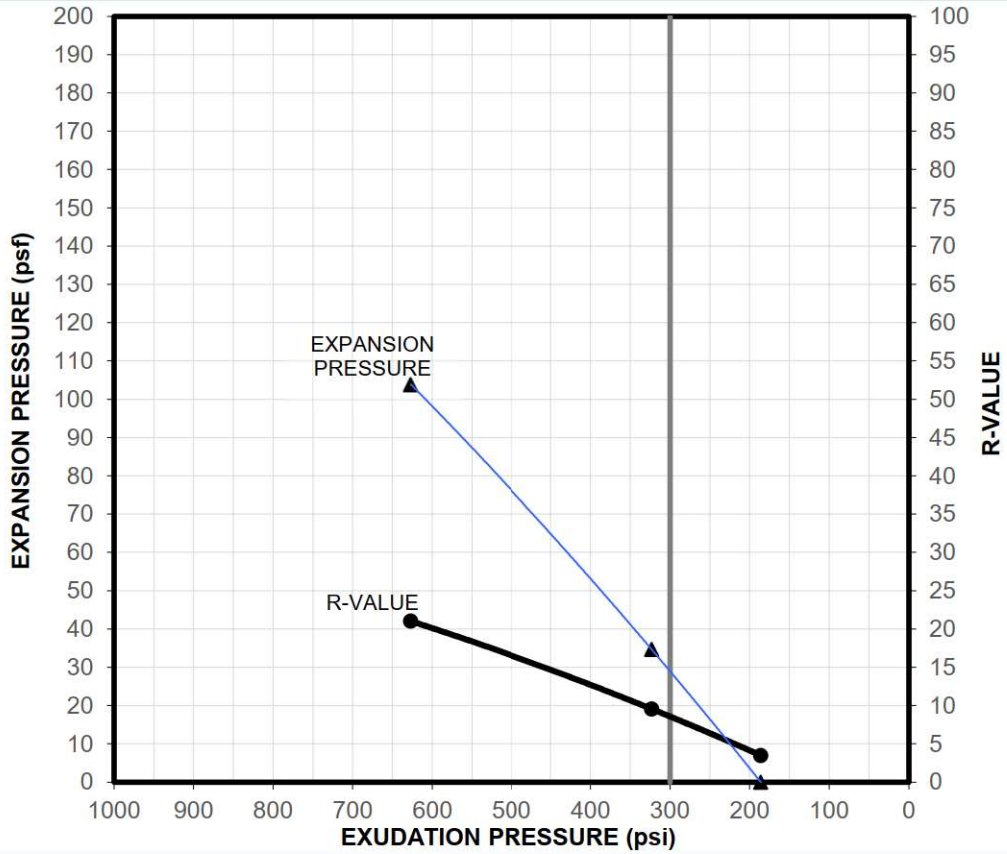
R-VALUE AT EXUDATION PRESSURE OF 300 psi	TEST RESULT
	10

ENGEO
Expect Excellence

CLIENT: COWI North American, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/22/2024
TESTED BY: M. Ryan
REVIEWED BY: M. Gilbert

R-VALUE TEST REPORT

CTM 301



SAMPLE ID	MATERIAL DESCRIPTION	SAMPLE LOCATION
1-C3@0-5	See exploration logs	1-C3 at 0 to 5 feet

SPECIMENS	1	2	3
EXUDATION PRESSURE (psi)	627	323	186
EXPANSION PRESSURE (psf)	104	35	0
R-VALUE	21	10	3
MOISTURE CONTENT (%)	14.7	16.0	17.8
DRY DENSITY (pcf)	118.5	114.0	109.9
EXPANSION PRESSURE (psf) AT EXUDATION PRESSURE OF 300 psi		29	

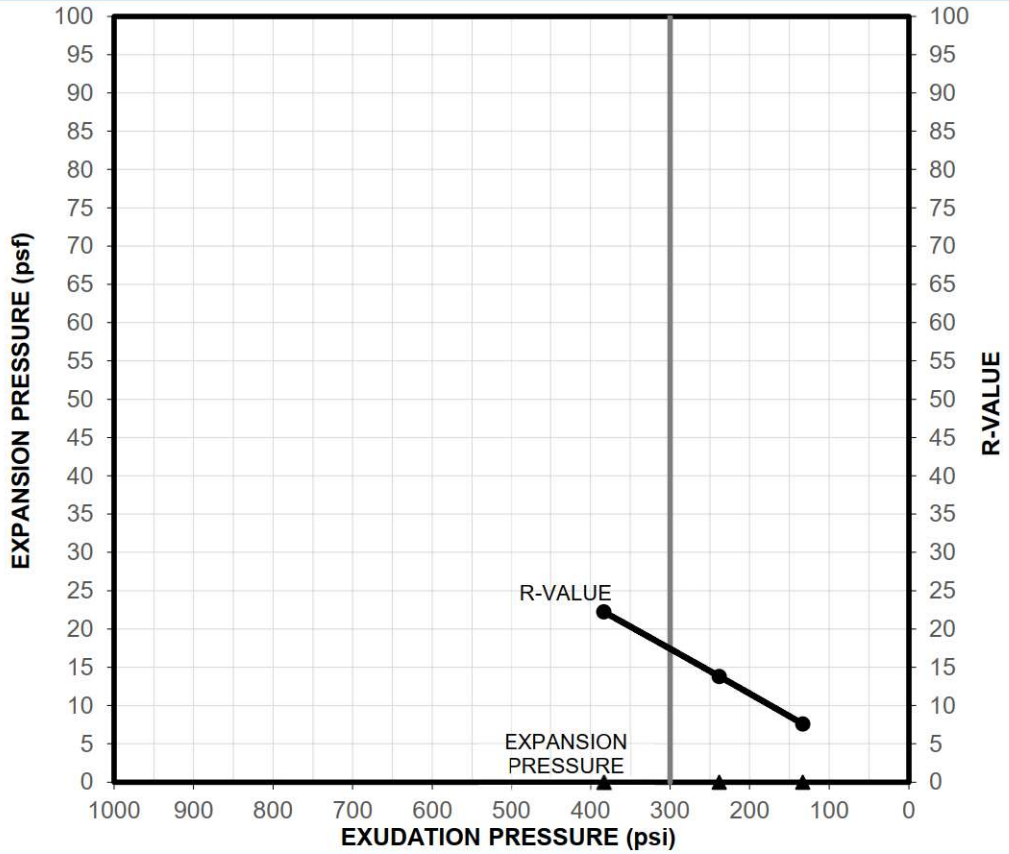
R-VALUE AT EXUDATION PRESSURE OF 300 psi	TEST RESULT
	9

ENGEO
Expect Excellence

CLIENT: COWI North American, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: M. Ryan
REVIEWED BY: M. Gilbert

R-VALUE TEST REPORT

CTM 301



SAMPLE ID	MATERIAL DESCRIPTION	SAMPLE LOCATION
1-C6 @ 0-5	See exploration logs	1-C6 at 0 to 5 feet

SPECIMENS	1	2	3
EXUDATION PRESSURE (psi)	383	238	133
EXPANSION PRESSURE (psf)	0	0	0
R-VALUE	22	14	8
MOISTURE CONTENT (%)	15.8	17.5	19.6
DRY DENSITY (pcf)	117.0	111.8	107.8
EXPANSION PRESSURE (psf) AT EXUDATION PRESSURE OF 300 psi		0	

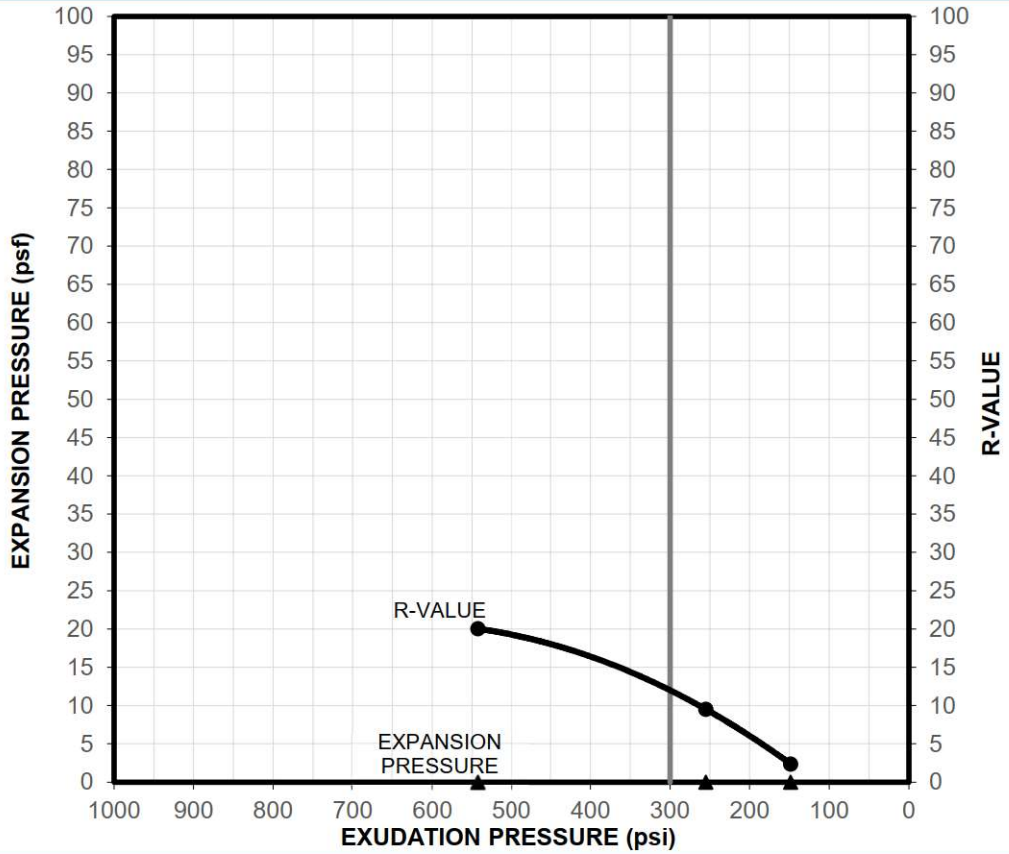
R-VALUE AT EXUDATION PRESSURE OF 300 psi	TEST RESULT
	17

ENGEO
Expect Excellence

CLIENT: COWI North American, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/22/2024
TESTED BY: M. Ryan
REVIEWED BY: M. Gilbert

R-VALUE TEST REPORT

CTM 301



SAMPLE ID	MATERIAL DESCRIPTION	SAMPLE LOCATION
1-C8@0-5	See exploration logs	1-C8 at 0 to 5 feet

SPECIMENS	1	2	3
EXUDATION PRESSURE (psi)	543	255	148
EXPANSION PRESSURE (psf)	0	0	0
R-VALUE	20	10	2
MOISTURE CONTENT (%)	13.8	15.0	16.9
DRY DENSITY (pcf)	118.3	114.3	109.3
EXPANSION PRESSURE (psf) AT EXUDATION PRESSURE OF 300 psi		0	

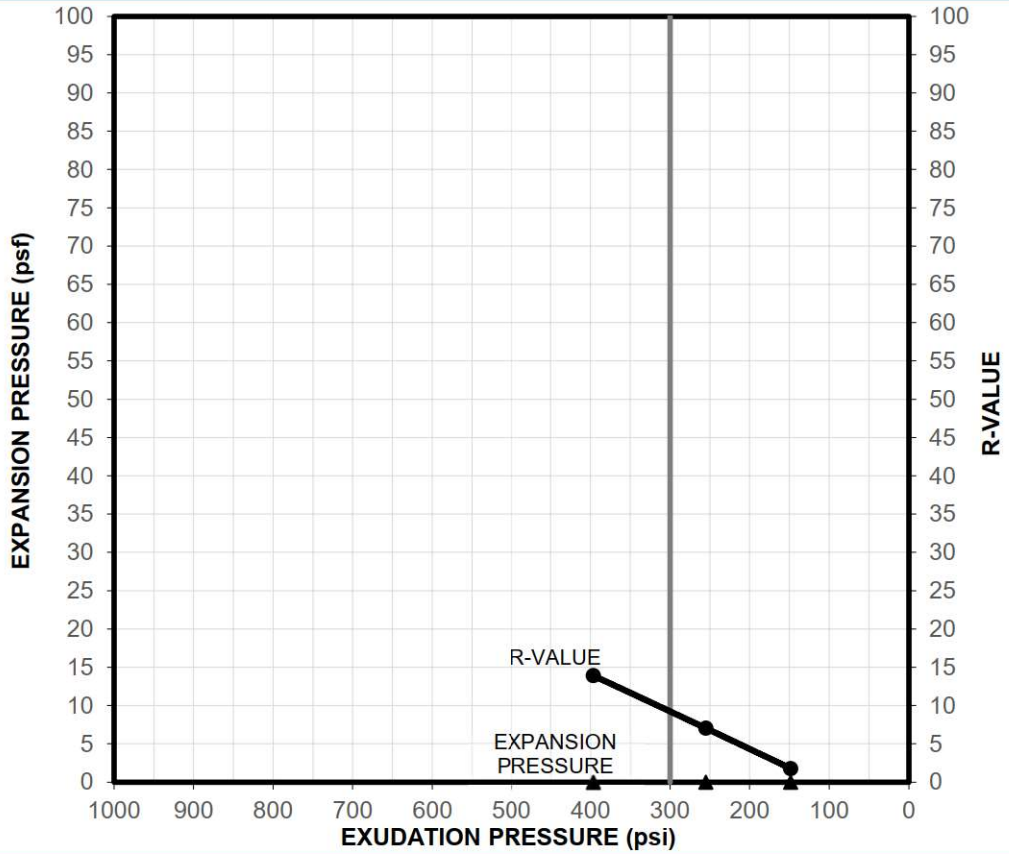
R-VALUE AT EXUDATION PRESSURE OF 300 psi	TEST RESULT
	12

ENGEO
Expect Excellence

CLIENT: COWI North American, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: M. Ryan
REVIEWED BY: M. Gilbert

R-VALUE TEST REPORT

CTM 301



SAMPLE ID	MATERIAL DESCRIPTION	SAMPLE LOCATION
1-B3 @ 0-5	See exploration logs	1-B3 at 0 to 5 feet

SPECIMENS	1	2	3
EXUDATION PRESSURE (psi)	397	255	148
EXPANSION PRESSURE (psf)	0	0	0
R-VALUE	14	7	2
MOISTURE CONTENT (%)	18.8	20.5	22.3
DRY DENSITY (pcf)	111.7	107.3	104.1
EXPANSION PRESSURE (psf) AT EXUDATION PRESSURE OF 300 psi		0	

R-VALUE AT EXUDATION PRESSURE OF 300 psi	TEST RESULT
	9

ENGEO Expect Excellence

CLIENT: COWI North American, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project

PROJECT NO: 25022.000.001 PH001 T003

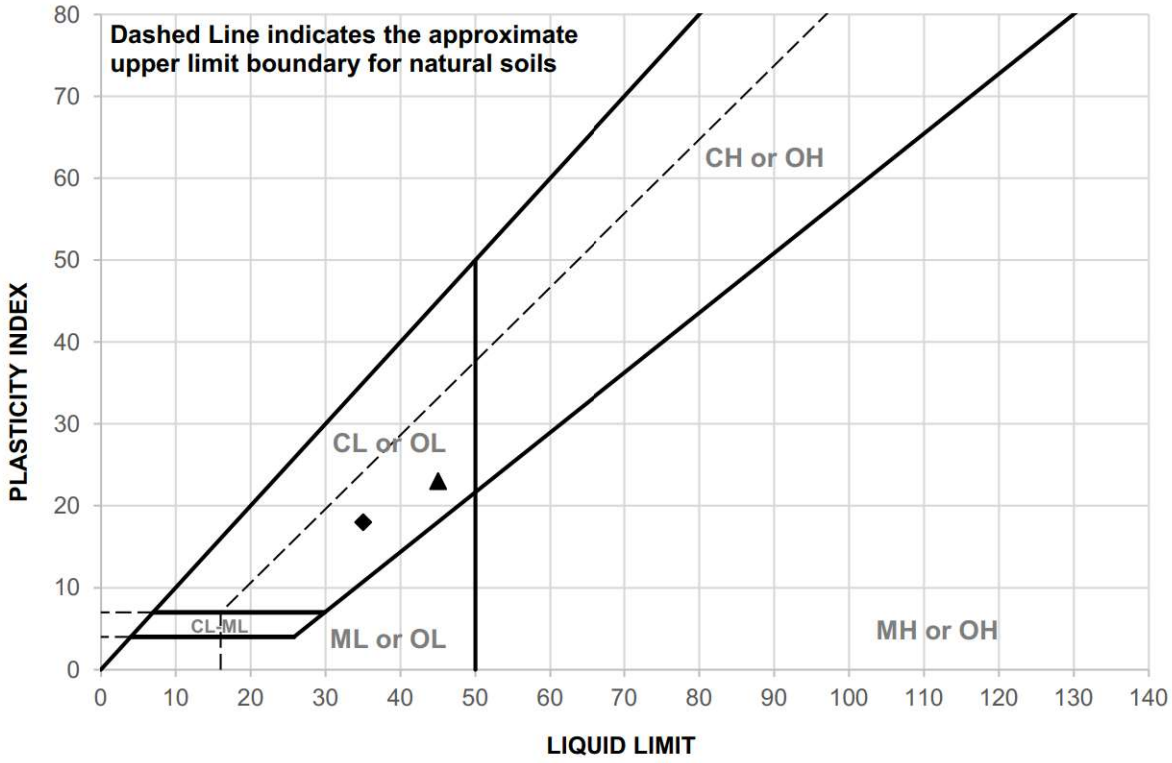
PROJECT LOCATION: Berkeley, CA

REPORT DATE: 10/22/2024

TESTED BY: M. Ryan

REVIEWED BY: M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT
ASTM D4318



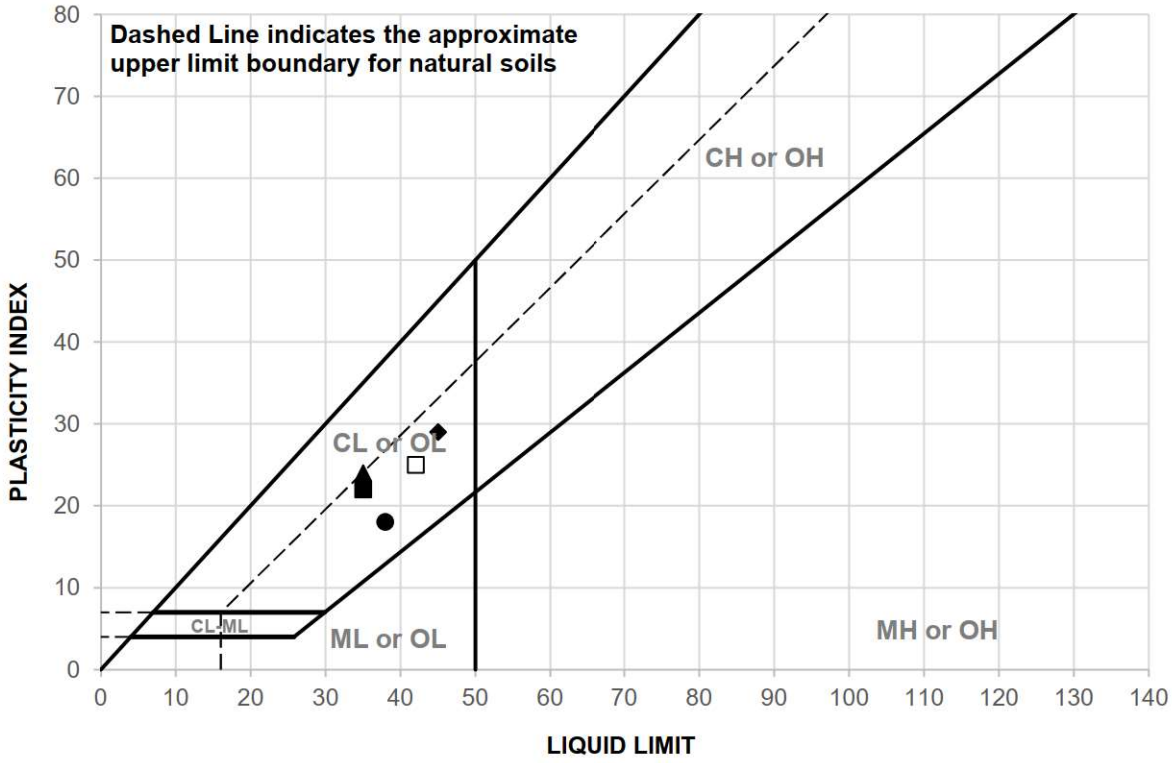
	SAMPLE ID	DEPTH (ft)	MATERIAL DESCRIPTION	LL	PL	PI
▲	1-B4@10-12	10-12	See exploration logs	45	22	23
◆	1OS-B1@12-14	12-14	See exploration logs	35	17	18

	SAMPLE ID	TEST METHOD	REMARKS
▲	1-B4@10-12	PI: ASTM D4318, Wet Method	
◆	1OS-B1@12-14	PI: ASTM D4318, Wet Method	

ENGEO
Expect Excellence

CLIENT: COWI North America
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/11/2024
TESTED BY: S. Fikre-Selassie
REVIEWED BY: G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT
ASTM D4318



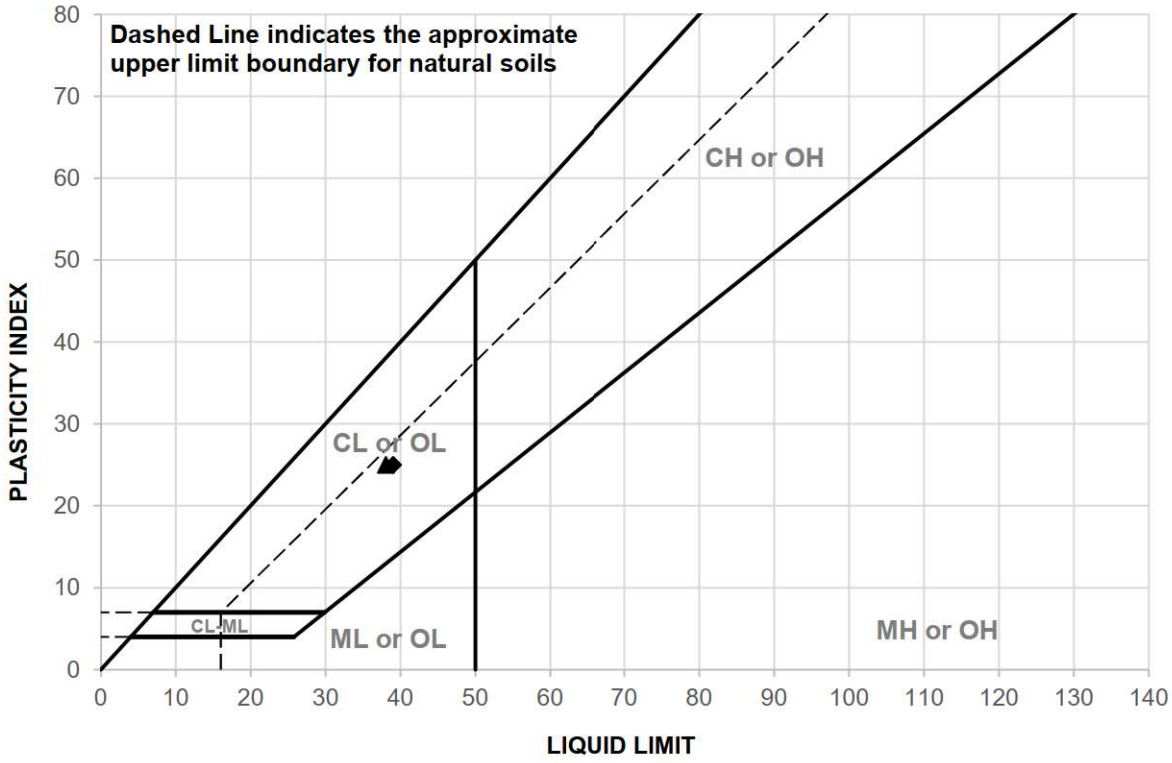
	SAMPLE ID	DEPTH (ft)	MATERIAL DESCRIPTION	LL	PL	PI
▲	1-B1@6-6.5	6-6.5	See exploration logs	35	11	24
◆	1-B1@11-11.5	11-11.5	See exploration logs	45	16	29
□	1-B2@5.5-6	5.5-6	See exploration logs	42	17	25
●	1-B2@8.5-9	8.5-9	See exploration logs	38	20	18
■	1-B2@30-31.5	30-31.5	See exploration logs	35	13	22

	SAMPLE ID	TEST METHOD	REMARKS
▲	1-B1@6-6.5	PI: ASTM D4318, Wet Method	
◆	1-B1@11-11.5	PI: ASTM D4318, Wet Method	
□	1-B2@5.5-6	PI: ASTM D4318, Wet Method	
●	1-B2@8.5-9	PI: ASTM D4318, Wet Method	
■	1-B2@30-31.5	PI: ASTM D4318, Wet Method	

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: R. Montalvo
REVIEWED BY: M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT
ASTM D4318



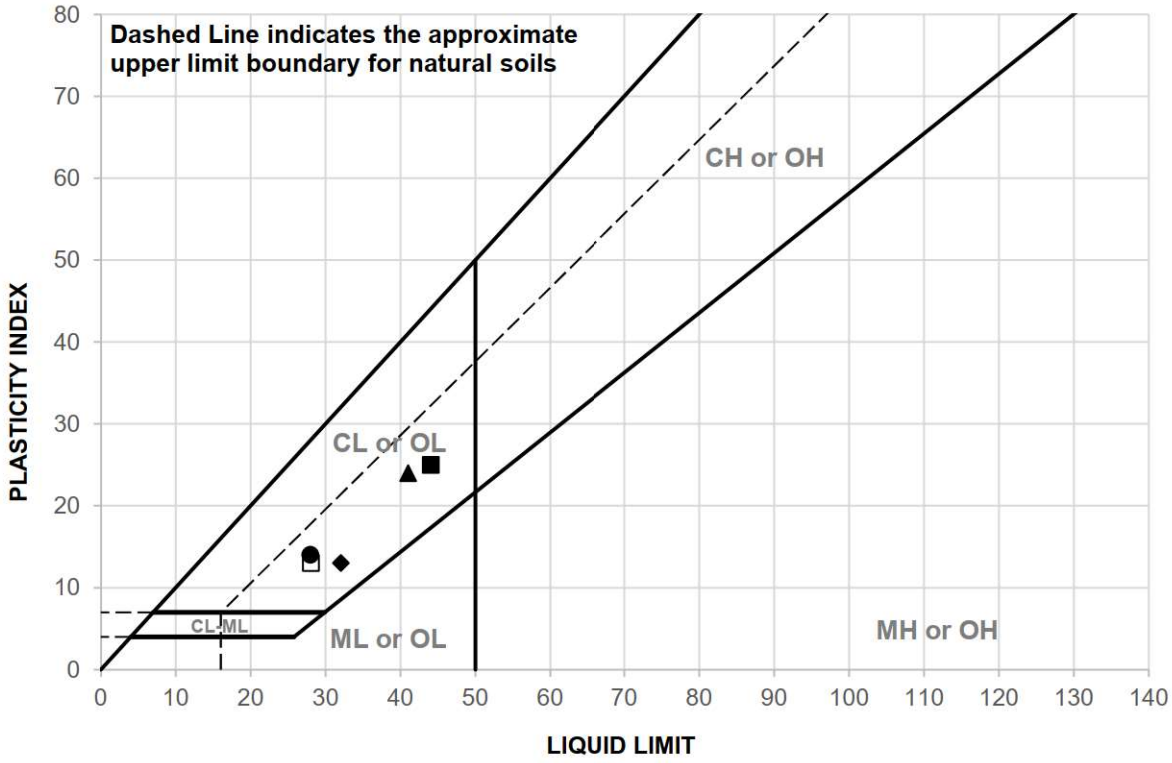
	SAMPLE ID	DEPTH (ft)	MATERIAL DESCRIPTION	LL	PL	PI
▲	1-B3@6-6.5	6-6.5	See exploration logs	38	13	25
◆	1-B3@15-16.5	15-16.5	See exploration logs	39	14	25

	SAMPLE ID	TEST METHOD	REMARKS
▲	1-B3@6-6.5	PI: ASTM D4318, Wet Method	
◆	1-B3@15-16.5	PI: ASTM D4318, Wet Method	

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: R. Montalvo
REVIEWED BY: M. Gilbert

LIQUID AND PLASTIC LIMITS TEST REPORT
ASTM D4318



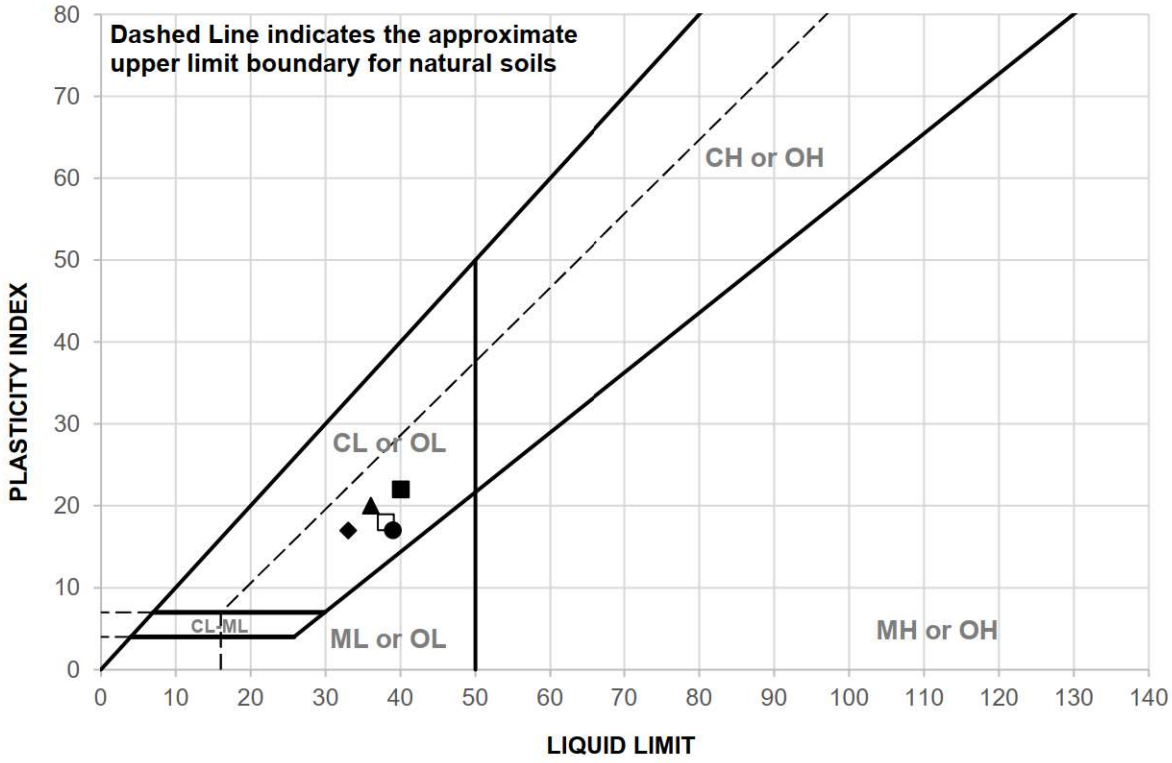
	SAMPLE ID	DEPTH (ft)	MATERIAL DESCRIPTION	LL	PL	PI
▲	1-B3@0-5	0-5	See exploration logs	41	17	24
◆	1-B3@26-26.5	26-26.5	See exploration logs	32	19	13
□	1OS-CPT1@14-15.5	14-15.5	See exploration logs	28	15	13
●	1OS-B6@25-26	25-26	See exploration logs	28	14	14
■	1-C1@SG	SG	See exploration logs	44	19	25

	SAMPLE ID	TEST METHOD	REMARKS
▲	1-B3@0-5	PI: ASTM D4318, Wet Method	
◆	1-B3@26-26.5	PI: ASTM D4318, Wet Method	
□	1OS-CPT1@14-15.5	PI: ASTM D4318, Wet Method	
●	1OS-B6@25-26	PI: ASTM D4318, Wet Method	
■	1-C1@SG	PI: ASTM D4318, Wet Method	

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/16/2024
TESTED BY: S.Fikre-Selassie/K. Nguyen/L. Schmitz
REVIEWED BY: O. Espinoza

LIQUID AND PLASTIC LIMITS TEST REPORT
ASTM D4318



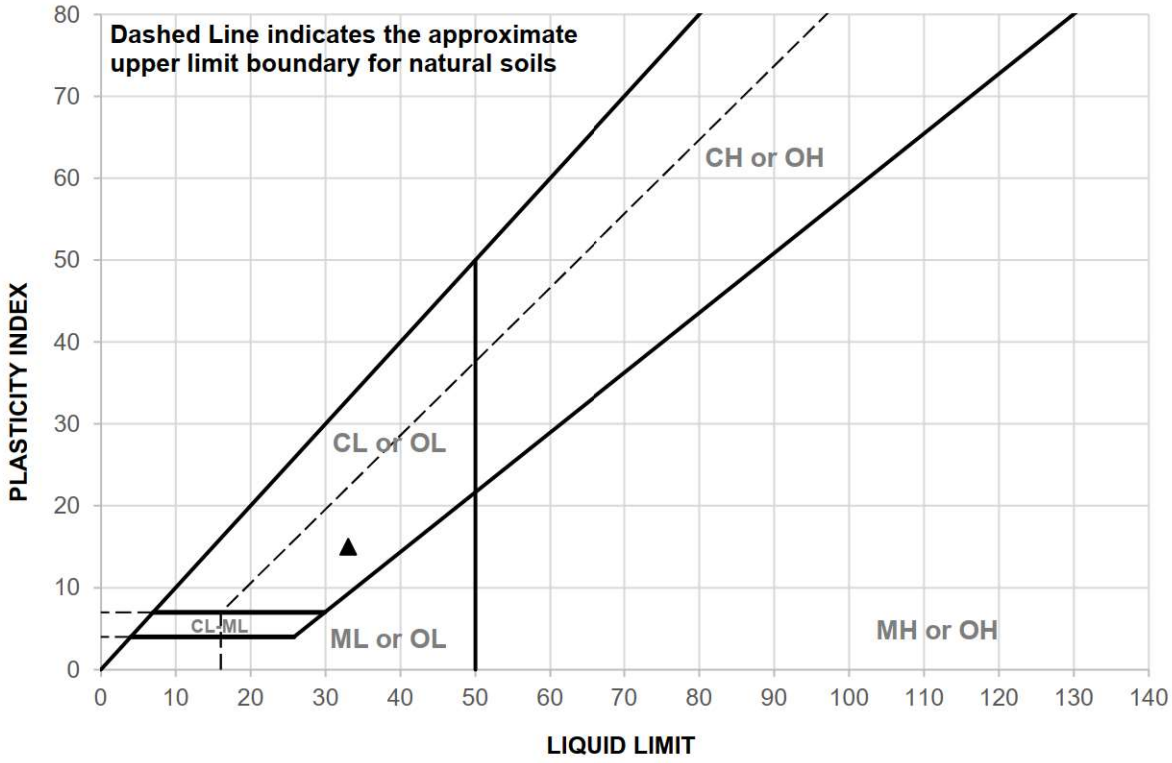
	SAMPLE ID	DEPTH (ft)	MATERIAL DESCRIPTION	LL	PL	PI
▲	1-C3@SG	SG	See exploration logs	36	16	20
◆	1-C4@SG	SG	See exploration logs	33	16	17
□	1-C6@SG	SG	See exploration logs	38	20	18
●	1-C8@SG	SG	See exploration logs	39	22	17
■	1-CPT2@SG	SG	See exploration logs	40	18	22

	SAMPLE ID	TEST METHOD	REMARKS
▲	1-C3@SG	PI: ASTM D4318, Wet Method	
◆	1-C4@SG	PI: ASTM D4318, Wet Method	
□	1-C6@SG	PI: ASTM D4318, Wet Method	
●	1-C8@SG	PI: ASTM D4318, Wet Method	
■	1-CPT2@SG	PI: ASTM D4318, Wet Method	

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/16/2024
TESTED BY: S.Fikre-Selassie/K. Nguyen
REVIEWED BY: O. Espinoza

LIQUID AND PLASTIC LIMITS TEST REPORT
ASTM D4318



	SAMPLE ID	DEPTH (ft)	MATERIAL DESCRIPTION	LL	PL	PI
▲	1OS-B1@7.5-9	7.5-9	See exploration logs	33	18	15

	SAMPLE ID	TEST METHOD	REMARKS
▲	1OS-B1@7.5-9	PI: ASTM D4318, Wet Method	

ENGEO
Expect Excellence

CLIENT: COWI North America
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T004
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 11/21/2024
TESTED BY: K. Nguyen
REVIEWED BY: G. Criste

MOISTURE CONTENT REPORT
ASTM D2216

SAMPLE ID	1OSB1@7.5-9							
DEPTH (ft.)	7.5-9							
METHOD A OR B	B							
MOISTURE CONTENT (%)	18.3							

SAMPLE ID								
DEPTH (ft.)								
METHOD A OR B								
MOISTURE CONTENT (%)								

SAMPLE ID								
DEPTH (ft.)								
METHOD A OR B								
MOISTURE CONTENT (%)								

SAMPLE ID								
DEPTH (ft.)								
METHOD A OR B								
MOISTURE CONTENT (%)								

SAMPLE ID								
DEPTH (ft.)								
METHOD A OR B								
MOISTURE CONTENT (%)								

SAMPLE ID								
DEPTH (ft.)								
METHOD A OR B								
MOISTURE CONTENT (%)								

ENGEO
Expect Excellence

CLIENT: COWI North America
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T004
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 11/21/2024
TESTED BY: K. Nguyen
REVIEWED BY: G. Criste

MOISTURE CONTENT REPORT
ASTM D2216

SAMPLE ID	1-B2	1-B2	1-B2	1-B2	1-B3	1-B3		
DEPTH (ft.)	8-8.5	8.5-9	10-11.5	16-16.5	11-11.5	15-16.5		
METHOD A OR B	B	B	B	B	B	B		
MOISTURE CONTENT (%)	15.6	13.6	8.2	14.9	22.1	19.7		

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/11/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

MOISTURE CONTENT DETERMINATION

Revision 01-20-2021

ASTM D2216

PROJECT NAME: Berkeley Water Trasportation Pier Ferry Pı
REPORT DATE: 10/11/24

PROJECT, PHASE, TASK NO.: 25022.000.001 PH001 T003

CLIENT: COWI North America, Inc.
TESTED BY: Y. Cabrale

PROJECT LOCATION: Berkeley, CA
REVIEWED BY: G. Criste

Sample #	1	2	3	4	5	6	7	8
Sample ID	1-B5@ 16-16.5	1-B5@ 17-17.5	1OS-CPT1@ 14-15.5	1OS-CPT3@ 12.5-14	1OS-CPT3@ 85-86.5	1OS-CPT3@ 101-101.5	1OS-B4@ 10-11.5	1OS-B4@ 26-26.5
Depth (ft)	16-16.5	17-17.5	14-15.5	12.5-14	85-86.5	101-101.5	10-11.5	26-26.5
Method A or B	B	B	B	B	B	B	B	B
Tare name:								
Wet soil + tare:	1306.78	1014.23	617.77	670.62	588.37	781.33	736.87	275.41
Dry soil + tare:	1175.22	960.21	585.34	638.77	509.65	680.59	649.17	237.98
Tare weight:	565.77	409.47	412.23	440.34	84.62	82.53	83.80	86.23
%Moisture:	21.6	9.8	18.7	16.1	18.5	16.8	15.5	24.7

Sample #	9	10	11	12	13	14	15	16
Sample ID	1OS-B5@ 19-20.5	1-C1@SG	1-C3@SG	1-C4@SG	1-C5@SG	1-C8@SG	CPT2@ SG	
Depth (ft)	19-20.5	SG	SG	SG	SG	SG	SG	
Method A or B	B	B	B	B	B	B	B	
Tare name:								
Wet soil + tare:	1047.22	749.07	541.6	1225.60	734.45	744.8	885.43	
Dry soil + tare:	938.81	698.56	505.96	1150.59	665.79	686.49	816.11	
Tare weight:	467.44	283.04	256.6	464.30	311.65	279.9	412.38	
%Moisture:	23.0	12.2	14.3	10.9	19.4	14.3	17.2	

Sample #	17	18	19	20	21	22	23	24
Sample ID								
Depth (ft)								
Method A or B								
Tare name:								
Wet soil + tare:								
Dry soil + tare:								
Tare weight:								
%Moisture:								

MOISTURE-DENSITY DETERMINATION REPORT
ASTM D7263

SAMPLE ID	1-B2	1-B2	1-B2					
DEPTH (ft.)	36-36.5	41-41.5	71-71.5					
METHOD A OR B	B	B	B					
MOISTURE CONTENT (%)	25.8	21.4	35.6					
DRY DENSITY (pcf)	100.1	107.8	84.3					

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/11/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

MOISTURE-DENSITY DETERMINATION REPORT
ASTM D7263

SAMPLE ID	1-B3@ 26-26.5	1-B5@ 5-5.25	1OS-B1@ 16-16.5	1OS-B1@ 21-21.5	1OS-B1@ 46-46.5	1OS-B1@ 96-96.5	1OS-B1@ 101-101.5	1OS-B4@ 16-16.5
DEPTH (ft.)	26-26.5	5-5.25	16-16.5	21-21.5	46-46.5	96-96.5	101-101.5	16-16.5
METHOD A OR B	B	B	B	B	B	B	B	B
MOISTURE CONTENT (%)	29.6	16.2	19.4	32.9	30.4	47.8	20.2	26.0
DRY DENSITY (pcf)	96.2	104.8	113.1	92.5	94.4	86.7	108.6	99.8

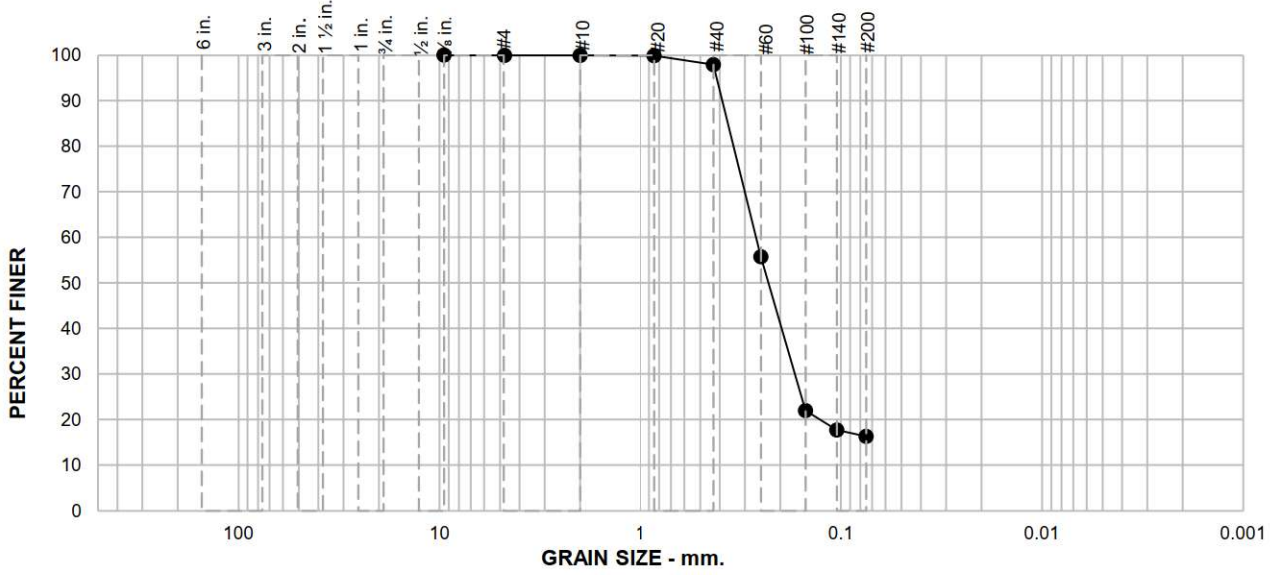
SAMPLE ID	1OS-B4@ 31-31.5	1OS-B4@ 111-111.5	1OS-B5@ 73.5-74	1OS-B6@ 16-16.5	1OS-B6@ 36-36.5	1OS-B6@ 56-56.5	1-B5@5.25-5.75	1OS-B6@ 16-16.5
DEPTH (ft.)	31-31.5	111-111.5	73.5-74	16-16.5	36-36.5	56-56.5	5.25-5.75	16-16.5
METHOD A OR B	B	B	B	B	B	B	B	B
MOISTURE CONTENT (%)	25.3	27.9	40.2	17.6	28.2	20.9	15.7	17.6
DRY DENSITY (pcf)	100.7	96.4	80.7	117.3	96.0	107.8	105.3	117.3

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/11/2024
TESTED BY: K. Nguyen
REVIEWED BY: G. Criste

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D6913, Method A



SAMPLE ID: 1-B1@41-41.5

DEPTH (ft): 41-41.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
				2	82	16	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
⅜ in.	100		
#4	100		
#10	100		
#20	100		
#40	98		
#60	56		
#100	22		
#140	18		
#200	16		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = 0.3878 mm D_{85} = 0.3636 mm D_{60} = 0.2633 mm

D_{50} = 0.2284 mm D_{30} = 0.1692 mm D_{15} =

D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

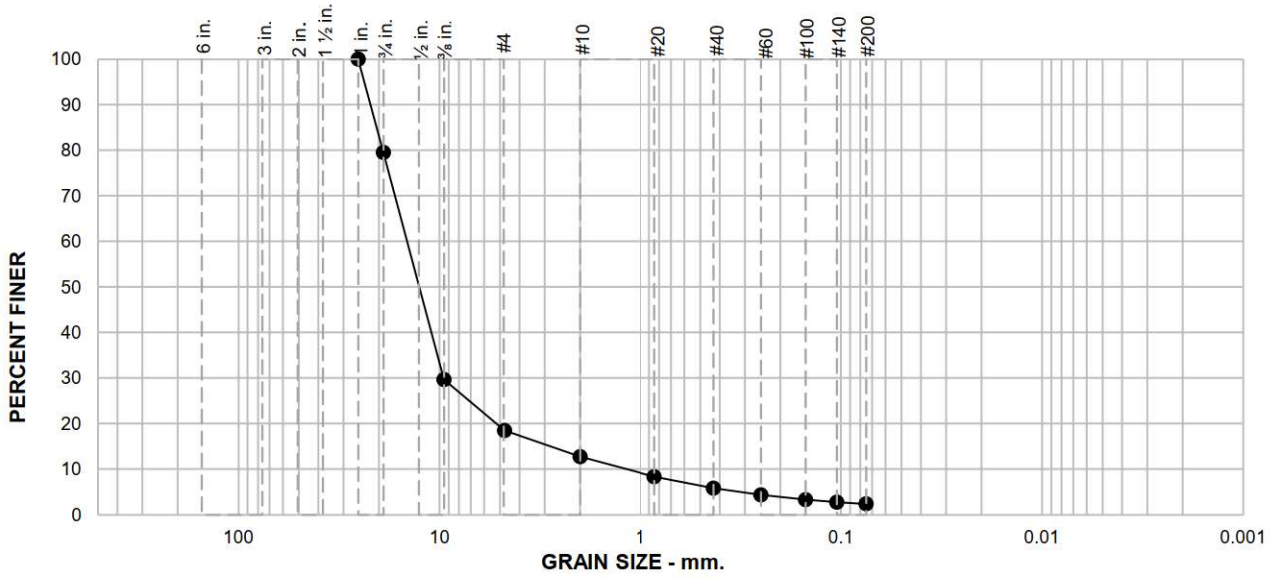
REPORT DATE: 10/16/2024

TESTED BY: L. Schmitz

REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D6913, Method A



SAMPLE ID: 1-B2@16-16.5

DEPTH (ft): 16-16.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	20	61	6	7	4	2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100		
¾ in.	80		
⅜ in.	30		
#4	19		
#10	13		
#20	8		
#40	6		
#60	4		
#100	3		
#140	3		
#200	2		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = 21.9970 mm D_{85} = 20.4706 mm D_{60} = 14.4372 mm

D_{50} = 12.5683 mm D_{30} = 9.5250 mm D_{15} = 2.6684 mm

D_{10} = 1.1969 mm C_u = 12.06 C_c = 5.25

CLASSIFICATION

USCS = GP

REMARKS

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

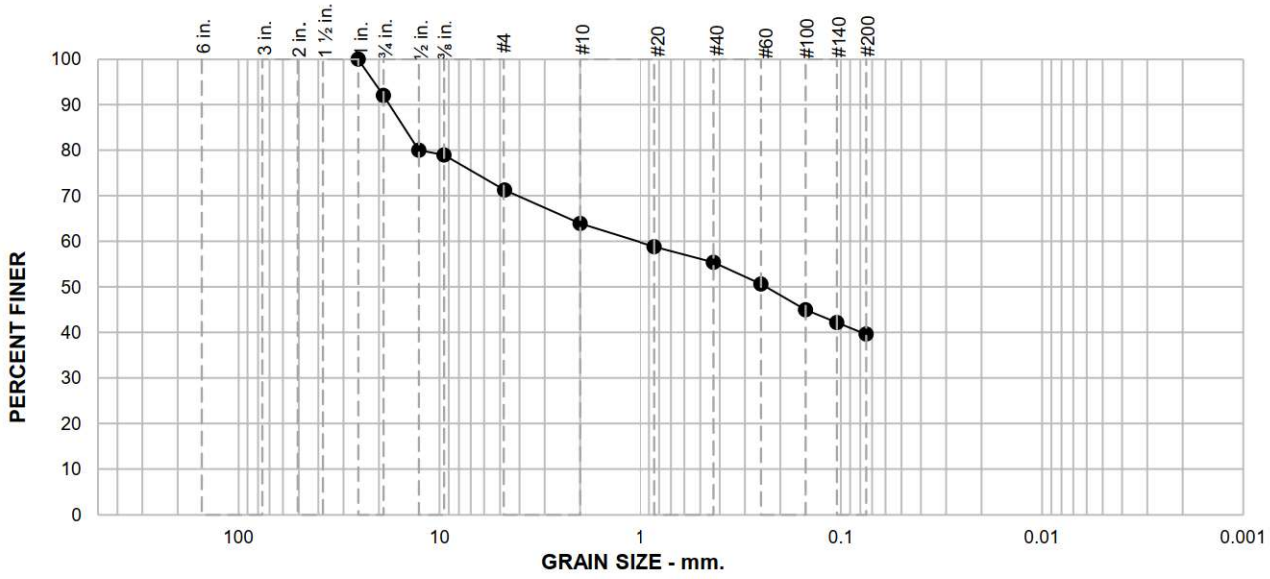
REPORT DATE: 10/16/2024

TESTED BY: L. Schmitz

REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D6913, Method A



SAMPLE ID: 1-B4@21'-21.5'

DEPTH (ft): 21-21.5

LOCATION: 1-B4@21'-21.5'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
	8	21	7	9	15	40	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100		
¾ in.	92		
½ in.	80		
⅜ in.	79		
#4	71		
#10	64		
#20	59		
#40	55		
#60	51		
#100	45		
#140	42		
#200	40		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = 17.8052 mm D_{85} = 15.0375 mm D_{60} = 1.0087 mm

D_{50} = 0.2296 mm D_{30} = D_{15} =

D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used

USCS: ASTM D2488

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

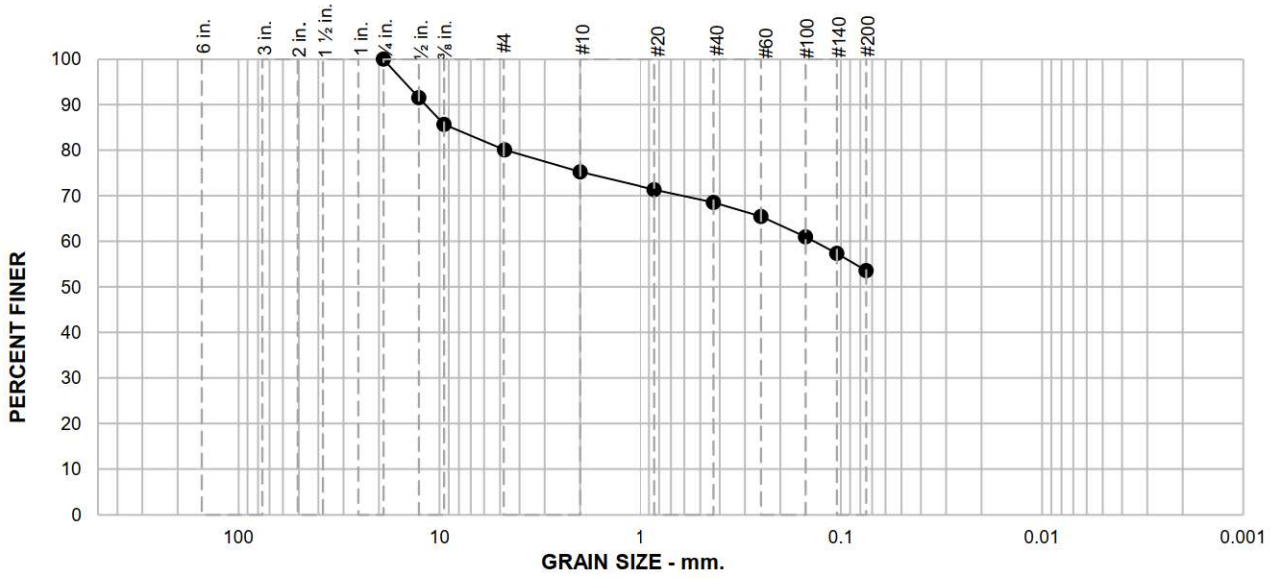
REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D6913, Method A



SAMPLE ID: 1-B4@16'-16.5'

DEPTH (ft): 16-16.5

LOCATION: 1-B4@16'-16.5'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
		20	5	6	15	54	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
¾ in.	100		
½ in.	92		
⅜ in.	86		
#4	80		
#10	75		
#20	71		
#40	69		
#60	65		
#100	61		
#140	57		
#200	54		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = 11.5387 mm D_{85} = 8.4821 mm D_{60} = 0.1372 mm

D_{50} = D_{30} = D_{15} =

D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used

USCS: ASTM D2488

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

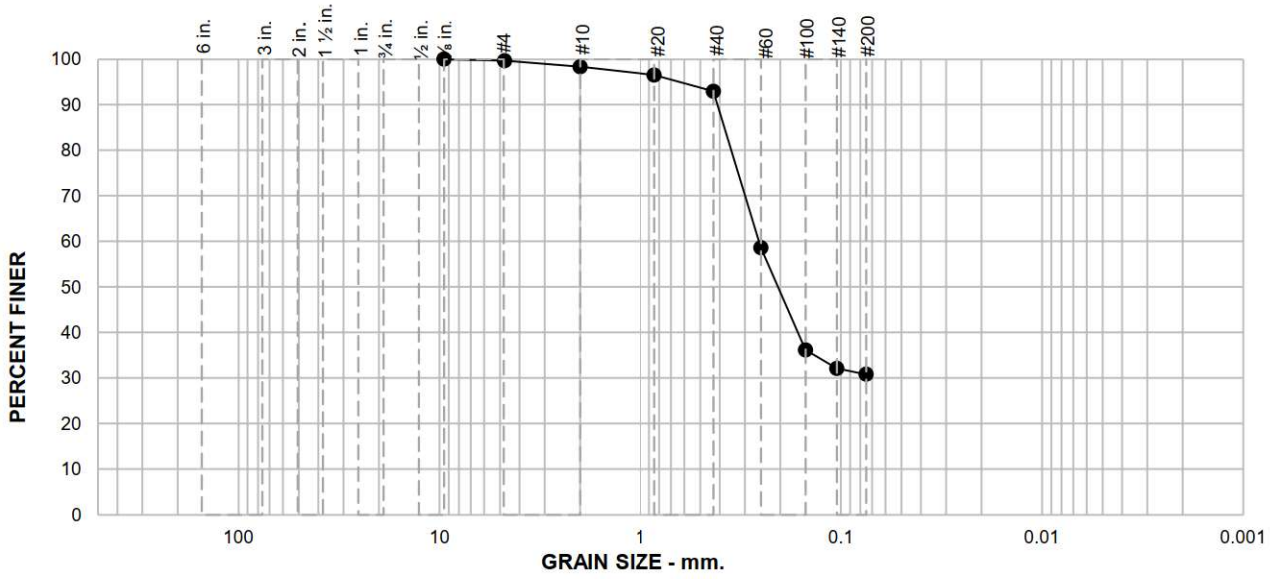
REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D6913, Method A



SAMPLE ID: 1OS-B5@19'-20.5'

DEPTH (ft): 19'-20.5'

LOCATION: 1OS-B5@19'-20.5'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
			2	5	62	31	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
⅜ in.	100		
#4	100		
#10	98		
#20	97		
#40	93		
#60	59		
#100	36		
#140	32		
#200	31		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = 0.4099 mm D_{85} = 0.3785 mm D_{60} = 0.2540 mm

D_{50} = 0.2047 mm D_{30} = D_{15} =

D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used
USCS: ASTM D2488

Contains abundance of shell fragments

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

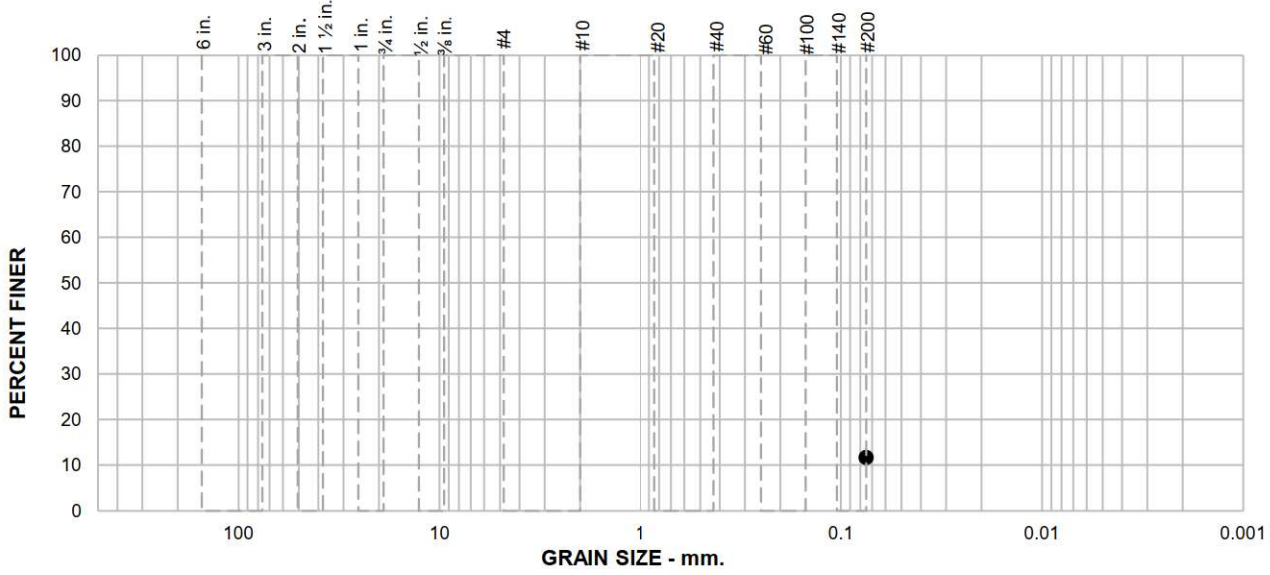
REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B1@6-6.5

DEPTH (ft): 6-6.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						12	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	12		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = 11 LL = 35 PI = 24

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

PI: ASTM D4318, Wet Method

Soak time = 180 min
Dry sample weight = 526.4 g
Largest particle size ≥ No. 4 Sieve

