# Appendix D

Geotechnical Engineering Report, SBC Valley Communication Center, San Bernardino, San Bernardino County, California

Terracon

February 2022

# Geotechnical Engineering Report

**SBC Valley Communication Center**
**San Bernardino, San Bernardino County, California**
February 24, 2022
Terracon Project No. CB215173

**Prepared for:**
County of San Bernardino Real Estate Services Department
San Bernardino, California

**Prepared by:**
Terracon Consultants, Inc.
Colton, California

February 24, 2022

Terracon GeoReport

County of San Bernardino Real Estate Services Department
385 N. Arrowhead Avenue 3rd Floor
San Bernardino, California 92415

Attn: Mr. Scott Hughes
P: (909) 387-5000
E: scott.hughes@res.sbcounty.gov

Re: Geotechnical Engineering Report
SBC Valley Communication Center
SEC of S Lena Road & E Rialto Avenue
San Bernardino, San Bernardino County, California
Terracon Project No. CB215173

Dear Mr. Hughes:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with the Terracon Proposal No. PCB215173 dated December 2, 2021. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
**Terracon Consultants, Inc.**

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## REPORT TOPICS



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

## ATTACHMENTS



**Note:** Refer to each individual Attachment for a listing of contents.

# Geotechnical Engineering Report

## SBC Valley Communication Center
## SEC of S Lena Road & E Rialto Avenue
## San Bernardino, San Bernardino County, California

**Terracon Project No. CB215173**
**February 24, 2022**

## INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed three-story building to be located at SEC of S Lena Road & E Rialto Avenue in San Bernardino, San Bernardino County, California. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions and historic high groundwater
- 2019 California Building Code (CBC) seismic design parameters
- Liquefaction analysis
- Subgrade preparation/earthwork recommendations
- Foundation design and concrete slabs-on-grade
- Design for preliminary pavement sections
- Infiltration and drainage

The proposed structure is an Essential Services Facility subject to review by the California Geological Survey (CGS) under the requirements of CGS Note 48. A base-isolated foundation system is proposed. As such, our scope of services includes calculation of response spectra and preparation of spectrum-compatible time histories. A peer review of the ground motion calculations is required. This report includes the draft response spectra intended for submittal for peer review. Preparation of time histories is pending our receipt of the peer review of the draft spectra.

The geotechnical engineering Scope of Services for this project included the advancement of twelve test borings to depths ranging from approximately 5 to 51½ feet below existing site grades. Our scope also included advancing six Cone Penetration Test (CPT) soundings to depths ranging from approximately 17 to 69 feet below existing grades, laboratory testing, and preparation of this report.

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

## SITE CONDITIONS

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

| Item | Description |
|---|---|
| **Parcel Information** | The project site is located at SEC of S Lena Road & E. Rialto Avenue in San Bernardino, San Bernardino County, California.<br>The approximate coordinates of the site are: 34.1005°N/117.2675°W<br>See **Site Location** |
| **Existing Improvements** | The site is currently an undeveloped lot with other County buildings to the southwest and west. |
| **Current Ground Cover** | Site is earthen with light growth of vegetation. |
| **Existing Topography** (from Google Earth) | Site is relatively flat with a gradient to the southwest. Elevations vary from approximately 1045 in the north to approximately 1036 in the southwest. |

## PROJECT DESCRIPTION

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

| Item | Description |
|---|---|
| **Proposed Development** | Based on our review of the site plans provided to us and discussions with the project team, a three-story building and appurtenant infrastructure will be constructed, including paved roadway/parking lots, and drainage infiltration/retention basins. |
| **Proposed Structures** | Structures include a three-story building with appurtenant improvements. A base isolation foundation system is proposed. Details on the type of construction or loading was not provided. **The building is classified as an Essential Services Facility subject to applicable design considerations. Geotechnical report will be subject to California Geological Survey (CGS) review for Essential Buildings.** |
| **Building Construction** | Building type not provided at the time on this report preparation. |
| **Finished Floor Elevation** | Anticipated to be within 3 feet of existing grade. |
| **Structural Loads** (assumed) | Structural loads were not provided at the time of this report. |

| Item | Description |
|---|---|
| **Grading Requirements** | Design grades are anticipated to be similar to the existing grades; however, remedial grading is anticipated. |
| **Below Grade Structures** | Not anticipated. |
| **Infiltration Systems** | On-site stormwater retention/infiltration systems are planned. We have performed infiltration testing on the site. |
| **Free-Standing Retaining Walls** | Expected for construction of base-isolated foundation. Assumed to be less than 12 feet in height. |
| **Pavements** | Paved driveway and parking will be constructed on site.<br>We assume flexible (asphalt) pavement sections should be considered.<br>Portland cement concrete (PCC) and pavers for pedestrian use are also considered.<br>Anticipated traffic indices (TIs) are as follows for asphalt pavement:<br>■ Auto Parking Areas: TI=4.5<br>■ Auto Driveways: TI=5.5<br>■ Delivery Truck Lanes TI=7<br>■ Heavy Fire Truck access: TI=8<br>■ The pavement design period: 20 years |

