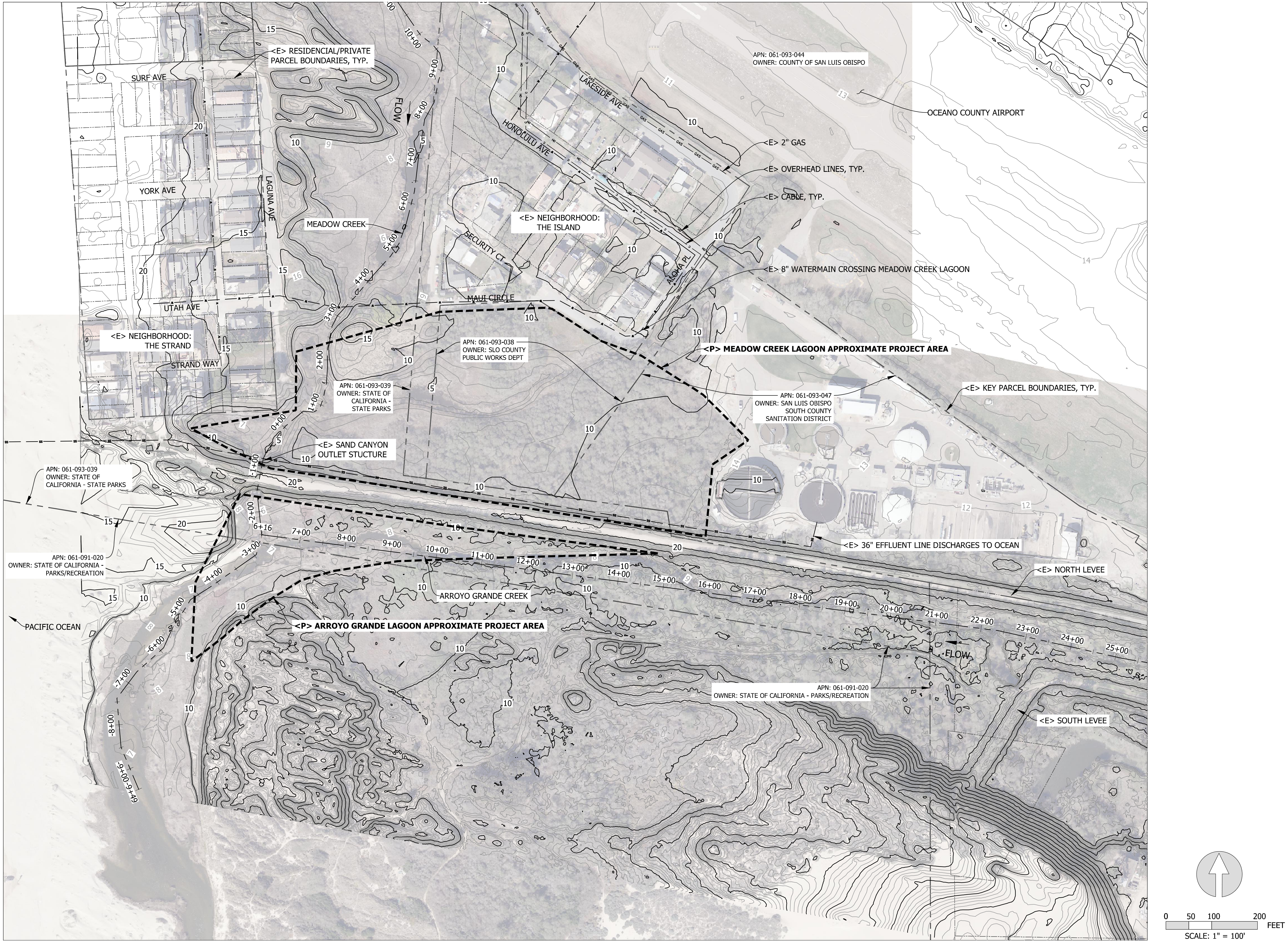
Appendices

Appendix A

Base Map



MEADOW CREEK LAGOON
HABITAT RESTORATION

SAN LUIS OBISPO, CA

Stillwater Sciences
895 NAPA AVENUE SUITE B-3
MORRO BAY, CA 93442
P: (805) 570-7499

REVISIONS

NO.	DESCRIPTION	DATE

PROJECT NUMBER: 939.00
SCALE: AS NOTED
DATE: 10/26/2021

DESIGN: NT
DRAWN: HG
CHECKED: NT
APPROVED: NT

OVERVIEW

SHEET 1 OF 1

IF BAR DOES NOT MEASURE 1" DRAWING IS NOT TO SCALE – ADJUST ACCORDINGLY

LAST SAVED: 11/22/2021 PLOT DATE: 11/22/2021 PLOT STYLE: STILLWATER–GRAYSCALE–255

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Appendix B

Geotechnical and Geological Hazards Report

(Yeh and Associates 2022)

PRELIMINARY GEOTECHNICAL AND GEOLOGIC HAZARDS REPORT

Meadow Creek Lagoon Habitat Restoration
San Luis Obispo County, California

Yeh Project No.: 220-331

January 18, 2022
Revised: January 28, 2022

Prepared for:

Stillwater Sciences
895 Napa Street, Suite B4
Morro Bay, California 93442
Attn: Ms. Aleks Wydzga

Prepared by:

Yeh and Associates, Inc.
391 Front Street, Suite D
Grover Beach, California 93433

Phone: 805-481-9590

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January 18, 2022
Revised January 28, 2022

Project No. 220-331

Stillwater Sciences
895 Napa Street, Suite B4
Morro Bay, California 93442

Attn: Ms. Aleks Wydzga

Subject: **Preliminary Geotechnical and Geologic Hazards Report, Meadow Creek Lagoon Habitat Restoration, San Luis Obispo County, California**

Dear Ms. Wydzga:

Yeh and Associates, Inc. is pleased to submit this Preliminary Geotechnical and Geologic Hazards Report for the Meadow Creek Lagoon Habitat Restoration project in San Luis Obispo County, California. This report was prepared to provide preliminary geotechnical recommendations and geologic considerations as input to the project alternatives development and evaluation required for the Environmental Impact Report (EIR). This report was prepared in accordance with our Task Order dated September 2, 2021, and our *Subconsulting Master Services Agreement* with Stillwater Sciences dated March 19, 2021. Yeh previously prepared an *Existing Geotechnical Data Review* letter dated June 11, 2021, that summarized existing geotechnical data pertinent to the project and provided preliminary recommendations for additional data collection.

The evaluation consisted of a program of site reconnaissance, review of previous studies, an evaluation of geologic hazards, and preliminary geotechnical analyses. Historic geotechnical exploration logs, laboratory data, and aerial photographs collected for this study are appended. Graphics showing the regional and site geology, historic seismicity and faulting in the site vicinity, locations of the field explorations, and site geologic conditions are presented on plates attached to this report. This report has been prepared to generally address the requirements for a geologic hazards study in accordance with San Luis Obispo County Guidelines. The following is a summary of key geologic hazards and geotechnical considerations for the project alternatives development and evaluation:

- Subsurface conditions within the project limits are anticipated to consist of artificial fill (af), estuarine deposits (Qe), stream channel deposits (Qhc), alluvial flood-plain deposits (Qa), beach sand (Qb), dune sand (Qd), and young eolian deposits (Qye) based on surface conditions observed during our site reconnaissance and on subsurface information presented in previous studies performed in the project vicinity.
- Groundwater measured by previous studies was generally shallow. Depths measured by those studies ranged between approximately 2 to 7 feet below the ground surface. The elevations of groundwater surfaces measured by those studies ranged from approximately 0 to 11 feet relative to mean sea level (MSL). Wet soil conditions should be anticipated and dewatering to lower groundwater levels for construction will likely be needed for excavations, particularly along the margins of Meadow Creek Lagoon.
- Geologic hazards that will likely need to be addressed by the project design include strong ground motion associated with the design earthquake, liquefaction and associated seismic settlement and slope instability of predominantly loose to medium dense sandy alluvial and eolian deposits, and subsidence or settlement of potentially compressible alluvial and estuarine deposits.
- The potential for liquefaction to impact the project alternatives is considered high based on the anticipated subsurface conditions and the findings of previous studies. Liquefaction occurred within the approximate project limits in response to the 2003 M6.5 San Simeon Earthquake. The preliminary design earthquake is a M6.7 event (similar to the M6.5 San Simeon Earthquake) that would result in an estimated peak ground acceleration of 0.47g: two to four times stronger than the acceleration estimated for the San Simeon Earthquake.
- It is anticipated that the potential for liquefaction will be similar for each of the project alternatives, including improvements to the existing north levee of Arroyo Grande Creek. Liquefaction effects that could impact the levee embankments or flood control structures within the embankment (such as culverts and flap gates), include settlement, slope instability, and/or cracking of the levee embankment that could reduce the flood protection provided by the improvements.
- Typical mitigation methods for liquefaction are discussed in the Liquefaction Considerations section of this report. Liquefaction and seismic hazards can be addressed by soft fixes that typically include emergency response and resource planning for seismic events. We understand the County of San Luis Obispo selected a soft fix-approach to seismic hazards for the upstream 2020 Arroyo Grande Creek flood control project (Yeh 2020).

- A new levee alignment along the margins of Meadow Creek Lagoon would likely be founded on relatively soft and compressible alluvial and estuarine deposits that are generally considered susceptible to settlement. The foundation soil underlying the existing north levee is anticipated to consist of alluvial deposits that may be susceptible to settlement resulting from additional stresses associated with raising the levee. New flood control structures (such as culverts and flap gates) constructed within the existing north levee are not anticipated to increase the potential for settlement. Mitigation options for static settlement are provided in the Foundation Design Considerations section of this report.

We appreciate the opportunity to be of service. Please contact Gresh Eckrich at 805-616-0399 or geckrich@yeh-eng.com if you have questions or require additional information.

Sincerely,
YEH AND ASSOCIATES, INC.

Reed Hooke

Reed J. Hooke, E.I.T.
Staff Engineer

Gresham D. Eckrich, P.E., C.E.G.
Senior Project Manager

REGISTERED PROFESSIONAL ENGINEER
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GEOTECHNICAL
STATE OF CALIFORNIA

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1. PROJECT DESCRIPTION, ZONING AND LOCATION

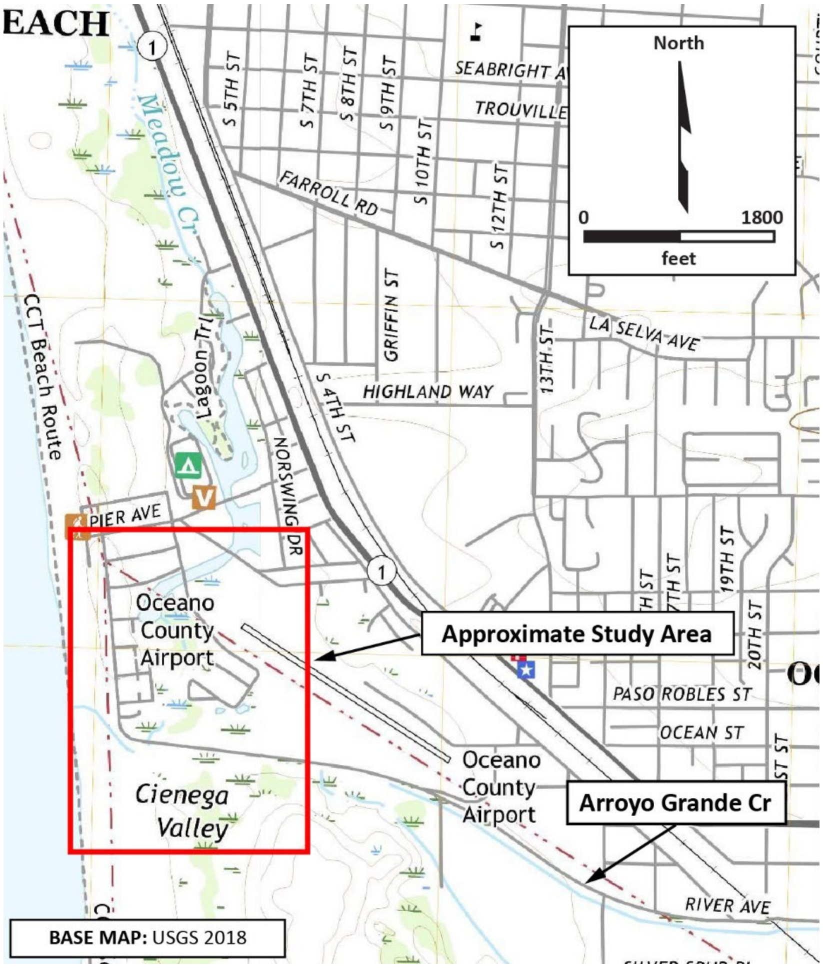


Figure 1: Vicinity Map

Yeh and Associates was retained by Stillwater Sciences to provide geotechnical services as input to the preliminary engineering and environmental analysis of the Meadow Creek Lagoon Habitat Restoration Project in San Luis Obispo County, California (see Figure 1). The evaluation consisted of a program of project coordination, site reconnaissance, review of previous studies, an evaluation of geologic hazards, and preliminary geotechnical analyses as a basis for providing the preliminary considerations and recommendations in this report. This report provides a discussion of preliminary findings and recommendations regarding regional and site geology, potential geologic hazards and their impact to the project, and preliminary geotechnical and construction considerations. This report is not intended to serve as a design-level report for the selected project alternative.

1.1 PROJECT DESCRIPTION

The purpose of the project is to increase connectivity between Arroyo Grande Creek and Meadow Creek Lagoon and restore/enhance the Meadow Creek Lagoon. The potential restoration area encompasses Meadow Creek Lagoon, Arroyo Grande Lagoon, and the earthen Arroyo Grande Creek Levee that separates those two waterbodies. The Sand Canyon Outlet is a flood control structure consisting of two corrugated metal pipe culverts that penetrate the north levee of Arroyo Grande Creek adjacent to the Meadow Creek Lagoon. Flap gates on the Arroyo Grande Creek side of the levee prevent high flows from Arroyo Grande Creek and high ocean tides from flowing into the Meadow Creek Lagoon. Long term sedimentation within the Meadow Creek and Arroyo Grande lagoons has resulted in reduced flood control capacity and the encroachment of invasive vegetation.

The approximate study area is shown on Plate 1 – Existing Exploration Map. We understand that the project alternatives consist of a levee setback, removal, or reconfiguration; replacement and/or augmentation of the outlet structure; and/or grading to create or modify channels, pools, and riparian habitat. We understand the length and location of levee modifications will be developed in subsequent tasks of Stillwater Sciences' scope of work for the County of San Luis Obispo.

1.2 EXISTING SITE DESCRIPTION

Meadow Creek flows north to south along the coastline from Pismo Beach to the Meadow Creek Lagoon (aka Oceano Lagoon) Oceano, California. The lagoon drains to Arroyo Grande Creek, which flows east to west from Lopez Lake to the Arroyo Grande Lagoon located just south of the Sand Canyon Outlet Structure. The Arroyo Grande Lagoon drains to the Pacific Ocean. The terrain in the site vicinity is generally flat with natural grades ranging from approximately 1 to 4 percent. Existing elevations at the site range from approximately mean sea level at the downstream end of the study area on Pismo Beach to approximately elevation 20 feet at the southern limits of the study area. Vegetation at the site predominantly consists of dense dune scrubs and brush, and emergent plants (e.g., cattails) typical of estuaries/lagoons.

The existing land uses adjacent to the study area are predominantly residential, industrial, and recreational. Residential properties are located along the western, northern, and eastern margins of the study area. The Oceano Airport and San Luis Obispo County Sanitation District Water Reclamation Facility (herein referred to as SSLOCSD) are also located east of the study area. Active sand dunes are located south of the study area within the Oceano Dunes State Vehicle Recreation Area (SVRA) operated by State Parks.

1.3 SITE HISTORY

The EDR (2021) Decade Package provided historic aerial photographs of the site. Figure 2 shows the site relative to a 1940 aerial photo (from UCSB 2021) and historic drainages of the Meadow Creek and Arroyo Grande Creek watersheds. The drainages flow west into coastal beach and dune sand deposits and toward the Pacific Ocean near the southern end of the approximate study area (shown as a red rectangle).

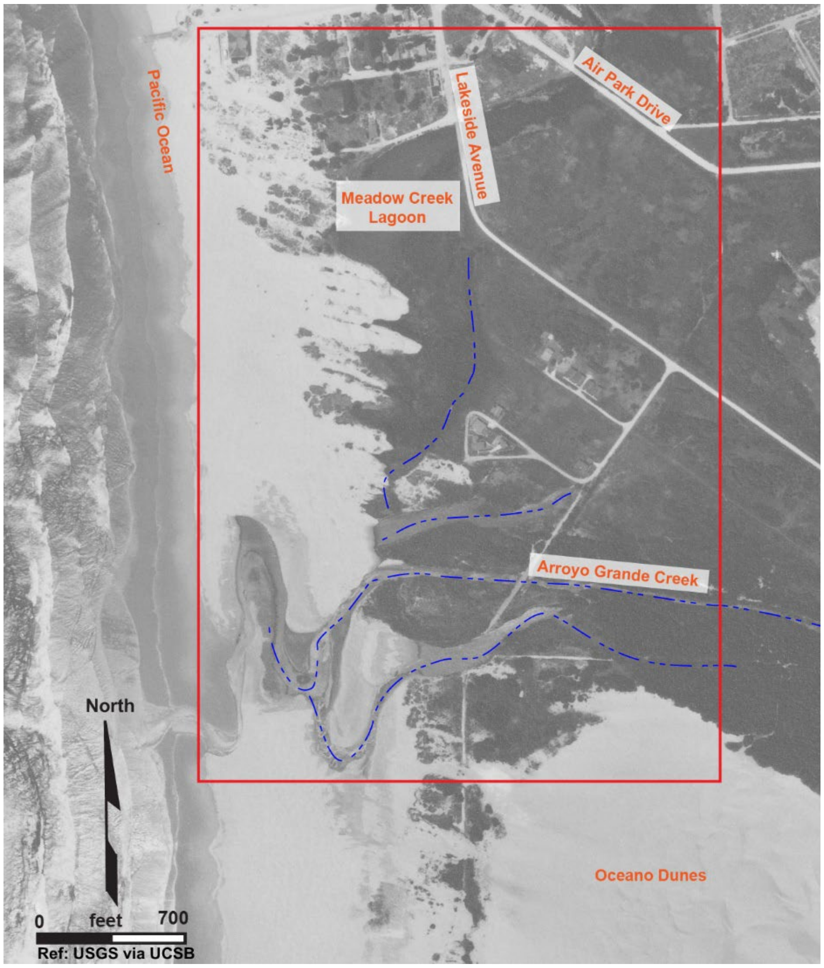


Figure 2: 1940 Aerial Photo

The Arroyo Grande Creek was channelized when the levees were constructed in 1959 as a U.S. Department of Agriculture, Soil Conservation Service project (USDA 1956). Portions of the creek were relocated as part of the construction of the levee system. The USDA (1956) design plans show the levee embankments were designed with 15-foot-wide crests, exterior slope inclinations of 1½h:1v to 2h:1v (horizontal to vertical), and 3h:1v interior slope inclinations. The interior slopes were likely constructed as steep as about 2h:1v based on cross sections developed by Fugro (2012a).

1.3.1 PRE-DEVELOPMENT TERRAIN

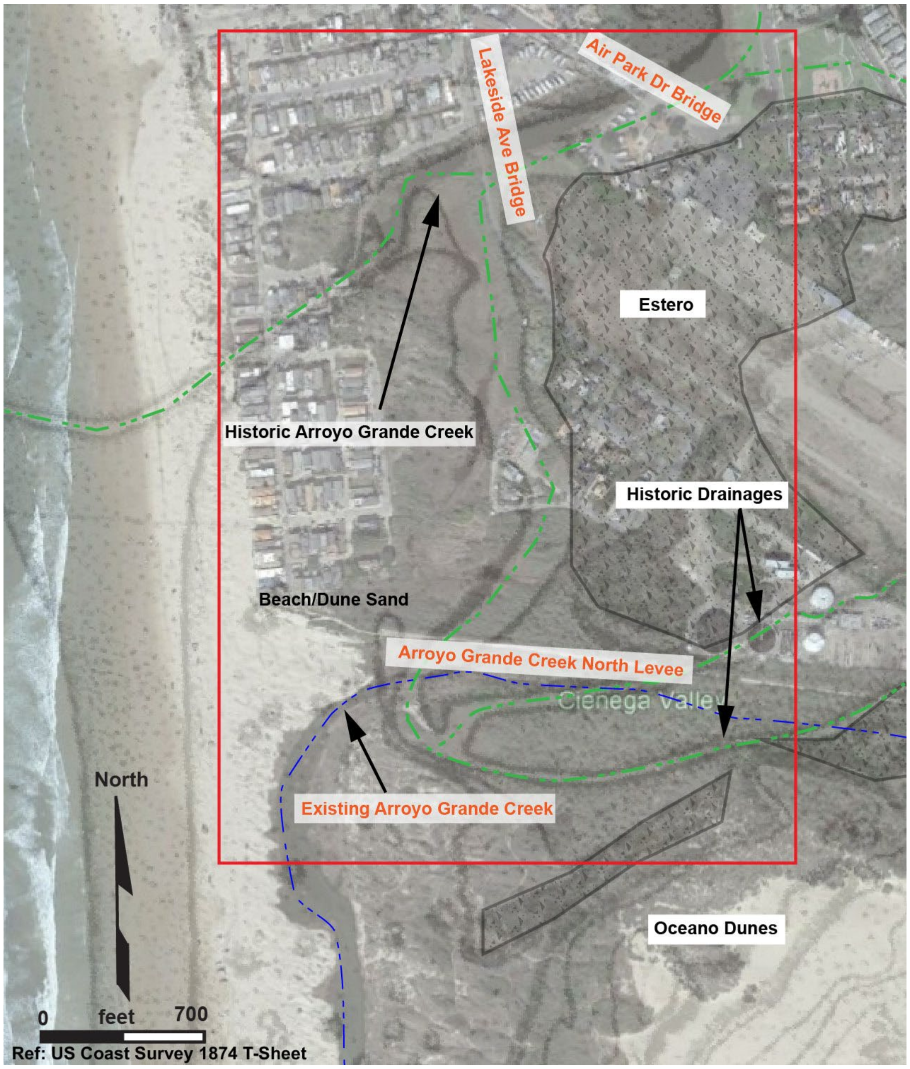


Figure 3: Historic 1874 Survey Overlay

Figure 3 presents an overlay of a recent aerial image and a historic map consisting of T-sheet number 1393 from a mapping project performed in 1874 by the U.S. Coast Survey (NOAA 2021). The figure shows the approximate locations of a historic estero (aka estuary) and historic drainages of Arroyo Grande Creek, the approximate thalweg of the existing creek, and the locations of existing roads and the north levee of Arroyo Grande Creek. The estero was eventually drained and the creeks were channelized to reduce flooding. The historic estero was filled over the last century for the development of surrounding properties, and Meadow Creek Lagoon is the only remaining trace of the estuary. In addition to the landscape modification by extensive filling, comparison of the 1874 survey and existing Arroyo Grande Creek channel in Figure 3 indicates that much of the original channel was filled and the active channel was relocated southwestward to an excavated channel at its present position (Holzer et. al 2004).

1.3.2 2003 SAN SIMEON EARTHQUAKE

The December 22, 2003, Magnitude 6.5 San Simeon earthquake caused damage to houses, road surfaces, and underground utilities in Oceano, which is approximately 50 miles southeast the earthquake's epicenter. Most of the damage was caused by two lateral spreads (ground cracks) associated with liquefaction. Cumulative horizontal displacements inferred from opening and compression across ground cracks at both of the lateral spreads were approximately 12 inches or less. Displacements across cracks continued to increase for weeks after the earthquake. In addition, a bearing capacity failure damaged the southern levee of Arroyo Grande Creek at Cardoza Ranch located approximately 1,800 feet east of the study area, where sand boils resulting from liquefaction also erupted over a large area in the ranch pasture to the south of the levee (Holzer et. al 2004).

1.3.3 HISTORIC FLOODING

The project vicinity has been inundated due to multiple flood events before and after the Arroyo Grande Creek Levee was constructed in the late 1950's. The south levee breached during a high-intensity storm event approximately 1 mile upstream of the study area in March 2001. The north levee did not breach during that event (Waterways 2010).

1.4 PREVIOUS STUDIES

Previous geotechnical studies were performed in the project vicinity. Data from those studies were used to supplement this report and are summarized below. The locations of pertinent borings are presented on Plate 1 – Existing Exploration Map. Relevant subsurface data from these reports are provided in Appendix A.

- Jenks & Harrison (1979) prepared a Log of Borings that shows five borings drilled for the SSLOCSD's Ocean Outfall project. The borings were located approximately 300 feet or farther west of the study area.
- The U.S. Geological Survey (Holzer et al., 2004) performed a geotechnical study to evaluate liquefaction and liquefaction-induced lateral spreading that occurred in Oceano in response to the 2003 San Simeon Earthquake. The USGS performed Cone Penetration Test (CPT) soundings at the SSLOCSD and along streets in residential neighborhoods surrounding the Meadow Creek Lagoon.
- A *Preliminary Geotechnical Investigation* of the Arroyo Grande Creek north and south of the levees was performed by Fugro (2009). Fugro performed CPT soundings located approximately 1,700 feet or farther east of the study area.
- A *Limited Geotechnical Report* was prepared by Fugro (2012a) addressing seepage conditions along the existing north levee of Arroyo Grande Creek. Fugro advanced three hollow stem auger borings along the crest of the north levee.
- An additional *Geotechnical Report* was prepared by Fugro (2012b) to further characterize the subsurface conditions along the existing north levee of Arroyo Grande Creek for the design of previous proposed levee improvements. Fugro advanced five hollow stem auger borings along the crest of the north levee.
- Kleinfelder (2014) prepared a *Preliminary Foundation Report* for the replacement of the Air Park Drive Bridge at Oceano Beach Lagoon. Kleinfelder drilled a boring at each end of bridge, approximately 1,900 feet northeast of the existing Sand Canyon Outlet structure. Kleinfelder (2016) also prepared a *Foundation Report* for the same project but did not perform additional subsurface exploration.
- A *Geotechnical Report* was prepared by Yeh and Associates (2019) to provide recommendations for the design of improvements to the SSLOCSD Wastewater Treatment

Facility Redundancy Project. Yeh advanced 9 CPT soundings and 3 hollow stem auger borings within the limits of the SSLOCSD property.

2. ENGINEERING GEOLOGY AND SITE CONDITIONS

2.1 REGIONAL AND SITE GEOLOGY

The study area is located within the Coast Ranges geologic and geomorphic province, which extends from the Transverse Ranges in southern California to the Klamath Mountains in northern California and into Oregon. The province is characterized by north-northwest trending mountain ranges (locally the Santa Lucia Mountains) composed of sedimentary, volcanic, and metamorphic rock formations. The rock units are predominantly Jurassic and Cretaceous age with Tertiary to Quaternary age units commonly overlying the older rock along the flanks and foothills of those ranges. Recent sediments are found within the intervening drainages and valleys, and coastal areas.

The study area includes a historic estuary, coastal dunes, and lagoons. The surficial geology at the site vicinity as mapped by Holland (2013) is shown on Figure 4. Areas of compression, extension and sand boils resulting from the 2003 M6.5 San Simeon Earthquake and documented by Holzer et. al (2004) are also shown on Figure 4. Holland (2013) maps the predominant surface geologic units as late Holocene age stream channel deposits (Qhc) described as unconsolidated sand, gravel, and cobbles in active channels, alluvial flood-plain deposits (Qa)consisting of unconsolidated sandy, silty, and clay-bearing alluvium, and young eolian deposits (Qye) described as well-sorted white to brown windblown sand. A concealed trace of the Oceano fault is mapped through the Arroyo Grande Lagoon in the southwest corner of the approximate study area. The Oceano fault is a late Quaternary age fault that is part of the San Luis Range fault system and characterized as a reverse fault (USGS 2021). The fault is interpreted to dip to the southwest according to the USGS (2021a) and to the northeast according to the County of San Luis Obispo (1999).

Yeh's mapped interpretation of surficial geology within the study area is shown on Plate 2 – Site Geologic Map and is based on surface conditions observed during our site reconnaissance on September 30, 2021, review of aerial photographs and historical U.S. Coast Survey T-sheets (NOAA 2018), and subsurface information presented in previous studies (Jenks & Harrison 1979; Kleinfelder 2014; Holzer et. al 2004; Fugro 2009, 2012a; Yeh 2019, 2020).

As noted in Holzer et. al (2004), the geology within the study area consists of a complex sequence of interbedded unconsolidated sediments resulting from the interaction of multiple geologic environments that are active in the area, including the floodplains of Meadow and Arroyo Grande Creeks, eolian (windblown) sand dunes, shallow bay, estuary, and marshes, and sandy beaches.

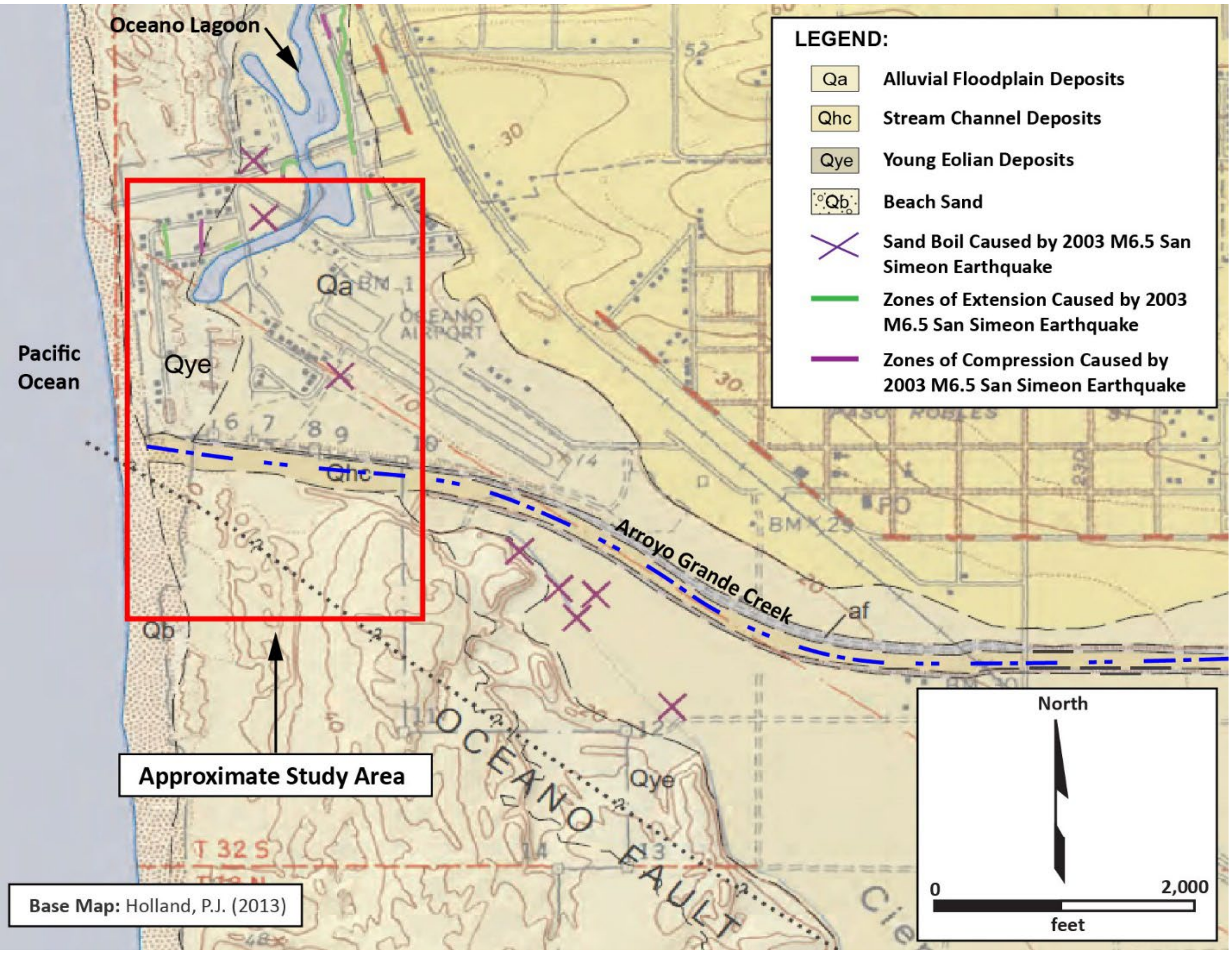


Figure 4: Geologic Map (Holland 2013)

2.2 Aerial Photograph Review and Geomorphologic Interpretations

Historic aerial photographs taken between 1939 and 2016 (about one per decade) were obtained from Environmental Data Research, Inc. (EDR 2021) and reviewed for this project. Yeh also collected aerial photography from the University of California – Santa Barbara Aerial Image Library (UCSB) and lidar imagery from the United States Geological Survey (USGS 2018) for review. These images were reviewed to evaluate changes in land use, topography, geomorphic features, and other characteristics pertinent to the site geology and geotechnical considerations discussed in this report. The aerial photos collected are provided in Appendix B with the approximate study area shown as a red rectangle on each photo. The following observations were made during the review:

- The January 1939 photo shows three drainages for the Meadow Creek, Arroyo Grande Creek, and Los Berros Creek watersheds that appear to be connected near the present-day Sand Canyon Outlet Structure location. The northern and central drainages appear to have been disconnected from the Pacific Ocean by beach or dune sand deposits, and the southern drainage outlets to the ocean approximately 500 feet south of the present-day Sand Canyon Outlet Structure location.
    - The northern drainage appears to be similar to the present-day drainage north of the Arroyo Grande Creek Levee.
    - The upstream alignment of the central drainage appears to be similar to the alignment of the present-day Arroyo Grande Creek.
    - The southern drainage appears to drain Los Berros Creek, which flowed along the southern edge of La Cienega Valley at the base of the Oceano Dunes.
- The May 1940 photo shows the Arroyo Grande Creek and Los Berros Creek outlet to the ocean. The northern drainage appears to have been disconnected from the Pacific Ocean by beach or dune sand deposits.
- The 1949 photo shows that Arroyo Grande Creek appears to have been channelized upstream of the present-day Sand Canyon Outlet Structure location along an alignment similar to the present-day alignment of Arroyo Grande Creek.
    - Los Berros Creek appears to have been channelized and connected to Arroyo Grande Creek approximately 1,400 feet upstream of the present-day Sand Canyon Outlet Structure location. (Note Los Berros Creek was diverted from its pre-1960 channel to its current confluence upstream of the Highway 1 Bridge approximately 2.5 miles upstream of the site.
    - The unchannelized section of the former Los Berros Creek appears to be connected to Arroyo Grande Creek approximately 550 feet upstream of the present-day Sand Canyon Outlet Structure location. The downstream section of Los Berros Creek appears to have flowed west through a relatively vegetated area at the base of the adjacent Oceano Dunes.
- The Oceano County Airport was constructed between the 1949 and 1956 photos.
- Construction of the Arroyo Grande Creek Levee was completed between the 1956 and 1960 photos. The south levee appears to have terminated approximately 1,700 upstream of the present-day Sand Canyon Outlet Structure location.
- The housing development in the northwest study area, south of present-day Pier Avenue, was completed between the 1963 and 1976 photos.
- The construction of the South San Luis Obispo County Sanitation District (SSLOCSD) began between the 1963 and 1976 photos. The SSLOCSD was expanded between the 1981 and 1994 photos.
- The 2005 photo shows the channels just south and north of the existing Sand Canyon Outlet appear to have been narrower and less defined than the 1994 photo. The change in channel morphology may be associated with sedimentation or vegetation growth near the outlet structure.
- The orientation of the Arroyo Grande Lagoon and outlet to the Pacific Ocean appears to have migrated southward between the 1939 and 2016 photos.

    - The Arroyo Grande Creek ocean outlet is oriented approximately east-west in the 1949 and 1963 photos.
    - The ocean outlet migrated south in the 1978, 1981, 2005, and 2012 photos, parallel to and along the base of the adjacent Oceano Dunes. Those photos show the development of Arroyo Grande Lagoon as an apparently static body of water along the base of the Ocean Dunes.
    - The orientation of Arroyo Grande Creek downstream of the south levee in the 2012 photo appears similar to the orientation of the former Los Berros Creek drainage visible in the 1949 photo.
- The 2009 and 2016 photos show an increase in vegetation between the two photos along the margins of the Arroyo Grande Lagoon, likely associated with predominantly fine-grained soil typical of estuarine/lagoon deposits.

2.3 ANTICIPATED SUBSURFACE CONDITIONS

Subsurface conditions within the study area are anticipated to consist of artificial fill (af), estuarine deposits (Qe), stream channel deposits (Qhc), alluvial flood-plain deposits (Qa), beach sand (Qb), dune sand (Qd), and young eolian deposits (Qye), as shown on Plate 2. Descriptions of the units are provided below and based on surface conditions observed during our site reconnaissance and on subsurface information presented in previous studies (Jenks & Harrison 1979; Holzer et. al 2004; Fugro 2009, 2012a; Kleinfelder 2014; Yeh 2019, 2020). The locations of explorations performed by previous studies are shown on Plate 1.

Artificial Fill (af). The historic estero shown in Figure 3 was filled to develop the properties surrounding Meadow Creek Lagoon, and the fill likely consisted of levelled dune and beach sands placed on estuarine and alluvial flood-plain deposits. A hybrid designation (Qye/af or Qa/af) is shown on Plate 2 where the surficial contact between young eolian deposits (Qye) or alluvial flood-plain deposits (Qa) and artificial fill (af) could not be distinguished. The fill is anticipated to consist of relatively loose, predominantly coarse-grained soil typical of dune and beach sand deposits.

Fugro (2009, 2012a) encountered artificial fill in borings and CPTs along Arroyo Grande Creek that generally consisted of soil placed during construction of the existing levee. The artificial fill materials encountered by those studies consisted predominantly of medium dense to very dense sand and silty sand.

Stream Channel Deposits (Qhc). Stream channel deposits were mapped south of the Arroyo Grande Creek Levee within the creek's active flow channel where we observed coarse gravel and cobbles typically deposited by relatively high-energy flow events. Surficial deposits consisted of dry, brown to gray, silty sand with subrounded gravel and few to some cobbles.

Jenks & Harrison (1979) encountered loose to medium dense sand and silty sand with varying amounts of silt, gravel, and shell fragments at the ground surface that we've interpreted as interbedded beach sand, alluvial, and stream channel deposits.

Alluvial Flood-plain Deposits (Qa). Alluvial flood-plain deposits were mapped along the southern margin of the active Arroyo Grande Creek channel. The alluvial deposits were mapped in relatively vegetated, flat topographic areas that have likely been periodically inundated by the creek. The surficial alluvial deposits consisted of dry, dark brown silty sand with trace to few subrounded gravel.

Alluvial flood-plain deposits were encountered by Fugro (2009, 2012a) and Yeh (2019, 2020) at the ground surface and underlying artificial fill. The alluvial deposits were described by those studies as interbedded and undifferentiated layers of sand and clay soil likely associated with a shallow marine, estuarine, or eolian depositional environment. Those previous studies differentiated predominant sub-units within the alluvial deposits. The sub-units generally consisted of loose to medium dense predominantly coarse-grained soil (sand and gravel with varying amounts of silt and clay), soft to very stiff predominantly clayey soil with varying amounts of silt and sand, medium dense to very dense predominantly sandy soil, and very stiff to hard predominantly clayey soil.

Kleinfelder (2014) and Jenks & Harrison (1979) encountered interbedded medium dense to very dense sand and gravel units (with varying amounts of silt, clay, and shell fragments) and soft to medium stiff fat clay and silty clay below the ground surface that we've interpreted as interbedded alluvial deposits, stream channel deposits, and beach sand deposits.

Beach Sand (Qb). Beach sand deposits were mapped along the western limits of the study area where the depositional environment is actively affected by ocean waves. Holland (2013) described beach sand as unconsolidated fine- to medium-grained well-sorted sand.

Dune Sand (Qd). Dune sand deposits were mapped east of modern beaches (Qb) along the western limits of the study area. Holland (2013) described dune sand as well-sorted white to brown windblown sand with little to no vegetation.

Young Eolian Deposits (Qye). Young eolian deposits were mapped surrounding the Meadow Creek and Arroyo Grande Creeks and Lagoons where we observed vegetation and uneven topography typical of stationary sand dune deposits. Young eolian deposits are anticipated to overlie estuarine deposits

Surficial deposits consisted of dry, yellowish brown to brown sand with silt. Holzer et. al (2004) encountered eolian sands at the ground surface consisting of predominantly clean sand. Kleinfelder

(2014) encountered medium dense sand and silty sand that we've interpreted as interbedded young eolian deposits and stream channel deposits underlying artificial fill at the Air Park Drive Bridge.

Estuarine Deposits (Qe). Estuarine deposits were mapped north and south of the existing levee within the interpreted limits of the Meadow Creek and Arroyo Grande Lagoons. Estuarine deposits were also mapped in low-lying areas where we observed relatively dense emergent plants, and soft ground with desiccation cracks indicative of fine-grained soil typical of estuarine deposits. Surficial deposits predominantly consisted of moist to wet, dark brown to black lean clay and silty clay with organic inclusions.

Estuarine deposits are anticipated to underlie artificial fill, young eolian deposits, and alluvial flood-plain deposits within the study area. Holzer et. al (2004) encountered estuarine deposits predominantly consisting of clayey silt underlying eolian sand and beach/estuarine sand.

Groundwater. Groundwater measured by previous studies (Jenks & Harrison 1979, Holzer et. al 2004, Kleinfelder 2014, Yeh 2019) was generally shallow. Depths measured by those studies ranged between approximately 2 to 7 feet below the ground surface. The elevations of groundwater surfaces measured by those studies ranged from approximately 0 to 11 feet relative to mean sea level (MSL). Arroyo Grande Creek was dry during our September 30, 2021, site reconnaissance, and the elevations of water in the Meadow Creek and Arroyo Grande lagoons were approximately 7.2 feet and 6.6 feet (MSL) based on the County's water data monitoring website (Home (slocountywater.org)).

Groundwater and soil moisture conditions within the study area will vary seasonally and due to variations in storm runoff, irrigation schedules, and groundwater pumping in the site vicinity. We understand water levels within seasonal ponds associated with the Meadow Creek and Arroyo Grande lagoons monitored by State Parks have lowered following dewatering that started in July 2021 for the SSLOCSD's Wastewater Treatment Facility Redundancy Project.

3. GEOLOGIC HAZARD CONSIDERATIONS

3.1 ACTIVE FAULTING AND COSEISMIC DEFORMATION

Fault rupture or coseismic deformation is the displacement of the ground surface caused by tectonic movement during a seismic event. The Alquist-Priolo Earthquake Fault Zoning Act of 1972 provides legislation intended to reduce losses from surface fault rupture on a statewide basis. The Act's main purpose is to categorize zones around active faults in an effort to prevent the construction of structures for human occupancy above active faults. The California Geological Survey (CGS 2008a) definitions consider faults "active" if they show evidence of displacement within the last 11,000 years (Holocene age) and "potentially active" if they show evidence of displacement within the last

1,600,000 years (Quaternary age), but do not have direct evidence to show whether the fault has been active during the Holocene age. Potentially active faults are considered active for the purpose of evaluating fault rupture.

The faults shown on Plate 3 are classified as Historic, Holocene, Late Quaternary, or Quaternary. CGS defines these terms based on the age of a fault as follows:

> **Historic.** Faults that show evidence of displacement or activity within the historical record; approximately the last 200 years.
>
> **Holocene.** Faults that show evidence of displacement in Holocene time (the last 11,000 years).
>
> **Late Quaternary.** Faults that show evidence of displacement in the Late Quaternary period (the last 750,000 years), but no evidence of movement in Holocene time.
>
> **Quaternary.** Faults that show evidence of displacement in the Quaternary period (the last 1,600,000 years), but no evidence of movement in Holocene time.

3.1.1 NEARBY FAULTING

The Hosgri Fault Zone is mapped trending northwest approximately 11.2 miles northwest of the study area (see Plate 3). An approximate 19.3-mile-long length of the Hosgri Fault Zone is classified by CGS (Bryant, 2005) as an active (Holocene) fault. A concealed trace of the Oceano fault is mapped trending northwest within the southwestern limits of the study area (see Plate 2). The Oceano fault is considered a part of the San Luis Range fault system and is classified by CGS (Bryant, 2005) as a potentially active (late Quaternary) northwest trending fault. The County of San Luis Obispo (1999) noted that the Oceano fault “is conservatively considered to be potentially active by current state standards,” and the County’s (2021) Land Use View mapping tool classifies the fault as inactive.

3.1.2 FAULT RUPTURE HAZARD

Fault rupture is the displacement of the ground surface due to fault movement during an earthquake. Yeh reviewed the local fault setting, published maps and literature references, and historic aerial photographs. The closest mapped fault to the site is the Oceano fault, which is considered a potentially active fault. The site is not within a designated Alquist-Priolo Earthquake Fault Zone. The potential for fault rupture should be evaluated by the design geotechnical investigation if improvements are proposed that will span the mapped trace of the Oceano fault. No special mitigation to address faulting or fault rupture are considered necessary for project improvements that do not span the mapped fault trace.

3.2 HISTORIC SEISMICITY

The site is located within a seismically active region of the central coast of California where earthquakes resulting in strong and damaging ground motion have occurred within the historical record. A summary of magnitude 2.0 and greater seismic events recorded from 1931 through 2021 by the Advanced National Seismic System (ANSS 2021) and Clark et al. (1994) is shown on Plate 3 – Historic Seismicity and Regional Fault Map. The project has been impacted by historic earthquakes (such as the 2003 San Simeon Earthquake). The primary effects of strong ground motion will generally be those phenomena associated with seismic shaking and/or ground acceleration, which are discussed in subsequent sections of this report.

Seismic data and a site classification for the project design should be reviewed and updated in the design-level geotechnical report in accordance with applicable County codes, ordinances, and guidelines. The report should provide design earthquake parameters (magnitude and peak ground acceleration) for use in geotechnical analyses, such as slope stability, liquefaction, and seismic settlement.

3.3 LIQUEFACTION

Liquefaction typically occurs in young, loose to medium dense granular sand or sensitive clay and silt below the groundwater table that are subject to ground motions from an earthquake. The potential for liquefaction is dependent on site-specific properties such as the relative density, plasticity, and particle size of a soil; groundwater conditions; and geologic history. Potentially liquefiable soils may be vulnerable to loss of strength and foundation support, seismic settlement, slope instability or lateral spreading depending on the severity of the liquefaction hazard and site conditions.

Liquefaction analyses performed by previous studies (Holzer et. al 2004; Fugro 2009, 2012a; Kleinfelder 2014; Yeh 2019, 2020) indicated that the alluvial and eolian deposits consisting of predominantly loose to medium dense sandy soil encountered by those studies was potentially liquefiable. Holzer et. al (2004) mapped evidence of liquefaction that occurred in the study area in response to the 2003 M6.5 San Simeon Earthquake (see Figure 4 and Plate 2). Evidence of liquefaction in the site vicinity consisted of lateral spreading and damage to homes in Oceano, sand boils and seismic settlement at the Oceano Airport, and failure of the south levee on Arroyo Grande Creek approximately 1,800 feet east of the study area (see Plate 2).

The selected project alternative will likely be underlain by alluvial flood-plain and eolian deposits that are considered vulnerable to liquefaction, seismic settlement, and instability during strong ground shaking. Typical mitigation methods for liquefaction are discussed in the Liquefaction Considerations section of this report.

3.4 LANDSLIDES AND SLOPE INSTABILITY

The published geologic map by Holland (2013), aerial photographs, and field reconnaissance were used to evaluate the potential for landslides and slope instability. We did not observe evidence of landslides or slope instability during our site reconnaissance. Holzer et. al (2004) reported failure of the Arroyo Grande Creek south levee that was attributed to a bearing capacity failure due to liquefaction. Static and seismic slope stability analyses should be performed as part of the design geotechnical investigation if the selected project alternative involves new levees or modifications to the existing levee slopes.

3.5 EXPANSIVE SOIL

Expansive soil conditions can cause differential movement and damage to foundations, slabs, flatwork, slopes, and other improvements due to shrinking and swelling of the soil in response to moisture fluctuations. These movements are most common in near surface soils, near the edge of slabs or pavements where seasonal moisture contents in the soil fluctuate the most.

Predominantly fine-grained soil types (such as fat clay) that are anticipated to comprise estuarine deposits and sub-units of the alluvial deposits are typically considered susceptible to volume changes in response to moisture changes. Expansion and contraction of underlying fine-grained soil can result in distress to structures and cracks in levee embankments that could reduce the level of flood protection provided by those improvements. Those soil types should be evaluated for expansion potential relative to the selected project alternative by the design geotechnical investigation, and mitigation options to reduce the impact of expansive soil on improvements should be provided, if necessary, in the design-level geotechnical report.

3.6 FLOODING

Elevations at the site range from sea level to approximately 20 feet above sea level. Terrain within the study area at elevations less than approximately 15 feet are mapped within FEMA’s (2021) 100-year flood hazard zone (1% Annual Flood Risk). The restoration project will likely include flood control measures such as new or modified levees or improvements to existing culverts and/or flap gates. We understand the project team will evaluate the flood control benefits as part of the project’s alternatives development and evaluation, and the level of flood control will likely be a factor in the County’s selection of a project alternative.

Seepage analyses to evaluate flood protection during the design storm event should be performed as part of the design geotechnical investigation if the selected project alternative will include new or modified levees.

3.7 EROSION

Predominantly coarse-grained soil types were encountered by previous studies and are anticipated to comprise dune and beach sand, and young eolian deposits that are typically considered susceptible to erosion when disturbed by grading or when exposed by excavations. Graded fill slopes associated with levee improvements will be susceptible to sheet and rill erosion. Predominantly coarse-grained soil types and low plasticity, predominantly fine-grained soil types are typically considered erodible as levee embankment material.

The potential for erosion of new embankment slopes should be evaluated by the design geotechnical investigation if the selected project alternative will involve new or modified levee embankments. Erosion control and suitable vegetation should be provided to reduce the potential for erosion on graded slopes. Drainage should be provided such that surface water does not run over slopes. Concentrated flows and runoff should not be permitted to discharge on slopes. Down drains, solid pipes, or lined ditches should be provided where needed to carry surface water from the top of the slope to the base of the slope. Energy dissipation and erosion control devices should be provided at the outlet of drainpipes and in areas of concentrated runoff to reduce the potential for erosion. Landscaping and maintenance of graded slopes should be provided to assist the establishment of vegetation and reduce the potential for erosion.