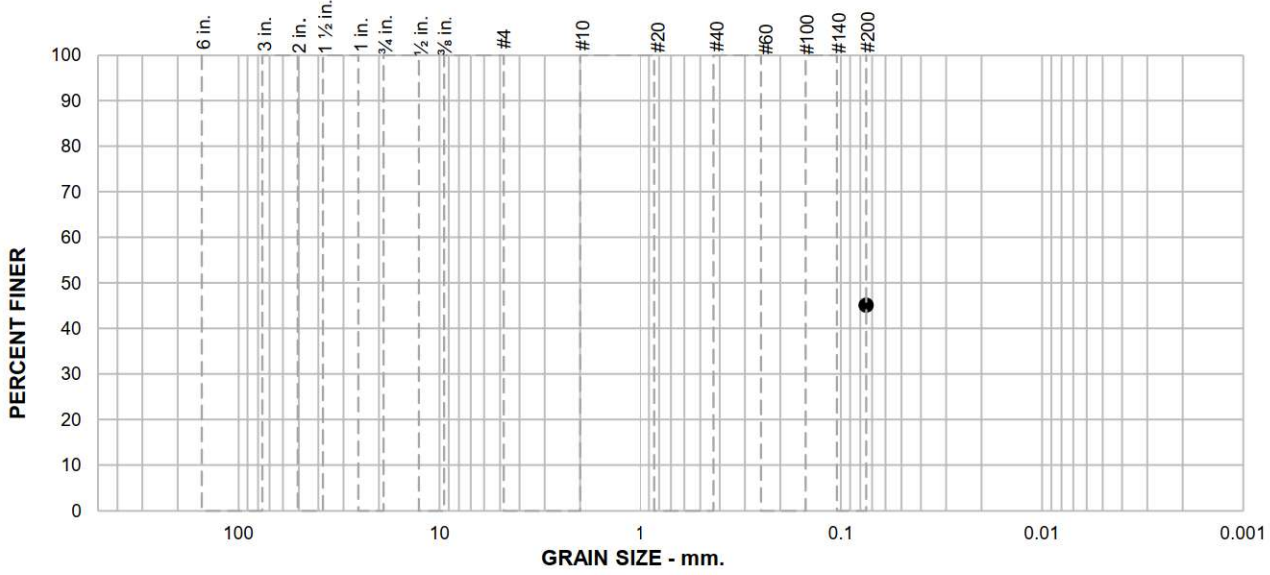
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B1@11-11.5

DEPTH (ft): 11-11.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						45	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	45		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = 16 LL = 45 PI = 29

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

PI: ASTM D4318, Wet Method

Soak time = 180 min
Dry sample weight = 396.6 g
Largest particle size ≥ No. 4 Sieve

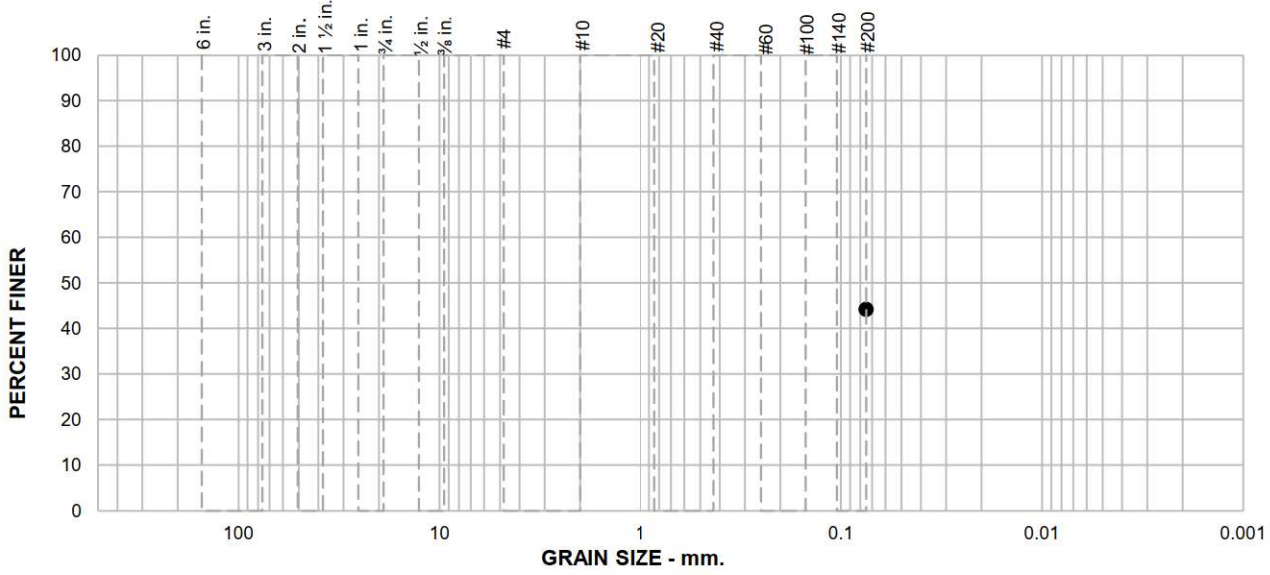
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B1@5.5-6

DEPTH (ft): 5.5-6

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						44	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	44		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = 17 LL = 42 PI = 25

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

PI: ASTM D4318, Wet Method

Soak time = 180 min
Dry sample weight = 459.7 g
Largest particle size ≥ No. 4 Sieve

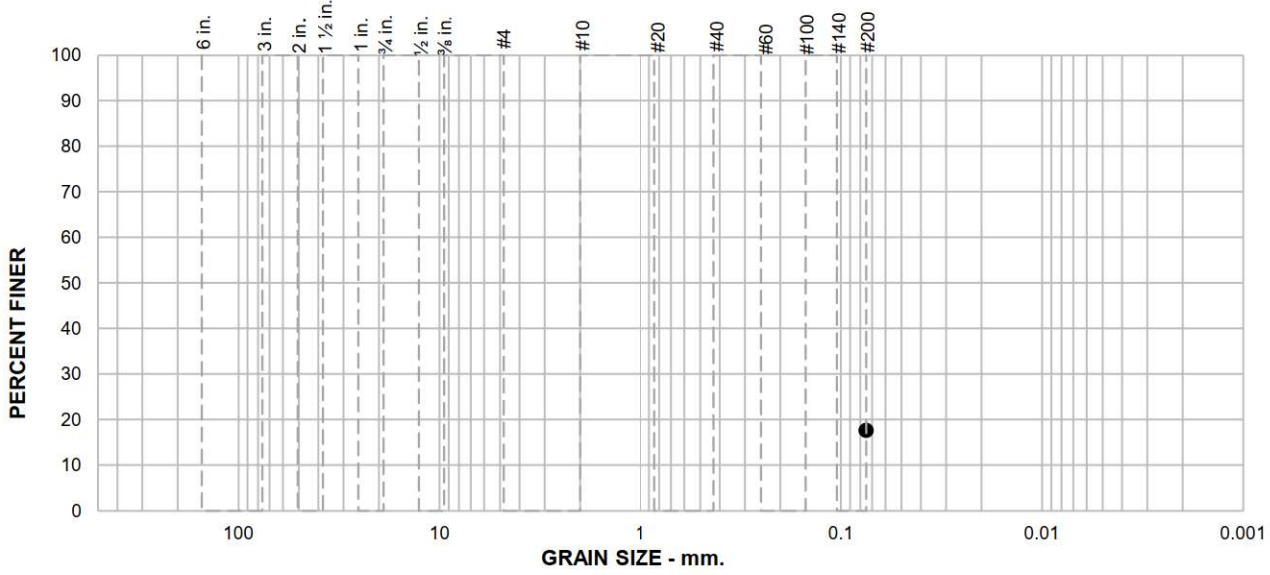
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B2@8-8.5

DEPTH (ft): 8-8.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						18	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	18		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Soak time = 180 min
Dry sample weight = 613.2 g
Largest particle size ≥ No. 4 Sieve

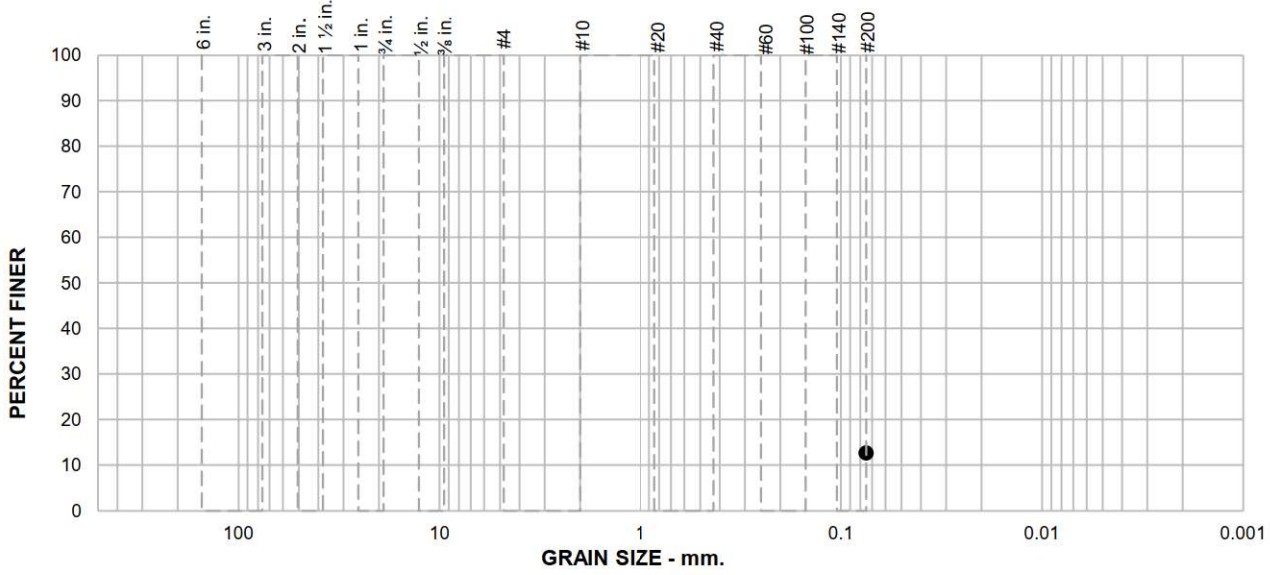
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/16/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B2@8.5-9

DEPTH (ft): 8.5-9

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						13	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	13		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = 20 LL = 38 PI = 18

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

PI: ASTM D4318, Wet Method

Soak time = 180 min
Dry sample weight = 473.5 g
Largest particle size ≥ No. 4 Sieve

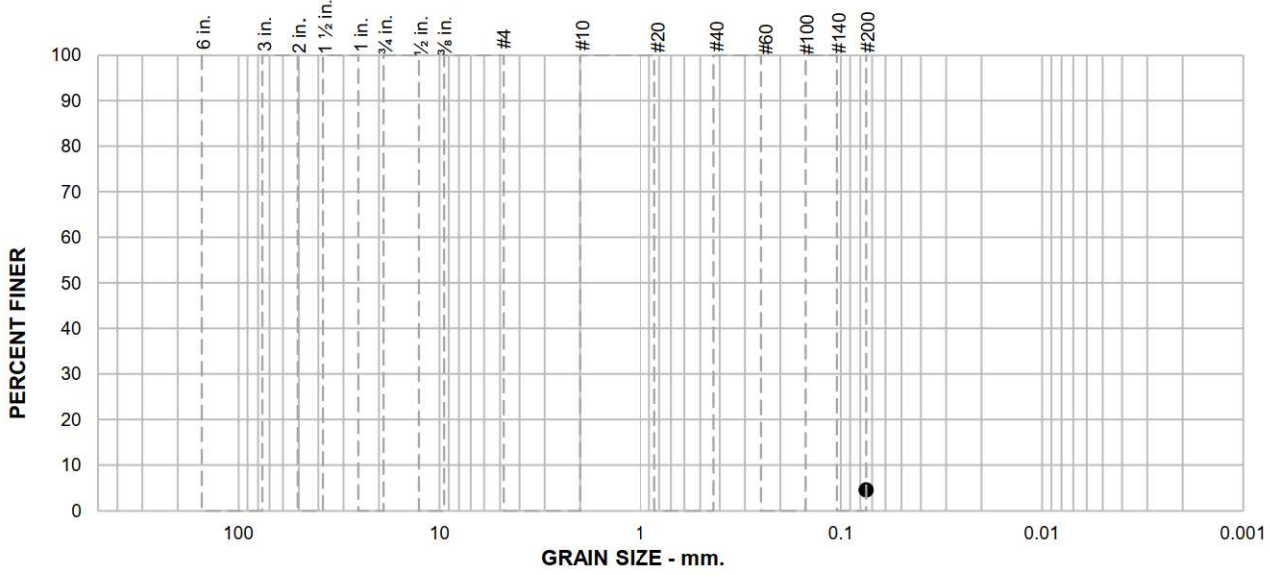
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B2@10-11.5

DEPTH (ft): 10-11.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	5		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Soak time = 180 min
Dry sample weight = 293.8 g
Largest particle size ≥ No. 4 Sieve

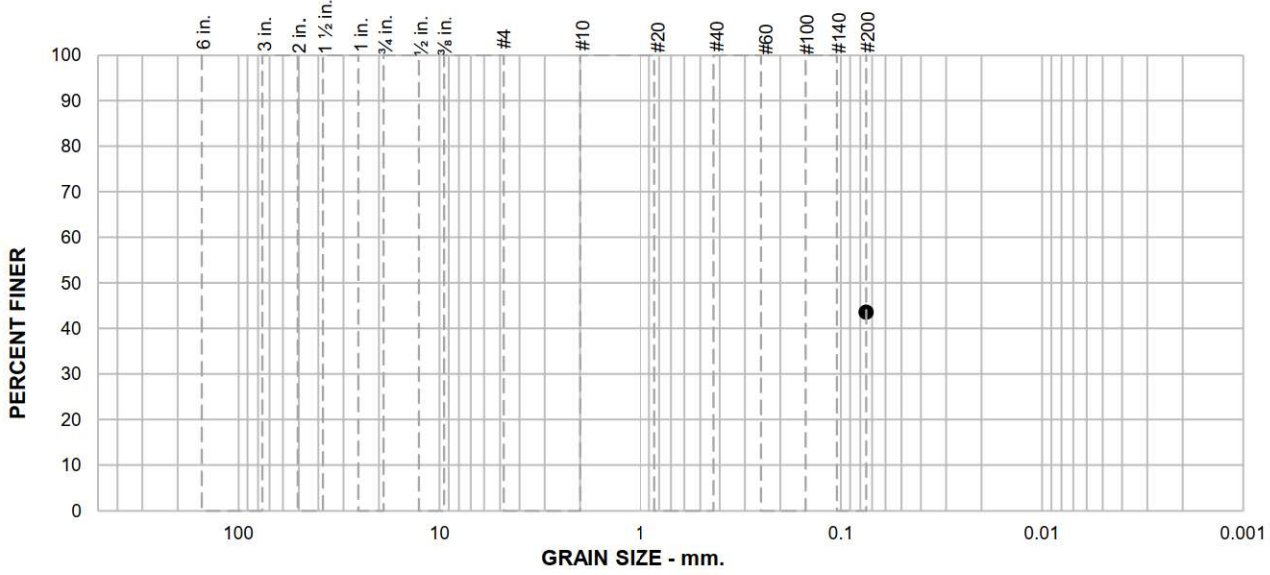
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/16/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B2@30-31.5

DEPTH (ft): 30-31.5

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						44	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	44		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = 13 LL = 35 PI = 22

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

PI: ASTM D4318, Wet Method

Soak time = 180 min
Dry sample weight = 324.9 g
Largest particle size ≥ No. 4 Sieve

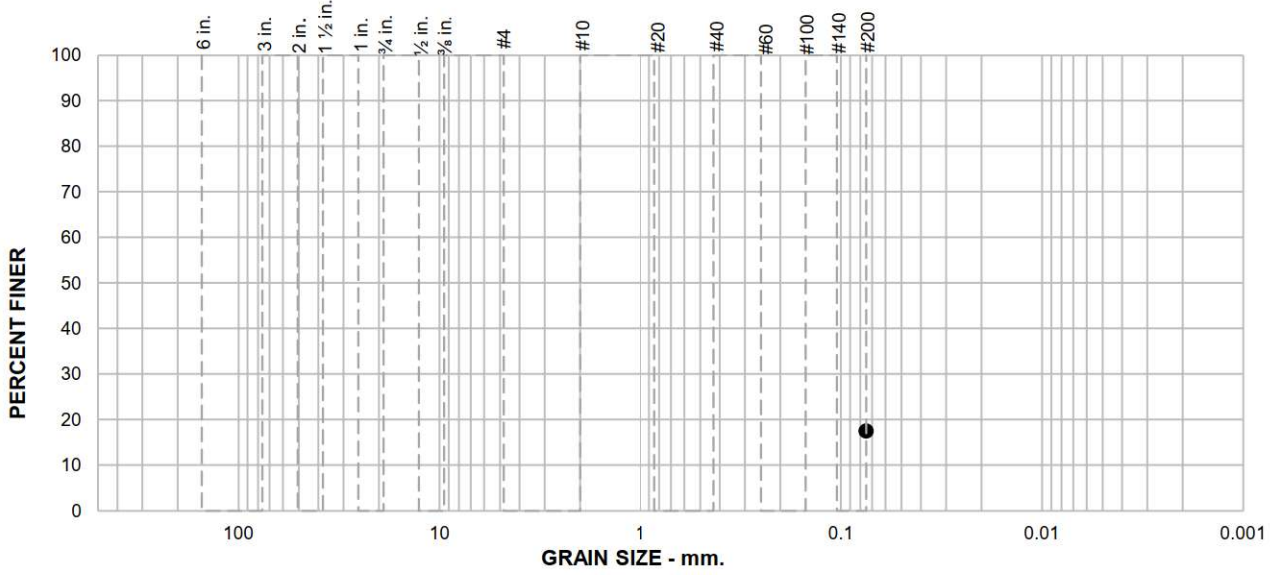
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/17/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B3@7.5-9

DEPTH (ft): 7.5-9

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						17	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	17		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Soak time = 180 min
Dry sample weight = 144.1 g
Largest particle size ≥ No. 4 Sieve

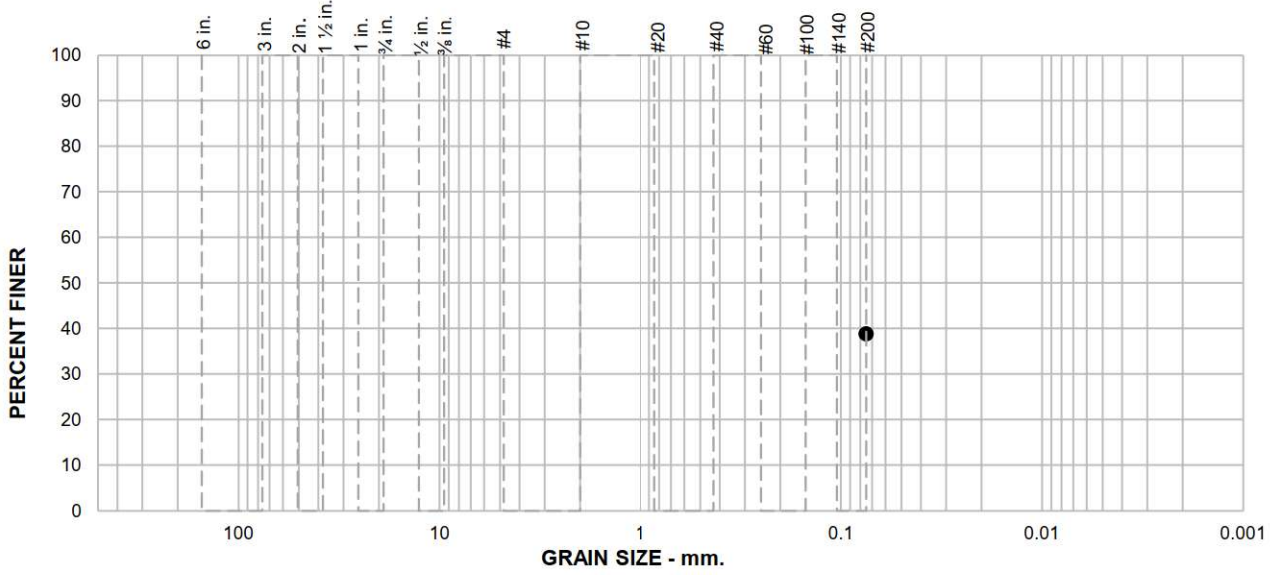
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/16/2024
TESTED BY: L. Schmitz
REVIEWED BY: M. Gilbert

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1-B5@5.25'-5.75'

DEPTH (ft): 5.25'-5.75'

LOCATION: 1-B5@5.25'-5.75'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						39	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	39		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used

Soak time = 180 min
Dry sample weight = 743.8 g
Largest particle size < No. 4 Sieve

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

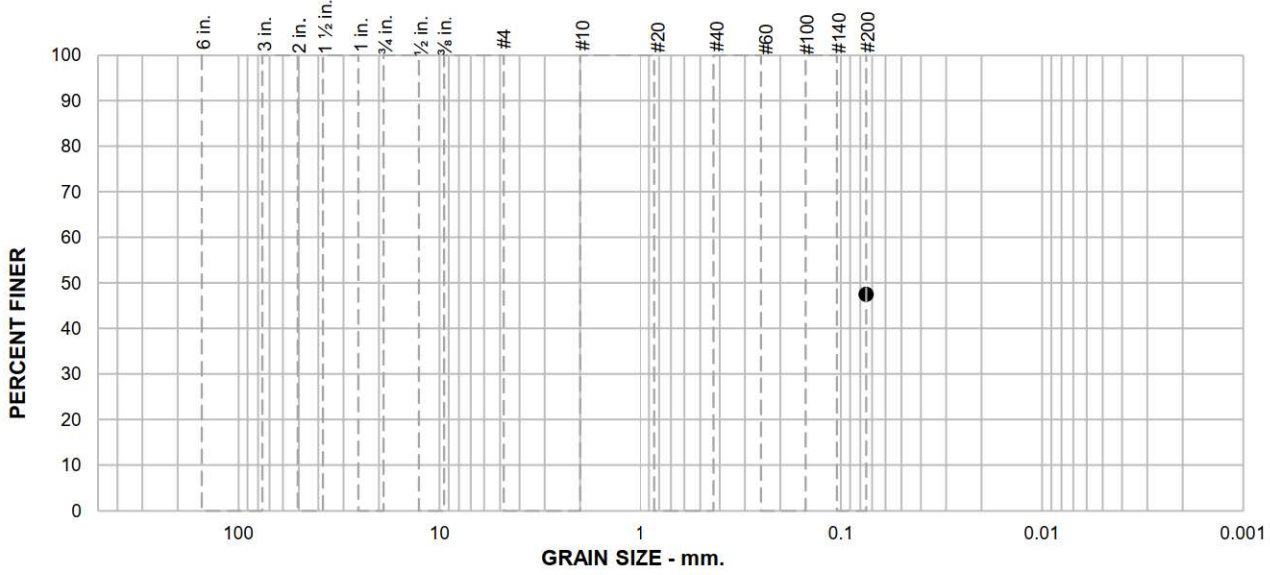
REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method A



SAMPLE ID: 1OS-B1@7.5-9

DEPTH (ft): 7.5-9

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						48	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	48		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = 18 LL = 33 PI = 15

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used
PI: ASTM D4318, Wet Method

Soak time = 1440 min
Dry sample weight = 402.9 g
Largest particle size ≥ No. 4 Sieve

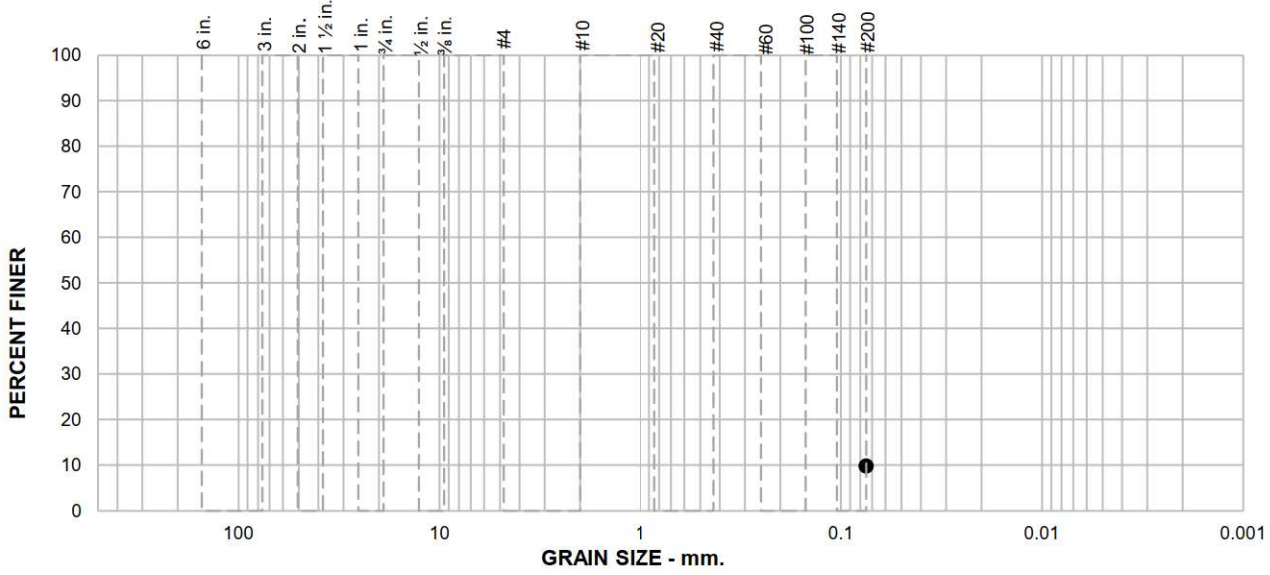
* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T004
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 11/21/2024
TESTED BY: K. Nguyen
REVIEWED BY: G. Criste

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1OS-B1@16'-16.5'

DEPTH (ft): 16'-16.5'

LOCATION: 1OS-B1@16'-16.5'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						9.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	9.8		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used

Soak time = 180 min
Dry sample weight = 179.76 g
Largest particle size < No. 4 Sieve

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

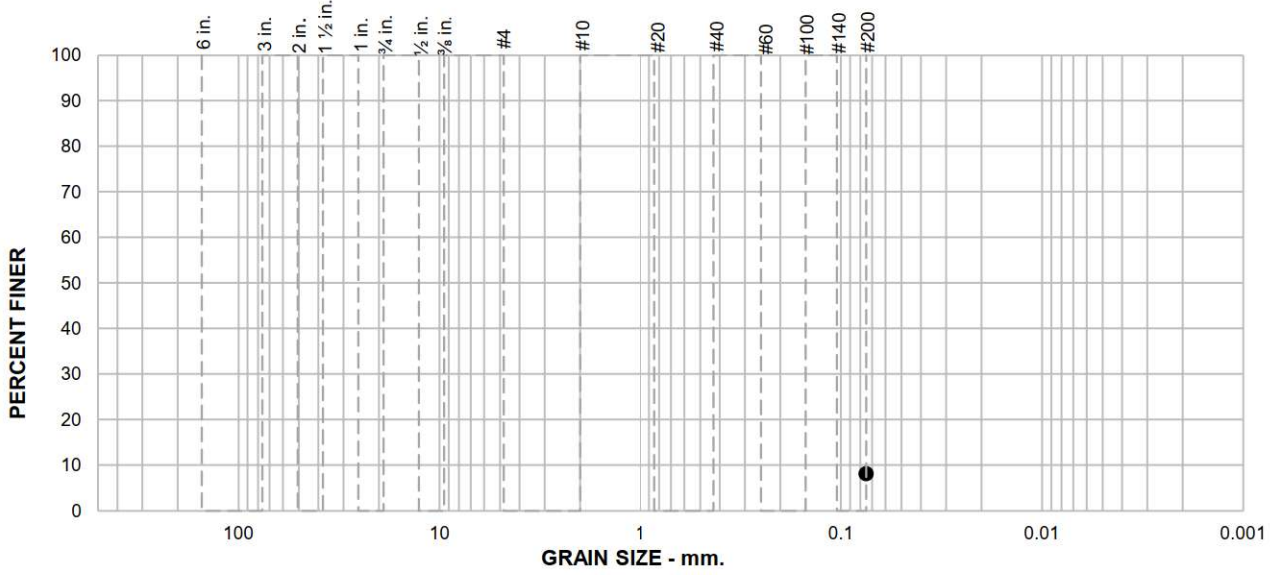
REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1OS-B6@16'-16.5'

DEPTH (ft): 16'-16.5'

LOCATION: 1OS-B6@16'-16.5'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						8.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	8.1		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used

Soak time = 180 min
Dry sample weight = 489.96 g
Largest particle size < No. 4 Sieve

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

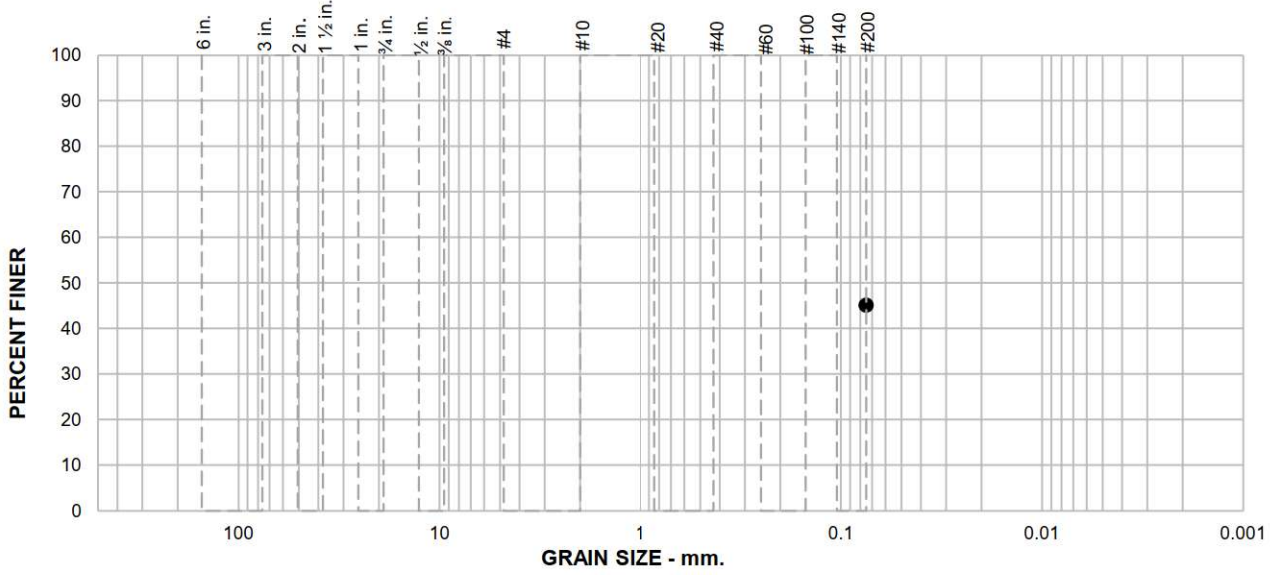
REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1OS-CPT1@14'-15.5'

DEPTH (ft): 14'-15.5'

LOCATION: 1OS-CPT1@14'-15.5'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						45.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	45.1		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used

Soak time = 180 min
Dry sample weight = 173.11 g
Largest particle size < No. 4 Sieve

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

PROJECT LOCATION: Berkeley, CA

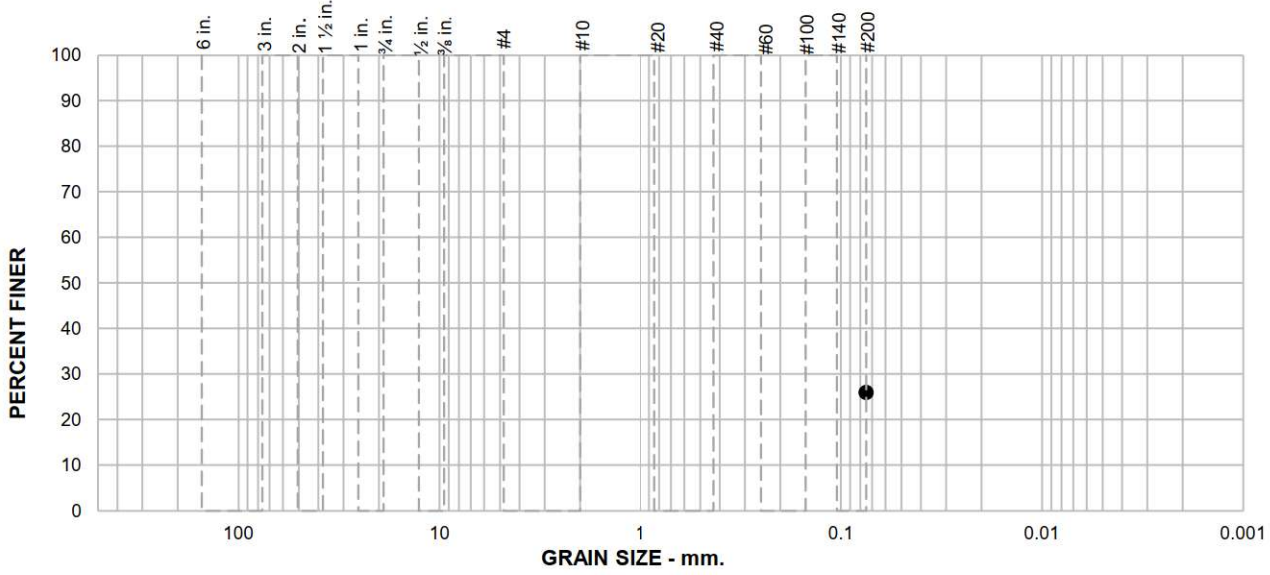
REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

PARTICLE SIZE DISTRIBUTION REPORT

ASTM D1140, Method B



SAMPLE ID: 1OS-CPT3@12.5'-14'

DEPTH (ft): 12.5'-14'

LOCATION: 1OS-CPT3@12.5'-14'

% +75mm	% GRAVEL		% SAND			% FINES	
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
						26.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	26.0		

SOIL DESCRIPTION

See exploration logs

ATTERBERG LIMITS

PL = LL = PI =

COEFFICIENTS

D_{90} = D_{85} = D_{60} =
D_{50} = D_{30} = D_{15} =
D_{10} = C_u = C_c =

CLASSIFICATION

USCS =

REMARKS

Silt/clay division of 0.002mm used

Soak time = 180 min
Dry sample weight = 198.43 g
Largest particle size < No. 4 Sieve

* (no specification provided)

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.

PROJECT NAME: Berkeley Water Transportation Pier Ferry Project Engineering and Design

PROJECT NO: 25022.000.001 PH001 T003

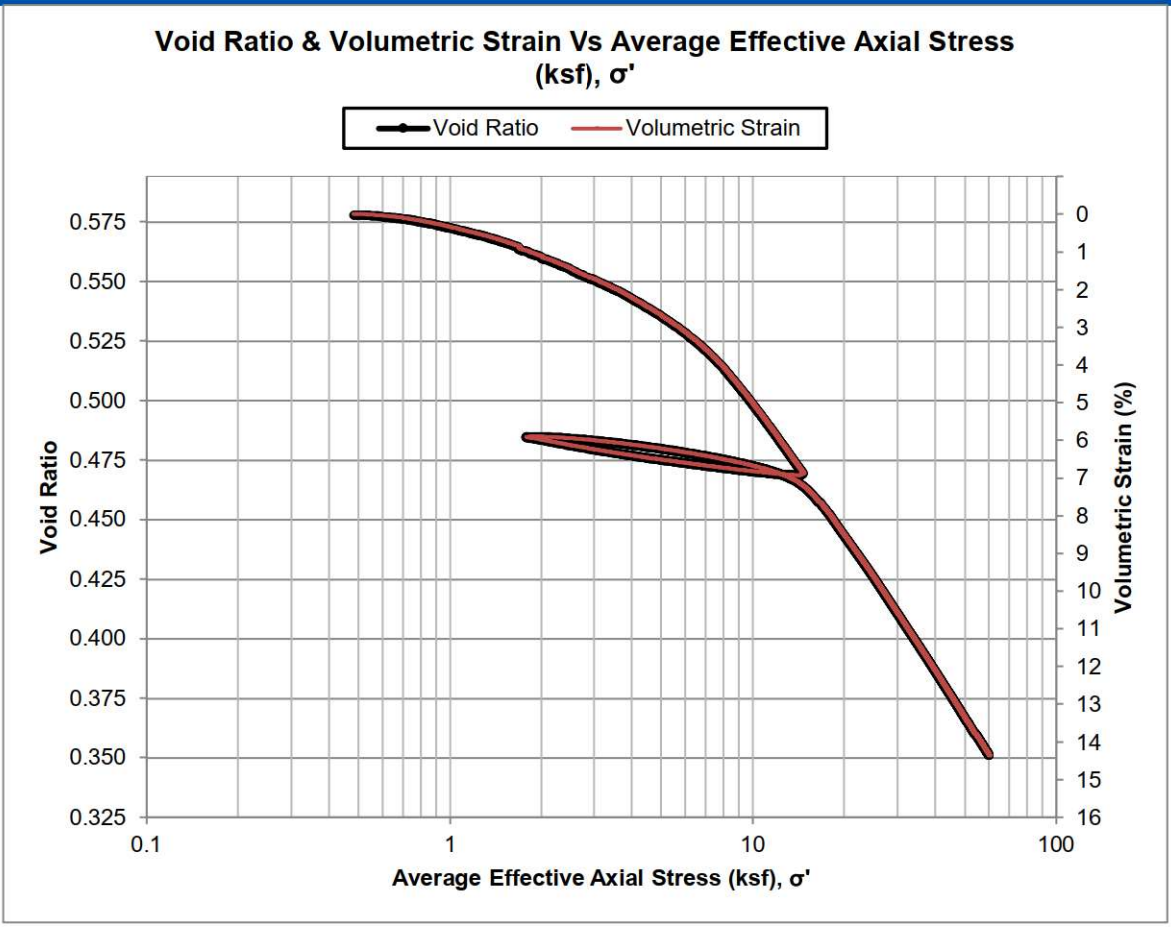
PROJECT LOCATION: Berkeley, CA

REPORT DATE: 10/15/2024

TESTED BY: K. Nguyen

REVIEWED BY: O. Espinoza

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID:	1-B1 at 55-57.5	**DEPTH:**	57-57.5 ft
SOIL DESCRIPTION:	See exploration logs		
REMARKS:			

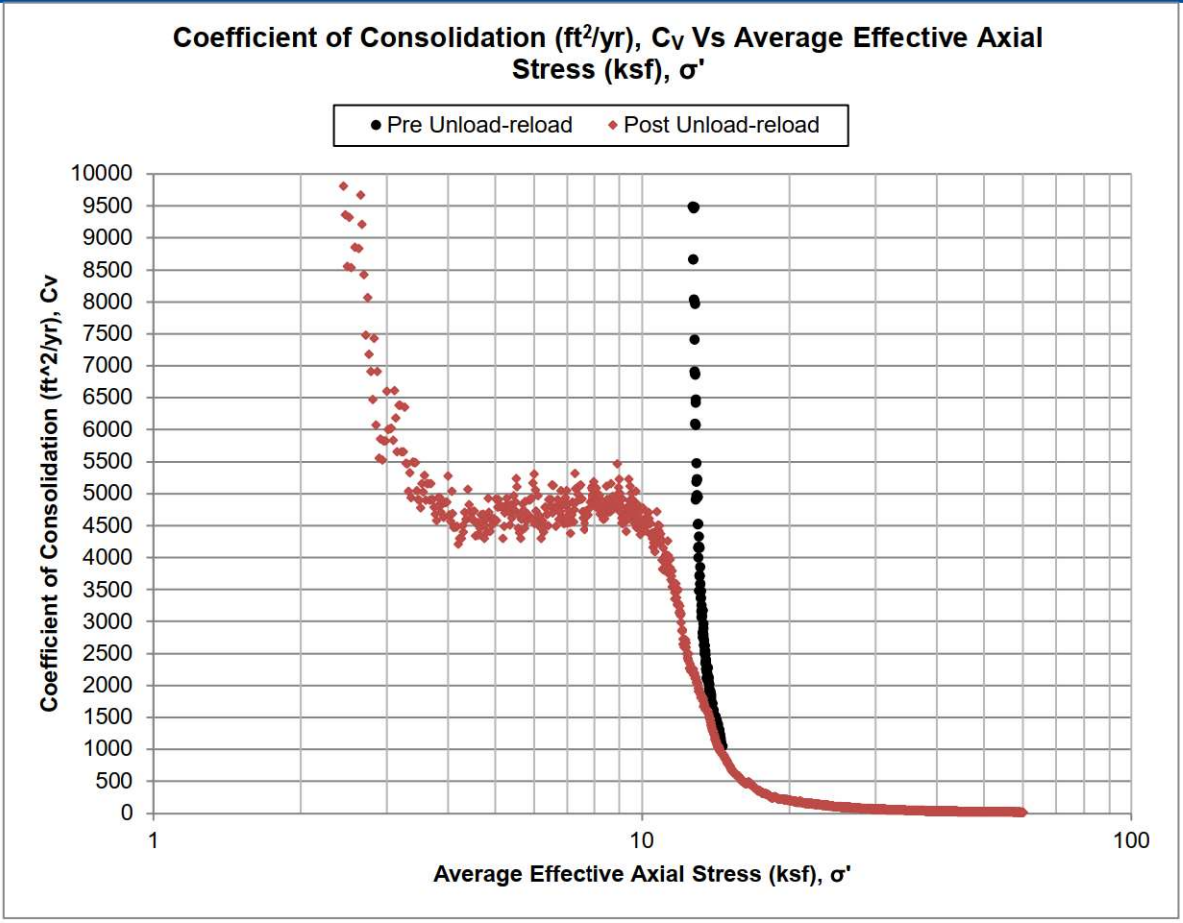
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	20.68	16.90	**LIQUID LIMIT:**	
DRY DENSITY (pcf):	103.76	125.08	**PLASTIC LIMIT:**	
SATURATION (%):	79.31	100.00	**ASTM D854 - Measured**	
VOID RATIO:	0.578	0.309	**SPECIFIC GRAVITY**	2.627
STRAIN RATE (in/min):	0.000062			

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: D. Seibold
REVIEWED BY: O. Espinoza

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID:	1-B1 at 55-57.5	**DEPTH:**	57-57.5 ft
SOIL DESCRIPTION:	See exploration logs		
REMARKS:			

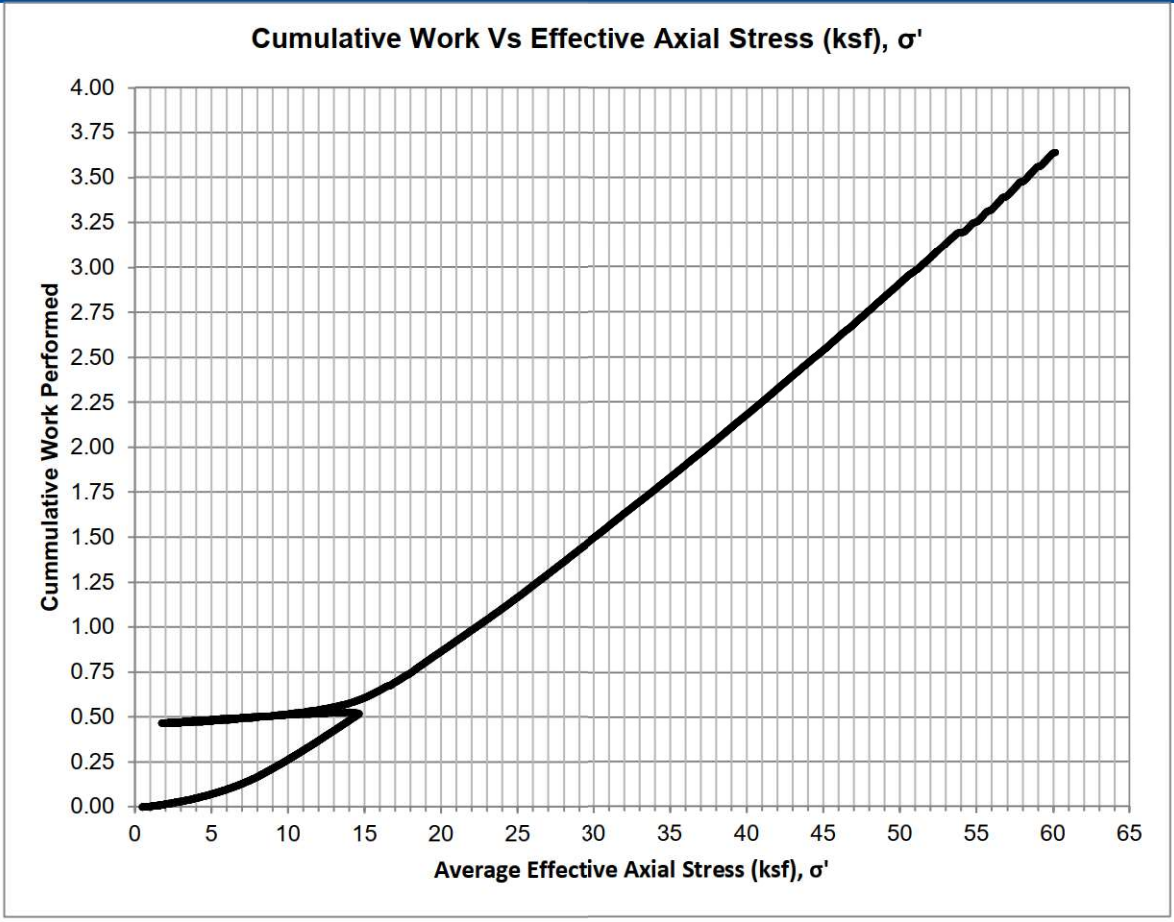
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	20.68	16.90	**LIQUID LIMIT:**	
DRY DENSITY (pcf):	103.76	125.08	**PLASTIC LIMIT:**	
SATURATION (%):	79.31	100.00	**ASTM D854 - Measured**	
VOID RATIO:	0.578	0.309	**SPECIFIC GRAVITY**	2.627
STRAIN RATE (in/min):	0.000062			

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: D. Seibold
REVIEWED BY: O. Espinoza

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID:	1-B1 at 55-57.5	**DEPTH:**	57-57.5 ft
SOIL DESCRIPTION:	See exploration logs		
REMARKS:			

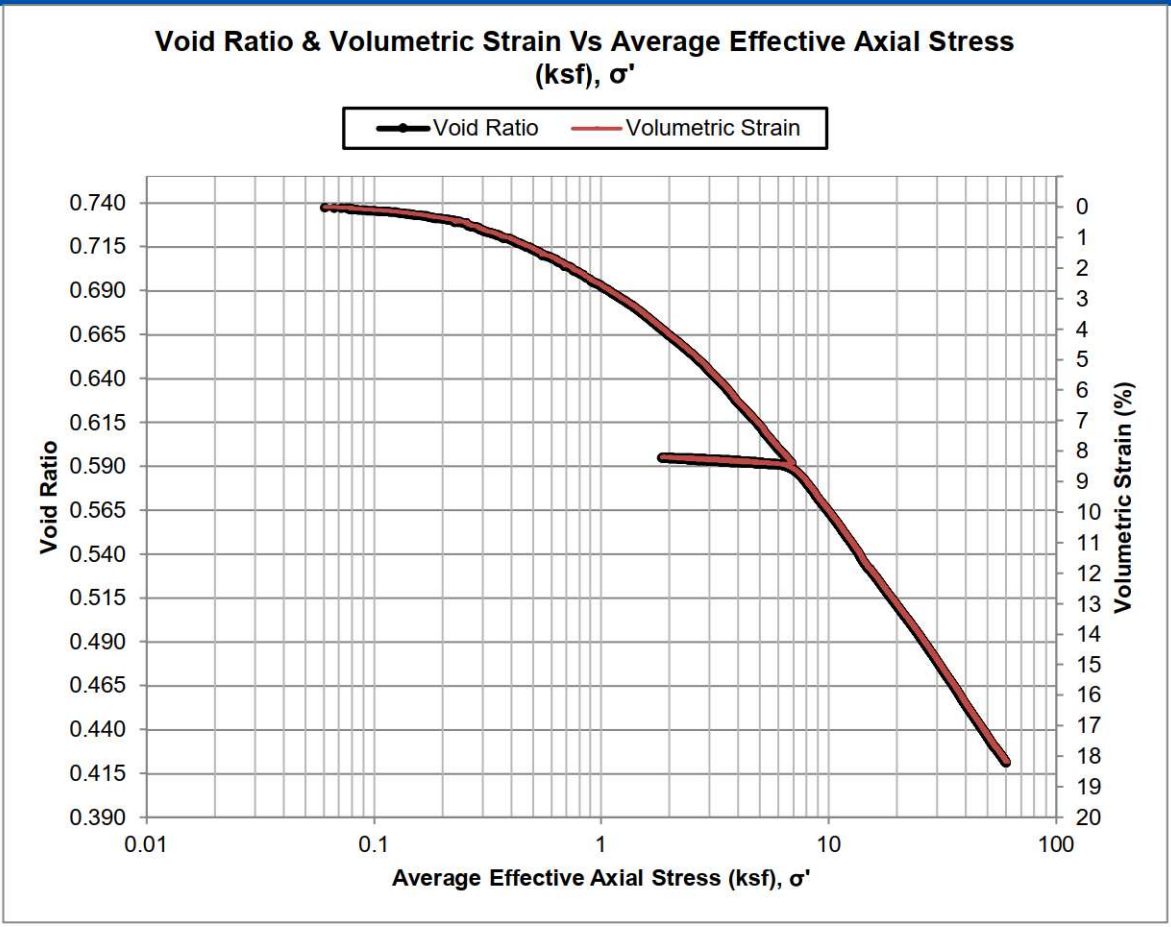
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	20.68	16.90	**LIQUID LIMIT:**	
DRY DENSITY (pcf):	103.76	125.08	**PLASTIC LIMIT:**	
SATURATION (%):	79.31	100.00	**ASTM D854 - Measured**	
VOID RATIO:	0.578	0.309	**SPECIFIC GRAVITY**	2.627
STRAIN RATE (in/min):	0.000062			

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: D. Seibold
REVIEWED BY: O. Espinoza

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID: 1-B2 at 20-22.5 **DEPTH:** 22-22.5 ft

SOIL DESCRIPTION: See exploration logs

REMARKS: The specimen contained abundant shell fragments.

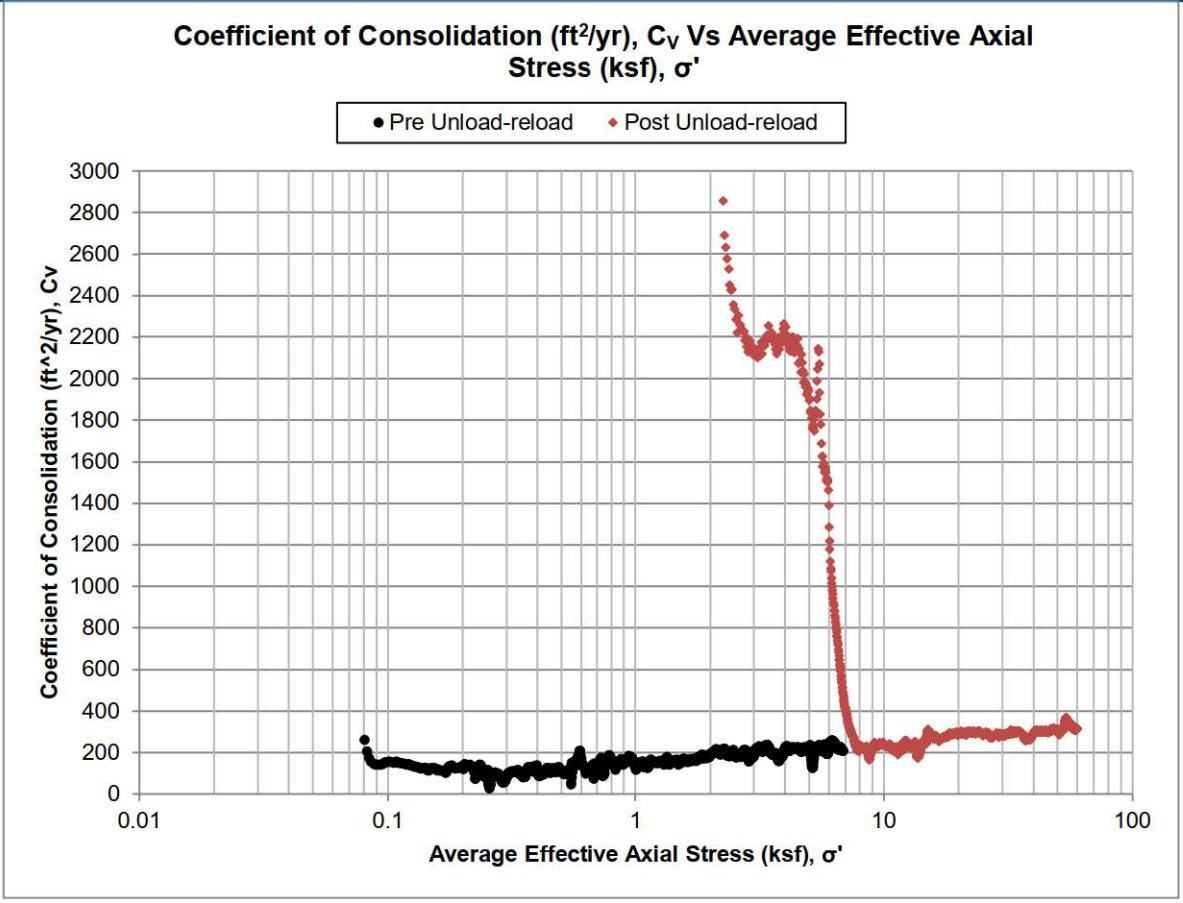
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	27.27	18.99	LIQUID LIMIT:	
DRY DENSITY (pcf):	96.96	118.52	PLASTIC LIMIT:	
SATURATION (%):	100.00	100.00	ASTM D854 - Measured	
VOID RATIO:	0.737	0.421	SPECIFIC GRAVITY	2.703
STRAIN RATE (in/min):	0.000062			

ENGEO Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: D. Seibold
REVIEWED BY: O. Espinoza

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID: 1-B2 at 20-22.5 **DEPTH:** 22-22.5 ft

SOIL DESCRIPTION: See exploration logs

REMARKS: The specimen contained abundant shell fragments.

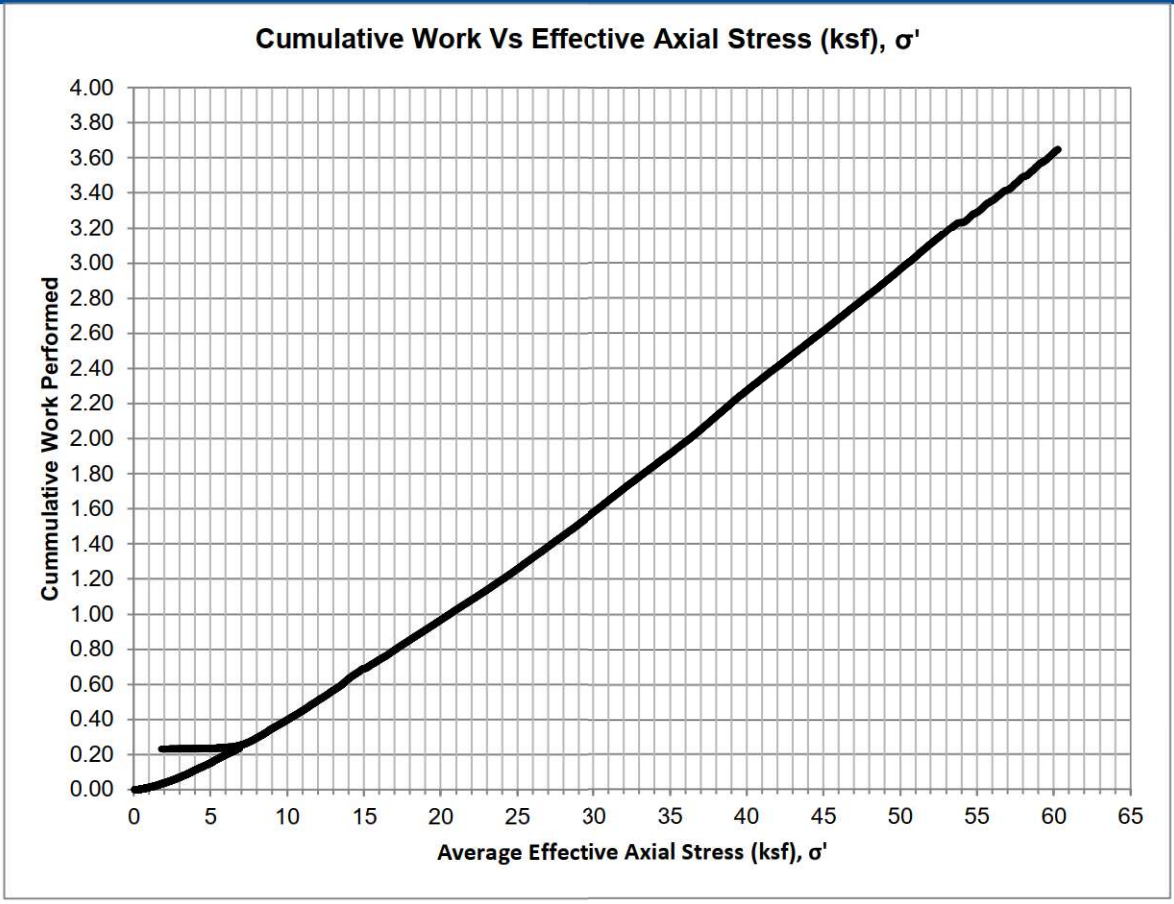
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	27.27	18.99	LIQUID LIMIT:	
DRY DENSITY (pcf):	96.96	118.52	PLASTIC LIMIT:	
SATURATION (%):	100.00	100.00	ASTM D854 - Measured	
VOID RATIO:	0.737	0.421	SPECIFIC GRAVITY	2.703
STRAIN RATE (in/min):	0.000062			

ENGEO Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: D. Seibold
REVIEWED BY: O. Espinoza

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID: 1-B2 at 20-22.5 **DEPTH:** 22-22.5 ft

SOIL DESCRIPTION: See exploration logs

REMARKS: The specimen contained abundant shell fragments.