## GEOTECHNICAL CHARACTERIZATION

### Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The site is generally underlain with layers of loose to very dense sand with varying amounts of silt and clay, and medium stiff sandy silt.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options, and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

## Groundwater Conditions

The borings were advanced using continuous flight auger drilling techniques that allow short-term groundwater observations to be made while drilling. Groundwater or seepage was not observed within the explorations during or at the completion of drilling.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. The following table summarized groundwater information for the site.

**Summary of Groundwater Data**

| Data ID | Date | Measuring Point Elevation (feet) | Depth to water (feet) | Location (miles) |
|---|---|---|---|---|
| 01S04W11H001S | 9-26-1957 | 1055 | 57 | 0.1 E |
| | 3-11-1958 | | 19 | |
| | 6-16-1971 | | 74 | |
| 01S04W11K003S | 1-5-2005 | 1032 | 84 | 0.15 SW |
| | 4-19-2005 | | 83 | |
| | 11-16-2010 | | 121 | |
| 01S04W12D001S | 8-23-1915 | 1068 | 51 | ½ NE |
| City of San Bernardino shallow well 13 ‘Rialto & San Felipe’ | 1981 to 1999 | 1030 | Dry at 25 feet bgs (Dry at 1005 feet elevation) | ½ mile W |
| Mendenhall (1905) | 1904 | -- | 0 (former artesian area) | site |
| Dutcher & Garrett (1963) | 1936 contours | -- | 2 (~el. 1038) | site |
| | 1945 contours | | 5 (~el. 1035) | |
| | 1951 contours | | 10 (~el. 1030) | |
| Carson & Matti (1985) | 1973-1979 contours | -- | <50 | site |
| Matti & Carson (1991) | 1973-1983 contours | -- | 10 | site |
| SBVWCD (2021) | 2020 contours | -- | >150 | site |
| | 2019 contours | -- | >150 | |
| SBVWCD (2018) | 2017 contours | -- | >150 | |
| | 2016 contours | -- | >150 | |

According to Matti and Carson (1991), the historic-high groundwater depth at the site is approximately 10 feet bgs.The site is located in an area with historic artesian conditions (Mendenhall, 1905). However, the City of San Bernardino and other agenies manage groundwater levels to mitigate the shallow groundwater condition in the San Bernardino area and future artesian conditions are not anticpated. Recent measurements suggest groundwater depths greater than 50 feet bgs; however, in accordance with use of historic-high groundwater conditions for evaluation of liquefaction potential, we utilized a groundwater depth of 5 feet bgs to represent the historic-high groundwater depth for the project.

### Hydroconsolidation

To evaluate the potential deformation that may be caused by the addition of water to subsurface soils, hydroconsolidation testing was performed on selected, representative relatively undisturbed samples. The results are shown in Exploration Results section. The test results indicate collapse potentials of 0.35% (B-1 at 7.5 feet) and 0.4% (B-3 at 10 feet). The soil samples were saturated under an axial pressure of 2,000 psf.

## SITE GEOLOGY

The site is located within the San Bernardino Valley, part of the Peninsular Ranges geomorphic province. Most of the Peninsular Ranges is underlain by batholithic rocks of granitic composition. The San Bernardino Valley is formed as a downdropped structural block beneath valley sediments between the San Jacinto fault and San Andreas fault zones.

The site is underlain by Holocene-age axial-channel deposits (alluvium) as mapped by Morton and Miller (2006). As encountered in our site explorations, these materials include interlayered mixtures of silt, sand and gravel..

### Examination of Aerial Imagery

Available aerial imagery of the site region was examined for past site usage and condition. The site area appears as farmland in 1930 and 1938 imagery. The site appears in a similar condition in imagery dated 1959 with adjacent areas exhibiting residential and industrial developments. A residential structure is visible in the northern portion of the site in 1959. The site appears in a similar condition in 1977, 1994, and in subsequent images until August 2018 when the residential structure is removed. Based on the aerial imagery examined, the proposed building area footprint has not been subject to prior development.