3.8 HYDROCONSOLIDATION, COLLAPSE, AND SUBSIDENCE

Hydroconsolidation is the potential for a soil to consolidate or collapse due to wetting. Anticipated subsurface conditions within the study area include loose to medium dense alluvial and eolian deposits that are generally considered susceptible to hydroconsolidation or collapse. Those soil types should be evaluated for hydroconsolidation potential relative to the selected project alternative by the design geotechnical investigation, and mitigation options should be provided, if necessary, in the design-level geotechnical report.

Deep subsidence is typically associated with the extraction of groundwater from water or oil wells that results in lowering of the groundwater table. Dewatering of young sediments or porous soil types can result in subsidence if the soil is prone to consolidation or collapse due to an increase in effective overburden stress that occurs when the groundwater level is lowered.

Anticipated subsurface conditions within the study area include relatively soft and compressible alluvial and estuarine deposits that are generally considered susceptible to subsidence. A new levee constructed within and/or along the margins of the Meadow Creek Lagoon would likely be founded on alluvial and/or estuarine deposits and would likely require dewatering for construction based on the anticipated shallow groundwater conditions. There is a potential for subsidence if the quantity of water extracted become excessive and leads to compaction of underlying soil layers. We understand the SSLOCSD’s adjacent Wastewater Treatment Facility Redundancy Project has implemented a settlement monitoring program as part of the project’s 2021 construction dewatering operations. Although settlement of structures has not been observed during that project’s dewatering operations, ground cracks and evidence of local subsidence near dewatering wells have been observed. Mitigation of subsidence due to dewatering is discussed in the Construction Considerations section of this report.

3.9 COASTAL HAZARDS – BLUFF EROSION, DAM INUNDATION, AND TSUNAMIS

The western boundary of the approximate study area is defined by beach and dune sand deposits along the Pacific Ocean that are generally not considered susceptible to the coastal erosion and retreat typical of bluffs formed by relatively resistant rock. We understand the restoration project will likely reduce the potential for sedimentation within the Meadow Creek and Arroyo Grande lagoons, and that additional sediment will likely be conveyed to the beach as a result of the project. Therefore, the potential for coastal erosion to immediately affect the site is considered low and no special measures are considered necessary in the project design to address coastal erosion.

Tsunamis are long-period sea waves formed during seismic events or submarine landslides, that have historically occurred in the project region. Tsunamis behave like a very fast-moving tide and can result in run-ups, or bores, extending great distances up streams, rivers, and creeks. The American Society of Civil Engineers (ASCE 2016) developed an interactive website as part of the tsunami design provisions of ASCE 7-16 standard, which is referenced by the 2018 International Building Code. ASCE's interactive website (ASCE 2016) shows probabilistic run-up elevations for the maximum considered tsunami with a 1 in 2,475-year recurrence interval. The estimated run-up elevations range from approximately 32 to 43 feet (NAVD88) within the approximate study area. Elevations at the site range from about sea level to approximately 20 feet (mean sea level). Therefore, there is a potential for tsunami inundation of the project.

The project will be located downstream of the Lopez Dam, which impounds the Lopez Reservoir that releases water into Arroyo Grande Creek. The County of San Luis Obispo (2019) inundation map for a hypothetical failure of Lopez Dam shows most of the area within the approximate study area would be inundated following failure of the Lopez Dam.

The project will not involve habitable structures or spaces that would need to be evacuated in response to a tsunami or dam inundation warning. Therefore, it is not anticipated that the project design will need to consider the potential for tsunami or dam inundation and evacuation, which are typically addressed by emergency response planning documents. The San Luis Obispo County Office of Emergency Services prepared warning and evacuation plans for areas that could be impacted by tsunamis (San Luis Obispo County Office of Emergency Services 2016).

3.10NATURALLY OCCURRING ASBESTOS

The soil encountered by previous studies predominantly consisted of unconsolidated sediments that are not typically known to contain naturally occurring asbestos (NOA). The site is also not underlain by a geologic formation known to have NOA present. Therefore, there is a low potential for NOA to impact this project, and no special mitigations are needed to address NOA during construction.

3.11RADON AND HAZARDOUS GASES

Radon (222Rn) is formed from the decay of small amounts of uranium and thorium naturally present in certain types of soil and rock. Radon gases are typically associated with organic-rich marine shale, diatomaceous shale, phosphate-rich marine sedimentary units, and certain granitic units. Radon hazards tend to also be related to an accumulation of radon gases within homes and closed structures and are not considered applicable to the proposed Meadow Creek Restoration project.

4. PRELIMINARY GEOTECHNICAL CONSIDERATIONS

The following sections provide preliminary geotechnical considerations as input to the project alternatives development and evaluation. The project alternatives consist of a levee setback, removal, or reconfiguration; replacement and/or augmentation of the outlet structure; and/or grading to create or modify channels, pools, and riparian habitat.

The design of levee embankments typically involves an evaluation of the potential for seepage beneath the levee, referred to as underseepage, and seepage through the levee embankment, referred to as through-seepage. Seepage and slope stability analyses to evaluate flood protection during the design storm event should be performed as part of the design geotechnical investigation if the selected project alternative will include a new levee or raising the existing north levee.

4.1 PRELIMINARY DESIGN EARTHQUAKE

Yeh estimated the preliminary design earthquake magnitude and peak ground acceleration tabulated below using the USGS unified hazard tool (USGS 2021b). The site is considered a Site Class F based on liquefiable soil conditions encountered by previous studies. The site response considering liquefiable soil conditions was classified as a “Site Class E” to estimate the preliminary design earthquake parameters presented in the following table. The design-level geotechnical report should estimate design earthquake parameters using a site class based on project -specific exploration. The report should also provide seismic data for the design of flood control structures, if necessary. The design earthquake magnitude was estimated as the deaggregated mean magnitude corresponding to a peak ground acceleration having a 2 percent exceedance probability in 50 years. Sources that predominantly contribute to the probabilistic seismic hazard are the Los Osos, San Andreas, Oceanic-West Huasna, Hosgri, and the Oceano faults.

Table 1: Preliminary Design Earthquake

Seismic Parameter	Value
Latitude, degrees	35.1015
Longitude, degrees	-120.6278
Site Class	“E” soft clay
Earthquake Magnitude	6.7
Peak ground acceleration (PGA) 2% in 50 years	0.49g

4.2 LIQUEFACTION CONSIDERATIONS

The potential for liquefaction to impact the project alternatives is considered high based on the anticipated subsurface conditions and the findings of previous studies (Holzer et. al 2004; Fugro 2009, 2012a; Kleinfelder 2014; Yeh 2019, 2020). Liquefaction is important to the development and evaluation of project alternatives because the severity of liquefaction will affect the seismic performance of the selected alternative and flood protection provided by the alternative following the design earthquake. As noted above, liquefaction occurred within the approximate study area in response to the 2003 M6.5 San Simeon Earthquake. The preliminary design earthquake is a M6.7 event (similar to the M6.5 San Simeon Earthquake) that would result in an estimated peak ground acceleration of 0.47g: two to four times stronger than the acceleration estimated for the San Simeon Earthquake.

It is anticipated that the potential for liquefaction will be similar for all of the project alternatives, including improvements to the existing north levee of Arroyo Grande Creek, based on previous studies (Fugro 2009). Liquefaction effects that could impact the levee embankments or flood control structures within the embankment (such as culverts and flap gates), include settlement, slope instability, and/or cracking of the levee embankment that could reduce the flood protection provided by the improvements.

Mitigation of the potential for liquefaction can be costly relative to the anticipated size of the project. Mitigation could consist of removal and replacement of potentially liquefiable soils with properly compacted fill, although potentially liquefiable soil may be deep enough that removal would be considered impractical for the selected project alternative. In-situ ground improvement is a typical mitigation method that consists of deeply compacting the soil and thereby reducing the potential for liquefaction and seismic settlement to impact the project. In-situ ground improvement consisting of deep compaction was successfully used on the SSLOCSD’s adjacent Wastewater Treatment Facility Redundancy Project and has successfully been used to mitigate liquefaction on other sites on the Central Coast including the Morro Bay Wastewater Treatment Plant, the Pismo Beach Wastewater

Treatment Plant, the Lompoc Regional Water Reclamation Plant and the City of Santa Barbara Wastewater Treatment Plant. New or existing levee embankments could be designed with a wider than typical crest and flatter slopes to help limit slope movement associated with liquefaction and seismic slope instability although projects constraints may limit the feasibility and practicality of that mitigation method.

Alternatively, liquefaction and seismic hazards can be addressed by soft fixes that typically include emergency response and resource planning for seismic events. Soft fixes could be used in association or in addition to the mitigation alternatives discussed above. The planning should consider the anticipated response of the flood control levee, potential vulnerabilities of flood control structures, and general damage to the flood control system in response to an earthquake, and repair strategies for the flood control system following an earthquake.

We understand the County of San Luis Obispo selected a soft fix-approach to seismic hazards for the upstream 2020 Arroyo Grande Creek flood control project. Yeh (2020) noted that the County’s scope of improvements for the upstream north levee improvements was for flood protection only, and no seismic criteria were considered in the design’s evaluation of levee slope stability. The County planned to perform repairs to the north levee of Arroyo Grande Creek in response to a damaging seismic event as part of the County’s operation and maintenance of the levee.

The design-level geotechnical investigation should evaluate the potential for settlement and slope instability associated with liquefaction based on project-specific exploration. The design-level geotechnical report should include recommended mitigation methods for liquefaction and seismic settlement, and/or geotechnical considerations to include in emergency response and resource planning documents relative to seismic hazards.

4.3 FOUNDATION DESIGN CONSIDERATIONS

New flood control structures (such as culverts and flap gates) could likely be designed according to standard plans prepared by the County (if available) or Caltrans. The subgrade for the structures would likely need to be prepared by excavating about 6 inches below the proposed base of the structure and replacing the excavated material with relatively impermeable compacted fill or controlled low-strength material. Recommendations for foundation design and subgrade preparation for flood control structures should be provided in the design-level geotechnical report.

Static Settlement. Levee embankments are typically supported on a relatively firm foundation to reduce the potential for settlement and loss of freeboard. A new levee alignment within and/or along the margins of Meadow Creek Lagoon would likely be founded on young eolian deposits, alluvial deposits, and/or estuarine deposits. The relatively soft and compressible alluvial and estuarine deposits are generally considered susceptible to static settlement. The foundation soil underlying the existing north levee is anticipated to consist of alluvial deposits that may be susceptible to settlement resulting from additional stresses associated with raising the levee. New flood control structures (such as culverts and flap gates) constructed within the existing north levee are not anticipated to increase the potential for settlement.

The magnitude of the settlement from static loads can range from fractions of an inch to feet, depending upon the compressibility characteristics and thicknesses of the underlying soil, and the loads and distributions of loads. Settlement can occur rapidly or can occur over long periods of time (months or years) depending on the site subsurface conditions. A typical mitigation option for static settlement of new levee embankment involves pre-construction surcharging. Alternatively, the initial freeboard could allow for subsequent loss in embankment height due to consolidation of the embankment and/or foundation. However, settlement of the embankment would likely occur differentially across the footprint and result in longitudinal or transverse cracks that could reduce the level of flood protection provided by the levee.

Seismically Induced Settlement. The selected project alternative will likely be underlain by alluvial flood-plain and eolian deposits that are considered vulnerable to liquefaction and seismic settlement. The magnitude of seismically induced settlement is predominantly dependent upon the underlying soil types and the earthquake characteristics. Typical mitigation methods for liquefaction are discussed in the Liquefaction Considerations section of this report.

The depth to a relatively firm foundation for a new levee and the magnitude of static and seismically induced settlement should be evaluated by the design geotechnical investigation relative to the design flood event and the minimum freeboard for flood protection.

4.4 EARTHWORK

Terrain in the vicinity of the lagoons is generally flat and bordered by artificial fill placed for the surrounding development and uneven topography defined by dune sand deposits. Vegetation is generally dense and consists of emergent plants and dune scrubs and brush. A program of clearing and grubbing, overexcavation, and placing compacted fill should be anticipated as part of the earthwork for the proposed improvements.

4.4.1 CLEARING AND GRUBBING

Clearing and grubbing should be performed to remove existing vegetation and objectionable material from improvement areas that will be graded, receive fill, or serve as borrow sources. Grubbing should include removing stumps, roots and buried vegetation. Care should be taken not to injure trees, plants or existing improvements outside of the clearing limits. Soil containing debris, organics, loose or disturbed materials, or other unsuitable materials, should be excavated and removed prior to commencing fill placement.

4.4.2 OVEREXCAVATION

Overexcavation should be anticipated for the construction of a new levee or improvements to the existing levee to provide suitable foundation support. Removing existing soil within the levee footprint to a level plane should be anticipated. Compressible and/or weak foundation soil is typically removed and replaced with compacted fill, although potentially compressible soil may be deep enough that removal would be considered impractical for the selected project alternative. A historic estero and historic drainages connected to Arroyo Grande Creek (see Figure 3) were filled in during development of the properties surrounding Meadow Creek Lagoon. The recommended depth and lateral limits of the overexcavation should be evaluated as part of the design geotechnical investigation. The bottom of the excavation should then be scarified to a depth of at least 9 inches, moisture conditioned, and compacted in-place to at least 90 percent relative compaction.

4.4.3 SUBGRADE STABILIZATION

Subgrade stabilization should be provided in areas where unsuitable materials or soft subgrade conditions are encountered that will not allow for proper compaction of the subgrade materials. Subgrade stabilization typically consists of removing the existing soil to a depth at least 1-foot below the bottom of the excavation or bottom of the unsuitable material, whichever is deeper. If the subgrade is wet or yielding, subexcavation should be performed using backhoe-type equipment such that construction equipment will not operate on the exposed subgrade during the excavation. A geotextile for stabilization is typically placed over the undisturbed subgrade and then aggregate is placed on the geotextile. The aggregate should be fully encased in the geotextile to reduce the potential for the overlying subgrade material to erode into the gravel.

4.4.4 REUSE OF ON-SITE SOIL

Anticipated fill materials for the project consist of embankment material for constructing a new levee, raising the existing north levee, or constructing new culverts and/or flap gates through the north levee. The composition of embankment material should be consistent with seepage and slope stability analyses performed for the design-level geotechnical investigation. Excavations for the project may remove the existing levee fill, young eolian deposits, alluvial deposits, and/or estuarine deposits. Soil excavated from those units that is free of debris, organics, oversized rocks, and other deleterious materials is anticipated to be generally suitable for use as embankment material. Predominantly fine-grained soil may be suitable as a relatively impermeable fill blanket typical for new levee construction. The design geotechnical investigation should evaluate the suitability of material within planned excavation depths for use as compacted fill.

Soil excavated from near or below groundwater table will likely be at a moisture content that is too high to be suitable for compaction. Wet soil removed from excavations will need to be dried to a moisture content suitable for compaction prior to being placed as compacted fill. Rainfall and coastal fog can prolong or impede drying efforts.

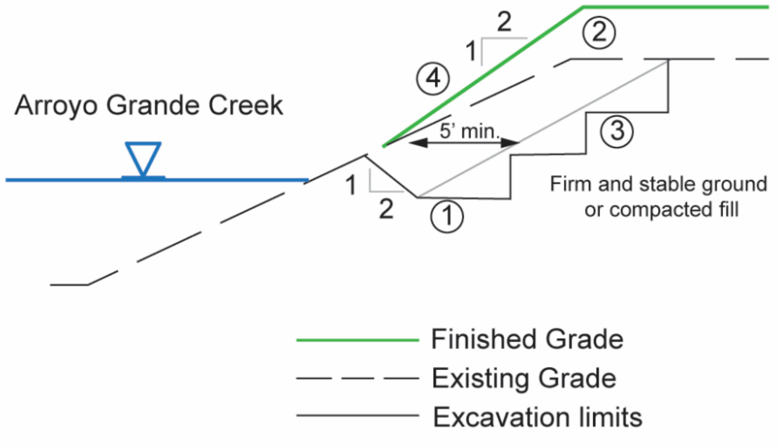
4.4.5 COMPACTION

Adequately moisture conditioned site soil is anticipated to be readily compactable with sheepsfoot or studded compactors provided. Site soil may also become unstable and overly moist to adequately compact in times of increased precipitation. Relative compaction of 90 to 95 percent should be anticipated for fill and subgrade compaction requirements.

4.4.6 GRADING FOR LEVEE IMPROVEMENTS

The dimensions of a new levee embankment are anticipated to be similar to the existing north levee embankment. Raising the existing north levee slopes at the same inclination would involve placing fill from the bottom of the slope and keying into the underlying foundation material. Alternatively, the levee slopes could be raised at a steeper inclination by keying into the existing levee, similar to the levee improvements selected by the County for the Arroyo Grande Creek Channel Waterway Management Program (Yeh 2020).

New levee slopes should be graded to an inclination 2h:1v or flatter. Slopes can be steepened by using internal geosynthetic reinforcements, retaining walls and/or select backfill, if needed.



1. Excavate base key into firm and competent material at the toe of the proposed fill.
2. Place compacted fill per recommendations of the report.
3. Key and bench into existing embankment slope such that the outer 5 feet of the existing embankment is removed. Existing fill and excavated soil can be incorporated into the new fill.
4. Overbuild slope and cut back to expose compacted fill at finished grade.

Figure 5: Typical Levee Grading Detail

Recommendations for the final inclination of levee slopes and the use of subgrade stabilization, keyways, benches, and need for subdrains should be provided in the design-level geotechnical report based on an evaluation of the specific slope conditions associated with the site grading.

Where the existing levee embankment will be raised by constructing against an existing slope, the fill materials should be keyed and benched into the existing slope. Typical grading recommendations for improvements to existing levee embankments is summarized in Figure 5.

Keying and benching should remove the outer 5 feet of the existing levee embankment materials to improve the existing embankment slopes impacted by rodent burrows and deep-rooted vegetation. The upper 9 inches of the top of the embankment should be scarified and recompacted to at least 90 percent relative compaction.

4.4.7 BURROWING ANIMALS

We observed rodent burrows on the interior and exterior slopes and Fugro (2012b) reported probing the levee slopes by hand to depths of up to 4 feet. Burrowing animals and large buried roots of vegetation such as trees that have been removed as part of a vegetation management program can cause extensive void systems within the levees. Subsurface voids generally shorten flow paths through the levee and increase the potential for seepage-related hazards and slope instability. Figure 6 illustrates the potential for seepage-related levee failure mechanism due to burrowing animals. The potential for instability of loose surficial soil and seepage-related hazards during relatively long-duration storm events would be reduced by removal and replacement of the outer 5 feet of the existing levee embankment if the selected project alternative involves modifying the existing north levee of Arroyo Grande Creek.

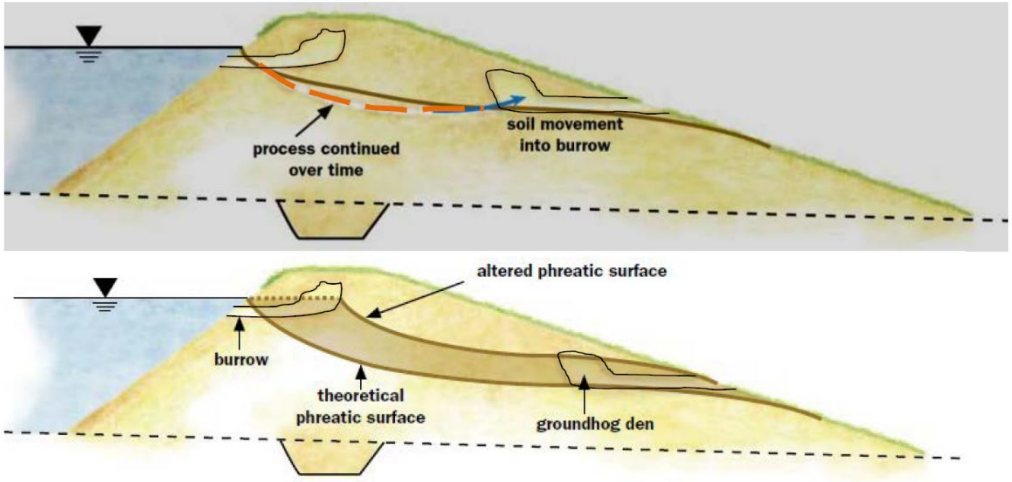


Figure 6: Seepage-related levee failure mechanism due to burrowing animals (FEMA, 2005)

4.4.8 EROSION AND SITE DRAINAGE

Newly graded slopes are vulnerable to erosion. Drainage should be provided such that surface water does not run over slopes or pond on the crest of new or modified levees. Concentrated flows and runoff should not be permitted to discharge on slopes. Down drains, solid pipes, or lined ditches should be provided where needed to carry surface water from the top of the slope to the base of the slope. Energy dissipation and erosion control devices should be provided at the outlet of drain pipes and in areas of concentrated runoff to reduce the potential for erosion. Landscaping and maintenance of graded slopes should be provided to assist the establishment of vegetation and reduce the potential for erosion.

4.5 CORROSION CONSIDERATIONS

We observed corrosion of the existing Sand Canyon Outlet CMP culvert and flap gates. The observed corrosion is likely the result of coastal fog and potentially corrosive water that is conveyed by the outlet structure. The design geotechnical investigation should evaluate the potential for corrosive soil to impact a new flood control structure. New flood control structures should be designed considering the potential for corrosive soil and water.

4.6 CONSTRUCTION CONSIDERATIONS

4.6.1 GROUNDWATER AND DEWATERING

Groundwater measured by previous studies in the project vicinity was generally shallow. The elevations of groundwater surfaces measured or inferred by those studies ranged from approximately 0 to 11 feet (MSL). Wet soil conditions should be anticipated and dewatering to lower groundwater levels for construction will likely be needed for excavations, particularly along the margins of Meadow Creek Lagoon. Dewatering should be designed by a licensed Professional Engineer, Geologist, or Hydrogeologist experienced in the design of dewatering systems. Dewatering should be performed in a controlled manner that includes the use of wells, well-points, gravel trenches, or other means of dewatering to lower the water surface elevation within the limits of the planned excavation as-needed to provide a stable subgrade for construction. Dewatering young sediments or porous soil types, such as those anticipated within the study area, are prone to consolidate or collapse when the groundwater level is lowered. Subsidence of the ground surface can occur over the area where dewatering is performed. Project specifications should indicate that dewatering should be concentrated to lower the groundwater elevation within the footprint of the excavation and only to the depth needed to facilitate construction as dewatering of soil below existing infrastructure could result in settlement of those structures. The impact of dewatering on existing infrastructure will be reduced if the contractor sufficiently provides support to those structures.

Dewatering facilities should be installed prior to beginning excavation, and time should be allowed for lowering of the groundwater table before beginning excavation. Secondary dewatering using sumps placed in the bottom of excavations and stabilization of the subgrade may be needed in addition to the initial dewatering. Well screens and sumps should be designed with properly designed filters such that sand and fine-grained materials are not removed from the soil during dewatering operations. Observation monitoring wells or points should be installed prior to beginning excavation to check that groundwater has been lowered to the specified depth below the depth of excavation.

4.6.2 EXCAVATION CHARACTERISTICS

Soil within the project limits is expected to be excavatable with conventional earthmoving equipment including bulldozers, excavators, backhoes, etc. Soft, saturated ground conditions will likely be encountered, and the use of low ground pressure equipment and long-reach excavation equipment may be needed. Subsurface data should be made available to contractors for bidding purposes to aid in assessing equipment requirements for designed excavations.

4.6.3 TEMPORARY EXCAVATIONS AND SHORING

Soil anticipated within the project limits is considered to be Type C based on Cal OSHA guidelines for the design of temporary slopes and shoring systems. Per OSHA guidelines, Type C soils should be excavated no steeper than 1.5h:1v. Excavations should be sloped or shored accordingly. Shoring systems such as trench shields or slide rail shoring systems that provide positive support for excavated slopes are considered suitable to supporting excavations during construction. The guidelines may need to be reconsidered depending on excavation configurations, groundwater and proximity to adjacent excavations and structures. Competent personnel at the time of construction should review the excavations and provide input to augment slopes and shoring as needed.

4.7 DESIGN-LEVEL GEOTECHNICAL REPORT

This report was prepared based on review of geologic data and historical maps and aerial photographs, and subsurface exploration performed by previous studies within the approximate project limits. A design-level geotechnical report should be prepared based on project -specific subsurface exploration that includes laboratory testing of soil samples.

Recommendations for project-specific subsurface exploration methods and laboratory testing were provided in Yeh's (2021) *Existing Geotechnical Data Review Letter*. We recommend performing project-specific exploration prior to development of 30-percent design if the selected project alternative involves construction of a new levee. We anticipate that project-specific subsurface data will assist the project team in evaluating the feasibility of the project and developing preliminary cost estimates relative to the geologic hazards and geotechnical considerations discussed in this report.

5. LIMITATIONS

This study has been conducted in general accordance with currently accepted geotechnical practices in this area for use by the client for preliminary design and conceptual planning purposes. The conclusions and preliminary recommendations submitted in this report are based upon the data obtained from field reconnaissance, subsurface data from previous studies, and our understanding of the proposed project and type of construction described in this report. Site conditions will vary between points of observation or sampling, seasonally, and with time. The nature and extent of subsurface variations across the site may not become evident until excavation is performed.

If there are any changes in the project or site conditions, Yeh should review those changes and provide additional recommendations if needed. Any modifications to the recommendations of this report or approval of changes made to the project should not be considered valid unless they are made in writing. The report and drawings contained in this report are intended for preliminary design-input; and are not intended to act as a design-level geotechnical report, construction drawings, or specifications.

6. REFERENCES

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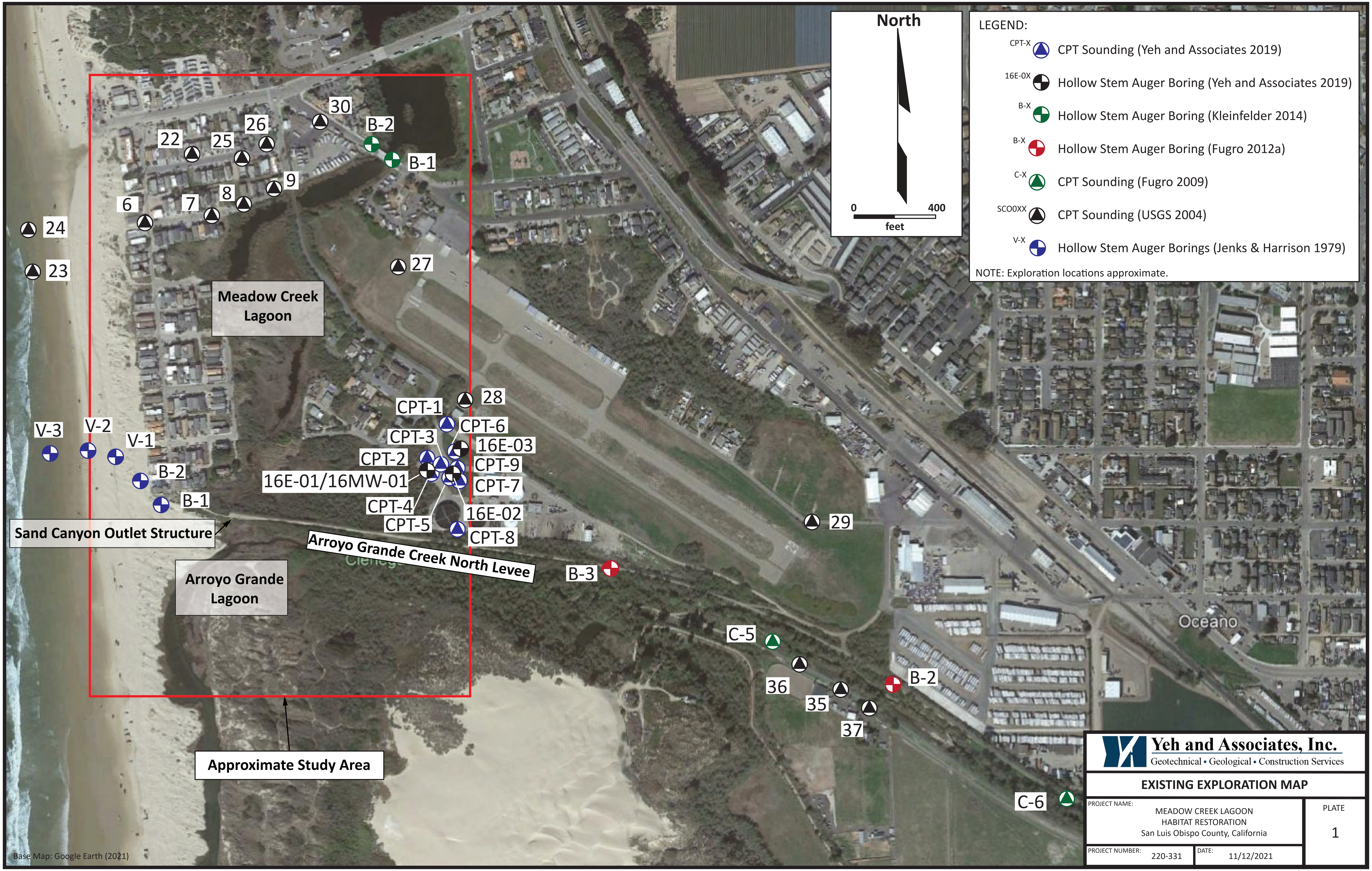


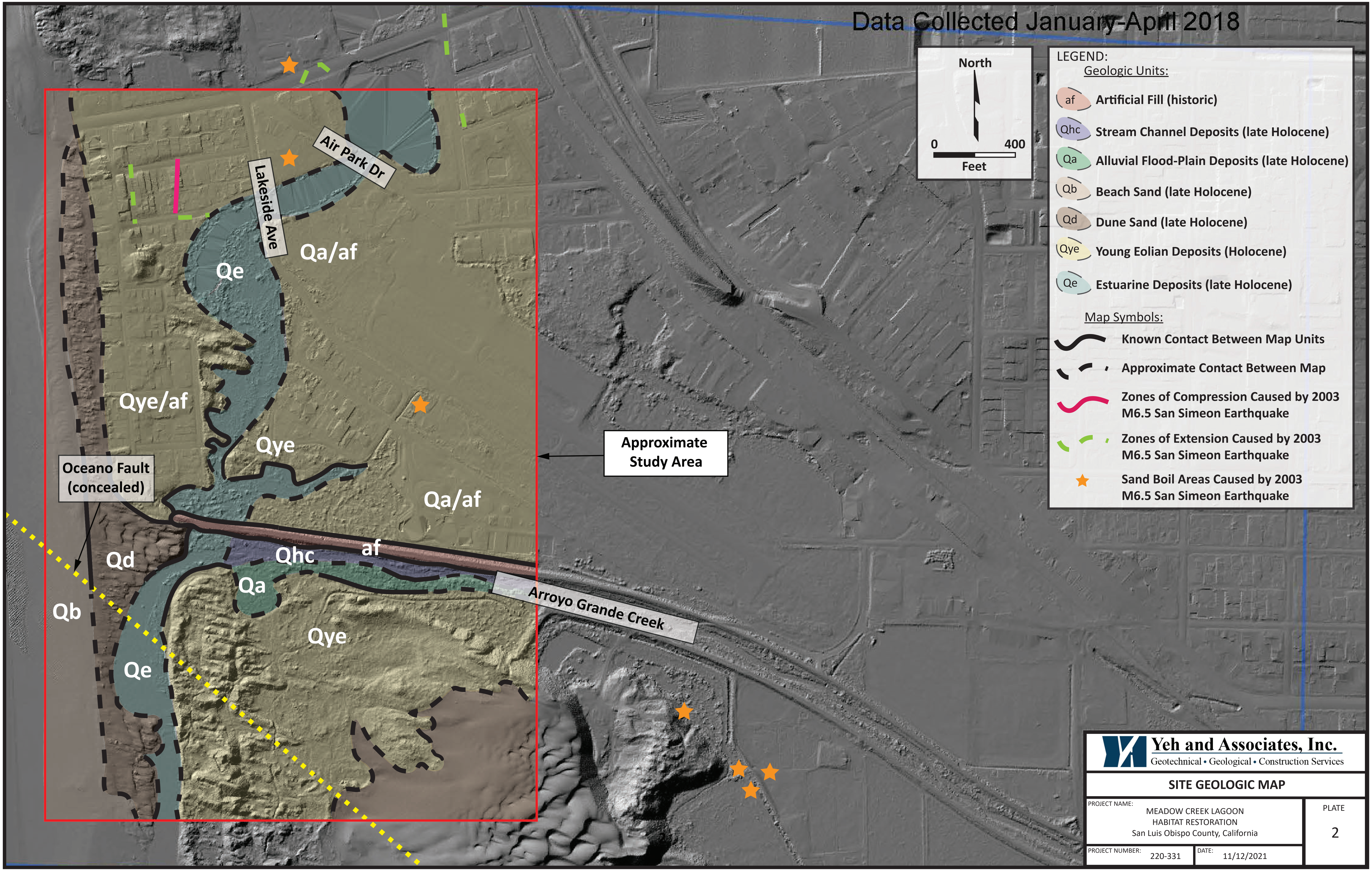
Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

EXISTING EXPLORATION MAP

PROJECT NAME:
MEADOW CREEK LAGOON
HABITAT RESTORATION
San Luis Obispo County, California

PLATE
1

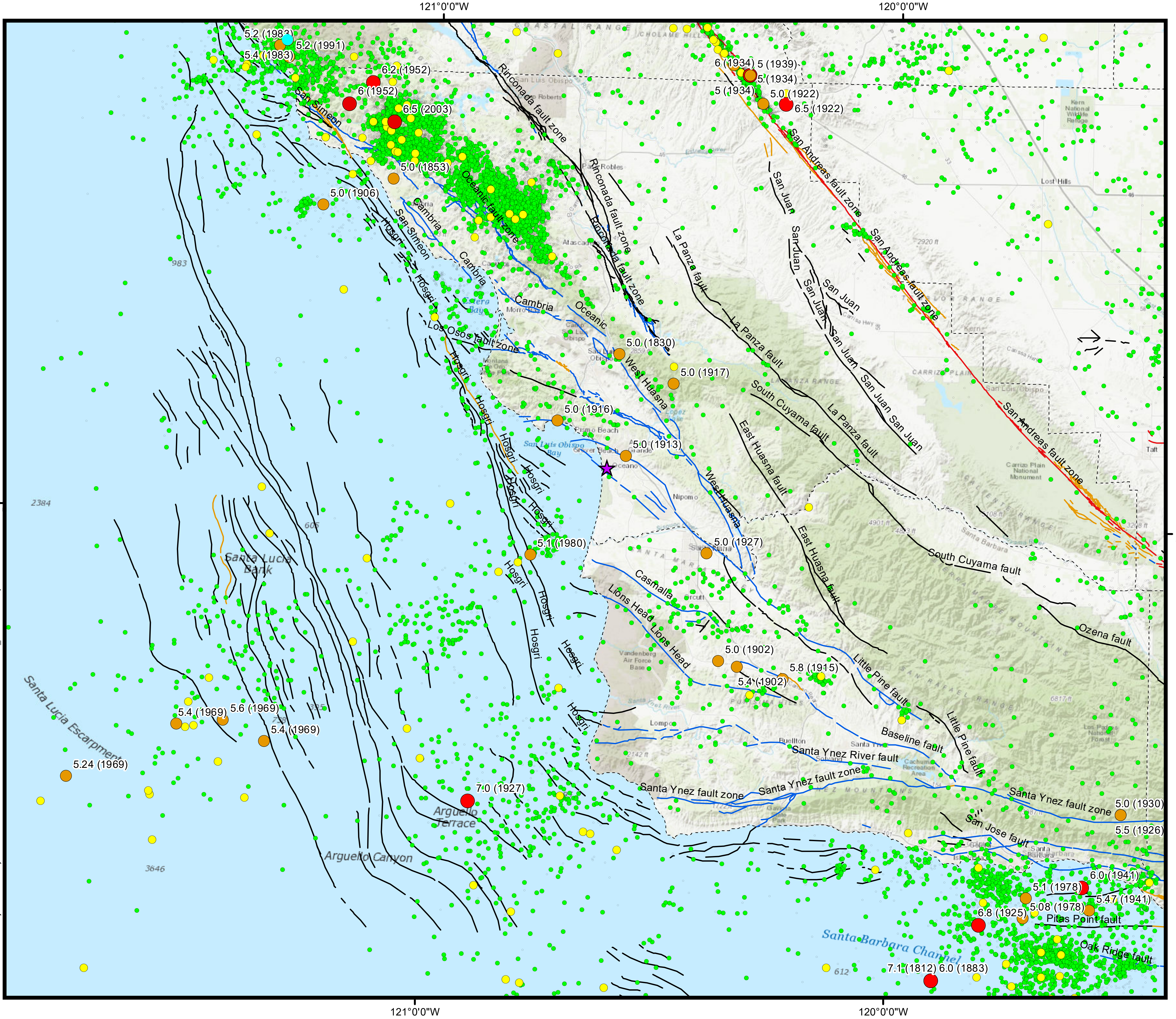
PROJECT NUMBER: 220-331
DATE: 11/12/2021



Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

SITE GEOLOGIC MAP

PROJECT NAME: MEADOW CREEK LAGOON HABITAT RESTORATION San Luis Obispo County, California	PLATE 2
PROJECT NUMBER: 220-331	DATE: 11/12/2021



LEGEND:

★ Project Location

Magntitude

- · 2.0 - 2.9
- ● 3.0 - 3.9
- ● 4.0 - 4.9
- ● 5.0 - 5.9
- ● >6.0

Faults

- ― Historic (last 200 years)
- ― Holocene (last 11,000 years)
- ― Late Quaternary (last 750,000 years)
- ― Quaternary (last 1,600,000 years)

Source:

1) Earthquake Data:
Earthquake epicenters from:
a) ANSS Composite Catalog Search, 1931 to 2021 <www.ncedc.org/anss/> (Downloaded October 2021)
b) "Seismotectonic framework, coastal central California", Seismotectonics of the Central California Coast Range, Special Paper 292, Geological Society of America, 1994.

2) Faults:
Bryant, W.A. (compiler), 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0:
California Geological Survey Web Page, <http://www.consrv.ca.gov /CGS/information/publications/QuaternaryFaults_ver2.htm>
(Downloaded June 2016)

N

0 5 10 20 30 Miles

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

HISTORIC SEISMICITY AND REGIONAL FAULT MAP

PROJECT NAME:
MEADOW CREEK LAGOON
HABITAT RESTORATION
San Luis Obispo County, California

PLATE
3

PROJECT NUMBER: 220-331
DATE: 10/27/2021

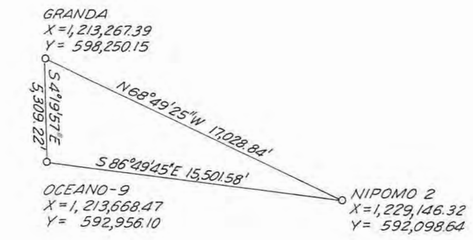
Document Path: X:\Projects\2020 Projects\220-331 Stillwater Meadow Creek Restoration\Stillwater_HistoricEQmap.mxd

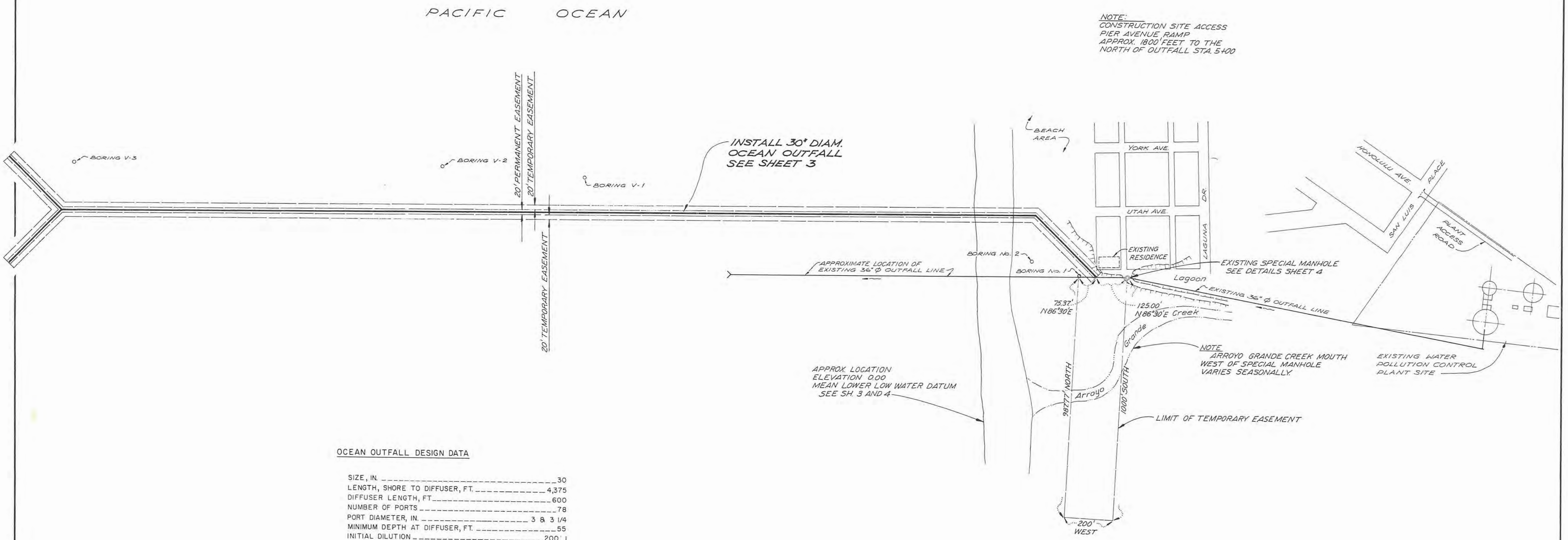
APPENDIX A - DATA FROM PREVIOUS STUDIES

PROJECT LOCATION NOTE

The Basis of Bearings for this Project is the Zone 5 Lambert Grid Bearing of N 68°49'25"W which is the Bearing of the line between Station Nipomo 2 and Station Granda.

The Project Location Reference Point is the Project Reference Bench Mark with the following Coordinates: X=1,213,890.37; Y=592,743.94





NOTE:
CONSTRUCTION SITE ACCESS
PIER AVENUE RAMP
APPROX. 1800' FEET TO THE
NORTH OF OUTFALL STA. 5+00

NOTE
ARROYO GRANDE CREEK MOUTH
WEST OF SPECIAL MANHOLE
VARIES SEASONALLY.

OCEAN OUTFALL DESIGN DATA

SIZE, IN.	30
LENGTH, SHORE TO DIFFUSER, FT.	4,375
DIFFUSER LENGTH, FT	600
NUMBER OF PORTS	78
PORT DIAMETER, IN.	3 & 3 1/4
MINIMUM DEPTH AT DIFFUSER, FT.	55
INITIAL DILUTION	200' 1
CAPACITY AT MAX. TIDE, MGD	8.5

HALF SCALE

2 OF 6

SO. SAN LUIS OBISPO CO. SANITATION DISTRICT
SAN LUIS OBISPO COUNTY, CALIFORNIA

WASTEWATER WORKS IMPROVEMENTS

OCEAN OUTFALL

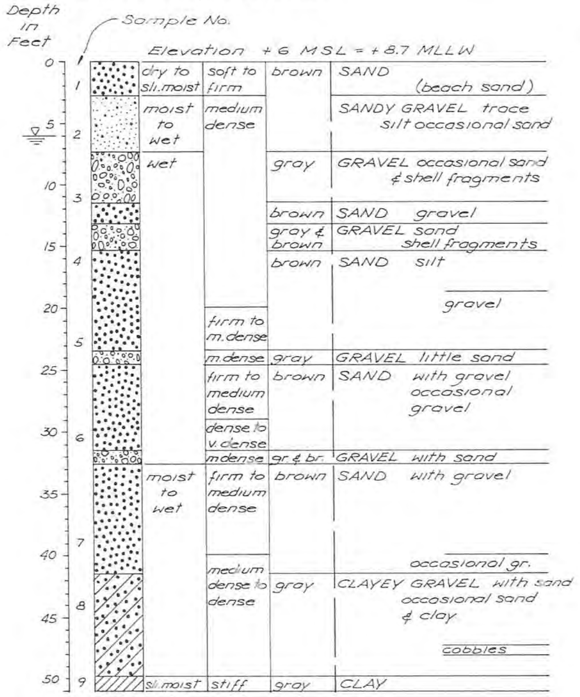
SITE PLAN

JENKS & HARRISON
CONSULTING SANITARY & CIVIL ENGINEERS

Drawn by:	CS SLH	Scale:	1" = 200'
Des/Chkd by:	HLH DAB	Date:	DEC. 1978

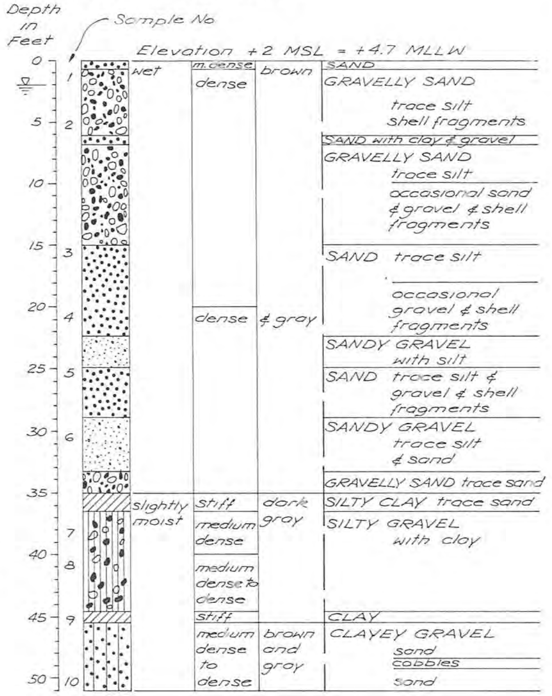
SUMMARY BORING No. 1

Date Drilled: April 26, 1978



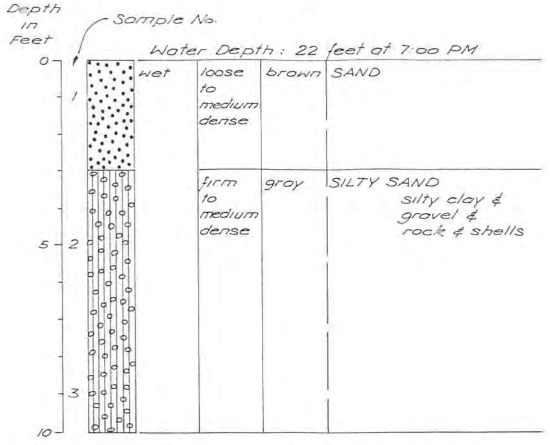
SUMMARY BORING No. 2

Date Drilled: April 26, 1978



SUMMARY VIBRATORY CORER V-1

Date Drilled · May 12, 1978

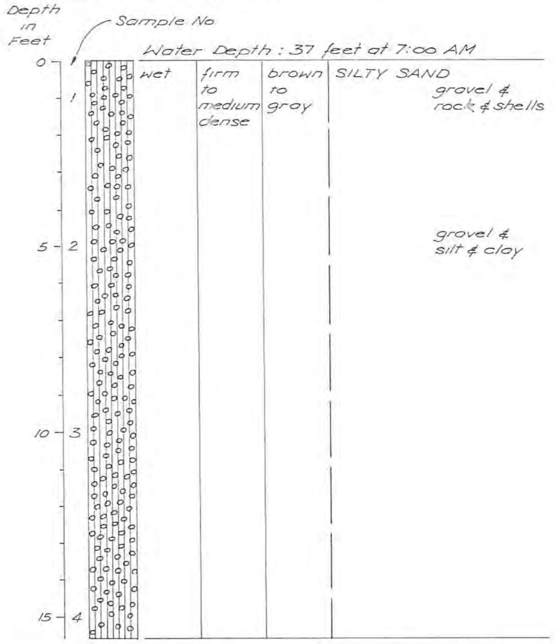


OIL & GREASE AND HEAVY METALS
(Part per million, ppm)

Depth	o/g	Hg	Pb	Cd	Zn
0-1½	2,493	1.4	11.6	1.0	7.3
8½-10	369	2.3	11.5	1.1	13.9

SUMMARY VIBRATORY CORER V-2

Date Drilled: May 13, 1978

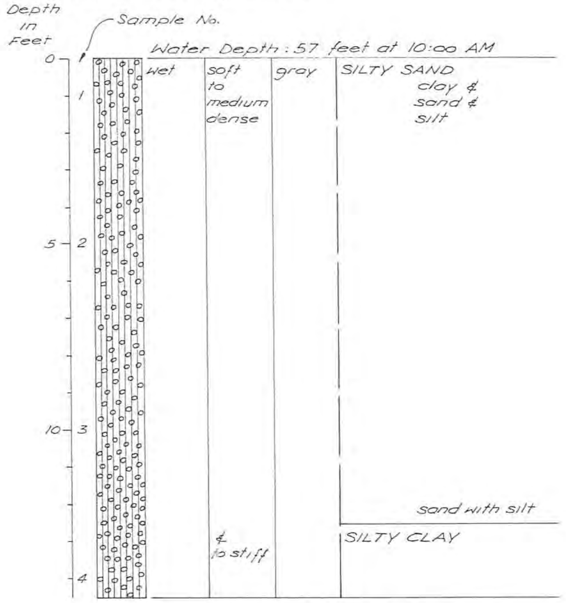


OIL & GREASE AND HEAVY METALS
(Part per million, ppm)

Depth	o/g	Hg	Pb	Cd	Zn
0-1½	2,175	5.0	12.9	1.0	10.7
14-15½	2,066	5.0	20.8	1.4	109

SUMMARY VIBRATORY CORER V-3

Date Drilled: May 13, 1978



OIL & GREASE AND HEAVY METALS
(Part per million, ppm)

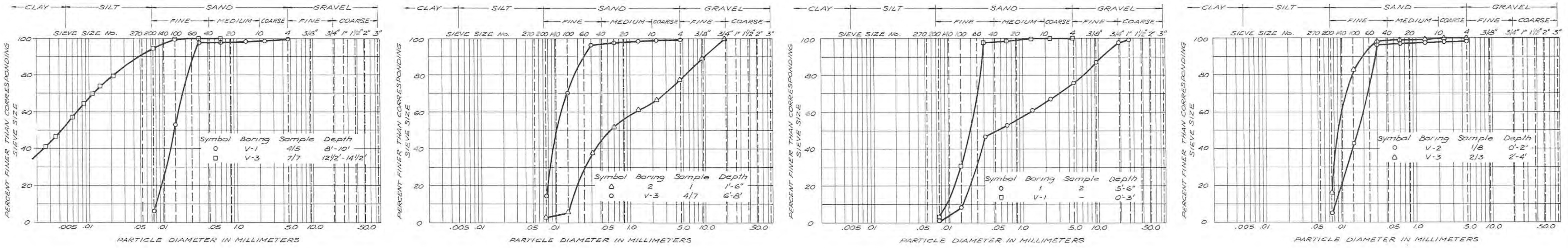
Depth	o/g	Hg	Pb	Cd	Zn
0-1½	2.486	1.5	15.6	1.3	19.5
13-14½	2,794	1.8	25.6	1.6	57 6

SAMPLE DATA

SAMPLE NUMBER	DEPTH IN FEET	DRIVE ENERGY FT KIPS/FT.	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB/CU FT	SHEAR RESISTANCE KIPS/SQ FT	TORVANE SHEAR RESISTANCE KIPS/SQ FT.
1-1	2	26	19	91	* .46 .38 .69 1.26	
2	6	10	26	96		
3	11	22	25	99		
4	16	32	19	98		
	20	32				
5	23	29	18	93		
	26	12				
	28	14				
6	30	66	12	123		
	36	34				
	37	32				
7	39	29	18	113		
	42	32				
8	44		39	85		
9	50	6.9	35	85		
2-1	1	37	21	106	.66	
2	5	15	18	103	.58	
3	16	41	22	101	95	
4	21	52	24	101	1.38	
5	25	52	24	99	1.65	
6	31	59	12	119	2.36	
	36	19				
7	38	27	19	109	2.62	
8	41	37	20	102	3.03	
9	46	41	21	102	2.99	
10	51	43	38	84	1.49	
V-1-1	1					80
2	5					120
3	9					140
V-2-1	1					80
2	5					140
3	10					140
4	15					180
V-3-1	1					130
2	5					200
3	10					400
4	14					750

* Sample sat before progressively shearing at .½, .½, 1, 2 ksf

GRAIN SIZE DISTRIBUTION CHART



NOTES

1. This subsurface soil data has been presented in a Marine Geotechnical Investigation for this project by Converse Davis Dixon Associates, Inc. as set forth in a Report dated June 30, 1978.
2. The locations of these borings are shown on the Site Plan sheet 2

FIELD NOTES - BORING No.1 & No.2

1. These borings were drilled on April 26, 1978 using a rotary-wash drill rig equipped for soil sampling using a 4¾-inch tricone bit.
2. Materials encountered during drilling were continuously logged and classified by visual examination in accordance with the Unified Soil Classification System.
3. Undisturbed samples were obtained by driving a thin-walled steel sampler with successive drops of the drilling bar. The driving energy required for one foot of penetration is shown in the Sample Data in the Drive Energy column.
4. Undisturbed samples were retained in brass rings 1.00 inch in height and 2.50 inches in diameter
5. Direct shear tests were made with a direct shear machine at a constant rate of strain.