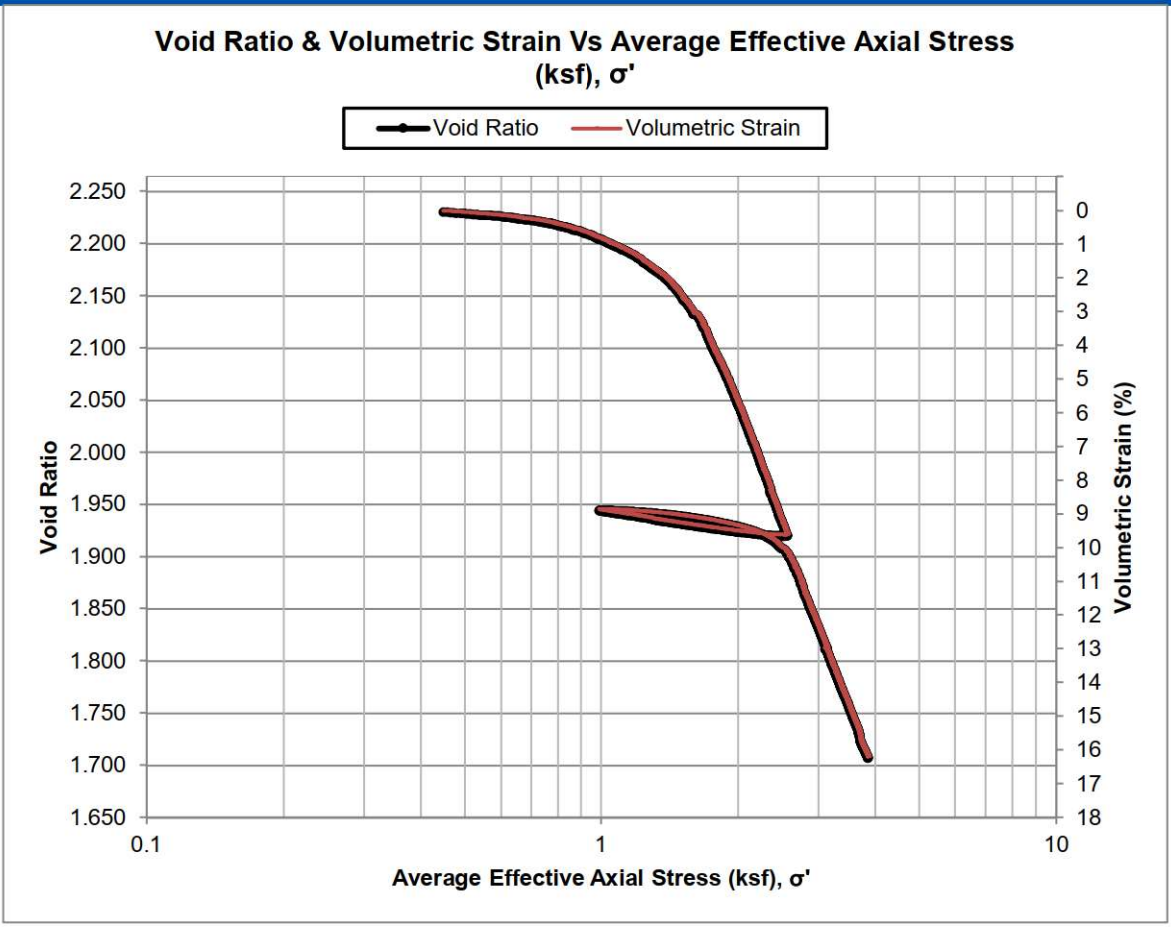
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	27.27	18.99	LIQUID LIMIT:	
DRY DENSITY (pcf):	96.96	118.52	PLASTIC LIMIT:	
SATURATION (%):	100.00	100.00	ASTM D854 - Measured	
VOID RATIO:	0.737	0.421	SPECIFIC GRAVITY	2.703
STRAIN RATE (in/min):	0.000062			

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: D. Seibold
REVIEWED BY: O. Espinoza

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID:	1-B3 at 20-22.5	**DEPTH:**	21.5-22 ft
SOIL DESCRIPTION:	See exploration logs		
REMARKS:			

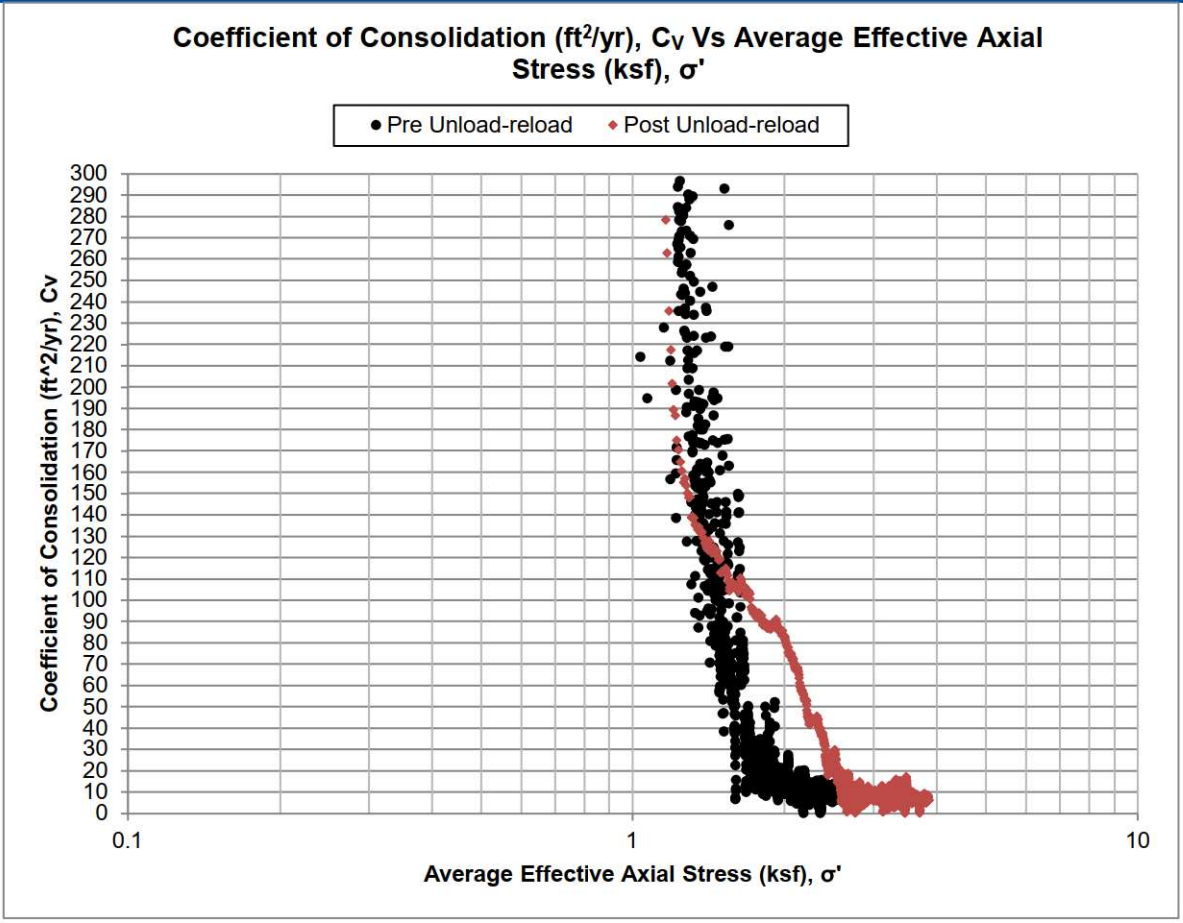
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	86.72	75.48	**LIQUID LIMIT:**	
DRY DENSITY (pcf):	49.16	58.66	**PLASTIC LIMIT:**	
SATURATION (%):	99.08	100.00	**ASTM D854 - Measured**	
VOID RATIO:	2.230	1.707	**SPECIFIC GRAVITY**	2.548
STRAIN RATE (in/min):	0.000042			

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: K. Nguyen
REVIEWED BY: D. Seibold

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID:	1-B3 at 20-22.5	**DEPTH:**	21.5-22 ft
SOIL DESCRIPTION:	See exploration logs		
REMARKS:			

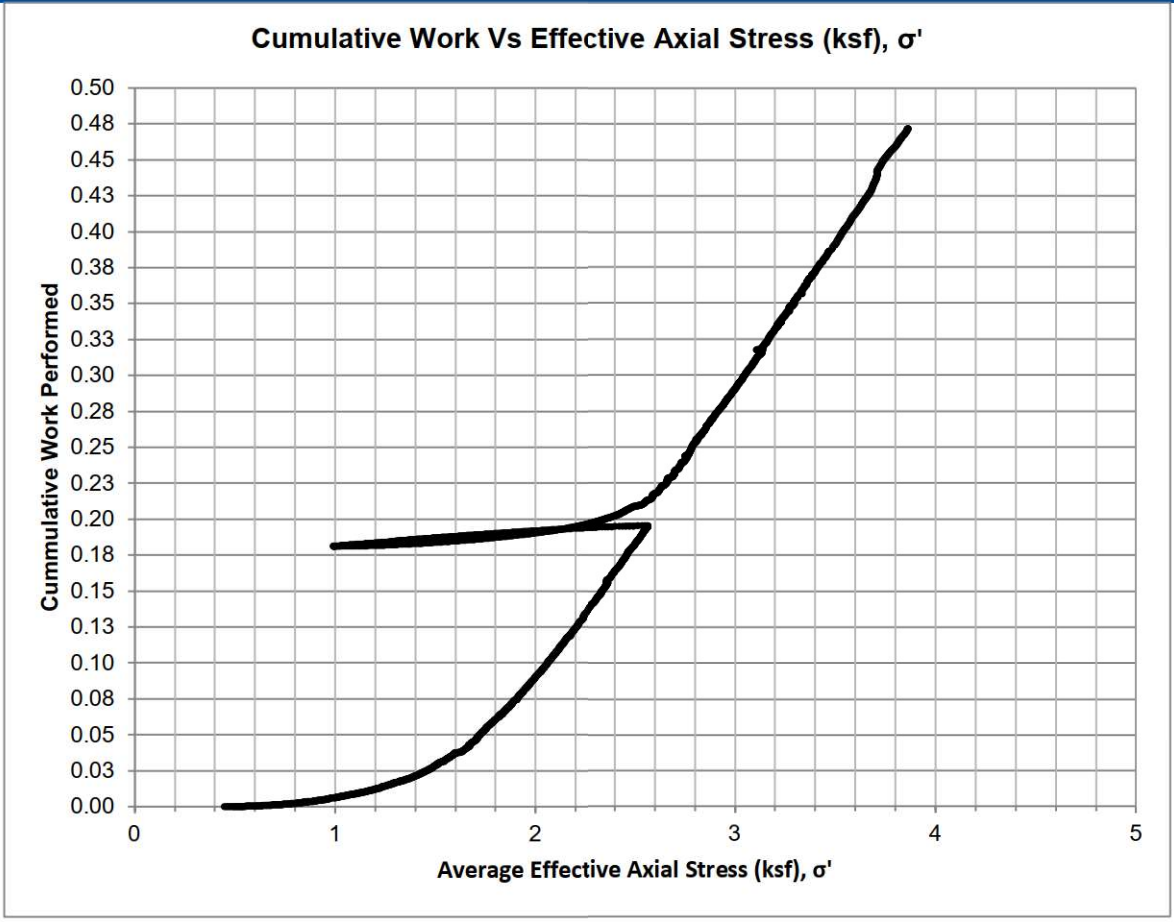
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	86.72	75.48	**LIQUID LIMIT:**	
DRY DENSITY (pcf):	49.16	58.66	**PLASTIC LIMIT:**	
SATURATION (%):	99.08	100.00	**ASTM D854 - Measured**	
VOID RATIO:	2.230	1.707	**SPECIFIC GRAVITY**	2.548
STRAIN RATE (in/min):	0.000042			

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: K. Nguyen
REVIEWED BY: D. Seibold

Constant Rate of Strain Consolidation
ASTM D4186



SPECIMEN INFORMATION

SAMPLE ID:	1-B3 at 20-22.5	**DEPTH:**	21.5-22 ft
SOIL DESCRIPTION:	See exploration logs		
REMARKS:			

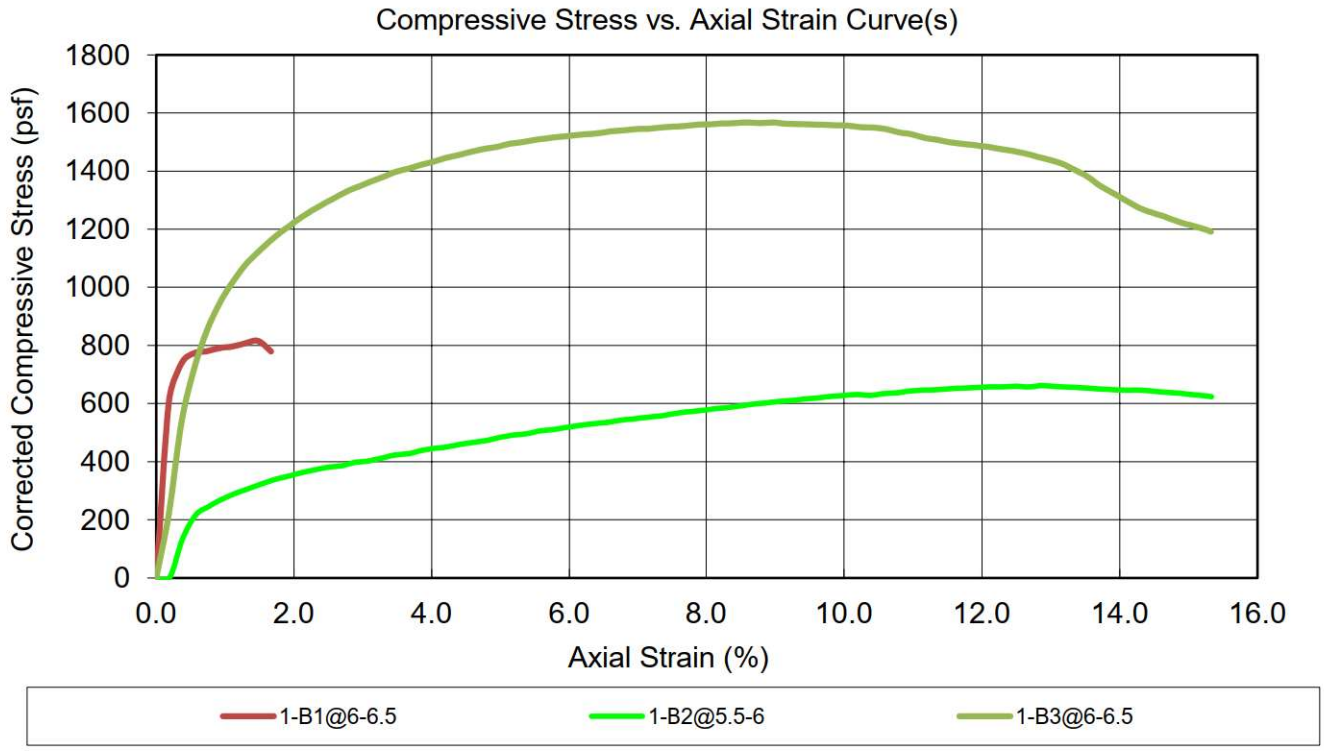
TEST DATA

	INITIAL	FINAL	ASTM D4318 - Wet Method	
MOISTURE CONTENT (%):	86.72	75.48	**LIQUID LIMIT:**	
DRY DENSITY (pcf):	49.16	58.66	**PLASTIC LIMIT:**	
SATURATION (%):	99.08	100.00	**ASTM D854 - Measured**	
VOID RATIO:	2.230	1.707	**SPECIFIC GRAVITY**	2.548
STRAIN RATE (in/min):	0.000042			

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportaion Pier Ferry Project
PROJECT NO: 25022.000.001-P:001-T:003
PROJECT LOCATION: Berkeley, California
REPORT DATE: 10/21/2024
TESTED BY: K. Nguyen
REVIEWED BY: D. Seibold

UNCONFINED COMPRESSION TEST REPORT
(ASTM D2166)



BEFORE TEST	SPECIMEN 1-B1@6-6.5	SPECIMEN 1-B2@5.5-6	SPECIMEN 1-B3@6-6.5
Test Moisture Content (%)	7.26	20.99	23.51
Dry Density (pcf)	110.5	107.8	100.2
Saturation (%)	36.7	99.2	92.1
Void Ratio	0.54	0.58	0.69
Diameter (in)	2.385	2.402	2.399
Height (in)	5.403	5.203	5.467
Height-To-Diameter Ratio	2.27	2.17	2.28
TEST DATA			
Unconfined Compressive Strength (psf)	816	662	1568
Undrained Shear Strength (psf)	408.00	331.11	783.95
Strain Rate (in/min)	0.050	0.050	0.050
Specific Gravity (ASSUMED)	2.720	2.720	2.720
Strain at Failure(%)	1.48	12.88	8.96
Test Remarks			

SPECIMEN	DESCRIPTION
1-B1@6-6.5	See exploration logs
1-B2@5.5-6	See exploration logs
1-B3@6-6.5	See exploration logs

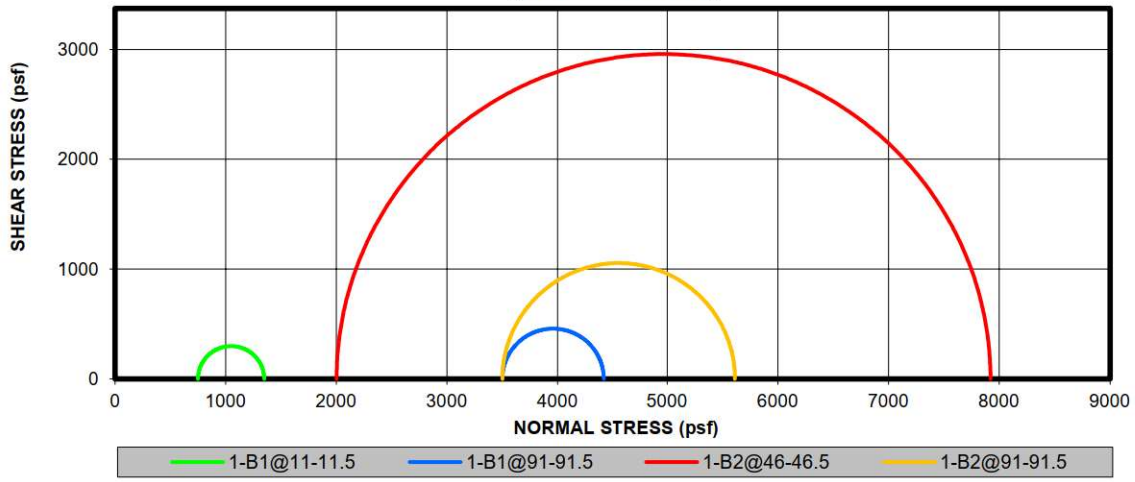
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
CLIENT: COWI North America, Inc.
LOCATION: Berkeley, CA

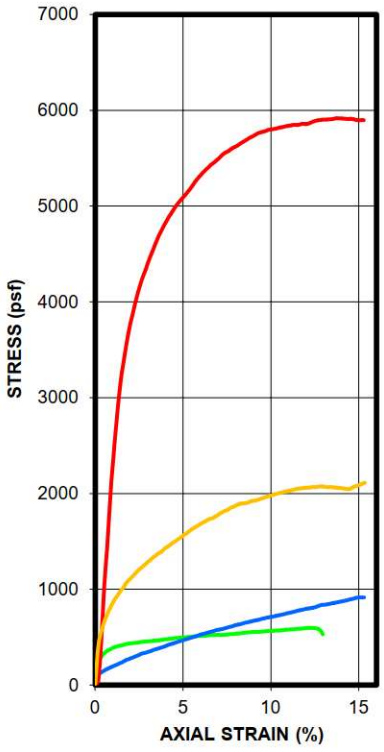
Test Date: 10/11/24
Tested By: L. Schmitz
Reviewed By: M. Gilbert

ENGEO
Expect Excellence

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES





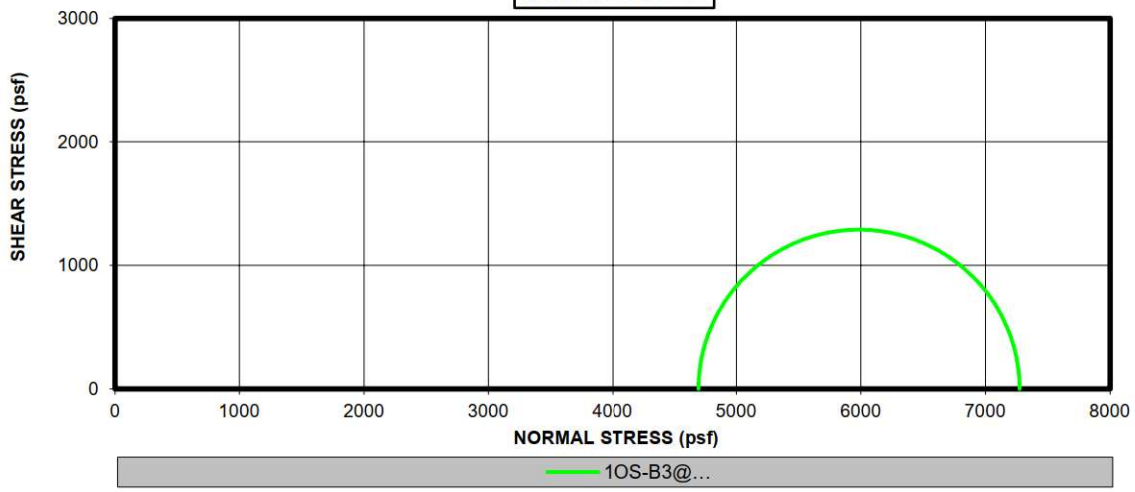
	SPECIMEN			
INITIAL PARAMETERS	**1-B1@11-11.5**	**1-B1@91-91.5**	**1-B2@46-46.5**	**1-B2@91-91.5**
MOISTURE (%)	19.84	23.24	23.61	34.99
DRY DENSITY (PCF)	94.70	103.90	103.20	86.70
SATURATION (%)	68.09	99.56	99.57	99.31
VOID RATIO	0.793	0.635	0.645	0.958
DIAMETER (IN.)	2.403	2.278	2.402	2.392
HEIGHT (IN.)	5.443	5.657	5.920	5.583
DIAMETER-TO-HEIGHT RATIO	2.265	2.483	2.465	2.334
LIQUID LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
PLASTIC LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	**1-B1@11-11.5**	**1-B1@91-91.5**	**1-B2@46-46.5**	**1-B2@91-91.5**
MOISTURE (%)	19.84	23.24	23.61	34.99
SATURATION (%)	68.09	99.56	99.57	99.31
STRAIN RATE (%/MIN.)	0.920	0.880	0.840	0.900
PEAK DEVIATOR STRESS (PSF)	598.4	916.5	5917.9	2111.5
AXIAL STRAIN AT FAILURE (%)	12.12	15.29	13.68	15.32
CELL PRESSURE				
CELL PRESSURE (PSF)	748.8	3499.2	2001.6	3499.2
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	1347.2	4415.7	7919.5	5610.7
σ3 (PSF)	748.8	3499.2	2001.6	3499.2
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	299.2	458.3	2959.0	1055.8
REMARKS				

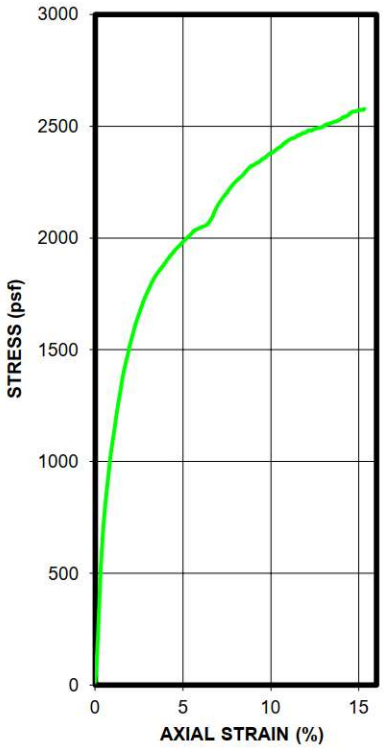
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/18/2024
TESTED BY: L. Schmitz
REVIEWED BY: N. Broussard

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES





	SPECIMEN			
INITIAL PARAMETERS	1OS-B3@ 122-124			
MOISTURE (%)	39.79			
DRY DENSITY (PCF)	81.40			
SATURATION (%)	99.56			
VOID RATIO	1.087			
DIAMETER (IN.)	2.839			
HEIGHT (IN.)	6.427			
DIAMETER-TO-HEIGHT RATIO	2.264			
LIQUID LIMIT (ASTM D4318)	n/a			
PLASTIC LIMIT (ASTM D4318)	n/a			
SPECIFIC GRAVITY (ASTM D854)	2.720			
FINAL PARAMETERS	1OS-B3@ 122-124			
MOISTURE (%)	39.79			
SATURATION (%)	99.56			
STRAIN RATE (%/MIN.)	0.930			
PEAK DEVIATOR STRESS (PSF)	2578.9			
AXIAL STRAIN AT FAILURE (%)	15.31			
CELL PRESSURE				
CELL PRESSURE (PSF)	4694.4			
BACK PRESSURE (PSF)	n/a			
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	7273.3			
σ3 (PSF)	4694.4			
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	1289.4			
REMARKS				

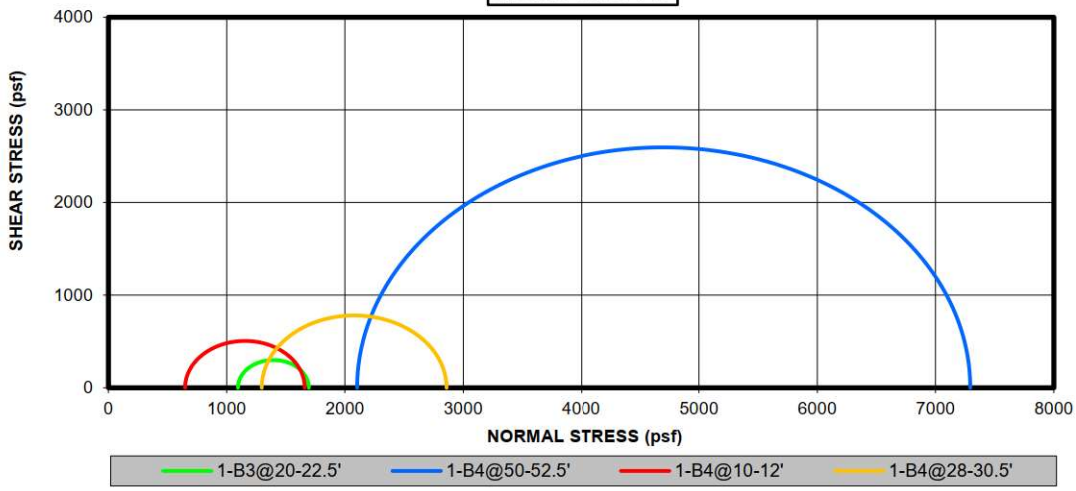
ENGEO
Expect Excellence

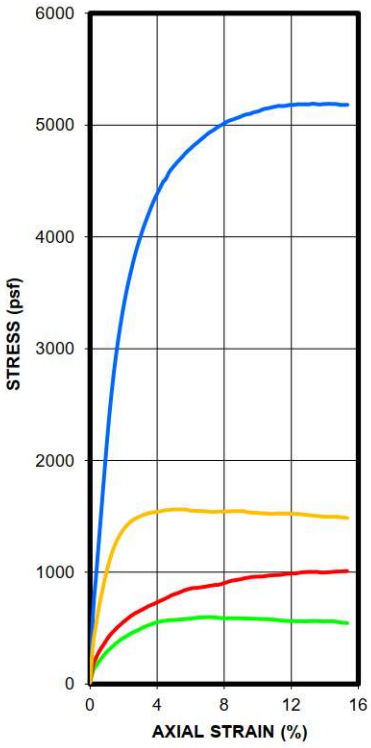
CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/18/2024
TESTED BY: L. Schmitz
REVIEWED BY: N. Broussard

Please Select Address

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES





	SPECIMEN			
INITIAL PARAMETERS	**1-B3@20-22.5'**	**1-B4@50-52.5'**	**1-B4@10-12'**	**1-B4@28-30.5'**
MOISTURE (%)	74.39	18.08	21.79	33.31
DRY DENSITY (PCF)	56.00	111.90	105.10	89.70
SATURATION (%)	99.47	95.02	96.35	100.00
VOID RATIO	2.034	0.517	0.615	0.894
DIAMETER (IN.)	2.852	2.868	2.846	2.838
HEIGHT (IN.)	5.713	5.961	5.634	5.969
DIAMETER-TO-HEIGHT RATIO	2.003	2.078	1.980	2.103
LIQUID LIMIT (ASTM D4318)			45	
PLASTIC LIMIT (ASTM D4318)			22	
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	**1-B3@20-22.5'**	**1-B4@50-52.5'**	**1-B4@10-12'**	**1-B4@28-30.5'**
MOISTURE (%)	74.39	18.08	21.79	33.31
SATURATION (%)	99.47	95.02	96.35	100.00
STRAIN RATE (%/MIN.)	0.057	0.060	0.056	0.060
PEAK DEVIATOR STRESS (PSF)	599.3	5191.0	1011.5	1562.1
AXIAL STRAIN AT FAILURE (%)	7.002	13.253	15.332	5.194
CELL PRESSURE				
CELL PRESSURE (PSF)	1094.4	2102.4	648.0	1296.0
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	1693.7	7293.4	1659.5	2858.1
σ3 (PSF)	1094.4	2102.4	648.0	1296.0
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	299.6	2595.5	505.7	781.1
REMARKS				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/22/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850







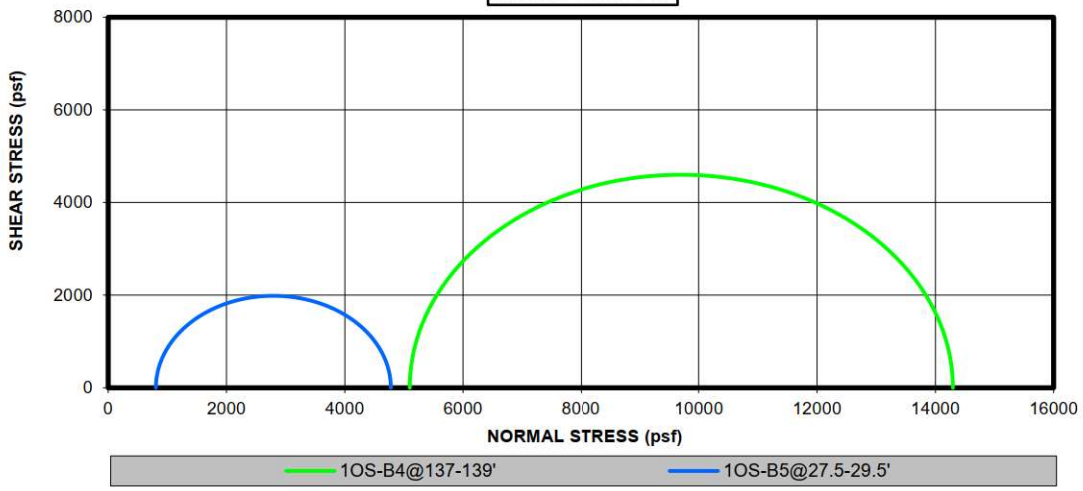


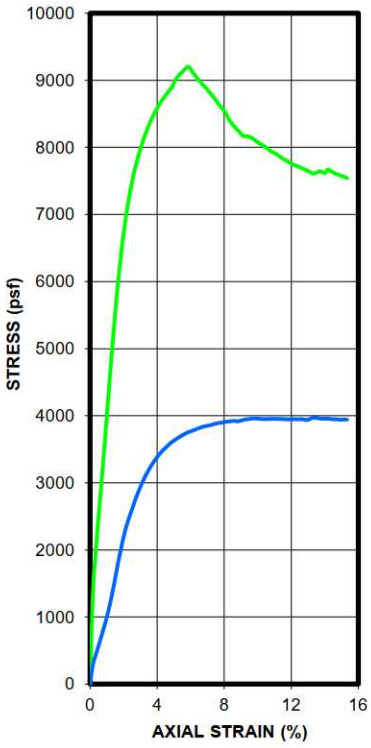
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/22/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES





	SPECIMEN			
INITIAL PARAMETERS	1OS-B4@137-139'	1OS-B5@27.5-29.5'	C	D
MOISTURE (%)	19.24	25.86		
DRY DENSITY (PCF)	110.80	96.80		
SATURATION (%)	98.20	93.15		
VOID RATIO	0.533	0.755		
DIAMETER (IN.)	2.868	2.897		
HEIGHT (IN.)	5.926	5.942		
DIAMETER-TO-HEIGHT RATIO	2.066	2.051		
LIQUID LIMIT (ASTM D4318)				
PLASTIC LIMIT (ASTM D4318)				
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720		
FINAL PARAMETERS	1OS-B4@137-139'	1OS-B5@27.5-29.5'	C	D
MOISTURE (%)	19.24	25.86		
SATURATION (%)	98.20	93.15		
STRAIN RATE (%/MIN.)	0.059	0.059		
PEAK DEVIATOR STRESS (PSF)	9198.9	3971.9		
AXIAL STRAIN AT FAILURE (%)	5.906	13.295		
CELL PRESSURE				
CELL PRESSURE (PSF)	5097.6	806.4		
BACK PRESSURE (PSF)	n/a	n/a		
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	14296.5	4778.3		
σ3 (PSF)	5097.6	806.4		
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	4599.5	1985.9		
REMARKS				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/24/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

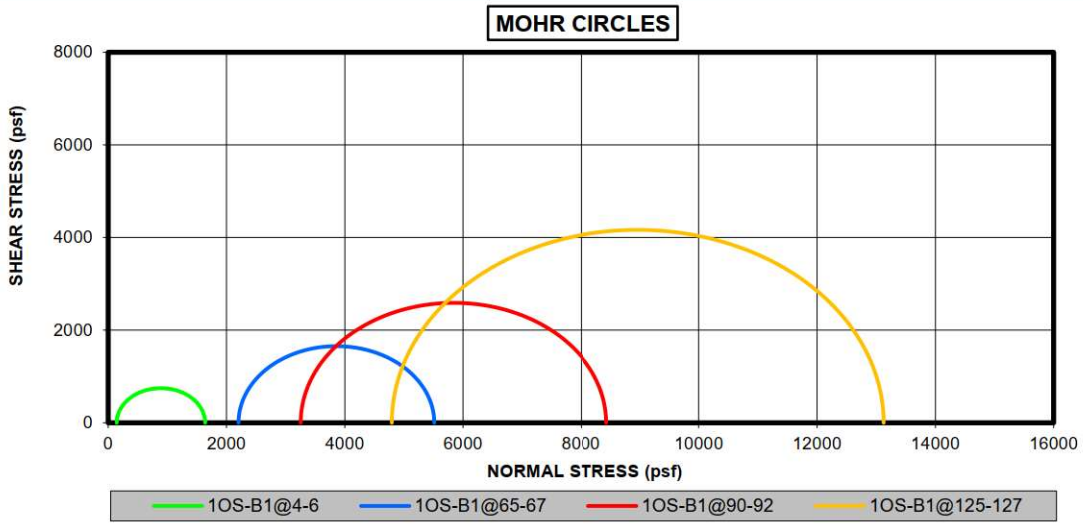


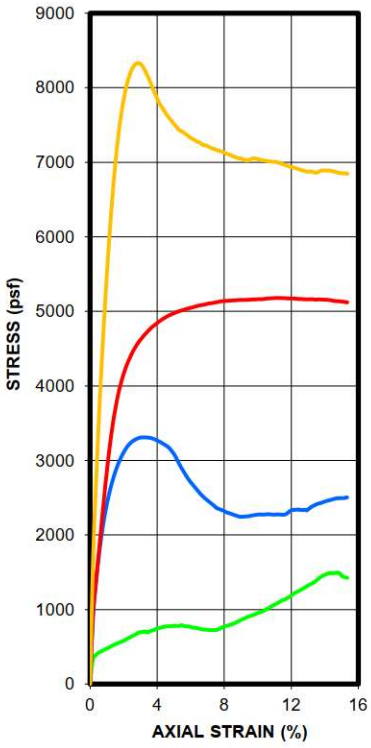


ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/24/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850





	SPECIMEN			
INITIAL PARAMETERS	1OS-B1@4-6	1OS-B1@65-67	1OS-B1@90-92	1OS-B1@125-127
MOISTURE (%)	22.05	43.06	23.61	26.05
DRY DENSITY (PCF)	108.80	78.60	102.60	99.80
SATURATION (%)	100.00	100.00	98.14	100.00
VOID RATIO	0.561	1.160	0.654	0.701
DIAMETER (IN.)	2.858	2.870	2.866	2.868
HEIGHT (IN.)	5.854	5.952	5.958	5.958
DIAMETER-TO-HEIGHT RATIO	2.048	2.074	2.079	2.077
LIQUID LIMIT (ASTM D4318)				
PLASTIC LIMIT (ASTM D4318)				
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	1OS-B1@4-6	1OS-B1@65-67	1OS-B1@90-92	1OS-B1@125-127
MOISTURE (%)	22.05	43.06	23.61	26.05
SATURATION (%)	100.00	100.00	98.14	100.00
STRAIN RATE (%/MIN.)	0.059	0.060	0.060	0.060
PEAK DEVIATOR STRESS (PSF)	1494.4	3309.0	5179.8	8330.9
AXIAL STRAIN AT FAILURE (%)	14.691	3.193	11.078	2.853
CELL PRESSURE				
CELL PRESSURE (PSF)	144.0	2203.2	3254.4	4795.2
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	1638.4	5512.2	8434.2	13126.1
σ3 (PSF)	144.0	2203.2	3254.4	4795.2
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	747.2	1654.5	2589.9	4165.5
REMARKS				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/21/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850







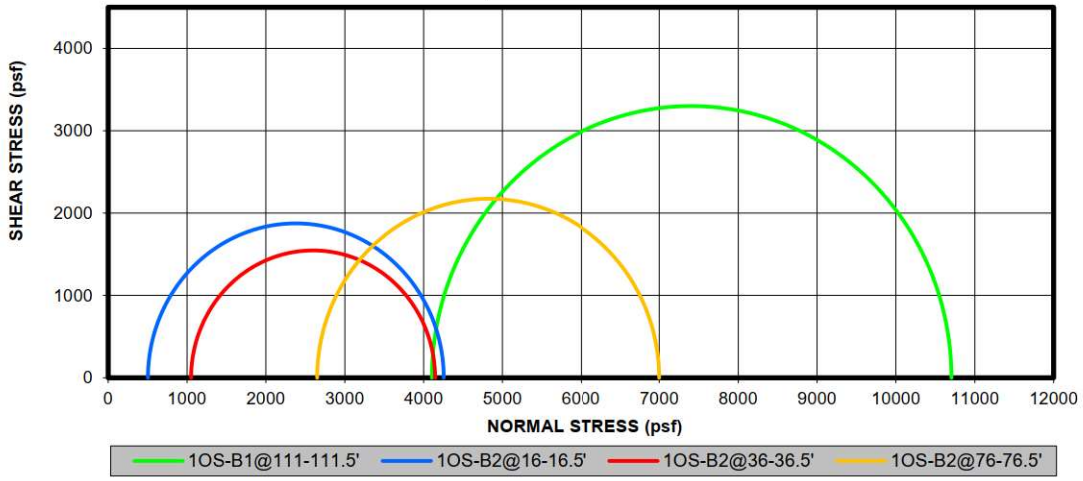


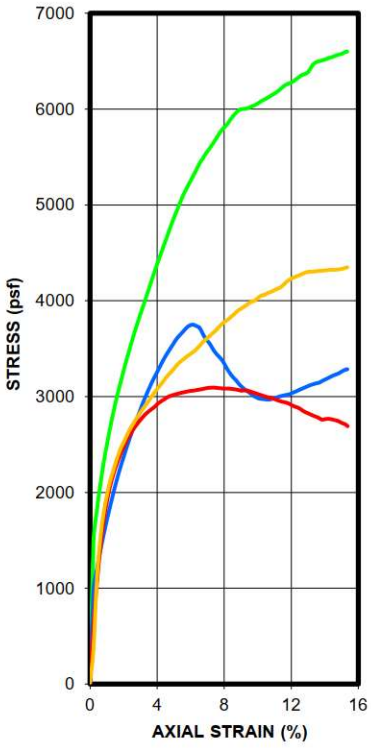
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/21/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES





	SPECIMEN			
INITIAL PARAMETERS	1OS-B1@111-111.5'	1OS-B2@16-16.5'	1OS-B2@36-36.5'	1OS-B2@76-76.5'
MOISTURE (%)	27.50	17.98	30.43	32.54
DRY DENSITY (PCF)	96.40	114.00	94.20	90.50
SATURATION (%)	98.26	99.94	100.00	100.00
VOID RATIO	0.761	0.490	0.802	0.876
DIAMETER (IN.)	2.412	2.411	2.407	2.391
HEIGHT (IN.)	5.057	5.049	4.993	5.001
DIAMETER-TO-HEIGHT RATIO	2.097	2.094	2.074	2.092
LIQUID LIMIT (ASTM D4318)				
PLASTIC LIMIT (ASTM D4318)				
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	1OS-B1@111-111.5'	1OS-B2@16-16.5'	1OS-B2@36-36.5'	1OS-B2@76-76.5'
MOISTURE (%)	27.50	17.98	30.43	32.54
SATURATION (%)	98.26	99.93	100.00	100.00
STRAIN RATE (%/MIN.)	0.051	0.050	0.050	0.050
PEAK DEVIATOR STRESS (PSF)	6600.3	3750.2	3093.4	4348.3
AXIAL STRAIN AT FAILURE (%)	15.343	6.140	7.410	15.345
CELL PRESSURE				
CELL PRESSURE (PSF)	4104.0	504.0	1051.2	2649.6
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	10704.3	4254.2	4144.6	6997.9
σ3 (PSF)	4104.0	504.0	1051.2	2649.6
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	3300.2	1875.1	1546.7	2174.1
REMARKS				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/24/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850







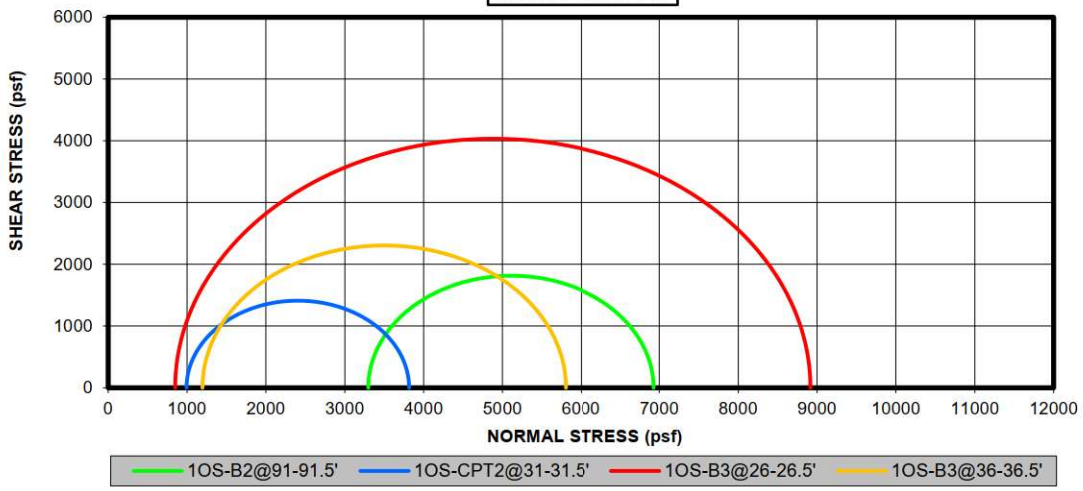


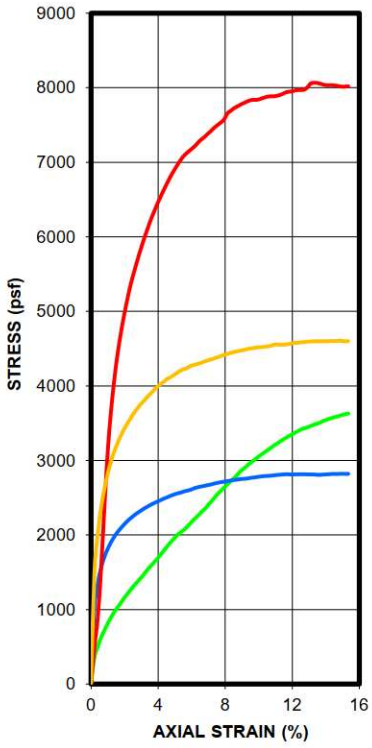
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/24/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES





	SPECIMEN			
INITIAL PARAMETERS	1OS-B2@91-91.5'	1OS-CPT2@31-31.5'	1OS-B3@26-26.5'	1OS-B3@36-36.5'
MOISTURE (%)	31.65	28.11	24.76	23.35
DRY DENSITY (PCF)	92.50	96.40	102.30	104.50
SATURATION (%)	100.00	100.00	100.00	100.00
VOID RATIO	0.837	0.761	0.660	0.624
DIAMETER (IN.)	2.405	2.392	2.389	2.398
HEIGHT (IN.)	5.000	5.054	5.040	5.061
DIAMETER-TO-HEIGHT RATIO	2.079	2.113	2.110	2.111
LIQUID LIMIT (ASTM D4318)				
PLASTIC LIMIT (ASTM D4318)				
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	1OS-B2@91-91.5'	1OS-CPT2@31-31.5'	1OS-B3@26-26.5'	1OS-B3@36-36.5'
MOISTURE (%)	31.65	28.11	24.76	23.35
SATURATION (%)	100.00	100.00	100.00	100.00
STRAIN RATE (%/MIN.)	0.050	0.051	0.050	0.051
PEAK DEVIATOR STRESS (PSF)	3629.5	2821.2	8066.6	4608.9
AXIAL STRAIN AT FAILURE (%)	15.353	15.344	13.294	14.819
CELL PRESSURE				
CELL PRESSURE (PSF)	3297.6	993.6	849.6	1195.2
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	6927.1	3814.8	8916.2	5804.1
σ3 (PSF)	3297.6	993.6	849.6	1195.2
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	1814.8	1410.6	4033.3	2304.4
REMARKS				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/25/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850







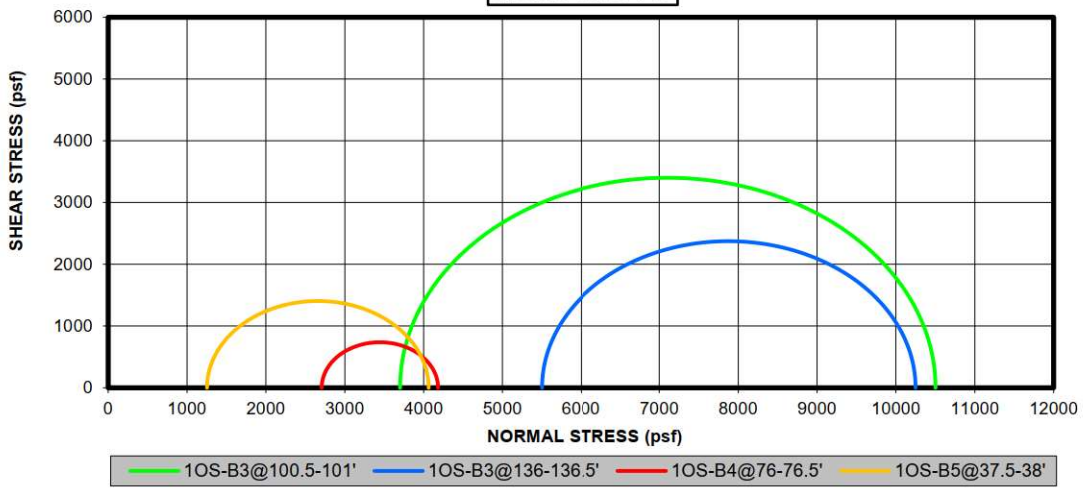


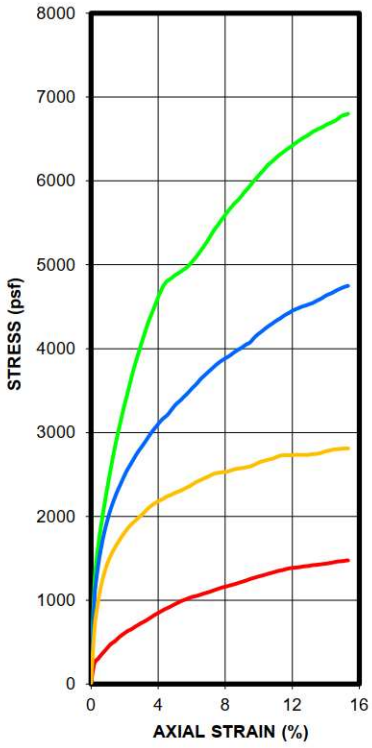
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/25/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES





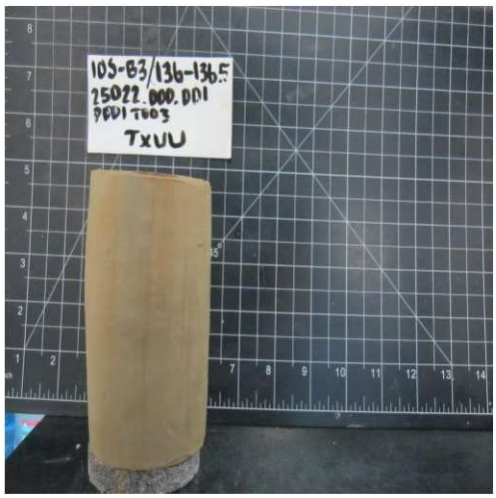
	SPECIMEN			
INITIAL PARAMETERS	1OS-B3@100.5-101'	1OS-B3@136-136.5'	1OS-B4@76-76.5'	1OS-B5@37.5-38'
MOISTURE (%)	22.66	19.13	42.57	26.24
DRY DENSITY (PCF)	106.40	112.00	80.00	99.20
SATURATION (%)	100.00	100.00	100.00	100.00
VOID RATIO	0.595	0.516	1.124	0.711
DIAMETER (IN.)	2.399	2.403	2.383	2.408
HEIGHT (IN.)	5.010	5.073	4.996	5.076
DIAMETER-TO-HEIGHT RATIO	2.088	2.111	2.097	2.108
LIQUID LIMIT (ASTM D4318)				
PLASTIC LIMIT (ASTM D4318)				
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	1OS-B3@100.5-101'	1OS-B3@136-136.5'	1OS-B4@76-76.5'	1OS-B5@37.5-38'
MOISTURE (%)	22.66	19.13	42.57	26.24
SATURATION (%)	100.00	100.00	100.00	100.00
STRAIN RATE (%/MIN.)	0.050	0.051	0.050	0.051
PEAK DEVIATOR STRESS (PSF)	6801.9	4748.4	1475.0	2809.9
AXIAL STRAIN AT FAILURE (%)	15.331	15.331	15.330	15.337
CELL PRESSURE				
CELL PRESSURE (PSF)	3700.8	5500.8	2707.2	1252.8
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	10502.7	10249.2	4182.2	4062.7
σ3 (PSF)	3700.8	5500.8	2707.2	1252.8
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	3401.0	2374.2	737.5	1405.0
REMARKS				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/28/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850





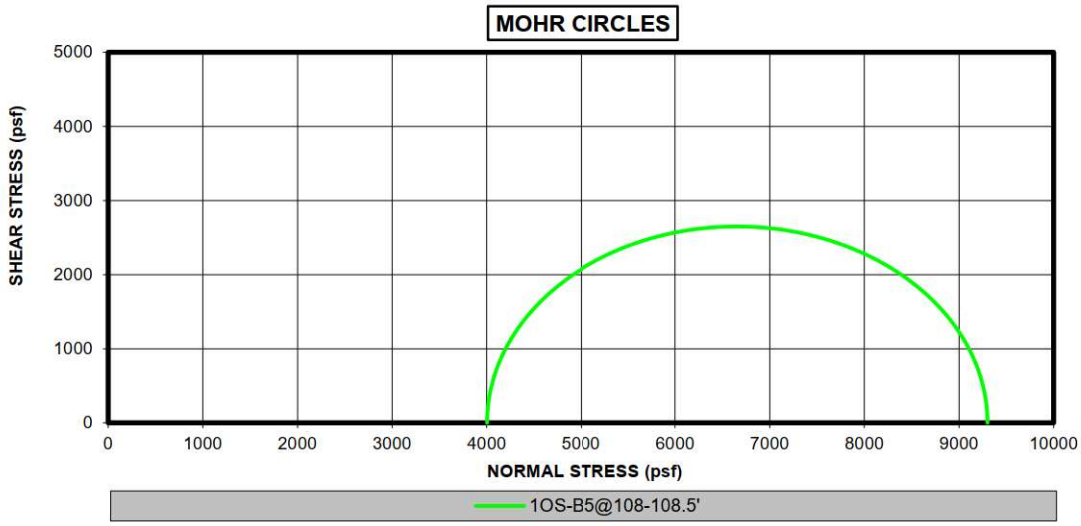


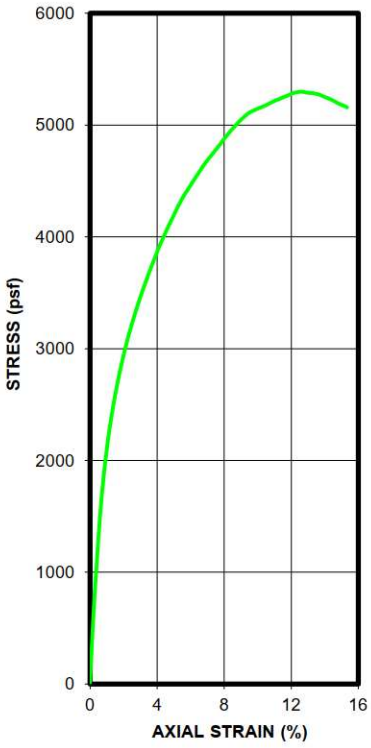


ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/28/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850





	SPECIMEN			
INITIAL PARAMETERS	1OS-B5@108-108.5'			
MOISTURE (%)	20.48			
DRY DENSITY (PCF)	108.80			
SATURATION (%)	99.42			
VOID RATIO	0.560			
DIAMETER (IN.)	2.408			
HEIGHT (IN.)	5.056			
DIAMETER-TO-HEIGHT RATIO	2.100			
LIQUID LIMIT (ASTM D4318)				
PLASTIC LIMIT (ASTM D4318)				
SPECIFIC GRAVITY (ASTM D854)	2.720			
FINAL PARAMETERS	1OS-B5@108-108.5'			
MOISTURE (%)	20.48			
SATURATION (%)	99.42			
STRAIN RATE (%/MIN.)	0.051			
PEAK DEVIATOR STRESS (PSF)	5297.9			
AXIAL STRAIN AT FAILURE (%)	12.658			
CELL PRESSURE				
CELL PRESSURE (PSF)	4003.2			
BACK PRESSURE (PSF)	n/a			
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	9301.1			
σ3 (PSF)	4003.2			
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	2648.9			
REMARKS				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/28/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

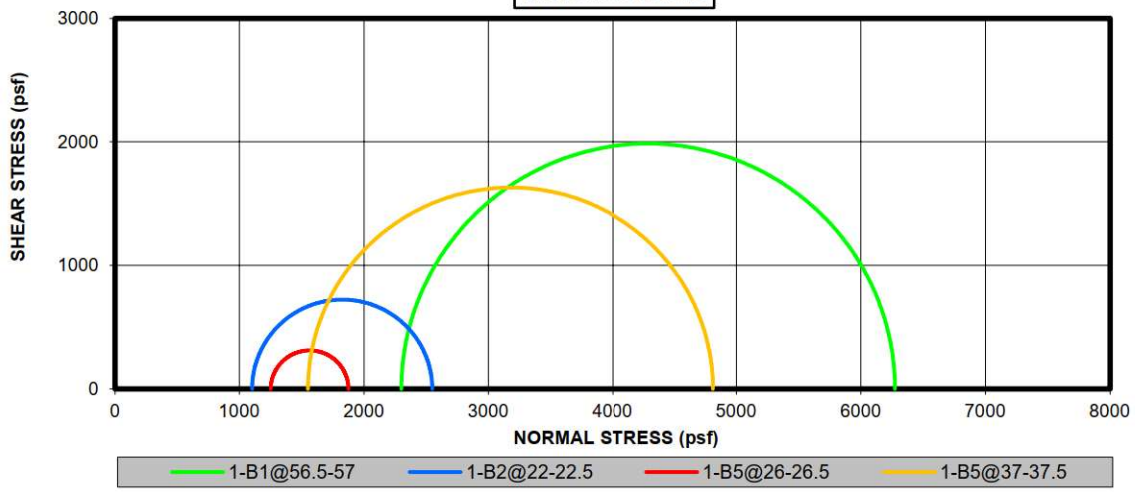


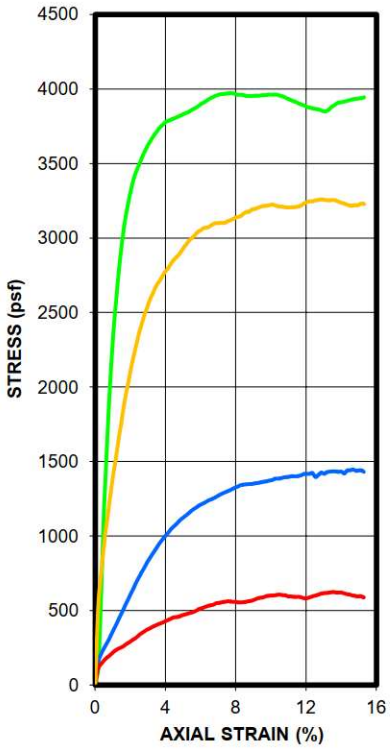
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/28/2024
TESTED BY: Y. Cabrales
REVIEWED BY: D. Seibold

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES



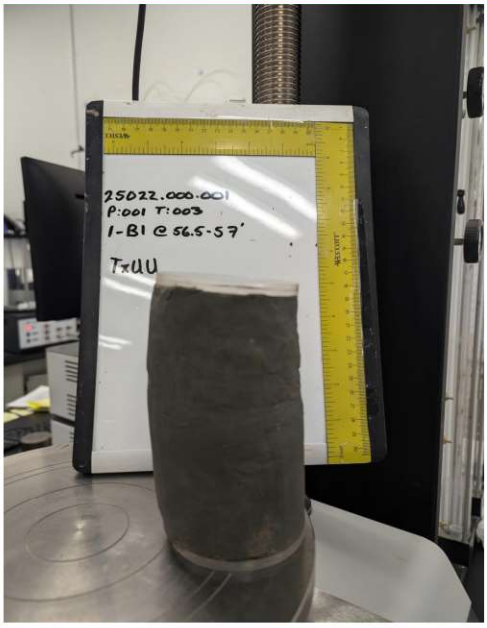


	SPECIMEN			
INITIAL PARAMETERS	1-B1@56.5-57	1-B2@22-22.5	1-B5@26-26.5	1-B5@37-37.5
MOISTURE (%)	22.73	27.57	19.40	31.13
DRY DENSITY (PCF)	102.00	96.80	112.20	89.10
SATURATION (%)	92.96	99.49	102.73	93.58
VOID RATIO	0.665	0.754	0.514	0.905
DIAMETER (IN.)	2.869	2.880	2.853	2.855
HEIGHT (IN.)	5.950	6.065	6.101	5.825
DIAMETER-TO-HEIGHT RATIO	2.074	2.106	2.138	2.040
LIQUID LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
PLASTIC LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	1-B1@56.5-57	1-B2@22-22.5	1-B5@26-26.5	1-B5@37-37.5
MOISTURE (%)	22.73	27.57	19.40	31.13
SATURATION (%)	92.96	99.49	100.00	93.58
STRAIN RATE (%/MIN.)	0.840	0.820	0.820	0.840
PEAK DEVIATOR STRESS (PSF)	3972.6	1447.2	624.3	3260.9
AXIAL STRAIN AT FAILURE (%)	7.731	14.674	13.441	12.876
CELL PRESSURE				
CELL PRESSURE (PSF)	2299.7	1100.2	1249.9	1549.4
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	6272.2	2547.4	1874.2	4810.3
σ3 (PSF)	2299.7	1100.2	1249.9	1549.4
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	1986.3	723.6	312.1	1630.4
REMARKS				

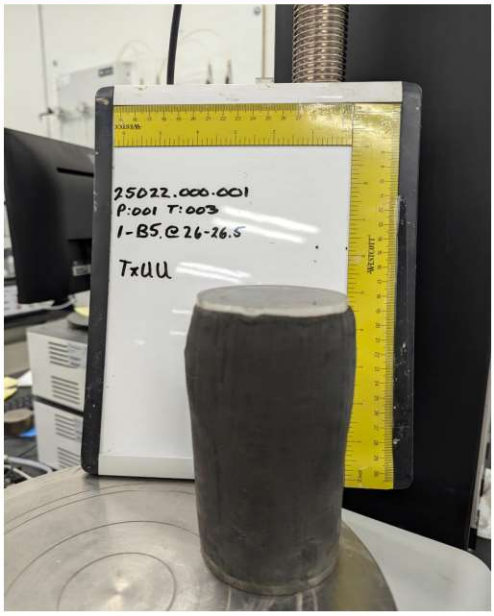
ENGEO
Expect Excellence

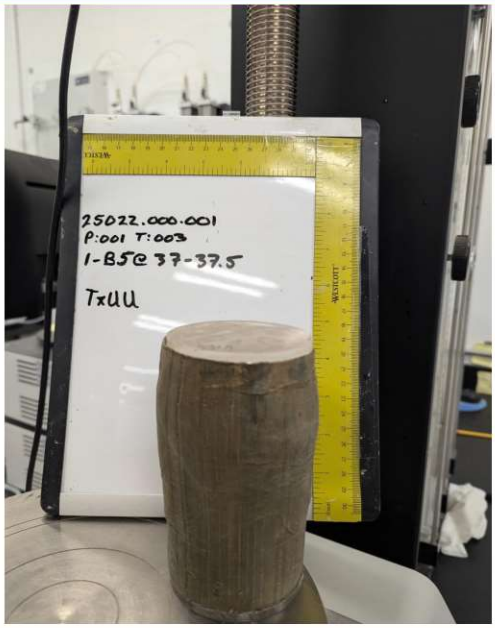
CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/22/2024
TESTED BY: K. Lecce
REVIEWED BY: D. Bryant

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850





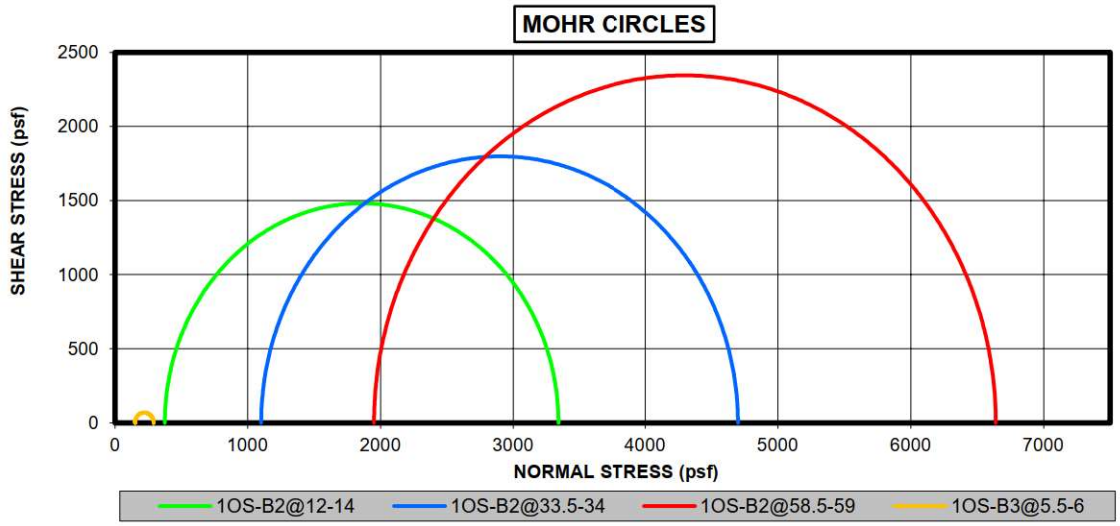


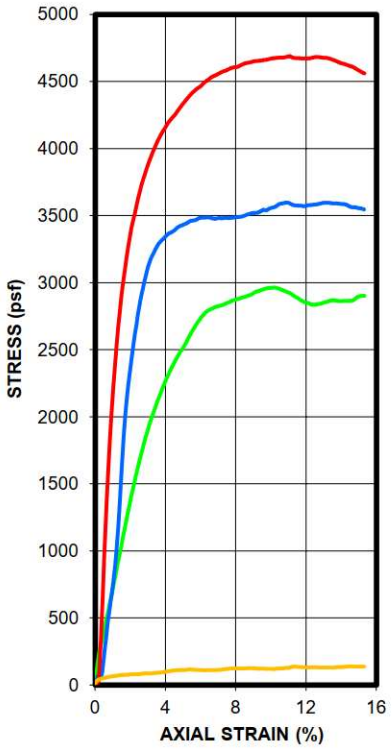


ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/22/2024
TESTED BY: K. Lecce
REVIEWED BY: D. Bryant

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850



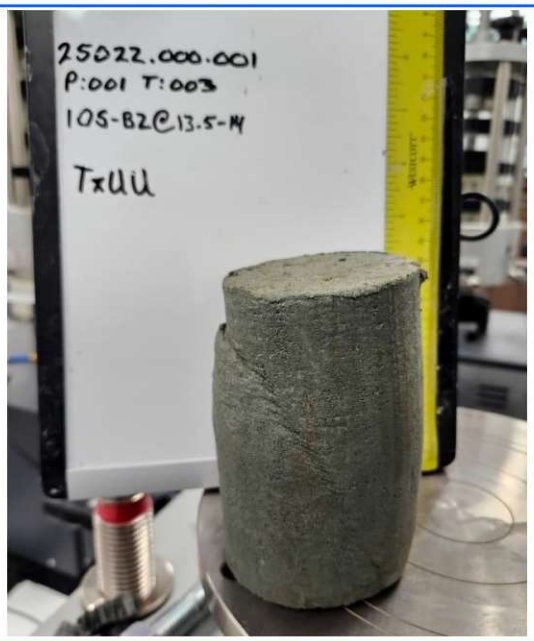


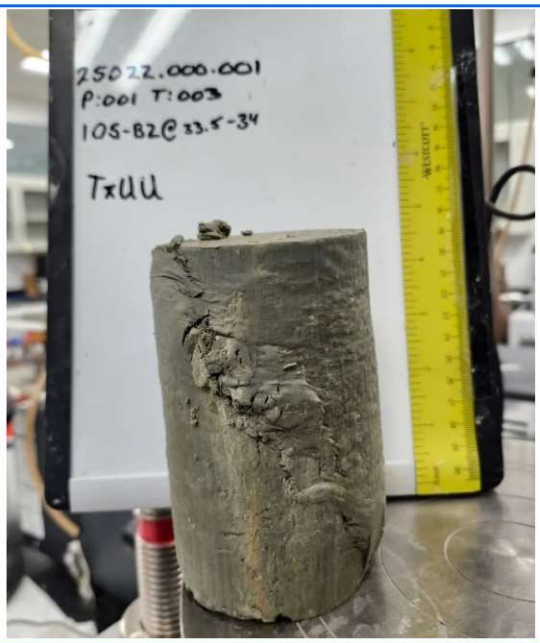
	SPECIMEN			
INITIAL PARAMETERS	**1OS-B2@12-14**	**1OS-B2@33.5-34**	**1OS-B2@58.5-59**	**1OS-B3@5.5-6**
MOISTURE (%)	18.72	23.04	29.04	34.93
DRY DENSITY (PCF)	111.50	102.50	94.40	84.70
SATURATION (%)	97.38	95.39	98.86	94.60
VOID RATIO	0.523	0.657	0.799	1.004
DIAMETER (IN.)	2.850	2.850	2.860	2.850
HEIGHT (IN.)	5.380	5.550	5.330	5.800
DIAMETER-TO-HEIGHT RATIO	1.888	1.947	1.864	2.035
LIQUID LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
PLASTIC LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.720
FINAL PARAMETERS	**1OS-B2@12-14**	**1OS-B2@33.5-34**	**1OS-B2@58.5-59**	**1OS-B3@5.5-6**
MOISTURE (%)	18.72	23.04	29.04	34.93
SATURATION (%)	97.37	95.39	98.86	94.60
STRAIN RATE (%/MIN.)	0.840	0.820	0.820	0.840
PEAK DEVIATOR STRESS (PSF)	2964.0	3597.4	4689.6	140.5
AXIAL STRAIN AT FAILURE (%)	10.223	13.153	11.070	14.483
CELL PRESSURE				
CELL PRESSURE (PSF)	374.4	1100.2	1949.8	149.8
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	3338.4	4697.6	6639.4	290.3
σ3 (PSF)	374.4	1100.2	1949.8	149.8
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	1482.0	1798.7	2344.8	70.2
REMARKS				
Due to its saturation/moisture content, sample 1OS-B3@5.5-6 was collapsing under its own weight when extruded from the liner and prepared for the test. It should be considered disturbed.				