### Regional Faulting

The tectonics of the Southern California area are dominated by the interaction of the North American and Pacific tectonic plates, which are sliding past each other in transform motion. Although some of the motion may be accommodated by rotation of crustal blocks such as the western Transverse Ranges (Dickinson, 1996), the San Andreas fault zone represents the major surface expression of the tectonic boundary and accommodates a significant portion of the slip between the Pacific and North American plates. Some of the slip is accommodated by other northwest-trending strike-slip faults that are related to the San Andreas system, such as the San Jacinto and Elsinore faults. Local compressional or extensional strain resulting from the transform motion along this boundary is accommodated by left-lateral, normal and reverse faults such as the Cucamonga fault. A Regional Fault Map is presented in **Supplemental Figures**.

**Fault Rupture Potential:** The site is not located within an Alquist-Priolo Earthquake Fault Zone (APZ) designated by the State of California for active faults (Hart, 1999). The closest APZ boundary, designated for the San Jacinto fault zone, is located approximately 2.4 miles (3.9 kilometers) southwest of the site. Known faults or fault-related features are not located within the site; therefore, the potential for fault rupture within the site is considered low.

**San Jacinto Fault Zone:** The San Jacinto fault zone is a system of northwest-trending, right-lateral, strike-slip faults and is a major element of the San Andreas fault system in southern California (Treiman and others, 1999). This right-slip fault zone branches off from the San Andreas near Cajon pass and extends southeastward through the Peninsular Ranges for 75 miles into southwestern Imperial Valley. The San Bernardino segment of the San Jacinto fault zone is located approximately 2.5 miles (4 kilometers) southwest of the site. Recent surface ruptures along the San Jacinto fault zone occurred in 1968 along the Coyote Creek segment during a magnitude 6.5 earthquake and in 1987 during the Superstiation Hills (magnitude 6.6) and Elmore Ranch (magnitude 6.2) earthquakes.

**San Andreas Fault Zone:** The San Andreas fault zone (SAFZ), a prominent geologic feature of California, traverses the northern side of the San Bernardino Valley along the southwest flank of the San Bernardino Mountains and is located approximately 4 miles northeast of the site. The mountain front in the San Bernardino area roughly demarcates the presently active trace of the San Andreas fault that is characterized by youthful fault scarps, aligned vegetation, topographic troughs, springs and offset drainage channels.

The greater San Andreas fault system is composed of multiple named segments extending through California that are postulated to rupture singly or together with other segments. The SAFZ is capable of producing magnitude 7.5 to 8 earthquakes under multi-segment rupture scenarios. The ShakeOut Scenario (USGS, 2008) is a study aimed at identifying the physical, social and economic effects of a major earthquake in southern California and preparing Californians before such an event occurs. The scenario earthquake selected for ShakeOut is a magnitude 7.8 event on the southern SAFZ, postulated to generate similar events on average every 150 years. Lateral slip for the scenario event is estimated as 9 to 30 feet. Fault rupture and strong ground shaking from the SAFZ present hazards to be mitigated for developments in the project area. Southwestward decrease in slip rates along the SAFZ northwest of its junction with the San Jacinto fault zone is suggested in studies by McGill and others (2021) and attests to the complexity of fault systems in southern California.

**Rialto Colton Fault:** The Rialto-Colton fault/groundwater barrier is depicted by U.S. Geological Survey, based on Treiman and Lundberg (1999), as a northwest-trending structure located approximately 3.9 miles southwest of the site. Additional depictions of the Rialto-Colton fault that approximate the locations depicted by U.S. Geological Survey include Morton and Miller (2006), Woolfenden and Kadhim (1997), Hart (1976) and Morton (1974).

Gravity data interpreted by Andersen and others (2000) depict the trend of the Rialto-Colton fault as an 8-mile-long, 1/2-mile-wide gravity anomaly trending northwest from the San Jacinto fault zone to San Sevaine Canyon at the foot of the San Gabriel Mountains. Catchings and others (2008) interpreted vertical offset in basement rocks near the projected surface trace of the Rialto-Colton fault and thus consider this fault, rather than the San Jacinto fault, to represent the southwest margin of the San Bernardino Valley structural basin. They also interpret faults of the San Bernardino Valley—including the Rialto-Colton fault—as having multiple parallel strands. Treiman and Lundberg (1999) state that the Rialto-Colton fault has no recognized geomorphic expression and is known principally as a groundwater barrier. Trenching studies along the trend of the Rialto-Colton fault revealed 6 feet of unfaulted Pleistocene-age sediments overlying a buried fault trace.