FIELD NOTES - BORING V-1, V-2 and V-3

1. These borings were made on May 12, 1978 and May 13, 1978 from a barge using a Vibracore sampling apparatus to obtain undisturbed samples.

HALF SCALE

6 OF 6

SO. SAN LUIS OBISPO CO. SANITATION DISTRICT
SAN LUIS OBISPO COUNTY, CALIFORNIA

WASTEWATER WORKS IMPROVEMENTS

OCEAN OUTFALL

LOG OF BORINGS

JENKS & HARRISON
CONSULTING SANITARY & CIVIL ENGINEERS

Drawn by:	CS	Scale:	AS NOTED
Des/Chkd by:	DAB	Date:	DEC. 1978

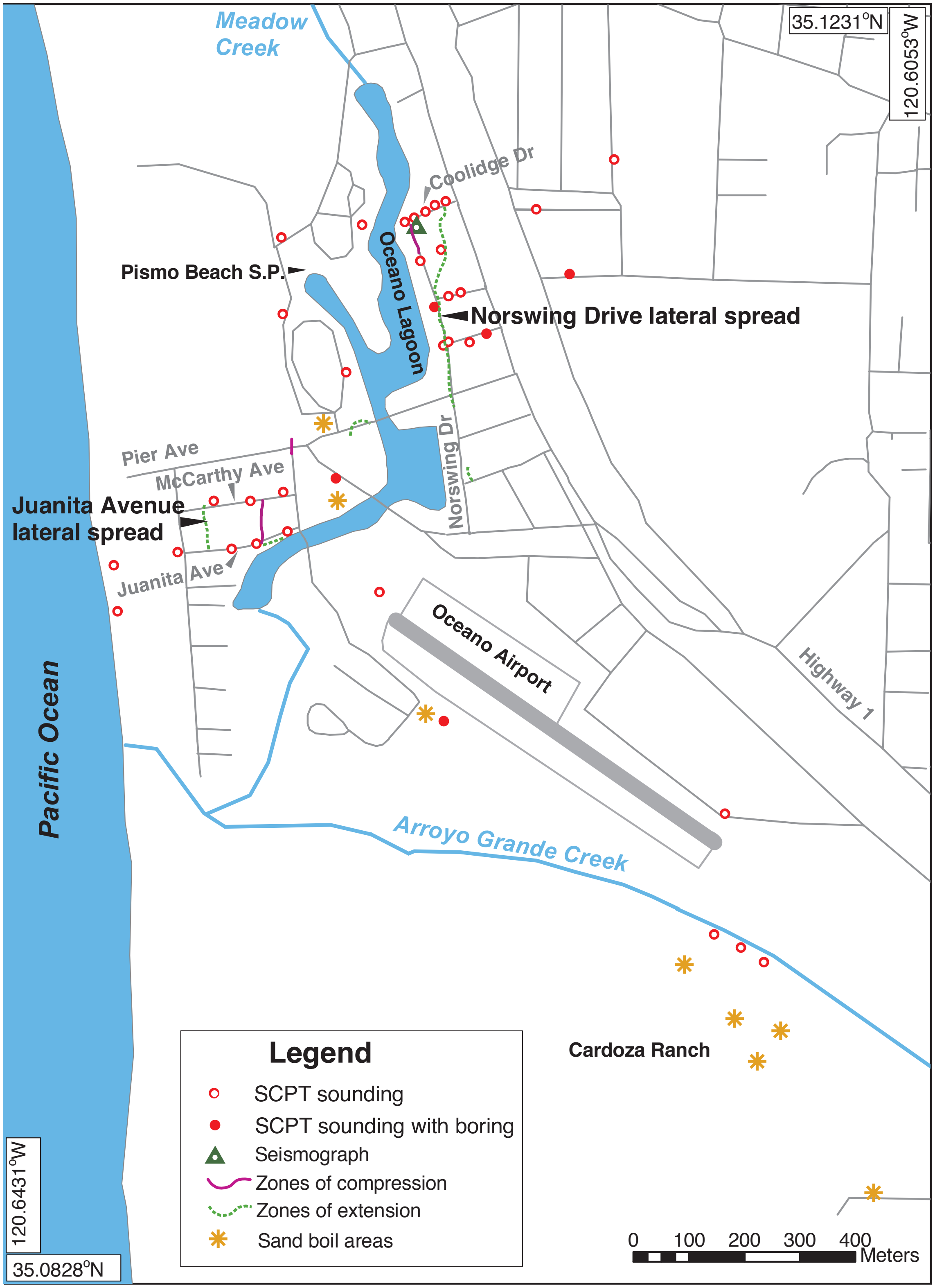


Figure 3. Map of Oceano, California, area with ground failure and liquefaction areas, USGS SCPT soundings and borings, and portable digital seismograph.

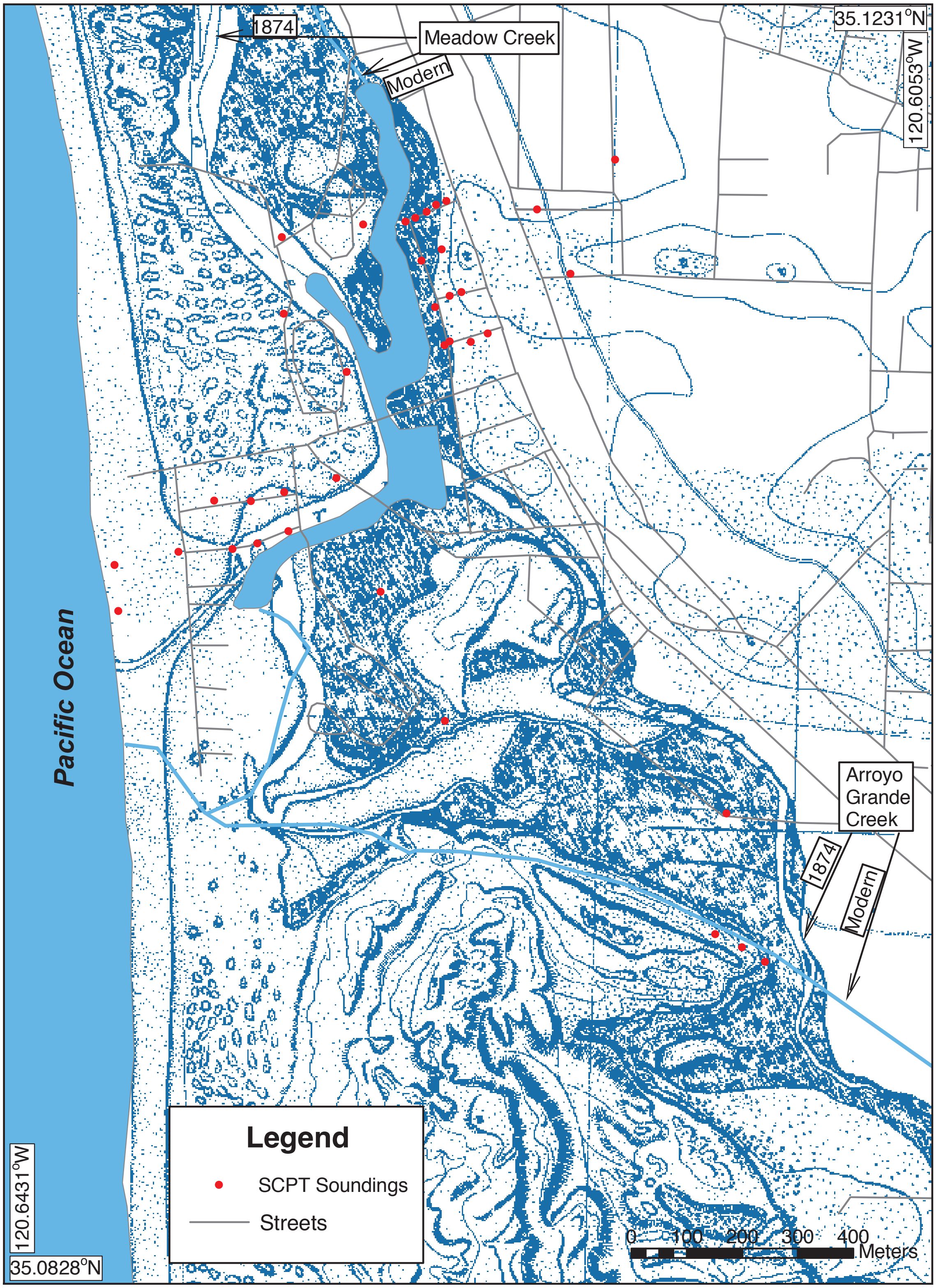


Figure 4. Oceano portion of 1873-1874 U.S. Coast Survey T-sheet 1393 with road network, modern hydrography (in light blue), and locations of USGS SCPT soundings superimposed. Stippled pattern denotes sandy areas including dune fields. Dark pattern denotes marshes along Meadow and Arroyo Grande Creeks.

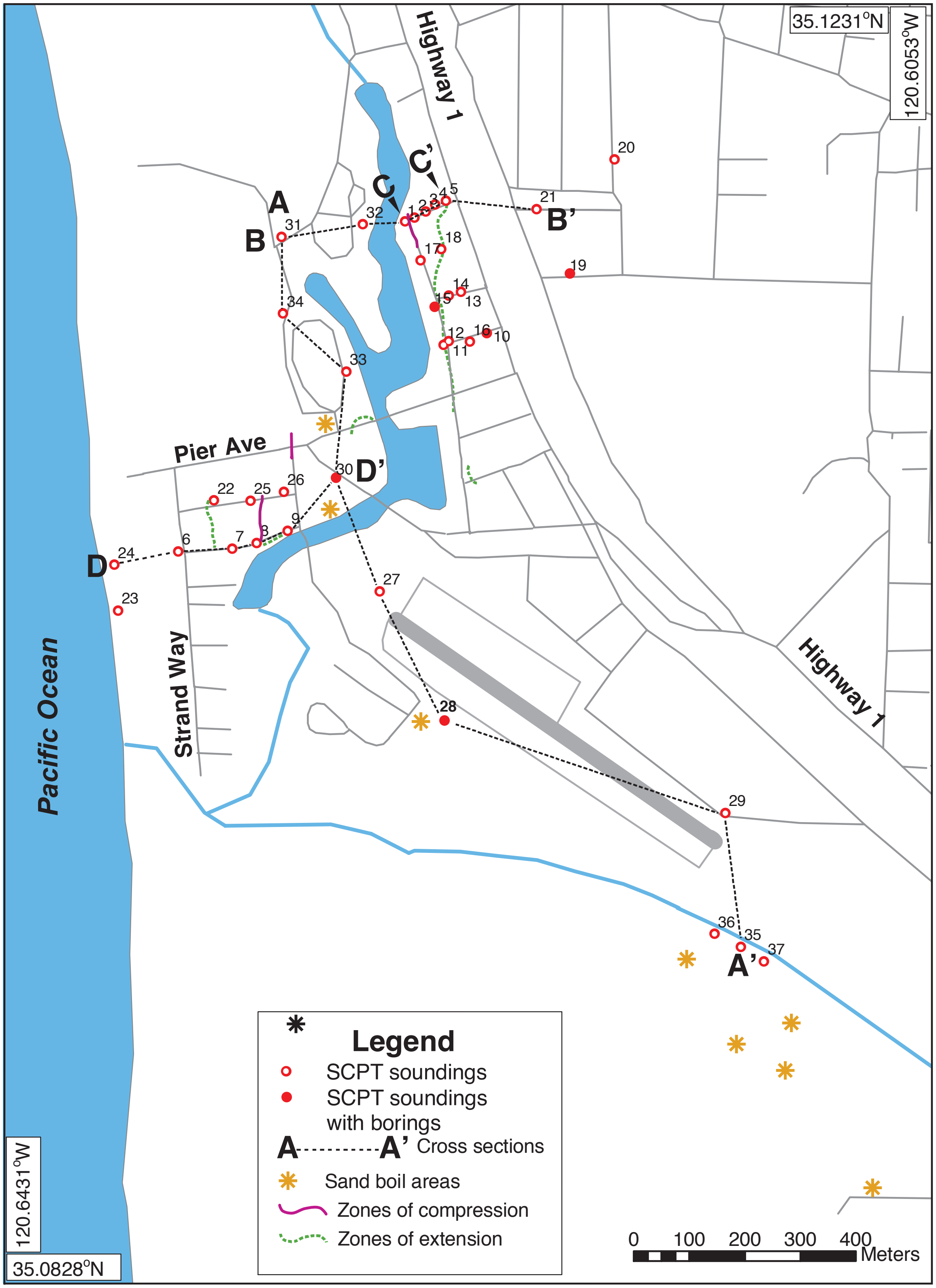


Figure 5. Locations of cross sections, Oceano.

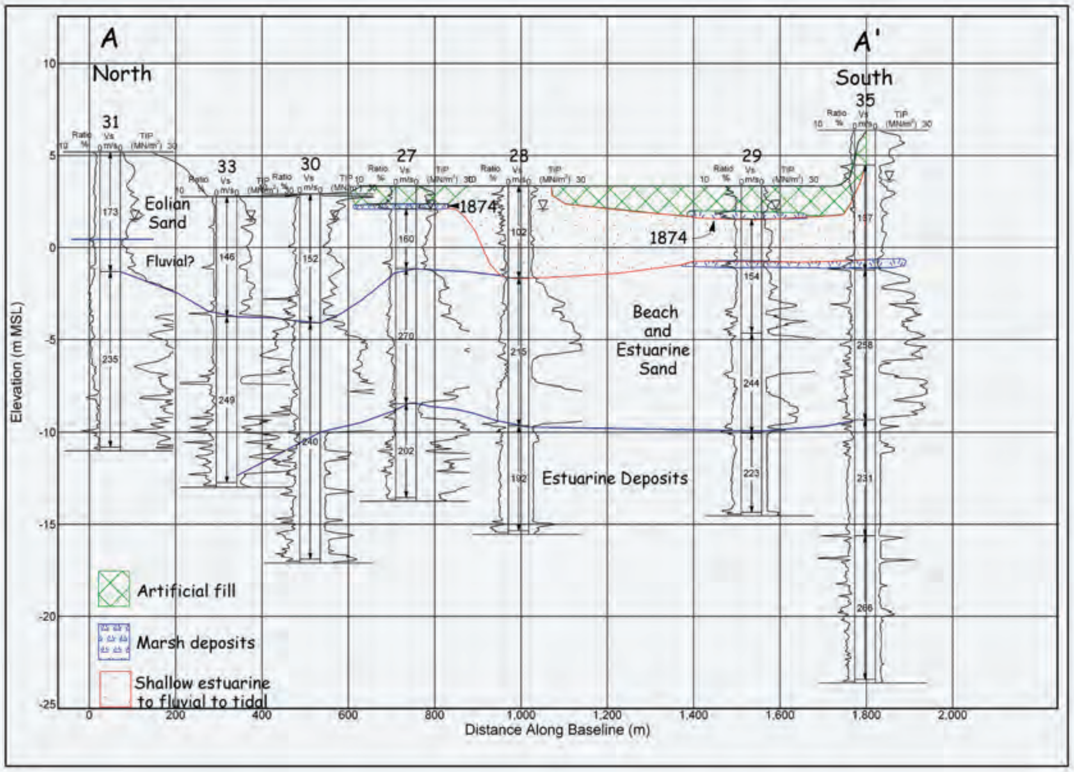


Figure 6a.

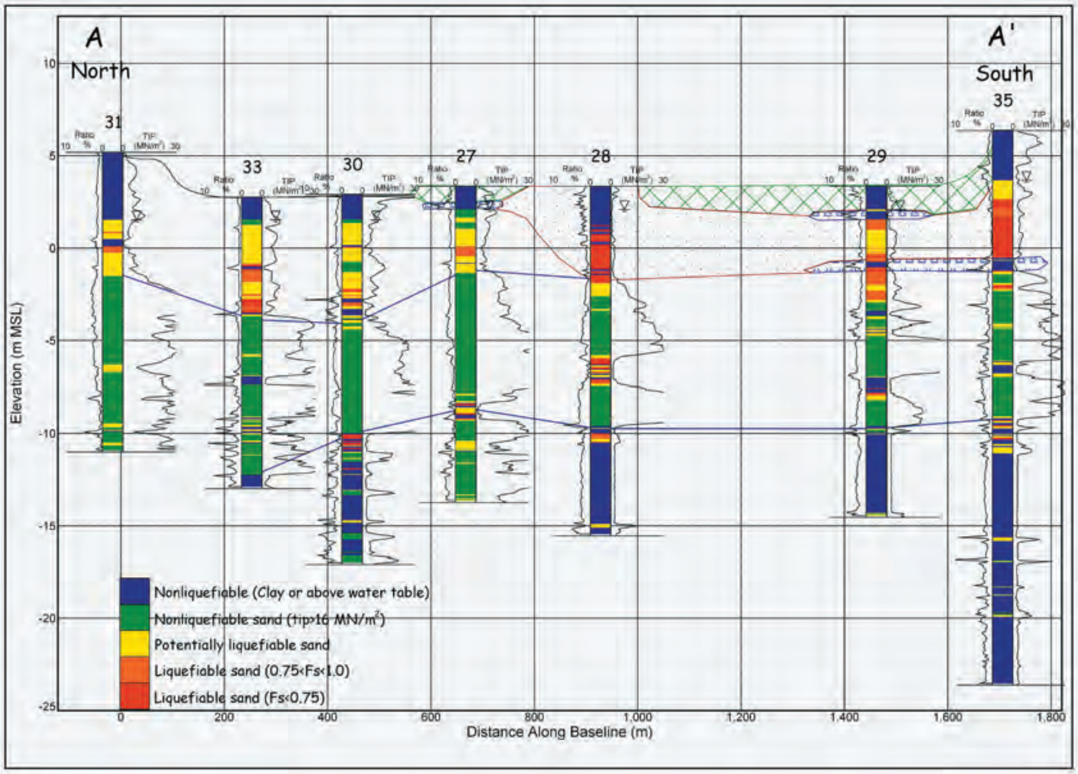


Figure 6b.

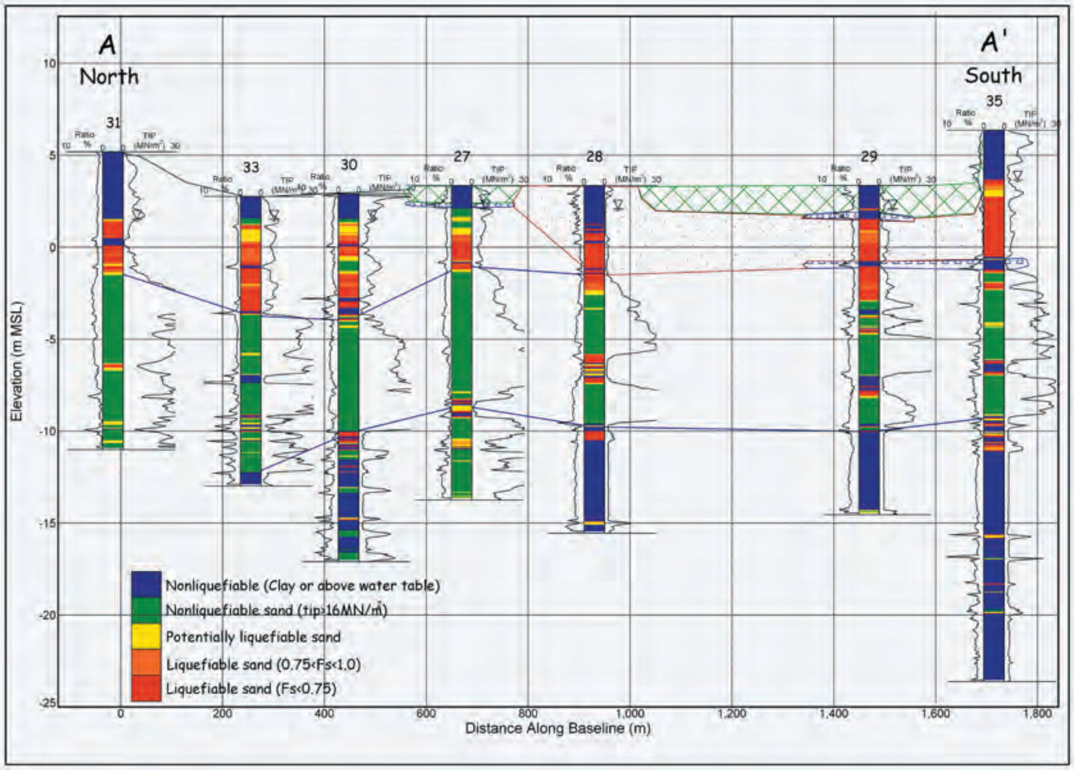


Figure 6c.

Figure 6. North-south cross section (A-A') at Oceano of generalized shallow subsurface conditions based on SCPT soundings. See Figure 5 for location of cross section. Cross section includes profiles of CPT tip and friction ratio, geologic units, and water table with (a) shear-wave velocity (V_S), (b) liquefaction factors of safety for a M6.5 and PGA=0.25 g, and (c) liquefaction factors of safety for a M6.8 and PGA=0.4 g.

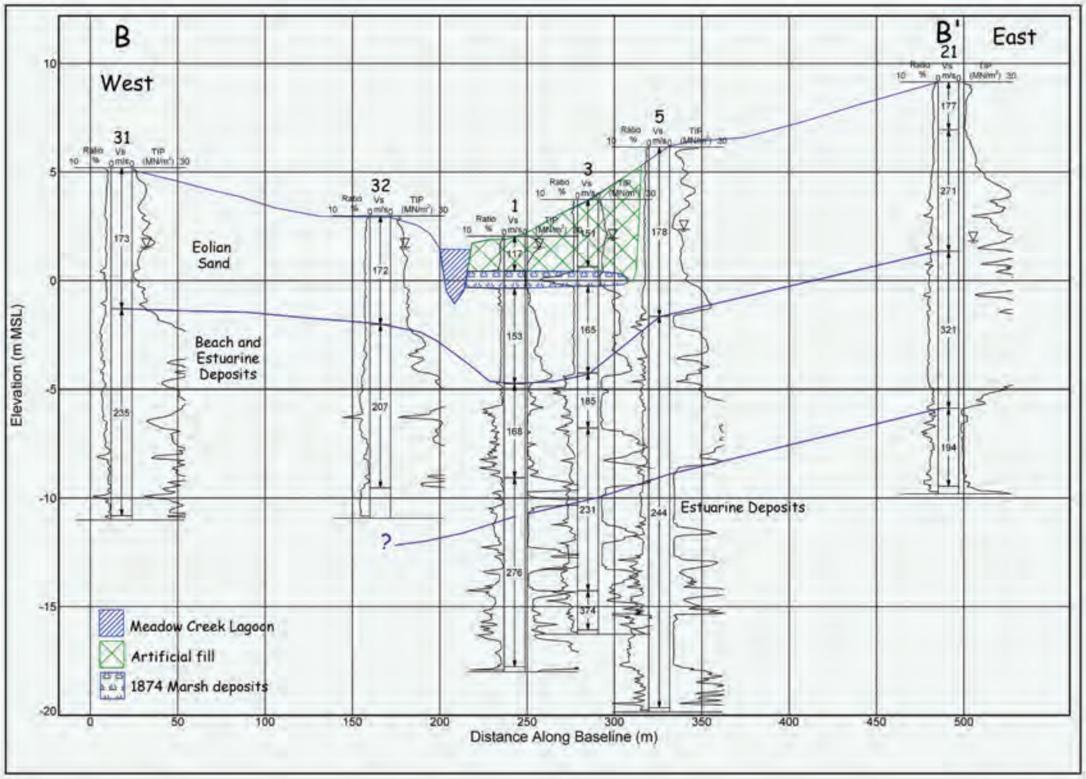


Figure 7a.

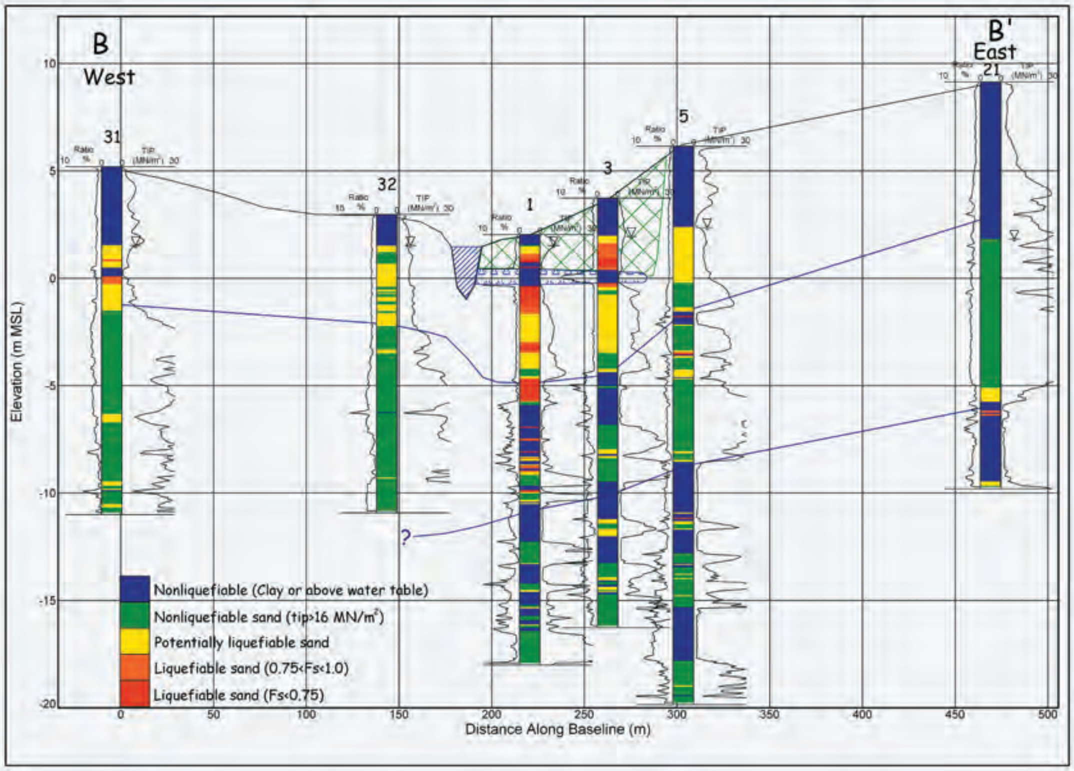


Figure 7b.

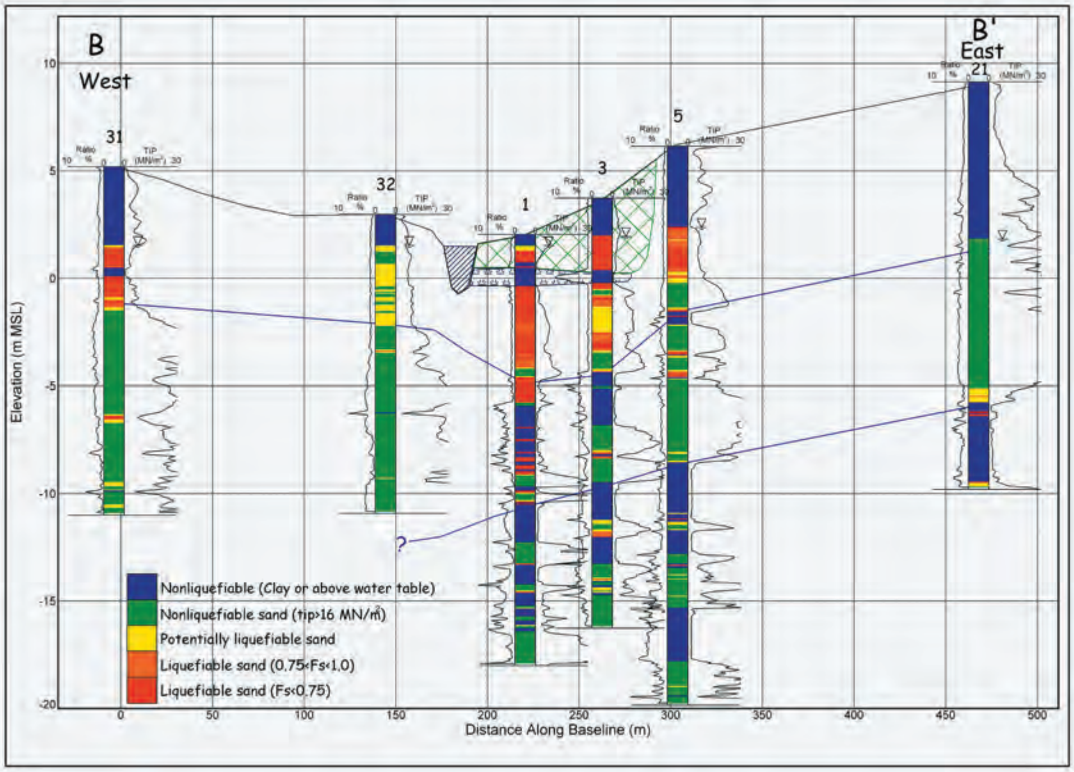


Figure 7c.

Figure 7. East-west cross section (B-B’) at Oceano of generalized shallow subsurface conditions based on SCPT soundings. See Figure 5 for location of cross section. Cross section includes profiles of CPT tip and friction ratio, geologic units, and water table with (a) shear-wave velocity (V_S), (b) liquefaction factors of safety for a M6.5 and PGA=0.25 g, and (c) liquefaction factors of safety for a M6.8 and PGA=0.4 g.

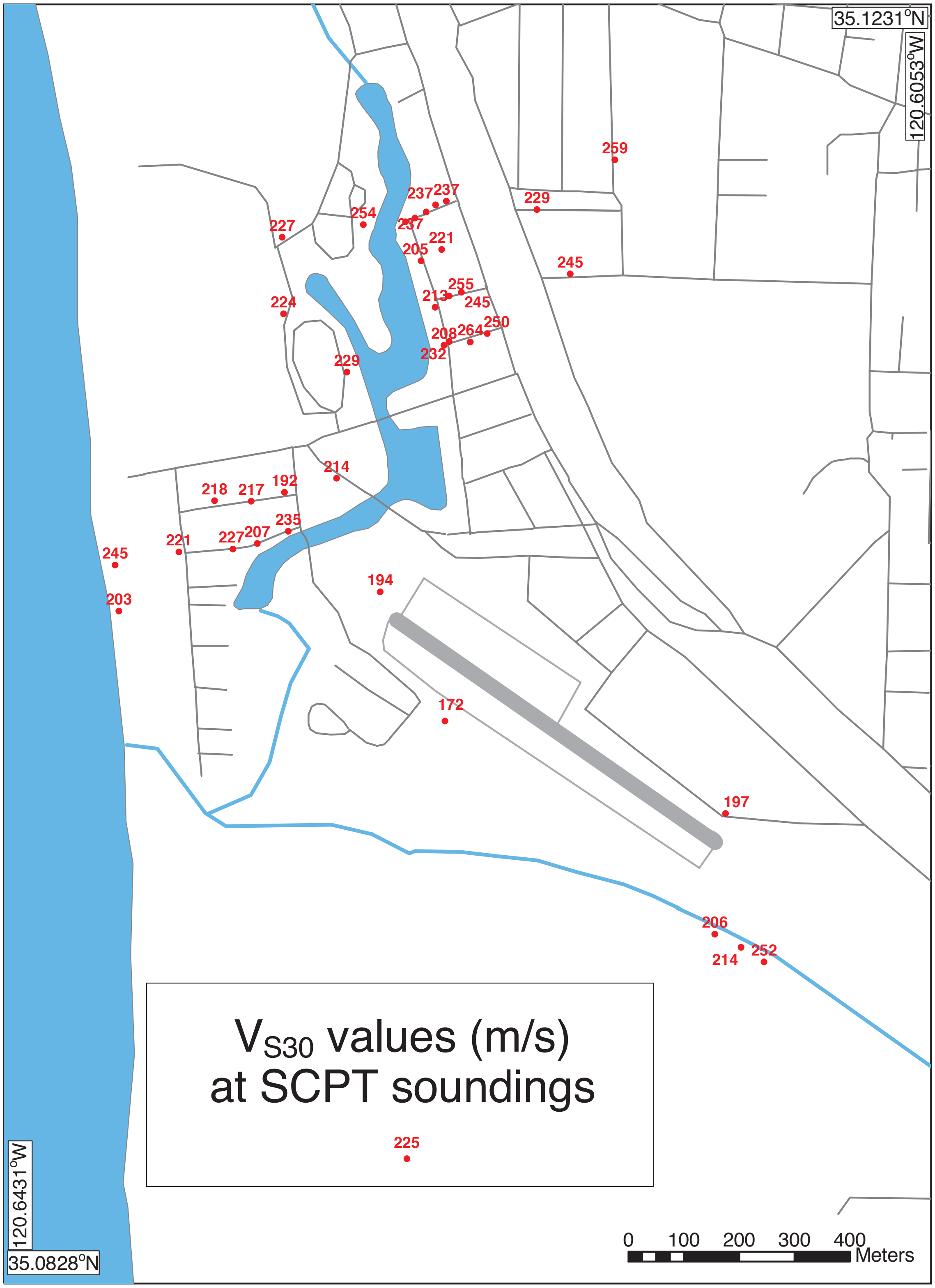


Figure 13. Map of V_{S30} values inferred from USGS SCPT soundings.

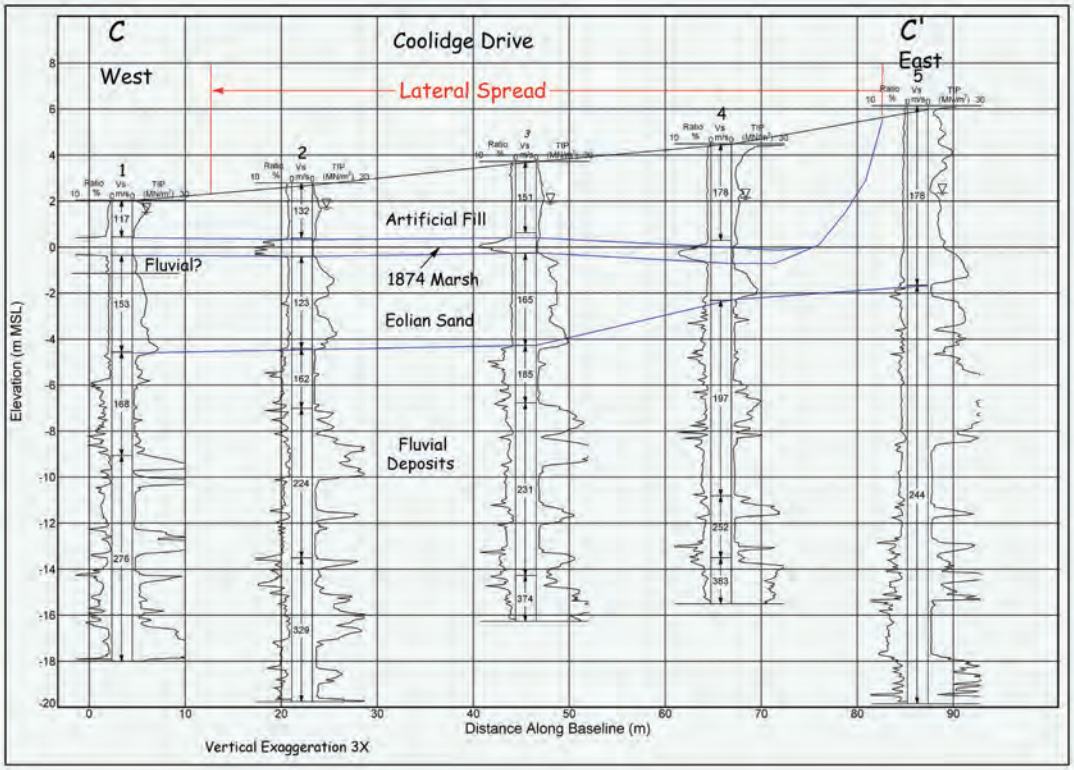


Figure 17a.

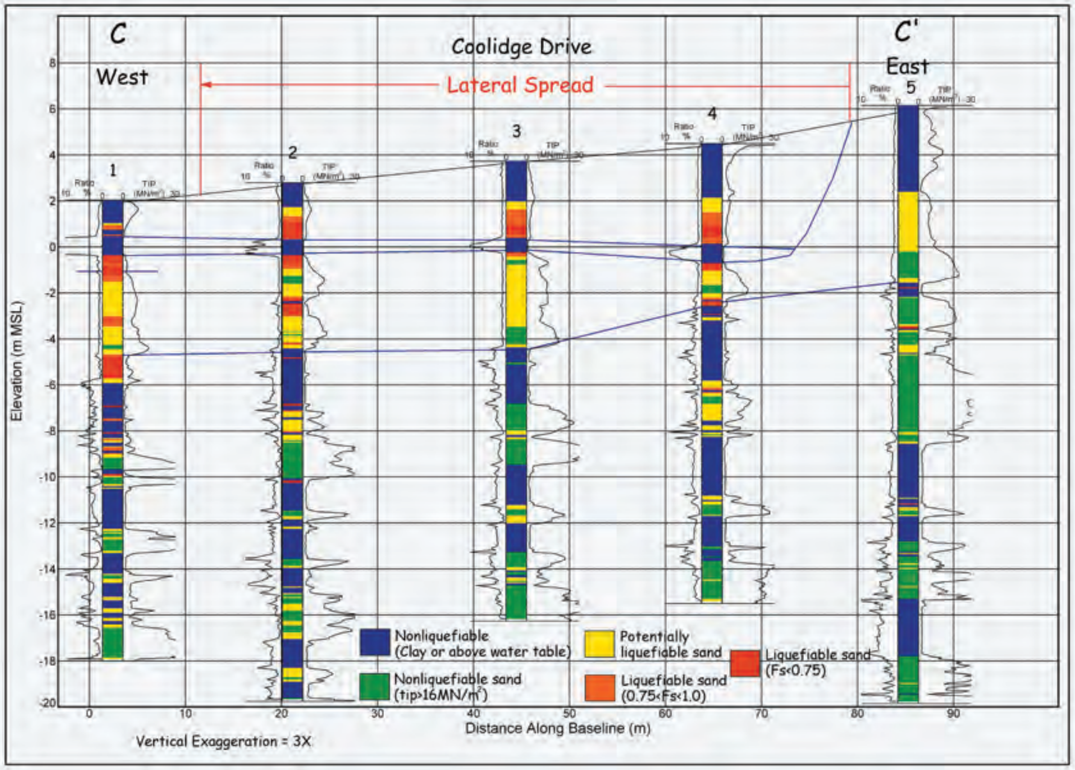


Figure 17b.

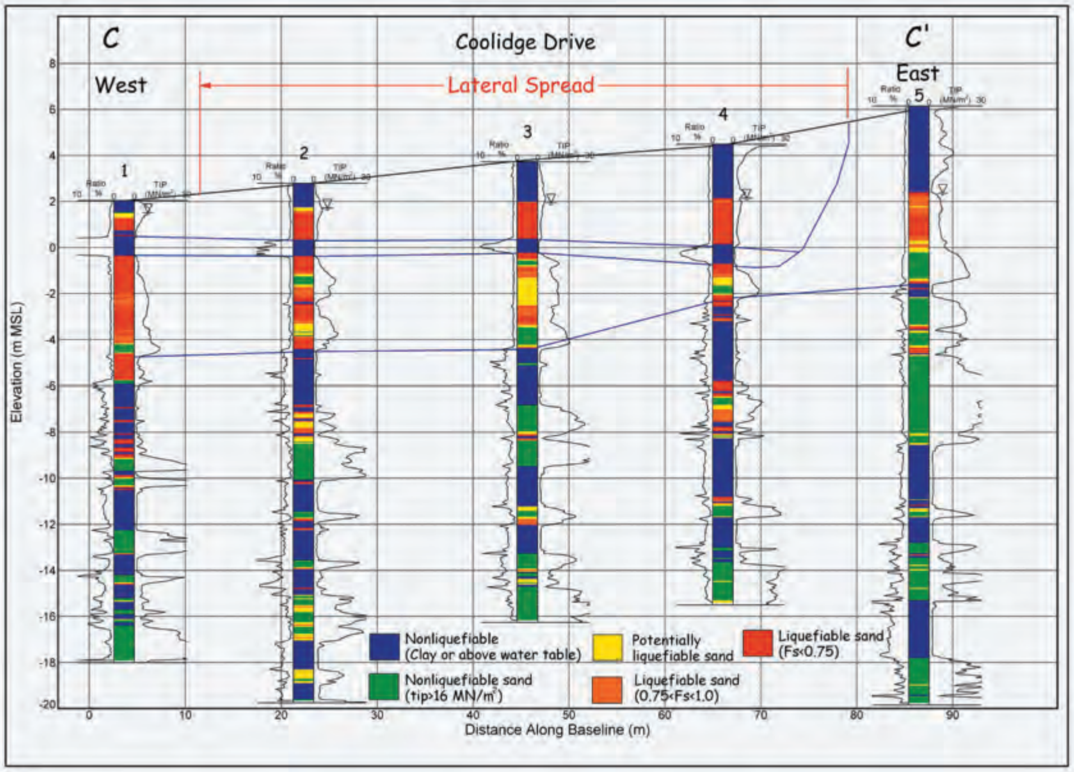


Figure 17c.

Figure 17. Cross section C-C' of Norswing Drive lateral spread along Coolidge Drive. See Figure 5 for location. Cross section includes profiles of CPT tip and friction ratio, geologic units, and water table with (a) shear-wave velocity (V_S), (b) liquefaction factors of safety for a M6.5 and PGA=0.25 g, and (c) liquefaction factors of safety for a M6.8 and PGA=0.4 g.

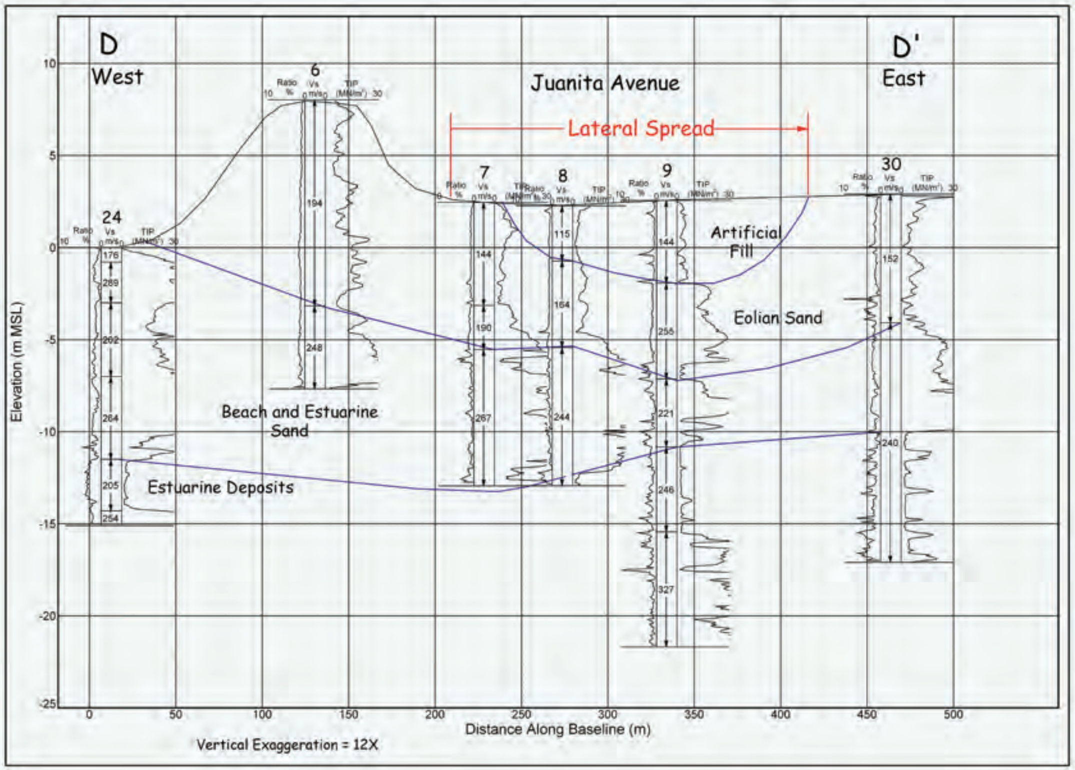


Figure 18a.

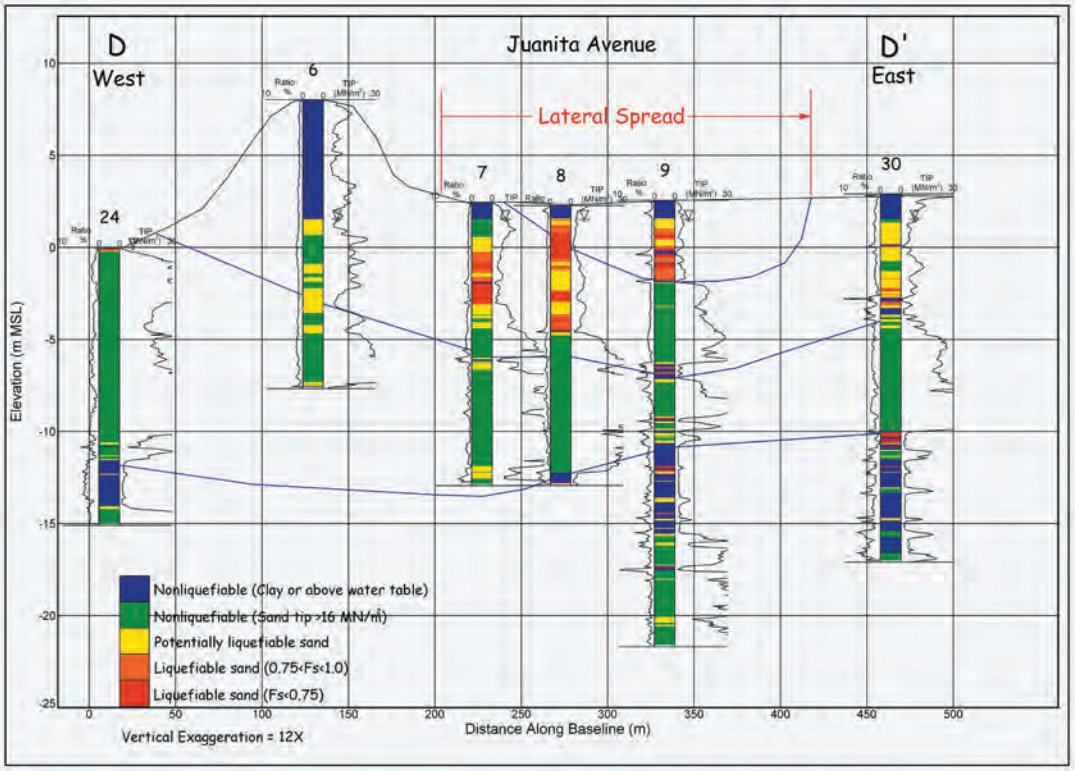


Figure 18b.