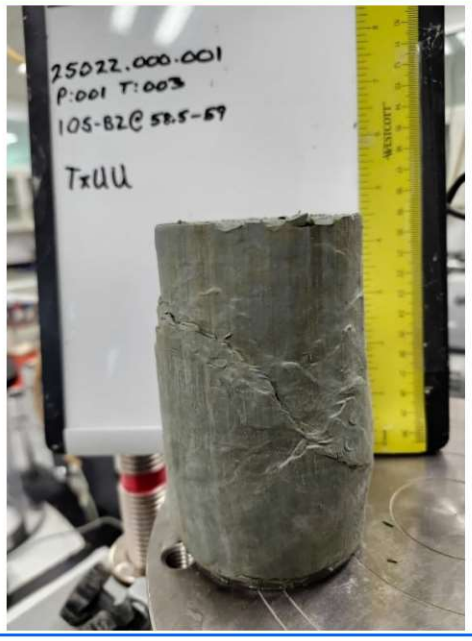
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: K. Lecce
REVIEWED BY: V. Nunez

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850









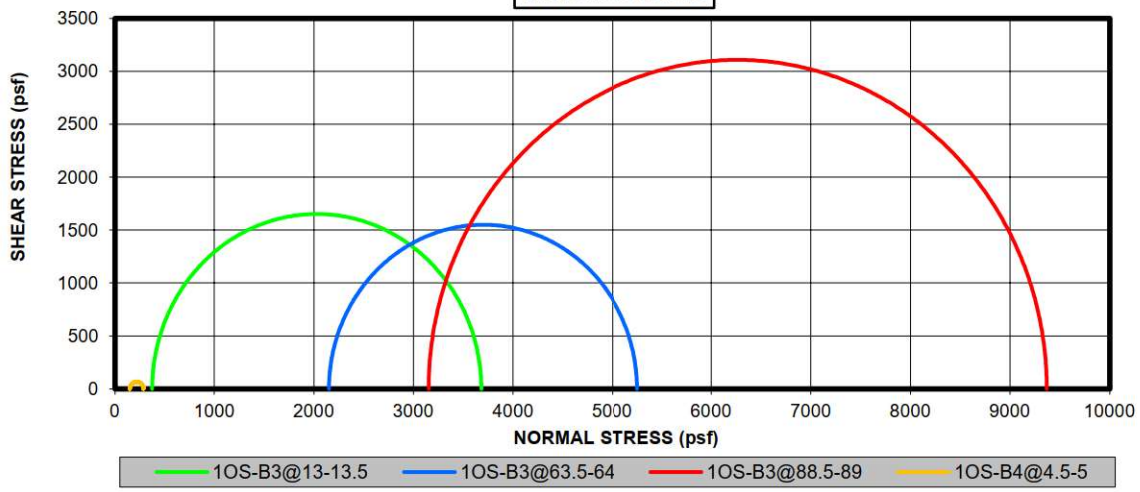
1OS-B3@5.5-6

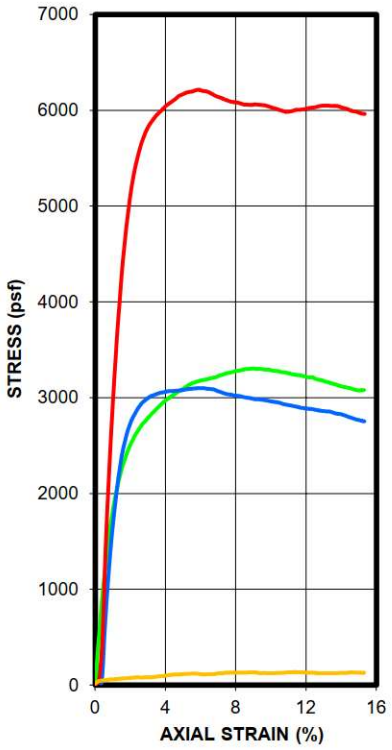
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: K. Lecce
REVIEWED BY: V. Nunez

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES



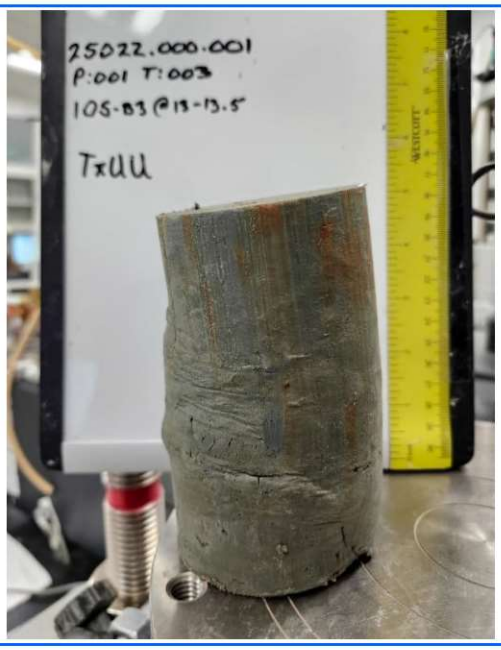


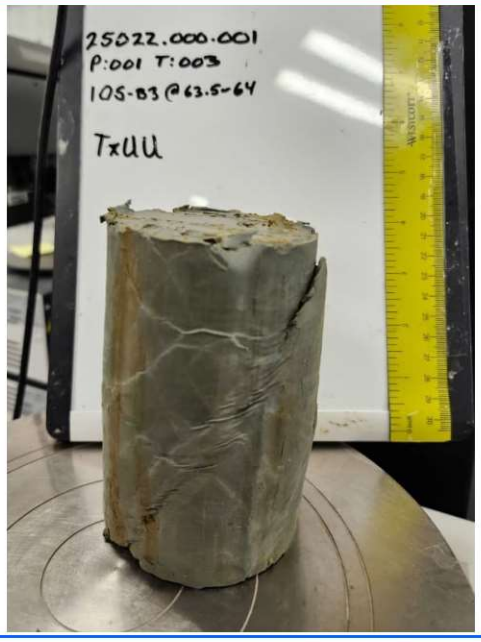
	SPECIMEN			
INITIAL PARAMETERS	**1OS-B3@13-13.5**	**1OS-B3@63.5-64**	**1OS-B3@88.5-89**	**1OS-B4@4.5-5**
MOISTURE (%)	20.43	44.62	25.33	38.18
DRY DENSITY (PCF)	109.70	76.50	99.00	83.30
SATURATION (%)	96.36	99.50	96.38	98.99
VOID RATIO	0.594	1.220	0.715	1.061
DIAMETER (IN.)	2.860	2.860	2.860	2.860
HEIGHT (IN.)	5.660	5.330	5.080	5.830
DIAMETER-TO-HEIGHT RATIO	1.979	1.864	1.776	2.038
LIQUID LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
PLASTIC LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
SPECIFIC GRAVITY (ASTM D854)	2.800	2.720	2.720	2.750
FINAL PARAMETERS	**1OS-B3@13-13.5**	**1OS-B3@63.5-64**	**1OS-B3@88.5-89**	**1OS-B4@4.5-5**
MOISTURE (%)	20.43	44.62	25.33	38.18
SATURATION (%)	96.36	99.50	96.38	98.99
STRAIN RATE (%/MIN.)	0.840	0.820	0.820	0.840
PEAK DEVIATOR STRESS (PSF)	3305.0	3102.1	6216.2	137.1
AXIAL STRAIN AT FAILURE (%)	9.011	6.004	5.906	11.321
CELL PRESSURE				
CELL PRESSURE (PSF)	374.4	2149.9	3150.7	149.8
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	3679.4	5252.0	9367.0	286.8
σ3 (PSF)	374.4	2149.9	3150.7	149.8
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	1652.5	1551.1	3108.1	68.5
REMARKS				
Due to its saturation/moisture content, sample 1OS-B4@4.5-5 was collapsing under its own weight when extruded from the liner and prepared for the test. It should be considered disturbed.				

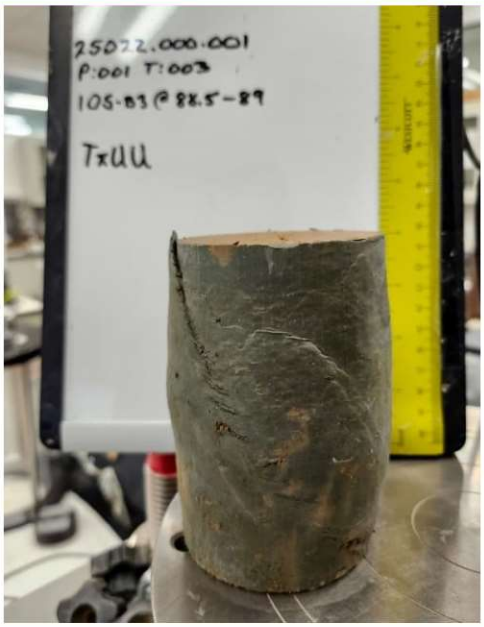
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: V. Nunez
REVIEWED BY: K. Lecce

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850









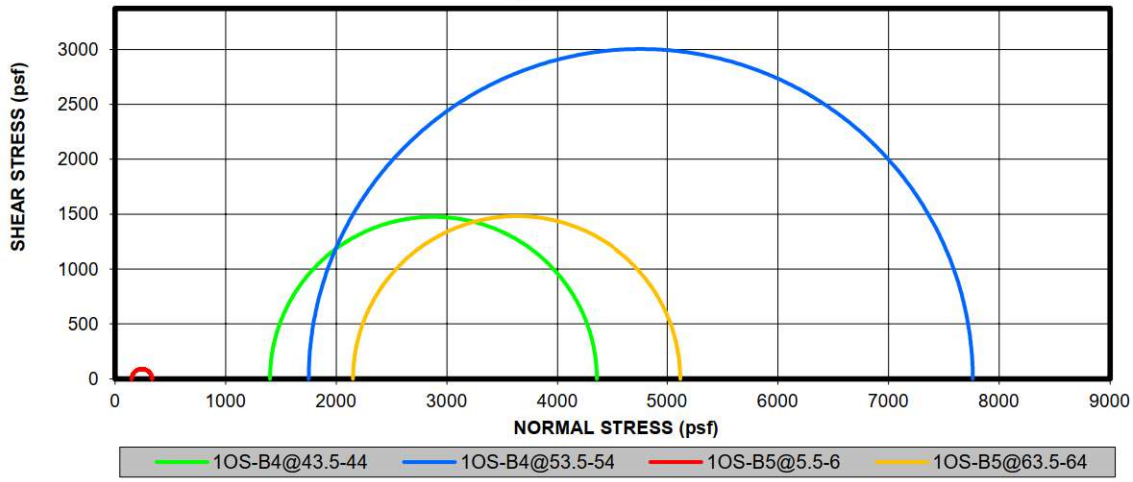
1OS-B4@4.5-5

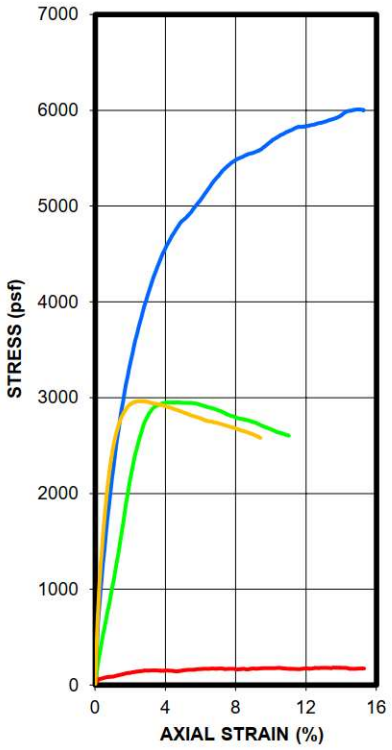
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: V. Nunez
REVIEWED BY: K. Lecce

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES



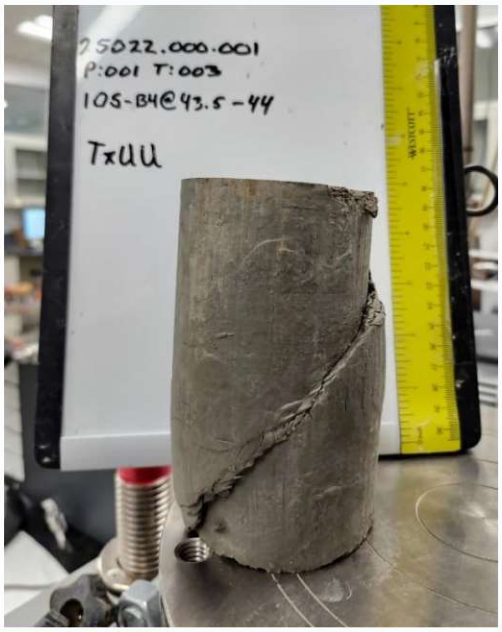


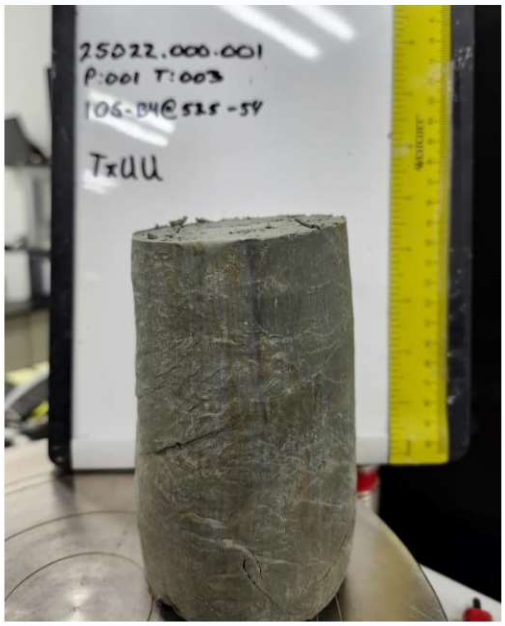
	SPECIMEN			
INITIAL PARAMETERS	**1OS-B4@43.5-44**	**1OS-B4@53.5-54**	**1OS-B5@5.5-6**	**1OS-B5@63.5-64**
MOISTURE (%)	29.55	28.58	35.14	47.12
DRY DENSITY (PCF)	92.00	94.70	78.30	74.30
SATURATION (%)	94.92	98.12	81.85	99.16
VOID RATIO	0.847	0.792	1.168	1.302
DIAMETER (IN.)	2.860	2.860	2.870	2.860
HEIGHT (IN.)	5.700	5.700	5.670	5.480
DIAMETER-TO-HEIGHT RATIO	1.993	1.993	1.976	1.916
LIQUID LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
PLASTIC LIMIT (ASTM D4318)	n/a	n/a	n/a	n/a
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	2.740
FINAL PARAMETERS	**1OS-B4@43.5-44**	**1OS-B4@53.5-54**	**1OS-B5@5.5-6**	**1OS-B5@63.5-64**
MOISTURE (%)	29.55	28.58	35.14	47.12
SATURATION (%)	94.92	98.12	81.85	99.16
STRAIN RATE (%/MIN.)	0.840	0.820	0.820	0.840
PEAK DEVIATOR STRESS (PSF)	2953.6	6009.7	183.1	2965.8
AXIAL STRAIN AT FAILURE (%)	4.737	15.088	13.580	2.555
CELL PRESSURE				
CELL PRESSURE (PSF)	1399.7	1749.6	149.8	2149.9
BACK PRESSURE (PSF)	n/a	n/a	n/a	n/a
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	4353.2	7759.3	332.8	5115.7
σ3 (PSF)	1399.7	1749.6	149.8	2149.9
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	1476.8	3004.9	91.5	1482.9
REMARKS				
Due to its saturation/moisture content, sample 1OS-B5@5.5-6 was collapsing under its own weight when extruded from the liner and prepared for the test. It should be considered disturbed.				

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: V. Nunez
REVIEWED BY: K. Lecce

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850







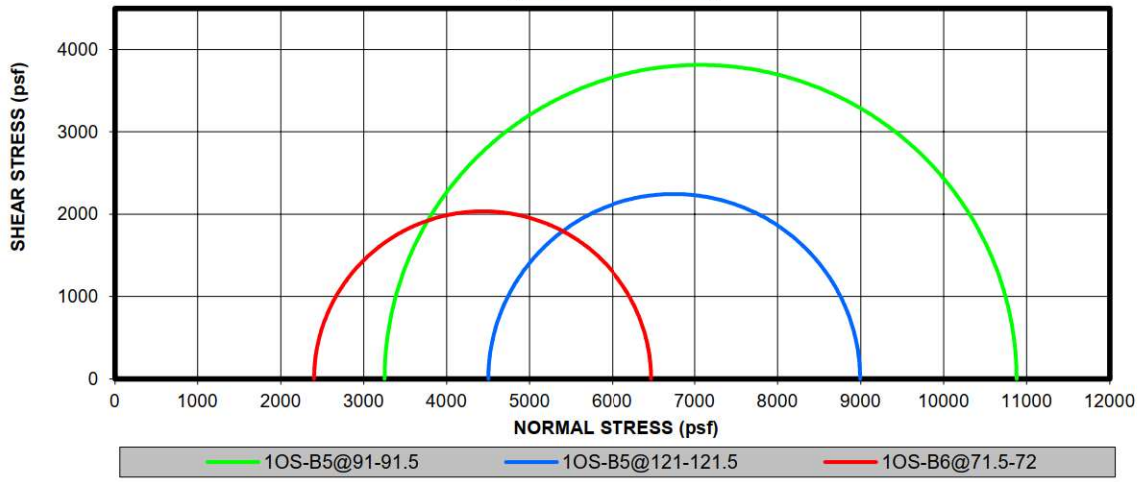


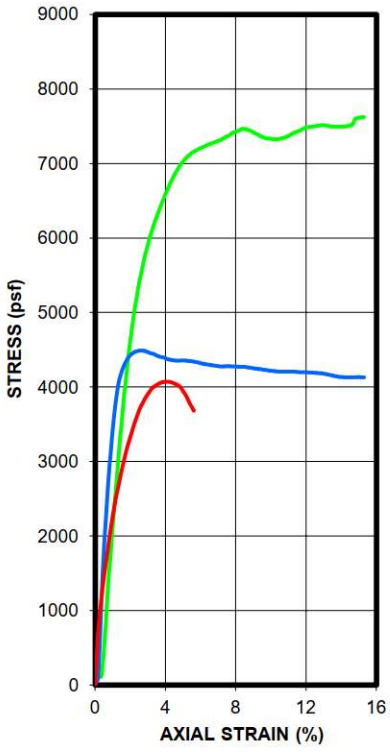
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: V. Nunez
REVIEWED BY: K. Lecce

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850

MOHR CIRCLES



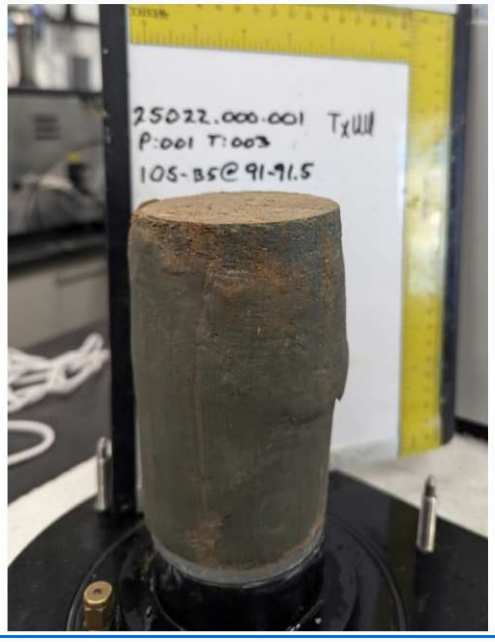


	SPECIMEN			
INITIAL PARAMETERS	1OS-B5@91-91.5	1OS-B5@121-121.5	1OS-B6@71.5-72	
MOISTURE (%)	19.78	46.03	44.46	
DRY DENSITY (PCF)	105.90	74.90	77.20	
SATURATION (%)	89.23	98.84	99.72	
VOID RATIO	0.603	1.267	1.231	
DIAMETER (IN.)	2.870	2.880	2.875	
HEIGHT (IN.)	5.745	5.752	5.965	
DIAMETER-TO-HEIGHT RATIO	2.002	1.997	2.075	
LIQUID LIMIT (ASTM D4318)	n/a	n/a	n/a	
PLASTIC LIMIT (ASTM D4318)	n/a	n/a	n/a	
SPECIFIC GRAVITY (ASTM D854)	2.720	2.720	2.720	
FINAL PARAMETERS	1OS-B5@91-91.5	1OS-B5@121-121.5	1OS-B6@71.5-72	
MOISTURE (%)	19.78	46.03	44.46	
SATURATION (%)	89.23	98.84	99.72	
STRAIN RATE (%/MIN.)	0.840	0.820	0.820	
PEAK DEVIATOR STRESS (PSF)	7626.6	4491.2	4072.0	
AXIAL STRAIN AT FAILURE (%)	15.293	2.608	4.024	
CELL PRESSURE				
CELL PRESSURE (PSF)	3250.1	4500.0	2400.5	
BACK PRESSURE (PSF)	n/a	n/a	n/a	
PRINCIPLE STRESSES AT FAILURE				
σ1 (PSF)	10876.7	8991.2	6472.5	
σ3 (PSF)	3250.1	4500.0	2400.5	
COHESION AT FAILURE WITH A ZERO FRICTION ANGLE (Ø=0)				
COHESION, C (PSF)	3813.3	2245.6	2036.0	
REMARKS				

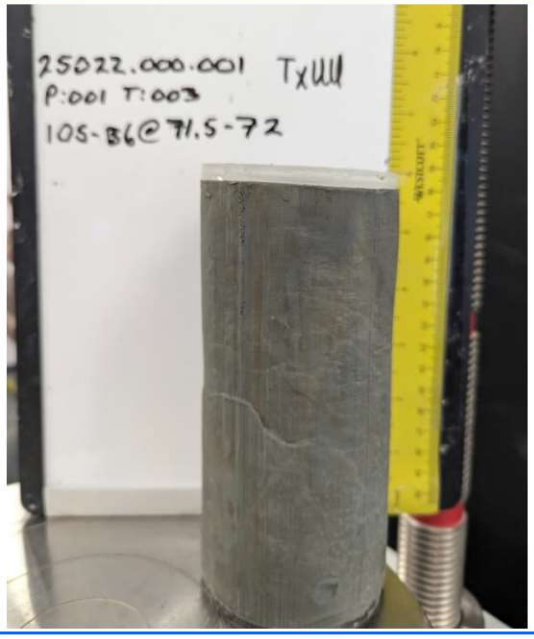
ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: K. Lecce
REVIEWED BY: V. Nunez

ISOTROPIC UNCONSOLIDATED UNDRAINED TRIAXIAL REPORT
ASTM D2850







ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry
PROJECT NO: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/30/2024
TESTED BY: K. Lecce
REVIEWED BY: V. Nunez

LABORATORY MINIATURE VANE SHEAR

ASTM D4648

APPARATUS USED: Wykeham Farrance, Model 27-WF1730/4

SAMPLE NUMBER	SAMPLE ID	Remold? (Y/N)	TEST DEPTH, ft	SPRING NUMBER	Shear strength, psf
1	1OS-B1@12-14	N	13.5-13.75	4	2245
2	1-B3@26-26.5	N	26.25	3	498

ENGEO
Expect Excellence

CLIENT: COWI North America, Inc.
PROJECT NAME: Berkeley Water Transportation Pier Ferry Project
PROJECT NUMBER: 25022.000.001 PH001 T003
PROJECT LOCATION: Berkeley, CA
REPORT DATE: 10/09/24
TESTED BY: G. Criste
REVIEWED BY: D. Seibold



APPENDIX E

CORROSION LABORATORY TESTING
(CERCO Analytical)

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

5 November, 2024

Job No. 2410076
Cust. No. 10169

Mr. Vlad Zasmolin
ENGEO Inc.
1630 San Pablo Ave Suite 200
Oakland, CA 94612

Subject: Project No.: 25022.000.001
Project Name: Berkeley Marina
Corrosivity Analysis – ASTM Test Methods

Dear Mr. Zasmolin:

Pursuant to your request, CERCO Analytical has analyzed the soil samples submitted on October 31, 2024. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurements, Sample No. 001 is classified as "severely corrosive". Sample No. 002 is classified as "corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentrations are none detected and 570 mg/kg. Chloride ion concentrations greater than 300 mg/kg are considered corrosive to embedded reinforcing steel; and, as such, the concrete mix design shall be adjusted accordingly by a qualified corrosion engineer.

The sulfate ion concentrations are 17 mg/kg and 97 mg/kg and are determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at these locations.

The pH of the soils are 6.86 and 8.00, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

The redox potentials are 200-mV and 270-mV. Both samples are indicative of potentially "slightly corrosive" soils resulting from anaerobic soil conditions.

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

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

Very truly yours,
CERCO ANALYTICAL, INC.

for

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

JDH/jdl
Enclosure

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

Client: ENGEO, Incorporated
Client's Project No.: 25022.000.001
Client's Project Name: Berkeley Marina
Date Sampled: 30-Oct-24
Date Received: 31-Oct-24
Matrix: Soil
Authorization: Chain of Custody

Date of Report: 5-Nov-2024

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)*	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
2410076-001	1-B2 (4.5'-5')	270	6.86	-	360	-	570	97
2410076-002	1-B3 (5.5-6')	200	8.00	-	760	-	N.D.	17

Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Reporting Limit:	-	-	-	-	-	15	15
Date Analyzed:	31-Oct-2024	1-Nov-2024	-	31-Oct-2024	-	1-Nov-2024	1-Nov-2024

Julia Clauson
Chemist

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

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

Chain of Custody

Page of

1100 Willow Pass Court
Concord, CA 94520-1005
925 462-2771
Fax: 925 462-2775
www.cercoanalytical.com

CERCO analytical

Job No.	CU#		Client Project I.D.	Schedule	Date Sampled	Date Due
24100776	13067		25022-000.001	Analyte	9/31/24	

Full Name Vlad Zasmolin **Phone** 510 9723585

Company and/or Mailing Address ENGEO Incorporated, 1630 San Pablo Ave, vzasmolin@engeo.com ☒ **Fax** **Cell**

Sample Source Berkeley Marina

vzasmolin@engeo.com

ANALYSIS — **ASTM w/Brief Evaluation**

Lab No.	Sample I.D.	Date	Time	Matrix	Contain.	Size	Preserv.	Qtv.	Redox Potential	pH	Sulfate	Chloride	Resistivity-100% Saturated		Brief Evaluation							
1	1-B2 (4.5-5')	10/30/24		S	Baggie			1	x	x	x	x	x		x							
2	1-B3 (5.5-6')	10/30/24		S	Liner			1	"	"	"	"	"		"							

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

Comments:
THERE IS AN ADDITIONAL CHARGE FOR EXTRUDING SOIL FROM TUBES

Relinquished By:	GLS	Date	Time
Received By:	Julia Cl	Date 10/31/24	Time 1000
Relinquished By:		Date	Time
Received By:		Date	Time
Relinquished By:		Date	Time
Received By:		Date	Time

Email Address 23



APPENDIX F

DISCUSSION OF SITE-SPECIFIC SEISMIC-HAZARD ANALYSIS

Site-Specific Seismic-Hazard Analysis

We performed a site-specific seismic-hazard analysis in accordance with ASCE 61-14 and ASCE 7-05 to develop response spectra for the seismic hazard and performance levels discussed in Section 3.4.2.

We performed the following tasks to develop the Maximum Considered Earthquake (MCE) and Design Earthquake (DE) response spectra for this site.

- Performed probabilistic seismic-hazard analysis (PSHA) to develop a median-component (RotD50) uniform hazard response spectrum (UHS) corresponding to a 2-percent probability of exceedance in 50 years (2,475 year return period)
- Performed deterministic seismic-hazard analysis (DSHA) to develop a response spectrum equal to 150 percent of the largest 50th-percentile RotD50 response spectrum
- Compared the DSHA response spectrum with the deterministic lower limit in accordance with Section 21.2.2 of ASCE 7-05.
- Compared the probabilistic and the deterministic response spectra to obtain the site-specific MCE response spectrum for the site
- Compared the MCE response spectrum developed in the previous step with 80 percent of the general MCE response spectrum to develop the recommended site-specific MCE response spectrum
- Multiplied the site-specific MCE response spectrum by two-thirds to obtain the site-specific Design Earthquake (DE) response spectrum for the site

As required by ASCE 61-14, we developed additional RotD50 response spectra based on the Operating level earthquake (OLE) and Contingency Level Earthquake (CLE) hazard levels corresponding to a 50-percent probability of exceedance in 50 years (72-year return period) and a 20-percent probability of exceedance in 50 years (225-year return period) or a 10-percent probability of exceedance in 50 years (475-year return period), respectively.

Seismic Source Model

We utilized the 2018 National Seismic Hazard Model (NSHM), as implemented in the United States Geological Survey *nshmp-haz* software. The 2018 NSHM is the most current and publicly available rupture forecast model for the conterminous United States and, as such, is required by ASCE 61-14 and ASCE 7-05. The 2018 NSHM incorporates the Third California Earthquake Rupture Forecast model or UCERF3 (Field et al. 2014 and 2015) for California sources and seismicity rates. Background seismicity, modeled as gridded point sources, is also included in the model. The implementation of the 2018 NSHM in seismic-hazard codes considers many sources of epistemic uncertainty regarding alternate rupture scenarios, maximum magnitudes for individual faults, and alternate magnitude-recurrence relations. This uncertainty affects the mean hazard that is provided by hazard codes implementing the 2018 NSHM and is used in typical applications, including this analysis.

Ground-Motion Models and Site Parameters

We used four semi-empirical ground-motion models (GMMs) from the Next Generation Attenuation West 2 (NGA West 2) project (Ancheta et al., 2014) to estimate ground motion for shallow crustal sources included within the 2018 NSHM. These models include Abrahamson et

al. (2014) [ASK], Boore et al. (2014) [BSSA], Campbell and Bozorgnia (2014) [CB], and Chiou and Youngs (2014) [CY]. We performed our analysis using all four GMMs for a spectral damping of 5 percent of critical damping. We used a logic-tree approach and assigned equal weight (0.25) to each of the four GMMs in our analysis. Other ground-motion models are considered for different source types within the seismic source model, such as subduction sources; however, the contributions from these sources are negligible at the project site for the return periods considered due their large source-to-site distances.

The ground-motion models incorporate "site parameters" to model how subsurface soil will amplify or attenuate ground motions as they propagate from the bedrock below. For the GMMs we implemented, these site parameters include the following.

- Time-averaged shear-wave velocity (V_S) over the top 100 feet or 30 meters (V_{S30})
- Depth at which V_S reaches 3,280 feet/sec or 1.0 kilometer/sec ($z_{1.0}$)
- Depth at which V_S reaches 8,200 feet/sec or 2.5 kilometers/sec ($z_{2.5}$)

We estimated a V_{S30} value of 690feet/sec (210 meters/sec) based on the measured and correlated V_S profiles from the CPTs. To estimate $z_{1.0}$ and $z_{2.5}$, we used the USGS Bay Area Velocity Model version 8.3.0 Basin Depth models, as implemented in the USGS Site Data Application available through OpenSHA. We applied $z_{1.0}$ and $z_{2.5}$ values of 311 and 2,789 feet (95 and 860 meters) in our analysis, respectively.

Directivity Effects

Directivity effects can increase long-period ground motions at near-fault sites (Somerville et al., 1997; Abrahamson 2000). We used the period-dependent models by Chiu and Spudich (2013), Bayless and Somerville (2013), and Bayless et al. (2020) to consider directivity effects, as implemented in the Natural Hazard and Resiliency Research Center (NHR3) directivity based PSHA interactive tool (Mazzoni et al., 2023), to estimate the period dependent directivity factors for return periods of 2,475, 475, 225, and 72 years. We calculated a weighted mean of the directivity factors obtained from these models with weights of 0.5, 0.25, and 0.25, respectively, as recommended by NHR3.

Probabilistic Seismic-Hazard Analysis

We performed a PSHA for the project site to develop a set of hazard curves and resulting uniform hazard response spectra (UHS) for return periods of 72, 225, 475, and 2,475 years. We calculated the seismic hazard using the standard methodology for hazard analysis (McGuire, 2004). The seismic-hazard calculations can be represented by the following equation, which is an application of the total-probability theorem.

$$H(a) = \sum_{i}^{n} v_i \iint P[A > a|m,r]\, f_{Mi}(\mathrm{m})\, f_{Ri|Mi}(\mathrm{r},\mathrm{m})\, dr dm$$

In this equation, the hazard **H*(a)*** is the annual frequency of earthquakes that produce a ground motion amplitude ***A*** higher than ***a***. Amplitude ***A*** may represent peak ground acceleration, velocity, or pseudo-spectral acceleration (PSa) at a given frequency. The summation in the equation shown extends over all sources (i.e., over all faults and areas). In the above equation, $\boldsymbol{v_i}$ is the annual rate of earthquakes (with magnitude higher than some threshold $\boldsymbol{M_i}$) in source ***i***, and $\boldsymbol{f_{Mi}(m)}$

and $f_{Ri|Mi}(r,m)$ are the probability density functions for magnitude and distance, respectively. $P[A > a|m, r]$ is the probability that an earthquake of magnitude m at distance r produces a ground-motion amplitude A at the site that is greater than a. Seismic sources may be either faults or background sources; the specification of source geometries and the calculation of $f_{Ri|Mi}$, are performed differently for these two types of sources.

We present the median component (RotD50) hazard curves for the equally weighted mean of all GMMs and the combined branches of UCERF3 (FM3.1 and FM3.2) in Figure 1. We used the hazard curves to calculate the mean RotD50 uniform hazard response spectra for return periods of 72, 225, 475, and 2,475 years. We additionally applied the directivity adjustment factors from the NHR3 tool. We present the uniform hazard response spectra in Figure 2.

Disaggregation of the Seismic Hazard

We performed a disaggregation of the seismic hazard associated with the 72-year, 225-year, 475-year, and 2,475-year return periods at the peak ground acceleration (PGA), and for spectral periods of 0.5, 1.0 and 2.0 seconds. We present the resulting faults and their respective contributions to the seismic hazard at the site for each return period considered in Tables F-1 through F-4.

TABLE F-1: Summary of Disaggregation Results for a 72-Year Return Period*

SOURCE	R_{RUP}		M_W	CONTRIBUTION (%)			
	Km	miles		PGA	0.5 sec	1.0 sec	2.0 sec
Hayward (North) [2]	6.3	3.9	7.1	10.0	9.9	10.5	11.0
San Andreas (Peninsula) [13]	25.0	15.5	7.9	5.3	5.6	6.4	7.5
Calaveras (North) [0]	24.0	14.9	7.0	1.8	1.9	2.0	2.1
San Gregorio (North) [3]	28.4	17.6	7.7	1.5	1.6	1.8	2.1
Concord [2]	28.1	17.5	6.5	1.3	1.5	1.4	1.1
Hayward (South) [7]	15.6	9.7	6.8	1.3	1.3	1.4	1.4
Hayward (South) [6]	21.2	13.2	6.7	1.1	1.2	1.2	1.2
Franklin [2]	18.4	11.4	7.1	1.0	1.1	1.2	1.2
Mount Diablo [2] (3)	26.7	16.6	7.0	<1.0	1.1	1.1	1.1
Hayward (South) [5]	28.7	17.8	6.8	<1.0	<1.0	1.0	<1.0

*Based on the USGS Earthquake Hazard Toolbox: NSHM Conterminous U.S. 2018

TABLE F-2: Summary of Disaggregation Results for a 225-Year Return Period*

SOURCE	R_{RUP}		M_W	CONTRIBUTION (%)			
	km	miles		PGA	0.5 sec	1.0 sec	2.0 sec
Hayward (North) [2]	6.3	3.9	7.2	17.1	17.1	19.1	20.4
San Andreas (Peninsula) [13]	25.0	15.5	7.9	5.8	1.7	7.7	9.4
Calaveras (North) [0]	24.0	14.9	7.1	1.5	1.7	1.7	1.6
San Gregorio (North) [3]	28.4	17.6	7.7	1.4	1.4	1.9	2.2
Hayward (South) [7]	15.6	9.7	6.8	1.3	1.2	1.4	1.3
Franklin [2]	18.4	11.4	7.2	1.1	1.2	1.2	1.2
Hayward (north) [3]	6.5	4.0	6.9	1.1	1.0	1.1	1.1

*Based on the USGS Earthquake Hazard Toolbox: NSHM Conterminous U.S. 2018

TABLE F-3: Summary of Disaggregation Results for a 475-Year Return Period*

SOURCE	R_{RUP}		M_W	CONTRIBUTION (%)			
	km	miles		PGA	0.5 sec	1.0 sec	2.0 sec
Hayward (North) [2]	6.3	3.9	7.2	21.1	21.1	24.2	25.8
San Andreas (Peninsula) [13]	25.0	15.5	7.9	5.6	6.7	7.6	9.2
Calaveras (North) [0]	24.0	14.9	7.1	1.3	1.3	1.4	1.1
San Gregorio (North) [3]	28.4	17.6	7.7	1.2	1.5	1.7	1.9
Hayward (North) [3]	6.5	4.0	6.8	1.2	1.2	1.3	1.2
Hayward (South) [7]	15.6	9.8	6.8	1.2	1.3	1.3	<1.0
Franklin [2]	18.4	11.4	7.2	<1.0	1.1	1.1	1.1

*Based on the USGS Earthquake Hazard Toolbox: NSHM Conterminous U.S. 2018

TABLE F-4: Summary of Disaggregation Results for a 2,475-Year Return Period*

SOURCE	R_{RUP}		M_W	CONTRIBUTION (%)			
	km	miles		PGA	0.5 sec	1.0 sec	2.0 sec
Hayward (North) [2]	6.3	3.9	7.3	56.7	57.7	66.2	69.4
San Andreas (Peninsula) [13]	25.0	15.5	8.0	9.3	12.1	12.2	14.2
Hayward (North) [3]	6.5	4.1	7.0	3.0	2.9	3.1	2.8
Hayward (North) [1]	7.2	4.5	6.9	2.1	2.1	2.1	< 1.0
San Gregorio (North) [3]	28.4	17.7	7.8	<1.0	2.4	2.2	1.0

*Based on the USGS Earthquake Hazard Toolbox: NSHM Conterminous U.S. 2018

These results represent known fault sources contributing at least 1 percent to the seismic hazard at the site for at least one of the spectral periods considered and for the given return period. Background seismicity zones, such as gridded or areal sources, are not presented. The rupture distances (R_{RUP}) and mean moment magnitude (M_W) values listed are based on values assigned according to the 2018 NSHM and UCERF3, and the bracketed numbers after each fault name correspond to fault subsections assigned by the 2018 NSHM and UCERF3. Magnitudes vary slightly between the two fault models (FM 3.1 and 3.2) utilized by the 2018 NSHM and UCERF3 and from one spectral period to another. Therefore, for each source we present the maximum mean magnitude of the spectral periods considered where that source contributes significantly to the hazard. Note that the above fault tables are not exhaustive lists and other faults in the region may generate seismic shaking at the project site.

Deterministic Seismic-Hazard Analysis

The DSHA involves developing the 50th-percentile median component (RotD50) response spectrum for a spectral damping of 5 percent of critical damping considering the characteristic magnitudes of significant faults, without background seismicity, and utilizing the ground-motion models previously discussed. However, the definition of the characteristic magnitude is ambiguous when using the UCERF3 model due to its complexity. Based on the 2020 NEHRP Provisions and ASCE/SEI 7-22, in deterministic analyses, “scenario” earthquakes with significant contribution to hazard should be used in lieu of “characteristic” earthquakes when using the 2018 NSHM and UCERF3. We identified the scenario earthquakes by considering the disaggregation of the PSHA results in Table F-4.

We considered the magnitudes in Table F-4 and associated distances (R_{RUP}, R_{JB}, R_X) to calculate the median deterministic response spectra. We estimated additional ground-motion model parameters (e.g., rupture width, depth to top of rupture, etc.) for each fault/scenario based on the UCERF3 model and fault-specific information published by the United States Geologic Survey (USGS). The DSHA is predominantly controlled by the Hayward (North) [2] fault with a M_W of 7.3 within 3.9 miles (6.3 kilometers) of the site. Similar to the probabilistic response spectrum, we applied the directivity adjustment factors from the NHR3 tool.

We scaled the spectral ordinates of the deterministic response spectra by 150 percent and compared the maximum of the median deterministic response spectra with the deterministic lower limit in accordance with Section 21.2.2 of ASCE 7-05. Per Section 21.2.2, the maximum PSa of the deterministic response spectrum shall not be less than the lower limit determined in accordance with Figure 21.2-1 of ASCE 7-05. In computing the lower-limit, the short-period site coefficient (F_a) is determined using Table 11.4-1 of ASCE 7-05 for an S_S value of 1.5 and the long-period site coefficient (F_v) is determined using Table 11.4-2 of ASCE 7-05 for an S_1 value of 0.6. For this site, the maximum of the deterministic response spectra is less than the deterministic lower limit across most spectral periods. We present the deterministic response spectra in Figure 3.

Resulting Ground Surface Response Spectra

According to Section 21.2.3 of ASCE 7-05, the MCE is controlled by the lesser of the probabilistic and the deterministic response spectra. At this site, the spectral accelerations associated with the deterministic response spectrum are generally lower than the probabilistic response spectrum, except for the period range of 0.01 to 0.12 second where the spectral accelerations associated with the probabilistic response spectrum are lower. Additionally, the MCE is not permitted to be lower than 80 percent of the associated general response spectrum for Site Class D (i.e., the code minimum). Finally, we calculated the DE response spectrum by taking two-thirds of the MCE response spectrum.

We present the site-specific OLE, CLE, DE, and MCE response spectra in Table F-5 and Figure 4.

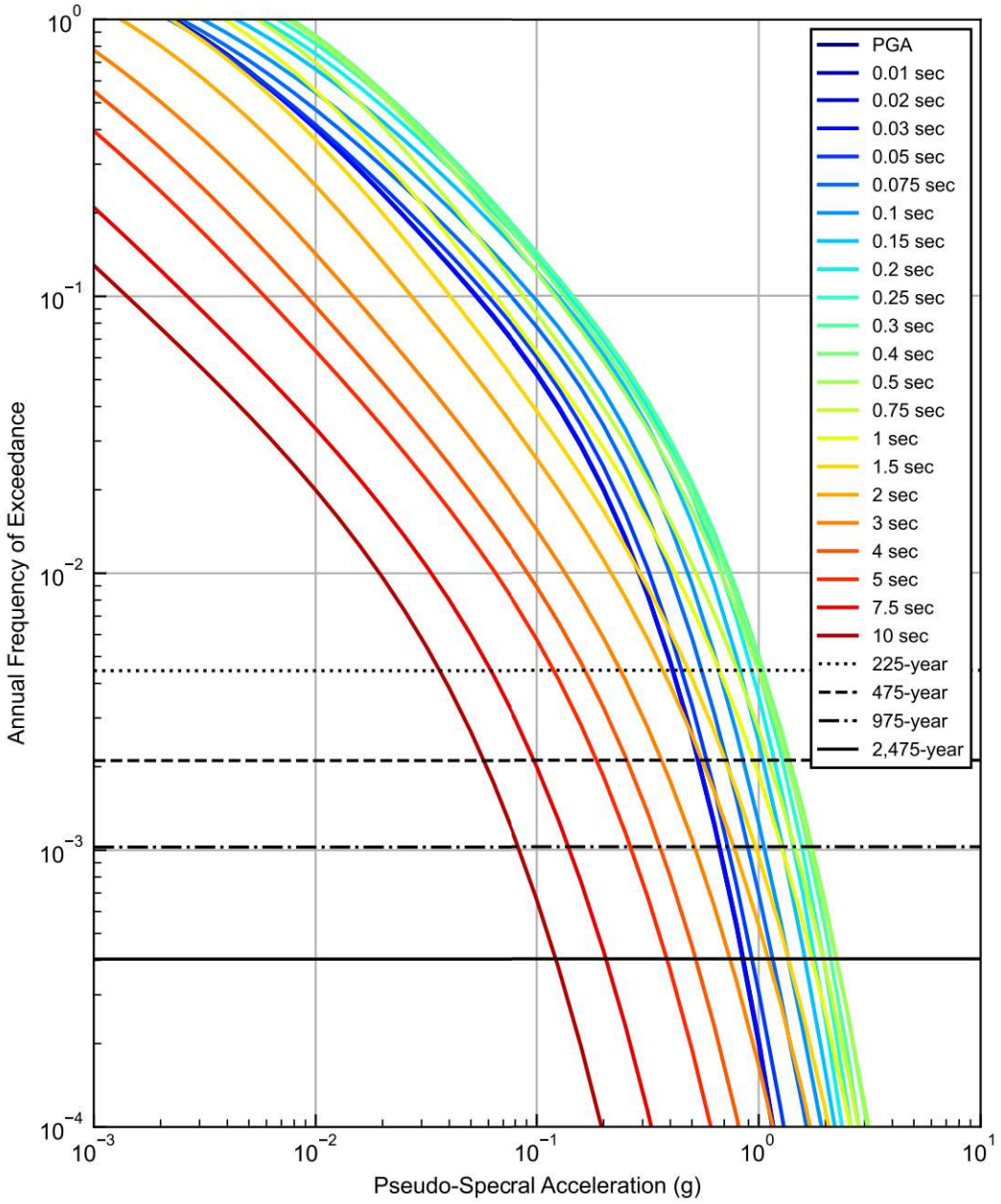
TABLE F-5: Site-Specific OLE, CLE, DE, and MCE Response Spectra

PERIOD (seconds)	PSEUDO-SPECTRAL ACCELERATION (g)				
	OLE (72-year)	CLE (225-year)	CLE (475-year)	DE (ASCE7-05)	MCE (ASCE 7-05)
0.01	0.25	0.41	0.54	0.57	0.85
0.02	0.24	0.41	0.53	0.57	0.85
0.03	0.25	0.41	0.53	0.56	0.85
0.05	0.27	0.45	0.58	0.62	0.93
0.08	0.34	0.55	0.72	0.77	1.16
0.10	0.41	0.66	0.85	0.91	1.36
0.12	0.46	0.73	0.93	0.98	1.47
0.15	0.52	0.82	1.05	1.00	1.50
0.20	0.58	0.93	1.18	1.00	1.50
0.25	0.62	1.00	1.28	1.00	1.50
0.30	0.63	1.05	1.35	1.00	1.50
0.40	0.60	1.04	1.38	1.00	1.50

PERIOD (seconds)	PSEUDO-SPECTRAL ACCELERATION (g)				
	OLE (72-year)	CLE (225-year)	CLE (475-year)	DE (ASCE7-05)	MCE (ASCE 7-05)
0.50	0.57	1.01	1.35	1.00	1.50
0.60	0.51	0.93	1.25	1.00	1.50
0.75	0.43	0.81	1.13	0.80	1.20
1.00	0.35	0.70	1.00	0.60	0.90
1.50	0.24	0.51	0.75	0.42	0.63
2.00	0.18	0.40	0.60	0.32	0.47
3.00	0.11	0.26	0.40	0.20	0.30
4.00	0.07	0.18	0.29	0.15	0.23
5.00	0.05	0.13	0.21	0.12	0.18
7.50	0.03	0.07	0.11	0.08	0.12
8.00	0.02	0.06	0.10	0.08	0.11
10.00	0.02	0.04	0.06	0.06	0.09

We estimated the site-specific MCE peak ground acceleration (PGA) to be 0.85 g. The PGA is a median component (RotD50) value and probabilistically controlled.

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

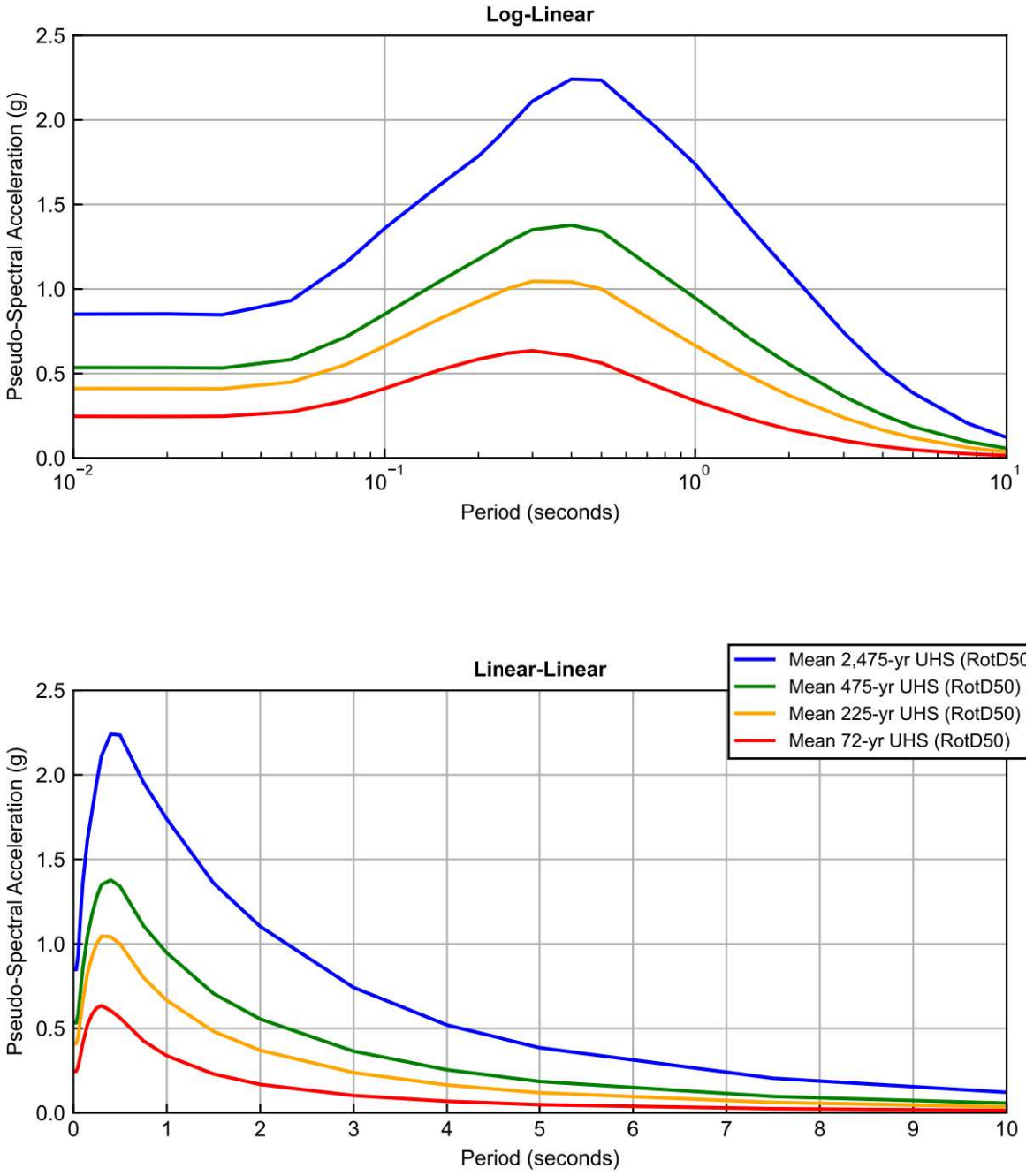


ENGEO Expect Excellence

MEAN ROTD50 HAZARD CURVES
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NO: 25022.000.001		FIGURE NO. 1
SCALE: AS SHOWN		
DRAWN BY: VZ	CHECKED BY: JF	

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

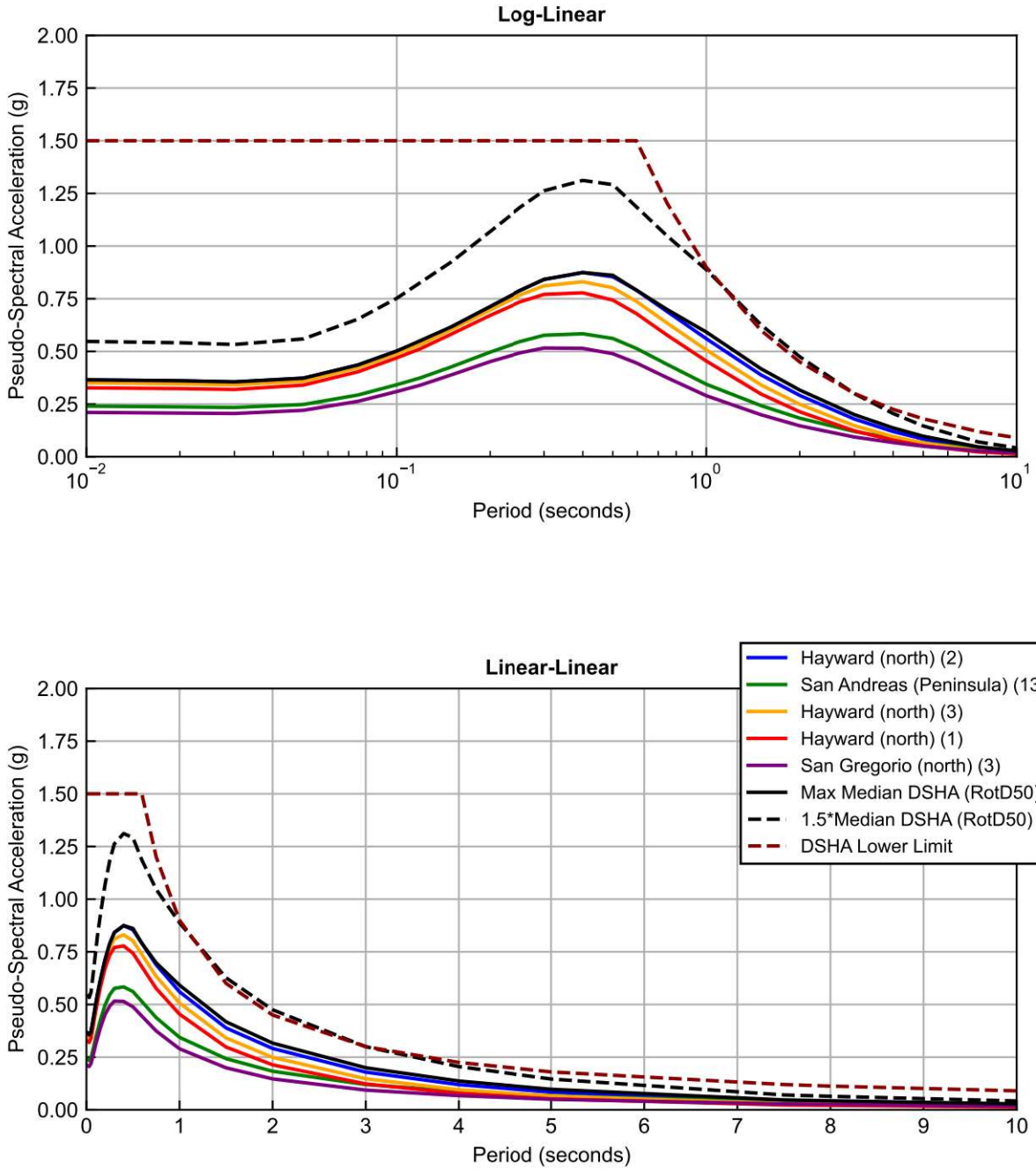


ENGEO Expect Excellence

MEAN UNIFORM HAZARD RESPONSE SPECTRA
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NO: 25022.000.001		FIGURE NO. 2
SCALE: AS SHOWN		
DRAWN BY: VZ	CHECKED BY: JF	

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.

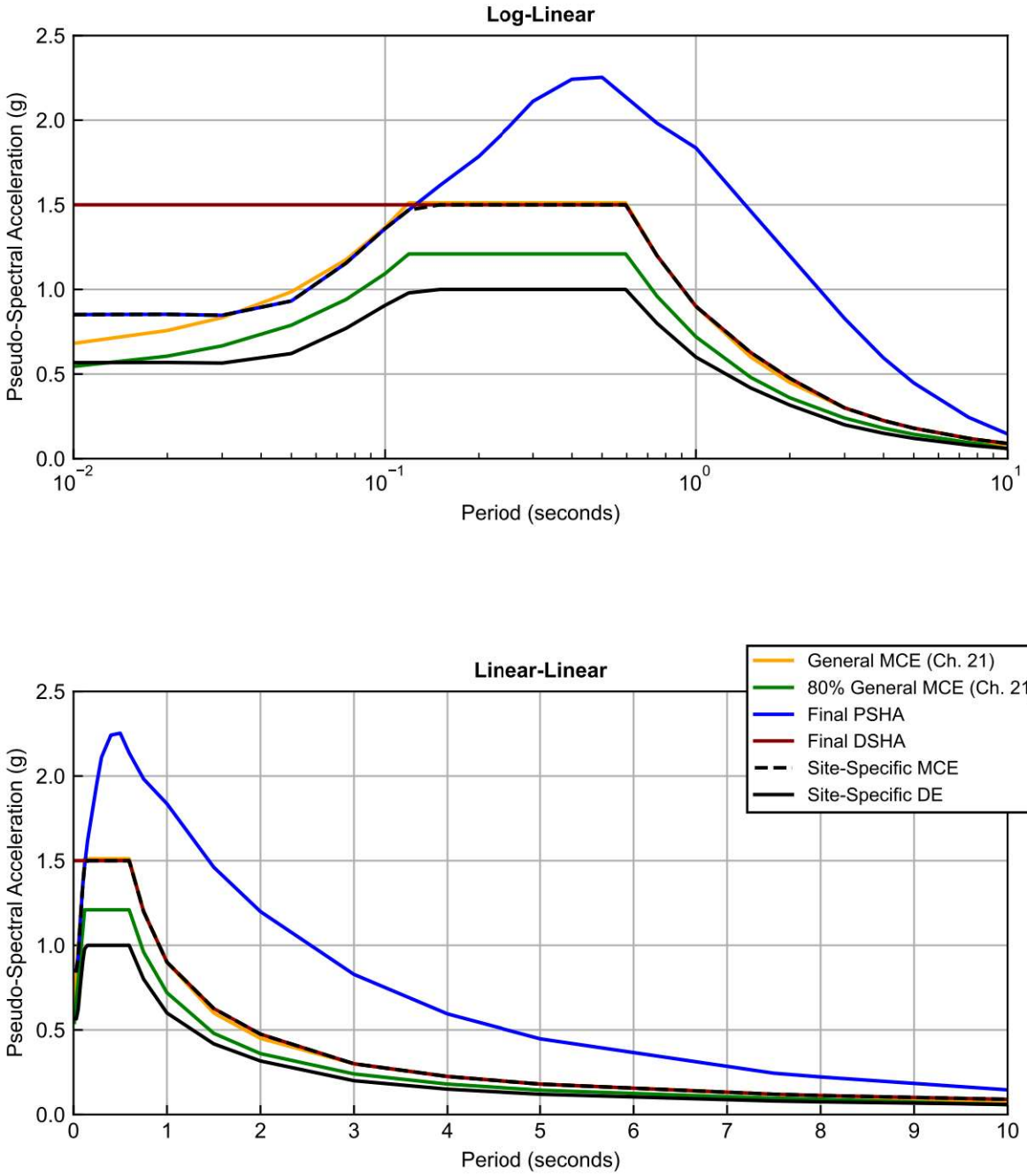


ENGEO Expect Excellence

DETERMINISTIC RESPONSE SPECTRA
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NO: 25022.000.001		FIGURE NO. 3
SCALE: AS SHOWN		
DRAWN BY: VZ	CHECKED BY: JF	

COPYRIGHT © 2024 BY ENGEO INCORPORATED. THIS DOCUMENT MAY NOT BE REPRODUCED IN WHOLE OR IN PART BY ANY MEANS WHATSOEVER, NOR MAY IT BE QUOTED OR EXCERPTED WITHOUT THE EXPRESS WRITTEN CONSENT OF ENGEO INCORPORATED.



ENGEO Expect Excellence

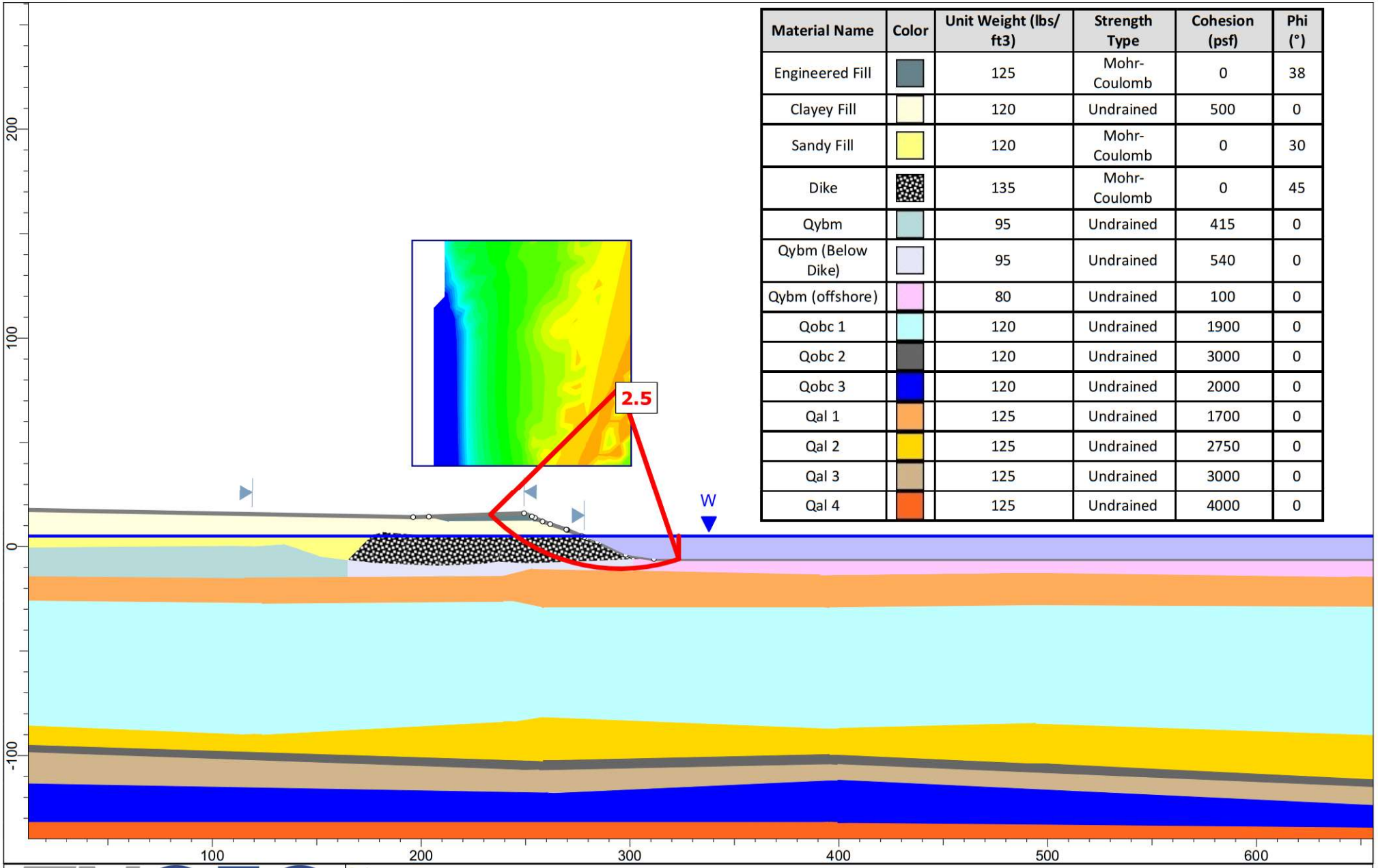
SITE-SPECIFIC RESPONSE SPECTRA
BERKELEY WATER TRANSPORTATION PIER FERRY
BERKELEY, CALIFORNIA

PROJECT NO: 25022.000.001		FIGURE NO. 4
SCALE: AS SHOWN		
DRAWN BY: VZ	CHECKED BY: JF	



APPENDIX G.1

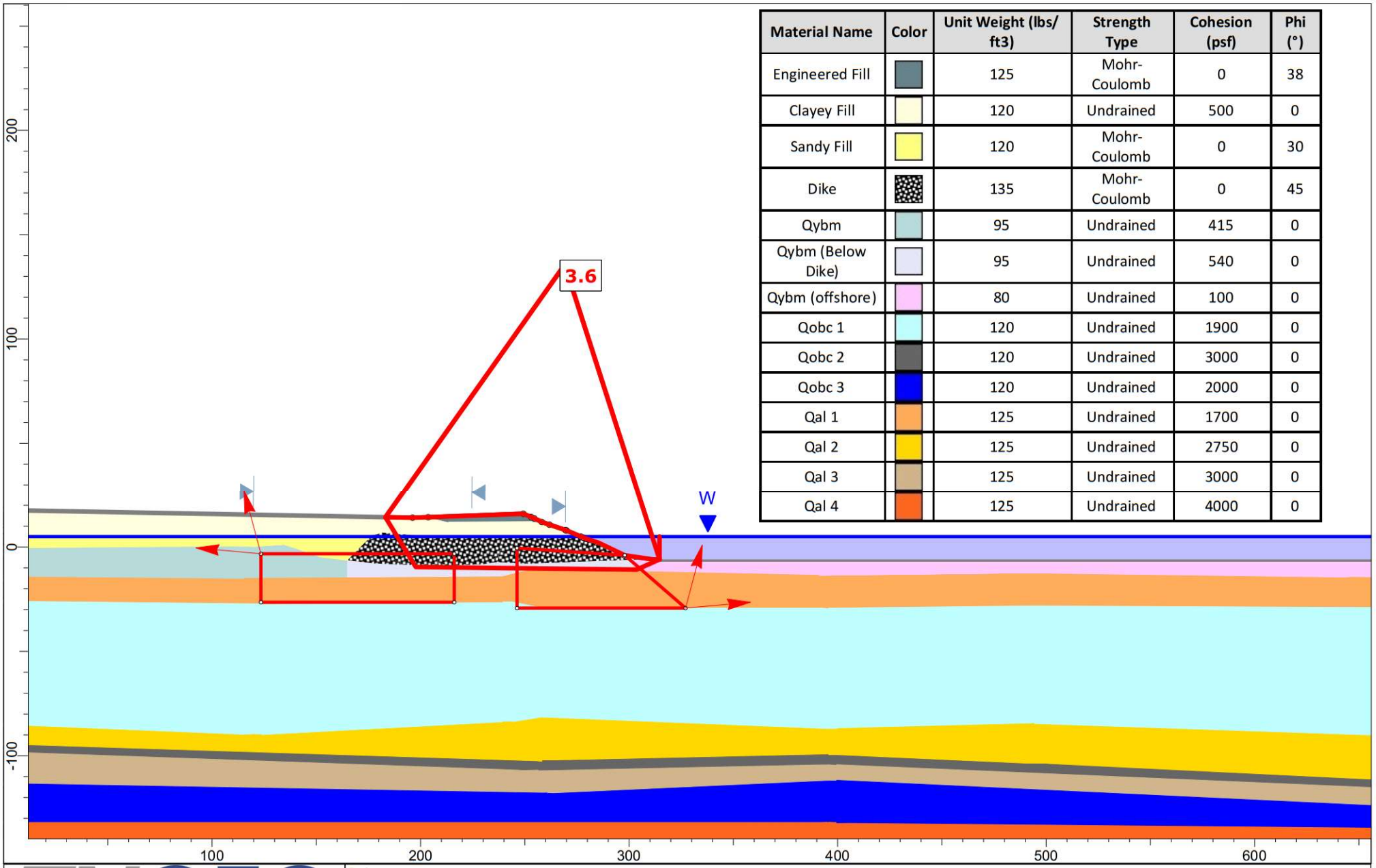
SLOPE STABILITY ANALYSIS – EXISTING SLOPE



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Sandy Fill		120	Mohr-Coulomb	0	30
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	415	0
Qybm (Below Dike)		95	Undrained	540	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

ENGEO
Expect Excellence

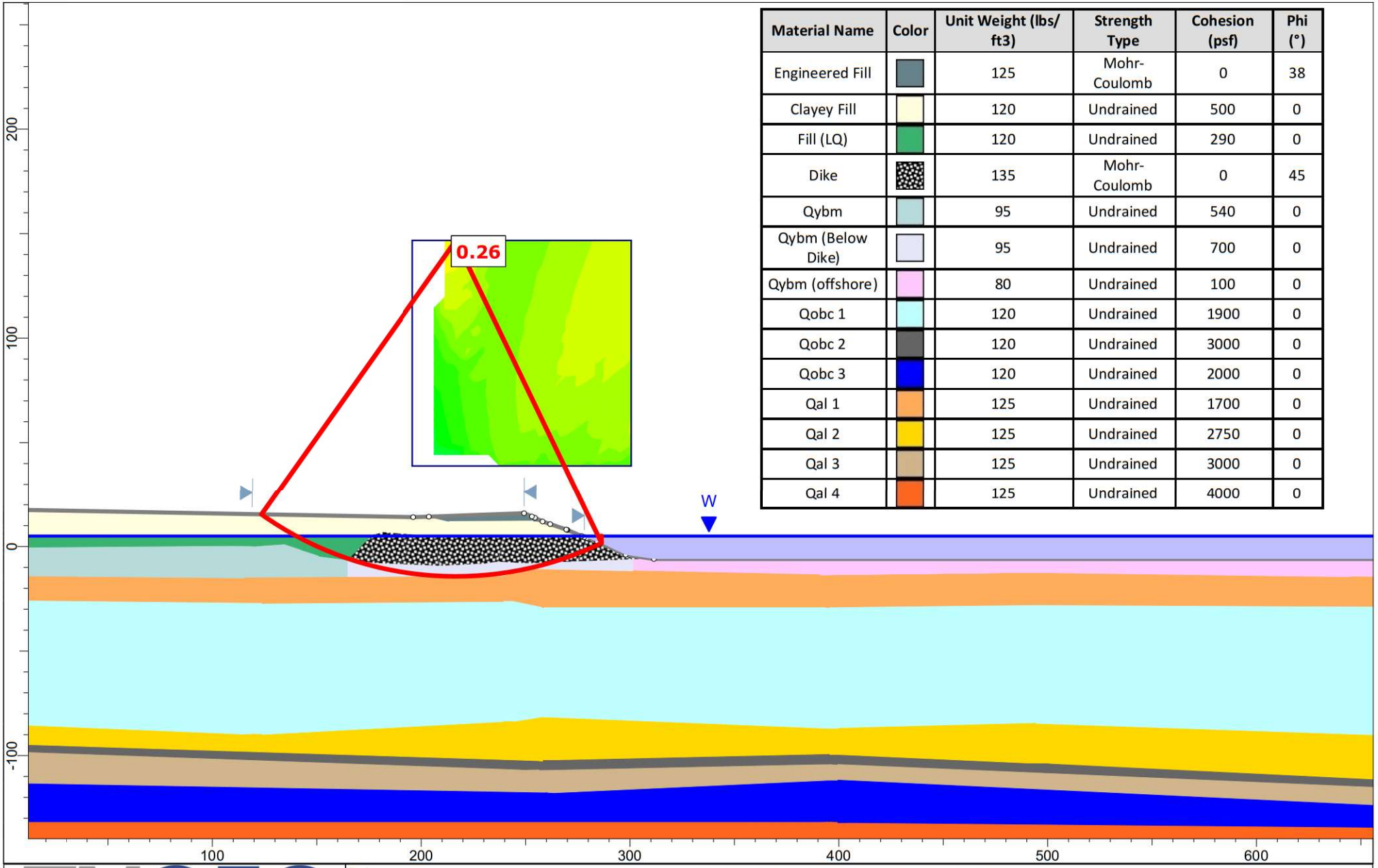
Project: Berkeley Water Transportation Pier Ferry			
Scale: 1:750	Author: VZ/JF	Project No.: 25022.000.001	
Date: 5/28/2025	Condition: Factor of Safety for Circular Failure Surface Near Waterside Slope Face		



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Sandy Fill		120	Mohr-Coulomb	0	30
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	415	0
Qybm (Below Dike)		95	Undrained	540	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

ENGEO
Expect Excellence

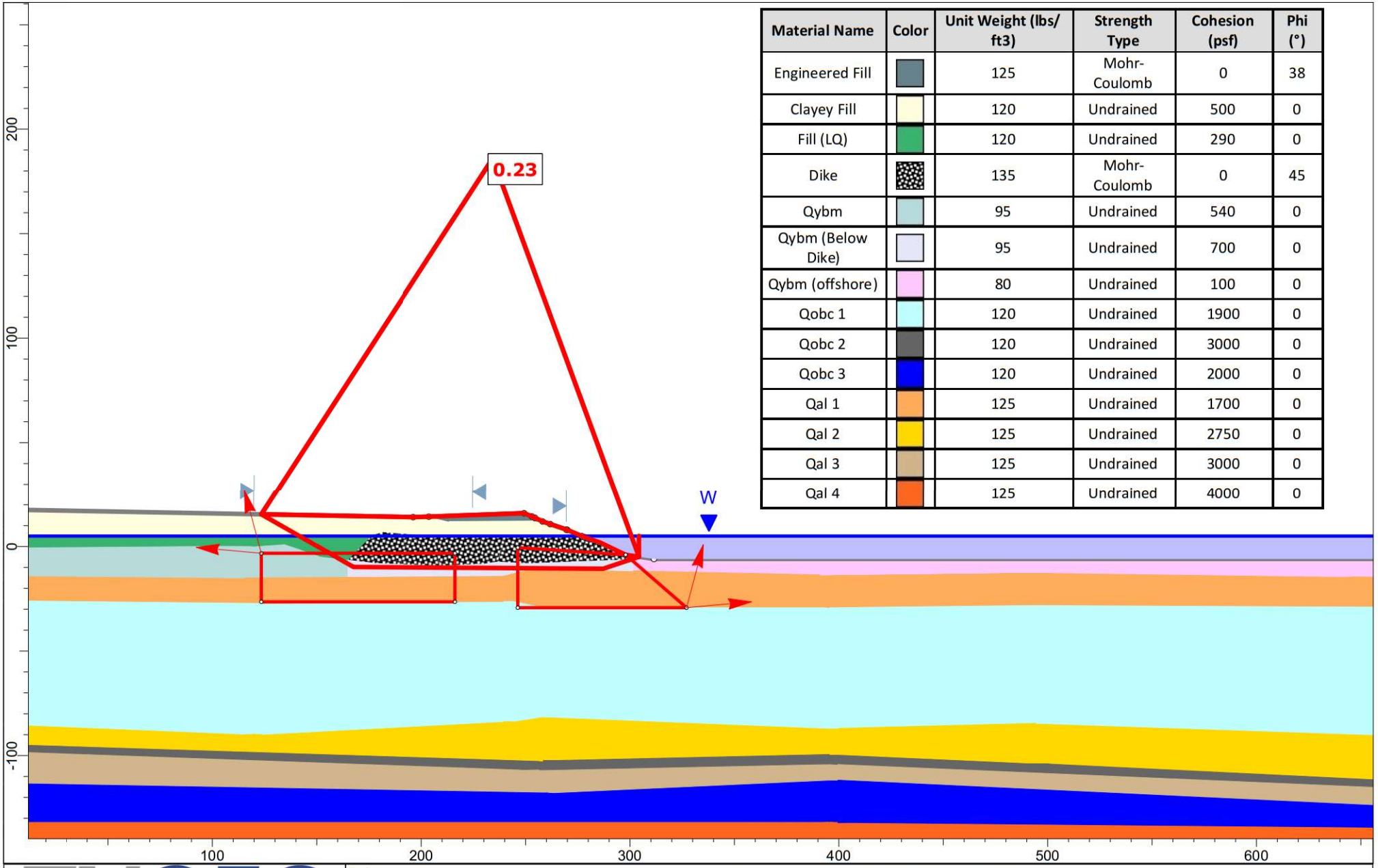
Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750		*Author* VZ/JF	*Project No.* 25022.000.001
Date 5/28/2025		*Condition* Factor of Safety for Block Failure Surface Near Waterside Slope Face	



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Below Dike)		95	Undrained	700	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

ENGEO
Expect Excellence

Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750		*Author* VZ/JF	*Project No.* 25022.000.001
Date 5/28/2025		*Condition* Yield Acceleration for Circular Failure Surface Near Waterside Slope Face	



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Below Dike)		95	Undrained	700	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

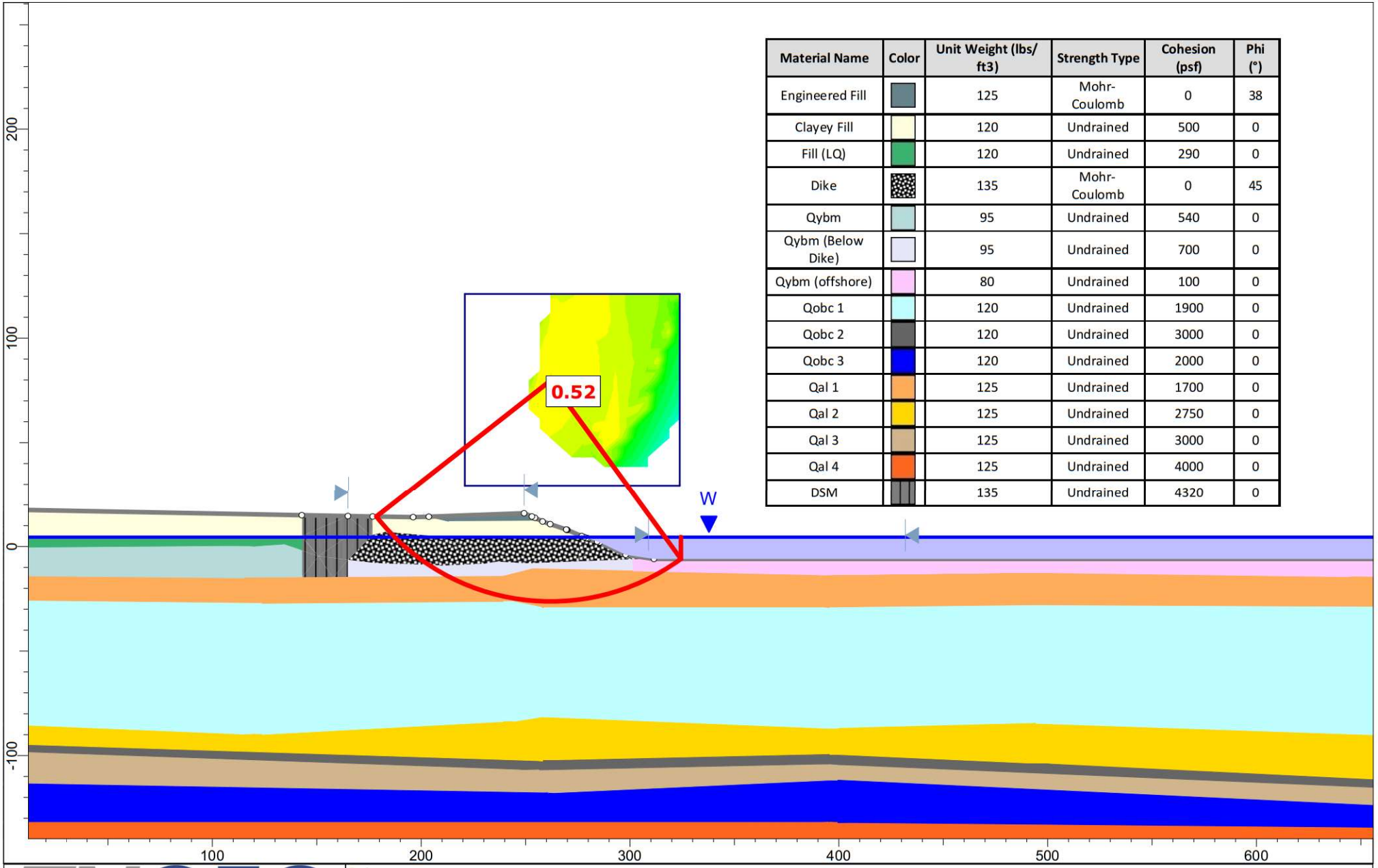
ENGEO
Expect Excellence

Project: Berkeley Water Transportation Pier Ferry			
Scale: 1:750	Author: VZ/JF	Project No.: 25022.000.001	
Date: 5/28/2025	Condition: Yield Acceleration for Block Failure Surface Near Waterside Slope Face		



APPENDIX G.2

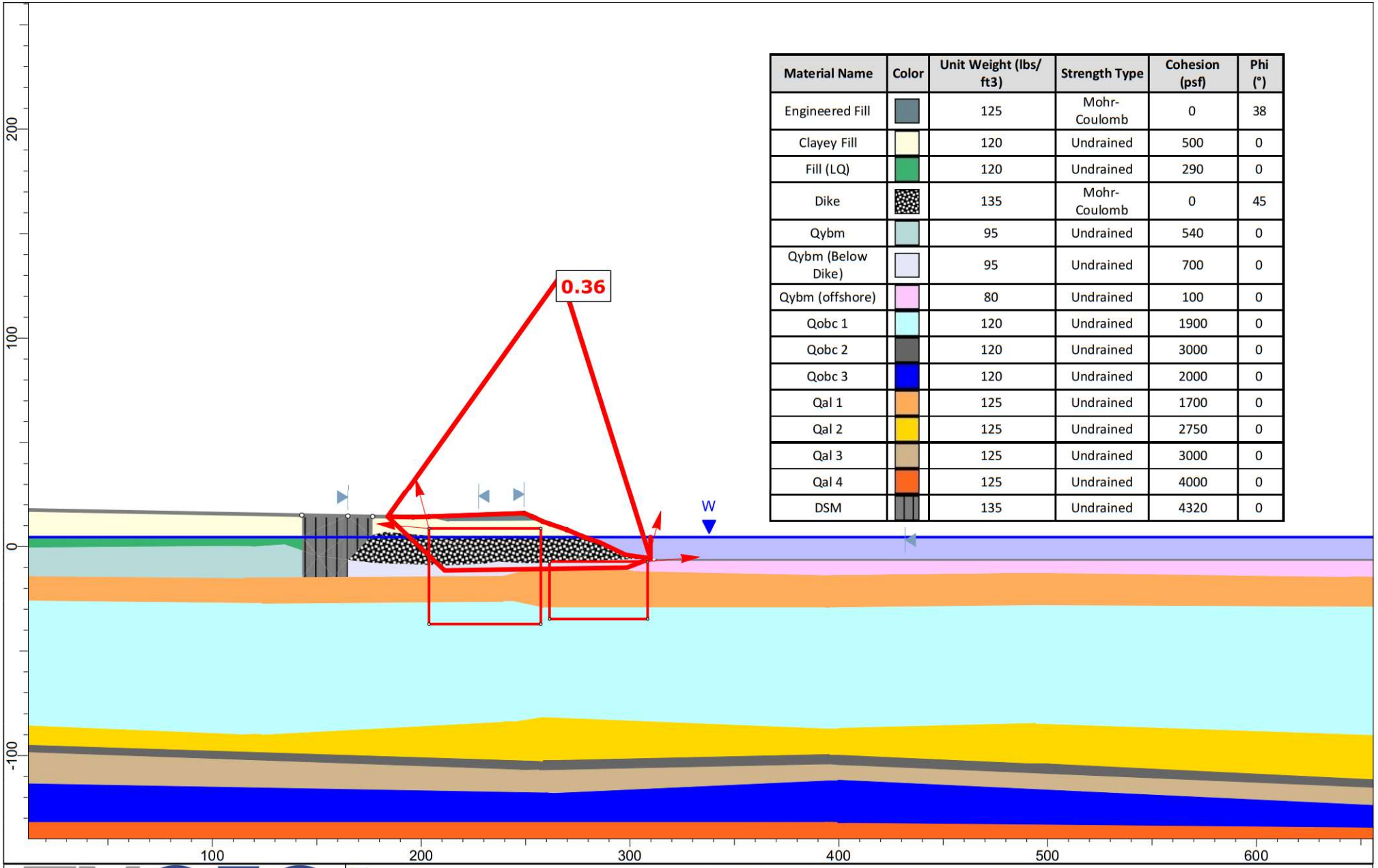
SLOPE STABILITY ANALYSIS – DEEP SOIL MIXING



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Below Dike)		95	Undrained	700	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0
DSM		135	Undrained	4320	0

ENGEO
Expect Excellence

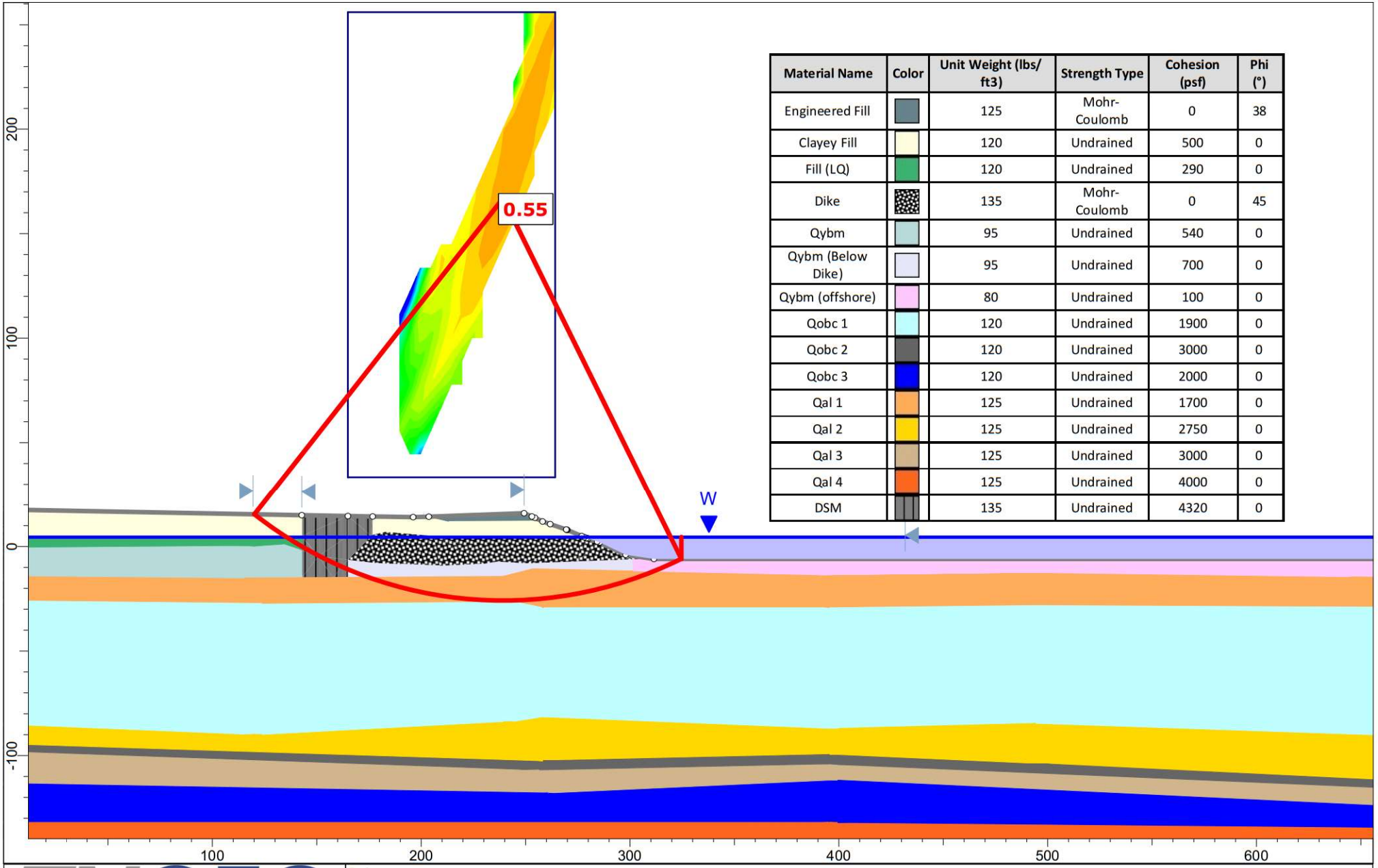
Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750		*Author* VZ/JF	*Project No.* 25022.000.001
Date 5/28/2025		*Condition* Yield Acceleration for Circular Failure Surface in Front of the DSM Ground Improvement	



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Below Dike)		95	Undrained	700	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0
DSM		135	Undrained	4320	0

ENGEO
Expect Excellence

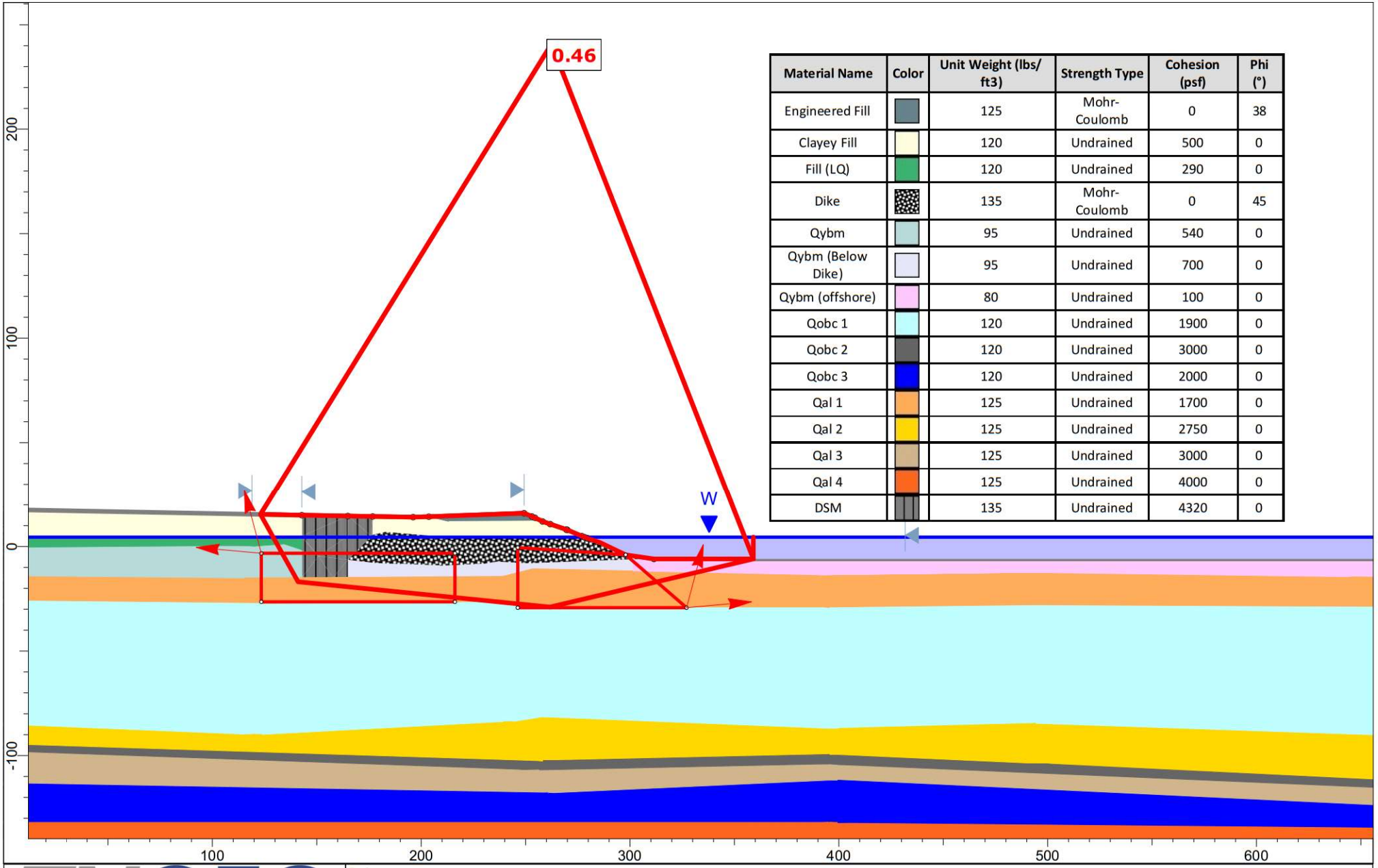
Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750	*Author* VZ/JF	*Project No.* 25022.000.001	
Date 5/28/2025	*Condition* Yield Acceleration for Block Failure Surface in Front of the DSM Ground Improvement		



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Below Dike)		95	Undrained	700	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0
DSM		135	Undrained	4320	0

ENGEO
Expect Excellence

Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750	*Author* VZ/JF	*Project No.* 25022.000.001	
Date 5/28/2025	*Condition* Yield Acceleration for Circular Failure Surface Behind the DSM Ground Improvement		



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Below Dike)		95	Undrained	700	0
Qybm (offshore)		80	Undrained	100	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0
DSM		135	Undrained	4320	0

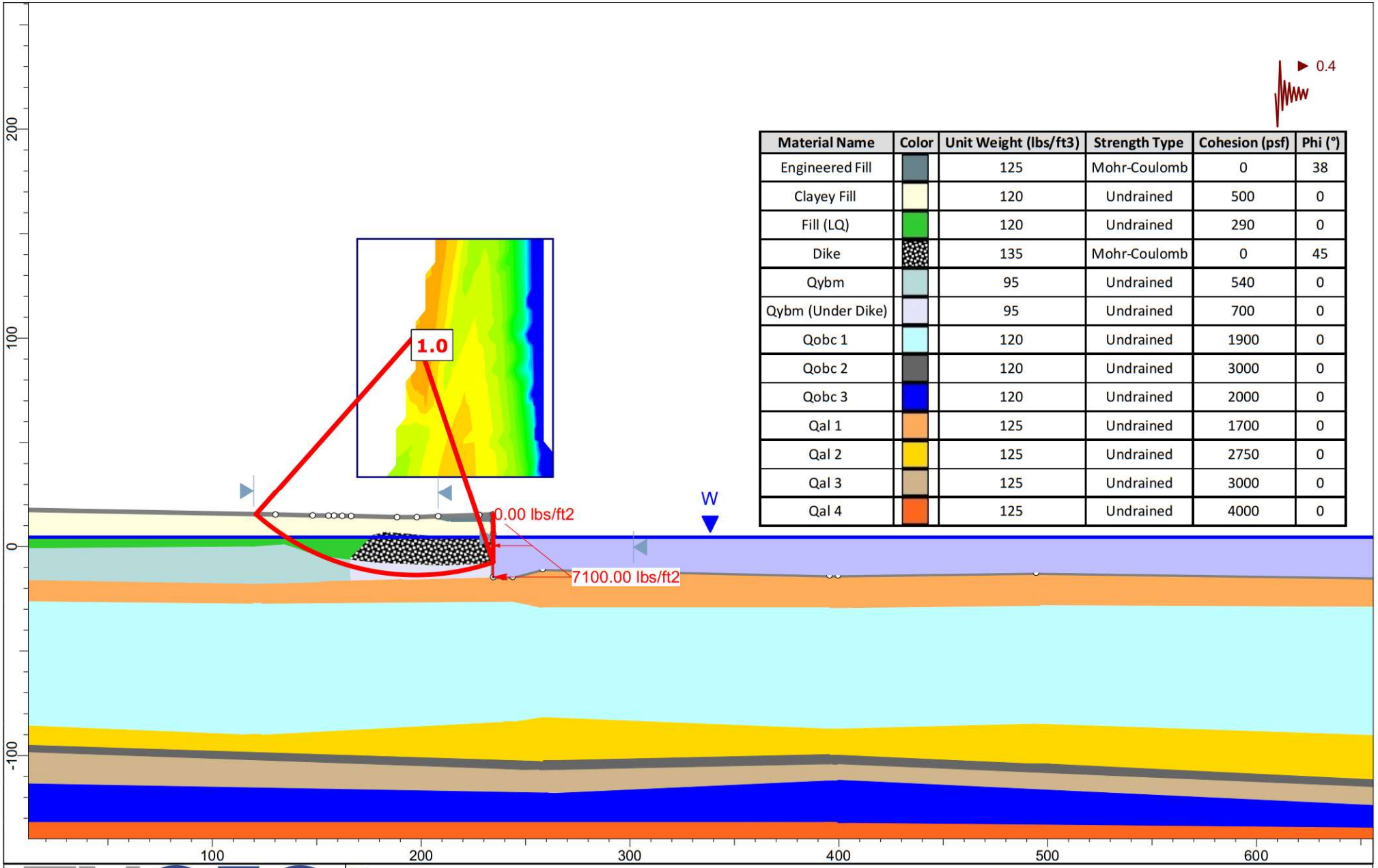
ENGEO
Expect Excellence

Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750	*Author* VZ/JF	*Project No.* 25022.000.001	
Date 5/28/2025	*Condition* Yield Acceleration for Block Failure Surface Behind the DSM Ground Improvement		



APPENDIX G.3

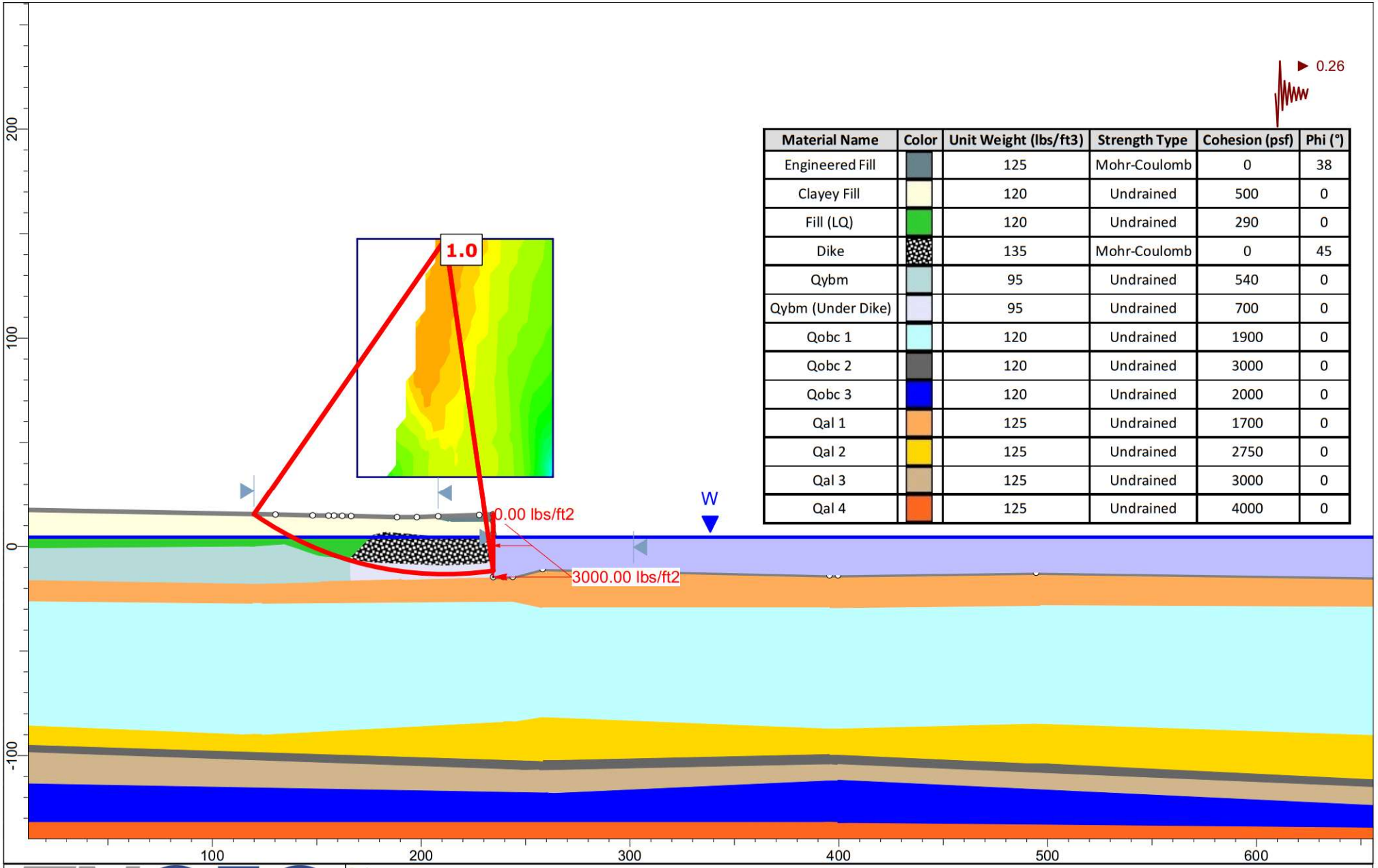
SLOPE STABILITY ANALYSIS – RETAINING WALL



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Under Dike)		95	Undrained	700	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

ENGEO
Expect Excellence

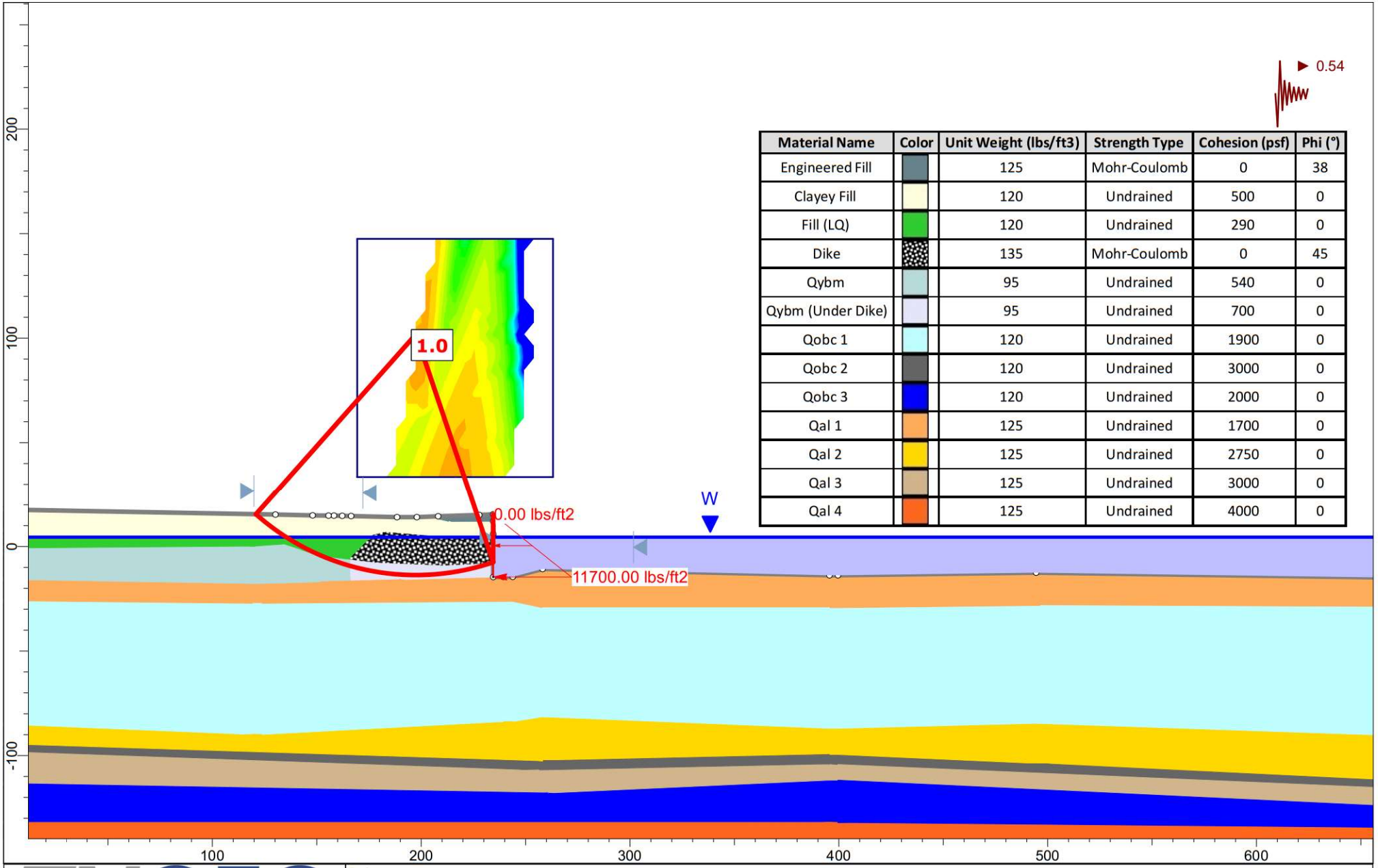
Project: Berkeley Water Transportation Pier Ferry			
Scale: 1:750	Author: VZ/JF	Project No.	
Date: 5/28/2025	Condition: Estimate of Earthquake and Soil Pressure on Retaining Wall Based on 2 inches of Lateral Movement During CLE-Level Earthquake (Bray and Macedo, 2019)	25022.000.001	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Under Dike)		95	Undrained	700	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

ENGEO
Expect Excellence

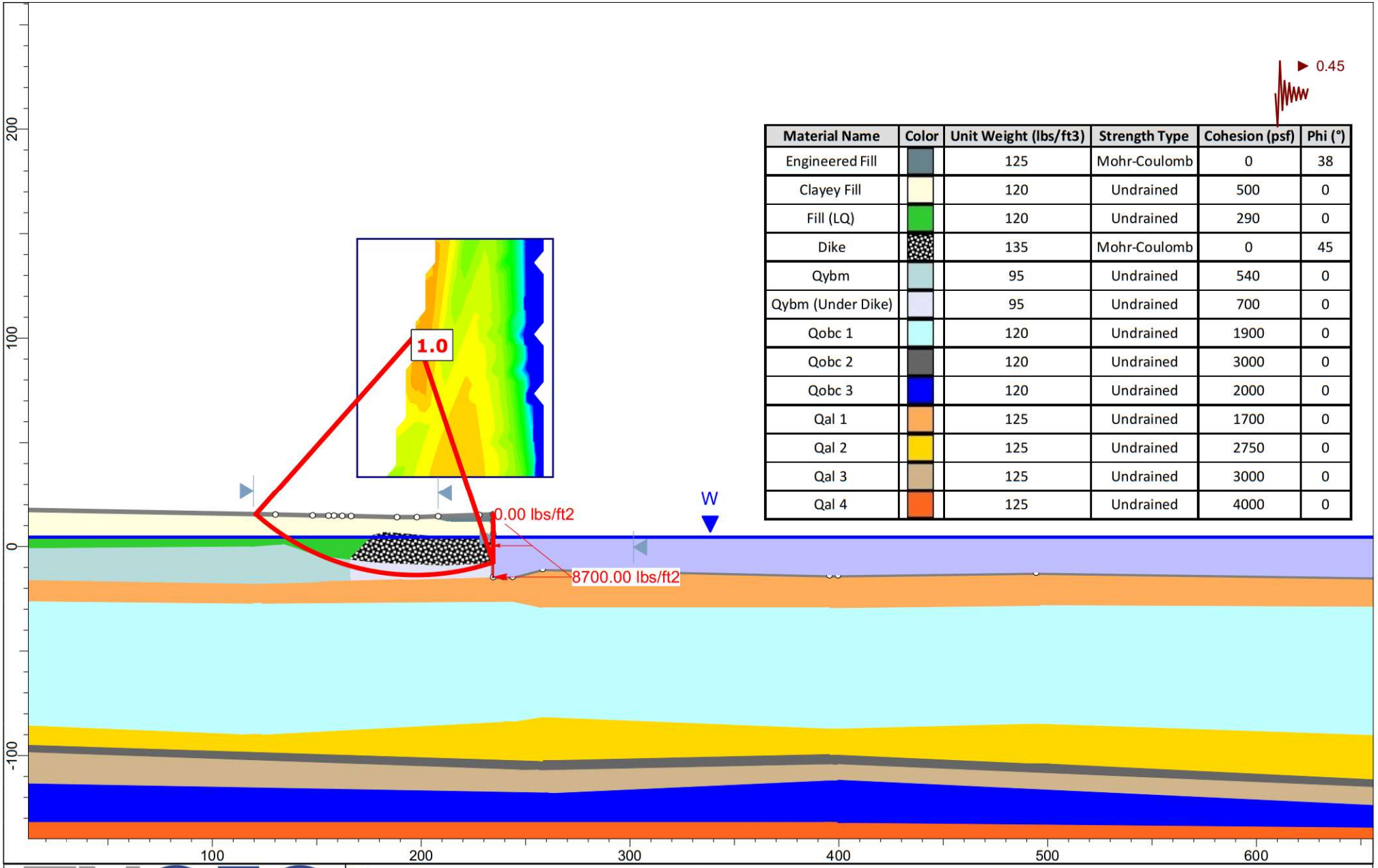
Project: Berkeley Water Transportation Pier Ferry			
Scale: 1:750	Author: VZ/JF	Project No.	
Date: 5/28/2025	Condition: Estimate of Earthquake and Soil Pressure on Retaining Wall Based on 2 inches of Lateral Movement During CLE-Level Earthquake (NCHRP, 2008)	25022.000.001	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Under Dike)		95	Undrained	700	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

ENGEO
Expect Excellence

Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750		Author VZ/JF	Project No. 25022.000.001
Date 5/28/2025		Condition Estimate of Earthquake and Soil Pressure on Retaining Wall Based on 2 inches of Lateral Movement During MCE-Level Earthquake (Bray and Macedo, 2019)	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)
Engineered Fill		125	Mohr-Coulomb	0	38
Clayey Fill		120	Undrained	500	0
Fill (LQ)		120	Undrained	290	0
Dike		135	Mohr-Coulomb	0	45
Qybm		95	Undrained	540	0
Qybm (Under Dike)		95	Undrained	700	0
Qobc 1		120	Undrained	1900	0
Qobc 2		120	Undrained	3000	0
Qobc 3		120	Undrained	2000	0
Qal 1		125	Undrained	1700	0
Qal 2		125	Undrained	2750	0
Qal 3		125	Undrained	3000	0
Qal 4		125	Undrained	4000	0

ENGEO
Expect Excellence

Project	Berkeley Water Transportation Pier Ferry		
Scale 1:750	*Author* VZ/JF	*Project No.* 25022.000.001	
Date 5/28/2025	*Condition* Estimate of Earthquake and Soil Pressure on Retaining Wall Based on 2 inches of Lateral Movement During MCE-Level Earthquake (NCHRP, 2008)		



APPENDIX H

P-Y SPRINGS

4ft Concrete Breakwater p-y Springs

Section	Pier Alignment						Best Estimate						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	9	2.84	16	16.59	21	39.32	26	76.80	26	81.60
Qybm	6.5	0	0	14	2.84	25	16.59	33	39.32	42	76.80	42	81.60
Qal 1 (Clay)	7.5	0	0	149	0.66	267	6.97	357	22.02	446	53.76	446	67.20
Qal 1 (Clay)	12.5	0	0	184	0.66	331	6.97	441	22.02	552	53.76	552	67.20
Qal 1 (Sand)	13.5	0	0	116	1.23	153	2.36	175	3.20	271	8.64	271	10.08
Qal 1 (Sand)	16.5	0	0	129	1.19	224	3.20	303	5.20	381	7.20	381	10.08
Qal 1 (Sand)	17.5	0	0	221	0.66	398	6.97	531	22.02	664	53.76	664	67.20
Qal 1 (Sand)	22.5	0	0	259	0.66	466	6.97	621	22.02	777	53.76	777	67.20
Qobc 1	23.5	0	0	284	0.66	512	6.97	682	22.02	853	53.76	853	67.20
Qobc 1	28	0	0	321	0.17	577	1.74	770	5.51	962	13.44	962	16.80
Qobc 1	33	0	0	362	0.66	651	6.97	868	22.02	1085	53.76	1085	67.20
Qobc 1	38	0	0	402	0.66	724	6.97	966	22.02	1207	53.76	1207	67.20
Qobc 1	43	0	0	443	0.66	798	6.97	1064	22.02	1330	53.76	1330	67.20
Qobc 1	48	0	0	475	0.66	855	6.97	1140	22.02	1425	53.76	1425	67.20
Qobc 1	79.5	0	0	475	0.66	855	6.97	1140	22.02	1425	53.76	1425	67.20
Qal 2 (Clay)	80.5	0	0	688	0.47	1238	4.98	1650	15.73	2063	38.40	2063	48.00
Qal 2 (Clay)	92.5	0	0	688	0.47	1238	4.98	1650	15.73	2063	38.40	2063	48.00
Qobc 2	93.5	0	0	750	0.47	1350	4.98	1800	15.73	2250	38.40	2250	48.00
Qobc 2	97.5	0	0	3000	0.47	5400	4.98	7200	15.73	9000	38.40	9000	48.00
Qal 3 (Clay)	98.5	0	0	750	0.47	1350	4.98	1800	15.73	2250	38.40	2250	48.00
Qal 3 (Clay)	105.5	0	0	750	0.47	1350	4.98	1800	15.73	2250	38.40	2250	48.00
Qobc 3	106.5	0	0	500	0.47	900	4.98	1200	15.73	1500	38.40	1500	48.00
Qobc 3	126.5	0	0	500	0.47	900	4.98	1200	15.73	1500	38.40	1500	48.00
Qal 4 (Clay)	127.5	0	0	750	0.47	1350	4.98	1800	15.73	2250	38.40	2250	48.00
Qal 4 (Clay)	139.5	0	0	750	0.47	1350	4.98	1800	15.73	2250	38.40	2250	48.00