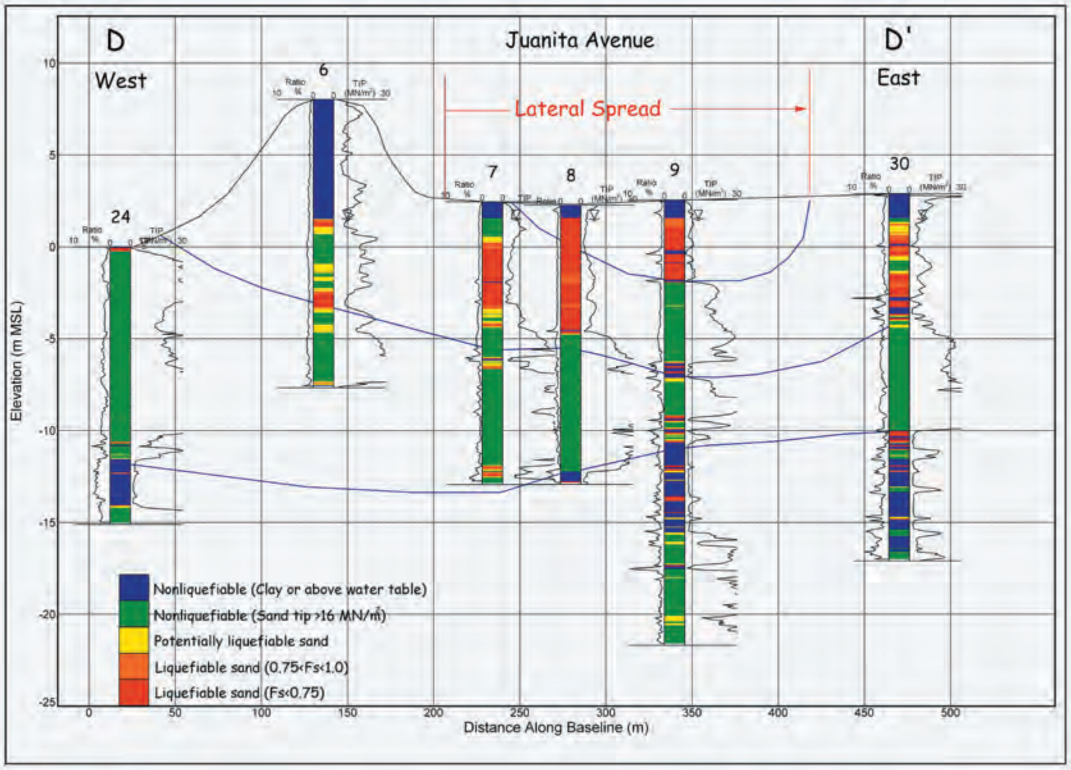


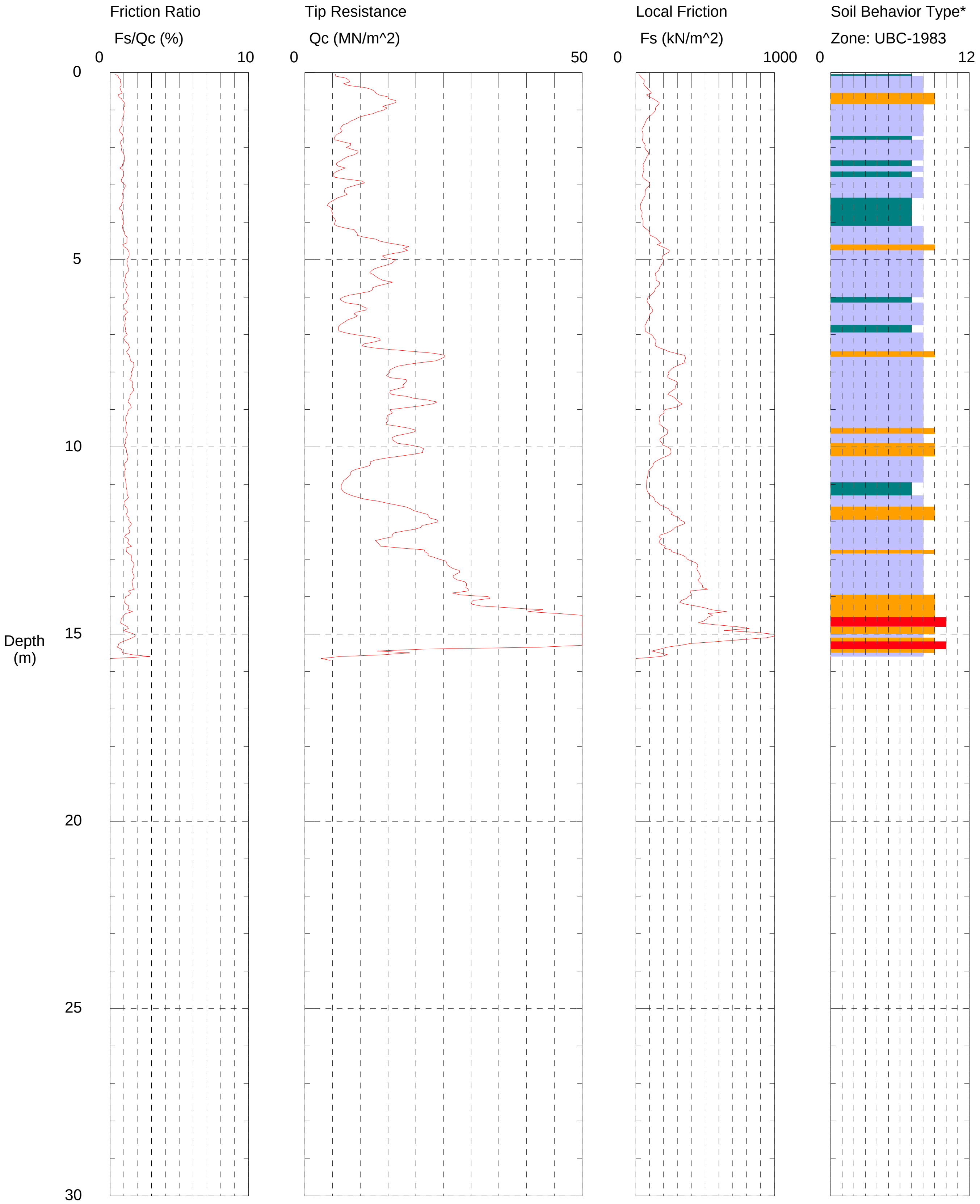
Figure 18c.

Figure 18. Cross section D-D' of Juanita Avenue lateral spread along Juanita Avenue. See Figure 5 for location. Cross section includes profiles of CPT tip and friction ratio, geologic units, and water table with (a) shear-wave velocity (V_S), (b) liquefaction factors of safety for a M6.5 and PGA=0.25 g, and (c) liquefaction factors of safety for a M6.8 and PGA=0.4 g.

US Geological Survey

Operator: Tom Noce
Sounding: SOC006
Cone Used: 766tc

CPT Date/Time: 02-24-04 12:04
Location: Strand & Juanita
Job Number: Oceano



Maximum Depth = 15.70 meters

Depth Increment = 0.050 meters

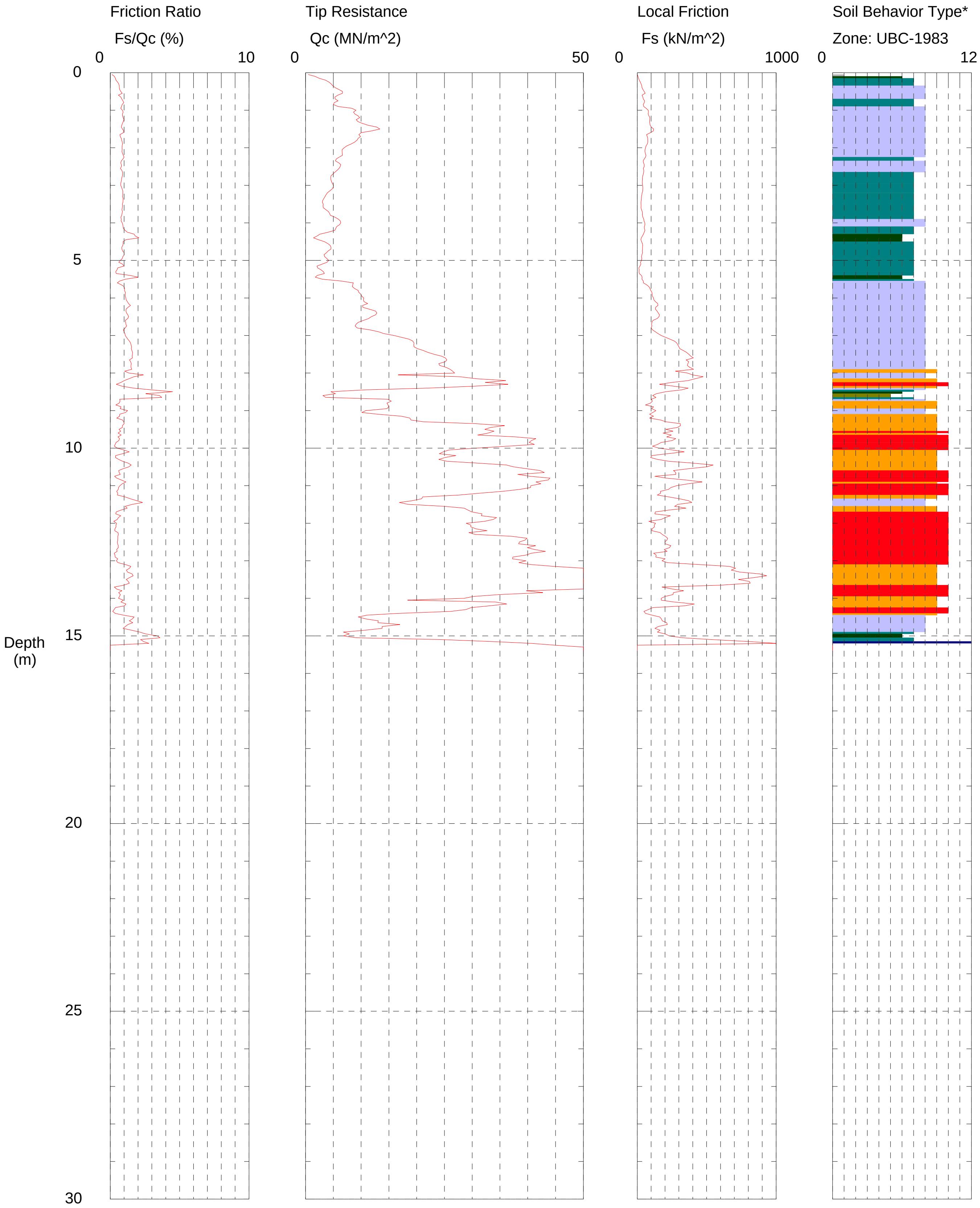
■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay
■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt
■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC007
Cone Used: 766tc

CPT Date/Time: 02-24-04 14:16
Location: 344 Juanita
Job Number: Oceano



Maximum Depth = 15.40 meters

Depth Increment = 0.050 meters

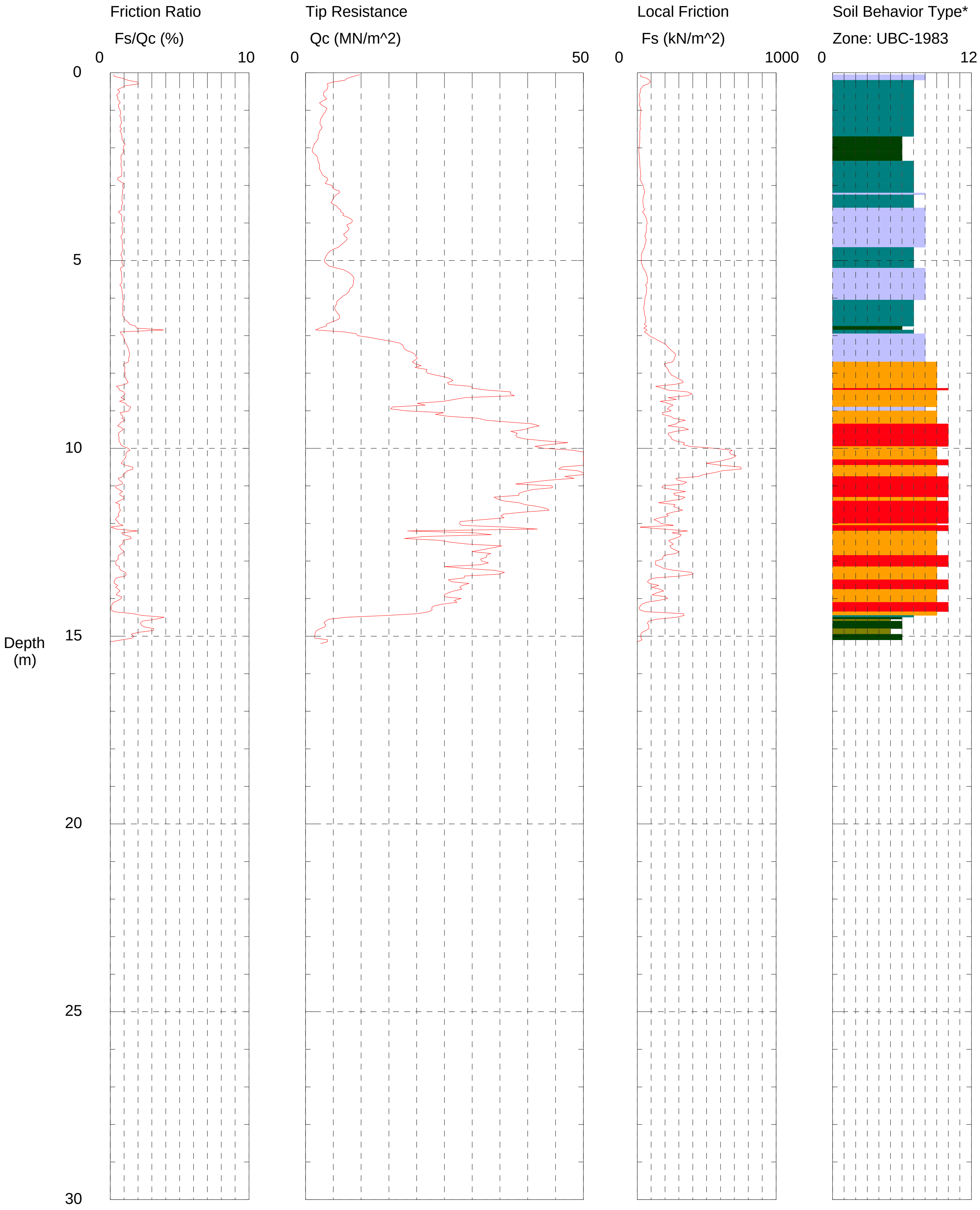
- ▨ 1 sensitive fine grained
- ▨ 2 organic material
- 🟥 3 clay
- 🟫 4 silty clay to clay
- 🟫 5 clayey silt to silty clay
- 🟩 6 sandy silt to clayey silt
- 🟦 7 silty sand to sandy silt
- 🟪 8 sand to silty sand
- 🟧 9 sand
- 🟥 10 gravelly sand to sand
- 🟪 11 very stiff fine grained (*)
- 🟦 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC008
Cone Used: 766tc

CPT Date/Time: 02-24-04 16:21
Location: 373 Juanita opp
Job Number: Oceano



Maximum Depth = 15.20 meters

Depth Increment = 0.050 meters

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

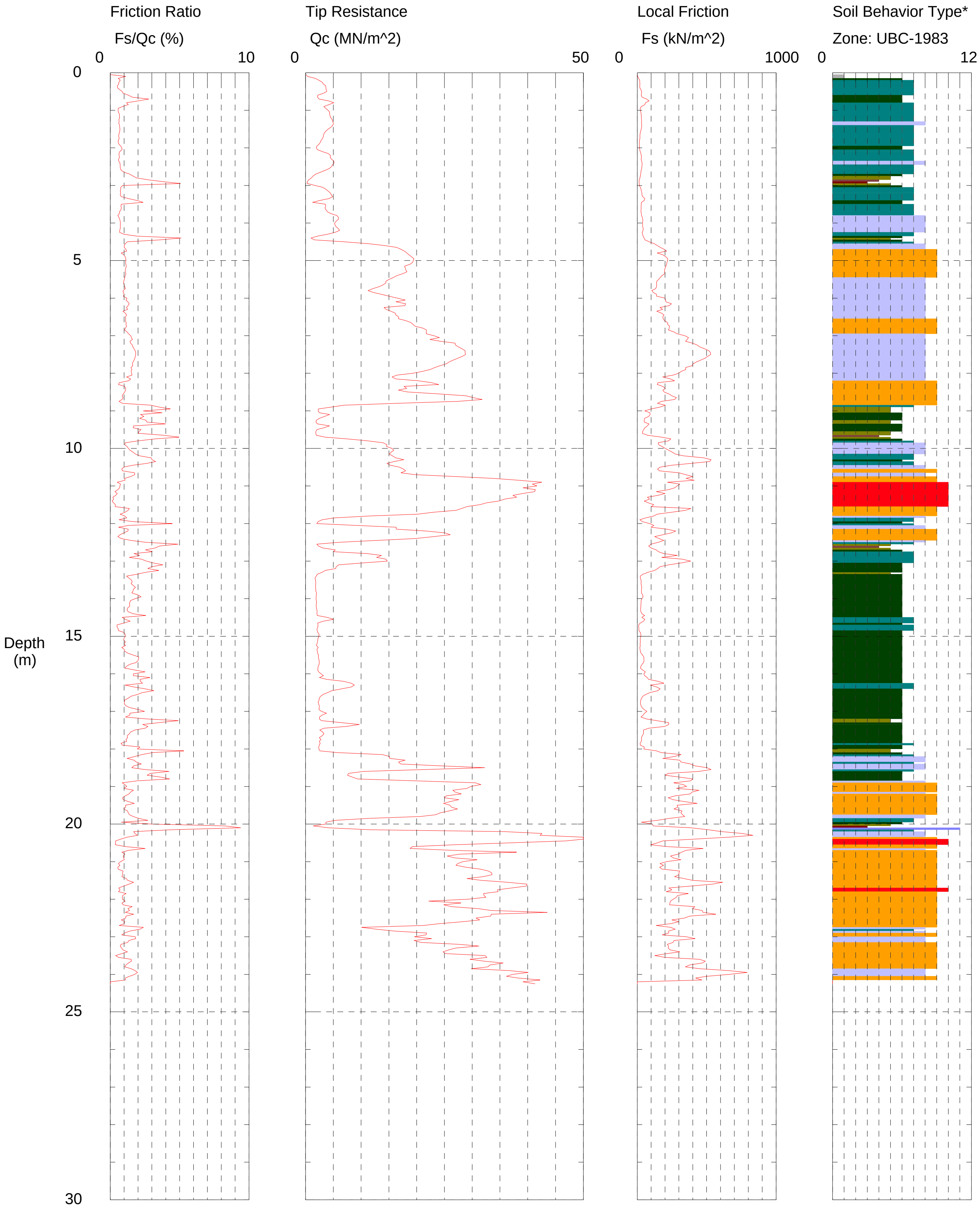
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC009
Cone Used: 766tc

CPT Date/Time: 02-25-04 06:53
Location: Juanita Lakeside
Job Number: Oceano



Maximum Depth = 24.25 meters

Depth Increment = 0.050 meters

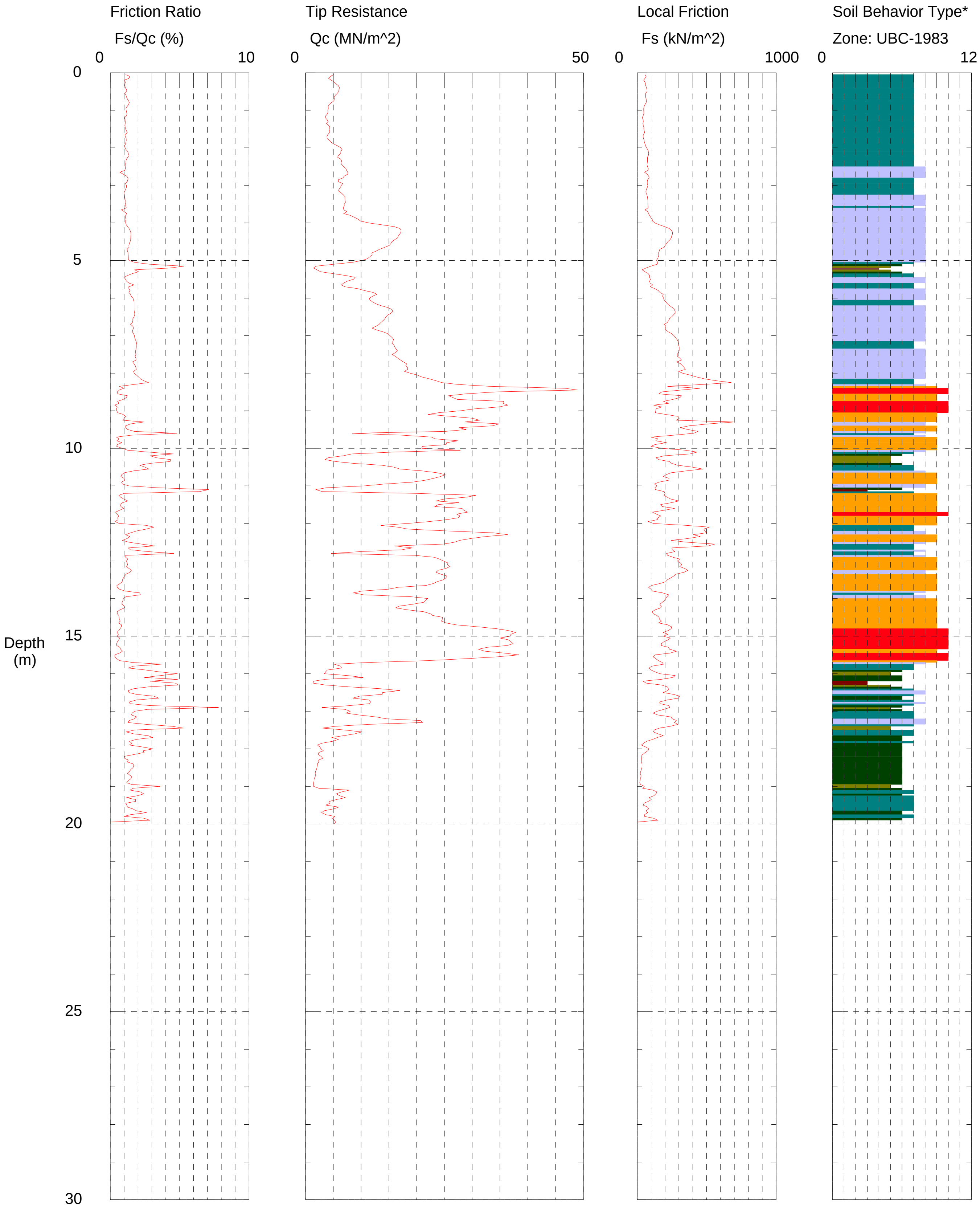
- ⬜ 1 sensitive fine grained
- ⬛ 2 organic material
- 🟥 3 clay
- 🟫 4 silty clay to clay
- 🟫 5 clayey silt to silty clay
- 🟩 6 sandy silt to clayey silt
- 🟦 7 silty sand to sandy silt
- ⬜ 8 sand to silty sand
- 🟧 9 sand
- 🟥 10 gravelly sand to sand
- 🟪 11 very stiff fine grained (*)
- 🟦 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC022
Cone Used: 766tc

CPT Date/Time: 03-01-04 15:06
Location: 339 McCarthy
Job Number: Oceano



Maximum Depth = 20.00 meters

Depth Increment = 0.050 meters

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

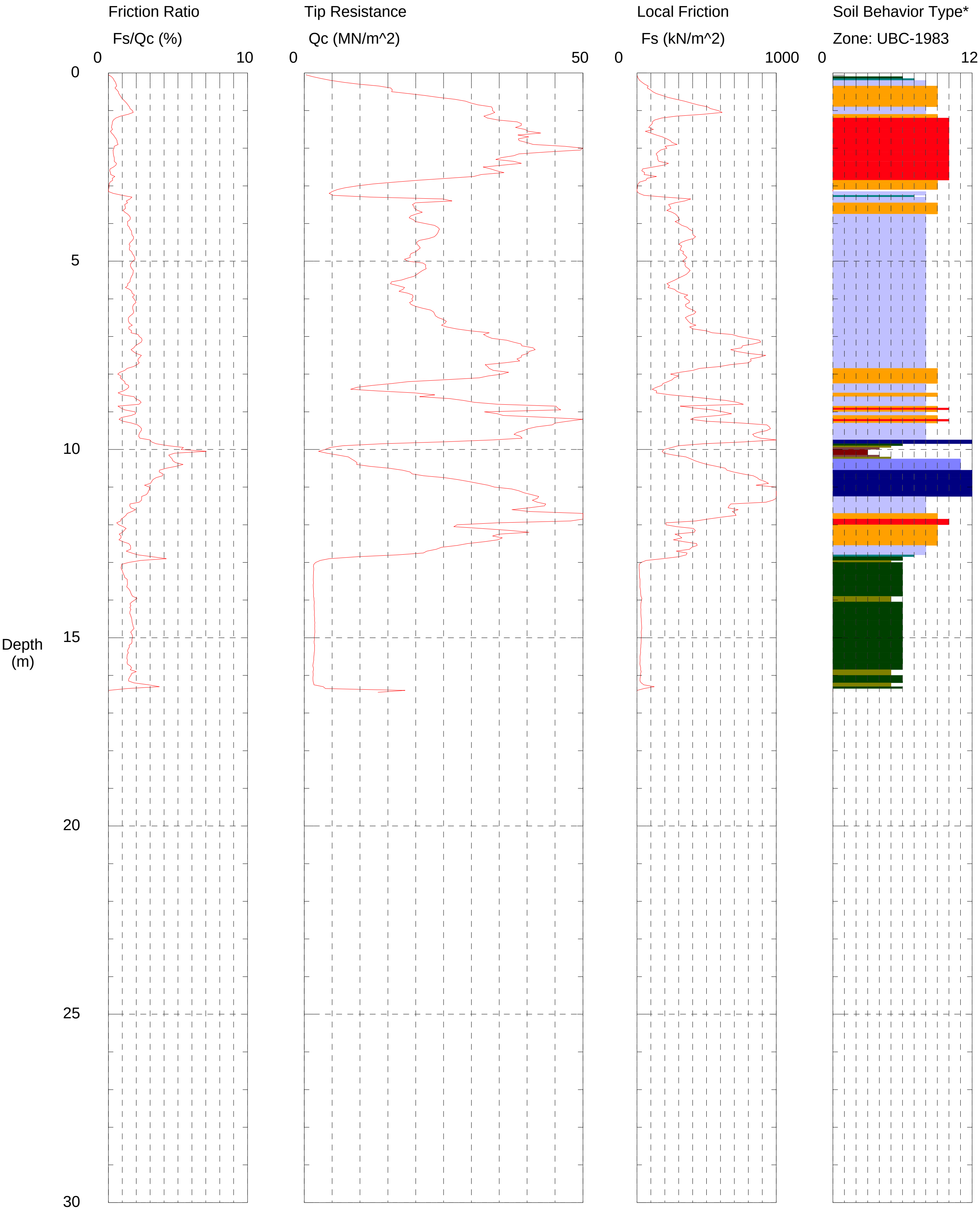
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC023
Cone Used: 766tc

CPT Date/Time: 03-02-04 08:32
Location: Beach Juanita
Job Number: Oceano



Maximum Depth = 16.45 meters

Depth Increment = 0.050 meters

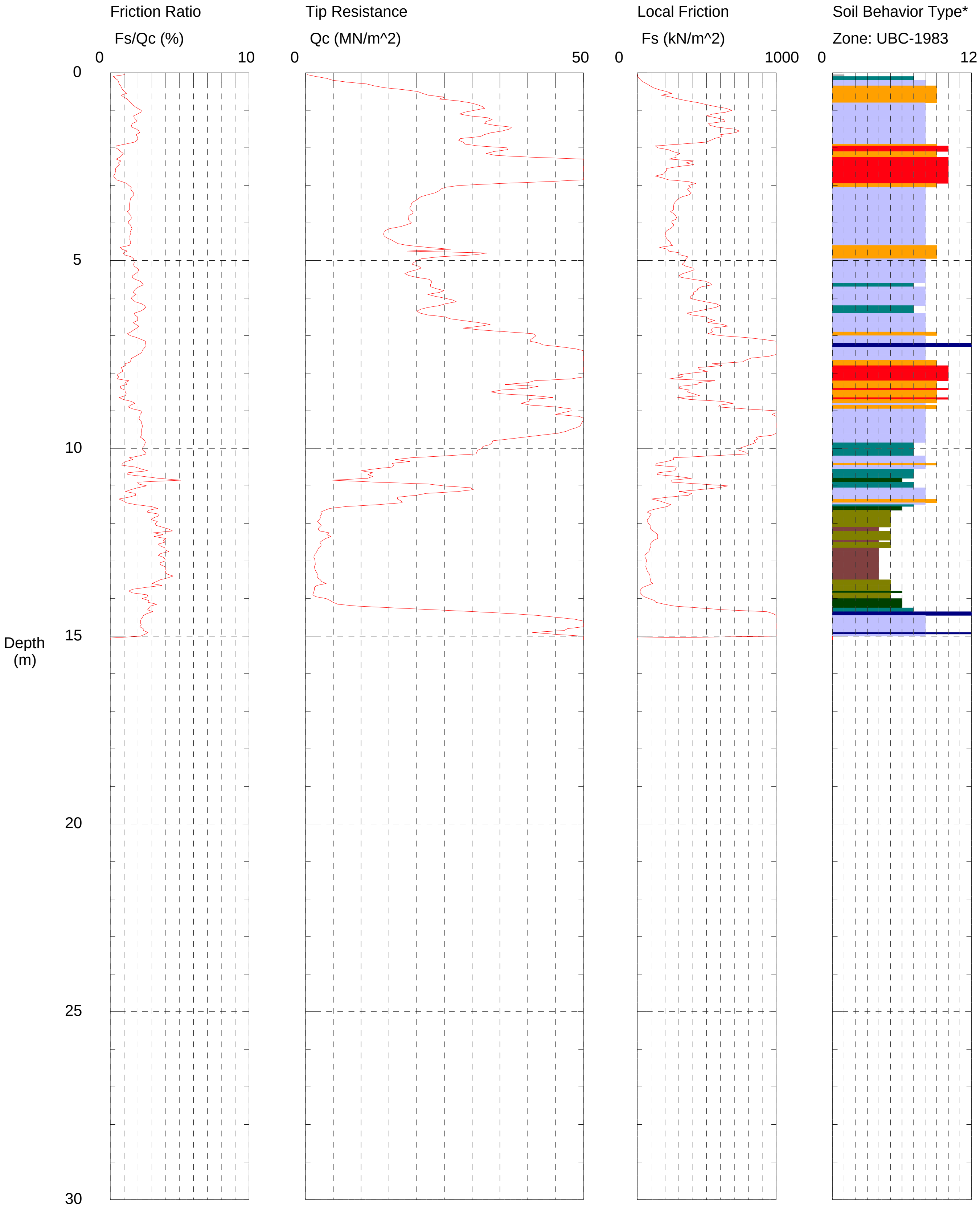
1	sensitive fine grained	4	silty clay to clay	7	silty sand to sandy silt	10	gravelly sand to sand
2	organic material	5	clayey silt to silty clay	8	sand to silty sand	11	very stiff fine grained (*)
3	clay	6	sandy silt to clayey silt	9	sand	12	sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC024
Cone Used: 766tc

CPT Date/Time: 03-02-04 11:09
Location: Beach McCarthy
Job Number: Oceano



Maximum Depth = 15.10 meters

Depth Increment = 0.050 meters

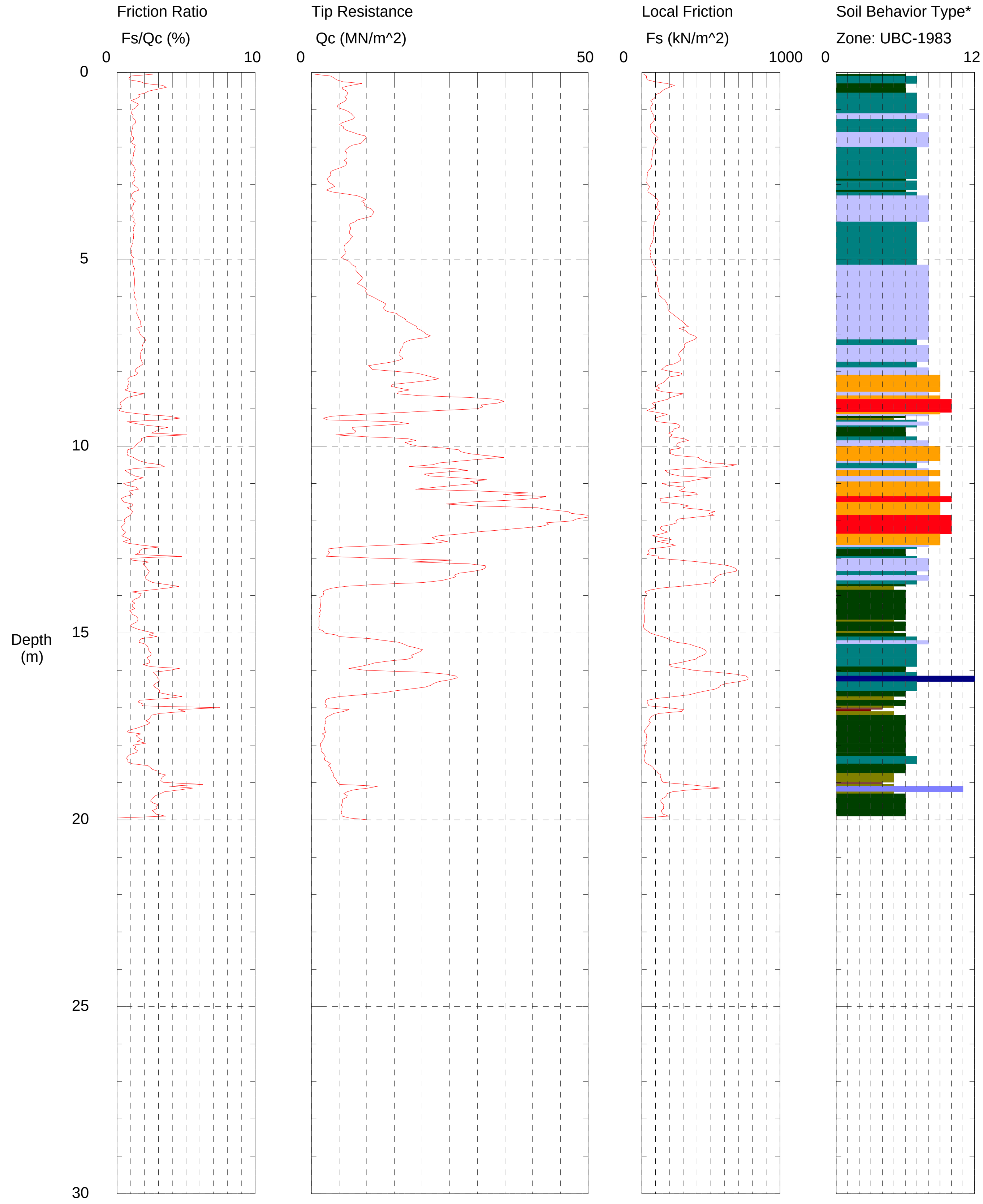
■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay
■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt
■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC025
Cone Used: 766tc

CPT Date/Time: 03-02-04 13:30
Location: 369 McCarthy opp
Job Number: Oceano



Maximum Depth = 20.00 meters

Depth Increment = 0.050 meters

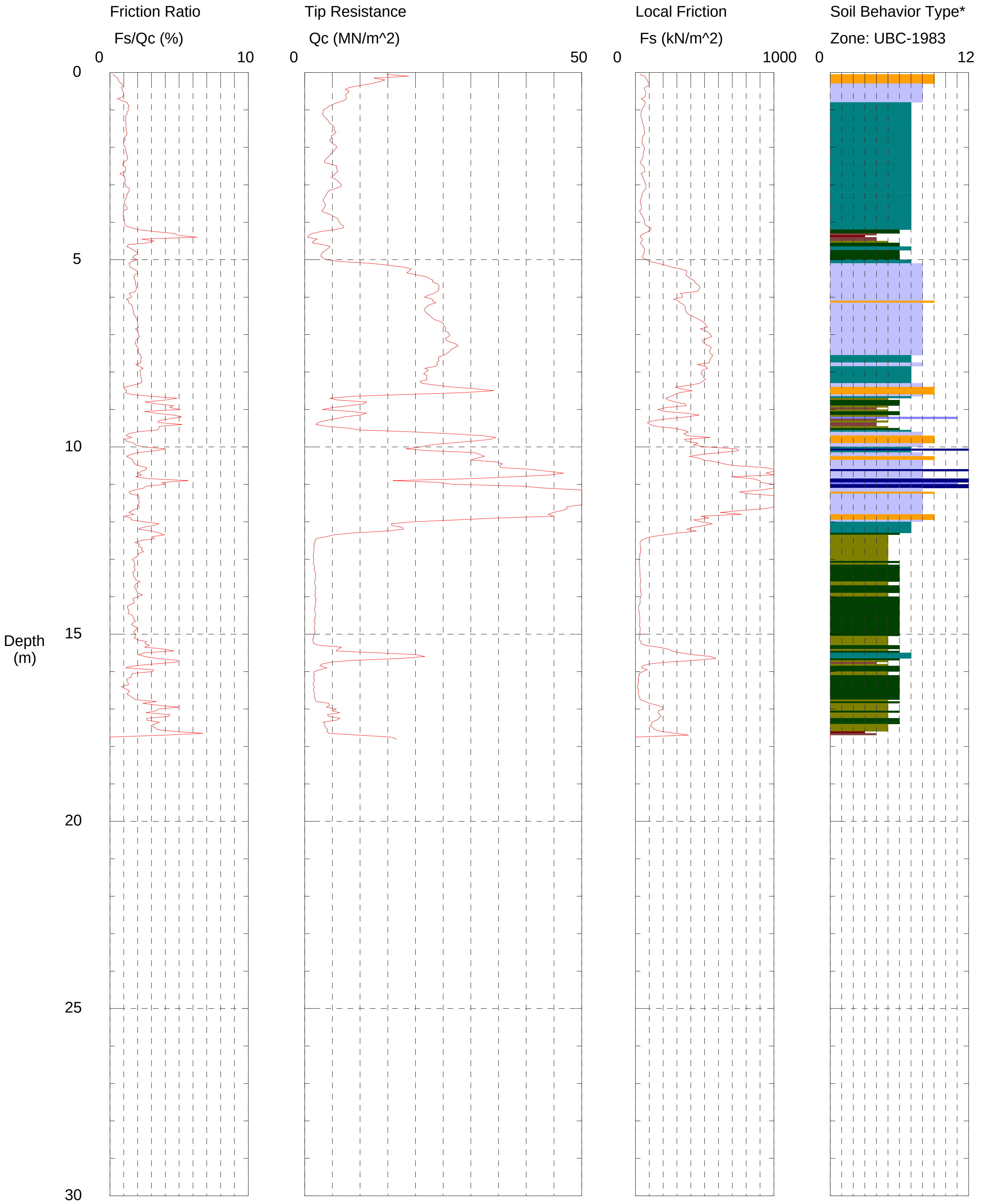
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC026
Cone Used: 766tc

CPT Date/Time: 03-02-04 15:15
Location: McCarthyLakeside
Job Number: Oceano



Maximum Depth = 17.80 meters

Depth Increment = 0.050 meters

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

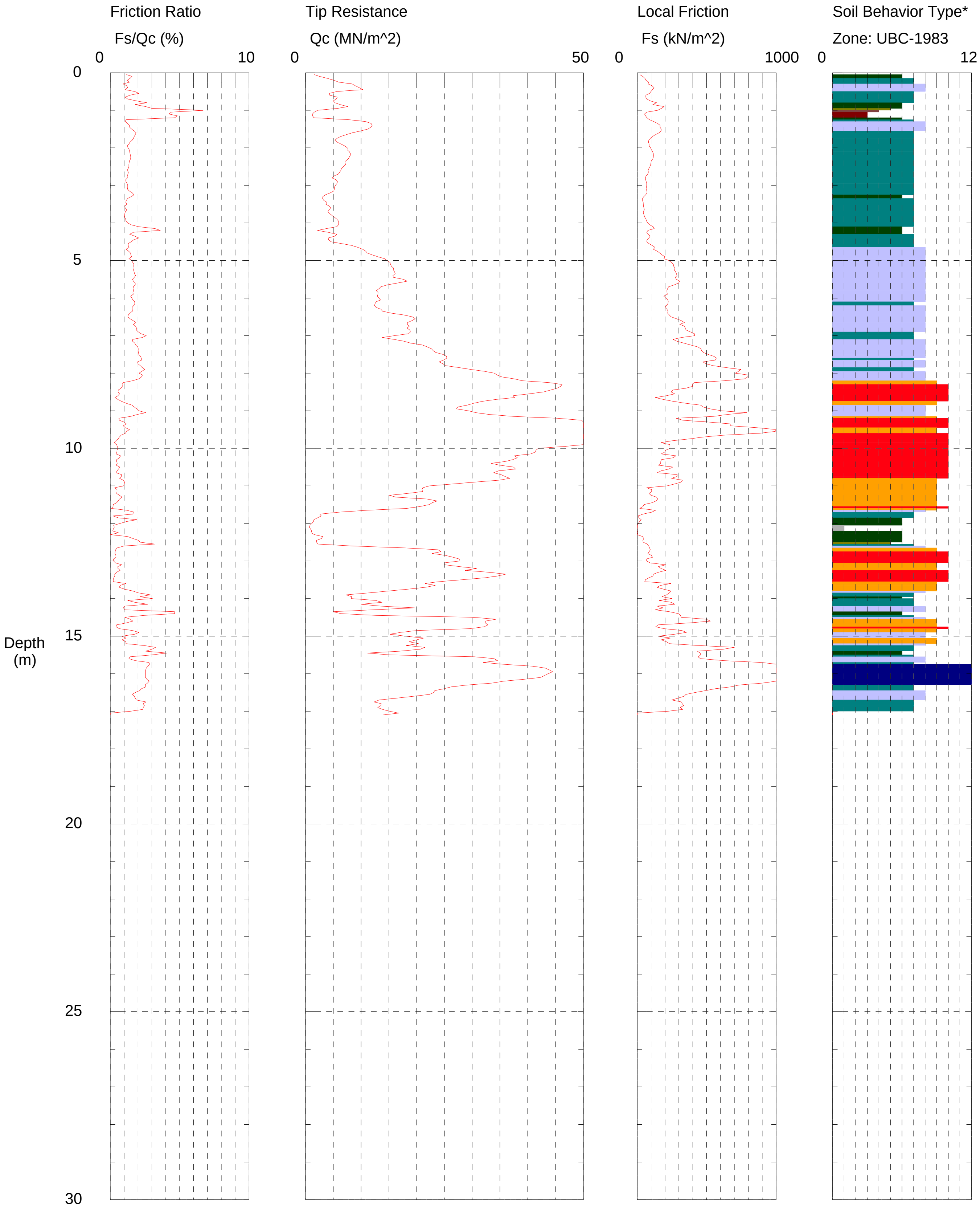
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC027
Cone Used: 766tc

CPT Date/Time: 03-03-04 08:00
Location: Airport North
Job Number: Oceano



Maximum Depth = 17.10 meters

Depth Increment = 0.050 meters

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

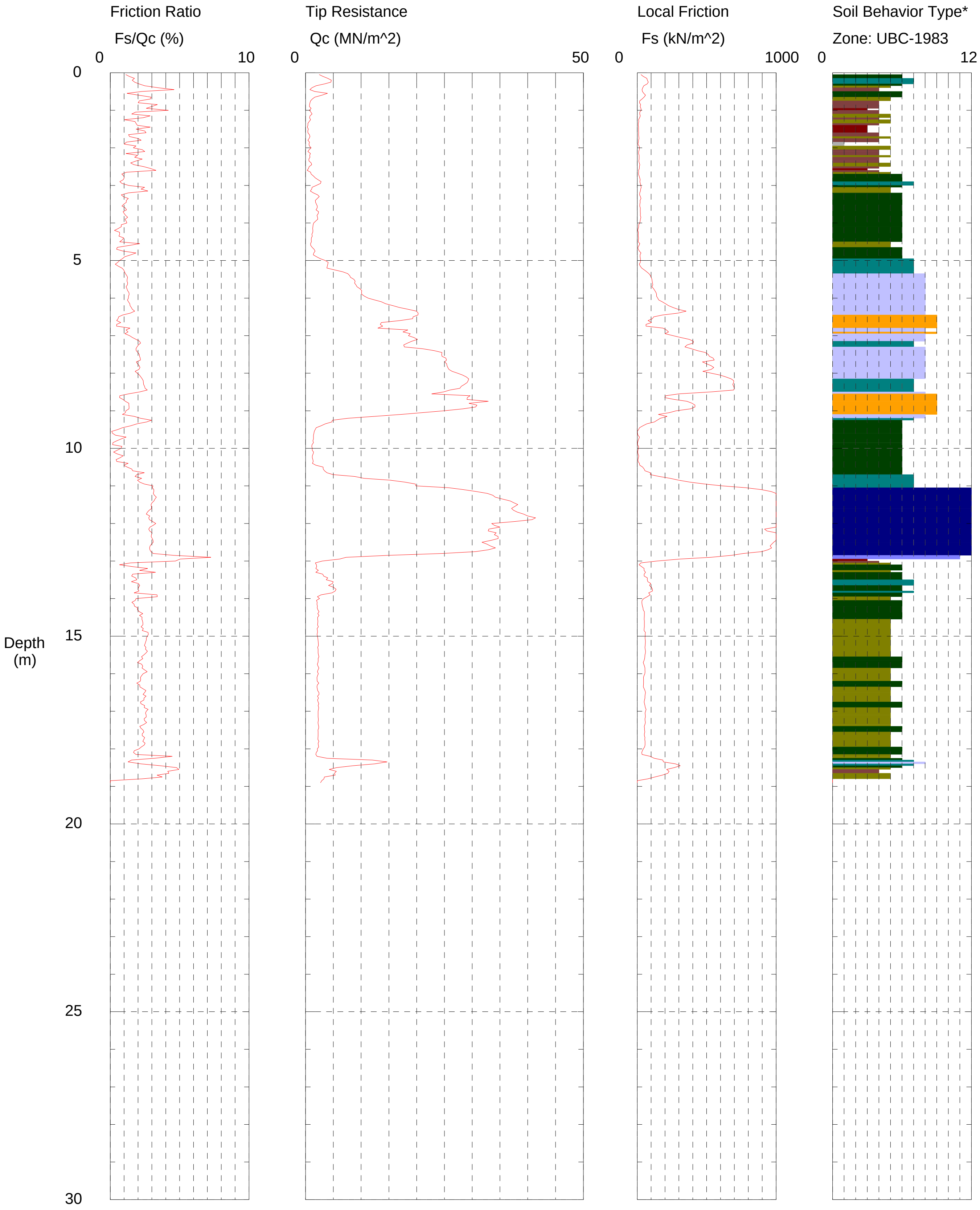
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC028
Cone Used: 766tc

CPT Date/Time: 03-03-04 10:31
Location: Pirates Lair Air
Job Number: Oceano



Maximum Depth = 18.90 meters

Depth Increment = 0.050 meters

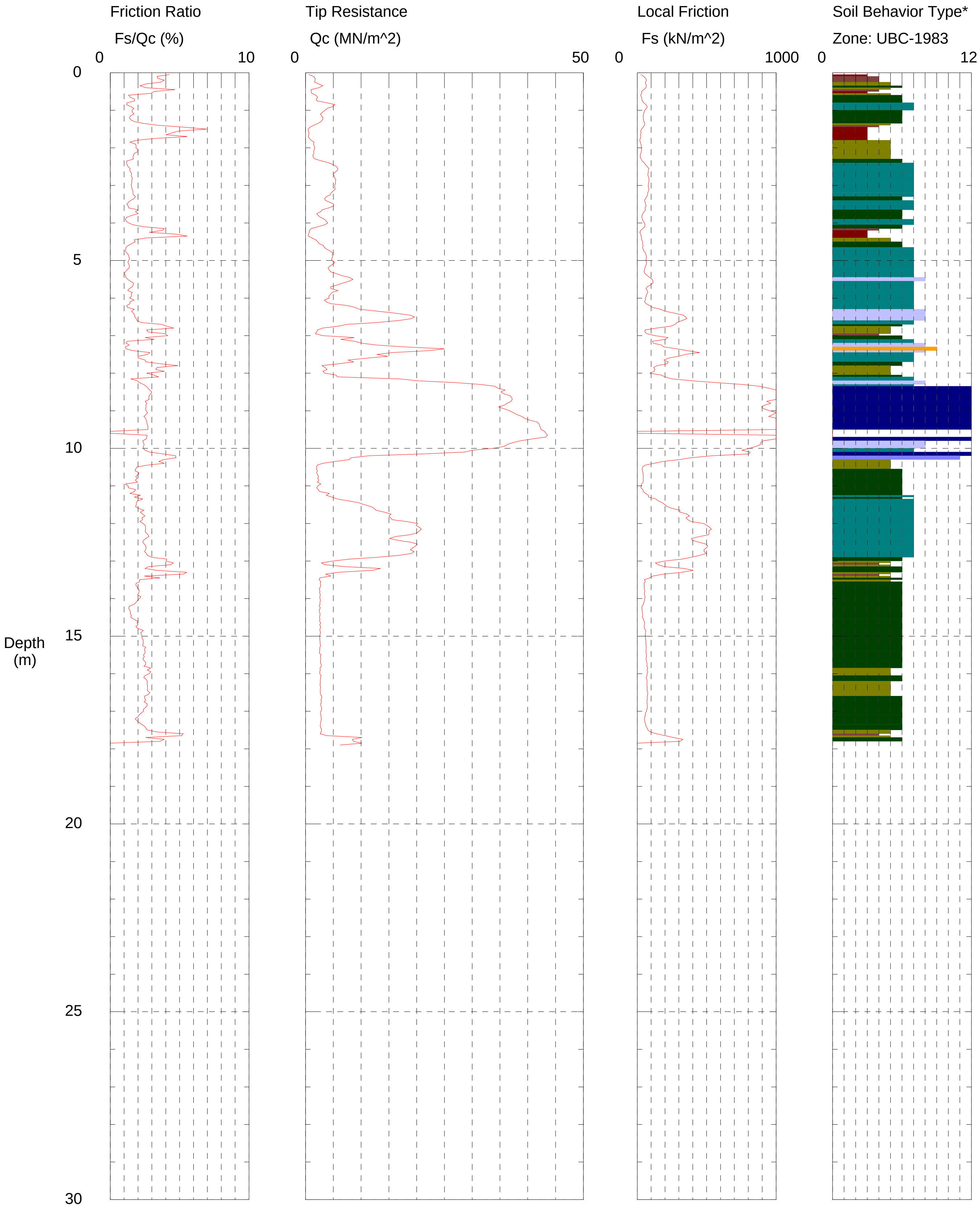
■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay
■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt
■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC029
Cone Used: 766tc

CPT Date/Time: 03-03-04 12:37
Location: Fountain Ave SPT
Job Number: Oceano



Maximum Depth = 17.90 meters

Depth Increment = 0.050 meters

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

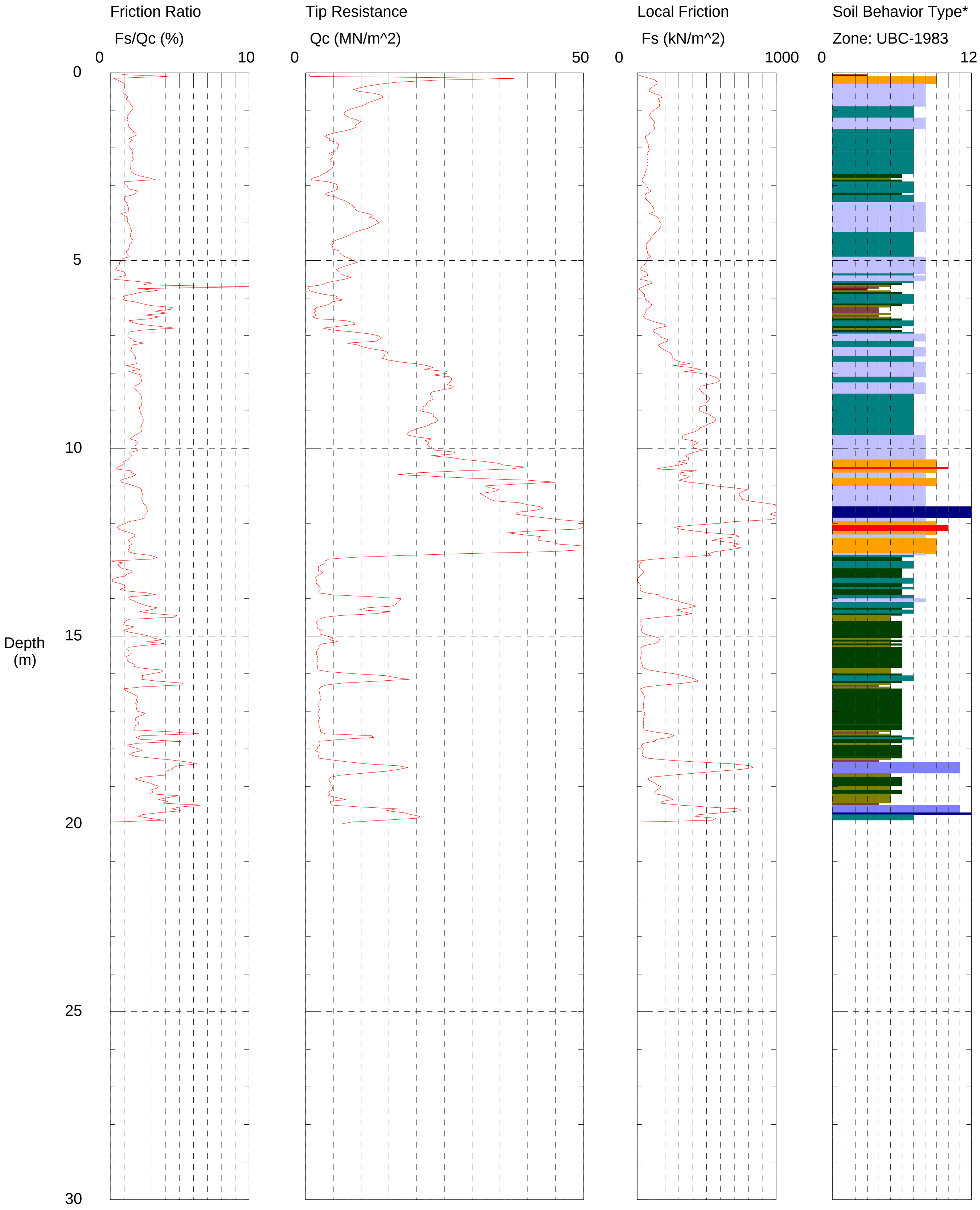
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC030
Cone Used: 766tc

CPT Date/Time: 03-03-04 14:17
Location: Airpark Road Elk
Job Number: Oceano



Maximum Depth = 20.00 meters

Depth Increment = 0.050 meters

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

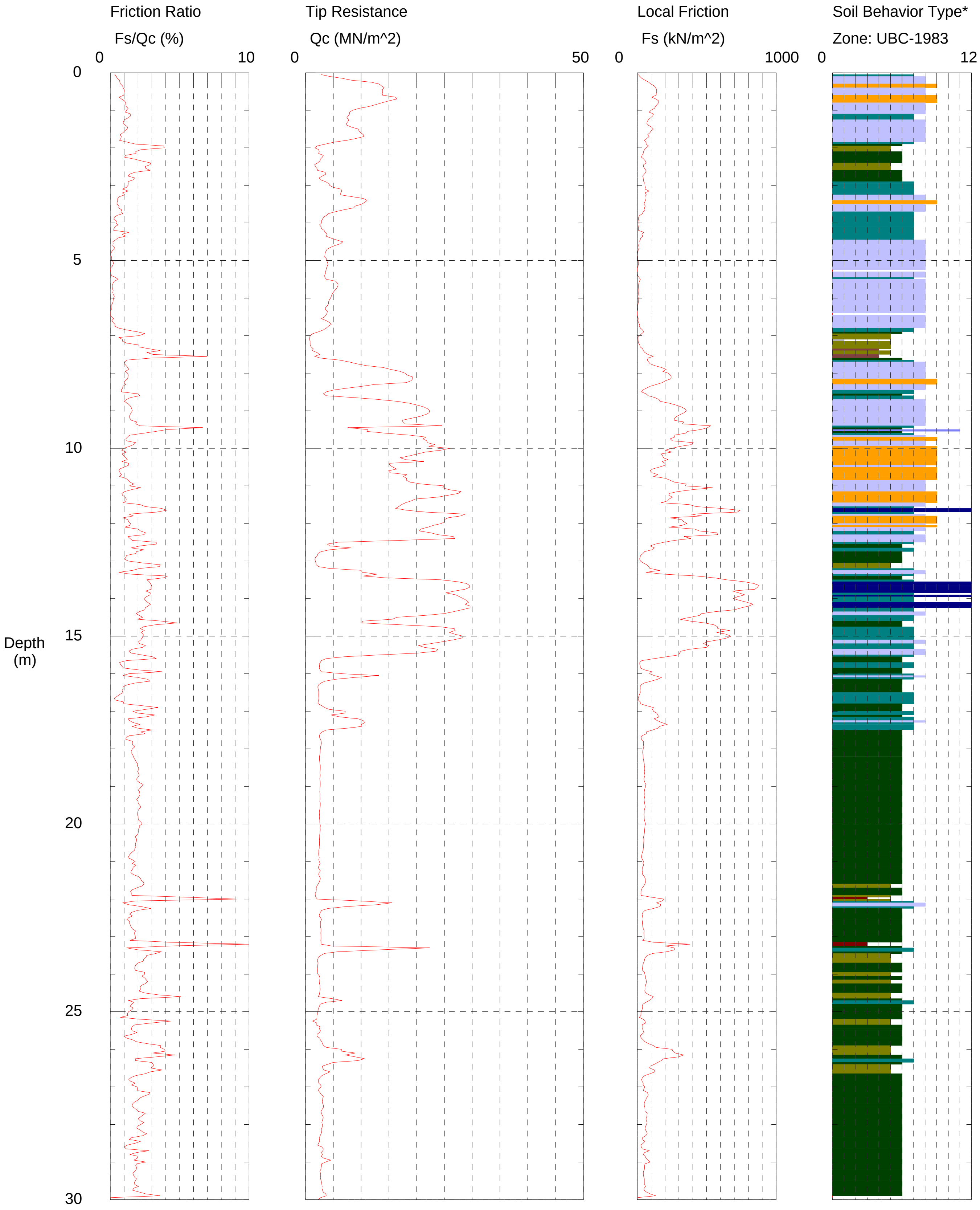
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC035
Cone Used: 766tc

CPT Date/Time: 03-05-04 08:29
Location: Levee Center
Job Number: Oceano



Maximum Depth = 30.00 meters

Depth Increment = 0.050 meters

■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

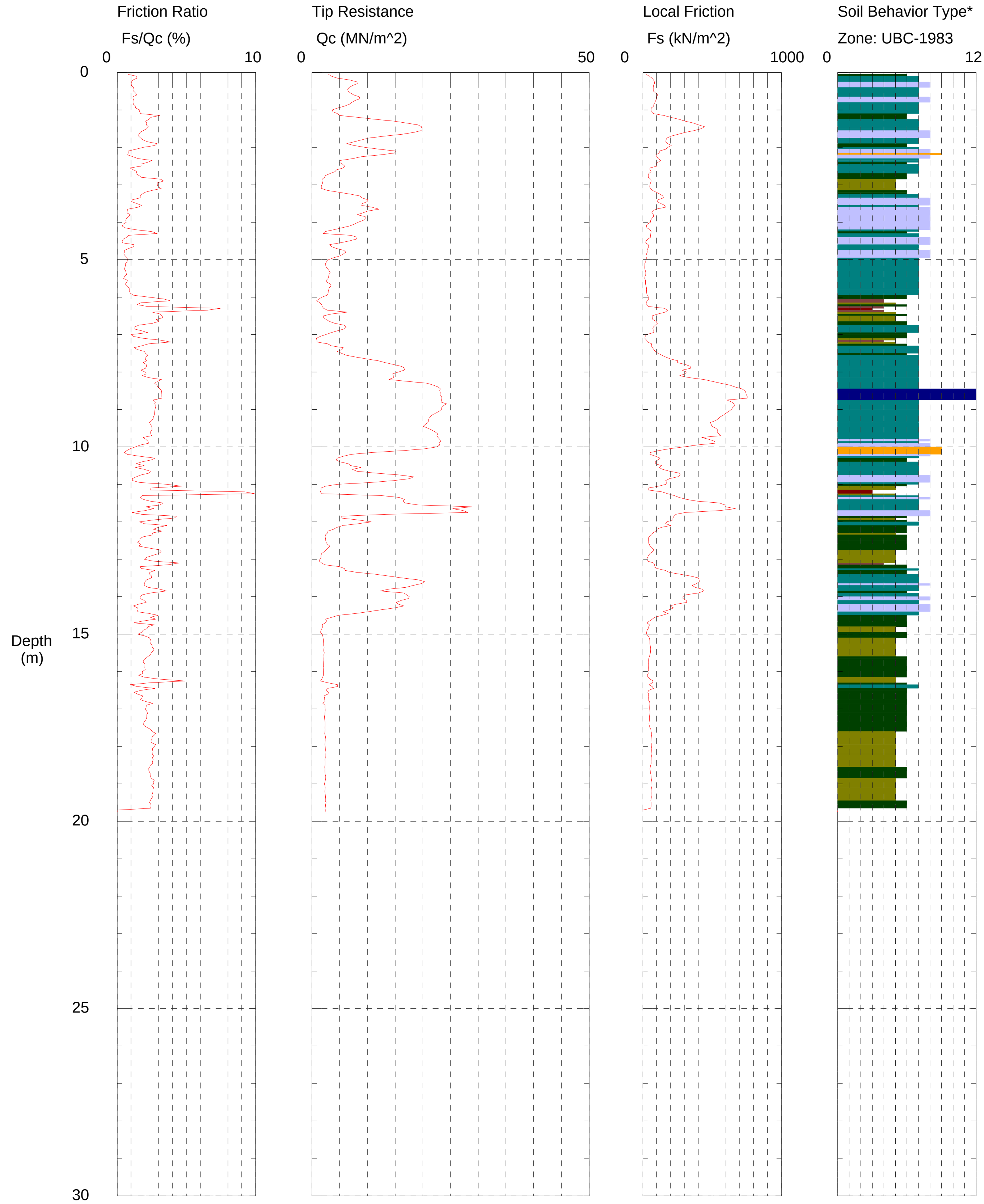
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC036
Cone Used: 766tc

CPT Date/Time: 03-05-04 10:07
Location: Levee Northwest
Job Number: Oceano



Maximum Depth = 19.75 meters

Depth Increment = 0.050 meters

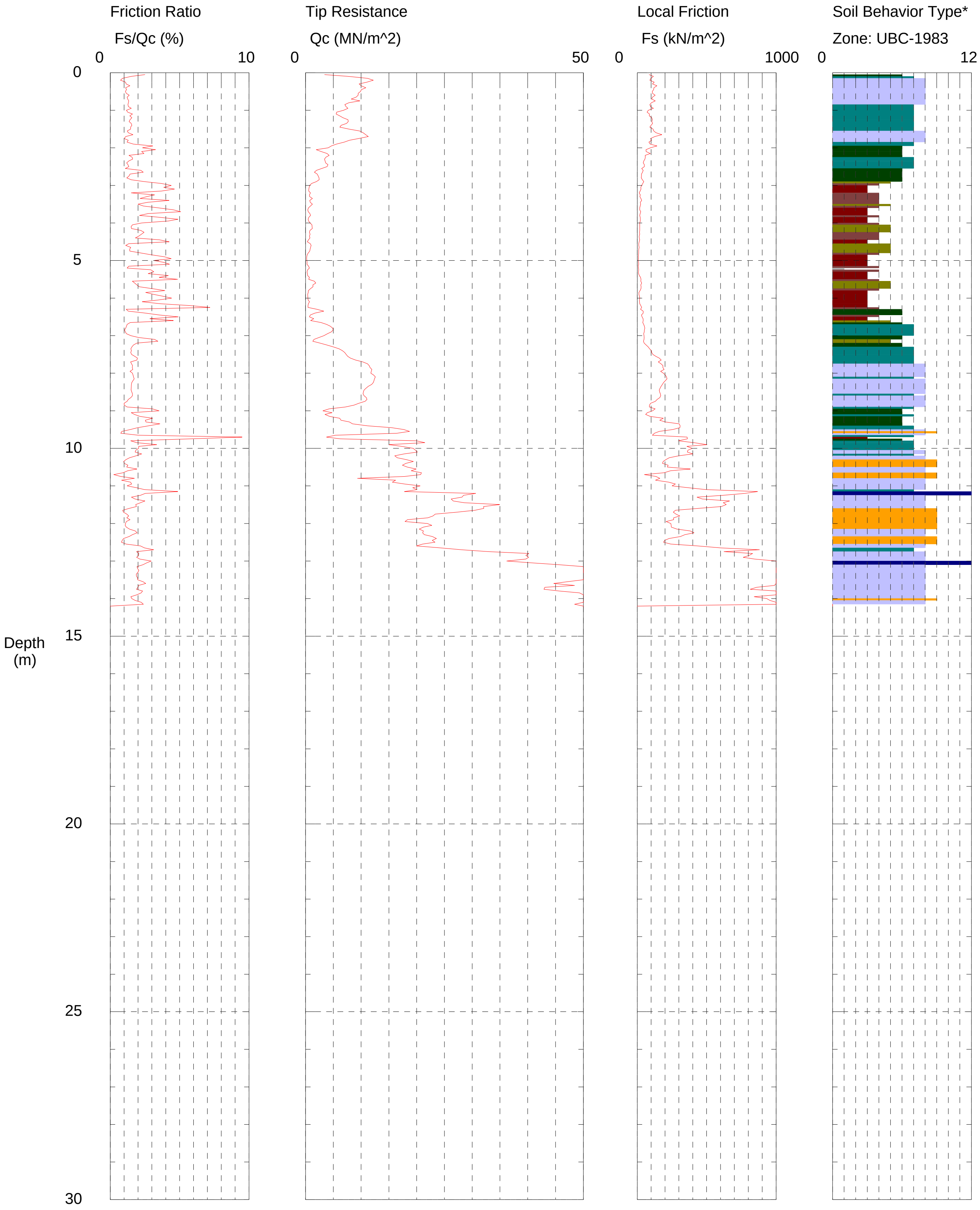
■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay
■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt
■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand
■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

US Geological Survey

Operator: Tom Noce
Sounding: SOC037
Cone Used: 766tc

CPT Date/Time: 03-05-04 11:10
Location: Levee Southeast
Job Number: Oceano



Maximum Depth = 14.25 meters

Depth Increment = 0.050 meters

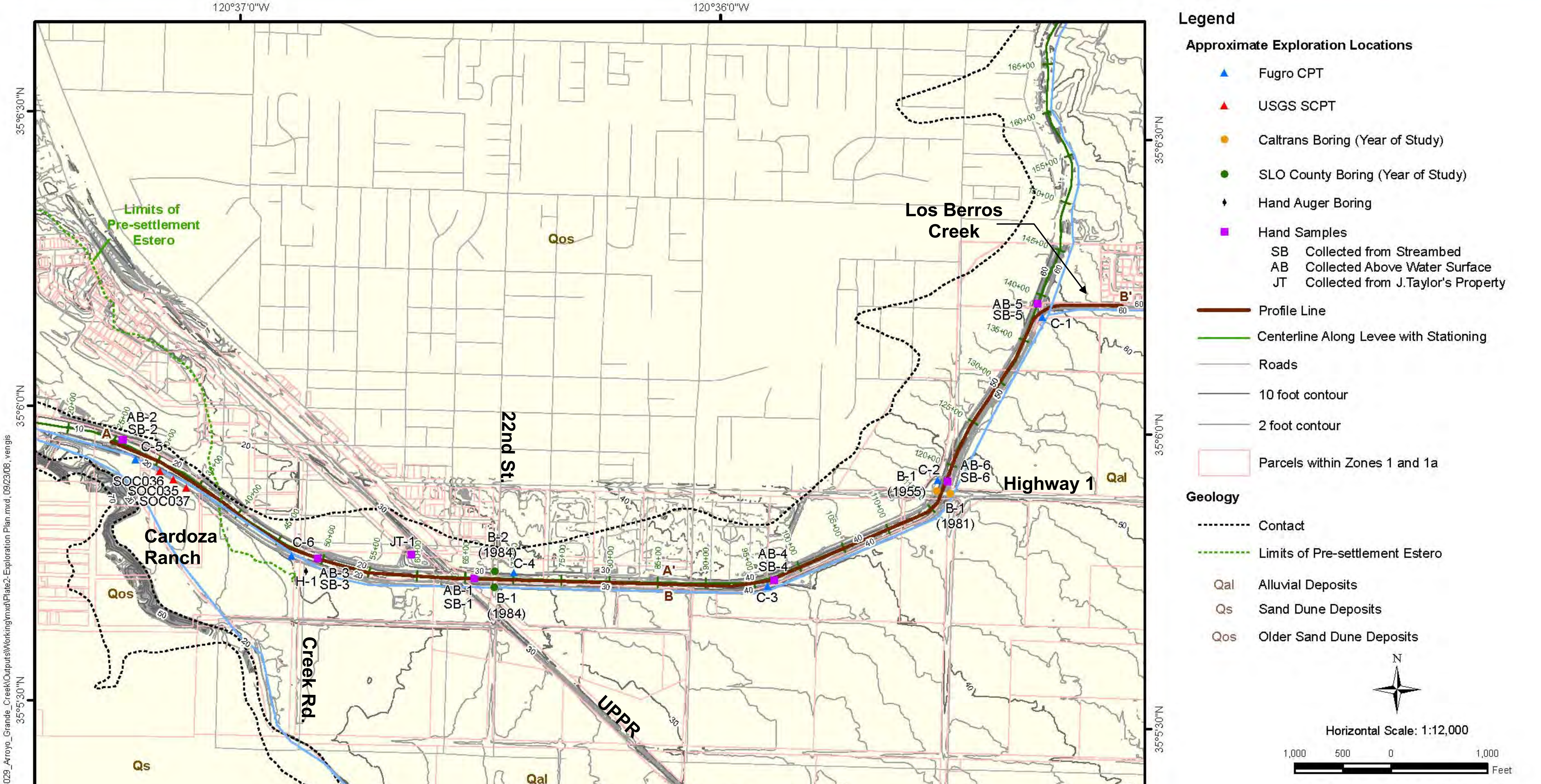
■ 1 sensitive fine grained
■ 2 organic material
■ 3 clay

■ 4 silty clay to clay
■ 5 clayey silt to silty clay
■ 6 sandy silt to clayey silt

■ 7 silty sand to sandy silt
■ 8 sand to silty sand
■ 9 sand

■ 10 gravelly sand to sand
■ 11 very stiff fine grained (*)
■ 12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

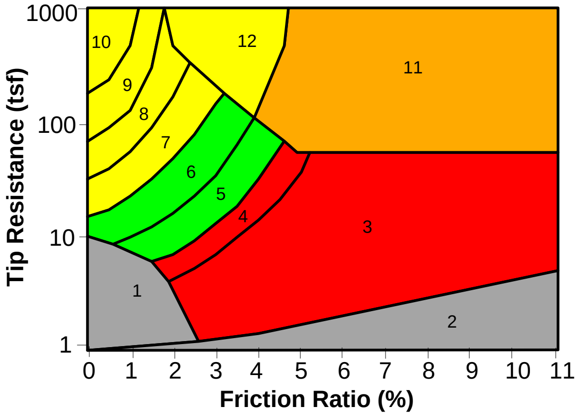


FIELD EXPLORATION PLAN
Arroyo Grande Creek
Waterways Management Plan
San Luis Obispo County, California

PLATE 2

N:\Projects\3014_SLOcounty\3014-029_Arroyo_Grande_Creek\Outputs\Working\mxd\Plate2-Exploration Plan.mxd, 09/23/08, vengis

COLOR LEGEND FOR FRICTION RATIO TRACES



Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

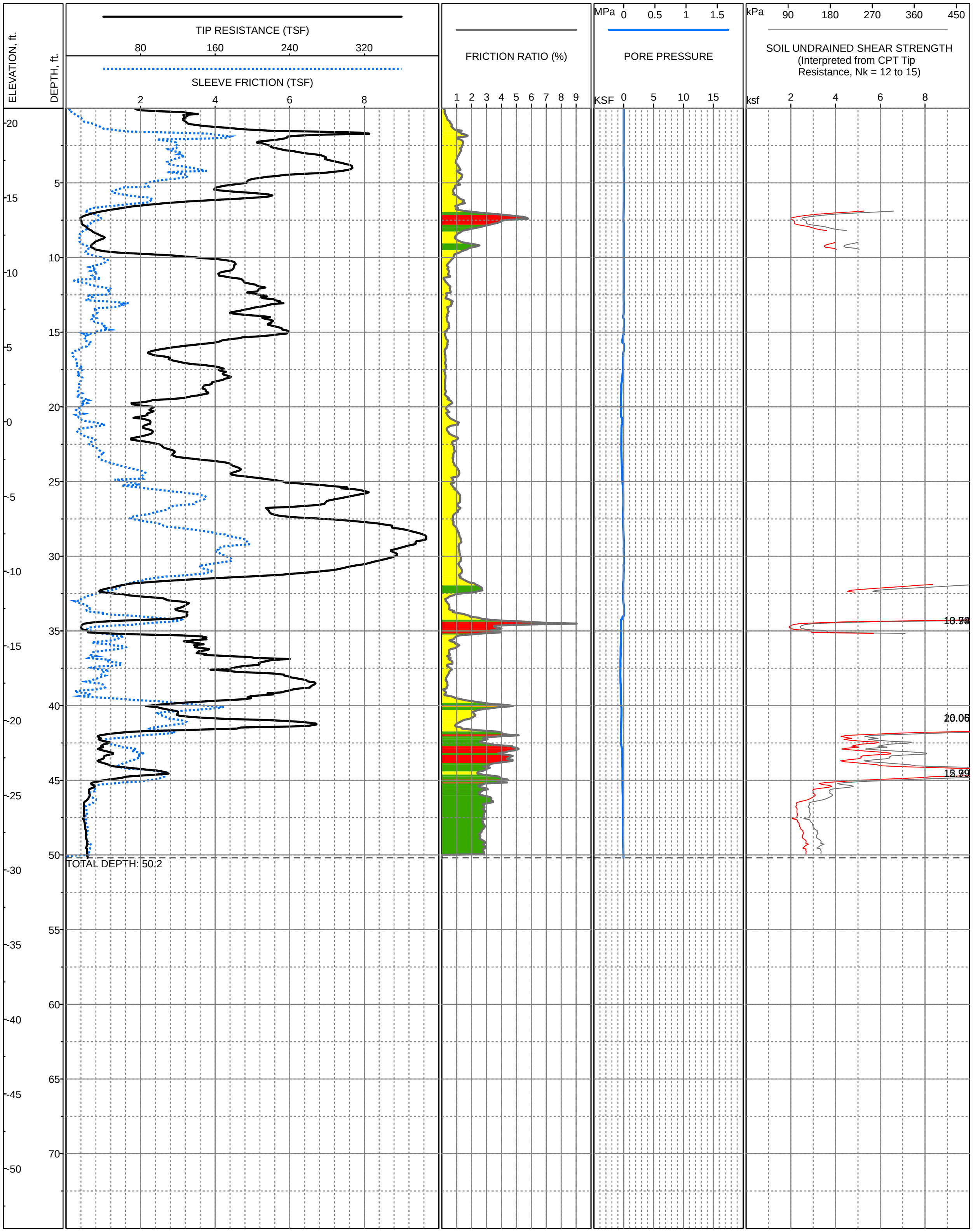
CPT CORRELATION CHART
(Robertson and Campanella, 1984)

N:\Projects\3014_SLOcounty\3014-029_Arroyo_Grande_Creek\Explorations\CPT\2008\Logs\Logs_Su_2008_08_13\MXD\PlateA-3_CPTKey.mxd, 08/29/08, ksheil

KEY TO CPT LOGS

Arroyo Grande Creek Waterways Management Plan
San Luis Obispo, California

PLATE A-3



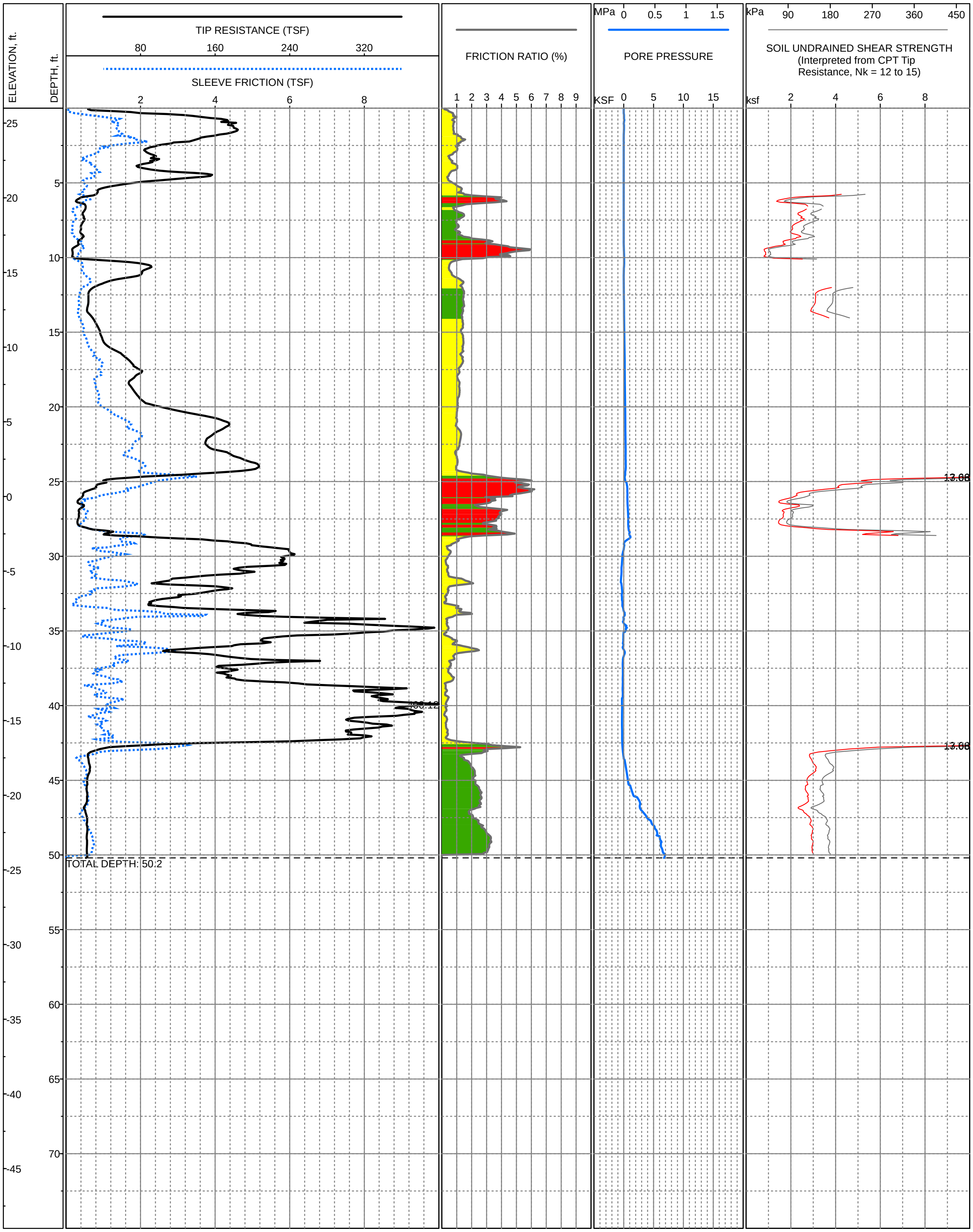
COORDINATES: 2,232,390.00N 5,778,074.64W
SURFACE EL: 21.0ft +/- (MSL)
COMPLETION DEPTH: 50.2ft
TESTDATE: 7/22/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Fugro Geosciences
REVIEWED BY: J.Blanchard

LOG OF C-5

Arroyo Grande Creek Waterways Management Plan
San Luis Obispo, California

N:\Projects\3014_SLOcounty\3014-029_Arroyo_Grande_Creek\Explorations\CPT\2008\Logs\Logs_Su_2008_08_13\MXD\CPTLog_Su.mxd,08/29/2008,ksheil



COORDINATES: 2,231,397.63N 5,779,691.56W
SURFACE EL: 26.0ft +/- (MSL)
COMPLETION DEPTH: 50.2ft
TESTDATE: 7/22/2008

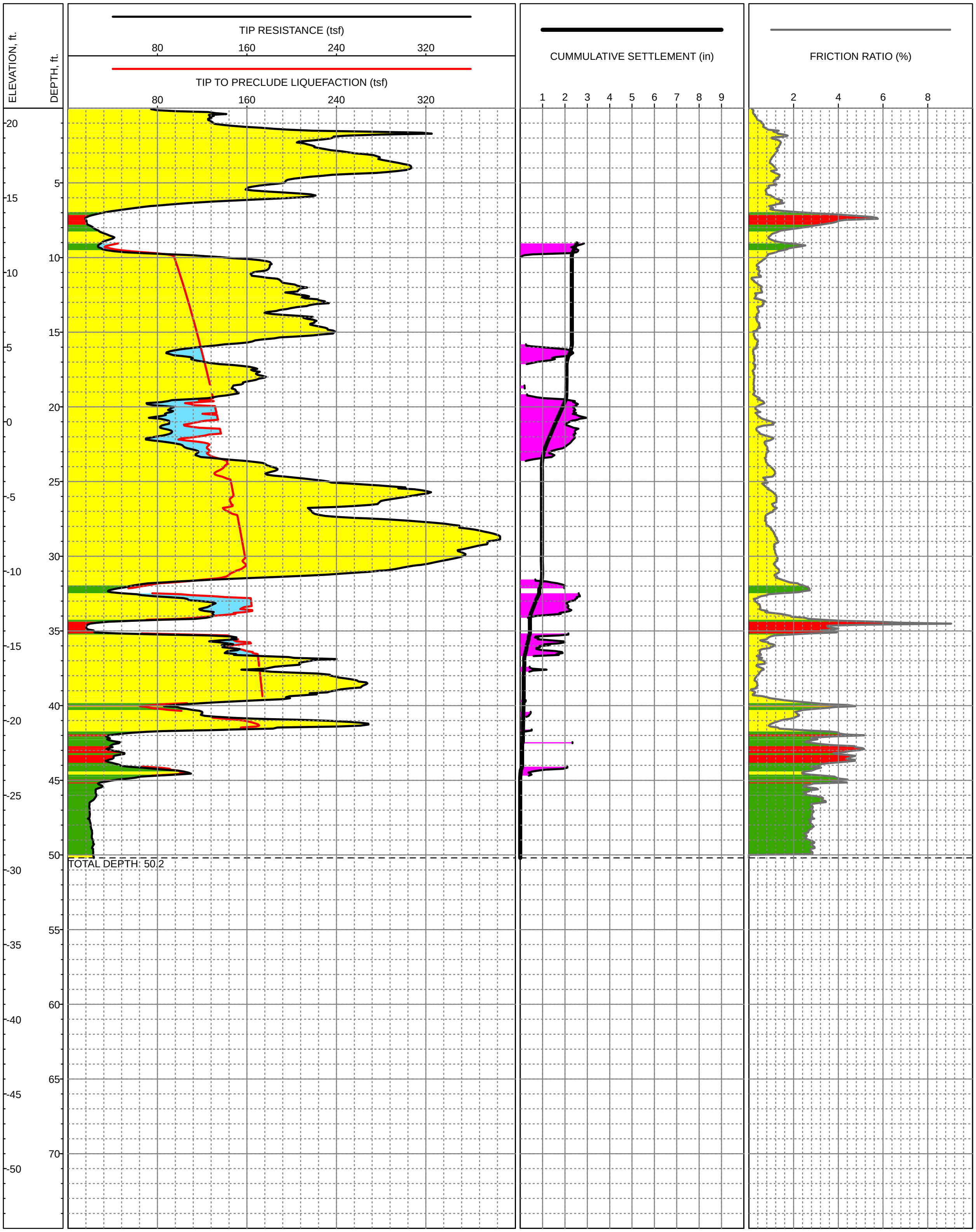
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Fugro Geosciences
REVIEWED BY: J.Blanchard

LOG OF C-6

Arroyo Grande Creek Waterways Management Plan
San Luis Obispo, California

N:\Projects\3014_SLOcounty\3014-029_Arroyo_Grande_Creek\Explorations\CPT\2008\Logs\Logs_Su_2008_08_13\MXD\CPTLog_Su.mxd,08/29/2008,ksheil

PLATE A-9



COORDINATES: 2,232,390.00N 5,778,074.64W
SURFACE EL: 21.0ft +/- (MSL)
COMPLETION DEPTH: 50.2ft
TESTDATE: 7/22/2008

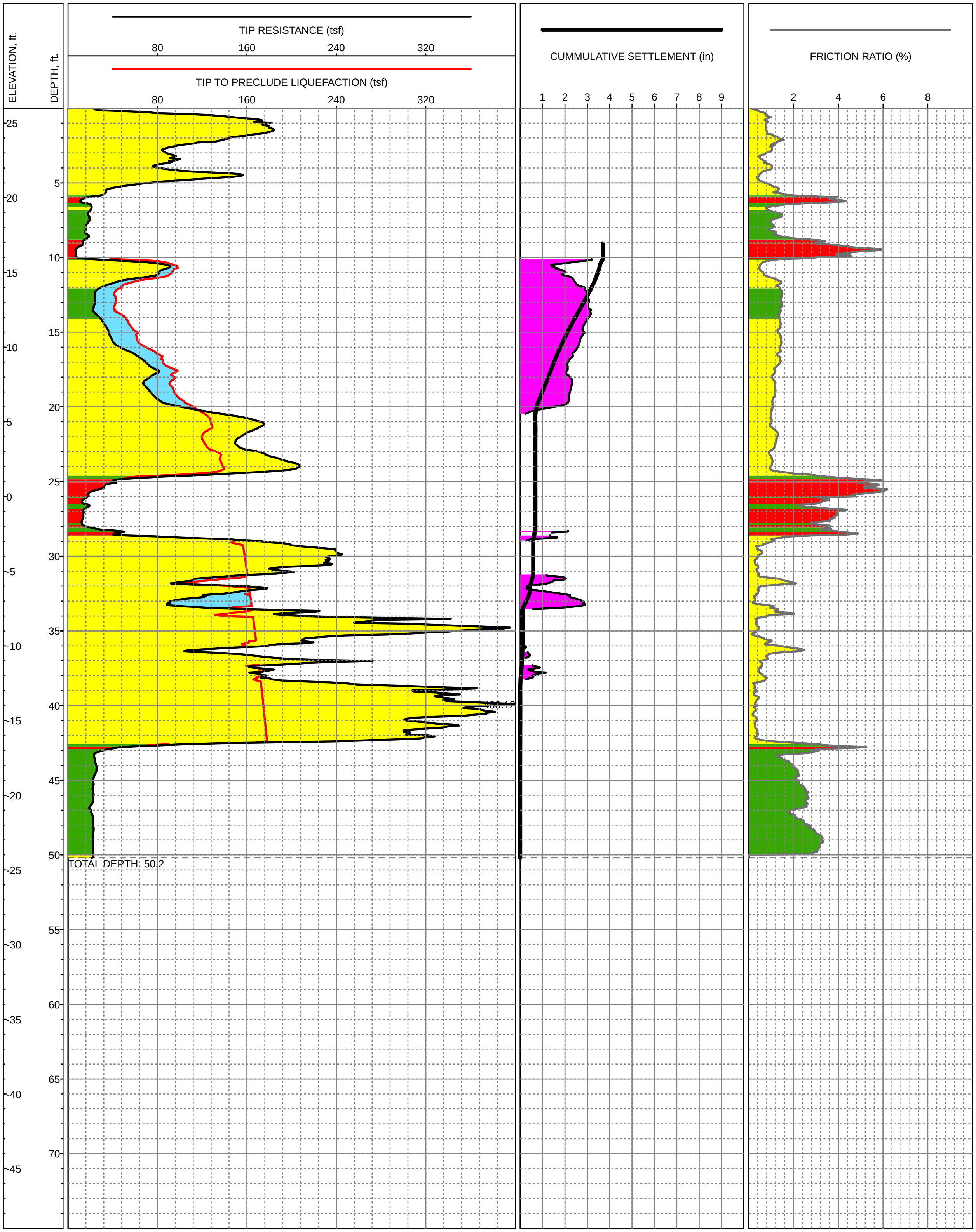
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Fugro Geosciences
REVIEWED BY: J Blanchard

LOG OF CPT C-5, M7.0, a=0.46

Arroyo Grande Creek Waterways Management Plan
San Luis Obispo County, California

N:\Projects\3014_SLOcounty\3014-029_Arroyo_Grande_Creek\Explorations\CPT\2008\Logs\Logs_Liq_2008_July\MXD\CPTLogs_Liq.mxd,08/29/2008,ksheil

PLATE C-6



COORDINATES: 2,231,397.63N 5,779,691.56W
SURFACE EL: 26.0ft +/- (MSL)
COMPLETION DEPTH: 50.2ft
TESTDATE: 7/22/2008

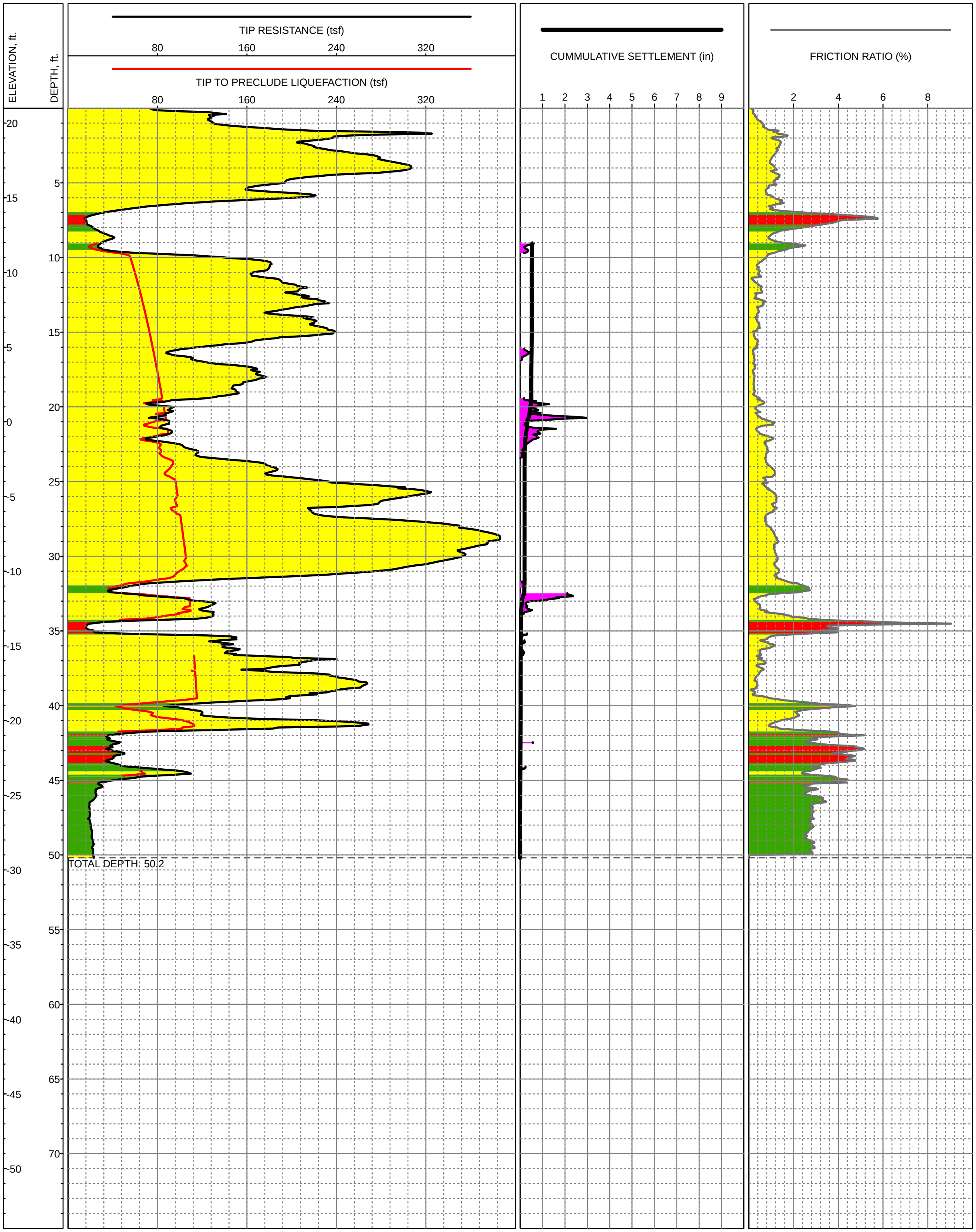
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Fugro Geosciences
REVIEWED BY: J Blanchard

LOG OF CPT C-6, M7.0, a=0.46

Arroyo Grande Creek Waterways Management Plan
San Luis Obispo County, California

PLATE C-7

N:\Projects\3014_SLOcounty\3014-029_Arroyo_Grande_Creek\Explorations\CPT\2008\Logs\Logs_Liq_2008_July\MXD\CPTLogs_Liq.mxd,08/29/2008,ksheil

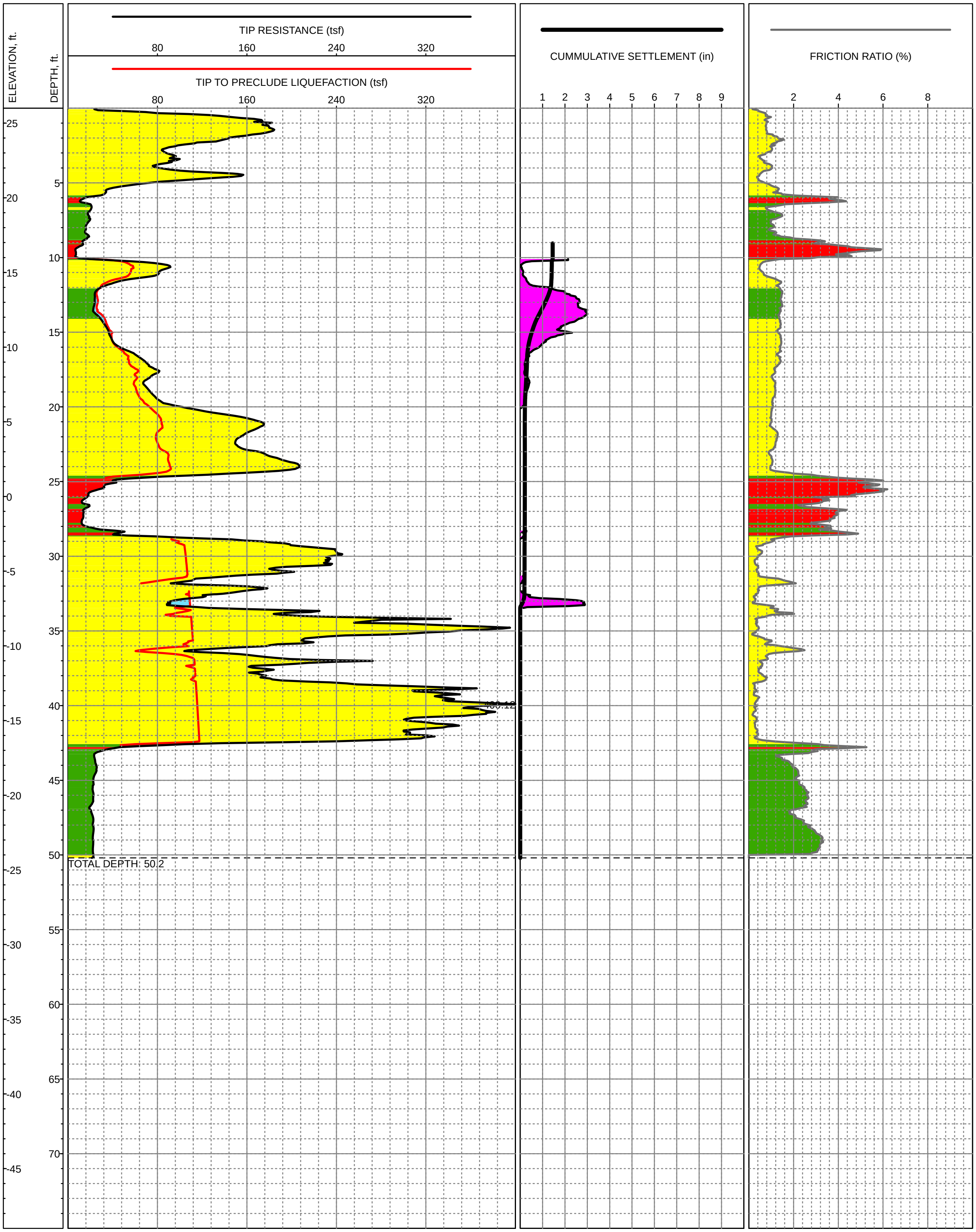


COORDINATES: 2,232,390.00N 5,778,074.64W
SURFACE EL: 21.0ft +/- (MSL)
COMPLETION DEPTH: 50.2ft
TESTDATE: 7/22/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Fugro Geosciences
REVIEWED BY: J Blanchard

LOG OF CPT C-5, M6.5, a=0.25

Arroyo Grande Creek Waterways Management Plan
San Luis Obispo County, California



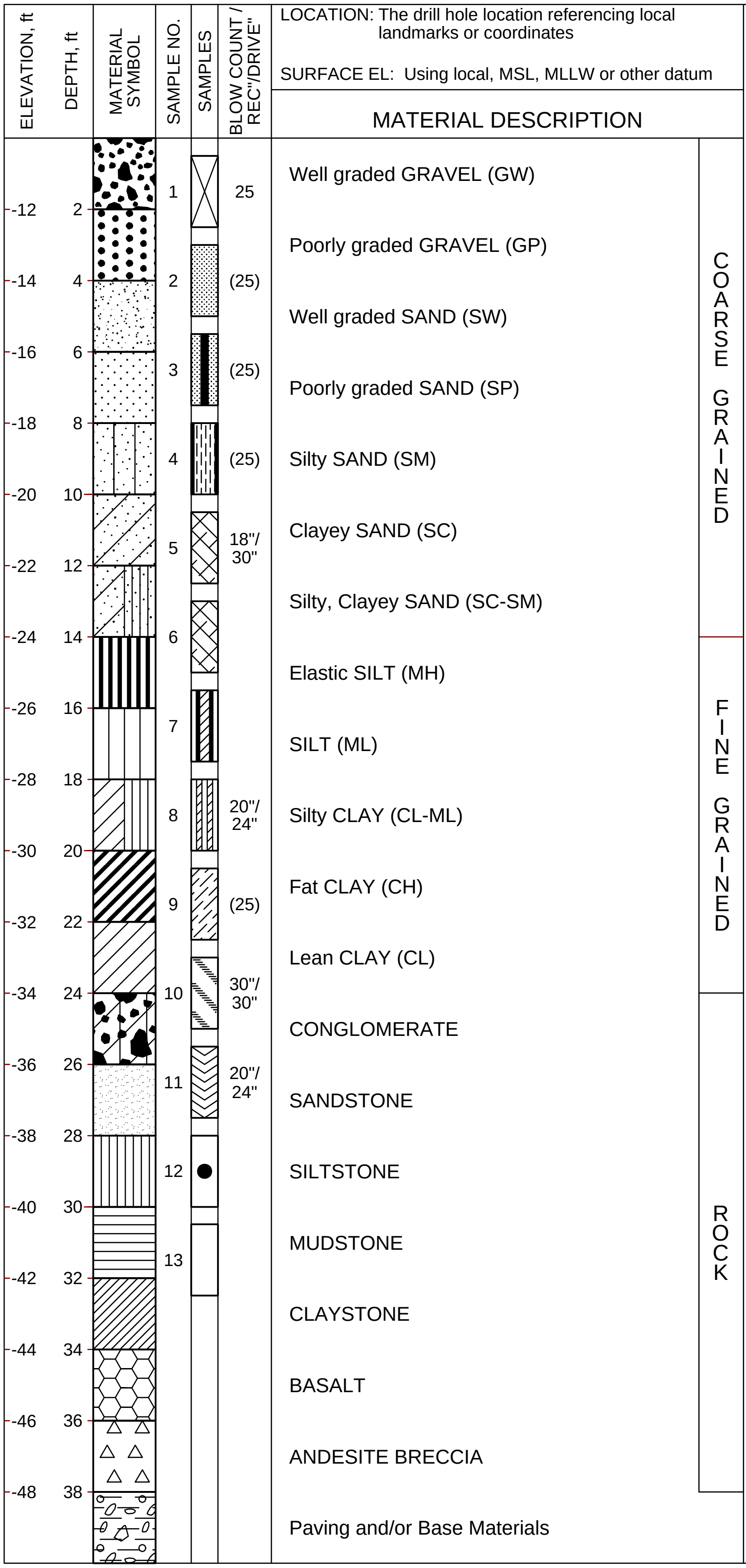
COORDINATES: 2,231,397.63N 5,779,691.56W
SURFACE EL: 26.0ft +/- (MSL)
COMPLETION DEPTH: 50.2ft
TESTDATE: 7/22/2008

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Fugro Geosciences
REVIEWED BY: J Blanchard

LOG OF CPT C-6, M6.5, a=0.25

Arroyo Grande Creek Waterways Management Plan
San Luis Obispo County, California

N:\Projects\3014_SLOcounty\3014-029_Arroyo_Grande_Creek\Explorations\CPT\2008\Logs\Logs_Liq_2008_July\MXD\CPTLogs_Liq.mxd,08/29/2008,ksheil



LOCATION: The drill hole location referencing local landmarks or coordinates

SURFACE EL: Using local, MSL, MLLW or other datum

ELEVATION, ft	DEPTH, ft
-12	2
-14	4
-16	6
-18	8
-20	10
-22	12
-24	14
-26	16
-28	18
-30	20
-32	22
-34	24
-36	26
-38	28
-40	30
-42	32
-44	34
-46	36
-48	38

SAMPLE NO.	BLOW COUNT / REC"/DRIVE"
1	25
2	(25)
3	(25)
4	(25)
5	18"/ 30"
6	
7	
8	20"/ 24"
9	(25)
10	30"/ 30"
11	20"/ 24"
12	
13	

MATERIAL DESCRIPTION	
Well graded GRAVEL (GW)	COARSE GRAINED
Poorly graded GRAVEL (GP)	
Well graded SAND (SW)	
Poorly graded SAND (SP)	
Silty SAND (SM)	
Clayey SAND (SC)	
Silty, Clayey SAND (SC-SM)	
Elastic SILT (MH)	FINE GRAINED
SILT (ML)	
Silty CLAY (CL-ML)	
Fat CLAY (CH)	
Lean CLAY (CL)	
CONGLOMERATE	ROCK
SANDSTONE	
SILTSTONE	
MUDSTONE	
CLAYSTONE	
BASALT	
ANDESITE BRECCIA	
Paving and/or Base Materials	

General Notes

Soil Texture Symbol

Sloped line in symbol column indicates transitional boundary

Samplers and sampler dimensions (unless otherwise noted in report text) are as follows:

Symbol for:

1	SPT Sampler, driven 1-3/8" ID, 2" OD
2	CA Liner Sampler, driven 2-3/8" ID, 3" OD
3	CA Liner Sampler, disturbed 2-3/8" ID, 3" OD
4	Thin-walled Tube, pushed 2-7/8" ID, 3" OD
5	Bulk Bag Sample (from cuttings)
6	CA Liner Sampler, Bagged
7	Hand Auger Sample
8	CME Core Sample
9	Pitcher Sample
10	Lexan Sample
11	Vibracore Sample
12	No Sample Recovered
13	Sonic Soil Core Sample

Sampler Driving Resistance

Number of blows with 140 lb. hammer, falling 30" to drive sampler 1 ft. after seating sampler 6"; for example,

Blows/ft	Description
25	25 blows drove sampler 12" after initial 6" of seating
86/11"	After driving sampler the initial 6" of seating, 36 blows drove sampler through the second 6" interval, and 50 blows drove the sampler 5" into the third interval
50/6"	50 blows drove sampler 6" after initial 6" of seating
Ref/3"	50 blows drove sampler 3" during initial 6" seating interval

Blow counts for California Liner Sampler shown in ( )

Length of sample symbol approximates recovery length

Classification of Soils per ASTM D2487 or D2488

Geologic Formation noted in bold font at the top of interpreted interval

Strength Legend

Q = Unconfined Compression
u = Unconsolidated Undrained Triaxial
t = Torvane
p = Pocket Penetrometer
m = Miniature Vane

Water Level Symbols

▽ Initial or perched water level
▼ Final ground water level
∿ Seepages encountered

Rock Quality Designation (RQD) is the sum of recovered core pieces greater than 4 inches divided by the length of the cored interval.