Section	Pier Alignment						Upper Bound						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	18	2.84	32	16.59	42	39.32	53	76.80	53	81.60
Qybm	6.5	0	0	28	2.84	50	16.59	66	39.32	83	76.80	83	81.60
Qal 1 (Clay)	7.5	0	0	297	0.66	535	6.97	713	22.02	891	53.76	891	67.20
Qal 1 (Clay)	12.5	0	0	368	0.66	662	6.97	882	22.02	1103	53.76	1103	67.20
Qal 1 (Sand)	13.5	0	0	231	1.23	307	2.36	351	3.20	541	8.64	541	10.08
Qal 1 (Sand)	16.5	0	0	257	1.19	448	3.20	605	5.20	763	7.20	763	10.08
Qal 1 (Sand)	17.5	0	0	443	0.66	797	6.97	1062	22.02	1328	53.76	1328	67.20
Qal 1 (Sand)	22.5	0	0	518	0.66	932	6.97	1243	22.02	1553	53.76	1553	67.20
Qobc 1	23.5	0	0	568	0.66	1023	6.97	1364	22.02	1705	53.76	1705	67.20
Qobc 1	28	0	0	642	0.17	1155	1.74	1540	5.51	1925	13.44	1925	16.80
Qobc 1	33	0	0	723	0.66	1302	6.97	1736	22.02	2170	53.76	2170	67.20
Qobc 1	38	0	0	805	0.66	1449	6.97	1932	22.02	2415	53.76	2415	67.20
Qobc 1	43	0	0	887	0.66	1596	6.97	2128	22.02	2660	53.76	2660	67.20
Qobc 1	48	0	0	950	0.66	1710	6.97	2280	22.02	2850	53.76	2850	67.20
Qobc 1	79.5	0	0	950	0.66	1710	6.97	2280	22.02	2850	53.76	2850	67.20
Qal 2 (Clay)	80.5	0	0	1375	0.47	2475	4.98	3300	15.73	4125	38.40	4125	48.00
Qal 2 (Clay)	92.5	0	0	1375	0.47	2475	4.98	3300	15.73	4125	38.40	4125	48.00
Qobc 2	93.5	0	0	1500	0.47	2700	4.98	3600	15.73	4500	38.40	4500	48.00
Qobc 2	97.5	0	0	6000	0.47	10800	4.98	14400	15.73	18000	38.40	18000	48.00
Qal 3 (Clay)	98.5	0	0	1500	0.47	2700	4.98	3600	15.73	4500	38.40	4500	48.00
Qal 3 (Clay)	105.5	0	0	1500	0.47	2700	4.98	3600	15.73	4500	38.40	4500	48.00
Qobc 3	106.5	0	0	1000	0.47	1800	4.98	2400	15.73	3000	38.40	3000	48.00
Qobc 3	126.5	0	0	1000	0.47	1800	4.98	2400	15.73	3000	38.40	3000	48.00
Qal 4 (Clay)	127.5	0	0	1500	0.47	2700	4.98	3600	15.73	4500	38.40	4500	48.00
Qal 4 (Clay)	139.5	0	0	1500	0.47	2700	4.98	3600	15.73	4500	38.40	4500	48.00

Section	Pier Alignment						Lower Bound						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	4	2.84	8	16.59	11	39.32	13	76.80	13	81.60
Qybm	6.5	0	0	7	2.84	12	16.59	17	39.32	21	76.80	21	81.60
Qal 1 (Clay)	7.5	0	0	74	0.66	134	6.97	178	22.02	223	53.76	223	67.20
Qal 1 (Clay)	12.5	0	0	92	0.66	165	6.97	221	22.02	276	53.76	276	67.20
Qal 1 (Sand)	13.5	0	0	58	1.23	77	2.36	88	3.20	135	8.64	135	10.08
Qal 1 (Sand)	16.5	0	0	64	1.19	112	3.20	151	5.20	191	7.20	191	10.08
Qal 1 (Sand)	17.5	0	0	111	0.66	199	6.97	266	22.02	332	53.76	332	67.20
Qal 1 (Sand)	22.5	0	0	129	0.66	233	6.97	311	22.02	388	53.76	388	67.20
Qobc 1	23.5	0	0	142	0.66	256	6.97	341	22.02	426	53.76	426	67.20
Qobc 1	28	0	0	160	0.17	289	1.74	385	5.51	481	13.44	481	16.80
Qobc 1	33	0	0	181	0.66	325	6.97	434	22.02	542	53.76	542	67.20
Qobc 1	38	0	0	201	0.66	362	6.97	483	22.02	604	53.76	604	67.20
Qobc 1	43	0	0	222	0.66	399	6.97	532	22.02	665	53.76	665	67.20
Qobc 1	48	0	0	238	0.66	428	6.97	570	22.02	713	53.76	713	67.20
Qobc 1	79.5	0	0	238	0.66	428	6.97	570	22.02	713	53.76	713	67.20
Qal 2 (Clay)	80.5	0	0	344	0.47	619	4.98	825	15.73	1031	38.40	1031	48.00
Qal 2 (Clay)	92.5	0	0	344	0.47	619	4.98	825	15.73	1031	38.40	1031	48.00
Qobc 2	93.5	0	0	375	0.47	675	4.98	900	15.73	1125	38.40	1125	48.00
Qobc 2	97.5	0	0	1500	0.47	2700	4.98	3600	15.73	4500	38.40	4500	48.00
Qal 3 (Clay)	98.5	0	0	375	0.47	675	4.98	900	15.73	1125	38.40	1125	48.00
Qal 3 (Clay)	105.5	0	0	375	0.47	675	4.98	900	15.73	1125	38.40	1125	48.00
Qobc 3	106.5	0	0	250	0.47	450	4.98	600	15.73	750	38.40	750	48.00
Qobc 3	126.5	0	0	250	0.47	450	4.98	600	15.73	750	38.40	750	48.00
Qal 4 (Clay)	127.5	0	0	375	0.47	675	4.98	900	15.73	1125	38.40	1125	48.00
Qal 4 (Clay)	139.5	0	0	375	0.47	675	4.98	900	15.73	1125	38.40	1125	48.00

24-inch Concrete Precast Prestressed Octagonal Pile P-y Springs

Section	Pier Alignment						Best Estimate						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	18	0.36	32	2.07	43	4.92	54	9.60	54	10.20
Qybm	6.5	0	0	32	0.36	58	2.07	77	4.92	97	9.60	97	10.20
Qal 1 (Clay)	7.5	0	0	311	0.08	560	0.87	747	2.75	933	6.72	933	8.40
Qal 1 (Clay)	12.5	0	0	441	0.08	793	0.87	1058	2.75	1322	6.72	1322	8.40
Qal 1 (Sand)	13.5	0	0	338	0.08	700	0.26	1614	0.90	1614	1.08	1614	1.26
Qal 1 (Sand)	16.5	0	0	569	0.08	1142	0.26	2619	0.90	2619	1.08	2619	1.26
Qal 1 (Clay)	17.5	0	0	608	0.08	1094	0.87	1459	2.75	1824	6.72	1824	8.40
Qal 1 (Clay)	22.5	0	0	742	0.08	1336	0.87	1782	2.75	2227	6.72	2227	8.40
Qobc 1	23.5	0	0	816	0.08	1468	0.87	1957	2.75	2447	6.72	2447	8.40
Qobc 1	28	0	0	948	0.08	1707	0.87	2276	2.75	2845	6.72	2845	8.40
Qobc 1	33	0	0	950	0.08	1710	0.87	2280	2.75	2850	6.72	2850	8.40
Qobc 1	79.5	0	0	1710	0.87	2280	2.75	2660	5.10	2850	6.72	2850	8.40
Qal 2 (Clay)	80.5	0	0	2475	0.62	3300	1.97	3850	3.64	4125	4.80	4125	6.00
Qal 2 (Clay)	92.5	0	0	2475	0.62	3300	1.97	3850	3.64	4125	4.80	4125	6.00
Qobc 2	93.5	0	0	2700	0.62	3600	1.97	4200	3.64	4500	4.80	4500	6.00
Qobc 2	97.5	0	0	2700	0.62	3600	1.97	4200	3.64	4500	4.80	4500	6.00
Qal 3 (Clay)	98.5	0	0	2700	0.62	3600	1.97	4200	3.64	4500	4.80	4500	6.00
Qal 3 (Clay)	105.5	0	0	2700	0.62	3600	1.97	4200	3.64	4500	4.80	4500	6.00
Qobc 3	106.5	0	0	1800	0.62	2400	1.97	2800	3.64	3000	4.80	3000	6.00
Qobc 3	126.5	0	0	1800	0.62	2400	1.97	2800	3.64	3000	4.80	3000	6.00
Qal 4 (Clay)	127.5	0	0	4000	0.76	5200	2.17	5600	2.91	6000	3.84	6000	4.80
Qal 4 (Clay)	139.5	0	0	4000	0.76	5200	2.17	5600	2.91	6000	3.84	6000	4.80

Section	Pier Alignment						Upper Bound						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	36	0.36	64	2.07	86	4.92	107	9.60	107	10.20
Qybm	6.5	0	0	64	0.36	116	2.07	155	4.92	193	9.60	193	10.20
Qal 1 (Clay)	7.5	0	0	622	0.08	1120	0.87	1493	2.75	1866	6.72	1866	8.40
Qal 1 (Clay)	12.5	0	0	881	0.08	1586	0.87	2115	2.75	2644	6.72	2644	8.40
Qal 1 (Sand)	13.5	0	0	676	0.08	1401	0.26	3229	0.90	3229	1.08	3229	1.26
Qal 1 (Sand)	16.5	0	0	1138	0.08	2284	0.26	5238	0.90	5238	1.08	5238	1.26
Qal 1 (Clay)	17.5	0	0	1216	0.08	2189	0.87	2918	2.75	3648	6.72	3648	8.40
Qal 1 (Clay)	22.5	0	0	1485	0.08	2673	0.87	3563	2.75	4454	6.72	4454	8.40
Qobc 1	23.5	0	0	1631	0.08	2936	0.87	3915	2.75	4894	6.72	4894	8.40
Qobc 1	28	0	0	1897	0.08	3414	0.87	4552	2.75	5690	6.72	5690	8.40
Qobc 1	33	0	0	1900	0.08	3420	0.87	4560	2.75	5700	6.72	5700	8.40
Qobc 1	79.5	0	0	3420	0.87	4560	2.75	5320	5.10	5700	6.72	5700	8.40
Qal 2 (Clay)	80.5	0	0	4950	0.62	6600	1.97	7700	3.64	8250	4.80	8250	6.00
Qal 2 (Clay)	92.5	0	0	4950	0.62	6600	1.97	7700	3.64	8250	4.80	8250	6.00
Qobc 2	93.5	0	0	5400	0.62	7200	1.97	8400	3.64	9000	4.80	9000	6.00
Qobc 2	97.5	0	0	5400	0.62	7200	1.97	8400	3.64	9000	4.80	9000	6.00
Qal 3 (Clay)	98.5	0	0	5400	0.62	7200	1.97	8400	3.64	9000	4.80	9000	6.00
Qal 3 (Clay)	105.5	0	0	5400	0.62	7200	1.97	8400	3.64	9000	4.80	9000	6.00
Qobc 3	106.5	0	0	3600	0.62	4800	1.97	5600	3.64	6000	4.80	6000	6.00
Qobc 3	126.5	0	0	3600	0.62	4800	1.97	5600	3.64	6000	4.80	6000	6.00
Qal 4 (Clay)	127.5	0	0	8000	0.76	10400	2.17	11200	2.91	12000	3.84	12000	4.80
Qal 4 (Clay)	139.5	0	0	8000	0.76	10400	2.17	11200	2.91	12000	3.84	12000	4.80

Section	Pier Alignment						Lower Bound						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	9	0.36	16	2.07	21	4.92	27	9.60	27	10.20
Qybm	6.5	0	0	16	0.36	29	2.07	39	4.92	48	9.60	48	10.20
Qal 1 (Clay)	7.5	0	0	156	0.08	280	0.87	373	2.75	467	6.72	467	8.40
Qal 1 (Clay)	12.5	0	0	220	0.08	397	0.87	529	2.75	661	6.72	661	8.40
Qal 1 (Sand)	13.5	0	0	169	0.08	350	0.26	807	0.90	807	1.08	807	1.26
Qal 1 (Sand)	16.5	0	0	285	0.08	571	0.26	1310	0.90	1310	1.08	1310	1.26
Qal 1 (Clay)	17.5	0	0	304	0.08	547	0.87	730	2.75	912	6.72	912	8.40
Qal 1 (Clay)	22.5	0	0	371	0.08	668	0.87	891	2.75	1114	6.72	1114	8.40
Qobc 1	23.5	0	0	408	0.08	734	0.87	979	2.75	1223	6.72	1223	8.40
Qobc 1	28	0	0	474	0.08	854	0.87	1138	2.75	1423	6.72	1423	8.40
Qobc 1	33	0	0	475	0.08	855	0.87	1140	2.75	1425	6.72	1425	8.40
Qobc 1	79.5	0	0	855	0.87	1140	2.75	1330	5.10	1425	6.72	1425	8.40
Qal 2 (Clay)	80.5	0	0	1238	0.62	1650	1.97	1925	3.64	2063	4.80	2063	6.00
Qal 2 (Clay)	92.5	0	0	1238	0.62	1650	1.97	1925	3.64	2063	4.80	2063	6.00
Qobc 2	93.5	0	0	1350	0.62	1800	1.97	2100	3.64	2250	4.80	2250	6.00
Qobc 2	97.5	0	0	1350	0.62	1800	1.97	2100	3.64	2250	4.80	2250	6.00
Qal 3 (Clay)	98.5	0	0	1350	0.62	1800	1.97	2100	3.64	2250	4.80	2250	6.00
Qal 3 (Clay)	105.5	0	0	1350	0.62	1800	1.97	2100	3.64	2250	4.80	2250	6.00
Qobc 3	106.5	0	0	900	0.62	1200	1.97	1400	3.64	1500	4.80	1500	6.00
Qobc 3	126.5	0	0	900	0.62	1200	1.97	1400	3.64	1500	4.80	1500	6.00
Qal 4 (Clay)	127.5	0	0	2000	0.76	2600	2.17	2800	2.91	3000	3.84	3000	4.80
Qal 4 (Clay)	139.5	0	0	2000	0.76	2600	2.17	2800	2.91	3000	3.84	3000	4.80

36-inch Steel Pipe Pile p-y Springs

Section	Pier Alignment						Best Estimate						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	26	0.53	48	3.11	63	7.37	79	14.40	79	15.30
Qybm	6.5	0	0	44	0.53	79	3.11	105	7.37	131	14.40	131	15.30
Qal 1 (Clay)	7.5	0	0	452	0.12	814	1.31	1086	4.13	1357	10.08	1357	12.60
Qal 1 (Clay)	12.5	0	0	588	0.12	1058	1.31	1411	4.13	1763	10.08	1763	12.60
Qal 1 (Sand)	13.5	0	0	407	0.11	825	0.38	1850	1.35	1850	1.62	1850	1.89
Qal 1 (Sand)	16.5	0	0	608	0.12	1261	0.38	2908	1.35	2908	1.62	2908	1.89
Qal 1 (Clay)	17.5	0	0	746	0.12	1344	1.31	1791	4.13	2239	10.08	2239	12.60
Qal 1 (Clay)	22.5	0	0	889	0.12	1600	1.31	2133	4.13	2666	10.08	2666	12.60
Qobc 1	23.5	0	0	976	0.12	1756	1.31	2341	4.13	2927	10.08	2927	12.60
Qobc 1	28	0	0	1115	0.12	2008	1.31	2677	4.13	3346	10.08	3346	12.60
Qobc 1	33	0	0	1271	0.12	2287	1.31	3050	4.13	3812	10.08	3812	12.60
Qobc 1	38	0	0	1425	0.12	2565	1.31	3420	4.13	4275	10.08	4275	12.60
Qobc 1	79.5	0	0	1425	0.12	2565	1.31	3420	4.13	4275	10.08	4275	12.60
Qal 1 (Clay)	80.5	0	0	2063	0.09	3713	0.93	4950	2.95	6188	7.20	6188	9.00
Qal 1 (Clay)	92.5	0	0	2063	0.09	3713	0.93	4950	2.95	6188	7.20	6188	9.00
Qobc 2	93.5	0	0	2250	0.09	4050	0.93	5400	2.95	6750	7.20	6750	9.00
Qobc 2	97.5	0	0	2250	0.09	4050	0.93	5400	2.95	6750	7.20	6750	9.00
Qal 3 (Clay)	98.5	0	0	2250	0.09	4050	0.93	5400	2.95	6750	7.20	6750	9.00
Qal 3 (Clay)	105.5	0	0	2250	0.09	4050	0.93	5400	2.95	6750	7.20	6750	9.00
Qobc 3	106.5	0	0	1500	0.09	2700	0.93	3600	2.95	4500	7.20	4500	9.00
Qobc 3	126.5	0	0	1500	0.09	2700	0.93	3600	2.95	4500	7.20	4500	9.00
Qal 4 (Clay)	127.5	0	0	2250	0.09	4050	0.93	5400	2.95	6750	7.20	6750	9.00
Qal 4 (Clay)	139.5	0	0	2250	0.09	4050	0.93	5400	2.95	6750	7.20	6750	9.00

Section	Pier Alignment						Upper Bound						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	53	0.53	95	3.11	127	7.37	159	14.40	159	15.30
Qybm	6.5	0	0	88	0.53	158	3.11	210	7.37	263	14.40	263	15.30
Qal 1 (Clay)	7.5	0	0	905	0.12	1629	1.31	2172	4.13	2715	10.08	2715	12.60
Qal 1 (Clay)	12.5	0	0	1176	0.12	2116	1.31	2821	4.13	3527	10.08	3527	12.60
Qal 1 (Sand)	13.5	0	0	813	0.11	1650	0.38	3699	1.35	3699	1.62	3699	1.89
Qal 1 (Sand)	16.5	0	0	1215	0.12	2523	0.38	5816	1.35	5816	1.62	5816	1.89
Qal 1 (Clay)	17.5	0	0	1493	0.12	2687	1.31	3583	4.13	4478	10.08	4478	12.60
Qal 1 (Clay)	22.5	0	0	1778	0.12	3200	1.31	4266	4.13	5333	10.08	5333	12.60
Qobc 1	23.5	0	0	1951	0.12	3512	1.31	4683	4.13	5854	10.08	5854	12.60
Qobc 1	28	0	0	2231	0.12	4015	1.31	5353	4.13	6692	10.08	6692	12.60
Qobc 1	33	0	0	2542	0.12	4575	1.31	6100	4.13	7625	10.08	7625	12.60
Qobc 1	38	0	0	2850	0.12	5130	1.31	6840	4.13	8550	10.08	8550	12.60
Qobc 1	79.5	0	0	2850	0.12	5130	1.31	6840	4.13	8550	10.08	8550	12.60
Qal 1 (Clay)	80.5	0	0	4125	0.09	7425	0.93	9900	2.95	12375	7.20	12375	9.00
Qal 1 (Clay)	92.5	0	0	4125	0.09	7425	0.93	9900	2.95	12375	7.20	12375	9.00
Qobc 2	93.5	0	0	4500	0.09	8100	0.93	10800	2.95	13500	7.20	13500	9.00
Qobc 2	97.5	0	0	4500	0.09	8100	0.93	10800	2.95	13500	7.20	13500	9.00
Qal 3 (Clay)	98.5	0	0	4500	0.09	8100	0.93	10800	2.95	13500	7.20	13500	9.00
Qal 3 (Clay)	105.5	0	0	4500	0.09	8100	0.93	10800	2.95	13500	7.20	13500	9.00
Qobc 3	106.5	0	0	3000	0.09	5400	0.93	7200	2.95	9000	7.20	9000	9.00
Qobc 3	126.5	0	0	3000	0.09	5400	0.93	7200	2.95	9000	7.20	9000	9.00
Qal 4 (Clay)	127.5	0	0	4500	0.09	8100	0.93	10800	2.95	13500	7.20	13500	9.00
Qal 4 (Clay)	139.5	0	0	4500	0.09	8100	0.93	10800	2.95	13500	7.20	13500	9.00

Section	Pier Alignment						Lower Bound						
Material	Depth Below Mudline(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Qybm	0.5	0	0	13	0.53	24	3.11	32	7.37	40	14.40	40	15.30
Qybm	6.5	0	0	22	0.53	39	3.11	53	7.37	66	14.40	66	15.30
Qal 1 (Clay)	7.5	0	0	226	0.12	407	1.31	543	4.13	679	10.08	679	12.60
Qal 1 (Clay)	12.5	0	0	294	0.12	529	1.31	705	4.13	882	10.08	882	12.60
Qal 1 (Sand)	13.5	0	0	203	0.11	413	0.38	925	1.35	925	1.62	925	1.89
Qal 1 (Sand)	16.5	0	0	304	0.12	631	0.38	1454	1.35	1454	1.62	1454	1.89
Qal 1 (Clay)	17.5	0	0	373	0.12	672	1.31	896	4.13	1120	10.08	1120	12.60
Qal 1 (Clay)	22.5	0	0	444	0.12	800	1.31	1067	4.13	1333	10.08	1333	12.60
Qobc 1	23.5	0	0	488	0.12	878	1.31	1171	4.13	1463	10.08	1463	12.60
Qobc 1	28	0	0	558	0.12	1004	1.31	1338	4.13	1673	10.08	1673	12.60
Qobc 1	33	0	0	635	0.12	1144	1.31	1525	4.13	1906	10.08	1906	12.60
Qobc 1	38	0	0	713	0.12	1283	1.31	1710	4.13	2138	10.08	2138	12.60
Qobc 1	79.5	0	0	713	0.12	1283	1.31	1710	4.13	2138	10.08	2138	12.60
Qal 1 (Clay)	80.5	0	0	1031	0.09	1856	0.93	2475	2.95	3094	7.20	3094	9.00
Qal 1 (Clay)	92.5	0	0	1031	0.09	1856	0.93	2475	2.95	3094	7.20	3094	9.00
Qobc 2	93.5	0	0	1125	0.09	2025	0.93	2700	2.95	3375	7.20	3375	9.00
Qobc 2	97.5	0	0	1125	0.09	2025	0.93	2700	2.95	3375	7.20	3375	9.00
Qal 3 (Clay)	98.5	0	0	1125	0.09	2025	0.93	2700	2.95	3375	7.20	3375	9.00
Qal 3 (Clay)	105.5	0	0	1125	0.09	2025	0.93	2700	2.95	3375	7.20	3375	9.00
Qobc 3	106.5	0	0	750	0.09	1350	0.93	1800	2.95	2250	7.20	2250	9.00
Qobc 3	126.5	0	0	750	0.09	1350	0.93	1800	2.95	2250	7.20	2250	9.00
Qal 4 (Clay)	127.5	0	0	1125	0.09	2025	0.93	2700	2.95	3375	7.20	3375	9.00
Qal 4 (Clay)	139.5	0	0	1125	0.09	2025	0.93	2700	2.95	3375	7.20	3375	9.00

24-inch Pier Steel Pipe Pile p-y Springs

Section	Pier Pipe Pile Within Rock Dike						Best Estimate						
Material	Depth Below Ground Surface (feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Rock Dike Above GWT	0.2	0	0	25	0.04	32	0.11	43	0.33	60	0.9	60	1.26
Rock Dike Above GWT	3.7	0	0	638	0.06	813	0.12	1138	0.34	1684	0.9	1684	1.26
Rock Dike Below GWT	4.7	0	0	908	0.11	1037	0.16	1340	0.35	2000	0.9	2000	1.26
Rock Dike Below GWT	17.7	0	0	1788	0.06	2792	0.12	5242	0.34	10226	0.9	10226	1.26
Qybm	18.7	0	0	270	0.18	486	1.04	648	2.46	810	4.8	810	5.1
Qybm	22.7	0	0	270	0.18	486	1.04	648	2.46	810	4.8	810	5.1
Qal 1 (Clay)	23.7	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qal 1 (Clay)	27.2	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qal 1 (Sand)	28.2	0	0	2744	0.11	3498	0.16	5576	0.35	10702	0.9	10702	1.26
Qal 1 (Sand)	31.2	0	0	3874	0.14	4641	0.19	6853	0.35	13029	0.9	13029	1.26
Qal 1 (Clay)	32.2	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qal 1 (Clay)	37.2	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qobc 1	38.2	0	0	950	0.08	1710	0.87	2280	2.75	2850	6.72	2850	8.4
Qobc 1	82.7	0	0	950	0.08	1710	0.87	2280	2.75	2850	6.72	2850	8.4
Qal 2 (Clay)	95.2	0	0	1375	0.06	2475	0.62	3300	1.97	4125	4.8	4125	6
Qal 2 (Clay)	107.2	0	0	1375	0.06	2475	0.62	3300	1.97	4125	4.8	4125	6
Qobc 2	108.2	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qobc 2	112.2	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qal 3 (Clay)	113.2	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qal 3 (Clay)	120.2	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qobc 3	121.2	0	0	1000	0.06	1800	0.62	2400	1.97	3000	4.8	3000	6
Qobc 3	141.2	0	0	1000	0.06	1800	0.62	2400	1.97	3000	4.8	3000	6
Qal 4 (Clay)	142.2	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qal 4 (Clay)	154.2	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6

Section	Pier Pipe Pile Within Rock Dike						Upper Bound						
Material	Depth Below Rock Dike(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Rock Dike Above GWT	0.2	0	0	49	0.04	64	0.11	86	0.33	120	0.9	120	1.26
Rock Dike Above GWT	3.7	0	0	1276	0.06	1625	0.12	2276	0.34	3369	0.9	3369	1.26
Rock Dike Below GWT	4.7	0	0	1816	0.11	2073	0.16	2679	0.35	4000	0.9	4000	1.26
Rock Dike Below GWT	17.7	0	0	3576	0.06	5584	0.12	10484	0.34	20452	0.9	20452	1.26
Qybm	18.7	0	0	540	0.18	972	1.04	1296	2.46	1620	4.8	1620	5.1
Qybm	22.7	0	0	540	0.18	972	1.04	1296	2.46	1620	4.8	1620	5.1
Qal 1 (Clay)	23.7	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qal 1 (Clay)	27.2	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qal 1 (Sand)	28.2	0	0	5487	0.11	6996	0.16	11152	0.35	21403	0.9	21403	1.26
Qal 1 (Sand)	31.2	0	0	7749	0.14	9281	0.19	13707	0.35	26058	0.9	26058	1.26
Qal 1 (Clay)	32.2	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qal 1 (Clay)	37.2	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qobc 1	38.2	0	0	1900	0.08	3420	0.87	4560	2.75	5700	6.72	5700	8.4
Qobc 1	82.7	0	0	1900	0.08	3420	0.87	4560	2.75	5700	6.72	5700	8.4
Qal 2 (Clay)	95.2	0	0	2750	0.06	4950	0.62	6600	1.97	8250	4.8	8250	6
Qal 2 (Clay)	107.2	0	0	2750	0.06	4950	0.62	6600	1.97	8250	4.8	8250	6
Qobc 2	108.2	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qobc 2	112.2	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qal 3 (Clay)	113.2	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qal 3 (Clay)	120.2	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qobc 3	121.2	0	0	2000	0.06	3600	0.62	4800	1.97	6000	4.8	6000	6
Qobc 3	141.2	0	0	2000	0.06	3600	0.62	4800	1.97	6000	4.8	6000	6
Qal 4 (Clay)	142.2	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qal 4 (Clay)	154.2	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6

Section	Pier Pipe Pile Within Rock Dike						Lower Bound						
Material	Depth Below Rock Dike(feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Rock Dike Above GWT	0.2	0	0	12	0.04	16	0.11	22	0.33	30	0.9	30	1.26
Rock Dike Above GWT	3.7	0	0	319	0.06	406	0.12	569	0.34	842	0.9	842	1.26
Rock Dike Below GWT	4.7	0	0	454	0.11	518	0.16	670	0.35	1000	0.9	1000	1.26
Rock Dike Below GWT	17.7	0	0	894	0.06	1396	0.12	2621	0.34	5113	0.9	5113	1.26
Qybm	18.7	0	0	135	0.18	243	1.04	324	2.46	405	4.8	405	5.1
Qybm	22.7	0	0	135	0.18	243	1.04	324	2.46	405	4.8	405	5.1
Qal 1 (Clay)	23.7	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qal 1 (Clay)	27.2	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qal 1 (Sand)	28.2	0	0	1372	0.11	1749	0.16	2788	0.35	5351	0.9	5351	1.26
Qal 1 (Sand)	31.2	0	0	1937	0.14	2320	0.19	3427	0.35	6514	0.9	6514	1.26
Qal 1 (Clay)	32.2	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qal 1 (Clay)	37.2	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qobc 1	38.2	0	0	475	0.08	855	0.87	1140	2.75	1425	6.72	1425	8.4
Qobc 1	82.7	0	0	475	0.08	855	0.87	1140	2.75	1425	6.72	1425	8.4
Qal 2 (Clay)	95.2	0	0	688	0.06	1238	0.62	1650	1.97	2063	4.8	2063	6
Qal 2 (Clay)	107.2	0	0	688	0.06	1238	0.62	1650	1.97	2063	4.8	2063	6
Qobc 2	108.2	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qobc 2	112.2	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qal 3 (Clay)	113.2	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qal 3 (Clay)	120.2	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qobc 3	121.2	0	0	500	0.06	900	0.62	1200	1.97	1500	4.8	1500	6
Qobc 3	141.2	0	0	500	0.06	900	0.62	1200	1.97	1500	4.8	1500	6
Qal 4 (Clay)	142.2	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qal 4 (Clay)	154.2	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6

24-inch Abutment Steel Pipe Pile p-y Springs

Section	Abutment Landside Pipe Pile						Best Estimate						
Material	Depth Below Bottom of Abutment (feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Engineered Fill	0.5	0	0	18	0.03	24	0.10	33	0.33	46	0.9	46	1.26
Rock Dike Above GWT	1.5	0	0	101	0.02	152	0.09	221	0.33	317	0.9	317	1.26
Rock Dike Above GWT	6	0	0	576	0.03	899	0.10	1442	0.33	2297	0.9	2297	1.26
Rock Dike Below GWT	7	0	0	736	0.06	1001	0.12	1560	0.34	2589	0.9	2589	1.26
Rock Dike Below GWT	20	0	0	2523	0.07	3643	0.13	6493	0.34	12607	0.9	12607	1.26
Qybm	21	0	0	270	0.18	486	1.04	648	2.46	810	4.8	810	5.1
Qybm	25	0	0	270	0.18	486	1.04	648	2.46	810	4.8	810	5.1
Qal 1 (Clay)	26	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qal 1 (Clay)	29.5	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qal 1 (Sand)	30.5	0	0	3741	0.14	4494	0.18	6664	0.35	12675	0.9	12675	1.26
Qal 1 (Sand)	33.5	0	0	5143	0.17	5876	0.21	8078	0.36	15203	0.9	15203	1.26
Qal 1 (Clay)	34.5	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qal 1 (Clay)	39.5	0	0	850	0.08	1530	0.87	2040	2.75	2550	6.72	2550	8.4
Qobc 1	40.5	0	0	950	0.08	1710	0.87	2280	2.75	2850	6.72	2850	8.4
Qobc 1	96.5	0	0	950	0.08	1710	0.87	2280	2.75	2850	6.72	2850	8.4
Qal 2 (Clay)	97.5	0	0	1375	0.06	2475	0.62	3300	1.97	4125	4.8	4125	6
Qal 2 (Clay)	109.5	0	0	1375	0.06	2475	0.62	3300	1.97	4125	4.8	4125	6
Qobc 2	110.5	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qobc 2	114.5	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qal 3 (Clay)	115.5	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qal 3 (Clay)	122.5	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qobc 3	123.5	0	0	1000	0.06	1800	0.62	2400	1.97	3000	4.8	3000	6
Qobc 3	143.5	0	0	1000	0.06	1800	0.62	2400	1.97	3000	4.8	3000	6
Qal 4 (Clay)	144.5	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6
Qal 4 (Clay)	156.5	0	0	1500	0.06	2700	0.62	3600	1.97	4500	4.8	4500	6

Section	Abutment Landside Pipe Pile						Upper Bound						
Material	Elevation, City of Berkeley Datum (feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Engineered Fill	0.5	0	0	36	0.03	47	0.10	66	0.33	92	0.9	92	1.26
Rock Dike Above GWT	1.5	0	0	201	0.02	304	0.09	441	0.33	634	0.9	634	1.26
Rock Dike Above GWT	6	0	0	1151	0.03	1798	0.10	2885	0.33	4594	0.9	4594	1.26
Rock Dike Below GWT	7	0	0	1471	0.06	2002	0.12	3120	0.34	5178	0.9	5178	1.26
Rock Dike Below GWT	20	0	0	5047	0.07	7286	0.13	12986	0.34	25214	0.9	25214	1.26
Qybm	21	0	0	540	0.18	972	1.04	1296	2.46	1620	4.8	1620	5.1
Qybm	25	0	0	540	0.18	972	1.04	1296	2.46	1620	4.8	1620	5.1
Qal 1 (Clay)	26	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qal 1 (Clay)	29.5	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qal 1 (Sand)	30.5	0	0	7482	0.14	8989	0.18	13328	0.35	25351	0.9	25351	1.26
Qal 1 (Sand)	33.5	0	0	10287	0.17	11751	0.21	16157	0.36	30405	0.9	30405	1.26
Qal 1 (Clay)	34.5	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qal 1 (Clay)	39.5	0	0	1700	0.08	3060	0.87	4080	2.75	5100	6.72	5100	8.4
Qobc 1	40.5	0	0	1900	0.08	3420	0.87	4560	2.75	5700	6.72	5700	8.4
Qobc 1	96.5	0	0	1900	0.08	3420	0.87	4560	2.75	5700	6.72	5700	8.4
Qal 2 (Clay)	97.5	0	0	2750	0.06	4950	0.62	6600	1.97	8250	4.8	8250	6
Qal 2 (Clay)	109.5	0	0	2750	0.06	4950	0.62	6600	1.97	8250	4.8	8250	6
Qobc 2	110.5	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qobc 2	114.5	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qal 3 (Clay)	115.5	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qal 3 (Clay)	122.5	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qobc 3	123.5	0	0	2000	0.06	3600	0.62	4800	1.97	6000	4.8	6000	6
Qobc 3	143.5	0	0	2000	0.06	3600	0.62	4800	1.97	6000	4.8	6000	6
Qal 4 (Clay)	144.5	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6
Qal 4 (Clay)	156.5	0	0	3000	0.06	5400	0.62	7200	1.97	9000	4.8	9000	6

Section	Abutment Landside Pipe Pile						Lower Bound						
Material	Elevation, City of Berkeley Datum (feet)	p0 (psi)	y0 (in)	p1 (psi)	y1 (in)	p2 (psi)	y2 (in)	p3 (psi)	y3 (in)	p4 (psi)	y4 (in)	p5 (psi)	y5 (in)
Engineered Fill	0.5	0	0	9	0.03	12	0.10	16	0.33	23	0.9	23	1.26
Rock Dike Above GWT	1.5	0	0	50	0.02	76	0.09	110	0.33	158	0.9	158	1.26
Rock Dike Above GWT	6	0	0	288	0.03	449	0.10	721	0.33	1149	0.9	1149	1.26
Rock Dike Below GWT	7	0	0	368	0.06	500	0.12	780	0.34	1295	0.9	1295	1.26
Rock Dike Below GWT	20	0	0	1262	0.07	1822	0.13	3247	0.34	6304	0.9	6304	1.26
Qybm	21	0	0	135	0.18	243	1.04	324	2.46	405	4.8	405	5.1
Qybm	25	0	0	135	0.18	243	1.04	324	2.46	405	4.8	405	5.1
Qal 1 (Clay)	26	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qal 1 (Clay)	29.5	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qal 1 (Sand)	30.5	0	0	1871	0.14	2247	0.18	3332	0.35	6338	0.9	6338	1.26
Qal 1 (Sand)	33.5	0	0	2572	0.17	2938	0.21	4039	0.36	7601	0.9	7601	1.26
Qal 1 (Clay)	34.5	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qal 1 (Clay)	39.5	0	0	425	0.08	765	0.87	1020	2.75	1275	6.72	1275	8.4
Qobc 1	40.5	0	0	475	0.08	855	0.87	1140	2.75	1425	6.72	1425	8.4
Qobc 1	96.5	0	0	475	0.08	855	0.87	1140	2.75	1425	6.72	1425	8.4
Qal 2 (Clay)	97.5	0	0	688	0.06	1238	0.62	1650	1.97	2063	4.8	2063	6
Qal 2 (Clay)	109.5	0	0	688	0.06	1238	0.62	1650	1.97	2063	4.8	2063	6
Qobc 2	110.5	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qobc 2	114.5	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qal 3 (Clay)	115.5	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qal 3 (Clay)	122.5	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qobc 3	123.5	0	0	500	0.06	900	0.62	1200	1.97	1500	4.8	1500	6
Qobc 3	143.5	0	0	500	0.06	900	0.62	1200	1.97	1500	4.8	1500	6
Qal 4 (Clay)	144.5	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6
Qal 4 (Clay)	156.5	0	0	750	0.06	1350	0.62	1800	1.97	2250	4.8	2250	6



APPENDIX I

T-Z AND Q-W SPRINGS

4ft Concrete Breakwater t-z Springs

Section	Pier Alignment						Best Estimate						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	t1 (psi)	z1 (in)	t2 (psi)	z2 (in)	t3 (psi)	z3 (in)	t4 (psi)	z4 (in)	t5 (psi)	z5 (in)
Qybm	0.5	0	0	0	0.17	0	0.24	0	0.31	0	0.61	0	6.11
Qybm	6.5	0	0	0	0.17	0	0.24	0	0.31	0	0.61	0	6.11
Qal 1 (Clay)	7.5	0	0	1	0.17	2	0.24	2	0.31	2	0.61	2	6.11
Qal 1 (Clay)	12.5	0	0	1	0.17	1	0.24	1	0.31	1	0.61	1	6.11
Qal 1 (Sand)	13.5	0	0	5	0.17	7	0.24	7	0.31	7	0.61	7	6.11
Qal 1 (Sand)	16.5	0	0	10	0.17	12	0.24	13	0.31	13	0.61	13	6.11
Qal 1 (Clay)	17.5	0	0	7	0.17	8	0.24	9	0.31	8	0.61	8	6.11
Qal 1 (Clay)	22.5	0	0	4	0.17	5	0.24	5	0.31	5	0.61	5	6.11
Qobc 1	23.5	0	0	4	0.17	5	0.24	6	0.31	5	0.61	5	6.11
Qobc 1	28	0	0	5	0.17	6	0.24	6	0.31	6	0.61	6	6.11
Qobc 1	33	0	0	5	0.17	6	0.24	6	0.31	6	0.61	6	6.11
Qobc 1	38	0	0	5	0.17	6	0.24	7	0.31	6	0.61	6	6.11
Qobc 1	43	0	0	5	0.17	7	0.24	7	0.31	7	0.61	7	6.11
Qobc 1	48	0	0	6	0.17	7	0.24	8	0.31	7	0.61	7	6.11
Qobc 1	53	0	0	6	0.17	7	0.24	8	0.31	7	0.61	7	6.11
Qobc 1	58	0	0	6	0.17	8	0.24	9	0.31	8	0.61	8	6.11
Qobc 1	63	0	0	7	0.17	8	0.24	9	0.31	8	0.61	8	6.11
Qobc 1	68	0	0	7	0.17	8	0.24	9	0.31	8	0.61	8	6.11
Qobc 1	73	0	0	7	0.17	9	0.24	10	0.31	9	0.61	9	6.11
Qobc 1	79.5	0	0	8	0.17	9	0.24	10	0.31	9	0.61	9	6.11
Qal 2 (Clay)	80.5	0	0	8	0.17	10	0.24	11	0.31	10	0.61	10	6.11
Qal 2 (Clay)	92.5	0	0	10	0.17	12	0.24	13	0.31	12	0.61	12	6.11
Qobc 2	93.5	0	0	10	0.17	12	0.24	14	0.31	12	0.61	12	6.11
Qobc 2	97.5	0	0	11	0.17	13	0.24	14	0.31	13	0.61	13	6.11
Qal 3 (Clay)	98.5	0	0	11	0.17	13	0.24	14	0.31	13	0.61	13	6.11
Qal 3 (Clay)	105.5	0	0	11	0.17	13	0.24	15	0.31	13	0.61	13	6.11
Qobc 3	106.5	0	0	10	0.17	12	0.24	13	0.31	12	0.61	12	6.11
Qobc 3	126.5	0	0	10	0.17	12	0.24	13	0.31	12	0.61	12	6.11
Qal 4 (Clay)	127.5	0	0	12	0.17	14	0.24	16	0.31	14	0.61	14	6.11
Qal 4 (Clay)	139.5	0	0	15	0.17	18	0.24	20	0.31	18	0.61	18	6.11

Section	Pier Alignment						Upper Bound						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	t1 (psi)	z1 (in)	t2 (psi)	z2 (in)	t3 (psi)	z3 (in)	t4 (psi)	z4 (in)	t5 (psi)	z5 (in)
Qybm	0.5	0	0	0	0.17	0	0.24	0	0.31	0	0.61	0	6.11
Qybm	6.5	0	0	0	0.17	0	0.24	0	0.31	0	0.61	0	6.11
Qal 1 (Clay)	7.5	0	0	3	0.17	3	0.24	4	0.31	3	0.61	3	6.11
Qal 1 (Clay)	12.5	0	0	2	0.17	3	0.24	3	0.31	3	0.61	3	6.11
Qal 1 (Sand)	13.5	0	0	11	0.17	13	0.24	15	0.31	15	0.61	15	6.11
Qal 1 (Sand)	16.5	0	0	20	0.17	24	0.24	27	0.31	27	0.61	27	6.11
Qal 1 (Clay)	17.5	0	0	14	0.17	17	0.24	18	0.31	17	0.61	17	6.11
Qal 1 (Clay)	22.5	0	0	8	0.17	10	0.24	11	0.31	10	0.61	10	6.11
Qobc 1	23.5	0	0	8	0.17	10	0.24	11	0.31	10	0.61	10	6.11
Qobc 1	28	0	0	9	0.17	11	0.24	12	0.31	11	0.61	11	6.11
Qobc 1	33	0	0	10	0.17	12	0.24	13	0.31	12	0.61	12	6.11
Qobc 1	38	0	0	10	0.17	12	0.24	14	0.31	12	0.61	12	6.11
Qobc 1	43	0	0	11	0.17	13	0.24	14	0.31	13	0.61	13	6.11
Qobc 1	48	0	0	12	0.17	14	0.24	15	0.31	14	0.61	14	6.11
Qobc 1	53	0	0	12	0.17	15	0.24	16	0.31	15	0.61	15	6.11
Qobc 1	58	0	0	13	0.17	15	0.24	17	0.31	15	0.61	15	6.11
Qobc 1	63	0	0	13	0.17	16	0.24	18	0.31	16	0.61	16	6.11
Qobc 1	68	0	0	14	0.17	17	0.24	19	0.31	17	0.61	17	6.11
Qobc 1	73	0	0	14	0.17	17	0.24	19	0.31	17	0.61	17	6.11
Qobc 1	79.5	0	0	15	0.17	18	0.24	20	0.31	18	0.61	18	6.11
Qal 2 (Clay)	80.5	0	0	17	0.17	20	0.24	22	0.31	20	0.61	20	6.11
Qal 2 (Clay)	92.5	0	0	20	0.17	24	0.24	26	0.31	24	0.61	24	6.11
Qobc 2	93.5	0	0	20	0.17	24	0.24	27	0.31	24	0.61	24	6.11
Qobc 2	97.5	0	0	21	0.17	25	0.24	28	0.31	25	0.61	25	6.11
Qal 2 (Clay)	98.5	0	0	21	0.17	26	0.24	28	0.31	26	0.61	26	6.11
Qal 2 (Clay)	105.5	0	0	22	0.17	27	0.24	30	0.31	27	0.61	27	6.11
Qobc 3	106.5	0	0	20	0.17	24	0.24	27	0.31	24	0.61	24	6.11
Qobc 3	126.5	0	0	20	0.17	24	0.24	26	0.31	24	0.61	24	6.11
Qal 4 (Clay)	127.5	0	0	24	0.17	29	0.24	32	0.31	29	0.61	29	6.11
Qal 4 (Clay)	139.5	0	0	30	0.17	35	0.24	39	0.31	35	0.61	35	6.11

Section	Pier Alignment						Lower Bound						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	t1 (psi)	z1 (in)	t2 (psi)	z2 (in)	t3 (psi)	z3 (in)	t4 (psi)	z4 (in)	t5 (psi)	z5 (in)
Qybm	0.5	0	0	0	0.17	0	0.24	0	0.31	0	0.61	0	6.11
Qybm	6.5	0	0	0	0.17	0	0.24	0	0.31	0	0.61	0	6.11
Qal 1 (Clay)	7.5	0	0	1	0.17	1	0.24	1	0.31	1	0.61	1	6.11
Qal 1 (Clay)	12.5	0	0	1	0.17	1	0.24	1	0.31	1	0.61	1	6.11
Qal 1 (Sand)	13.5	0	0	3	0.17	3	0.24	4	0.31	4	0.61	4	6.11
Qal 1 (Sand)	16.5	0	0	5	0.17	6	0.24	7	0.31	7	0.61	7	6.11
Qal 1 (Clay)	17.5	0	0	3	0.17	4	0.24	5	0.31	4	0.61	4	6.11
Qal 1 (Clay)	22.5	0	0	2	0.17	2	0.24	3	0.31	2	0.61	2	6.11
Qobc 1	23.5	0	0	2	0.17	3	0.24	3	0.31	3	0.61	3	6.11
Qobc 1	28	0	0	2	0.17	3	0.24	3	0.31	3	0.61	3	6.11
Qobc 1	33	0	0	2	0.17	3	0.24	3	0.31	3	0.61	3	6.11
Qobc 1	38	0	0	3	0.17	3	0.24	3	0.31	3	0.61	3	6.11
Qobc 1	43	0	0	3	0.17	3	0.24	4	0.31	3	0.61	3	6.11
Qobc 1	48	0	0	3	0.17	3	0.24	4	0.31	3	0.61	3	6.11
Qobc 1	53	0	0	3	0.17	4	0.24	4	0.31	4	0.61	4	6.11
Qobc 1	58	0	0	3	0.17	4	0.24	4	0.31	4	0.61	4	6.11
Qobc 1	63	0	0	3	0.17	4	0.24	4	0.31	4	0.61	4	6.11
Qobc 1	68	0	0	3	0.17	4	0.24	5	0.31	4	0.61	4	6.11
Qobc 1	73	0	0	4	0.17	4	0.24	5	0.31	4	0.61	4	6.11
Qobc 1	79.5	0	0	4	0.17	5	0.24	5	0.31	5	0.61	5	6.11
Qal 2 (Clay)	80.5	0	0	4	0.17	5	0.24	6	0.31	5	0.61	5	6.11
Qal 2 (Clay)	92.5	0	0	5	0.17	6	0.24	7	0.31	6	0.61	6	6.11
Qobc 2	93.5	0	0	5	0.17	6	0.24	7	0.31	6	0.61	6	6.11
Qobc 2	97.5	0	0	5	0.17	6	0.24	7	0.31	6	0.61	6	6.11
Qal 2 (Clay)	98.5	0	0	5	0.17	6	0.24	7	0.31	6	0.61	6	6.11
Qal 2 (Clay)	105.5	0	0	6	0.17	7	0.24	7	0.31	7	0.61	7	6.11
Qobc 3	106.5	0	0	5	0.17	6	0.24	7	0.31	6	0.61	6	6.11
Qobc 3	126.5	0	0	5	0.17	6	0.24	7	0.31	6	0.61	6	6.11
Qal 4 (Clay)	127.5	0	0	6	0.17	7	0.24	8	0.31	7	0.61	7	6.11
Qal 4 (Clay)	139.5	0	0	7	0.17	9	0.24	10	0.31	9	0.61	9	6.11

24-inch Concrete Precast Prestressed Octagonal Pile t-z Springs

Section	Pier Alignment						Best Estimate						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	t1 (psi)	z1 (in)	t2 (psi)	z2 (in)	t3 (psi)	z3 (in)	t4 (psi)	z4 (in)	t5 (psi)	z5 (in)
Qybm	0.5	0	0.00	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qybm	6.5	0	0.00	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qal 1 (Clay)	7.5	0	0.00	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qal 1 (Clay)	12.5	0	0.00	1	0.14	2	0.20	2	0.25	2	0.51	2	5.08
Qal 1 (Sand)	13.5	0	0.00	1	0.14	1	0.20	1	0.25	1	0.51	1	5.08
Qal 1 (Sand)	16.5	0	0.00	10	0.14	12	0.20	13	0.25	13	0.51	13	5.08
Qal 1 (Clay)	17.5	0	0.00	10	0.14	12	0.20	13	0.25	12	0.51	12	5.08
Qal 1 (Clay)	22.5	0	0.00	4	0.14	5	0.20	5	0.25	5	0.51	5	5.08
Qobc 1	23.5	0	0.00	4	0.14	5	0.20	5	0.25	5	0.51	5	5.08
Qobc 1	28	0	0.00	5	0.14	5	0.20	6	0.25	5	0.51	5	5.08
Qobc 1	33	0	0.00	5	0.14	6	0.20	6	0.25	6	0.51	6	5.08
Qobc 1	38	0	0.00	5	0.14	6	0.20	7	0.25	6	0.51	6	5.08
Qobc 1	43	0	0.00	5	0.14	6	0.20	7	0.25	6	0.51	6	5.08
Qobc 1	48	0	0.00	6	0.14	7	0.20	7	0.25	7	0.51	7	5.08
Qobc 1	53	0	0.00	6	0.14	7	0.20	8	0.25	7	0.51	7	5.08
Qobc 1	58	0	0.00	6	0.14	7	0.20	8	0.25	7	0.51	7	5.08
Qobc 1	63	0	0.00	6	0.14	8	0.20	9	0.25	8	0.51	8	5.08
Qobc 1	68	0	0.00	7	0.14	8	0.20	9	0.25	8	0.51	8	5.08
Qobc 1	73	0	0.00	7	0.14	8	0.20	9	0.25	8	0.51	8	5.08
Qobc 1	79.5	0	0.00	7	0.14	9	0.20	10	0.25	9	0.51	9	5.08
Qal 2 (Clay)	80.5	0	0.00	7	0.14	9	0.20	10	0.25	9	0.51	9	5.08
Qal 2 (Clay)	92.5	0	0.00	10	0.14	11	0.20	13	0.25	11	0.51	11	5.08
Qobc 2	93.5	0	0.00	10	0.14	12	0.20	13	0.25	12	0.51	12	5.08
Qobc 2	97.5	0	0.00	10	0.14	12	0.20	13	0.25	12	0.51	12	5.08
Qal 3 (Clay)	98.5	0	0.00	10	0.14	12	0.20	13	0.25	12	0.51	12	5.08
Qal 3 (Clay)	105.5	0	0.00	11	0.14	13	0.20	14	0.25	13	0.51	13	5.08
Qobc 3	106.5	0	0.00	11	0.14	13	0.20	14	0.25	13	0.51	13	5.08
Qobc 3	126.5	0	0.00	10	0.14	12	0.20	13	0.25	12	0.51	12	5.08
Qal 4 (Clay)	127.5	0	0.00	10	0.14	12	0.20	13	0.25	12	0.51	12	5.08
Qal 4 (Clay)	137.5	0	0.00	14	0.14	17	0.20	19	0.25	17	0.51	17	5.08
Qal 4 (Clay)	145.5	0	0.00	14	0.14	17	0.20	19	0.25	17	0.51	17	5.08

Section	Pier Alignment						Upper Bound						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	t1 (psi)	z1 (in)	t2 (psi)	z2 (in)	t3 (psi)	z3 (in)	t4 (psi)	z4 (in)	t5 (psi)	z5 (in)
Qybm	0.5	0	0.00	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qybm	6.5	0	0.00	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qal 1 (Clay)	7.5	0	0.00	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qal 1 (Clay)	12.5	0	0.00	3	0.14	3	0.20	3	0.25	3	0.51	3	5.08
Qal 1 (Sand)	13.5	0	0.00	2	0.14	2	0.20	2	0.25	2	0.51	2	5.08
Qal 1 (Sand)	16.5	0	0.00	20	0.14	24	0.20	27	0.25	27	0.51	27	5.08
Qal 1 (Clay)	17.5	0	0.00	20	0.14	24	0.20	27	0.25	24	0.51	24	5.08
Qal 1 (Clay)	22.5	0	0.00	8	0.14	9	0.20	10	0.25	9	0.51	9	5.08
Qobc 1	23.5	0	0.00	8	0.14	9	0.20	10	0.25	9	0.51	9	5.08
Qobc 1	28	0	0.00	9	0.14	11	0.20	12	0.25	11	0.51	11	5.08
Qobc 1	33	0	0.00	9	0.14	11	0.20	13	0.25	11	0.51	11	5.08
Qobc 1	38	0	0.00	10	0.14	12	0.20	13	0.25	12	0.51	12	5.08
Qobc 1	43	0	0.00	11	0.14	13	0.20	14	0.25	13	0.51	13	5.08
Qobc 1	48	0	0.00	11	0.14	13	0.20	15	0.25	13	0.51	13	5.08
Qobc 1	53	0	0.00	12	0.14	14	0.20	16	0.25	14	0.51	14	5.08
Qobc 1	58	0	0.00	12	0.14	15	0.20	16	0.25	15	0.51	15	5.08
Qobc 1	63	0	0.00	13	0.14	16	0.20	17	0.25	16	0.51	16	5.08
Qobc 1	68	0	0.00	13	0.14	16	0.20	18	0.25	16	0.51	16	5.08
Qobc 1	73	0	0.00	14	0.14	17	0.20	19	0.25	17	0.51	17	5.08
Qobc 1	79.5	0	0.00	15	0.14	18	0.20	20	0.25	18	0.51	18	5.08
Qal 2 (Clay)	80.5	0	0.00	15	0.14	18	0.20	20	0.25	18	0.51	18	5.08
Qal 2 (Clay)	92.5	0	0.00	19	0.14	23	0.20	26	0.25	23	0.51	23	5.08
Qobc 2	93.5	0	0.00	19	0.14	23	0.20	26	0.25	23	0.51	23	5.08
Qobc 2	97.5	0	0.00	20	0.14	24	0.20	26	0.25	24	0.51	24	5.08
Qal 3 (Clay)	98.5	0	0.00	20	0.14	24	0.20	26	0.25	24	0.51	24	5.08
Qal 3 (Clay)	105.5	0	0.00	21	0.14	26	0.20	29	0.25	26	0.51	26	5.08
Qobc 3	106.5	0	0.00	22	0.14	26	0.20	29	0.25	26	0.51	26	5.08
Qobc 3	126.5	0	0.00	19	0.14	23	0.20	26	0.25	23	0.51	23	5.08
Qal 4 (Clay)	127.5	0	0.00	19	0.14	23	0.20	26	0.25	23	0.51	23	5.08
Qal 4 (Clay)	137.5	0	0.00	28	0.14	34	0.20	38	0.25	34	0.51	34	5.08
Qal 4 (Clay)	145.5	0	0.00	29	0.14	35	0.20	38	0.25	35	0.51	35	5.08

Section	Pier Alignment						Lower Bound						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	t1 (psi)	z1 (in)	t2 (psi)	z2 (in)	t3 (psi)	z3 (in)	t4 (psi)	z4 (in)	t5 (psi)	z5 (in)
Qybm	0.5	0	0	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qybm	6.5	0	0	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qal 1 (Clay)	7.5	0	0	0	0.14	0	0.20	0	0.25	0	0.51	0	5.08
Qal 1 (Clay)	12.5	0	0	1	0.14	1	0.20	1	0.25	1	0.51	1	5.08
Qal 1 (Sand)	13.5	0	0	0	0.14	1	0.20	1	0.25	1	0.51	1	5.08
Qal 1 (Sand)	16.5	0	0	5	0.14	6	0.20	7	0.25	7	0.51	7	5.08
Qal 1 (Clay)	17.5	0	0	5	0.14	6	0.20	7	0.25	6	0.51	6	5.08
Qal 1 (Clay)	22.5	0	0	2	0.14	2	0.20	3	0.25	2	0.51	2	5.08
Qobc 1	23.5	0	0	2	0.14	2	0.20	3	0.25	2	0.51	2	5.08
Qobc 1	28	0	0	2	0.14	3	0.20	3	0.25	3	0.51	3	5.08
Qobc 1	33	0	0	2	0.14	3	0.20	3	0.25	3	0.51	3	5.08
Qobc 1	38	0	0	2	0.14	3	0.20	3	0.25	3	0.51	3	5.08
Qobc 1	43	0	0	3	0.14	3	0.20	4	0.25	3	0.51	3	5.08
Qobc 1	48	0	0	3	0.14	3	0.20	4	0.25	3	0.51	3	5.08
Qobc 1	53	0	0	3	0.14	4	0.20	4	0.25	4	0.51	4	5.08
Qobc 1	58	0	0	3	0.14	4	0.20	4	0.25	4	0.51	4	5.08
Qobc 1	63	0	0	3	0.14	4	0.20	4	0.25	4	0.51	4	5.08
Qobc 1	68	0	0	3	0.14	4	0.20	4	0.25	4	0.51	4	5.08
Qobc 1	73	0	0	3	0.14	4	0.20	5	0.25	4	0.51	4	5.08
Qobc 1	79.5	0	0	4	0.14	4	0.20	5	0.25	4	0.51	4	5.08
Qal 2 (Clay)	80.5	0	0	4	0.14	4	0.20	5	0.25	4	0.51	4	5.08
Qal 2 (Clay)	92.5	0	0	5	0.14	6	0.20	6	0.25	6	0.51	6	5.08
Qobc 2	93.5	0	0	5	0.14	6	0.20	6	0.25	6	0.51	6	5.08
Qobc 2	97.5	0	0	5	0.14	6	0.20	7	0.25	6	0.51	6	5.08
Qal 3 (Clay)	98.5	0	0	5	0.14	6	0.20	7	0.25	6	0.51	6	5.08
Qal 3 (Clay)	105.5	0	0	5	0.14	6	0.20	7	0.25	6	0.51	6	5.08
Qobc 3	106.5	0	0	5	0.14	6	0.20	7	0.25	6	0.51	6	5.08
Qobc 3	126.5	0	0	5	0.14	6	0.20	6	0.25	6	0.51	6	5.08
Qal 4 (Clay)	127.5	0	0	5	0.14	6	0.20	6	0.25	6	0.51	6	5.08
Qal 4 (Clay)	137.5	0	0	7	0.14	9	0.20	9	0.25	9	0.51	9	5.08
Qal 4 (Clay)	145.5	0	0	7	0.14	9	0.20	10	0.25	9	0.51	9	5.08

24-inch Concrete Precast Prestressed Octagonal Pile Q-w Springs

Section	Pier Alignment						Best Estimate						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	Q1 (kips)	w1 (in)	Q2 (kips)	w2 (in)	Q3 (kips)	w3 (in)	Q4 (kips)	w4 (in)	Q5 (kips)	w5 (in)
Qobc 1	50	0	0	14	0.05	28	0.32	42	1.03	56	2.46	56	4.92
Qobc 1	75	0	0	14	0.05	28	0.32	42	1.03	56	2.46	56	4.92
Qal 2 (Clay)	86	0	0	20	0.05	41	0.32	61	1.03	82	2.46	82	4.92
Qal 3 (Clay)	102	0	0	22	0.05	45	0.32	67	1.03	89	2.46	89	4.92
Qobc 3	116	0	0	15	0.05	30	0.32	45	1.03	59	2.46	59	4.92
Qal 4 (Clay)	135	0	0	30	0.05	59	0.32	89	1.03	119	2.46	119	4.92

Section	Pier Alignment						Upper Bound						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	Q1 (kips)	w1 (in)	Q2 (kips)	w2 (in)	Q3 (kips)	w3 (in)	Q4 (kips)	w4 (in)	Q5 (kips)	w5 (in)
Qobc 1	50	0	0	28	0.05	56	0.32	85	1.03	113	2.46	113	4.92
Qobc 1	75	0	0	28	0.05	56	0.32	85	1.03	113	2.46	113	4.92
Qal 2 (Clay)	86	0	0	41	0.05	82	0.32	123	1.03	163	2.46	163	4.92
Qal 3 (Clay)	102	0	0	45	0.05	89	0.32	134	1.03	178	2.46	178	4.92
Qobc 3	116	0	0	30	0.05	59	0.32	89	1.03	119	2.46	119	4.92
Qal 4 (Clay)	135	0	0	59	0.05	119	0.32	178	1.03	238	2.46	238	4.92

Section	Pier Alignment						Lower Bound						
Material	Depth Below Mudline (feet)	t0 (psi)	z0 (in)	Q1 (kips)	w1 (in)	Q2 (kips)	w2 (in)	Q3 (kips)	w3 (in)	Q4 (kips)	w4 (in)	Q5 (kips)	w5 (in)
Qobc 1	50	0	0	7	0.05	14	0.32	21	1.03	28	2.46	28	4.92
Qobc 1	75	0	0	7	0.05	14	0.32	21	1.03	28	2.46	28	4.92
Qal 2 (Clay)	86	0	0	10	0.05	20	0.32	31	1.03	41	2.46	41	4.92
Qal 3 (Clay)	102	0	0	11	0.05	22	0.32	33	1.03	45	2.46	45	4.92
Qobc 3	116	0	0	7	0.05	15	0.32	22	1.03	30	2.46	30	4.92
Qal 4 (Clay)	135	0	0	15	0.05	30	0.32	45	1.03	59	2.46	59	4.92



APPENDIX J

PIER PLAZA SETTLEMENT MITIGATION

Project No.
25022.000.001

June 2, 2025

Mr. James Connolly
COWI
555 12th Street, Suite 1700
Oakland, CA 94601

Subject: Berkeley Water Transportation Pier Ferry
Berkeley, California

PIER PLAZA SETTLEMENT MITIGATION

Reference: ENGEO. 2024. Geotechnical Report, Berkeley Water Transportation Pier Ferry, Berkeley. December 16, 2024, Revised May 28, 2025. Project No. 25022.000.001.