KEY TO TERMS & SYMBOLS USED ON LOGS

PLATE A-1

LOCATION: North levee, Station 40+00

SURFACE EL: 24.9 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
						ARTIFICIAL FILL (af) Approximately 5" of base material							
24			A 1A		(35)	Silty SAND with gravel (SM): medium dense, brown, moist, angular gravel, pockets of fat CLAY (CH), gravel up to 2"							
	2		1B				107	98	9	14			
22			2		27								
	4												
20					(45)								
			3A 3B			Clayey SAND (SC): medium dense, dark brown, moist, angular gravel	123	104	18	42			
	6		4		33	Silty SAND with gravel (SM): medium dense, brown, moist							
18													
	8												
16			5A		(11)	**ALLUVIUM (Qal$_1$)** Poorly graded SAND with silt (SP-SM): loose, light brown to brown, moist, well-rounded gravel							
	10		5B				102	93	9	11			
14													
	12				▼								
12			B			**Qal$_3$** Sandy Lean CLAY (CL): brown, wet				66			
	14												
10			6A		(6)	**Qal$_2$** Silty SAND (SM): very loose, brown, wet							
	16		6B			- color change to dark gray at 16.2', fine to coarse sand							
8													
	18												
6													
	20		7A		(6)	Poorly graded SAND with silt (SP-SM): very loose, brown, wet							
4			7B				121	94	30	11			
	22												
2													
	24												
0			8		(4)	- driller notes flowing sands at 25'							
	26												
-2			C			**Qal$_4$** Fat CLAY (CH): hard, dark gray, wet							
	28												p 1.8
-4													
	30				(51)	**Qal$_2$** Clayey GRAVEL with sand (GC): dense, brown to dark gray matrix, wet, abundant oxidation staining							
-6			9A 9B										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 31.5 ft
DEPTH TO WATER: 12.0 ft
BACKFILLED WITH: 2 Sack Slurry
DRILLING DATE: January 12, 2012

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: S/G Drilling Company
LOGGED BY: G Eckrich
CHECKED BY: J Blanchard

LOG OF BORING NO. B-2

Arroyo Grande Creek Levee Seepage Evaluation
San Luis Obispo County, California

PLATE A-3

LOCATION: North levee, Station 23+30

SURFACE EL: 22.5 ft +/- (rel. NAVD88 datum)

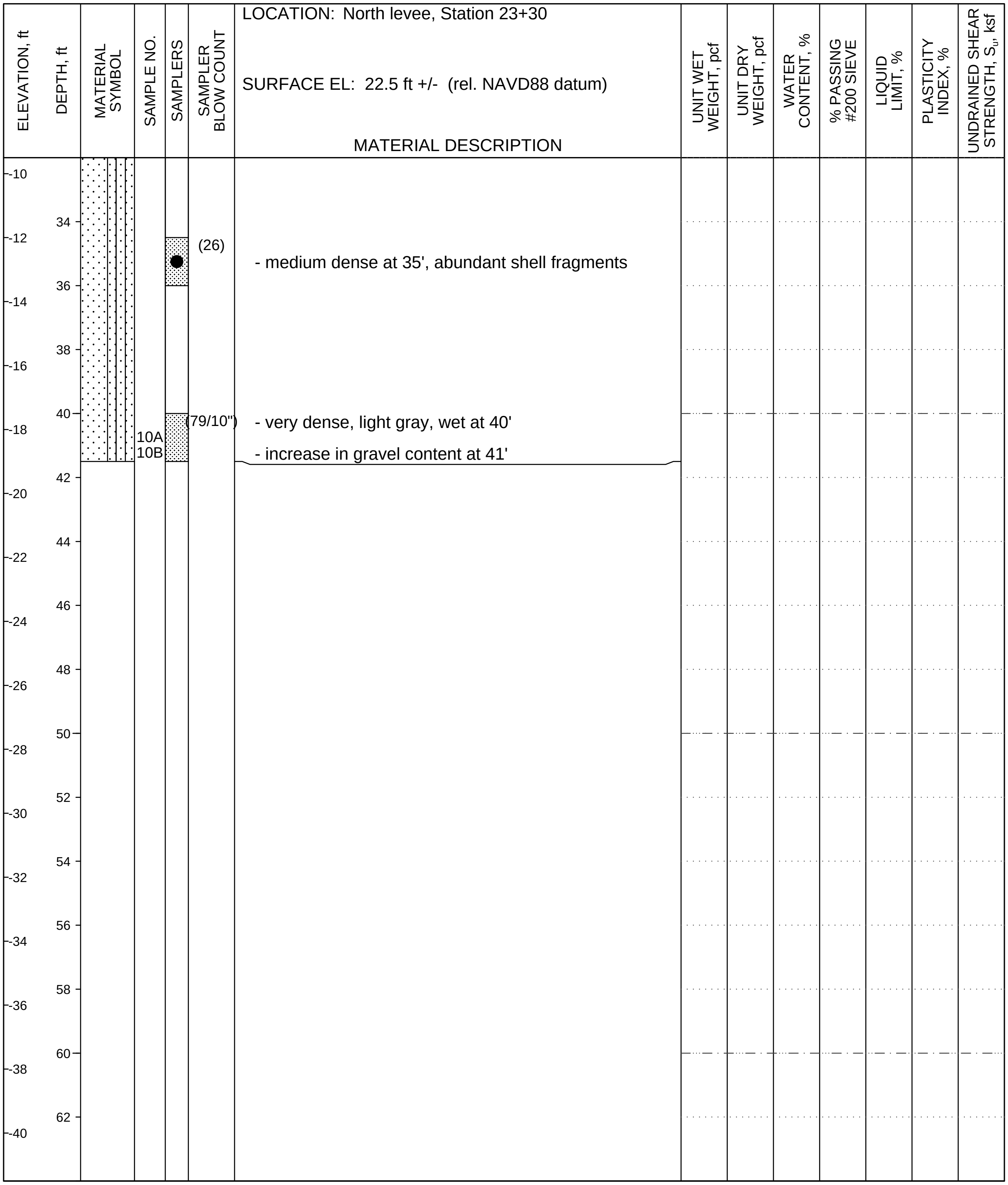
ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
22													
			A 1		(46)	**ARTIFICIAL FILL (af)** Poorly graded SAND with silt and gravel (SP-SM): dense, brown, moist, gravel up to approximately 2"	107	94	13	7			
	2												
20													
			2		22	- medium dense at 3'							
	4												
18													
			3		(39)		108	98	11	19			
	6												
			4A		17								
16													
			4B			**ALLUVIUM (Qal_3)** Sandy SILT (ML): very stiff, brown, moist				49			
	8												
14													
			5A		(7)	**Qal_2** Silty SAND (SM): loose, brown, moist, roots and rootlets, pockets of silty clay							
			5B				106	92	16	26			
	10												
12													
	12												
10													
					▼								
	14												
8													
			6A 6B		(17)	- medium dense, light yellowish brown to light yellow, wet, well-rounded gravel at 15' - approximately 1" thick layer of lean CLAY (CL) at 15.8'	111	82	36	12			
	16												
6													
	18												
4													
	20												
			7		(18)	Poorly graded SAND with gravel (SP): medium dense, light brown to light yellowish brown, wet, well-rounded gravel	124	105	18	2			
2													
	22												
0													
	24												
-2													
			8A 8B		(40)	Silty SAND (SM): medium dense, dark gray, wet							
	26												
-4													
	28												
-6													
	30												
-8			9A 9B		(64)	Poorly graded SAND with silt (SP-SM): dense, dark gray, wet	128	103	24	10			

COMPLETION DEPTH: 41.5 ft
DEPTH TO WATER: 13.0 ft
BACKFILLED WITH: 2 Sack Slurry
DRILLING DATE: January 12, 2012

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: S/G Drilling Company
LOGGED BY: G Eckrich
CHECKED BY: J Blanchard

LOG OF BORING NO. B-3
Arroyo Grande Creek Levee Seepage Evaluation
San Luis Obispo County, California

PLATE A-4a



LOCATION: North levee, Station 23+30

SURFACE EL: 22.5 ft +/- (rel. NAVD88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-12	35			●	(26)	- medium dense at 35', abundant shell fragments							
-18	40		10A 10B		(79/10")	- very dense, light gray, wet at 40' - increase in gravel content at 41'							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 41.5 ft
DEPTH TO WATER: 13.0 ft
BACKFILLED WITH: 2 Sack Slurry
DRILLING DATE: January 12, 2012

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: S/G Drilling Company
LOGGED BY: G Eckrich
CHECKED BY: J Blanchard

LOG OF BORING NO. B-3

Arroyo Grande Creek Levee Seepage Evaluation
San Luis Obispo County, California

PLATE A-4b

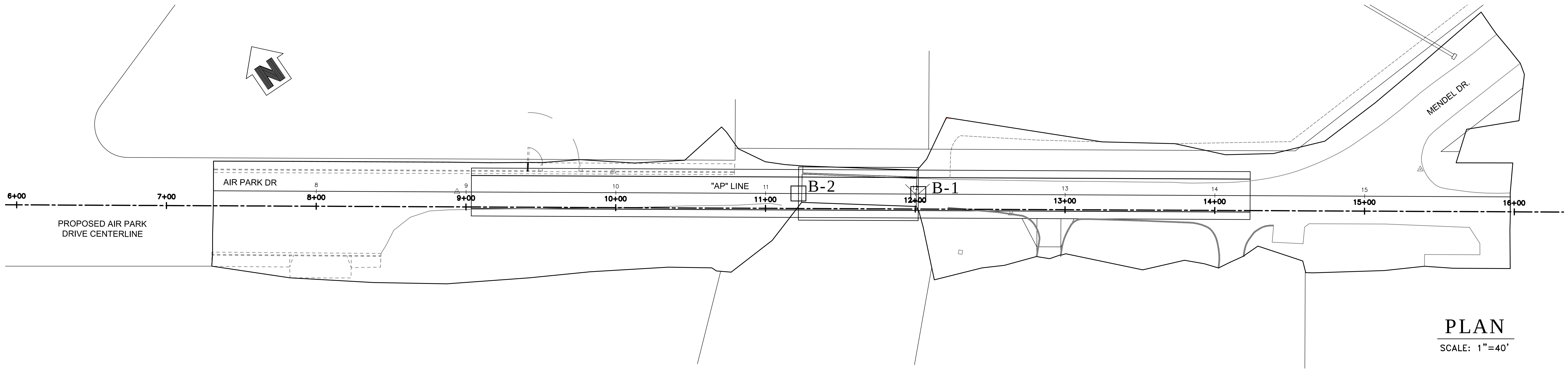
DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
X	X	X			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

DAVE PEARSON
No. 674
Exp. 12/31/13
GEOTECHNICAL

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

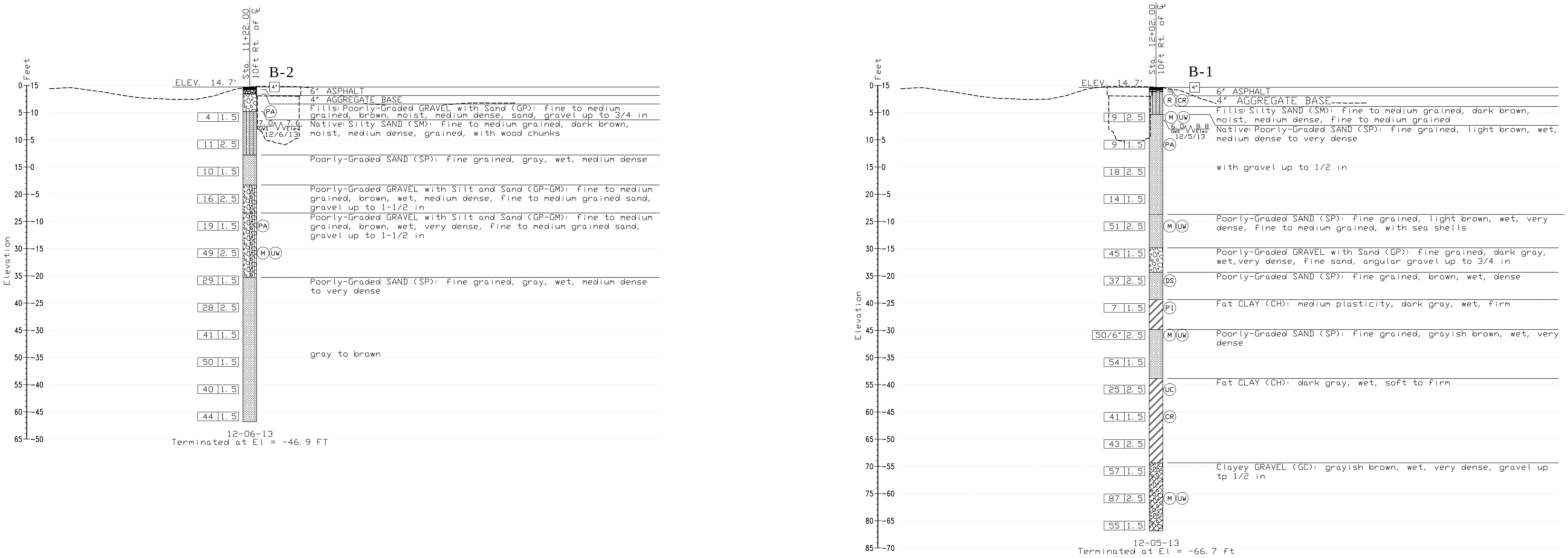


PLAN

SCALE: 1"=40'

NOTES:

1. TBM BB OF EXISTING BRIDGE, ELEVATION 100.0 FEET.
2. GROUNDWATER ENCOUNTERED AT DEPTHS INDICATED.
3. 1.5-INCH DIAMETER SAMPLES WERE TAKEN USING A STANDARD PENETRATION TEST (SPT) SPLIT BARREL SAMPLER WITH AN INSIDE DIAMETER (ID) OF 1.5 INCHES AND AN OUTSIDE DIAMETER (OD) OF 2.0 INCHES.
4. 2.5-INCH DIAMETER RING SAMPLES WERE TAKEN USING A CALIFORNIA SPLIT BARREL SAMPLER WITH AN ID OF 2.5 INCHES AND AN OD OF 3.0 INCHES.
5. ALL DRIVE SAMPLES WERE DRIVEN WITH 140 LB HAMMER WITH A FALLING HEIGHT OF 30 INCHES, WHICH WAS CALIBRATED AT 92% EFFICIENCY.



B-2

Sta. 11+22.00
10ft Rt. of ℄

ELEV. 14.7'

4	1.5
11	2.5
10	1.5
16	2.5
19	1.5
49	2.5
29	1.5
28	2.5
41	1.5
50	1.5
40	1.5
44	1.5

7.0 GWS 7.6 Elev 12/6/13

6" ASPHALT

4" AGGREGATE BASE

Fills: Poorly-Graded GRAVEL with Sand (GP): fine to medium grained, brown, moist, medium dense, sand, gravel up to 3/4 in

Native: Silty SAND (SM): fine to medium grained, dark brown, moist, medium dense, grained, with wood chunks

Poorly-Graded SAND (SP): fine grained, gray, wet, medium dense

Poorly-Graded GRAVEL with Silt and Sand (GP-GM): fine to medium grained, brown, wet, medium dense, fine to medium grained sand, gravel up to 1-1/2 in

Poorly-Graded GRAVEL with Silt and Sand (GP-GM): fine to medium grained, brown, wet, very dense, fine to medium grained sand, gravel up to 1-1/2 in

Poorly-Graded SAND (SP): fine grained, gray, wet, medium dense to very dense

gray to brown

12-06-13
Terminated at El = -46.9 FT

B-1

Sta. 12+02.00
10ft Rt. of ℄

ELEV. 14.7'

9	2.5
9	1.5
18	2.5
14	1.5
51	2.5
45	1.5
37	2.5
7	1.5
50/6"	2.5
54	1.5
25	2.5
41	1.5
43	2.5
57	1.5
87	2.5
55	1.5

6.0 GWS 8.8 Elev 12/5/13

6" ASPHALT

4" AGGREGATE BASE

Fills: Silty SAND (SM): fine to medium grained, dark brown, moist, medium dense, fine to medium grained

Native: Poorly-Graded SAND (SP): fine grained, light brown, wet, medium dense to very dense

with gravel up to 1/2 in

Poorly-Graded SAND (SP): fine grained, light brown, wet, very dense, fine to medium grained, with sea shells

Poorly-Graded GRAVEL with Sand (GP): fine grained, dark gray, wet, very dense, fine sand, angular gravel up to 3/4 in

Poorly-Graded SAND (SP): fine grained, brown, wet, dense

Fat CLAY (CH): medium plasticity, dark gray, wet, firm

Poorly-Graded SAND (SP): fine grained, grayish brown, wet, very dense

Fat CLAY (CH): dark gray, wet, soft to firm

Clayey GRAVEL (GC): grayish brown, wet, very dense, gravel up tp 1/2 in

12-05-13
Terminated at El = -66.7 ft

PROFILE

SCALE: 1"=10' VERT.

PLOTTED: 07 Mar 2014, 2:57pm, MGriffin

CAD FILE: C:\CADD\2014\137686\AirParkDrive-BL_3-2014\ LAYOUT: 2

ATTACHED IMAGES: Images: td_Markups_pl2_LOTB_3-7-14_2.jpg
ATTACHED XREFS:
LONG BEACH, CA

KLEINFELDER
Bright People. Right Solutions.
620 West 16th Street, Unit F
Long Beach, CA 90813
PH. 562.432.1696 FAX. 562.432.1796
www.kleinfelder.com

PROJECT NO.	137686
DRAWN:	01/2014
DRAWN BY:	MRG
CHECKED BY:	NP
137686p2_LOTB.dwg	

LOG OF TEST BORINGS

AIR PARK DRIVE BRIDGE
COUNTY OF SAN LUIS OBISPO
OCEANO BEACH LAGOON, OCEANO, CALIFORNIA

PLATE
1

GROUP SYMBOLS AND NAMES

Graphic / Symbol	Group Names	Graphic / Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY elastic ELASTIC SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTS

C	Consolidation (ASTM D 2435-04)
CL	Collapse Potential (ASTM D 5333-03)
CP	Compaction Curve (ASTM D1557)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301 - 00)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression - Soil (ASTM D 2166-06) Unconfined Compression - Rock (ASTM D 2938-95)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])
-200	200 Wash (ASTM D1140-14)

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT) (2" O.D.)
- Standard California Sampler (2.5" O.D.)
- Modified California Sampler (3" O.D.)
- Shelby Tube
- Piston Sampler
- Rock Core
- Grab Sample
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- ▽ First Water Level Reading (during drilling)
- ▼ Static Water Level Reading (short-term)
- ▼ Static Water Level Reading (long-term)

Yeh and Associates, Inc.
Consulting Engineers & Scientists

REPORT TITLE
BORING RECORD LEGEND

PROJECT NAME
SSLOCSD - Redundancy Project

DATE
9/25/2018

SHEET
1 of 1

LOGGED BY **J. King**	BEGIN DATE **5/31/16**	COMPLETION DATE **5/31/16**	HAMMER TYPE **140-lb Automatic Trip**
FINAL BY **J. Cravens**			BOREHOLE LOCATION (Lat/Long or North/East and Datum) **--**
DRILLING METHOD **8" Hollow-Stem Auger/Mud Rotary**			BOREHOLE LOCATION (Offset, Station, Line) **--**
DRILLER **S/G Drilling Company**			LOCATION DESCRIPTION **Gravel area on S edge of proposed secondary clarifier, 20' NW of SD pump station**
DRILL RIG **CME 75**			GROUNDWATER READINGS — DURING DRILLING **5.5 ft** — AFTER DRILLING (DATE) **3.9 ft on 8-7-18**

BORING NUMBER	**16E-01**
SURFACE ELEVATION	**9.0 ft**
WEATHER NOTES	**Cloudy**
BACKFILLED WITH	**Monitoring Well**
TOTAL DEPTH OF BORING	**60.0 ft**

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Well Description	Remarks
	0	CLAYEY SAND with GRAVEL (SC); medium dense; brown; moist; (ARTIFICIAL FILL).										
	1		1	6 6 14	20	89		15	94	PP =3.0		CR (pH = 8.97, r = 2,008 ohm-cm)
7	2										Bentonite Chips	
	3											▼
5	4	CLAYEY SAND (SC); loose; gray; moist; trace organic fibers; (ALLUVIUM).										
	5		2	1 5 3	8	89		34	88	PP =4.25		▽
3	6											
	7	Lean CLAY (CL); soft; gray; moist to wet; with shell fragments and fine GRAVEL.	A									CR (pH = 8.39, r = 817 ohm-cm, Chlorides = 117 mg/kg, Sulfates = 122 mg/kg)
1	8											
	9	Poorly graded SAND with CLAY (SP-SC); loose; gray; wet; fine SAND.	3	1 3 2	5	78		28				-200 (0% G, 92% S, 8% F)
-1	10											
	11											
-3	12											
	13											
-5	14	Poorly graded SAND (SP); grayish brown; wet; trace fine GRAVEL and shell layers to 3-inches thick.	4			89		27		PP =0.5		-200 (0% G, 98% S, 2% F)
	15										Cemex, #2/12 Sand	
-7	16											
	17										2-7/16" O.D. PVC Pipe 2" I.D., Slotted 0.01"	
-9	18											
	19	Medium dense; gray; trace CLAY.	5	6 10 9	19	56						
-11	20											
	21										2" PVC Cap	
-13	22											
	23											
-15	24		6	11 22 27	49	78		25	100			CU
	25											
-17	26											
	27											
-19	28	Poorly graded SAND with GRAVEL (SP); medium dense; gray; wet; abundant shell fragments, 0.25" to 1" in dimension.										
	29		7	6 9 6	15							
	30											

(continued)

Yeh and Associates, Inc.
Consulting Engineers & Scientists

PROJECT NAME	**SSLOCSD - Redundancy Project**
PROJECT NUMBER	**216-193**
BORING NUMBER	**16E-01**
REVISION DATE	**9/25/2018**
SHEET	**1 of 2**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Drilling Method	Well Diagram	Well Description	Remarks
	30		Poorly graded SAND with GRAVEL (SP) *(continued)*.													
	31															
-23	32															
	33															
-25	34		Well-graded GRAVEL (GW); medium dense; gray; wet; sub-rounded.		8	5 10 16	26									Possible slough due to plugged hole at 33.0'
	35															Switched to 8-inch HSA
-27	36															
	37															
-29	38															
	39															
-31	40															
	41															
-33	42		Fat CLAY (CH); stiff; gray; very moist; mottled with dark gray and dark brown.		9			96		43	77	TV =0.75 tsf				C
	43															
-35	44															
	45		Trace shell fragments.		10			92		47	75	TV =0.75 tsf PP =2.0				-200 (0% G, 1% S, 99% F) PI (76 LL, 32 PL, 44 PI)
-37	46															
	47															
-39	48															
	49				11	4 7 8	15	100				TV =0.75 tsf				
-41	50															
	51															
-43	52															
	53															
-45	54				12			92				TV =0.8 tsf				
	55															
-47	56															
	57															
-49	58															
	59		SILTY SAND (SM); loose; dark grayish brown; very moist; trace fine, rounded GRAVEL and organic root clasts/charcoal fragments.		13	2 3 5	8	78								
-51	60															
	61		Bottom of borehole at 60.0 ft bgs													
-53	62															
	63		This Boring Record was developed in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010) except as noted on the Soil or Rock Legend or below.													
-55	64															
	65															
	66															

Yeh and Associates, Inc.
Consulting Engineers & Scientists

PROJECT NAME
SSLOCSD - Redundancy Project
PROJECT NUMBER
216-193
BORING NUMBER
16E-01
REVISION DATE
9/25/2018
SHEET
2 of 2

LOGGED BY **S. Boone**
BEGIN DATE **6-1-16**
COMPLETION DATE **6-1-16**
HAMMER TYPE **140-lb Automatic Trip**
BORING NUMBER **16E-02**
FINAL BY **J. Cravens**
BOREHOLE LOCATION (Lat/Long or North/East and Datum) **°/°**
SURFACE ELEVATION **10.0 ft**
DRILLING METHOD **8" Hollow-Stem Auger**
BOREHOLE LOCATION (Offset, Station, Line) **--**
WEATHER NOTES **Overcast**
DRILLER **S/G Drilling Company**
LOCATION DESCRIPTION **Turf area between proposed aeration basin and clarifier, 47' NW of primary clarifier no. 2**
BACKFILLED WITH **Bentonite Grout**
DRILL RIG **CME 75**
GROUNDWATER READINGS DURING DRILLING **6.1 ft** AFTER DRILLING (DATE)
TOTAL DEPTH OF BORING **71.5 ft**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Drilling Method	Casing Depth	Remarks
	0		CLAYEY SAND (SC); medium dense; brown; moist; little angular GRAVEL to 1"; (ARTIFICIAL FILL).												
	1				B 14	4 7 11	18			15	116				-200 (11% G, 57% S, 32% F) PI (31 LL, 22 PL, 9 PI) CP (UW = 117 pcf, W = 12.5%) DS
8	2														
	3		CLAYEY SAND (SC); dark brown; moist; (ALLUVIUM).												
6	4														
	5		Poorly graded SAND (SP); medium dense; gray; wet; some angular GRAVEL to 1"; 1" to 2" layers of lean CLAY.		15	7 13 15	28			21	106				CR (pH = 8.50, r = 1,143 ohm-cm)
4	6														▽
	7														
2	8														
	9				16					37	82				
0	10														CU
	11														
-2	12														
	13														
-4	14														
	15		CLAYEY SAND (SC); loose; gray; wet; trace shell fragments to 0.25".		17	0 2 2	4	56		28					PA (3% G, 85% S, 12% F)
-6	16														
	17														
-8	18														
	19														
-10	20		Poorly graded SAND (SP); loose; gray; wet.		18	4 8 7	15	56		22	104				
	21														
-12	22														
	23														
-14	24														
	25		Poorly graded SAND with CLAY (SP-SC); loose; grayish brown; wet; with shell fragments to 0.75".		19	2 2 4	6			30					-200 (1% G, 90% S, 9% F)
-16	26														
	27														
-18	28														
	29														
	30														

(continued)

Yeh and Associates, Inc.
Consulting Engineers & Scientists

PROJECT NAME **SSLOCSD - Redundancy Project**
PROJECT NUMBER **216-193**
BORING NUMBER **16E-02**
REVISION DATE **9/25/2018**
SHEET **1 of 3**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Drilling Method	Casing Depth	Remarks
	30		Medium dense. Poorly graded SAND with CLAY (SP-SC) *(continued)*.		20	3 10 12	22	78		24	100				
	31														
-22	32														
	33														
-24	34		Poorly graded SAND with CLAY and GRAVEL (SP-SC); medium dense; tan; wet; tan, orange, and green angular to subangular GRAVEL to 1".												
	35				21	4 12 30	42	44		24					PA (34% G, 56% S, 10% F)
-26	36														
	37														
-28	38														
	39		Poorly graded SAND (SP); dense; brown to gray; wet; trace CLAY.												
-30	40				22	12 27 42	69	100		27	97				
	41														
-32	42														
	43														
-34	44														
	45		Fat CLAY (CH); medium stiff; gray; wet.		23 A/B										No Recovery of Shelby tube @ 45'; SPT driven
-36	46														
	47														
-38	48														
	49														
-40	50				24			42							
	51														
-42	52														
	53														
-44	54														
	55		Trace shell fragments to 0.25".		25	2 3 4	7			43					-200 (0% G, 8% S, 92% F) PI (67 LL, 29 PL, 38 PI)
-46	56														
	57														
-48	58				26			83				0.35 tsfTV			
	59														
-50	60		Lean CLAY (CL); medium stiff; gray; wet; trace fine SAND.		27			83		37	83	0.25 tsfTV			C
	61														
-52	62														
	63														
-54	64														
	65				28			100				0.175 tsfTV			
	66														

(continued)

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PROJECT NAME
SSLOCSD - Redundancy Project
PROJECT NUMBER
216-193
BORING NUMBER
16E-02
REVISION DATE
9/25/2018
SHEET
2 of 3

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Drilling Method	Casing Depth	Remarks
	66		Lean CLAY (CL) *(continued)*.		28			100				0.175 tsfTV			
	67														
-58	68		Poorly graded SAND (SP); medium dense; gray; wet; fine to medium SAND; with trace shell fragments to 0.25".												
	69														
-60	70														
	71		Well-graded GRAVEL with SAND (GW); medium dense; wet; subangular to subrounded GRAVEL to 1".		29 A/B	4 9 21	30	100							
-62	72		Bottom of borehole at 71.5 ft bgs												
	73														
-64	74		This Boring Record was developed in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010) except as noted on the Soil or Rock Legend or below.												
	75														
-66	76														
	77														
-68	78														
	79														
-70	80														
	81														
-72	82														
	83														
-74	84														
	85														
-76	86														
	87														
-78	88														
	89														
-80	90														
	91														
-82	92														
	93														
-84	94														
	95														
-86	96														
	97														
-88	98														
	99														
-90	100														
	101														
	102														

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PROJECT NAME **SSLOCSD - Redundancy Project**	
PROJECT NUMBER **216-193**	
BORING NUMBER **16E-02**	
REVISION DATE **9/25/2018**	SHEET **3 of 3**

LOGGED BY **S. Boone**	BEGIN DATE **6-2-16**	COMPLETION DATE **6-2-16**	HAMMER TYPE **140-lb Automatic Trip**
FINAL BY **J. Cravens**			BOREHOLE LOCATION (Lat/Long or North/East and Datum) **°/°**
DRILLING METHOD **8" Hollow-Stem Auger**			BOREHOLE LOCATION (Offset, Station, Line) **--**
DRILLER **S/G Drilling Company**			LOCATION DESCRIPTION **Turf area at N end of proposed aeration basin, 225' N of primary clarifier no. 2**
DRILL RIG **CME 75**			GROUNDWATER READINGS DURING DRILLING **4.0 ft** AFTER DRILLING (DATE)

BORING NUMBER **16E-03**
SURFACE ELEVATION **9.0 ft**
WEATHER NOTES **Overcast**
BACKFILLED WITH **Bentonite Grout**
TOTAL DEPTH OF BORING **81.5 ft**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Drilling Method	Casing Depth	Remarks
	0		CLAYEY SAND (SC); loose; gray; moist; trace angular GRAVEL to 1"; (ARTIFICIAL FILL).												
	1				30 C	3 6 9	15	89		25	97				PA (4% G, 65% S, 31% F) PI (28 LL, 20 PL, 8 PI) R (51) -200 (4% G, 68 % S, 28% F)
7	2														
	3														
5	4														∇
	5		Poorly graded SAND with CLAY (SP-SC); loose; gray; wet; interbedded CLAY beds to 2" thick; with organics (roots, decomposing vegetation); (ALLUVIUM).		31	2 7 6	13	100		29	91				DS
3	6														
	7														
1	8														
	9				32	0 1 1	2	89		36	84				CU
-1	10														
	11														
-3	12		CLAYEY SAND with GRAVEL (SC); very loose; gray; wet.		33			33		25					-200 (16% G, 64% S, 20% F) CR (pH = 8.09, r = 1,507 ohm-cm)
	13														
-5	14														
	15		Poorly graded SAND with GRAVEL (SP); loose; tan and green with red and black particles; wet; coarse SAND, fine GRAVEL to 1".		34	1 3 4	7	33		24					-200 (40% G, 56% S, 4% F)
-7	16														
	17														
-9	18														
	19														
-11	20		Lean CLAY (CL); medium stiff; gray; wet.		35	4 7 11	18	89							
	21		CLAYEY SAND (SC); medium dense; dark gray; wet; with shell fragments.												
-13	22				36					37	86				-200 (6% G, 81% S, 13% F)
	23														
-15	24														
	25		Poorly graded SAND (SP); medium dense; gray; wet.		37	7 16 23	39	78							
-17	26														
	27														
-19	28														
	29														
	30														

(continued)

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PROJECT NAME **SSLOCSD - Redundancy Project**
PROJECT NUMBER **216-193**
BORING NUMBER **16E-03**
REVISION DATE **9/25/2018**
SHEET **1 of 3**

5 BR - STANDARD 216-193 SSLOCSD BORING LOGS.GPJ CALIFORNIA YEH LIBRARY (FEB 2013).GLB 9/25/18

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Drilling Method	Casing Depth	Remarks
	30		Poorly graded SAND with CLAY and GRAVEL (SP-SC); dense; gray; wet; angular to subangular GRAVEL to 2".		38	8 23 39	62	89		24	107				-200 (17% G, 72% S, 10% F)
	31														
-23	32														
	33														
-25	34														
	35		Poorly graded SAND (SP); medium dense; grayish brown; wet.		39	7 11 19	30	100							
-27	36														
	37														
-29	38														
	39														
-31	40		Fine to very fine SAND.		40	9 17 24	41	100		25	100				
	41														
-33	42														
	43														
-35	44														
	45				41					30	90	0.35 tsfTV			
-37	46		Lean CLAY (CL); medium stiff; gray; wet.												
	47														
-39	48														
	49														
-41	50		Very stiff; trace shell fragments to 0.25".		42	4 9 10	19	89							
	51														
-43	52														
	53														
-45	54														
	55				43	2 4 4	8	100							
-47	56														
	57														
-49	58														
	59														
-51	60		Lean CLAY with SAND (CL); stiff; dark gray; wet.		44					33	87	0.5 tsfTV			PI (42 LL, 26 PL, 16 PI)
	61														
-53	62														
	63														
-55	64														
	65				45		22	100				0.6 tsfTV			
	66														

(continued)

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PROJECT NAME
SSLOCSD - Redundancy Project
PROJECT NUMBER
216-193
BORING NUMBER
16E-03
REVISION DATE
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SHEET
2 of 3

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (ksf)	Drilling Method	Casing Depth	Remarks
	66		Lean CLAY with SAND (CL) *(continued)*.			6 9 13									
	67														
-59	68														
	69														
-61	70		Lean CLAY (CL); medium stiff; dark gray; wet; trace fine SAND.		46	2 5 6	11	100							
	71														
-63	72														
	73														
-65	74														
	75				47	2 4 6	10	100							
-67	76														
	77														
-69	78														
	79														
-71	80		Well-graded SAND (SW); medium dense; gray with green and brown particles; wet; trace shell fragments to 0.125" and trace GRAVEL to 0.5".		48	4 12 20	32	78							
	81														
-73	82		Bottom of borehole at 81.5 ft bgs												
	83														
-75	84														
	85														
-77	86														
	87														
-79	88														
	89														
-81	90														
	91														
-83	92														
	93														
-85	94														
	95														
-87	96														
	97														
-89	98														
	99														
-91	100														
	101														
	102														

This Boring Record was developed in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010) except as noted on the Soil or Rock Legend or below.

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PROJECT NAME
SSLOCSD - Redundancy Project
PROJECT NUMBER
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BORING NUMBER
16E-03
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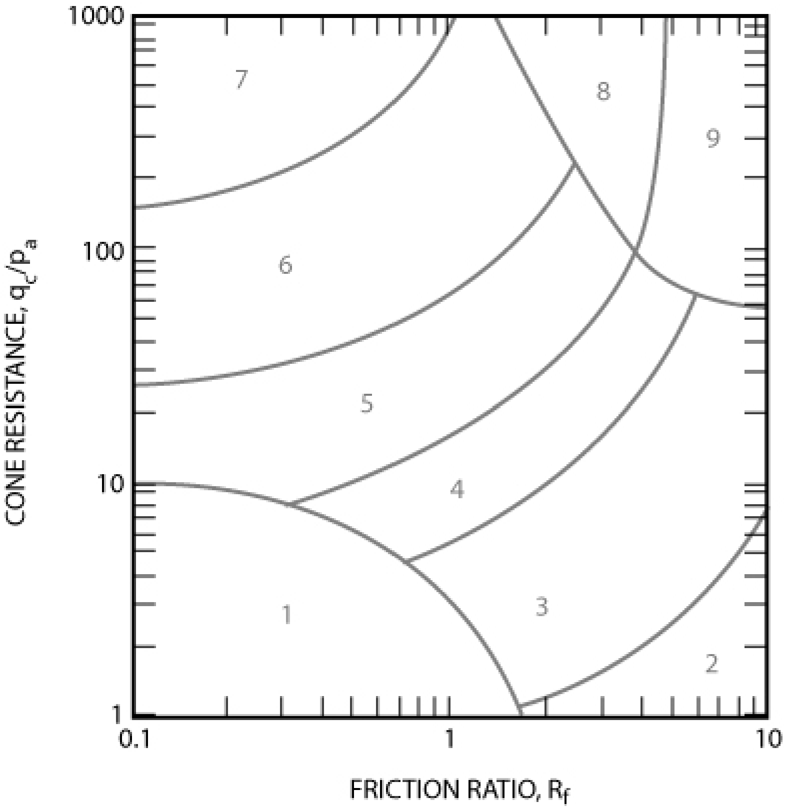

Zone	Soil Behavior Type	USCS
1	Sensitive, fine grained	OL-CH
2	Organic soils - clay	OL-OH, CH
3	Clay – silty clay to clay	CL-CH
4	Silt mixtures – clayey silt to silty clay	MH-CL
5	Sand mixtures – silty sand to sandy silt	SM-ML
6	Sands – clean sand to silty sand	SW-SP
7	Gravelly sand to dense sand	SW-GW
8	Very stiff sand to clayey sand*	SC-SM
9	Very stiff fine grained*	CH-CL

* Heavily overconsolidated or cemented

P_a = atmospheric pressure = 100 kPa = 1 tsf

Non-normalized CPT Soil Behavior Type (SBT) chart
(Robertson et al., 1986, updated by Robertson, 2010).

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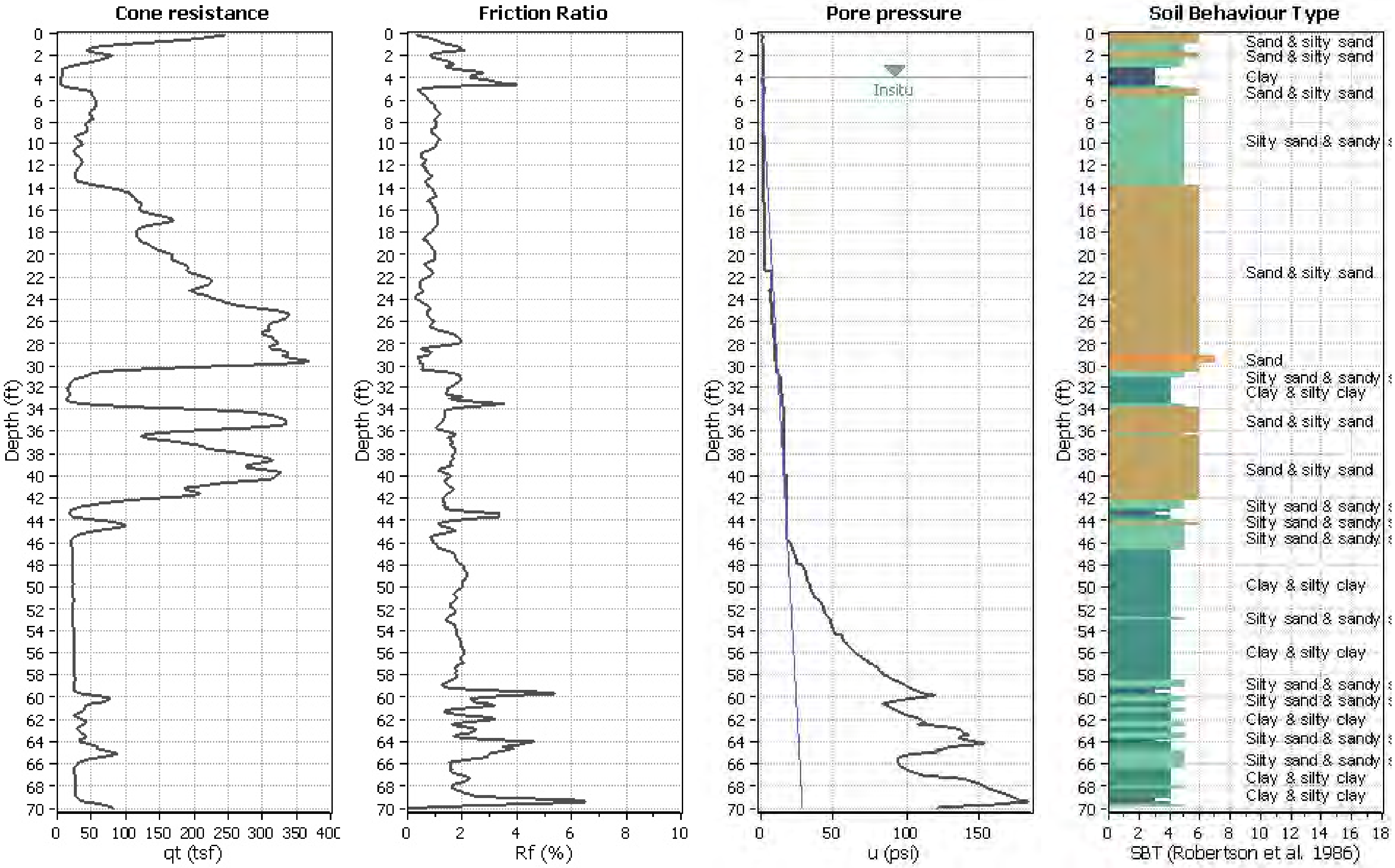
REPORT TITLE CPT SOIL BEHAVIOR CHART (SBT) LEGEND	
PROJECT NAME SSLOCSD - Redundancy Project	
DATE 9/25/2018	SHEET 1 of 1

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

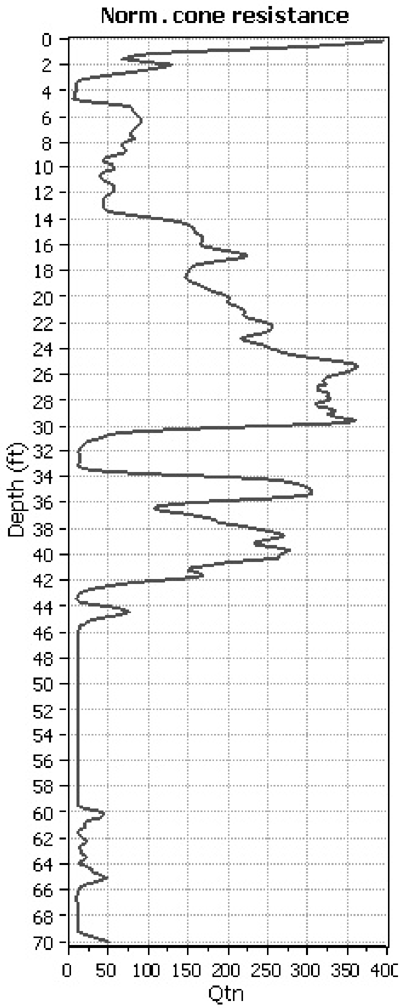
CPT: CPT-01
Total depth: 70.05 ft

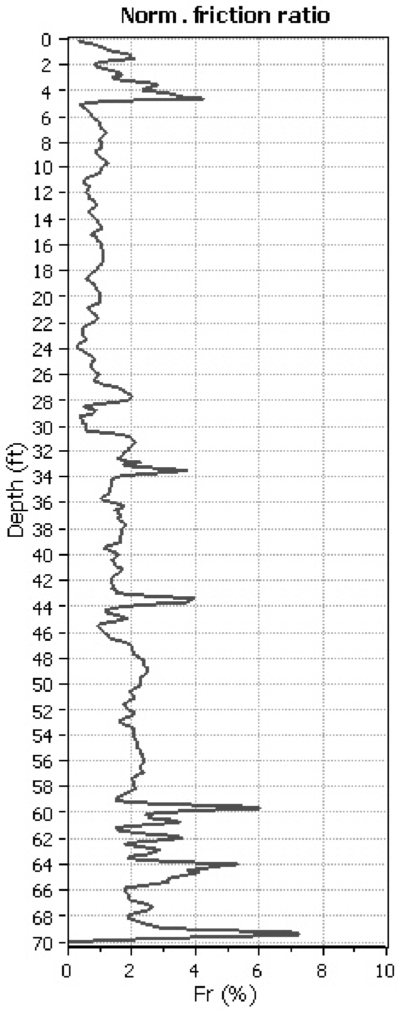


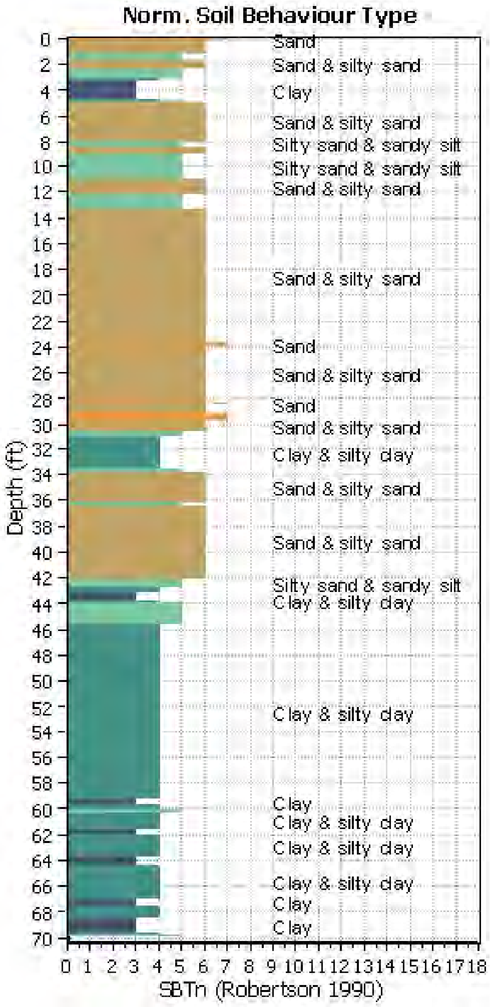
Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

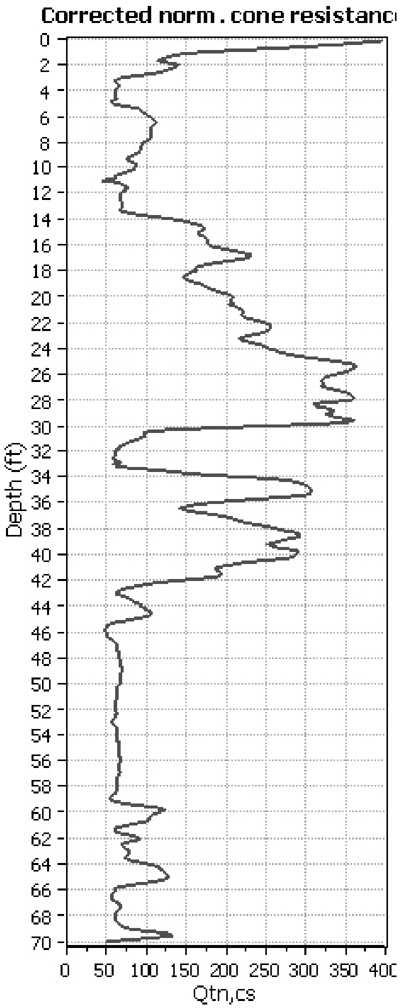
Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-01
Total depth: 70.05 ft









Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Yeh and Associates, Inc.
391 Front Street, Suite D
Grover Beach, CA 93433

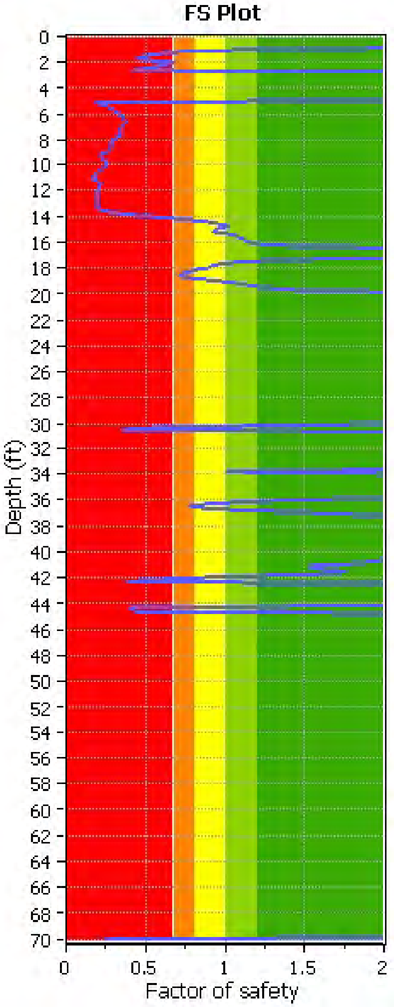
Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**

Location: **1600 Aloha Ave, Oceano, CA**

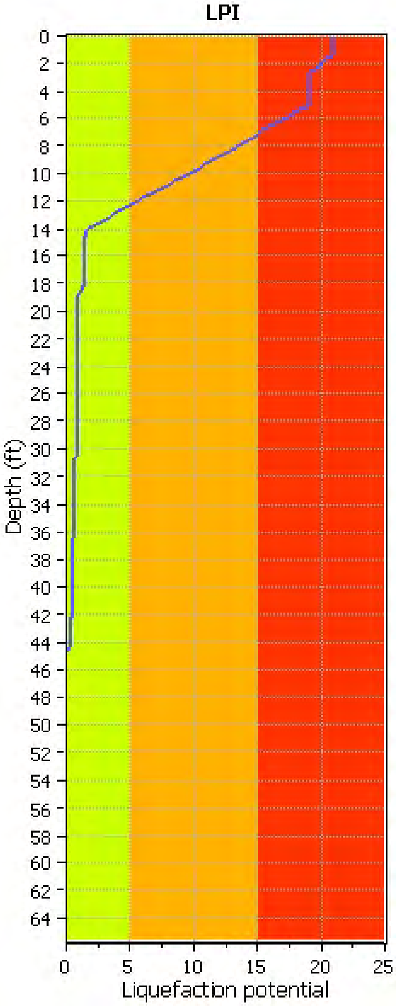
CPT: CPT-01

Total depth: 70.05 ft

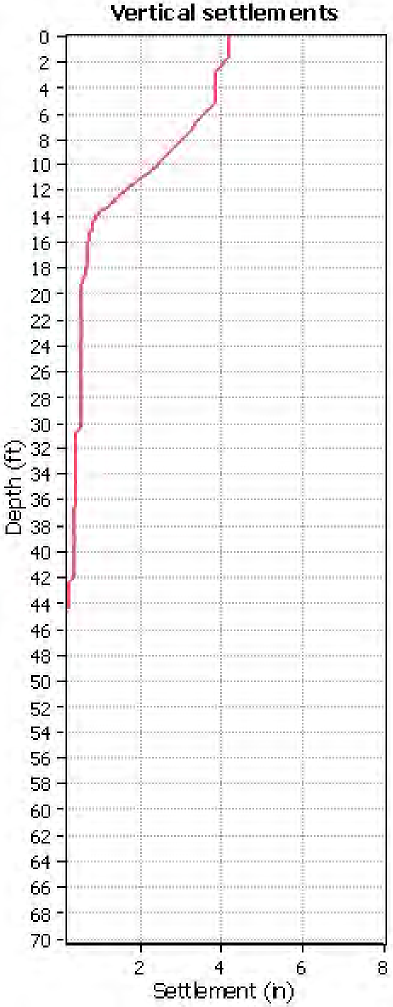
FS Plot



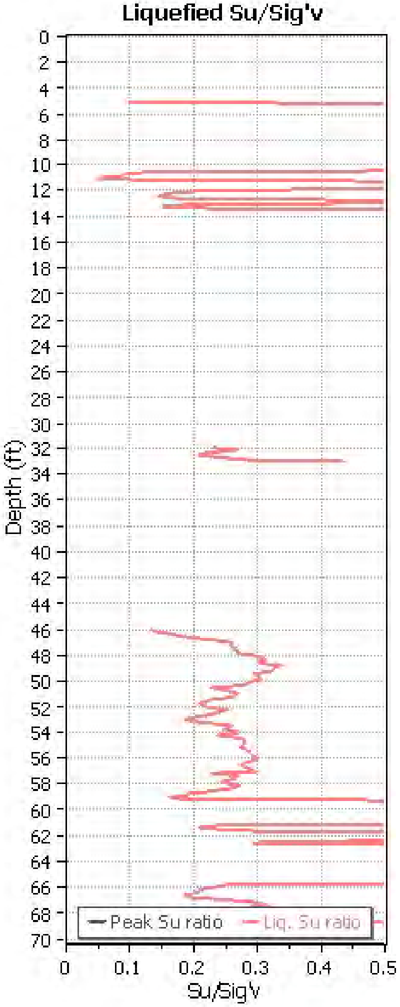
LPI



Vertical settlements



Liquefied Su/Sig'v



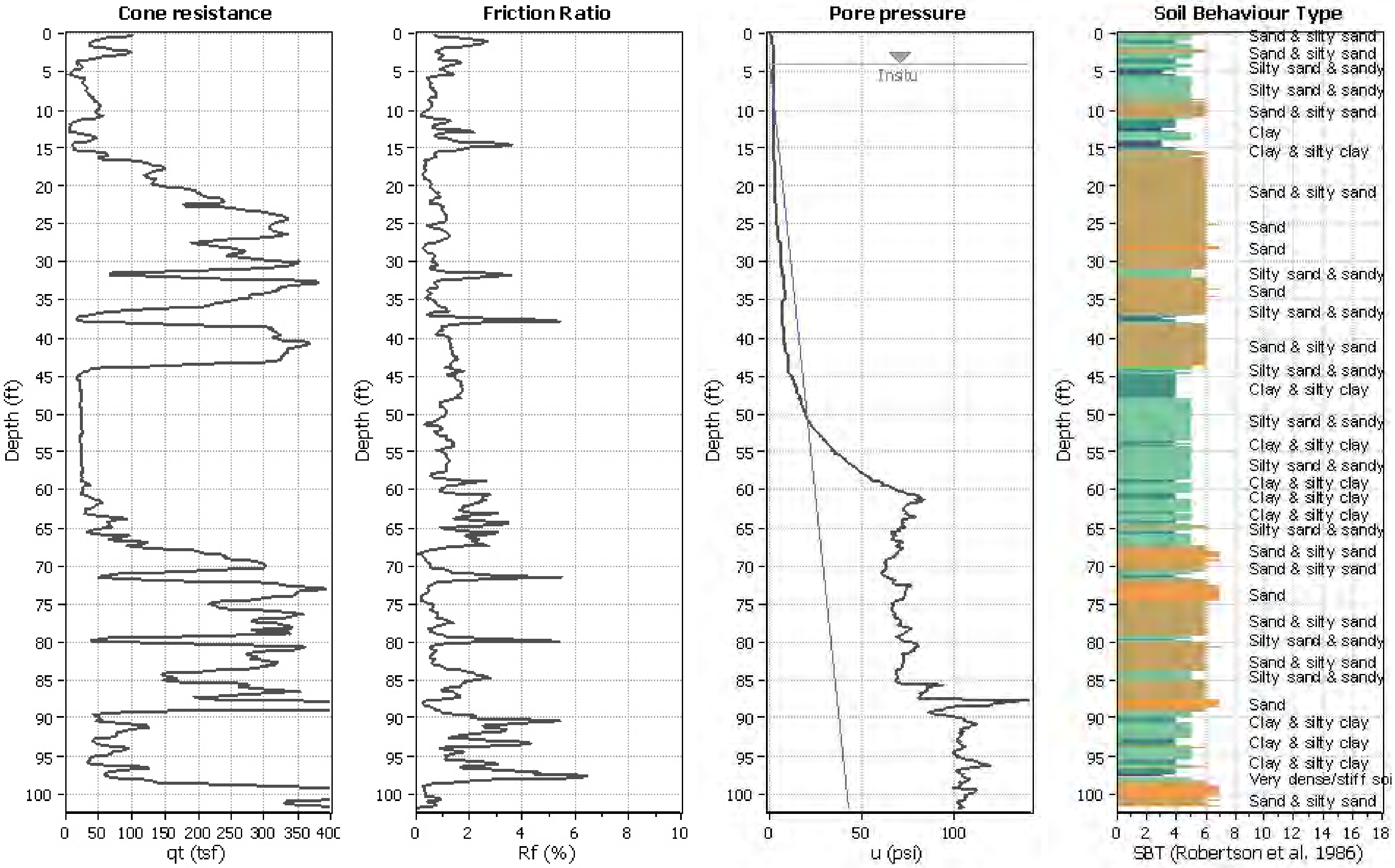
Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**

Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-02

Total depth: 101.87 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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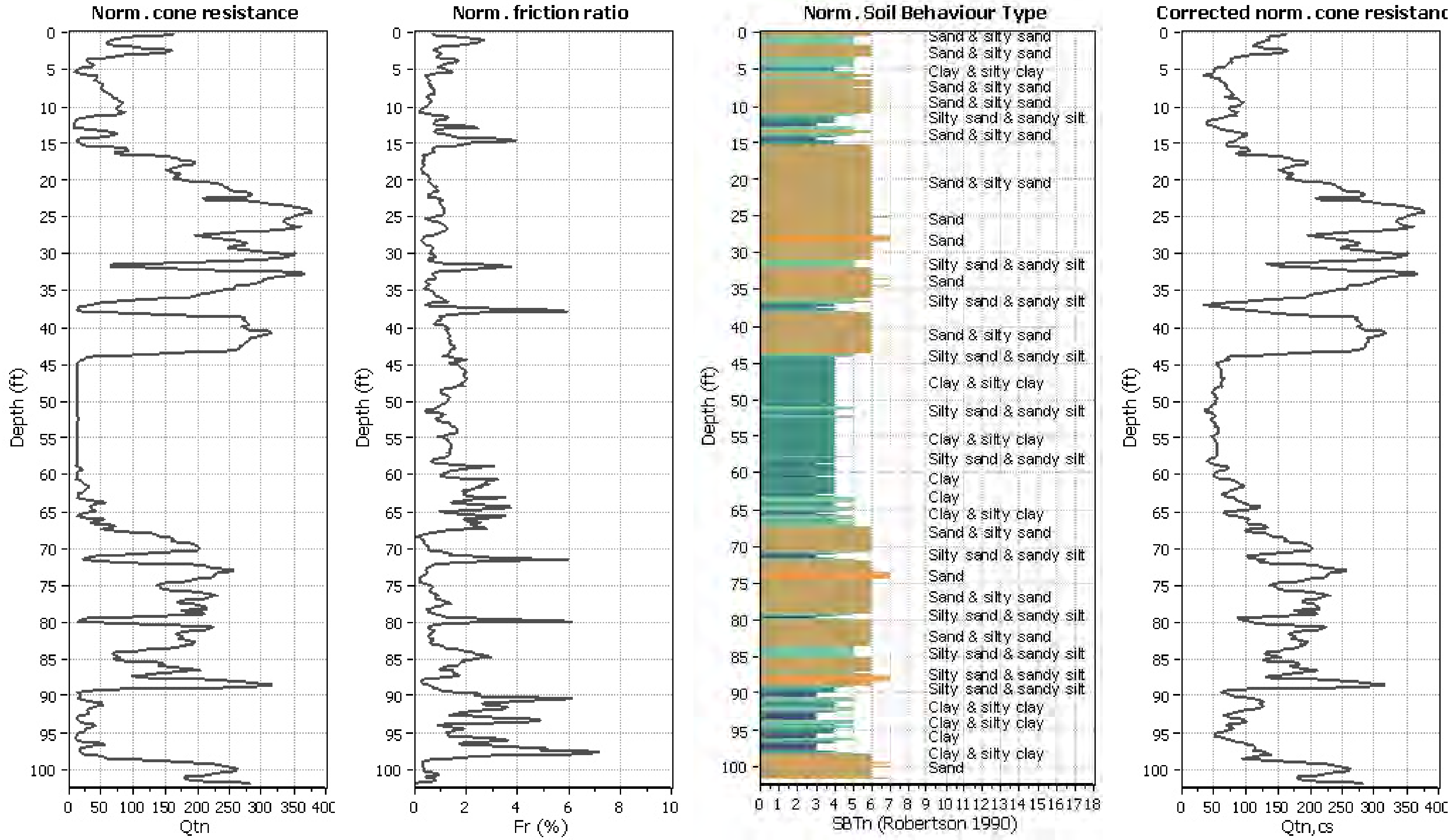
Grover Beach, CA 93433

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**

Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-02

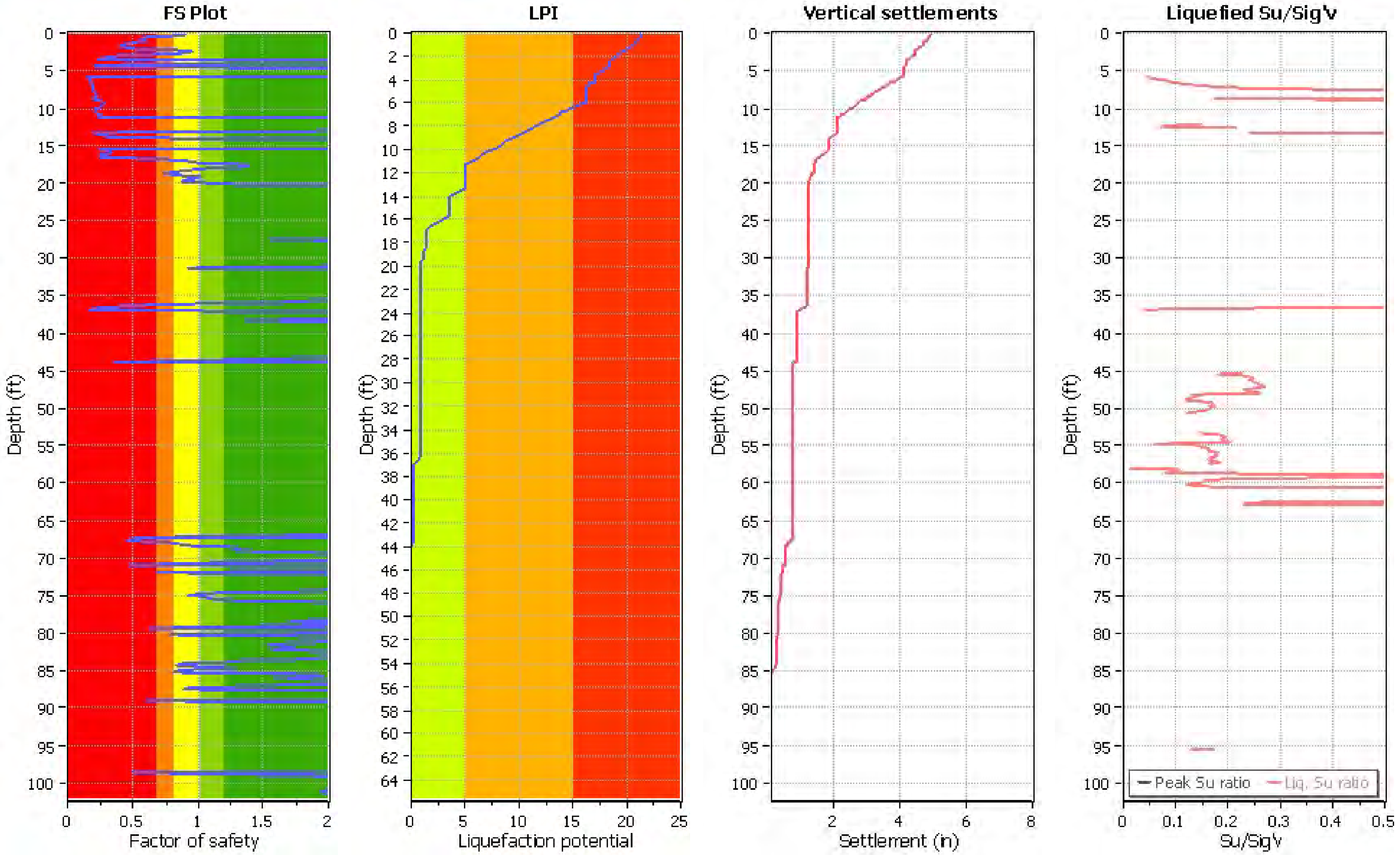
Total depth: 101.87 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-02
Total depth: 101.87 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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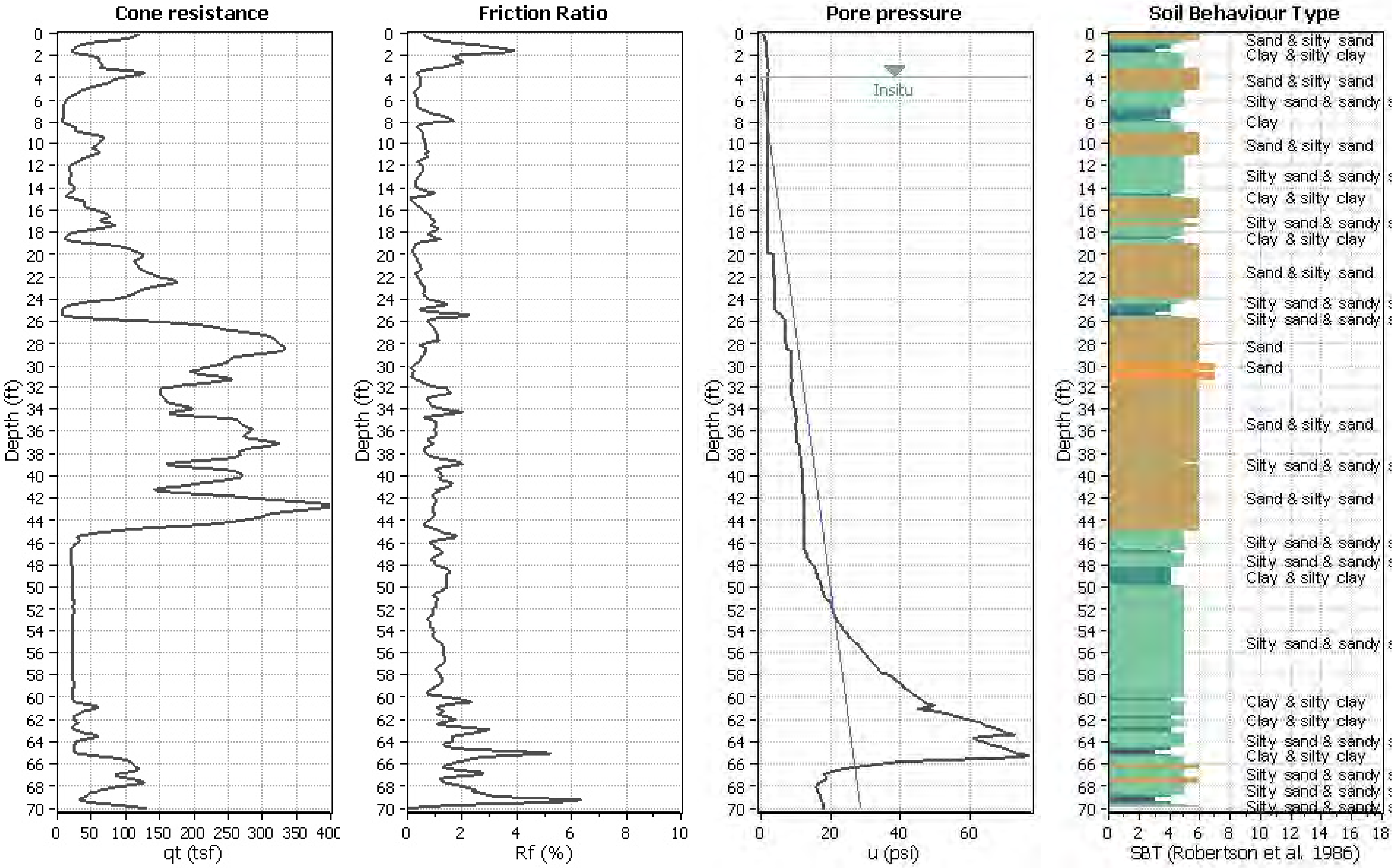
391 Front Street, Suite D
Grover Beach, CA 93433

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

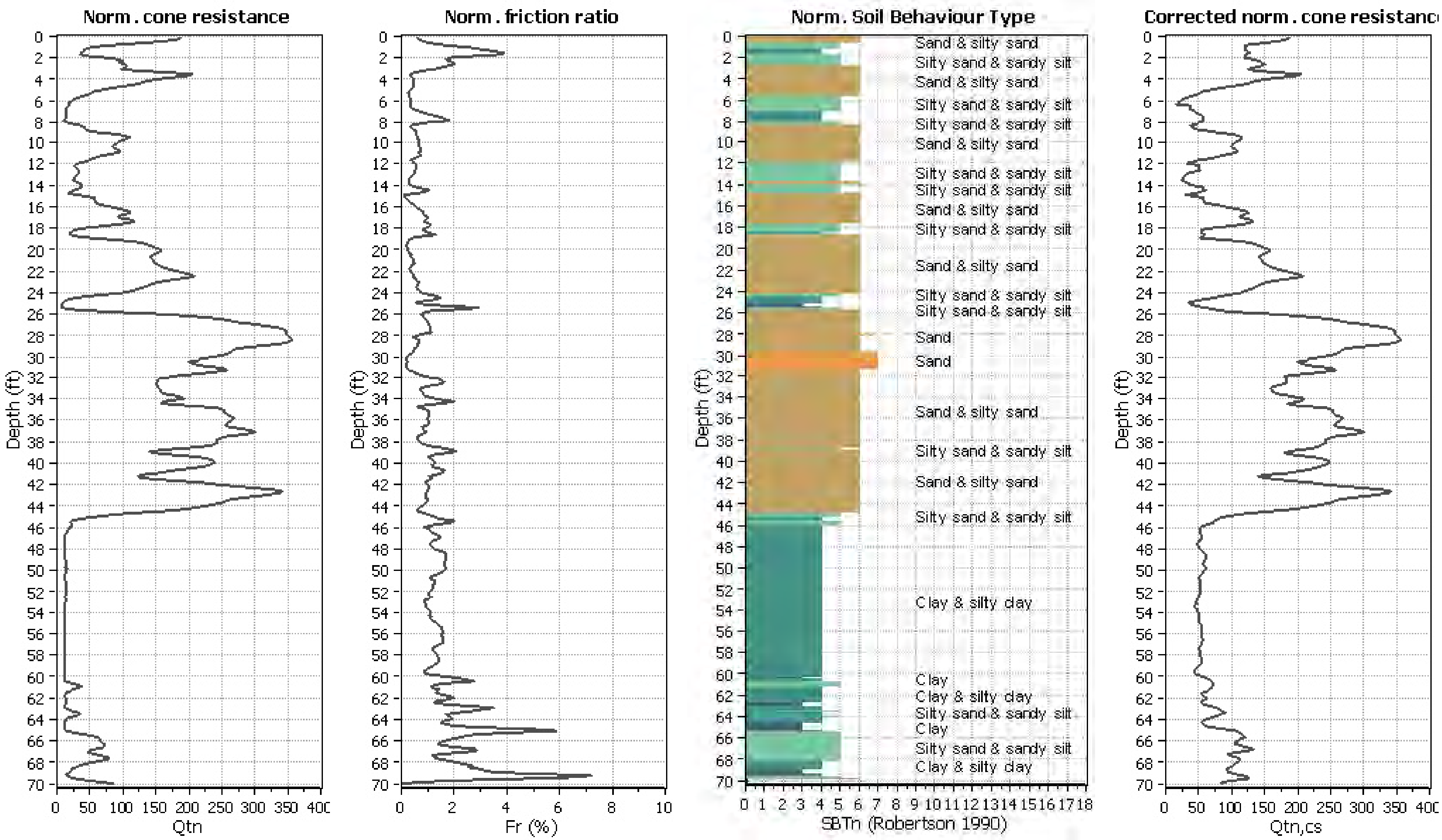
CPT: CPT-03
Total depth: 70.05 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

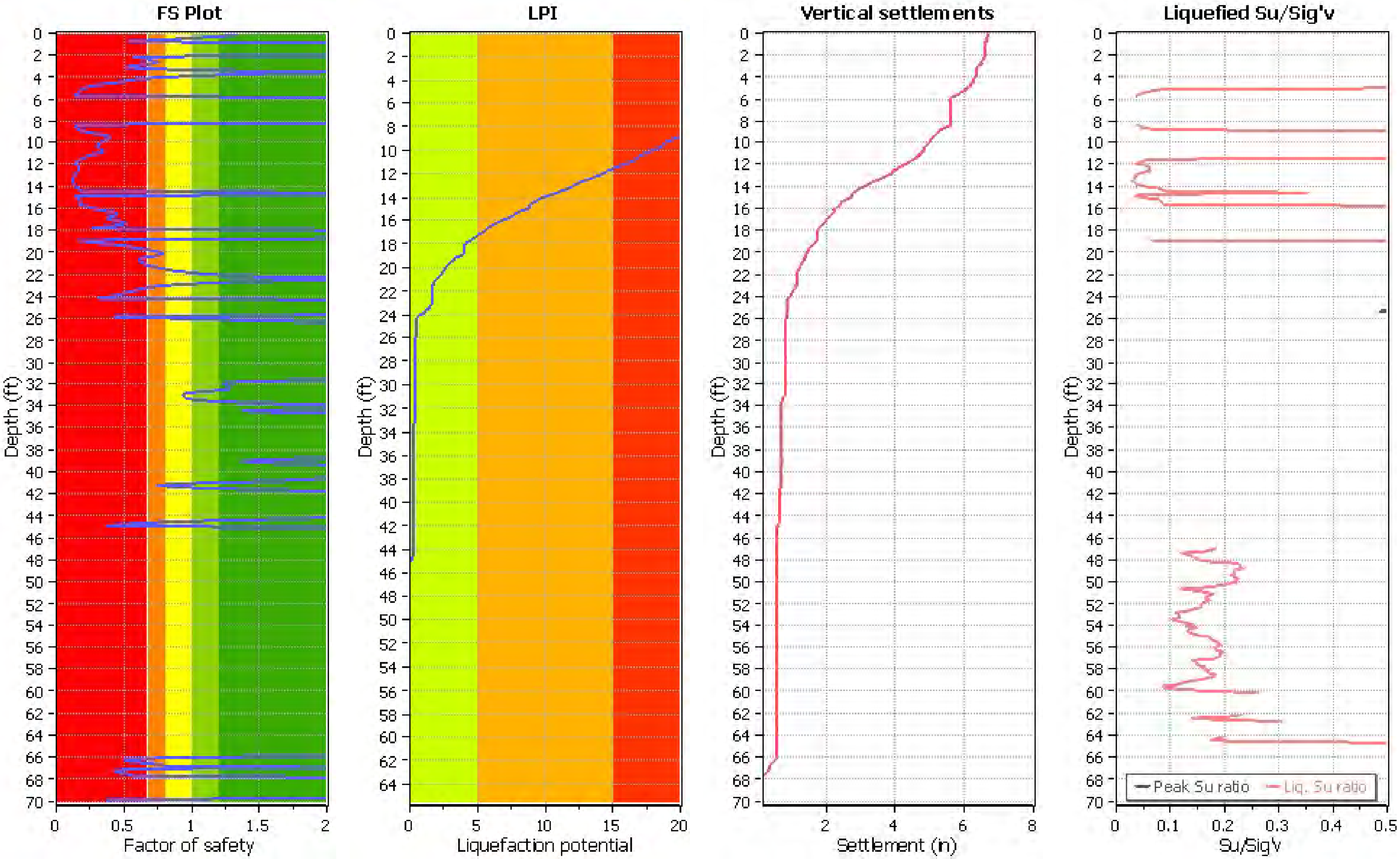
CPT: CPT-03
Total depth: 70.05 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

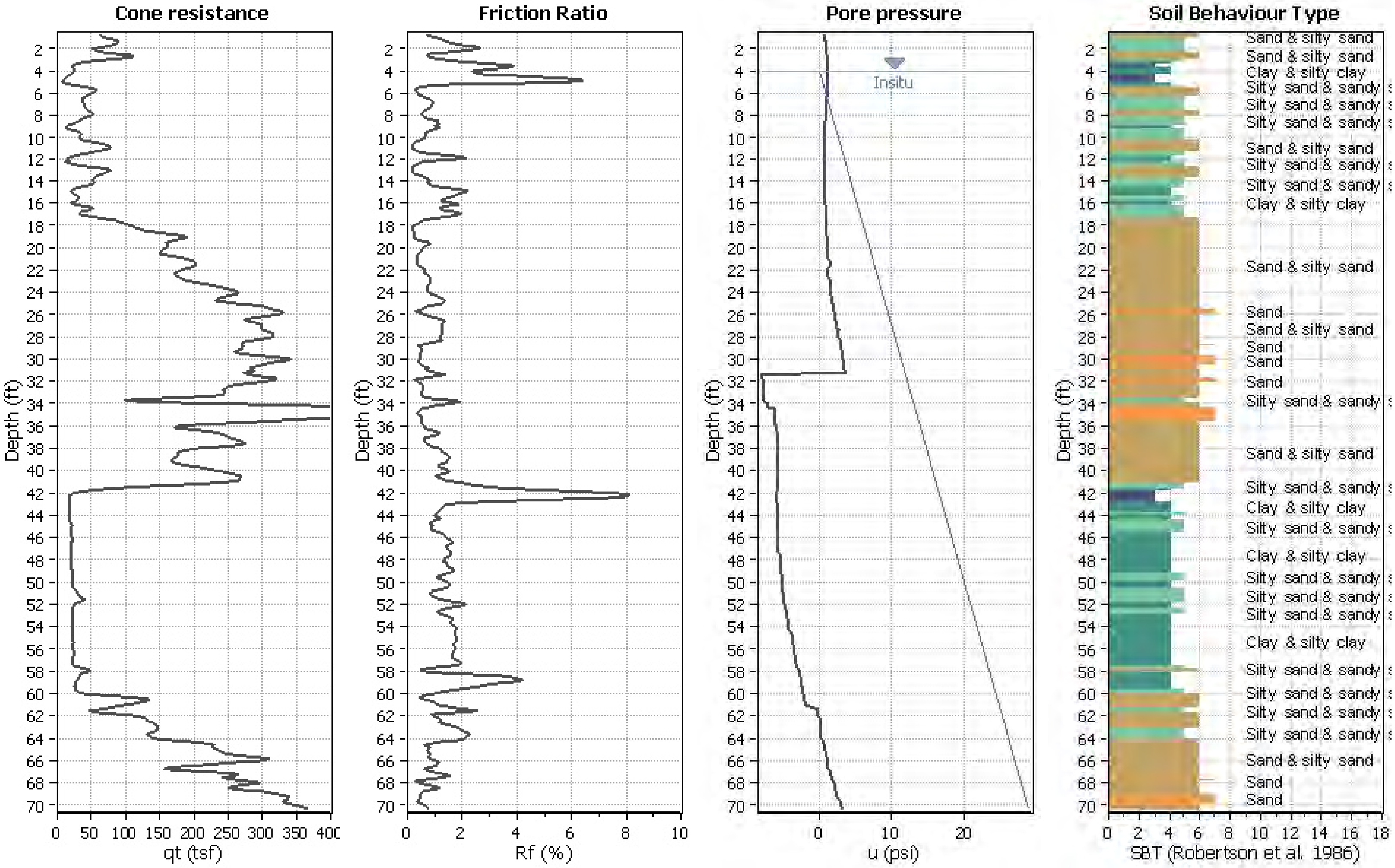
CPT: CPT-03
Total depth: 70.05 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

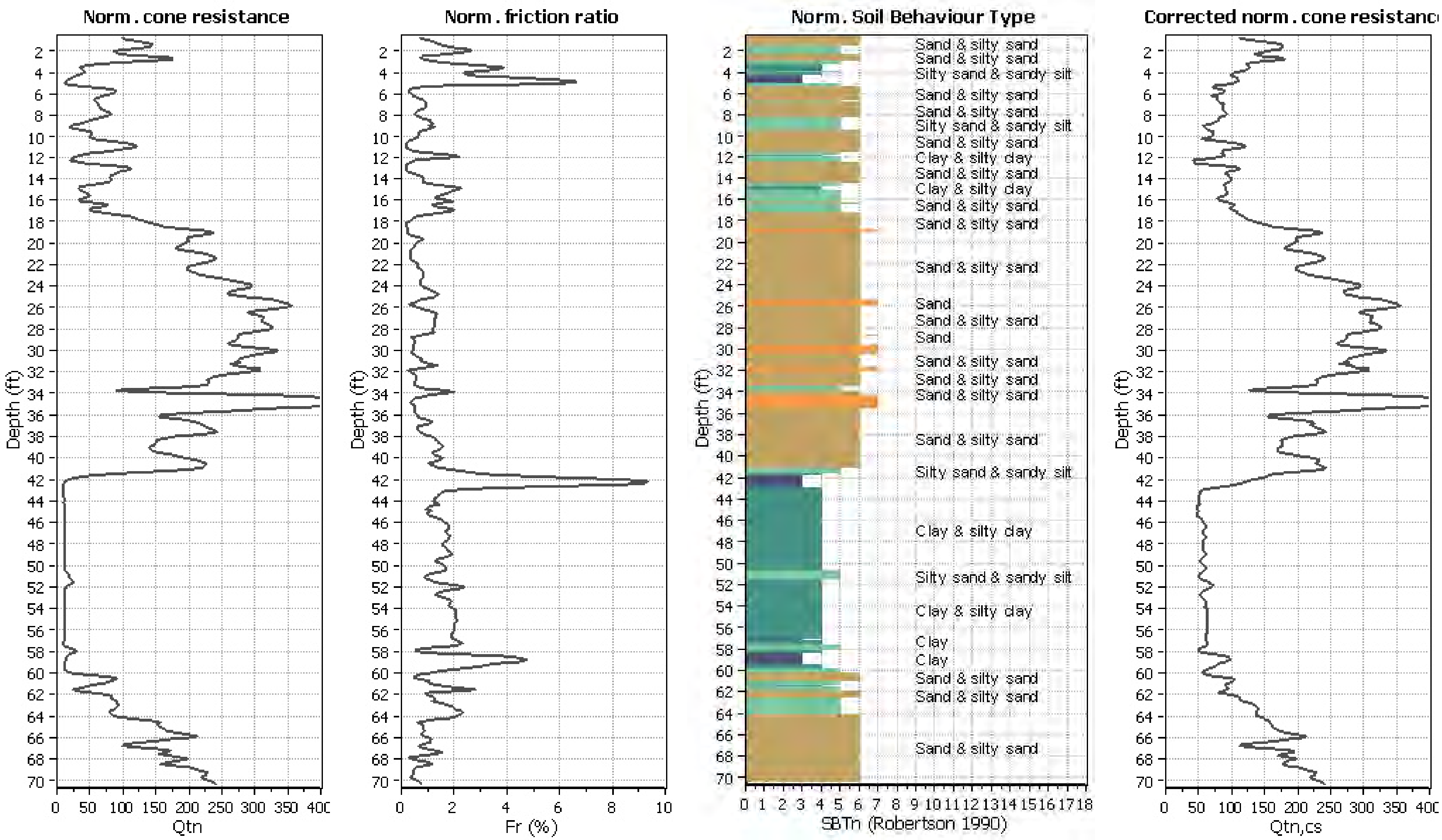
CPT: CPT-04
Total depth: 70.37 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-04
Total depth: 70.37 ft

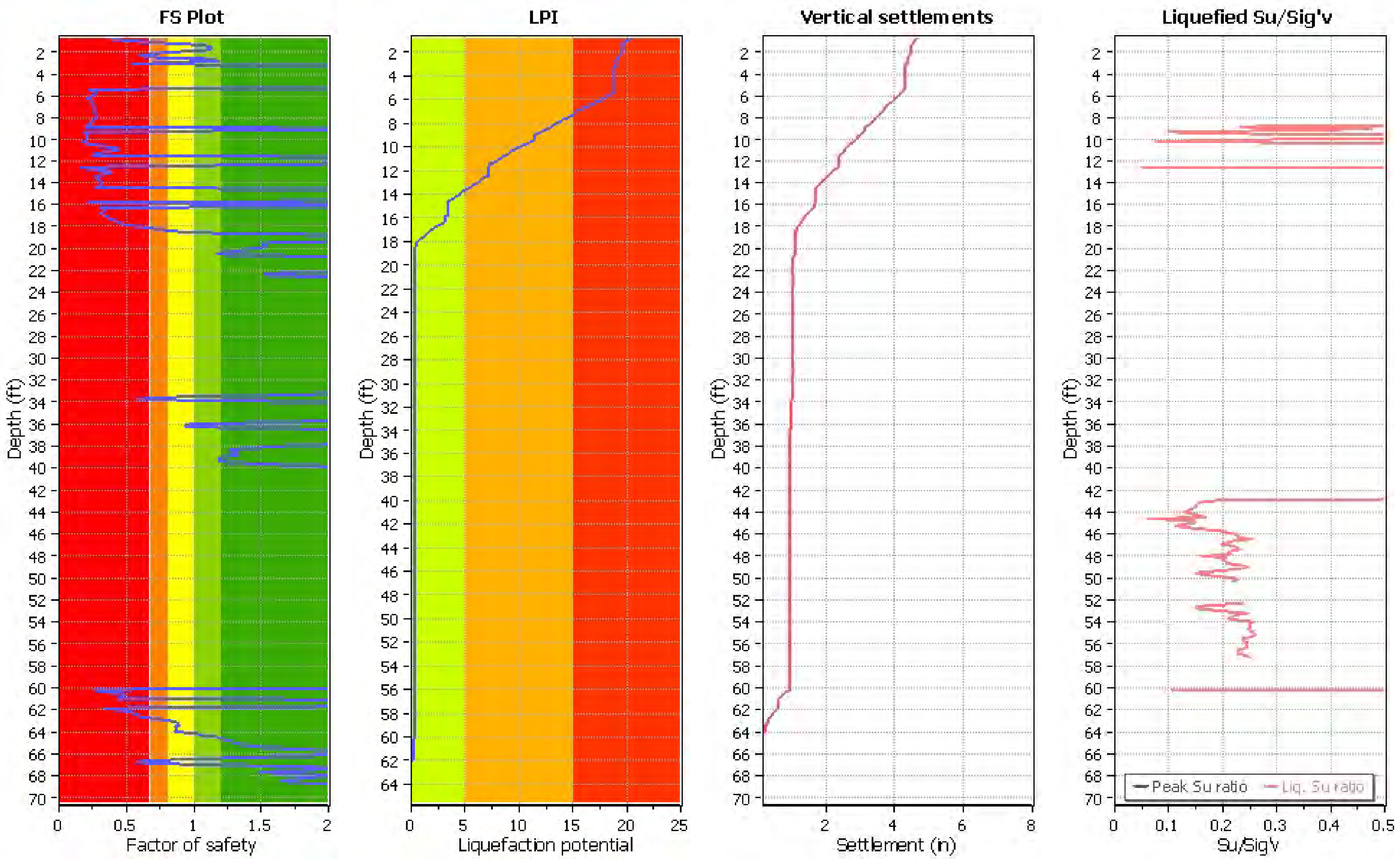


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

CLiq v.2.2.0.28 - CPTU data presentation & interpretation software - Report created on: 9/26/2018, 8:34:14 AM
Project file: Y:\Projects - Grover\216-193 SSLCSD - ES WWTP Redundancy KJ\4.0 CPT\216-193 SSLOCSD Redundancy Cliq updated 9-26-18 IC cutoff 2.4.clq

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

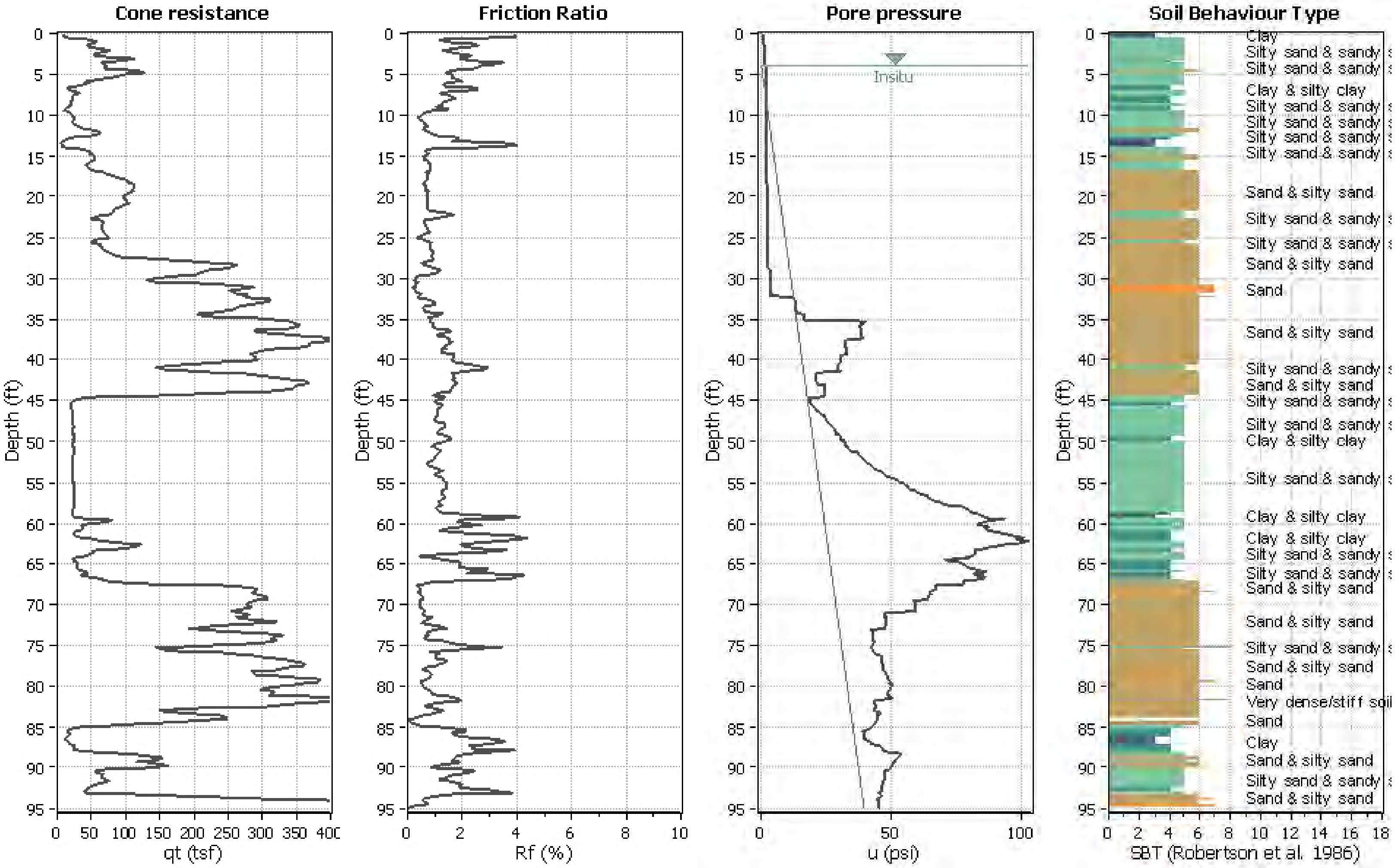
CPT: CPT-04
Total depth: 70.37 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

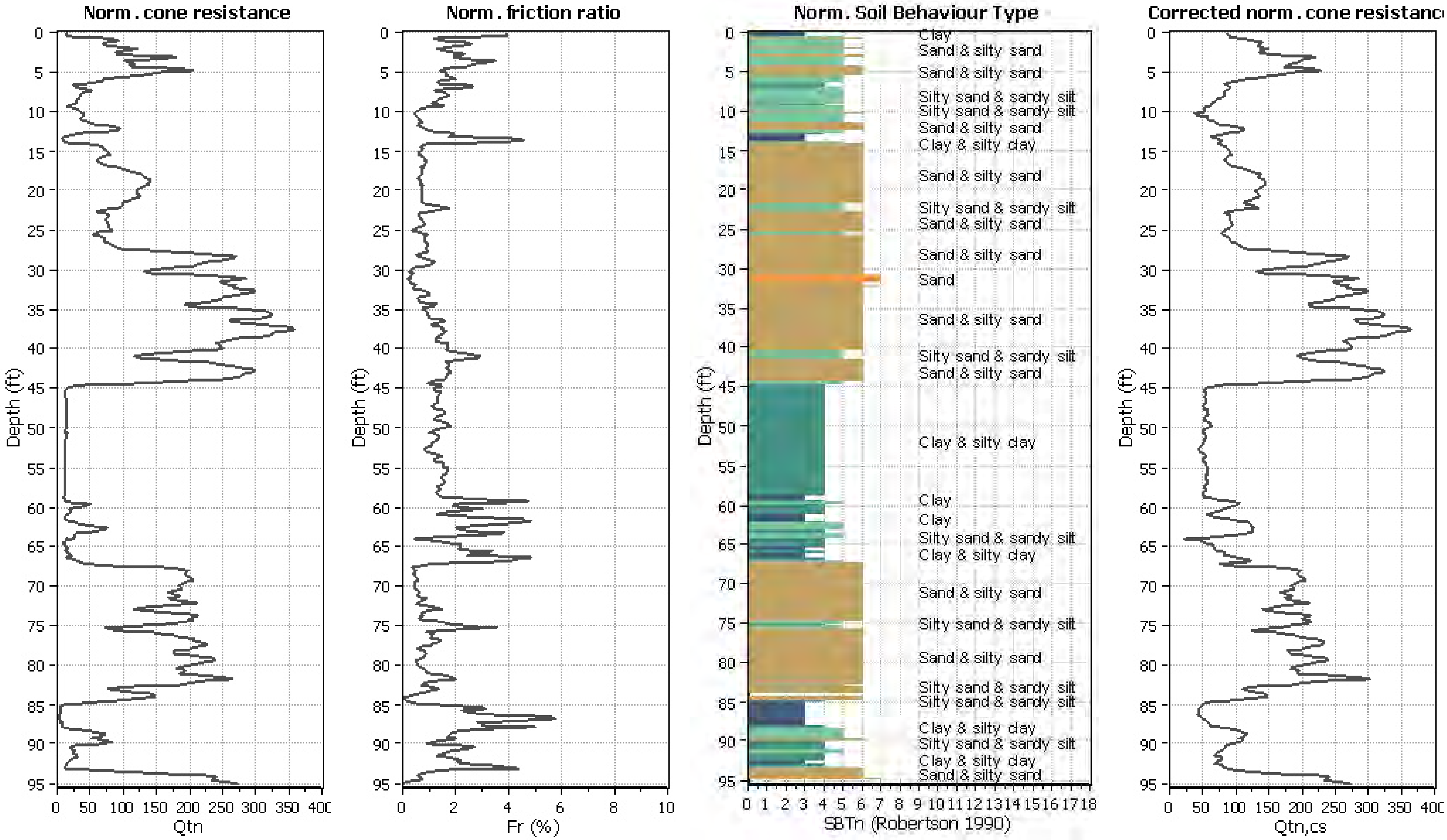
CPT: CPT-05
Total depth: 94.98 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-05
Total depth: 94.98 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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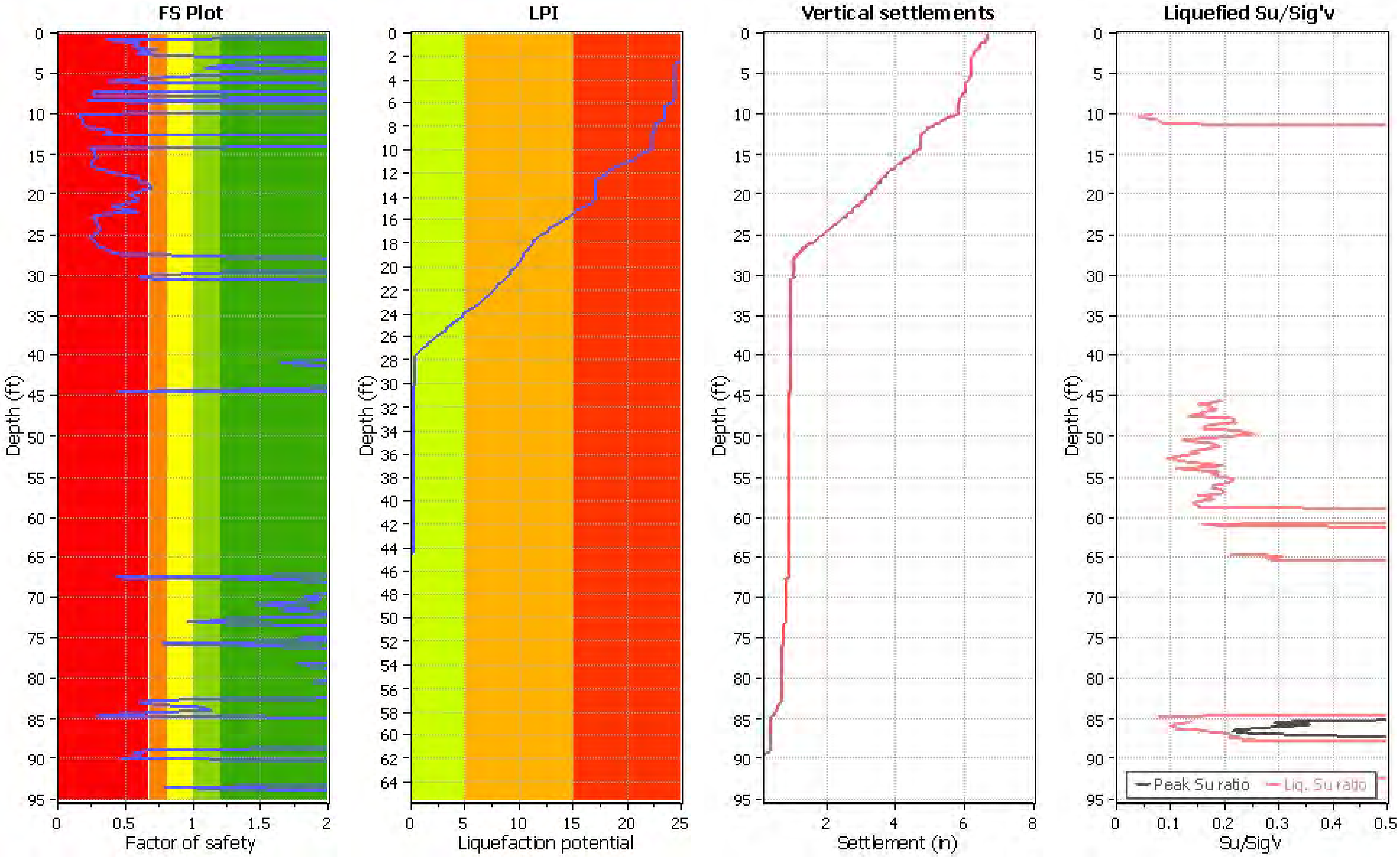
Grover Beach, CA 93433