Dear Mr. Connolly:

Based on our understanding, grades within the Pier Plaza portion of the Berkeley Water Transportation Pier Ferry project in Berkeley, California will be raised by up to 5½ feet to facilitate the Berkeley Water Transportation Pier Ferry project. The Pier Plaza area is shown in Exhibit 1. During our geotechnical exploration for our referenced Geotechnical Report, we encountered 4 to 16 feet of compressible Young Bay Mud in each of our explorations. Table 1 summarizes the thickness of Young Bay Mud that we encountered in the area within or directly adjacent to Pier Plaza. As discussed in the referenced Geotechnical Report, we estimate the resulting settlement from fill placement will be approximately 2½ to 5 inches.

TABLE 1: Summary of Young Bay Mud Thickness in Borehole and CPT Explorations near the Pier Plaza

EXPLORATION ID	THICKNESS OF YOUNG BAY MUD (ft)
1-B1	16
1-B2	7½
1-B3	6
2-B1	4
2-B4	5
1-CPT1	4

EXHIBIT 1: Pier Plaza Area

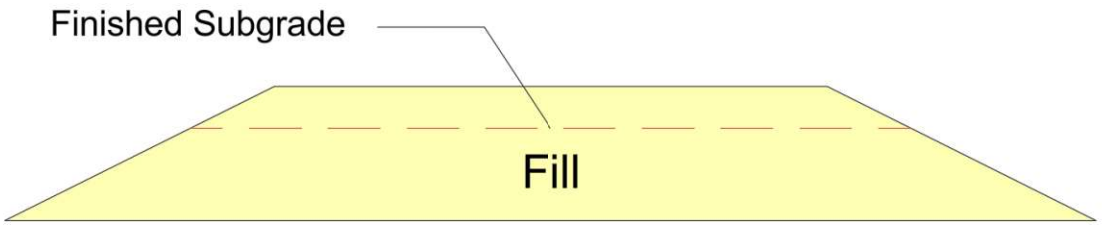


Based on our discussions with you, this range of potential long-term settlement is excessive for the planned improvements. In our referenced Geotechnical Report, we recommend the use of cellular concrete and/or surcharging to limit the impacts of long-term consolidation settlement on the site. Due to the existing shoreline slope, it is not feasible to place surcharge at the location of the wall as that would require placing new fill beyond the existing shoreline.

Therefore, through our conversations with the design team, we selected a segmental wall with precast concrete panels for the facing. This segmental wall will allow for some settlement since the panels can move independently to address differential settlement. Further, the team elected to backfill the wall with cellular concrete to limit that settlement. Once the fill at the wall is far enough from the retaining wall that it will not add additional loading on the wall, a surcharge fill should be placed to cost-effectively mitigate the settlement of the rest of the Pier Plaza. We recommend the following construction sequence below.

1. Construct an 8-foot-high engineered fill embankment with slope gradients not exceeding 2:1 (horizontal:vertical), as shown in Exhibit 2. The embankment should begin at the shoreline and extend 65 feet wide.

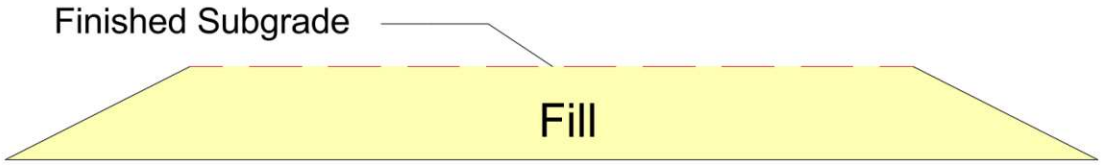
EXHIBIT 2: Construct Embankment Surcharge



2. Allow the Young Bay Mud to settle for approximately 3 months. Surcharge release should be based on accomplishing at least 75 percent consolidation of the fill and surcharge based on settlement monitoring.

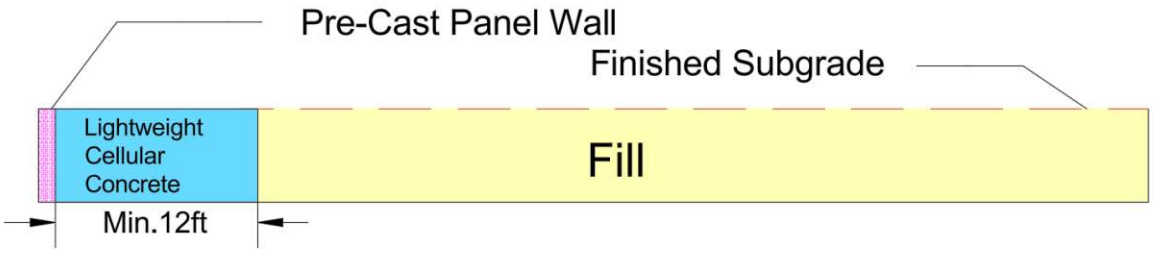
3. Cut the embankment to finished subgrade as shown in Exhibit 3.

EXHIBIT 3: Cut Embankment Surcharge to Final Grade



4. Excavate the embankment at the wall location to allow for a minimum 12-foot-wide lightweight cellular concrete backfill behind the wall as shown in Exhibit 4.

EXHIBIT 4: Excavate Embankment Surcharge far Enough Back to Allow for Construction of Pre-Cast Segmental Panel Wall and Minimum 12-foot-wide area of Lightweight Cellular Concrete Backfill



If the above steps are taken, we expect that the post-construction settlement will be reduced to approximately 1 to 2 inches within 50 years. Cellular concrete lift heights will be restricted by the vertical locations of the reinforcement strips and should be kept to no more than the height of material that is capable of supporting its own weight.

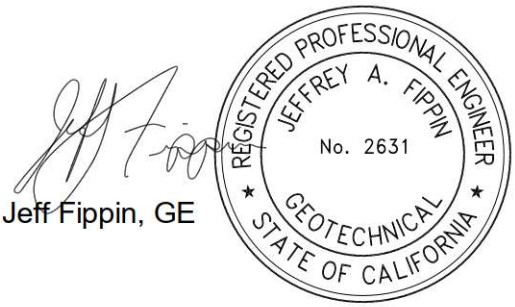
If you have any questions or comments regarding this letter, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated



Vlad Zasmolin, PE



Jeff Fippin, GE

vz/jaf/cb



APPENDIX K

PIER ABUTMENT LATERAL EARTH PRESSURE RECOMMENDATIONS

Project No.
25022.000.001

November 24, 2025

Mr. James Connolly
COWI
555 12th Street, Suite 1700
Oakland, CA 94601

Subject: Berkeley Water Transportation Pier Ferry
Berkeley, California

PIER ABUTMENT LATERAL EARTH PRESSURE RECOMMENDATIONS

References:
1. ENGEO. 2025. Geotechnical Report, Berkeley Water Transportation PierFerry. December 12, 2024; Revised June 2, 2025. Project No. 25022.000.001.
2. California Geologic Survey (CGS). 2008. Guidelines for Evaluating and Mitigating Seismic Hazards in California, Special Publication 117A, California Department of Conservation.

Dear Mr. Connolly:

At your request, we have prepared this letter to provide design recommendations for lateral earth pressure on the proposed concrete pier abutment wall at the Berkeley Water Transportation Pier Ferry at the Berkeley Marina in Berkeley, California. We understand the abutment will support a portion of the pier entrance, and a separate retaining structure will support the edge of the entrance and plaza extending north and south of the pier. The abutment wall will be supported on 24-inch-diameter, 1-inch-thick, steel-driven pipe piles and will retain lightweight cellular concrete (LWCC) extending approximately 14 feet laterally from the back of the wall.

The project elevation datum referred to in this letter is the City of Berkeley Mean Lower Low Water tidal datum.

GROUNDWATER CONDITIONS

We anticipate the landside groundwater level to be tidally influenced due to the proximity to the San Francisco Bay and the fill material type. Based on our discussions with the design team, we developed design recommendations assuming that water may accumulate behind the abutment up to Elevation 14.5 feet due to sea level rise, extreme rainfall, and wave run-up conditions. Although the LWCC backfill is designed to be free-draining (permeability of 1×10^{-2} centimeters per second or greater) and the wall will be designed with a perforated subdrain, the design team elected to assume a hydraulic lag will create a differential hydrostatic load on the wall. The specific groundwater assumptions for static and seismic design are detailed below.

- Static Loading Conditions: For static load evaluation, the design team elected to use a landside groundwater level at Elevation 14.5 based on sea level rise, extreme rainfall, and wave run-up. On the bayside we assumed a water level below the retained height of the proposed abutment (a conservative estimate).
- Seismic Loading Conditions: Since it would be unlikely that a seismic event occur during an extreme storm event, we assumed the landside and bayside groundwater table to be below the retained soil height, a condition that holds true even when considering the Mean Higher High Water level with a long-term sea level rise scenario.

LATERAL EARTH PRESSURES

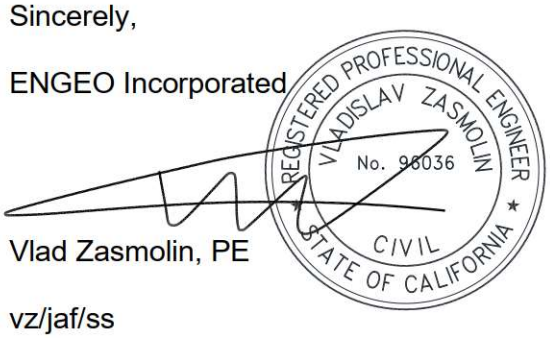
The wall should be designed for static load conditions using a combination of active earth pressures, surcharge loading, and hydrostatic pressures. For static loading, the walls may be designed for the equivalent fluid pressures of 64 pounds per cubic foot. To accommodate for fire truck and vehicular loading at the top of the wall, a uniform horizontal lateral load of 125 pounds per square foot (psf) should be applied to the entire height of the abutment wall.

Because the ferry terminal is an essential facility, we recommend designing the abutment wall for the Maximum Considered Earthquake (MCE) defined in our geotechnical report (Reference 1). To evaluate pressures on the wall during an MCE-level seismic event, we utilized the General Limit Equilibrium (GLE) method. In this analysis, we modeled the wall as a vertical cut subject to a driving horizontal seismic coefficient (k_h) equal to 0.48g. We then applied a counteracting external force to the face of the cut, iteratively adjusting the load magnitude until the system reached equilibrium (factor of safety of 1.0). We developed the seismic coefficient (k_h) in accordance with CGS Special Publication 117A (Reference 2), utilizing the MCE Geometric Mean Peak Ground Acceleration (PGA) equal to 0.85g (per the seismic hazard analysis in Reference 1), a Magnitude 8.1 event on the San Andreas Fault, and a maximum wall deflection allowance of 2 inches (5 centimeters). Based on this analysis, we recommend applying an equivalent lateral earth pressure of 70 pounds per cubic foot (pcf) for seismic loading. This value is equal to the sum of the active lateral earth pressure plus the seismic increment. We show our slope stability results as an attachment to this letter.

Resistance to overturning of the seawall is developed through the passive earth pressure generated by deflection of the wall into the embedded foreground as well as the rotation of the driven piles. We recommend using an ultimate passive resistance of 150 pcf for the Class V armor rock.

Sincerely,

ENGEO Incorporated



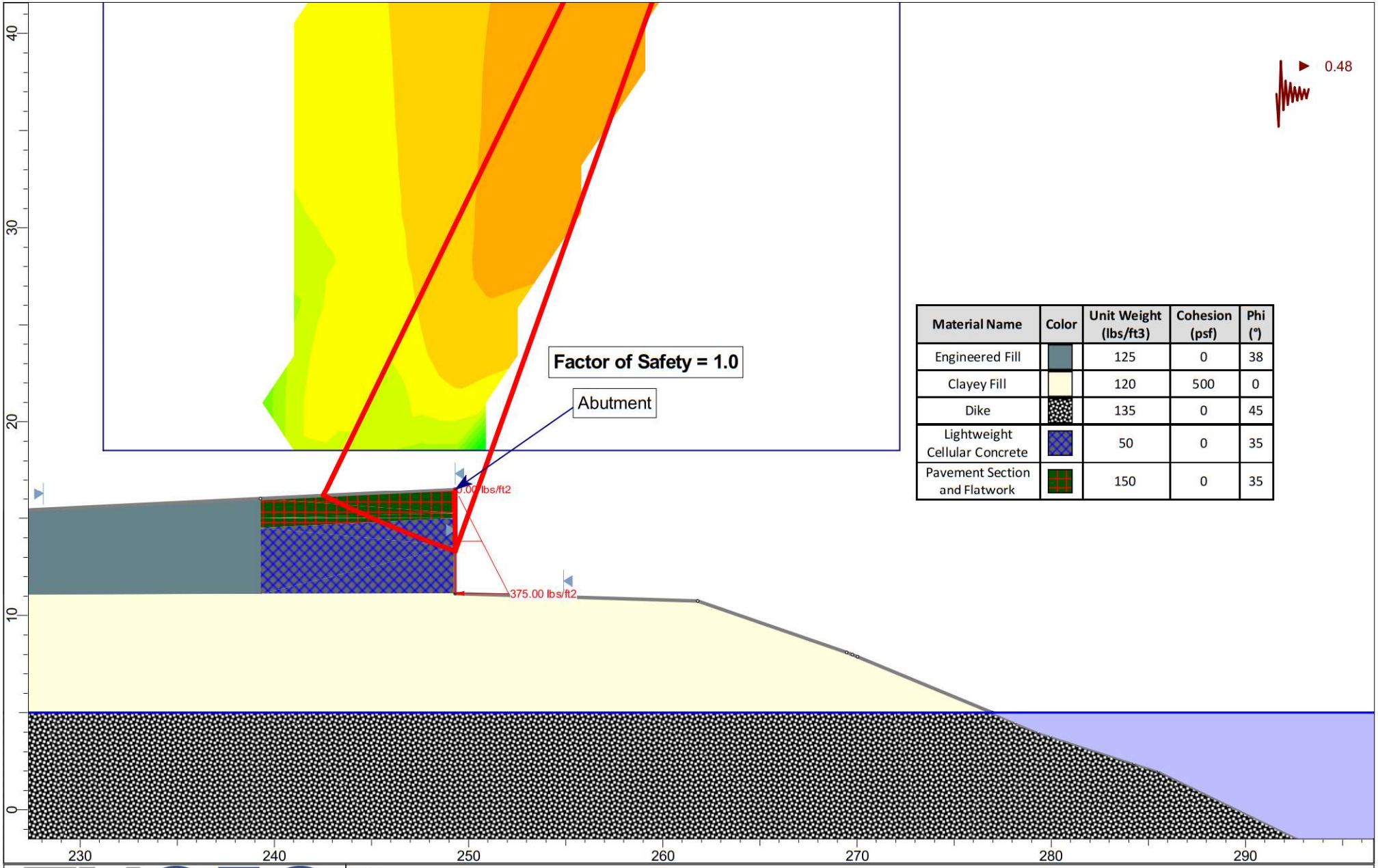
Vlad Zasmolin, PE



Jeff Fippin, GE

vz/jaf/ss

Attachment: Seismic Slope Stability Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (°)
Engineered Fill		125	0	38
Clayey Fill		120	500	0
Dike		135	0	45
Lightweight Cellular Concrete		50	0	35
Pavement Section and Flatwork		150	0	35

ENGEO
Expect Excellence

Project	Berkeley Water Transportation Pier Ferry		
Scale 1:81		*Author* VZ/JF	*Project No.* 25022.000.001
Date 11/14/2025		*Condition* Estimate of Earthquake and Soil Pressure on Abutment based on 2 inches of Lateral Movement during MCE-Level Earthquake (SP117A)	



APPENDIX L

PRECAST PANEL MECHANICALLY STABILIZED EARTH SEAWALL SUBMITTAL

Project No.
25022.000.001

December 12, 2025

Mr. James Connolly
COWI
555 12th Street, Suite 1700
Oakland, CA 94601

Subject: Berkeley Water Transportation Pier Ferry
Berkeley Marina
Berkeley, California

PRECAST PANEL MECHANICALLY STABILIZED EARTH RETAINING WALL DESIGN

Dear Mr. Connolly:

This submittal presents our narrative, calculation package, and plan set for the proposed precast panel mechanically stabilized earth (MSE) seawall (retaining wall) for the Berkeley Water Transportation Pier Ferry (BWTPF) project. We used our findings, recommendations and conclusions outlined in our Geotechnical Report (ENGEO, 2025) to support the design of this MSE retaining wall. All project elevations referenced herein are based on the City of Berkeley Mean Lower Low Water (MLLW) datum.

PROJECT OVERVIEW AND SYSTEM DESCRIPTION

The Request for Qualifications (RFQ) document prepared by the City of Berkeley, dated December 15, 2023, describes that the project consists of demolishing 1,080 linear feet of the existing Municipal Berkeley Pier and replacing it with a new 1,480 linear foot sword-shaped pier and breakwater. The new pier will serve as a dual-use facility, functioning as a Water Transportation Authority (WETA) electric-ready ferry terminal and a recreational pier for walking and fishing. At the pier entrance, the grade will be raised from Elevation 11 feet to Elevation 16½ feet to facilitate construction of the entrance plaza. To the north and south of the pier the ground surface will slope down at a gradient of 1.4 and 1.7 percent, respectively.

The design team has selected to construct a precast panel MSE retaining wall to retain the new fill. This system was chosen to mitigate architectural distress in the wall due to consolidation settlement of the underlying Young Bay Mud following fill placement. Unlike conventional gravity or cantilever concrete walls, the joints between the precast panels are can move relative to each other to accommodate minor differential settlement with negligible to minor distress.

The proposed MSE retaining wall will comprise precast concrete facing panels (Maccaferri MacRes or approved equivalent) connected to discrete high-adherence polymeric soil reinforcing strips (Paraweb 2D30 Series or approved equivalent). The reinforcing strips will be mechanically connected to the rear face of the panels by threading them through cast-in-panel connection cavities. The reinforced backfill will consist of permeable Class II Lightweight Cellular Concrete (LWCC) extending 14 feet behind the wall. A Mirafi 180N non-woven geotextile will encapsulate the LWCC to prevent soil fines from clogging the pervious cellular structure. Water will be captured in a perforated pipe placed at the base of the fill that outlets through holes drilled in the wall panels; these outlets will be buried under the surface of the revetment placed at the base of the wall.

We designed the wall to retain up to 5½ feet of level backfill with a 2:1 (horizontal:vertical) sloping foreground. In addition, the design accounts for hydrostatic lateral earth pressure due to temporary inundation and surcharge loading from handrails, pedestrians and periodic emergency vehicles.

SOIL CONDITIONS

During our geotechnical exploration we drilled one mud rotary boring (1-B2), four sonic borings (2-B1, 2-B2, 2-B3, and 2-B4) and advanced one cone penetration test (1-CPT1) at the pier plaza. We present the idealized soil units and their approximate depth and elevation in Table 1.

TABLE 1: Idealized Soil Conditions at the Pier Plaza

APPROXIMATE LAYER ELEVATION (FEET)	LAYER THICKNESS (FEET)	MATERIAL	DESCRIPTION
Ground Surface to 4	6 to 10	Artificial Fill	Medium stiff lean clay and medium dense clayey sand with intermittent debris.
4 to -8	10 to 16	Rock Dike	Dense to very dense, well-graded gravels and sand containing cobble up to 4½ inches in diameter. Intermixed with accreted bay sediments.
-8 to -15	4 to 7½	Young Bay Mud	Soft to medium stiff compressible silt and clay.
-15 and below	100+	Alluvium/Old Bay Clay/Upper Alameda Formation	Stiff to very stiff clay with silt/sand interbeds

A detailed description of each geologic unit and a geologic cross section is provided in our Geotechnical Report (ENGEO, 2025).

GROUNDWATER CONDITIONS

We anticipate the landside groundwater level to be tidally influenced due to the proximity to the San Francisco Bay. Based on our discussions with the design team, we developed design recommendations assuming that water may accumulate behind the retaining wall up to Elevation 14.5 feet due to sea level rise, extreme rainfall, and wave run-up conditions. Although the LWCC backfill is designed to be free-draining (permeability of $1x10^{-2}$ centimeters per second or greater) and the wall will be designed with a perforated subdrain, the design team elected to assume a hydraulic lag will create a differential hydrostatic load on the wall. The specific groundwater assumptions for static and seismic design are detailed below.

- Static Loading Conditions: For static load evaluation, the design team elected to use a landside groundwater level at Elevation 14.5 based on sea level rise, extreme rainfall, and wave run-up conditions. On the bayside we assumed a water level below the retained height of the proposed wall (a conservative estimate).
- Seismic Loading Conditions: Since it would be unlikely that a seismic event occur during an extreme storm event, we assumed the landside and bayside groundwater table to be below the retained soil height to represent Mean Sea Level, a condition that holds true even when considering the long-term sea level rise scenario.

SETTLEMENT

As discussed in our Geotechnical Report (ENGEO, 2025), we estimate the settlement resulting from fill placement in the pier plaza to be approximately 2½ to 5 inches. Post-construction settlement will be mitigated through a combination of a surcharge program and load compensation with LWCC. The surcharge program involves constructing an 8-foot-high engineered fill embankment extending 65 feet behind the shoreline, which will remain in place for approximately 3 months or until 75 percent of primary consolidation in the Young Bay Mud is achieved. Subsequently, the embankment will be cut to finished subgrade and excavated at the wall location to accommodate the construction of the MSE wall and a 14-foot-wide zone of lightweight cellular concrete backfill. The construction sequence for the proposed surcharge program is detailed in Appendix J of our Geotechnical Report (ENGEO, 2025). If the surcharge program is implemented, we anticipate 1 inch of post-construction settlement over 50 years, which can be accommodated by the MSE retaining wall with negligible to minor distress.

DESIGN CRITERIA

General Design Standard

We designed the MSE retaining wall in accordance with the AASHTO LRFD Bridge Design Specifications, 9th Edition (2020). The design follows the load and resistance factor design (LRFD) methodology to evaluate internal stability of the geostrips (tensile strength, connection strength, and pullout capacity of reinforcement) and external stability of the wall (sliding, overturning, and bearing capacity) for strength limit state (static) and extreme limit state (seismic) loading conditions.

Surchage Loading

We applied surcharge loads behind the MSE retaining wall to account for handrails, pedestrian traffic, and periodic fire truck loading. The coping is structurally connected to the panels via dowels; therefore, our model considers it part of the retaining height rather than a surcharge load. Table 2 summarizes the loading magnitudes we used in our analysis.

TABLE 2: Surcharge Loading Summary

ITEM	DEAD LOAD (DIRECTION)	LIVE LOAD #1 (DIRECTION)	LIVE LOAD #2	SOURCE
Handrail	50 pounds per lineal foot (plf) (Vertical)	50 plf (Vertical and Horizontal)	200 pounds (lbs) (Vertical and Horizontal)	Estimated handrail weight and AASHTO LRFD SECTION 13.8.2
Pedestrian Traffic	-	75 pounds per square foot (psf) (Vertical)	-	AASHTO LRFD SECTION 3.6.1.6
Fire Truck Loading (Applied to Static Condition only)	-	250 psf (Vertical)	-	Standard of Practice for Highways

Seismic Design Criteria

We understand the pier is classified as an essential facility and require ongoing access during and following seismic events. In our Geotechnical Report (ENGEO, 2025) we developed seismic-

design response spectra for the pier structure in accordance with the guidelines presented in the 2014 ASCE/COPRI 61 Standard: Seismic Design of Piers and Wharves (ASCE 61-14). We estimated the site-specific MCE peak ground acceleration (PGA_M) to be 0.85g. Based on experience with similar waterfront structures, we assume a displacement of no more than 6 inches is allowable during an MCE level event. The global seismic slope stability analysis in our Geotechnical Report (ENGEO, 2025) shows conformance to this requirement.

In this submittal, we analyzed the seismic stability of the MSE retaining wall using a horizontal seismic coefficient equal to half of the PGA_M. According to AASHTO LRFD Article 11.6.5, achieving a capacity to demand ratio greater than 1.0 using half of the PGA_M will limit permanent wall displacement to approximately 2 inches or less following a seismic event.

MATERIAL PARAMETERS

Physical Parameters of Soil and Lightweight Cellular Concrete

The soil parameters selected for the analysis are described below and summarized in Table 3.

- **Existing Fill**: Physical properties of the existing fill were derived from triaxial laboratory testing. Our laboratory tests are presented in Appendix D of our Geotechnical Report (ENGEO, 2025).
- **Lightweight Cellular Concrete**: We used the "Guide to Lightweight Cellular Concrete" manual written by the Portland Cement Association in 2021 and a conference presentation titled "The Design of Mechanically Stabilized Earth Walls with Lightweight Cellular" presented by Reinforced Earth in 2017 to derive the properties of the LWCC.

  It should be noted that although the specified dry cast density of Class II LWCC is 30 pounds per cubic foot (pcf), we anticipate the material will become saturated upon inundation during its lifetime. Therefore, we adopted a higher design unit weight of 50 pcf to reflect a permanent increase in density.
- **Engineered Fill**: The material type and source of the engineered fill is unknown. Therefore, we assumed a conservative friction angle and typical unit weight for compacted fill.

TABLE 3: Physical Properties of Soil and Lightweight Cellular Concrete

SOIL LAYER	UNIT WEIGHT, γ (pcf)	COHESION, c (psf)	FRICTION ANGLE, ϕ (deg)	COEFFICIENT OF FRICTION, f*
Existing Clayey Fill	120	500	-	-
Lightweight Cellular Concrete (Saturated)	50	-	35	2.0 at top of wall, decreasing linearly to tan(φ) at a depth of 20 feet
Engineered Fill	125	-	32	-

Geostrip Reinforcement

Our design utilizes discrete high-adherence polymeric strips from the Paraweb 2D30 Series. These geostrips are composed of high-tenacity polyester fibers encased in a durable polyethylene sheath. If alternative geostrip products are used they should be polymeric strips, meet the minimum performance criteria outlined in Table 4, and be submitted to the Engineer for approval.

TABLE 4: Minimum Geostrip Tensile and Connection Strength Requirements

MECHANICAL PROPERTY	VALUE	TEST METHOD
Ultimate Tensile Strength, Tult	24,749 pounds per foot (lbs/ft)	ASTM D6637
Connection Strength	35,073 lbs/ft	ASTM D6638

Based on manufacturer recommendations, we used tensile strength reduction factors to account for creep, installation damage, and durability. Additionally, we applied a Factor of Safety of 2.0 to the tensile strength based on Duncan and Wright (2014) criteria for reinforced slopes where the consequences of failure are high. These design factors are summarized in Table 5.

TABLE 5: Ultimate Tensile Strength Reduction Factors

REDUCTION FACTOR	VALUE	SOURCE
Creep Reduction Factor (RF_{cr})	1.38	Manufacturer Recommendation
Installation Damage Factor (RF_{id})	1.1	Manufacturer Recommendation
Deterioration in Service Factor (RF_{d})	1.1	Manufacturer Recommendation
Factor of Safety	2.0	Duncan and Wright (2014)

Our selected reinforcement layout consists of six connections per 4-foot-10¼-inch tall panel (Panel Type A) and three connections per 2-foot-4¾-inch tall panel (Panel Type B). This configuration results in a reinforcement coverage ratio (R_c) of 33.2 percent.

Precast Facing Panels

Our design utilizes the Maccaferri MacRes precast concrete panels. The panels will be manufactured to be suitable for installation in a marine environment in accordance with American Concrete Institute (ACI) 318-19 and 357R standard. The minimum precast concrete production requirements are summarized in Table 6.

TABLE 6: Precast Panel Concrete Production Requirements

MECHANICAL PROPERTY		VALUE	TEST METHOD
Concrete Compressive Strength		5,000psi	ASTM C39
Cement Type		Type II/V (Sulfate Resistant)	ASTM C150
Reinforcement	Reinforcing Steel	Grade 60 (Deformed) or Grade 75 (Plain)	ASTM A615
	Welded Wire Mesh	-	ASTM 1064
Corrosion Protection		Epoxy Coated or Dual Coated	ASTM A934/ ASTM A1055
Maximum Water to Cement Ratio		0.40	-
Minimum Concrete Cover		3 inches	-

METHOD OF ANALYSIS AND RESULTS

We used the Rocscience RSWall software to evaluate the internal and external stability of the MSE retaining wall. For internal reinforcement stability we calculated the tensile rupture and pullout capacity at each geostrip level. We did not include the connection rupture failure mode in our analysis because the geostrip's tensile strength is lower than the connection strength, and therefore, governs the design. For external stability, we assessed the sliding, overturning, and bearing capacity of the wall.

We performed our analyses on three select wall sections that correspond with the project's three panel configurations. Segment 1 is located at Station 0+00 to 0+45 and 2+52 to 3+57, comprising only Panel Type B; Segment 2 is located at Station 0+45 to 1+32 and 2+13 to 2+52, comprising only Panel Type A; Segment 3 is located at Station 1+32 to 1+62 and 1+84 to 2+13, comprising stacked Panel Type A and Panel Type B. We evaluated the maximum retained soil height for each segment. Table 7 summarizes the retaining properties for each case. All sections were conservatively designed assuming a minimum embedment depth of 2.0 feet, satisfying AASHTO (2020) Table 11.10.2.2-1 requirements for walls with a 2:1 (horizontal:vertical) sloping foreground.

TABLE 7: Segment Configuration and Stationing

SEGMENT NUMBER	STATIONING	PANEL TYPE	TOP/BOTTOM OF WALL ELEVATION (FEET)	HEIGHT OF RETAINED SOIL (FEET)
1	0+00 to 0+45 and 2+52 to 3+57	B	14.8/10.5	2.2
2	0+45 to 1+32 and 2+13 to 2+52	A	16.1/9.75	4.3
3	1+32 to 1+62 and 1+84 to 2+13	A and B	16.5/7.25	7.25

We present the results of our analysis in Table 8 and Table 9 for strength limit state and extreme limit state conditions, respectively. A capacity to demand ratio (CDR) greater than 1.0 indicates that the design meets the prescribed criteria.

TABLE 8: Strength Limit State (Static) Results

SEGMENT NUMBER	ANALYSIS TYPE	SOURCE	CDR
1	Internal	Tensile Rupture	2.2*
		Pullout Resistance	4.1*
	External	Base Sliding	2.2
		Overturning	2.4
		Bearing	2.6
2	Internal	Tensile Rupture	2.9*
		Pullout Resistance	2.9*
	External	Base Sliding	2.0
		Overturning	1.9
		Bearing	2.0
3	Internal	Tensile Rupture	2.3*
		Pullout Resistance	2.6*
	External	Base Sliding	1.8
		Overturning	1.2
		Bearing	1.4

*Critical reinforcement level

TABLE 9: Extreme Limit State (Seismic) Results

SEGMENT NUMBER	ANALYSIS TYPE	FAILURE MODE	CDR
1	Internal	Tensile Rupture	9.6*
		Pullout Resistance	6.9*
	External	Base Sliding	1.8
		Overturning	5.4
		Bearing	8.4
2	Internal	Tensile Rupture	9.4*
		Pullout Resistance	5.4*
	External	Base Sliding	1.5
		Overturning	3.6
		Bearing	5.0
3	Internal	Tensile Rupture	7.5*
		Pullout Resistance	4.4*
	External	Base Sliding	1.4
		Overturning	2.4
		Bearing	2.7

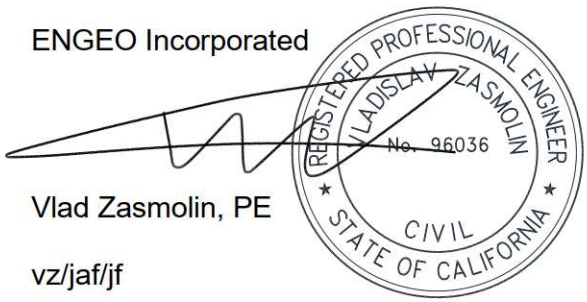
*Critical reinforcement level

CLOSING

We appreciate the opportunity to be of service to you on this project. If you have any questions regarding the content of this letter, please do not hesitate to contact us.

Sincerely,

ENGEO Incorporated



Vlad Zasmolin, PE



Jeff Fippin, GE

vz/jaf/jf

Attachments: Selected References
Plan Set
Calculation Package

SELECTED REFERENCES

1. American Association of State Highway and Transportation Officials (AASHTO). 2020. AASHTO LRFD Bridge Design Specifications, 9th Edition.

2. American Concrete Institute (ACI). 2019. Building Code Requirements for Structural Concrete and Commentary (ACI 318-19).

3. American Concrete Institute ACI. 1997. Guide for the Design and Construction of Fixed Offshore Concrete Structures (ACI 357R-84).

4. American Society of Civil Engineers (ASCE). 2014. Seismic Design of Piers and Wharves (ASCE/COPRI 61-14).

5. ASTM International. Book of ASTM Standards.

    a. ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
    b. ASTM A934: Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
    c. ASTM A1055: Standard Specification for Zinc and Epoxy Dual-Coated Steel Reinforcing Bars.
    d. ASTM A1064: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
    e. ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
    f. ASTM C150: Standard Specification for Portland Cement.
    g. ASTM D6637: Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method.
    h. ASTM D6638: Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units.

6. City of Berkeley.2023. Response to Qualifications (RFQ) for the Berkeley Water Transportation Pier Ferry Project, Berkeley, California. December 15, 2023.

7. Duncan, J.M., Wright, S.G., and Brandon, T.L. 2014. Soil Strength and Slope Stability, 2nd Edition.

8. ENGEO. 2025. Geotechnical Report, Berkeley Water Transportation Pier Ferry, Berkeley, California. December 16, 2024; Revised December 12, 2025. Project No. 25022.000.001.

9. Portland Cement Association (PCA). 2021. Guide to Lightweight Cellular Concrete.

10. Reinforced Earth. 2017. The Design of Mechanically Stabilized Earth Walls with Lightweight Cellular Concrete. Presented at 2017 KU CEAE Geotechnical Conference, Kansas, Missouri. November 9, 2017

PLAN SET

25022.000.001
December 12, 2025

GENERAL NOTES:

1. BASIS OF DESIGN

1.1 ENGEO; GEOTECHNICAL EXPLORATION, BERKELEY WATER TRANSPORTATION PIER FERRY, BERKELEY, CALIFORNIA; DECEMBER 12, 2025.

1.2 NCE; TOPOGRAPHIC SURVEY, BERKELEY WATER TRANSPORTATION PIER FERRY, BERKELEY, CALIFORNIA; SEPTEMBER 23, 2024.

1.3 AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO). 2020. AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 9th EDITION.

1.4 DATUM: CITY OF BERKELEY MEAN LOWER LOW WATER DATUM.

2. SYSTEM DESCRIPTION

2.1 THE MECHANICALLY STABILIZED EARTH (MSE) RETAINING WALL SYSTEM WILL CONSIST OF PRECAST CONCRETE FACING PANELS AND DISCRETE HIGH-ADHERENCE POLYMERIC SOIL REINFORCING STRIPS.

2.2 POLYMERIC SOIL REINFORCING STRIPS CONSIST OF DISCRETE BUNDLES OF CLOSELY PACKED HIGH STRENGTH POLYESTER FILAMENTS, LYING PARALLEL TO EACH OTHER, ENCASED IN A TOUGH AND DURABLE POLYETHYLENE COATING.

3. MATERIALS

3.1 THE REINFORCED BACKFILL SHALL BE CLASS I PERVIOUS LIGHTWEIGHT CELLULAR CONCRETE, AND SHALL BE REVIEWED AND APPROVED BY THE GEOTECHNICAL ENGINEER OF RECORD.

LIGHTWEIGHT CELLULAR CONCRETE PROPERTIES

MAXIMUM IN-PLACE UNIT WEIGHT, γ = 30 PCF

MINIMUM 28-DAY UNCONFINED COMPRESSIVE STRENGTH = 40 PSI

MINIMUM COEFFICIENT OF PERMEABILITY = 1 X 10^{-2} CM/S

3.4 PRECAST CONCRETE FACING PANELS SHALL BE CONSTRUCTED USING CONCRETE HAVING A MINIMUM COMPRESSIVE STRENGTH OF 5,000 POUNDS PER SQUARE INCH (PSI) AT 28 DAYS. CEMENT SHALL BE TYPE II/V CONFORMING TO ASTM C150. WATER CEMENT RATIO SHOULD NOT BE GREATER THAN 0.4.

3.5. REINFORCING STEEL SHALL BE ASTM 615 GRADE 60 DEFORMED REBAR, PLAIN GRADE 75 OR WELDED WIRE REINFORCEMENT (WWR) C CONFORMING TO ASTM A1064.

3.6 ALL REINFORCEMENT SHALL BE EPOXY COATED OR DUAL COATED PER PROJECT SPECIFICATIONS. EPOXY COATED BARS SHALL CONFORM TO ASTM A934 AND CALTRANS STANDARD SPECIFICATION 52-2.

3.7 POLYMERIC REINFORCEMENTS STRIPS MANUFACTURED FROM HIGH TENACITY, MULTIFILAMENT POLYESTER YARNS ALIGNED AND CO-EXTRUDED WITH LLDPE LINEAR LOW DENSITY POLYTHENE TO FROM POLYMERIC STRIPS. POLYMERIC REINFORCEMENT STRIPS SHALL BE "PARAWEB 2D 30" OR APPROVED EQUIVALENT (TULT = 6,744 LBS, WIDTH = 3.27 INCHES).

3.8 FILTER FABRIC SHALL BE NON-WOVEN NEEDLE PUNCHED POLYPROPYLENE GEOTEXTILE MEETING MINIMUM CRITERIA IN PROJECT SPECIFICATIONS (MIRAFI 180N, OR APPROVED EQUIVALENT).

3.9 DRAINAGE PIPES SHALL BE A 4-INCH DIAMETER PVC PERFORATED PIPE (SCHEDULE SDR 35) PIPE.

3.10 DRAINAGE MEDIUM SHALL CONSIST OF CLEAN, WASHED, CRUSHED ROCK MEETING THE GRADATION AND DURABILITY REQUIREMENTS IN THE PROJECT SPECIFICATIONS.

4. SITE PREPARATION

PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL CLEAR AND GRADE THE FOUNDATION AND REINFORCED BACKFILL AREA, REMOVING TOP SOIL, BRUSH, SOD AND OTHER ORGANIC DELETERIOUS MATERIALS. ANY UNSUITABLE SOIL SHALL BE REMOVED AND REPLACED WITH COMPACTED BACKFILL MATERIAL TO PROJECT SPECIFICATIONS.

AN EVALUATION OF THE SUITABILITY OF THE FOUNDATION SOIL AND THE REQUIRED BEARING CAPACITY SHOULD BE PERFORMED BY THE OWNER TESTING AGENCY.

5. CONSTRUCTION

5.1 LEVELING PAD – PLACE LEAN CONCRETE, CAST IN-SITU AND TOWELED SMOOTH TO FORM A HORIZONTAL BASE FOR THE PANELS. THE LEVELING PAD SHOULD BE CONSTRUCTED WITHIN 1/8- INCH TOLERANCE OF THE SPECIFIED BOTTOM OF PANEL. THE LEVELING PAD SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 2,000 PSI.

5.2 PANEL POSITIONING – CHECK THAT ALL PANELS COMPLY WITH THE REQUIRED PANEL DIMENSIONS AND THE CORRECT NUMBER OF CONNECTIONS PRIOR TO PLACING.

5.3 PLACING GEOTEXTILE – INSTALL NON-WOVEN GEOTEXTILE TO FULLY ENCAPSULATE THE LIGHTWEIGHT CELLULAR CONCRETE. THE GEOTEXTILE MUST COVER ALL VERTICAL AND HORIZONTAL PANEL JOINTS AND CREATE A COMPLETE SEPARATION LAYER BETWEEN THE LIGHTWEIGHT CELLULAR CONCRETE AND THE RETAINED BACKFILL.

5.4 PLACING LIGHTWEIGHT CELLULAR CONCRETE – THE CONTRACTOR IS RESPONSIBLE FOR COMPLYING WITH THE MIXING AND PLACEMENT OF LIGHTWEIGHT CELLULAR CONCRETE PER SPECIFICATION SECTION 02304.

5.5 PLACING AND CONNECTION OF THE REINFORCEMENT LAYERS – STARTING FROM THE BACK OF THE PANELS, THE WIDTH OF THE REINFORCED BACKFILL SHOULD BE MEASURED AND MARKED WITH PINS OR WITH A STRING LINE. LIGHTWEIGHT CELLULAR CONCRETE SHALL BE PLACED TO THE ELEVATION OF EACH STRIP LEVEL AND ALLOWED TO CURE FOR A MINIMUM OF 24 HOURS. REINFORCEMENT STRIPS SHALL BE CONNECTED TO PANELS AFTER CURING.REFER TO POLYMERIC GEOSTRIP REINFORCEMENT MANUFACTURER CONSTRUCTION MANUAL FOR INSTALLATION GUIDELINES.

5.6 A 4-INCH DIAMETER PERFORATED PVC COLLECTOR PIPE SHALL BE INSTALLED BEHIND THE WALL. THE PIPE SHALL DISCHARGE TO THE BAY VIA SOLID PVC OUTLET PIPES SPACED AT 50 FEET ON CENTER. THE COLLECTOR PIPE SHALL DISCHARGE TO THE BAY VIA PVC OUTLETS SPACED AT 50 FEET ON CENTER.

5.7 SUBGRADE PREPARATION AND RETAINED BACKFILL – PREPARE THE FOUNDATION SUBGRADE LEFT AT GRADE OR IN AREAS TO RECIEVE FILL BY SCARIFYING TO A DEPTH OF 8-INCHES, MOISTURE CONDITIONING, AND RECOMPACTING. PLACE ALL NEW SOIL FILL IN HORIZONTAL LIFTS NOT EXCEEDING 12-INCHES (LOOSE).

BOTH THE PREPARED SUBGRADE AND THE NEW FILL SHALL BE MOISTURE CONDITIONED TO 2 PERCENTAGE ABOVE OPTIMUM AND COMPACTED TO A MINIMUM OF 90% OF THE MAXIMUM DRY DENSITY (ASTM D1557).

60% SUBMITTAL
DECEMBER 12, 2025

REVISION	MARK	DATE	DESCRIPTION	APPROVAL
B		12-06-2025	60% SUBMITTAL	JAF
A		06-27-2025	30% SUBMITTAL	JAF

PROJECT MANAGER: DATE
DEPICTION OF MONUMENTS: DATE
SURVEY PARTY CHIEF
WATERSHED REVIEW: DATE
SUBMITTED: DATE
SUPERVISING CIVIL ENGINEER
APPROVED: DATE
CITY ENGINEER
R.C.E. EXP.
DESIGN VZ
DRAWN LL
CHECK JAF
AS BUILT
HORIZ. NO SCALE
VERT. NO SCALE
BOOK
DATE 06/27/25

0 1 2 3
FOR REDUCED PLANS – ORIGINAL SCALE IS IN INCHES

PARKS RECREATION & WATERFRONT
1947 CENTER ST., 5TH FL. BERKELEY, CA94704

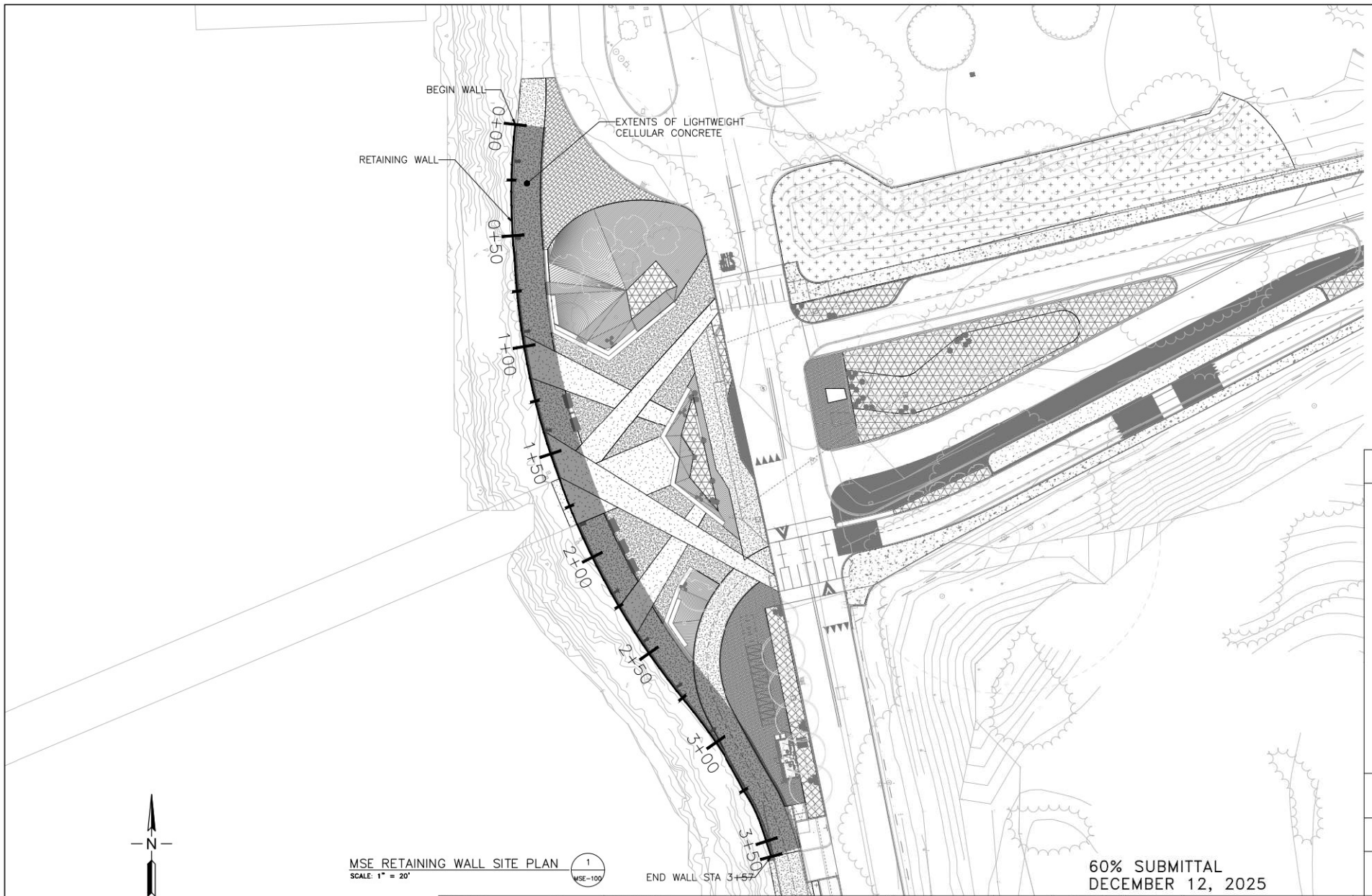
ENGEO

BERKELEY WATER TRANSPORTATION PIER FERRY (BWTPF) PROJECT
CITY OF BERKELEY, ALAMEDA COUNTY, CALIFORNIA

MSE RETAINING WALL GENERAL NOTES

PLAN
FILE
MSE-001
SHEET OF

FILE NAME: G:\Drafting\PROJECTS_24000 to 25999\24502\MSE-WALL\60Percent Set\24502000001_MSE-001-121225.dwg LAYOUT NAME: MSE-001 PLOTTED: Friday, December 12, 2025 - 3:47pm USER: CCulbertson



MSE RETAINING WALL SITE PLAN (1 / MSE-100)
SCALE: 1" = 20'

60% SUBMITTAL
DECEMBER 12, 2025

REVISION	MARK	DATE	DESCRIPTION	APPROVAL
B		12-08-2025	60% SUBMITTAL	JAF
A		06-27-2025	30% SUBMITTAL	JAF

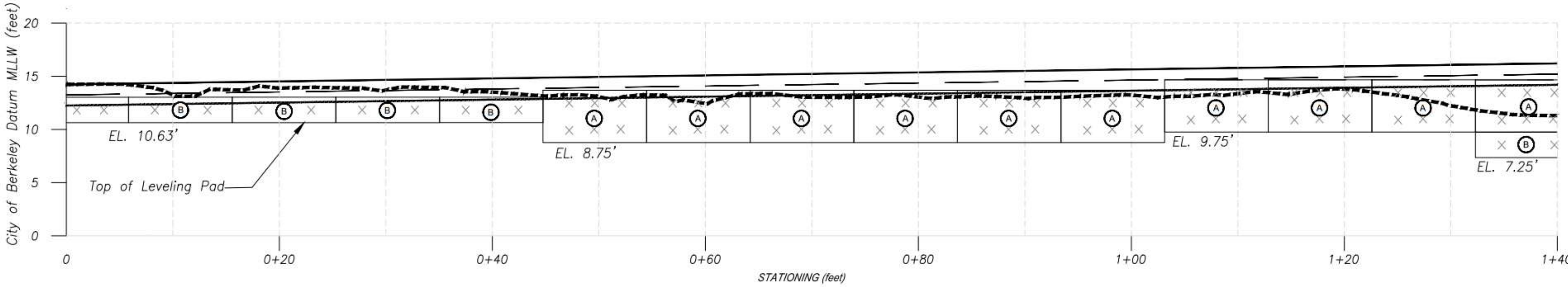
PROJECT MANAGER: DATE
DEPICTION OF MONUMENTS: DATE
SURVEY PARTY CHIEF
WATERSHED REVIEW: DATE
SUBMITTED: DATE
SUPERVISING CIVIL ENGINEER R.C.E. EXP.
APPROVED: DATE
CITY ENGINEER R.C.E. EXP.
DESIGN VZ
DRAWN LL
CHECK JAF
AS BUILT
HORIZ. AS SHOWN
VERT.
BOOK
DATE 06/27/25
FOR REDUCED PLANS – ORIGINAL SCALE IS IN INCHES (0 1 2 3)

PARKS RECREATION & WATERFRONT 1947 CENTER ST., 5TH FL. BERKELEY, CA 94704

BERKELEY WATER TRANSPORTATION PIER FERRY (BWTPF) PROJECT
CITY OF BERKELEY, ALAMEDA COUNTY, CALIFORNIA
MSE RETAINING WALL SITE PLAN

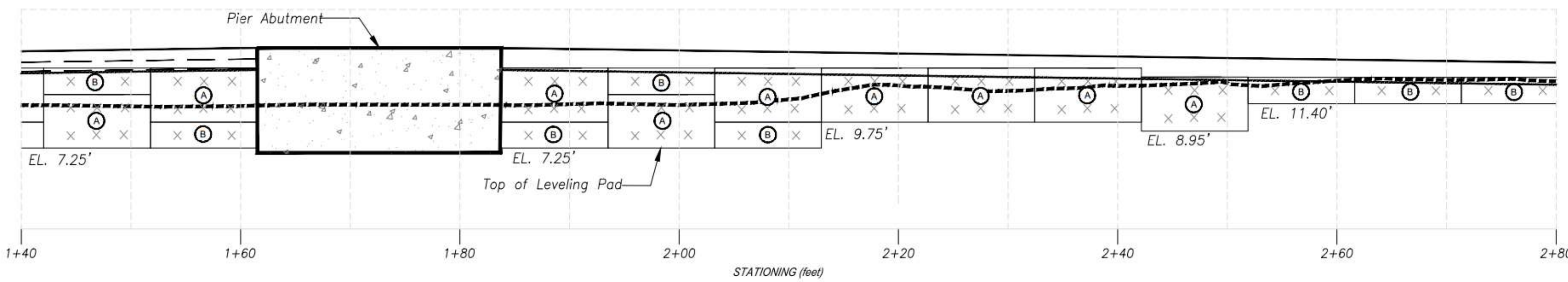
PLAN
FILE
MSE-100
SHEET OF

FILE NAME: G:\Drafting\PROJECTS_24000 to 25999_25022\MSE-WALL\60Percent\Sht_25022200001_MSE_1-=_12125.dwg LAYOUT NAME: MSE-100 PLOTTED: Friday, December 12, 2025 - 3:47pm USER: CAubertsen



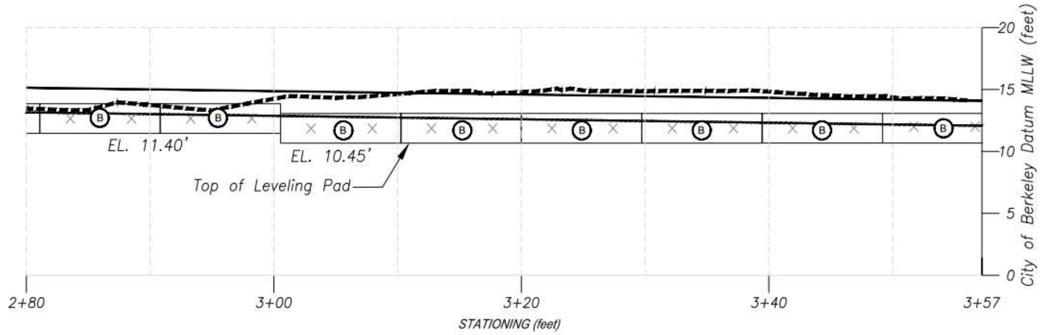
PROFILE ALONG WALL ALIGNMENT (BEGIN) 1 MSE-200

SCALE: 1" = 5'



PROFILE ALONG WALL ALIGNMENT (CONTINUED) 2 MSE-200

SCALE: 1" = 5'



PROFILE ALONG WALL ALIGNMENT (END) 3 MSE-200

SCALE: 1" = 5'

Legend

- Finished Grade at Top of Wall
- Existing Grade and Finished Grade at Bottom of Wall
- Bottom of Coping
- (B) Pannel Type (See Sheet MSE-300)
- × × × Geostrip Connection (typical)

60% SUBMITTAL
DECEMBER 12, 2025

REVISION	MARK	DATE	DESCRIPTION	APPROVAL
A		06-27-2025	30% SUBMITTAL	JAF
B		12-06-2025	60% SUBMITTAL	JAF

PROJECT MANAGER: DATE | DEPICTION OF MONUMENTS: DATE | SURVEY PARTY CHIEF | WATERSHED REVIEW: DATE | SUBMITTED: | SUPERVISING CIVIL ENGINEER | APPROVED: | CITY ENGINEER | DATE R.C.E. EXP.

0 1 2 3 FOR REDUCED PLANS – ORIGINAL SCALE IS IN INCHES

DESIGN VZ | DRAWN LL | CHECK JAF | AS BUILT

HORIZ. AS SHOWN | VERT. | BOOK | DATE 06/27/25

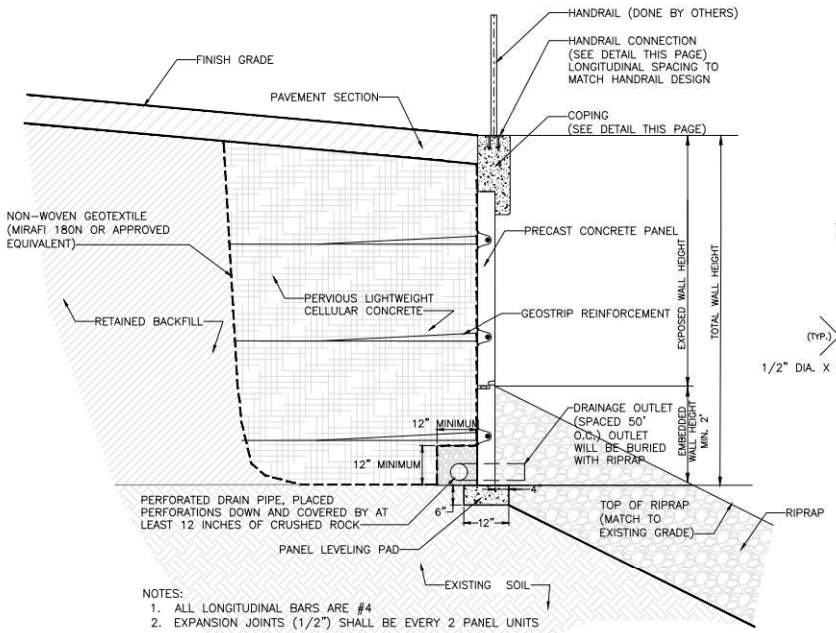
BERKELEY PARKS RECREATION & WATERFRONT

ENGEO

BERKELEY WATER TRANSPORTATION PIER FERRY (BWTPF) PROJECT
CITY OF BERKELEY, ALAMEDA COUNTY, CALIFORNIA
MSE RETAINING WALL ELEVATION SECTION

PLAN | FILE | MSE-200 | SHEET __ OF __

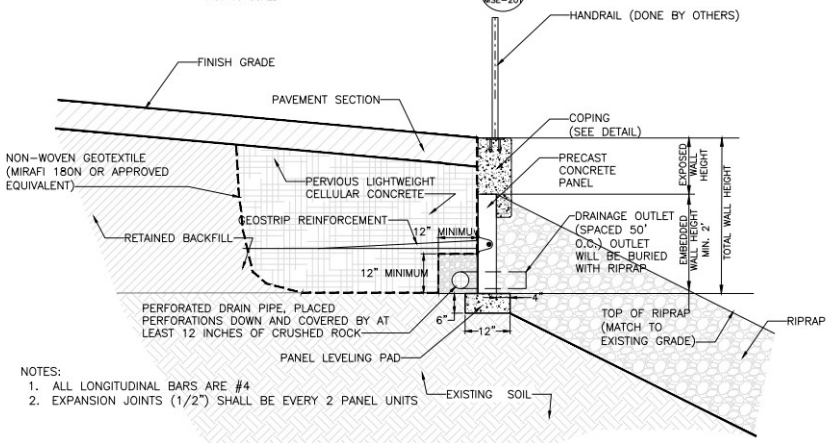
FILE NAME: G:\Drafting\PROJECTS_24000 to 25999\25022\MSE-WALL\60PercentSet\25022000001_MSE_200-121225.dwg LAYOUT NAME: MSE-200 PLOTTED: Friday, December 12, 2025 – 3:47pm USER: CCulbertson



NOTES:
1. ALL LONGITUDINAL BARS ARE #4
2. EXPANSION JOINTS (1/2") SHALL BE EVERY 2 PANEL UNITS

TYPICAL 1-1/2 PANEL DETAIL
STATION 1+32 TO 1+62
STATION 1+84 TO 2+13
NOT TO SCALE

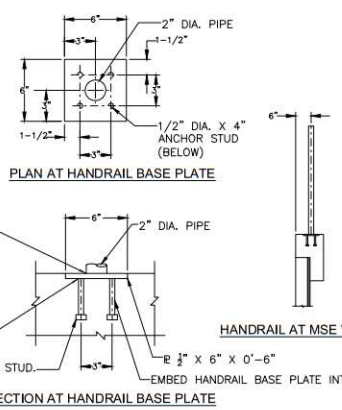
1 MSE-201



NOTES:
1. ALL LONGITUDINAL BARS ARE #4
2. EXPANSION JOINTS (1/2") SHALL BE EVERY 2 PANEL UNITS

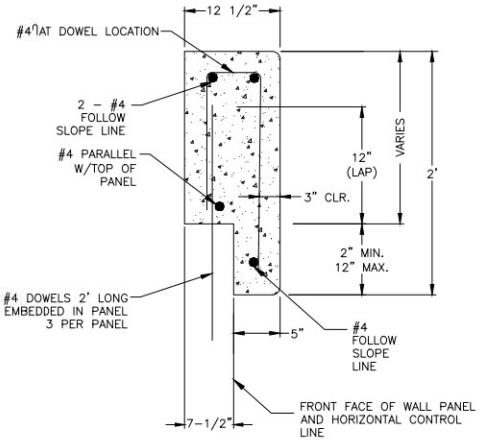
TYPICAL 1/2 PANEL DETAIL
STATION 0+00 TO 0+45
STATION 2+52 TO 3+57
NOT TO SCALE

3 MSE-201



HANDRAIL CONNECTION DETAILS
NOT TO SCALE

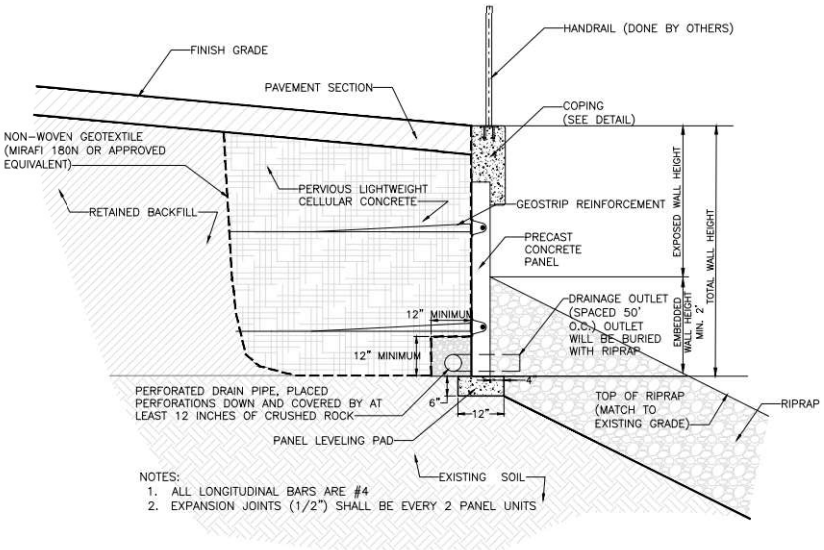
4 MSE-201



NOTES:
1. ALL LONGITUDINAL BARS ARE #4
2. EXPANSION JOINTS (1/2") SHALL BE EVERY 2 PANEL UNITS

COPING DETAIL
NOT TO SCALE

5 MSE-201



NOTES:
1. ALL LONGITUDINAL BARS ARE #4
2. EXPANSION JOINTS (1/2") SHALL BE EVERY 2 PANEL UNITS

TYPICAL 1 PANEL DETAIL
STATION 0+45 TO 1+32
STATION 2+13 TO 2+52
NOT TO SCALE

2 MSE-201

60% SUBMITTAL
DECEMBER 12, 2025

REVISION	MARK	DATE	DESCRIPTION	APPROVAL
B		12-08-2025	60% SUBMITTAL	JAF
A		06-27-2025	30% SUBMITTAL	JAF

PROJECT MANAGER:	DATE	DEPICTION OF MONUMENTS:	DATE	SUBMITTED:	DATE	DESIGN VZ	HORIZ. AS SHOWN
		SURVEY PARTY CHIEF		SUPERVISING CIVIL ENGINEER	R.C.E. EXP.	DRAWN LS	VERT.
0 1 2 3 FOR REDUCED PLANS – ORIGINAL SCALE IS IN INCHES		WATERSHED REVIEW:	DATE	APPROVED:	DATE R.C.E. EXP.	CHECK JAF	BOOK
				CITY ENGINEER		AS BUILT	DATE 06/27/25

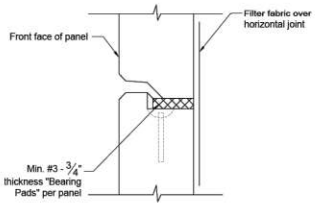
PARKS RECREATION & WATERFRONT 1947 CENTER ST., 5TH FL. BERKELEY, CA 94704

ENGEO

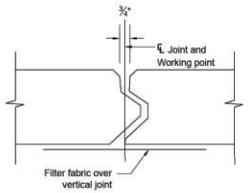
BERKELEY WATER TRANSPORTATION PIER FERRY (BWTPF) PROJECT
CITY OF BERKELEY, ALAMEDA COUNTY, CALIFORNIA
TYPICAL CROSS SECTION

PLAN
FILE
MSE-201
SHEET OF

FILE NAME: G:\Drafting\PROJECTS_24000 to 25999_24022\MSE-WALL\60Percent\Set_24022000001_MSE_1-5_12125.dwg LAYOUT NAME: MSE-201 PLOTTED: Friday, December 12, 2025 - 3:47pm USER: CGulbertson

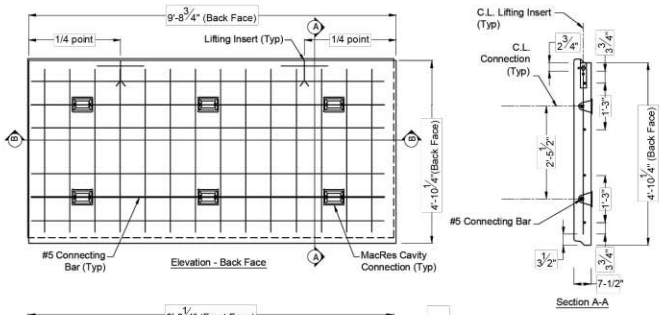


HORIZONTAL JOINT

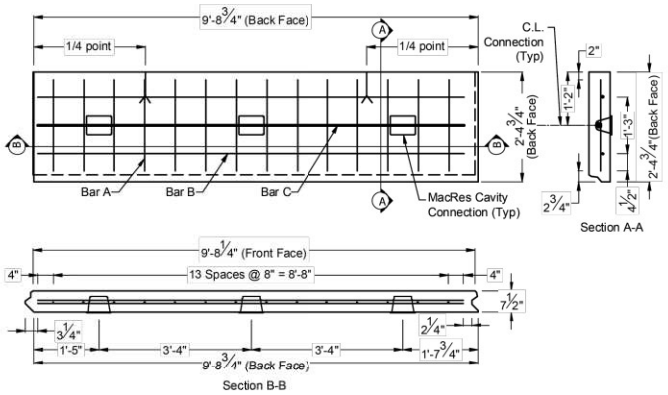


VERTICAL JOINT

PANEL JOINT DETAIL 1 MSE-300
NOT TO SCALE



TYPICAL "A" PANEL 2 MSE-300
NOT TO SCALE

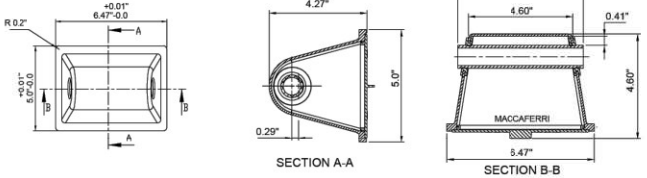


TYPICAL "B" PANEL 3 MSE-300
NOT TO SCALE



1. CAVITY
2. COVER FOR CAVITY
3. BUSH
4. SLEEVE

CONNECTION DETAIL



CONNECTION SECTIONS

GEOSTRIP CONNECTION DETAIL 4 MSE-300
NOT TO SCALE

PANEL TYPE	PANEL THICKNESS	MINIMUM/TYPICAL PANEL REINFORCEMENT
A	7 1/2" MIN.	VERTICAL BARS ARE #3 @ 8" O/C HORIZONTAL BARS ARE #4 @15" O/C
B	7 1/2" MIN.	VERTICAL BARS ARE #3 @ 8" O/C HORIZONTAL BARS ARE #4 @15" O/C

NOTES:
1. REBAR LAYOUT IS SHOWN ON DETAILS A AND B. WWR (ASTM A1064) MAY BE SUBSTITUTED, AT THE SAME SPACING, AS FOLLOWS:
#4 Rebar >> WWR Grade 60 W19.6
#4 Rebar >> WWR Grade 75 W15.7
#4 Rebar >> WWR Grade 80 W14.7
#3 Rebar >> WWR Grade 60 W11.1
#3 Rebar >> WWR Grade 75 W8.9
#3 Rebar >> WWR Grade 80 W8.3
2. ALL PANEL SHALL HAVE TWO BURKE 2-TON LIFTING ANCHORS.
3. ALL REINFORCEMENT SHALL BE EPOXY COATED OR DUAL COATED PER PROJECT SPECIFICATIONS.

PANEL REINFORCEMENT SCHEDULE 5 MSE-300
NOT TO SCALE

60% SUBMITTAL
DECEMBER 12, 2025

REVISION	MARK	DATE	DESCRIPTION	APPROVAL
B		12-08-2025	60% SUBMITTAL	JAF
A		06-27-2025	30% SUBMITTAL	JAF

FILE NAME: G:\Drafting\PROJECTS_24000 to 25999_25022\MSE-WALL\60Percent\Set_25022000001_MSE-300-12122025.dwg LAYOUT NAME: MSE-300 PLOTTED: Friday, December 12, 2025 - 3:47pm USER: CCulbertson

PROJECT MANAGER:	DATE	DEPICTION OF MONUMENTS:	DATE	SUBMITTED:	DATE	DESIGN VZ	HORIZ. NO SCALE
		SURVEY PARTY CHIEF		SUPERVISING CIVIL ENGINEER	R.C.E. EXP.	DRAWN LS	VERT. NO SCALE
0 1 2 3 FOR REDUCED PLANS – ORIGINAL SCALE IS IN INCHES		WATERSHED REVIEW:	DATE	APPROVED:	DATE	CHECK JAF	BOOK
				CITY ENGINEER	R.C.E. EXP.	AS BUILT	DATE 06/27/25

PARKS RECREATION & WATERFRONT 1947 CENTER ST., 5TH FL. BERKELEY, CA 94704

BERKELEY WATER TRANSPORTATION PIER FERRY (BWTPF) PROJECT
CITY OF BERKELEY, ALAMEDA COUNTY, CALIFORNIA
PANEL DETAILS

PLAN
FILE
MSE-300
SHEET OF

CALCULATION PACKAGE

25022.000.001
December 12, 2025

ENGEO
Expect Excellence



Berkeley Transportation Pier Ferry
Precast Panel Mechanically Stabilized Earth Seawall
ENGEO
12/12/2025
Software Version: RSWall 1.001

Project Summary

Project Name:	BERKELEY WATER TRANSPORTATION PIER FERRY
Analysis:	PRECAST PANEL MSE SEAWALL
Author:	VZ/JAF
Company:	ENGEO
Date Created:	12/12/2025

Project Settings

Units

Unit system:	Imperial, stress as psf

Wall Type

Wall type:	Segmental retaining wall

Design standard

Selected design standard:	AASHTO 2020
Base design standard:	AASHTO 2020

Segmental Wall Unit Properties

0+00 to 0+45 and 2+52 to 3+57

Height:	4.2 ft
Depth:	0.625 ft
Width:	357 ft
Center of gravity:	0.23 ft
Unit weight:	150 lbs/ft3

0+45 to 1+32 and 2+13 to 2+52

Height:	6.3 ft
Depth:	0.625 ft
Width:	357 ft
Center of gravity:	0.23 ft
Unit weight:	150 lbs/ft3

1+32 to 1+62 and 1+84 to 2+13

Height:	9.3 ft
Depth:	0.625 ft
Width:	357 ft
Center of gravity:	0.23 ft
Unit weight:	150 lbs/ft3

Soil Properties

Retained Backfill	
Unit weight:	125 lbs/ft3
Friction angle:	32°
Soil-structure friction angle:	21.3°
Long-term cohesion:	0 psf
Interface adhesion ratio:	0
Water confined:	No
Lightweight Cellular Concrete	
Unit weight:	50 lbs/ft3
Friction angle:	35°
Soil-structure friction angle:	23°
Long-term cohesion:	0 psf
Interface adhesion ratio:	0
Water confined:	No
Existing Fill	
Unit weight:	120 lbs/ft3
Friction angle:	0°
Soil-structure friction angle:	0°
Long-term cohesion:	500 psf
Interface adhesion ratio:	0
Water confined:	No
Rip Rap	
Unit weight:	135 lbs/ft3
Friction angle:	40°
Soil-structure friction angle:	26°
Long-term cohesion:	0 psf
Interface adhesion ratio:	0
Water confined:	No
Concrete Leveling Pad	
Unit weight:	150 lbs/ft3
Friction angle:	0°
Soil-structure friction angle:	0°
Long-term cohesion:	14400 psf
Interface adhesion ratio:	0
Water confined:	No

Reinforcement Properties

ParaWEB 2	
General	
Coverage:	33.2
Geosynthetic Properties	
Allowable tensile strength (static):	7455.61 lbs/ft
Allowable tensile strength (seismic):	10288.7418 lbs/ft
Creep factor:	1.38
Secant stiffness:	68521.7660918697 lbs/ft
Interaction	
Friction Factor Function	
F* at top:	2
F* at reference depth:	0.7
Reference depth:	20 ft
Alpha coefficient:	0.9
Interface sliding friction angle:	25.27°
Connection Properties	
Connection Strength Function (constant)	
Constant strength:	35073 lbs/ft

SEGMENT 1 (Stationing 0+00 to 0+45 and 2+52 to 3+57)

1. Strength Limit State

1.1. Summary

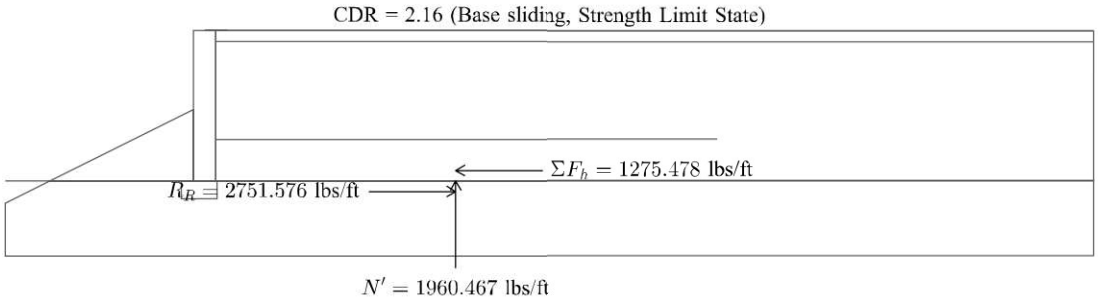
1.1.1. External stability - Strength Limit State

Failure mode	CDR
Base sliding	2.157
Overturning	2.405
Bearing	2.617

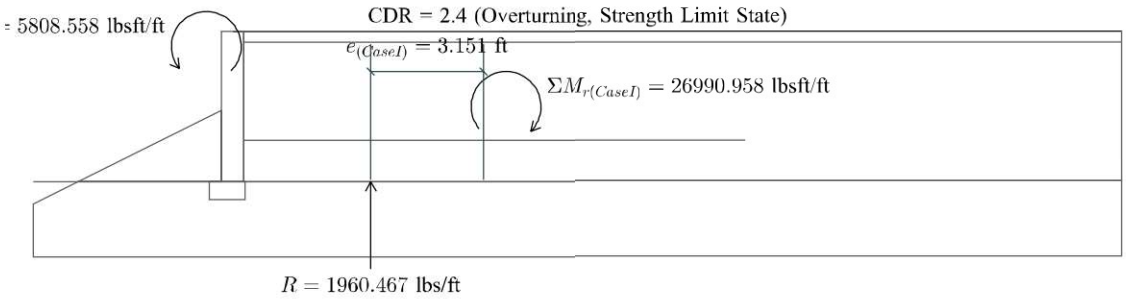
2.1.2. Reinforcement stability - Strength Limit State

Layer	Tensile strength	Connection	Pullout
1	2.19	2.19	4.139

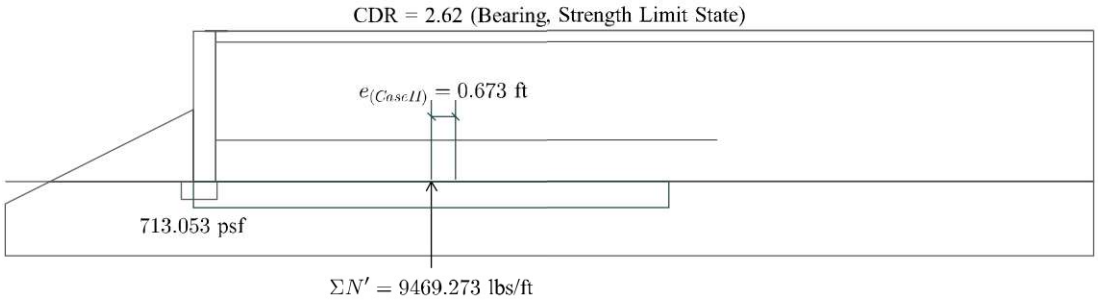
1.2. Base sliding



1.3. Overturning



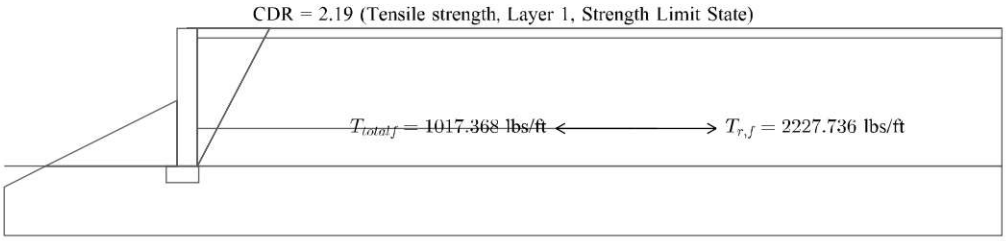
1.4. Bearing



1.5. Tensile strength

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

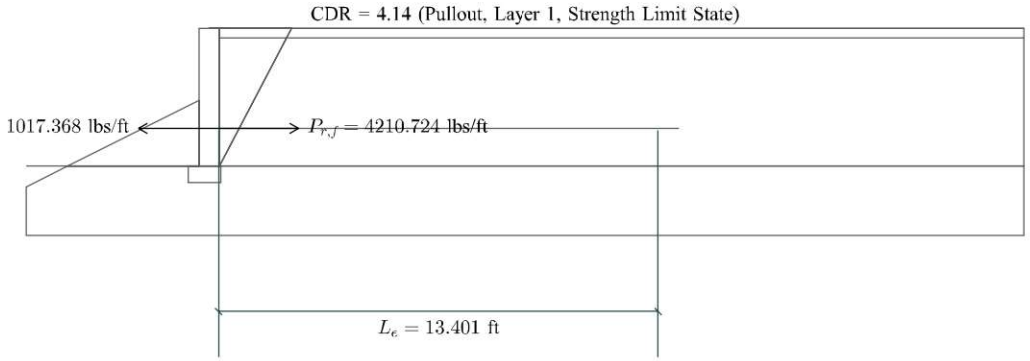
1.5.1. Tensile strength (layer 1)



1.6. Pullout

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

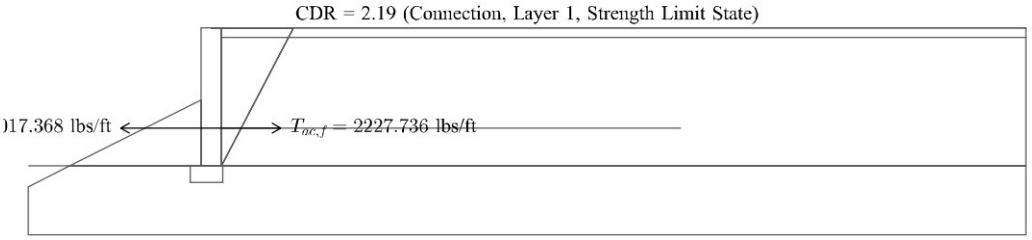
1.6.1. Pullout (layer 1)



1.7. Connection

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

1.7.1. Connection (layer 1)



2. Extreme Limit State

2.1. Summary

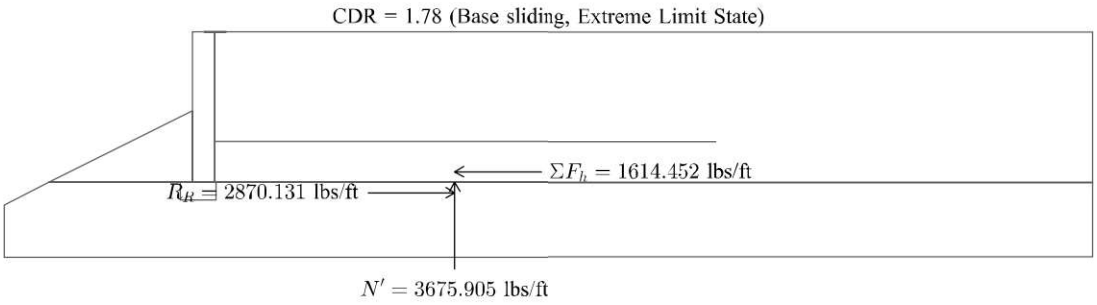
2.1.1. External stability - Extreme Limit State

Failure mode	CDR
Base sliding	1.778
Overturning	5.403
Bearing	8.373

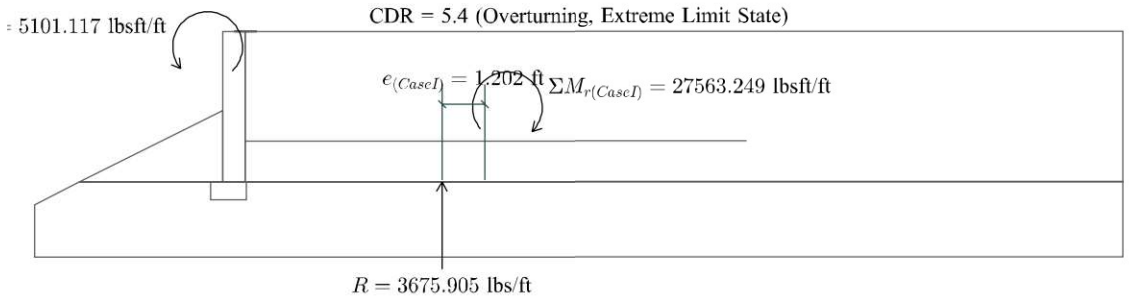
2.1.2. Reinforcement stability - Extreme Limit State

Layer	Tensile strength	Connection	Pullout
1	9.632	9.632	6.85

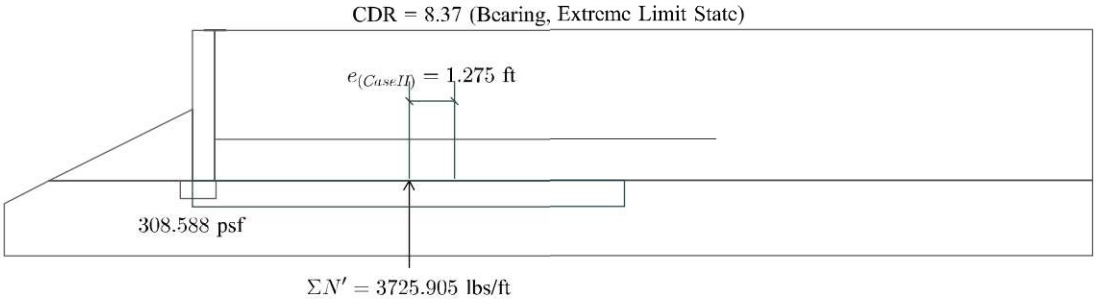
2.2. Base sliding



2.3. Overturning



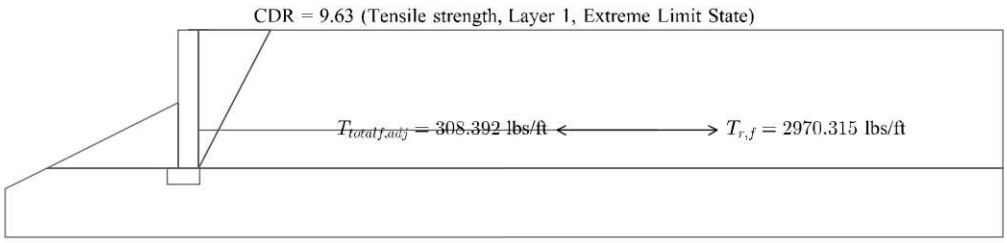
2.4. Bearing



2.5. Tensile strength

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

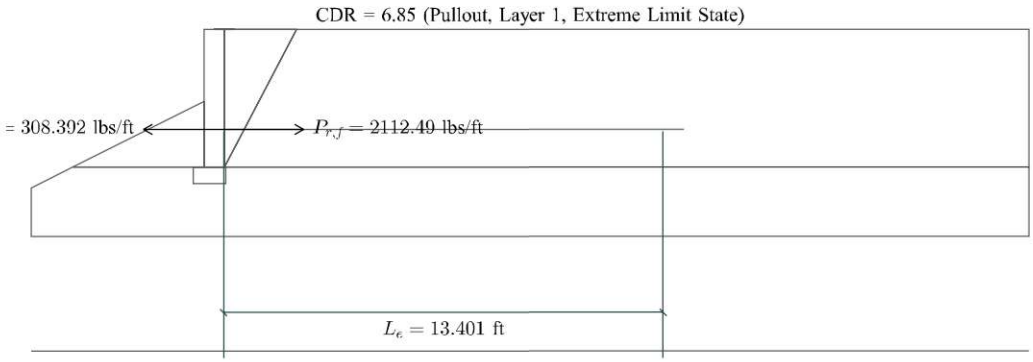
2.5.1. Tensile strength (layer 1)



2.6. Pullout

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

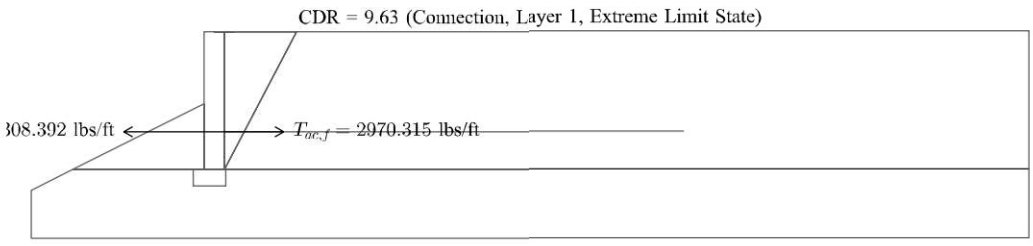
2.6.1. Pullout (layer 1)



2.7. Connection

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

2.7.1. Connection (layer 1)



SEGMENT 2 (Stationing 0+45 to 1+32 and 2+13 to 2+52)

1. Strength Limit State

1.1. Summary

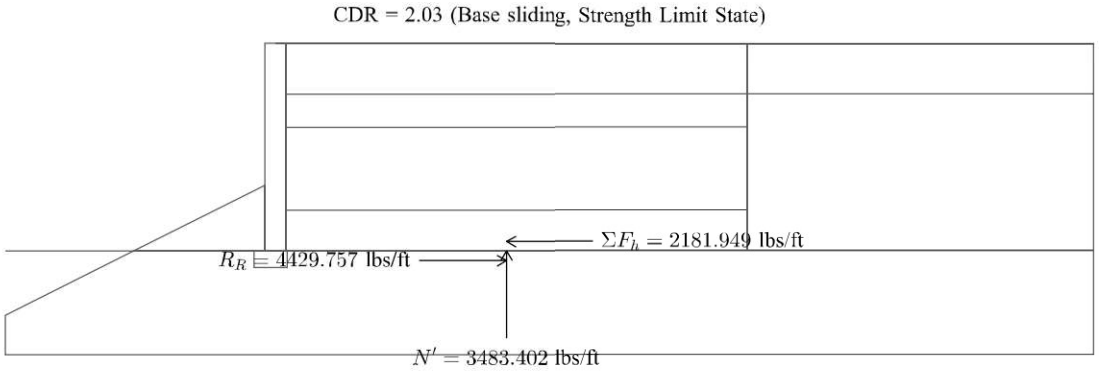
1.1.1. External stability - Strength Limit State

Failure mode	CDR
Base sliding	2.03
Overturning	1.934
Bearing	1.987

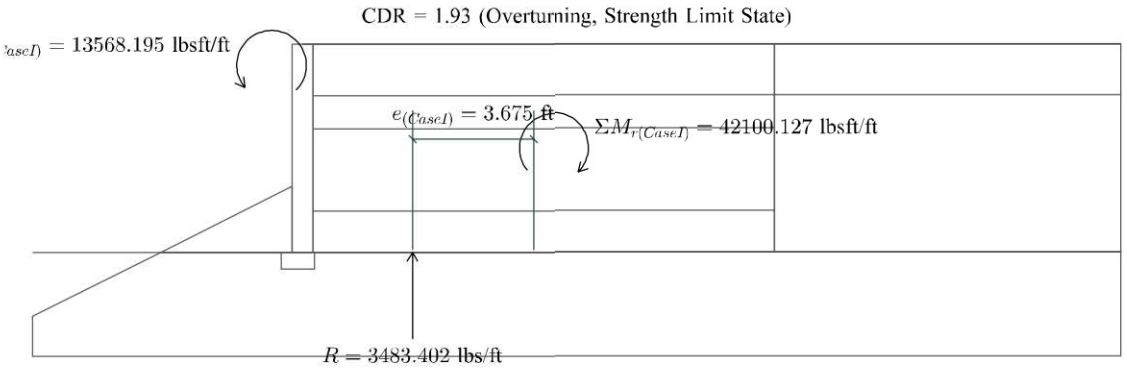
1.1.2. Reinforcement stability - Strength Limit State

Layer	Tensile strength	Connection	Pullout
1	3.156	3.156	8.011
2	2.931	2.931	2.971

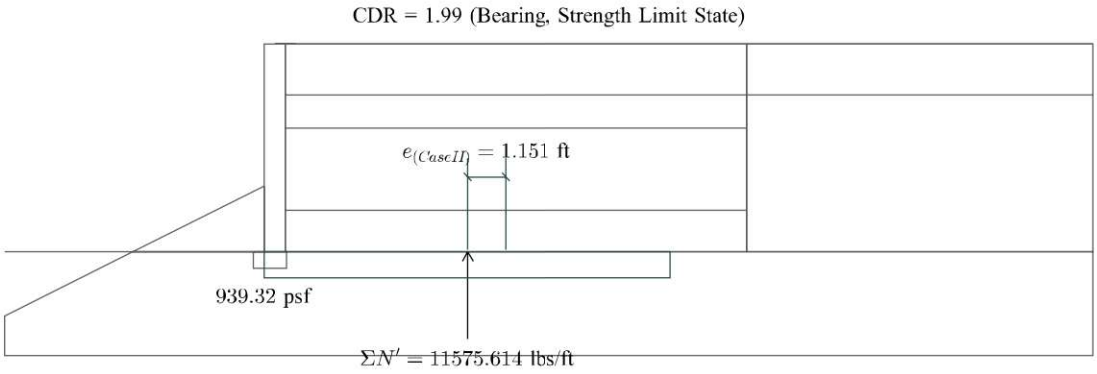
1.2. Base sliding



1.3. Overturning



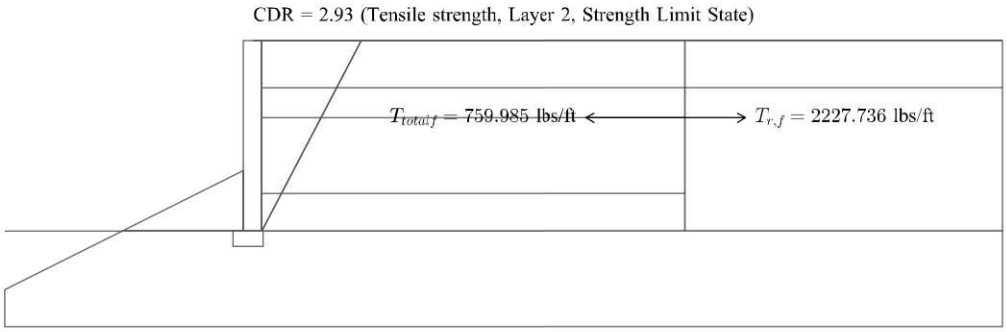
1.4. Bearing



1.5. Tensile strength

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

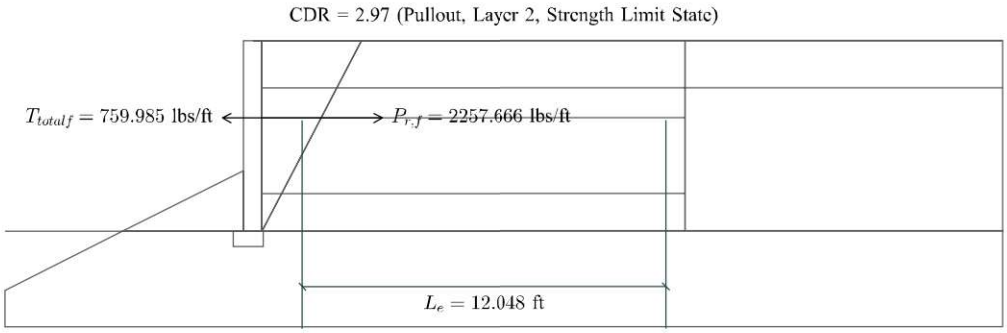
1.5.1. Tensile strength (layer 2)



1.6. Pullout

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

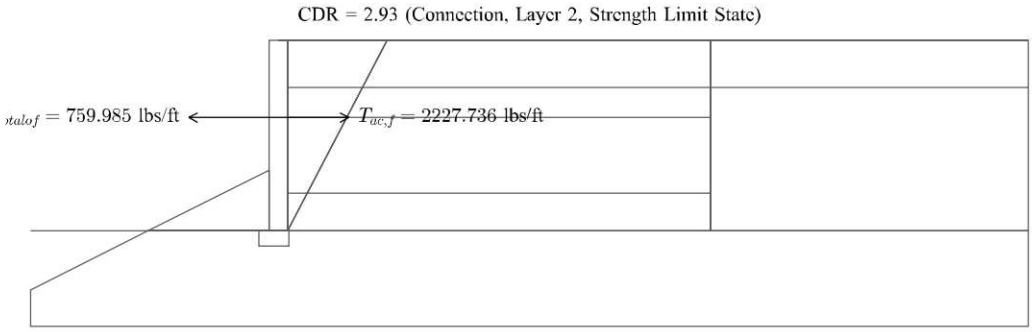
1.6.1. Pullout (layer 2)



1.7. Connection

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

1.7.1. Connection (layer 2)



2. Extreme Limit State

2.1. Summary

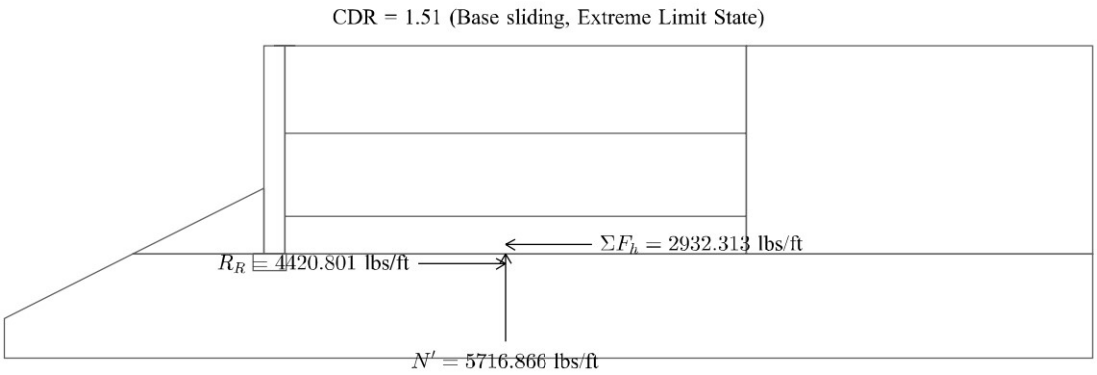
2.1.1. External stability - Extreme Limit State

Failure mode	CDR
Base sliding	1.508
Overturning	3.565
Bearing	4.956

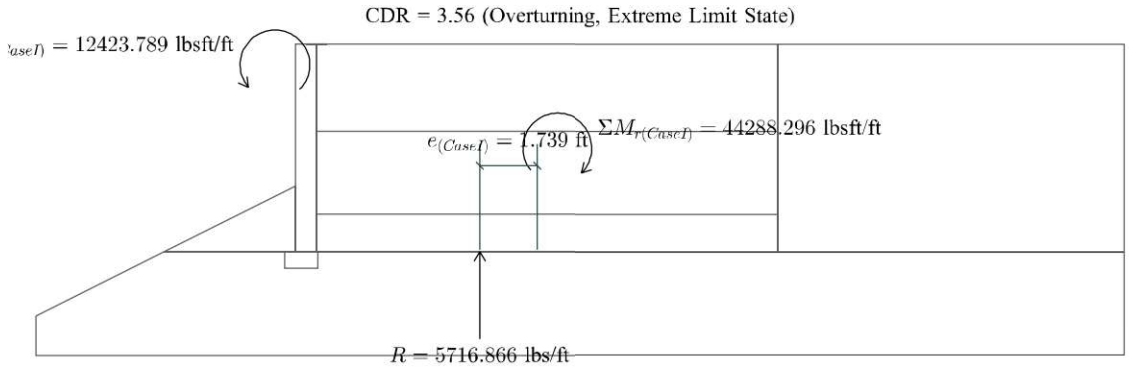
2.1.2. Reinforcement stability - Extreme Limit State

Layer	Tensile strength	Connection	Pullout
1	11.137	11.137	12.361
2	9.493	9.493	5.373

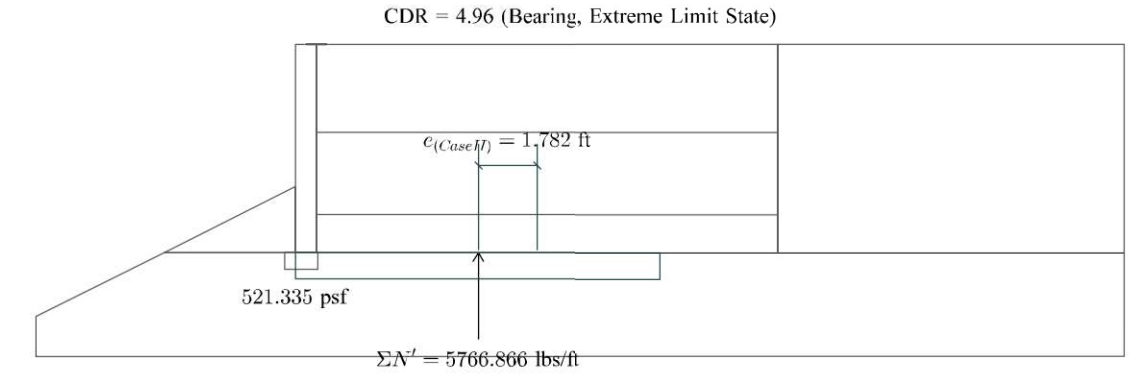
2.2. Base sliding



2.3. Overturning



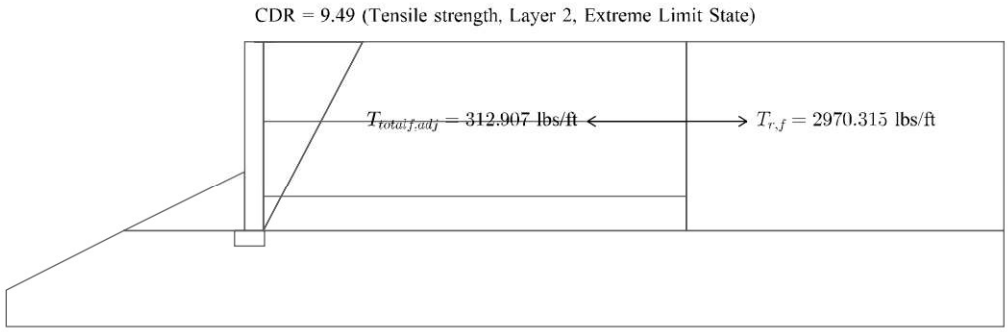
2.4. Bearing



2.5. Tensile strength

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

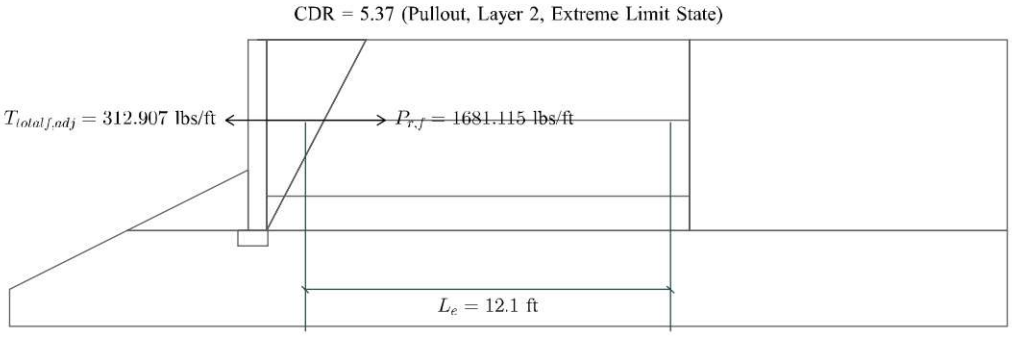
2.5.1. Tensile strength (layer 2)



2.6. Pullout

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

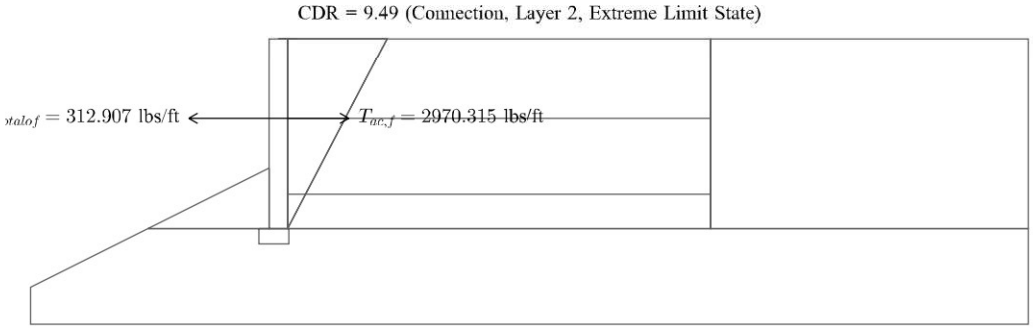
2.6.1. Pullout (layer 2)



2.7. Connection

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

2.7.1. Connection (layer 2)



SEGMENT 3 (Stationing 0+45 to 1+32 and 2+13 to 2+52)

1. Strength Limit State

1.1. Summary

1.1.1. External stability - Strength Limit State

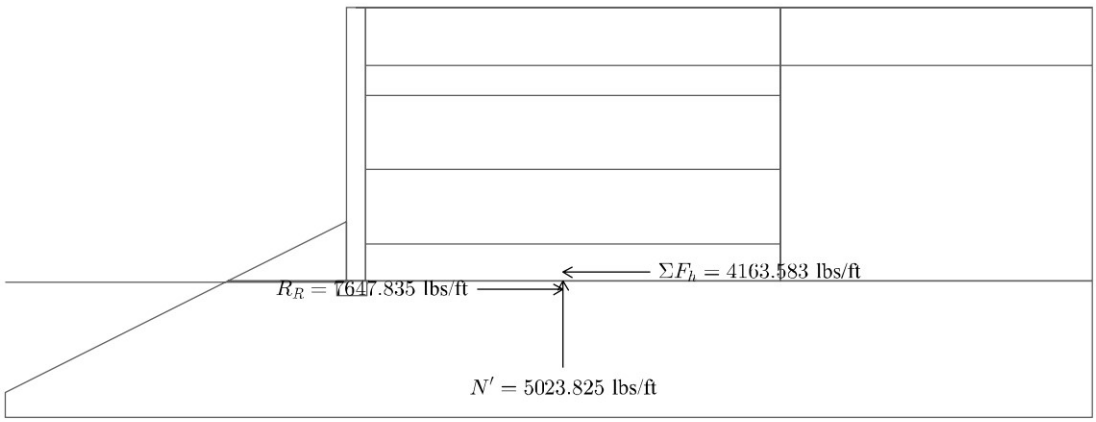
Failure mode	CDR
Base sliding	1.837
Overturning	1.235
Bearing	1.379

1.1.2. Reinforcement stability - Strength Limit State

Layer	Tensile strength	Connection	Pullout
1	2.313	2.313	8.538
2	3.092	3.092	7.269
3	2.631	2.631	2.591

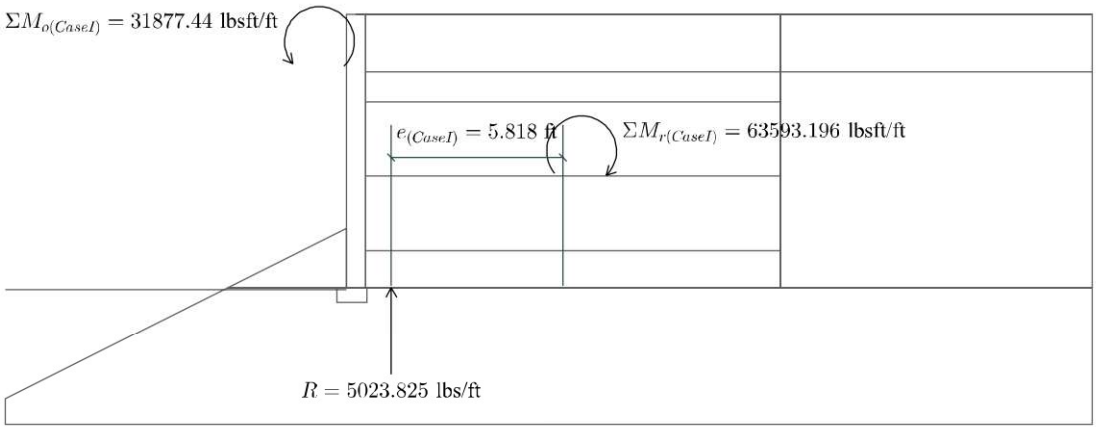
1.2. Base sliding

CDR = 1.84 (Base sliding, Strength Limit State)



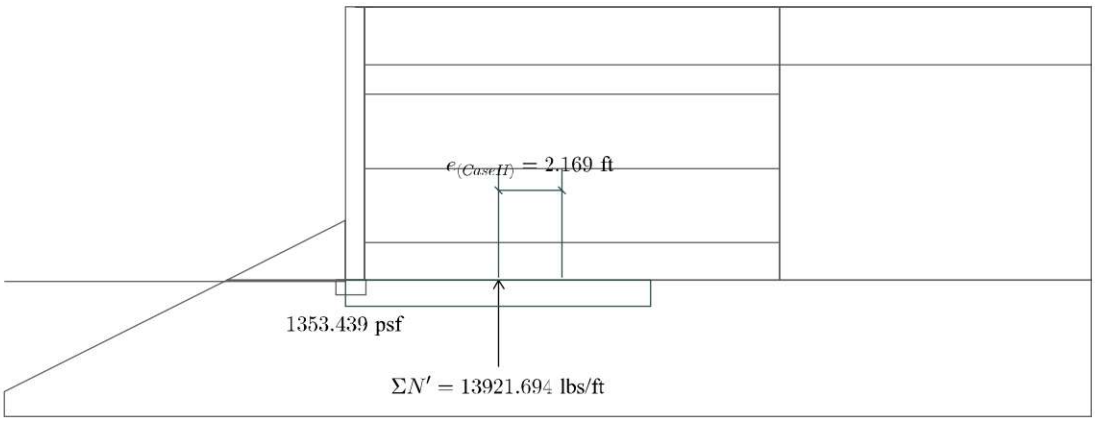
2.3. Overturning

CDR = 1.24 (Overturning, Strength Limit State)



2.4. Bearing

CDR = 1.38 (Bearing, Strength Limit State)

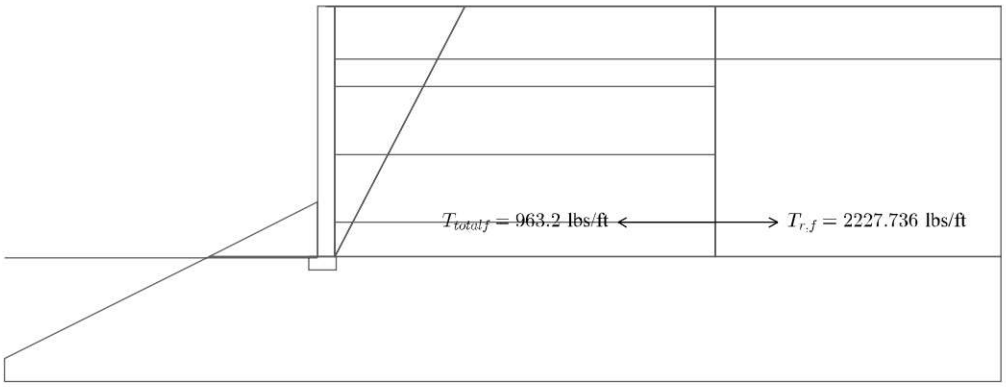


2.5. Tensile strength

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

2.5.1. Tensile strength (layer 1)

CDR = 2.31 (Tensile strength, Layer 1, Strength Limit State)

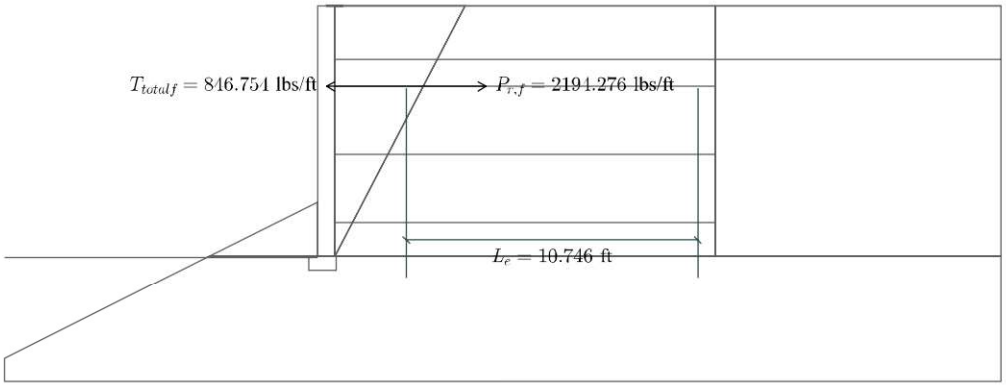


2.6. Pullout

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

2.6.1. Pullout (layer 3)

CDR = 2.59 (Pullout, Layer 3, Strength Limit State)

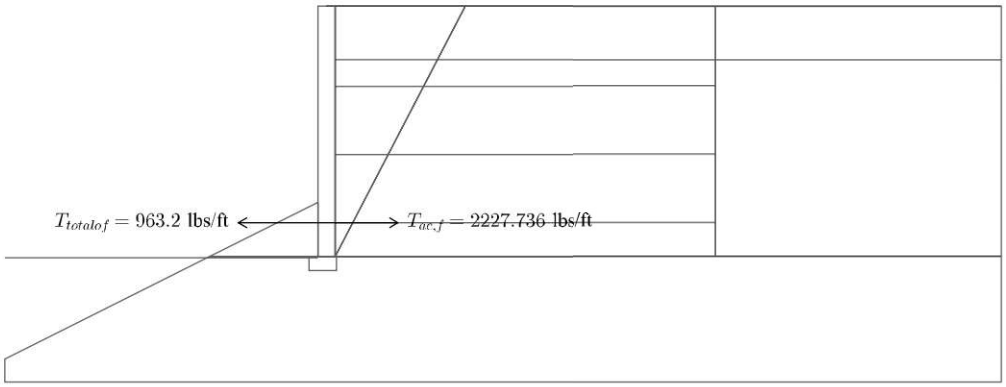


2.7. Connection

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

2.7.1. Connection (layer 1)

CDR = 2.31 (Connection, Layer 1, Strength Limit State)



3. Extreme Limit State

3.1. Summary

3.1.1. External stability - Extreme Limit State

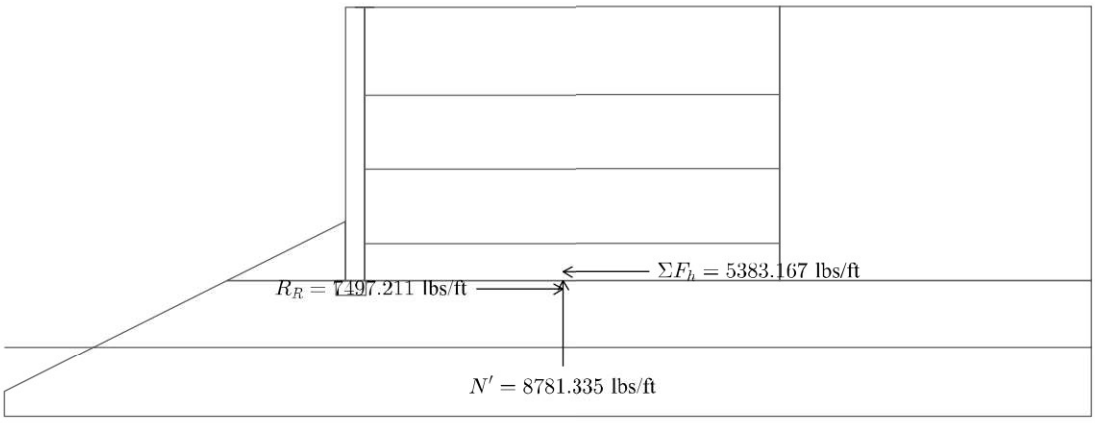
Failure mode	CDR
Base sliding	1.393
Overturning	2.391
Bearing	2.738

3.1.2. Reinforcement stability - Extreme Limit State

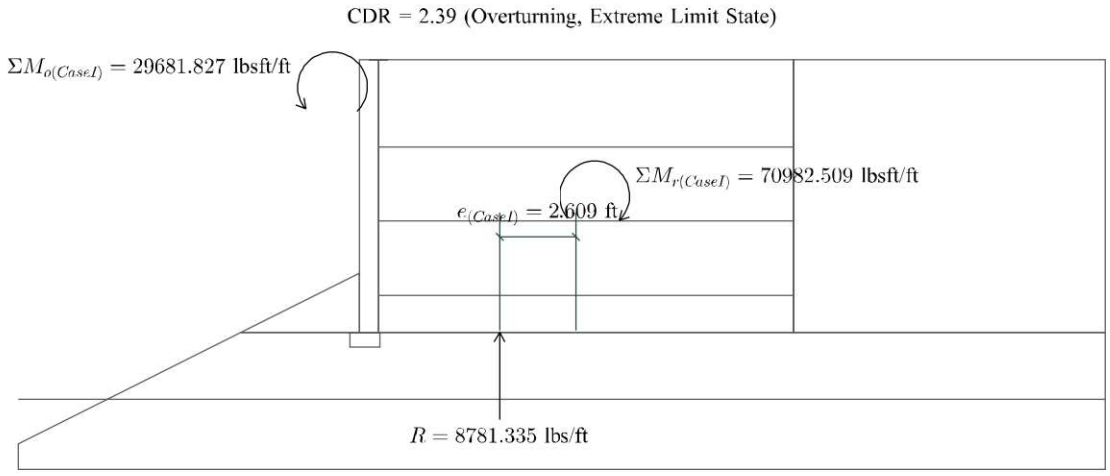
Layer	Tensile strength	Connection	Pullout
1	7.548	7.548	11.474
2	9.311	9.311	9.716
3	7.986	7.986	4.421

3.2. Base sliding

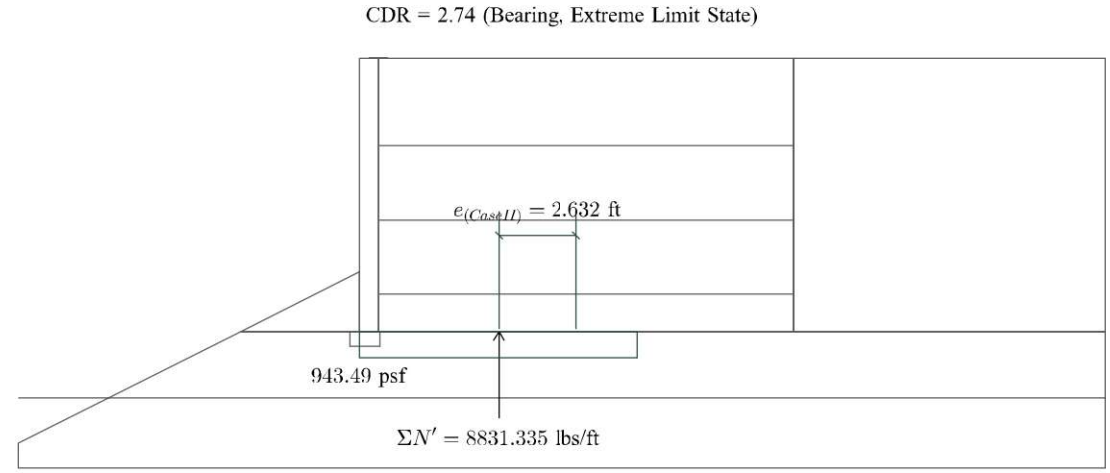
CDR = 1.39 (Base sliding, Extreme Limit State)



3.3. Overturning



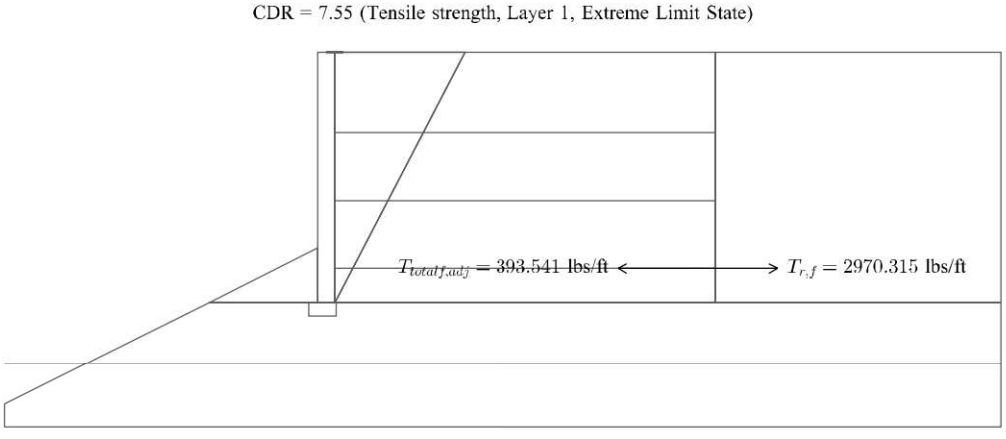
3.4. Bearing



3.5. Tensile strength

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

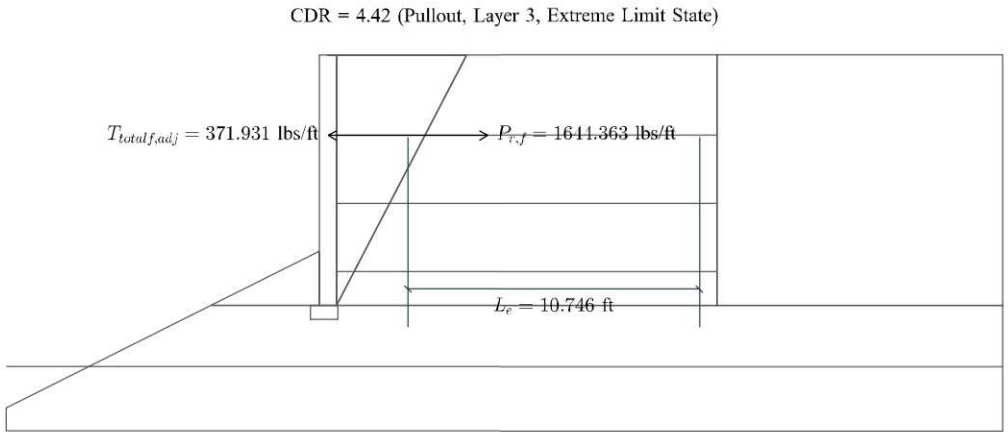
3.5.1. Tensile strength (layer 1)



3.6. Pullout

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

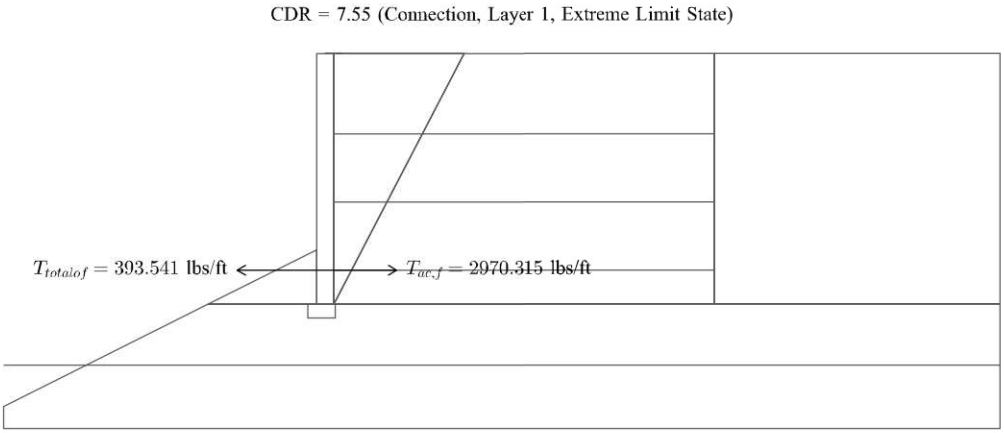
3.6.1. Pullout (layer 3)



3.7. Connection

Note: Displaying result for critical layer only. See the summary section for a table of results for all layers, or enable display of all layers in the Display Options.

3.7.1. Connection (layer 1)





ENGEO

Expect Excellence