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

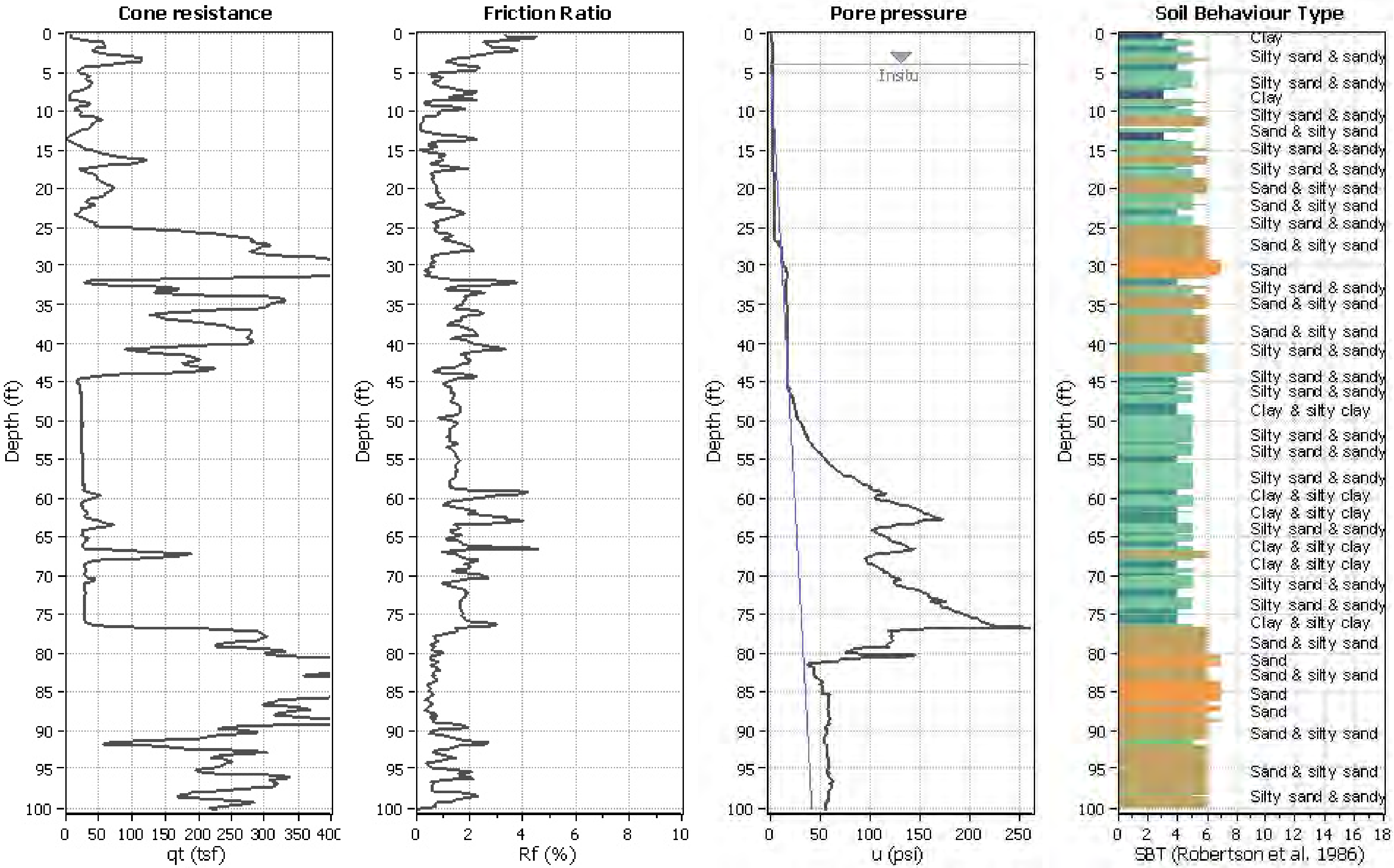
CPT: CPT-05
Total depth: 94.98 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	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:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-06
Total depth: 100.23 ft

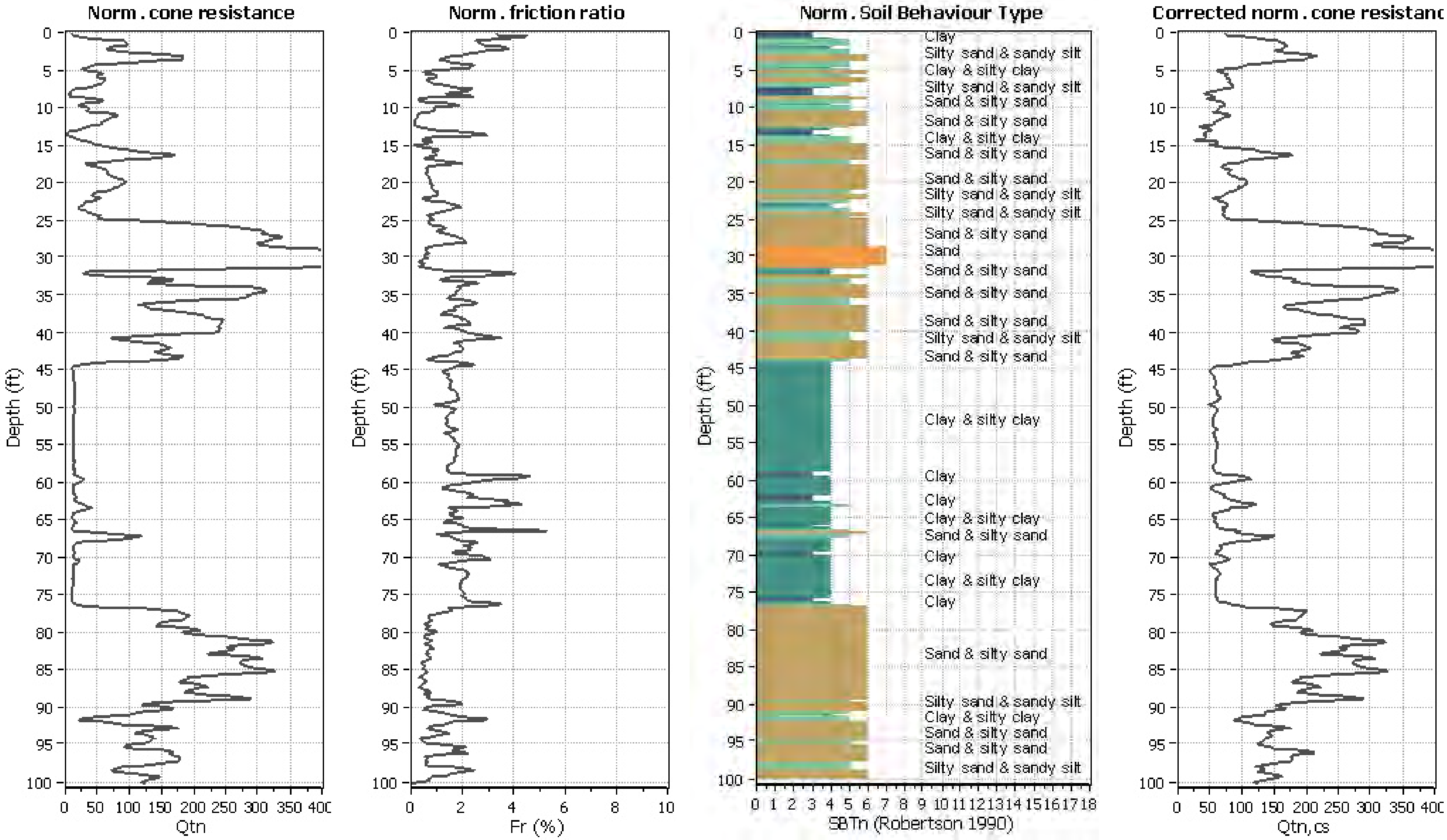


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

CLiq v.2.2.0.28 - CPTU data presentation & interpretation software - Report created on: 9/26/2018, 8:34:17 AM
Project file: Y:\Projects - Grover\216-193 SSLCSD - ES WWTP Redundancy KJ\4.0 CPT\216-193 SSLOCSD Redundancy Cliq updated 9-26-18 IC cutoff 2.4.clq

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

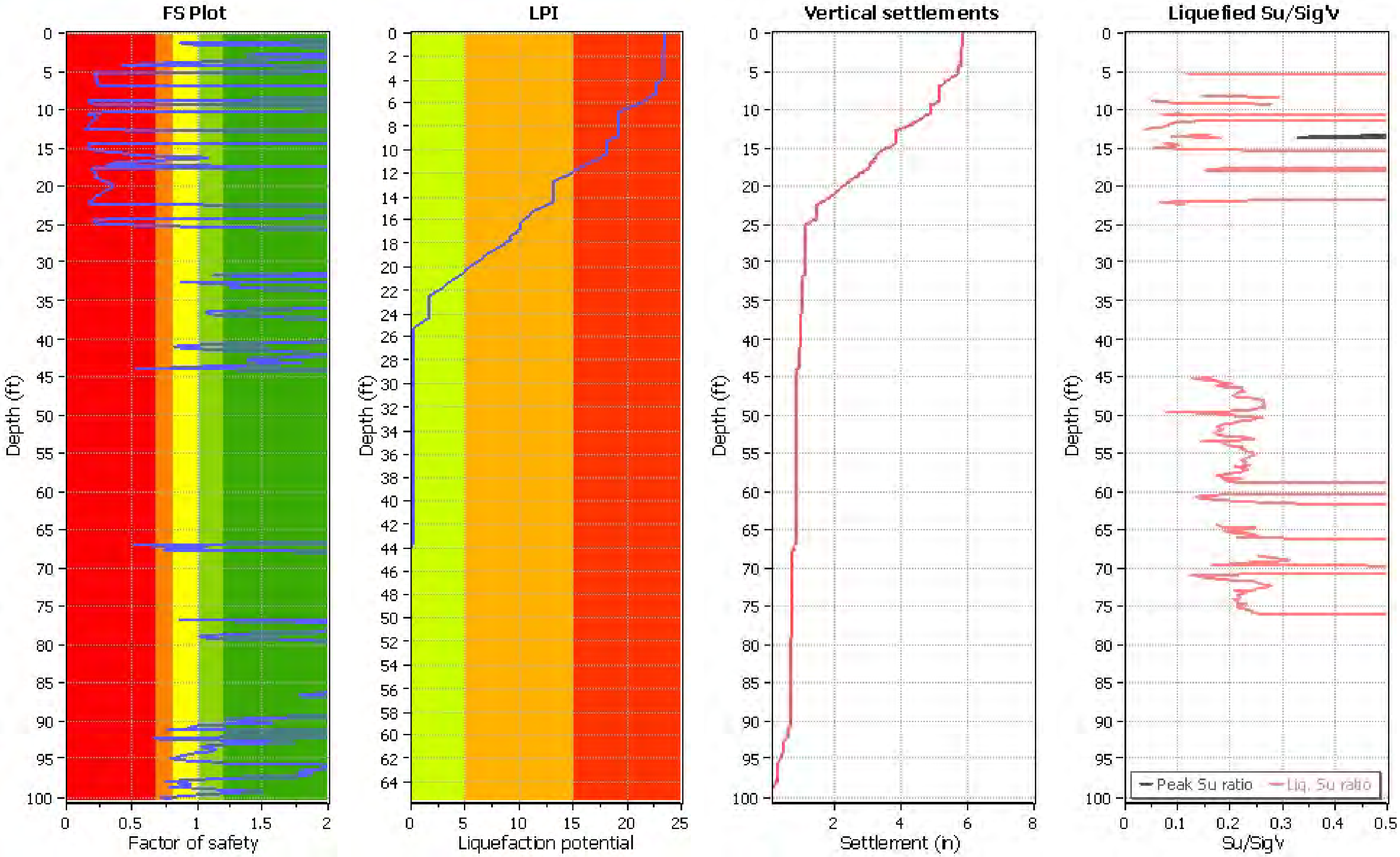
CPT: CPT-06
Total depth: 100.23 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

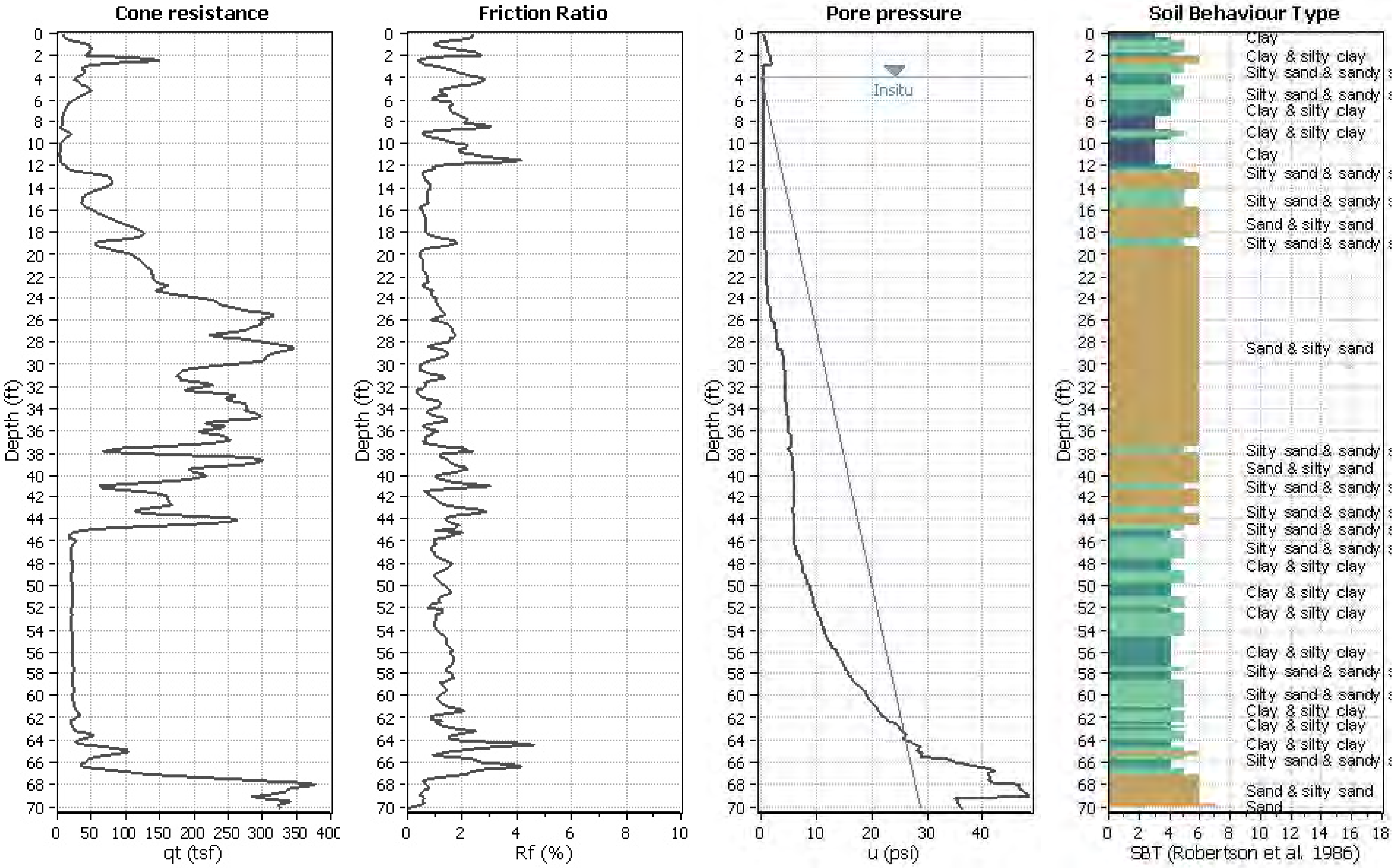
CPT: CPT-06
Total depth: 100.23 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

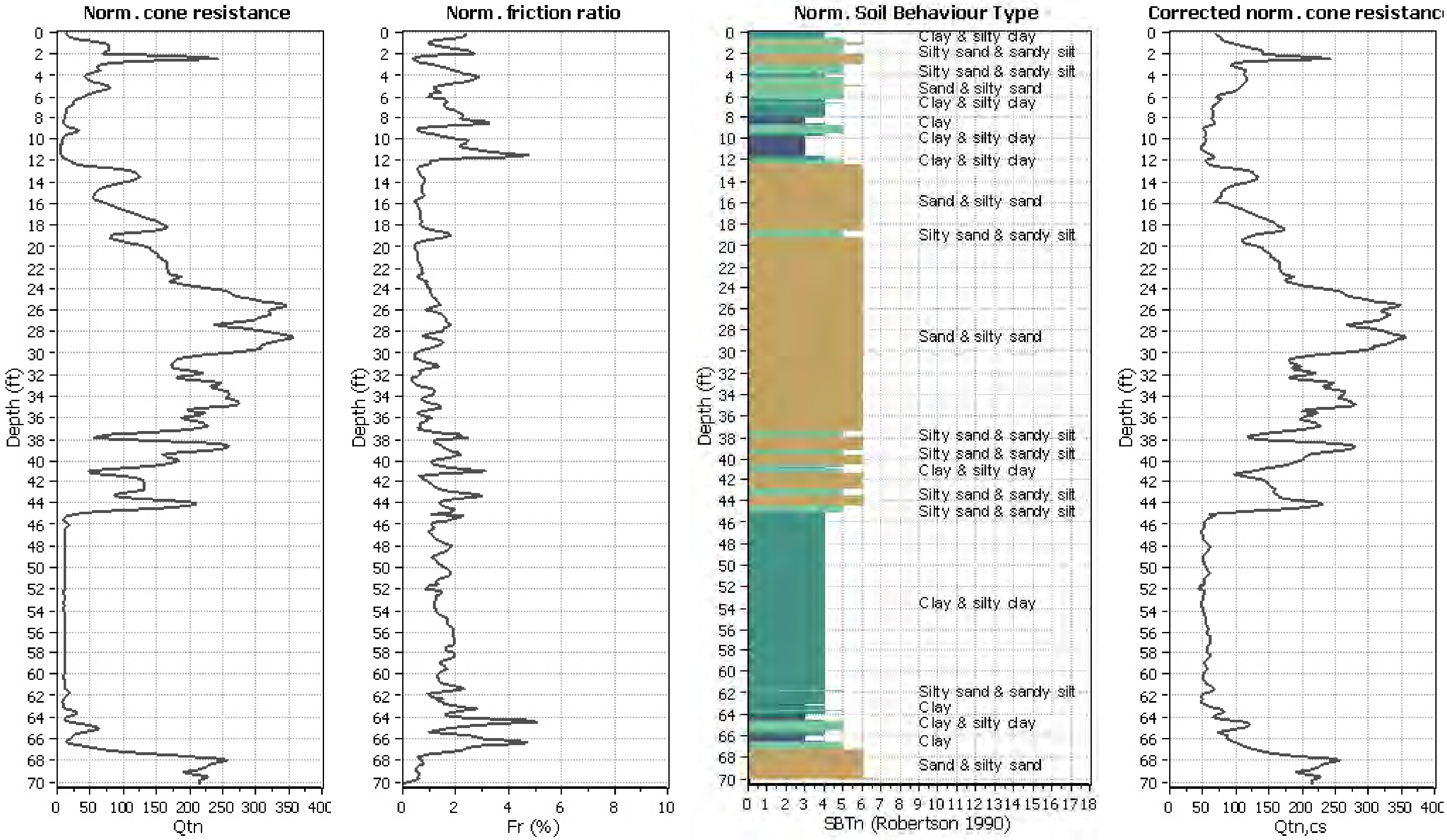
CPT: CPT-07
Total depth: 70.21 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

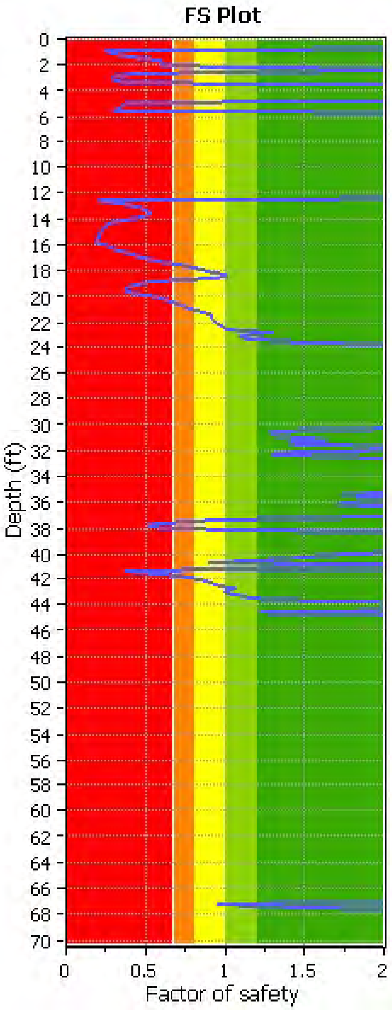
CPT: CPT-07
Total depth: 70.21 ft

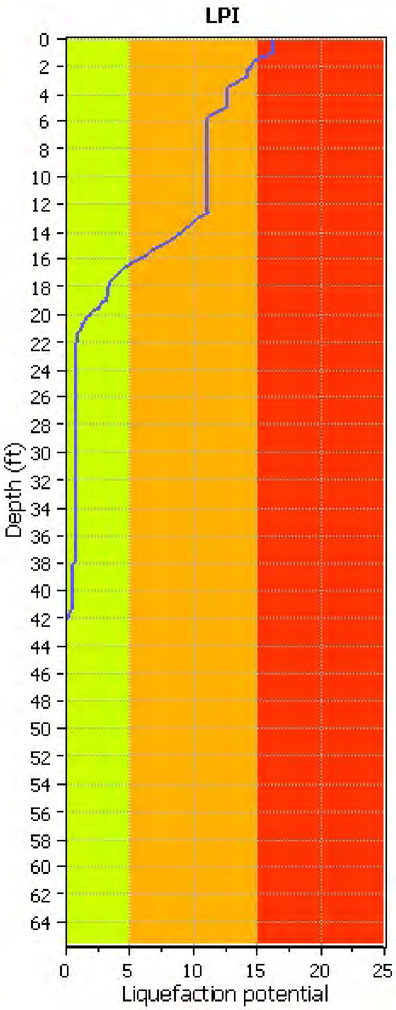


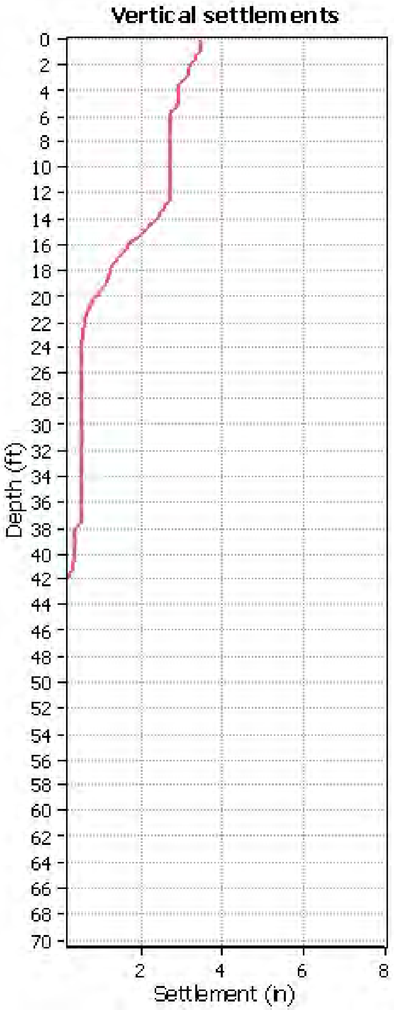
Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

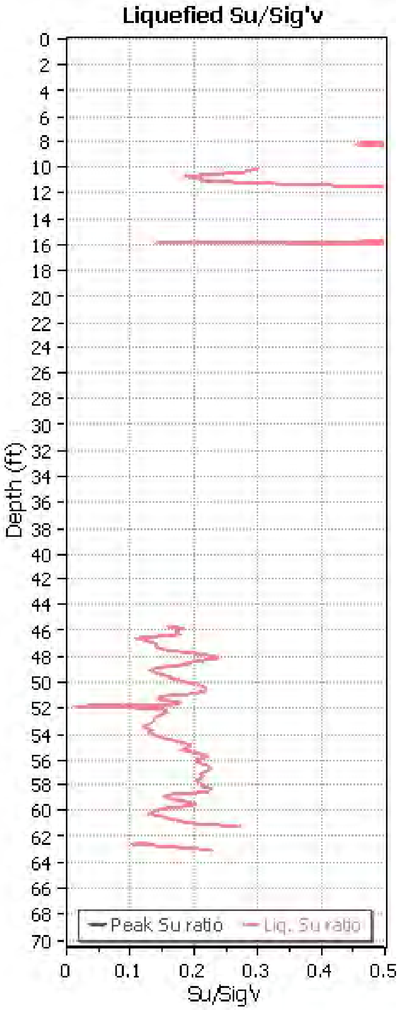
Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-07
Total depth: 70.21 ft





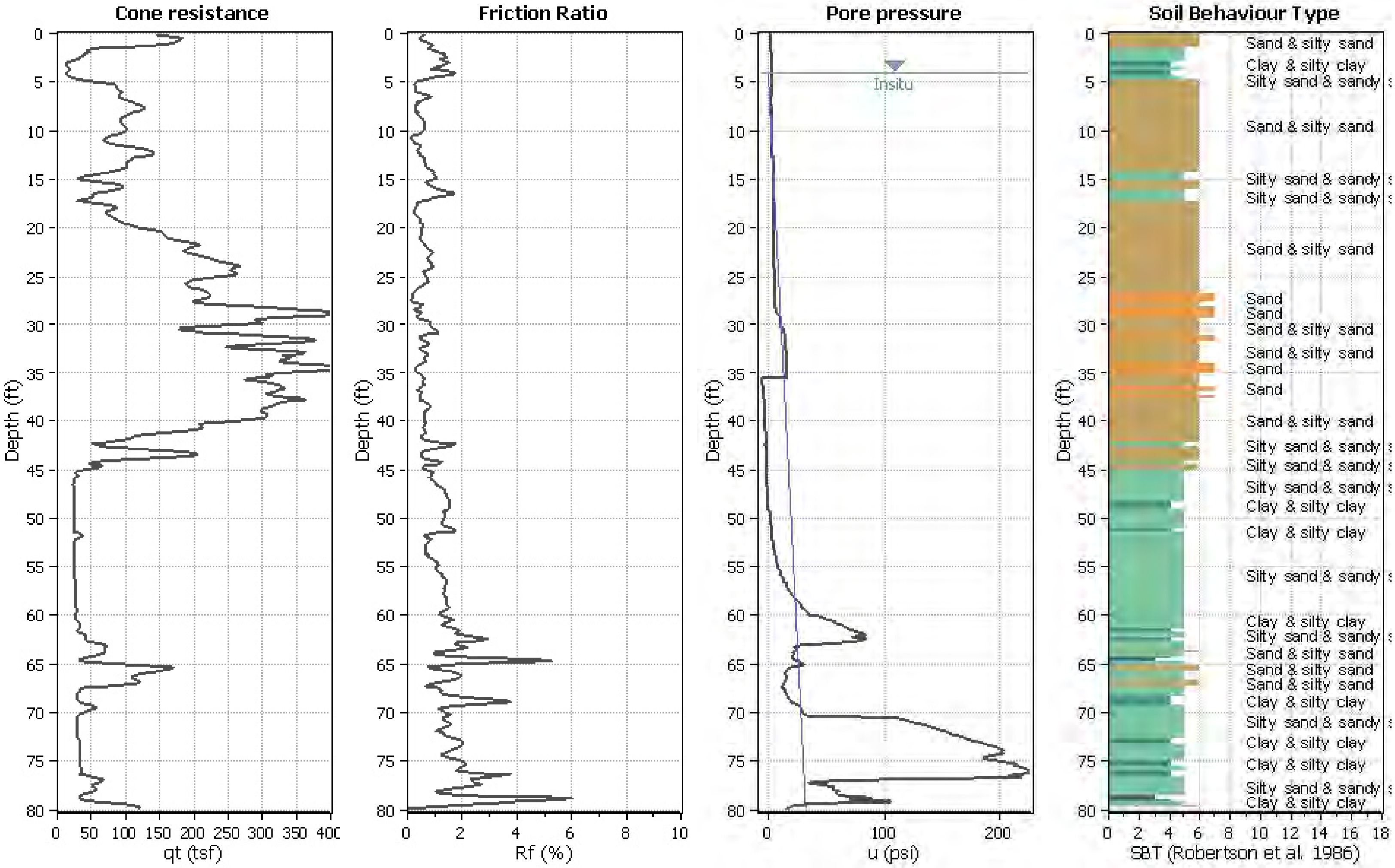




Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

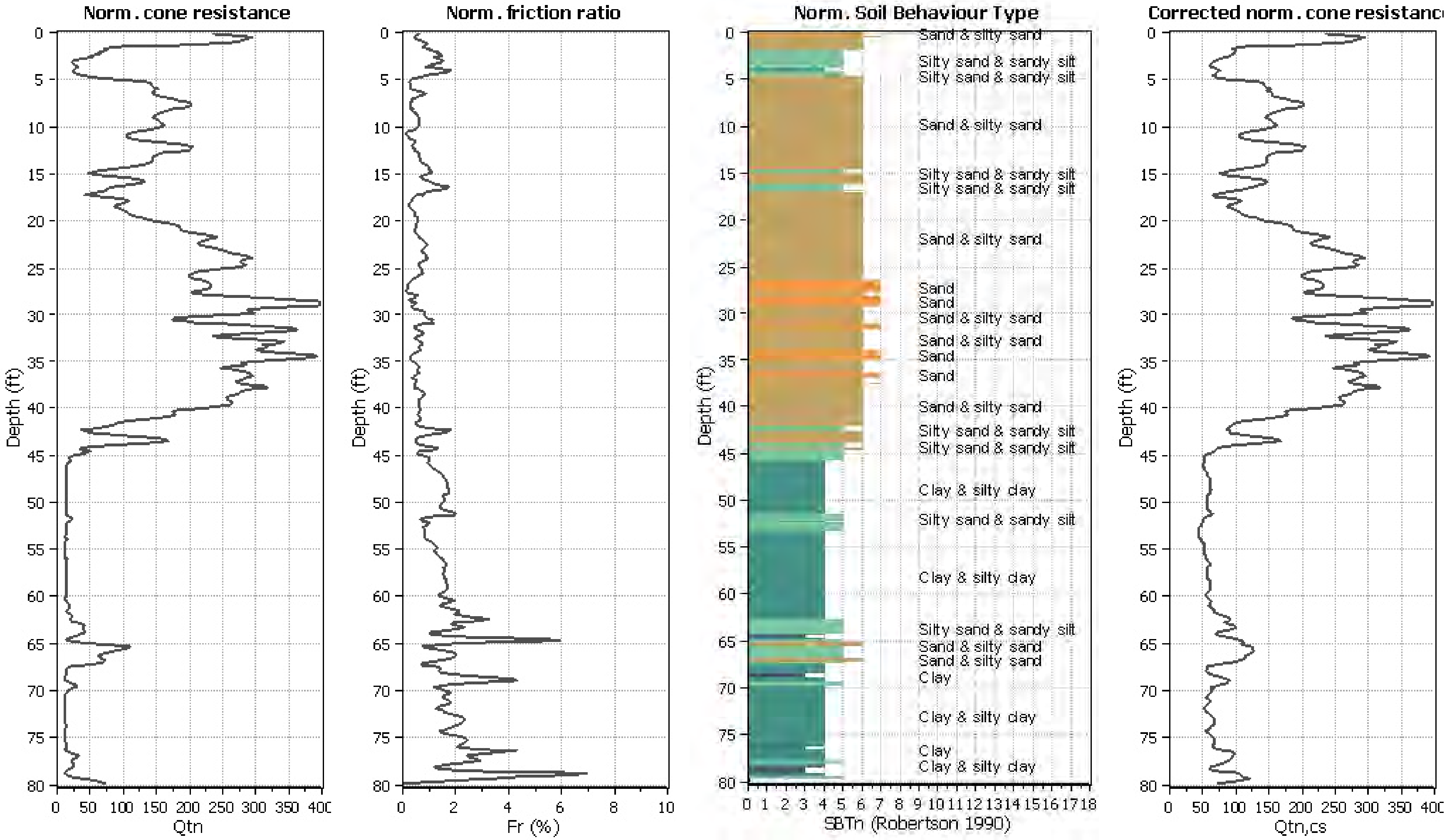
CPT: CPT-08
Total depth: 79.89 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-08
Total depth: 79.89 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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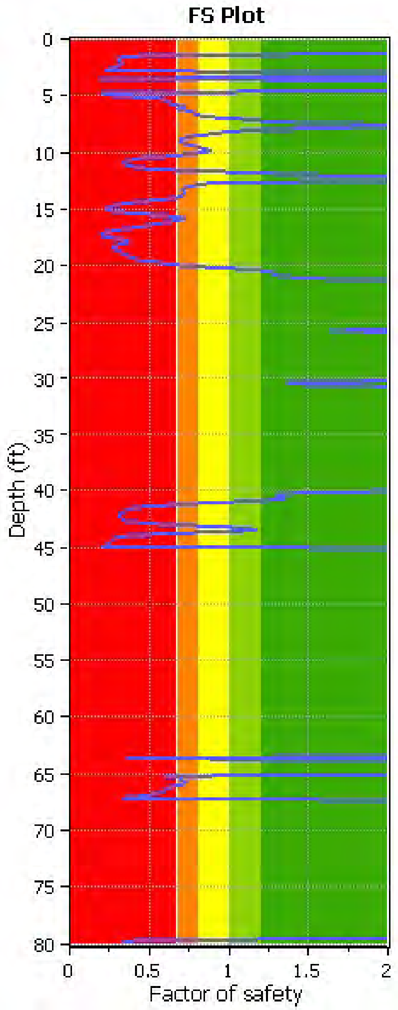
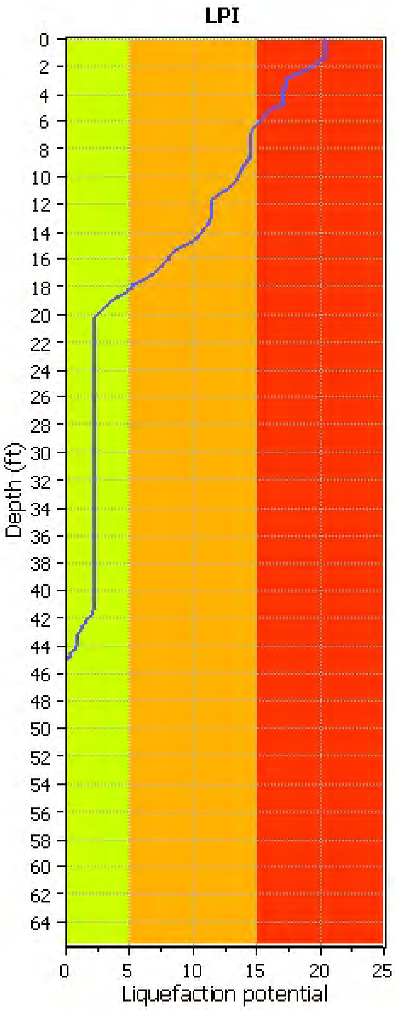
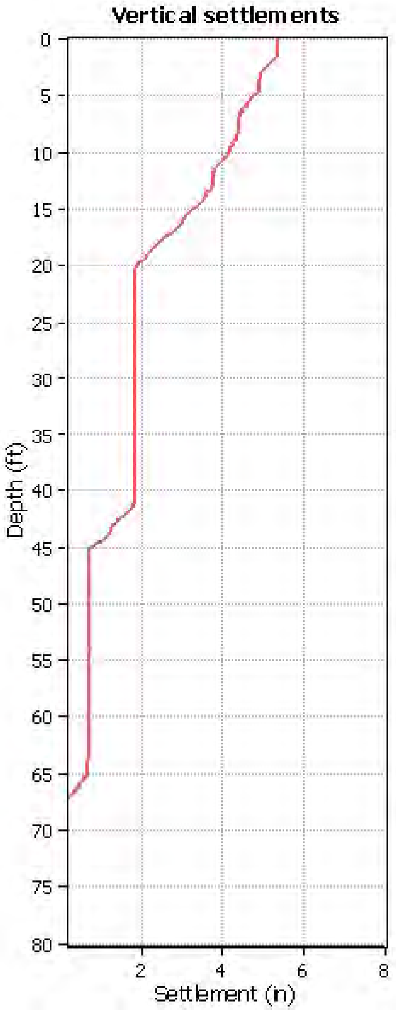
391 Front Street, Suite D
Grover Beach, CA 93433

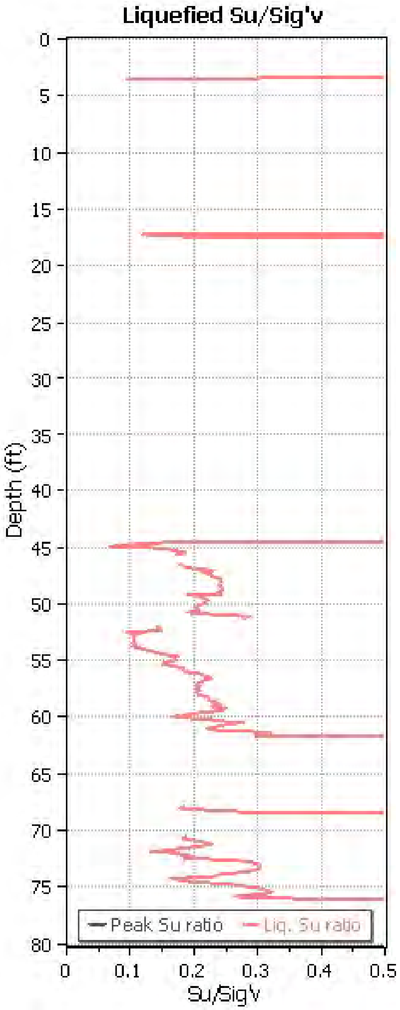
Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-08
Total depth: 79.89 ft


FS Plot


LPI


Vertical settlements


Liquefied Su/Sig'v

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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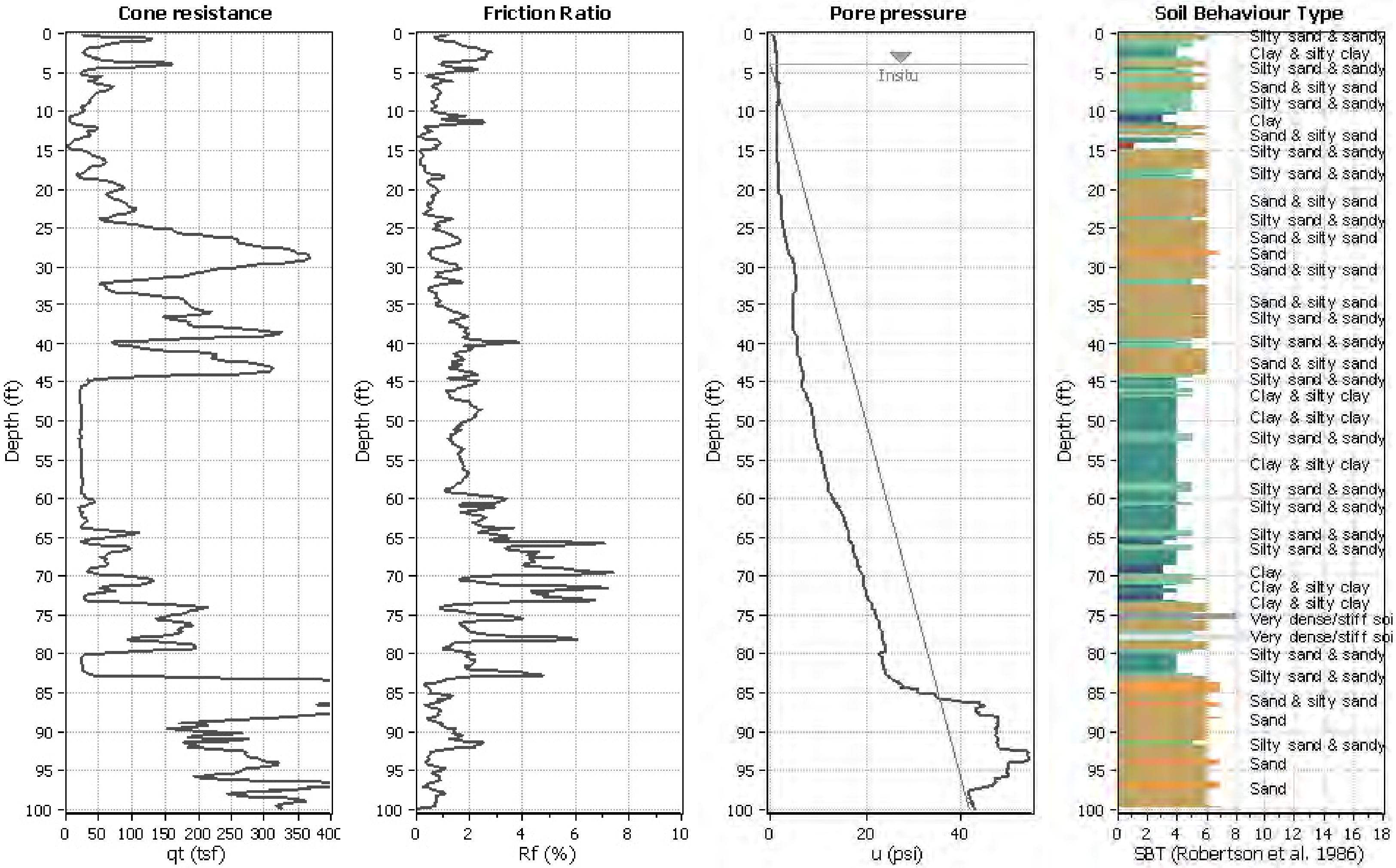
Grover Beach, CA 93433

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

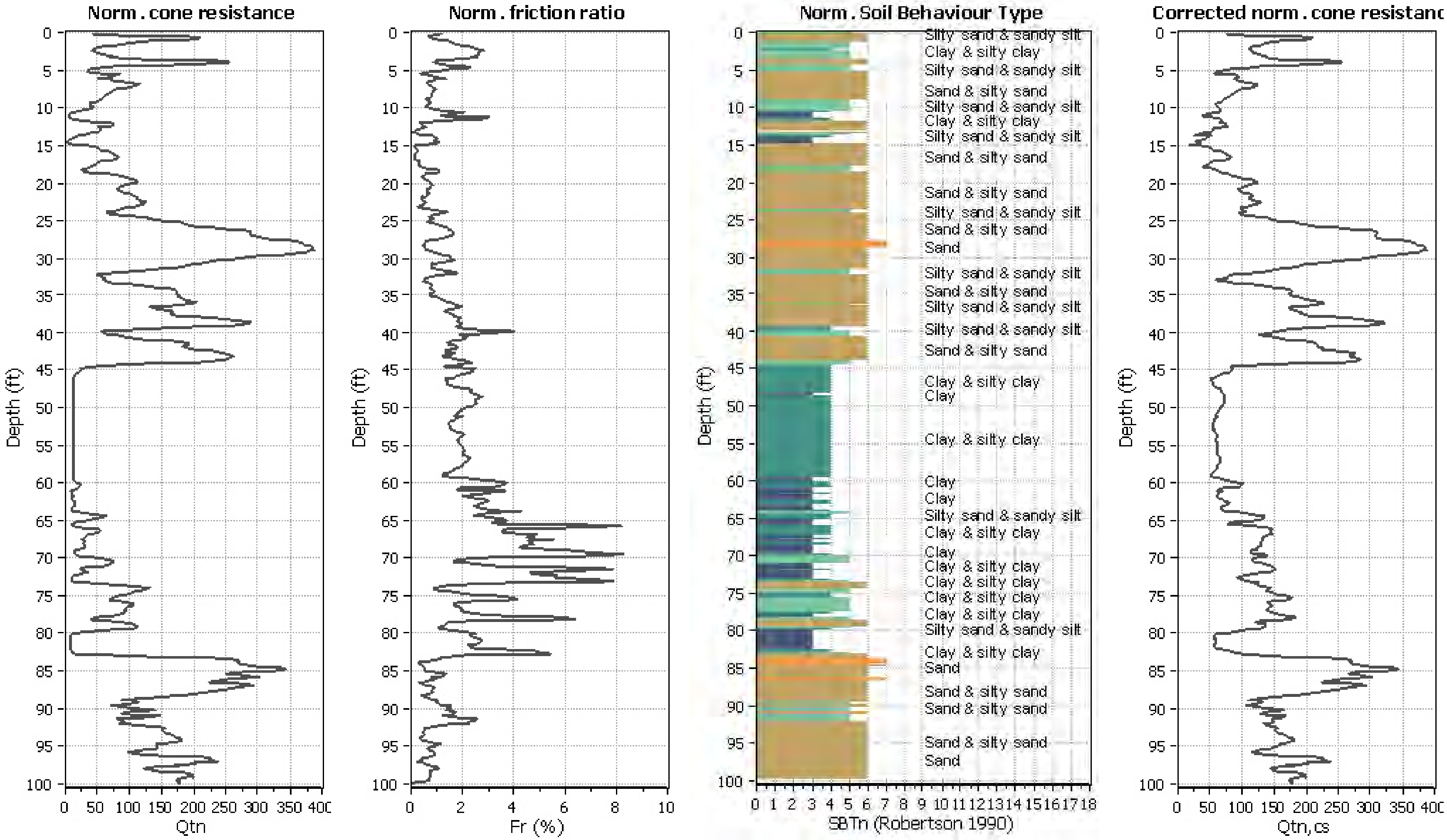
CPT: CPT-09
Total depth: 100.07 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-09
Total depth: 100.07 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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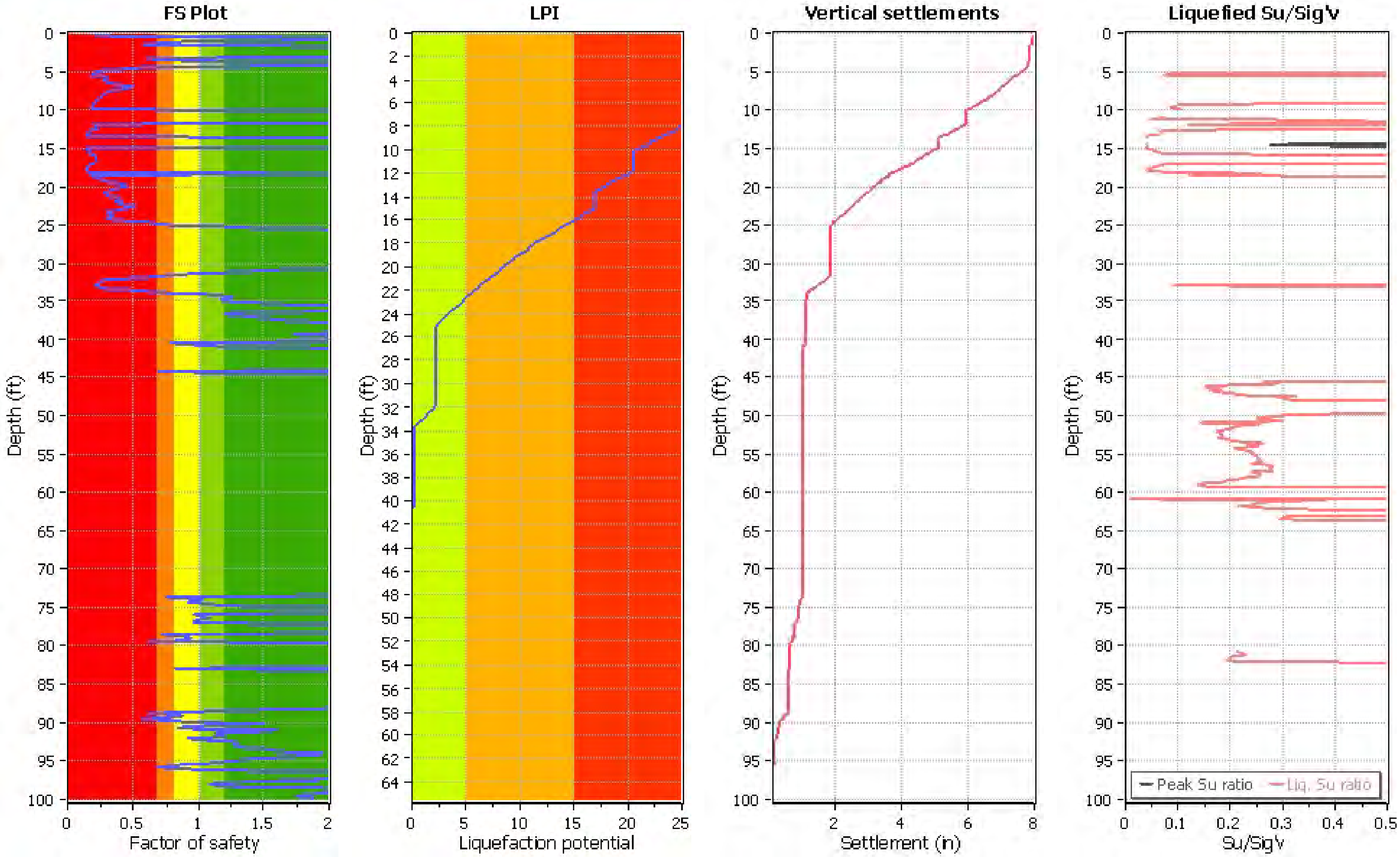
Grover Beach, CA 93433

Project: **SSLOCSD - WWTP Redundancy Project - As-is Conditions**
Location: **1600 Aloha Ave, Oceano, CA**

CPT: CPT-09
Total depth: 100.07 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	4.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.40	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.51	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		