**Cucamonga Fault :** The southern margin of the San Gabriel Mountains is coincident with a series of east-west trending, predominantly reverse and thrust faults known as the Transverse Ranges frontal fault system. The San Fernando fault of this system ruptured during the 1971 magnitude 6.7 San Fernando earthquake. The Cucamonga fault of this system is located at the base of the San Gabriel Mountains, approximately 12 miles northwest of the site. Evidence of recent activity on this fault includes fresh scarps, sag ponds and disrupted Holocene alluvium (Dutcher and Garrett, 1963; Yerkes, 1985; Morton and Yerkes, 1987).

**Faults in San Bernardino Valley:** Several short fault splays defined by trenching studies for the Interstate 215/State Route 210 interchange and analysis of regional photographic lineaments and seismicity were reported by Schell (2008) at a location approximately 4-1/2 miles northwest of the site. These features are postulated to be a portion of an active fault zone that extends southeastward from the San Gabriel Mountains into the San Bernardino Valley along a trend located between and sub-parallel to the San Andreas and San Jacinto faults. Based on length/magnitude relations, this structure is estimated to produce magnitude 6 to magnitude 6.75 earthquakes (Schell, 2008). These and more distant regional faults such as the Cleghorn, Sierra Madre, Crafton Hills, Helendale and North Frontal faults are capable of producing strong ground shaking in the southern California region.

### Historical Earthquakes

A search of the USGS earthquake catalog for earthquakes of magnitude 4.5 or greater within 150 kilometers of the site returned 340 results including 3 events of magnitude 7 or greater, 21 events of magnitude 6 to 7, 96 events of magnitude 5 to 6 and 218 events of magnitude 4.5 to 5. A Regional Seismicity Map based on these data is attached.

The Clark segment of the San Jacinto fault zone is associated with the magnitude 6.4 San Jacinto earthquake of 1954. The most recent surface rupture along the San Jacinto fault zone occurred in 1968 along the Coyote Creek segment during an Mw 6.5 earthquake. Two earthquakes took place in the San Bernardino Valley. A magnitude 6.5 event in 1899 near Lytle Creek and a magnitude 6.2 event in 1923 near Lorna Linda may have occurred on the San Jacinto fault.

The Coachella Valley segment of the San Andreas fault was the locus for the 1948 Mw 6.5 earthquake in the Desert Hot Springs area and for the 1986 Mw 5.6 earthquake in the North Palm Springs area. Surface rupture occurred on the Mojave segment of the San Andreas fault in the great 1857 Fort Tejon earthquake. Using dendrochronological evidence, Jacoby and others (1987) inferred that a great earthquake on December 8, 1812, ruptured the northern reaches of the San Bernardino Mountains segment. Recent trenching studies have revealed evidence of rupture on the San Andreas fault at Wrightwood within this time frame (Fumal and others, 1993). Comparison of rupture events at the Wrightwood site and Pallett Creek, and analysis of reported intensities at the coastal missions, led Fumal and others (1993) to conclude that the December 8, 1812, event ruptured the San Bernardino Mountains segment of the San Andreas fault largely to the southeast of Wrightwood, possibly extending into the San Bernardino Valley.

### Tsunamis, Inundation, and Seiche and Flooding Potential

The site is not located within a 100-year flood zone or 500-year flood zone (FEMA, 2016). No evidence of recent significant flooding of the site was observed during the geologic field reconnaissance or on the aerial photographs reviewed. An evaluation of the storm-induced flood potential of the site falls under the purview of others.

The site is located within a potential inundation zone for seismically-induced dam/reservoir failure from Seven Oaks dam (City of San Bernardino General Plan, 2005).

The site is not located in a coastal area. No large water storage facilities are known to exist within the area of the site. Therefore, the potential for seismically-induced flooding due to seiche or tsunami to affect the site is considered very low.

### Subsidence Potential

The City of San Bernardino General Plan (2005) depicts an area of subsidence potential within the San Bernardino Valley that includes the site area. The most likely subsidence mechanism for this area would be permanent dewatering of artesian aquifers that occurred during the 20th century. Structures susceptible to subsidence include gravity sewers, surface drainage and storm drains. The proposed development is unlikely to be significantly affected should subsidence occur.

### Erosion Potential

Most of the subject site will be covered with structures or flatwork. Erosion by wind and water is not considered to be a hazard at the site.

### Slope Stability and Landslide Potential

The site is not located in an area identified as having a potential for landslides or lateral spreading. The site is relatively flat and level, and slopes are not located within the project boundaries. Therefore, the potential for landsliding or lateral spreading is considered very low.

Based on the relatively flat-lying site surface and planned development, significant temporary cut slopes are not expected during the proposed construction. For purposes of construction, the soils encountered in our explorations are considered type "C" materials. Accordingly, temporary slopes in near surface native soil should conform to applicable standards as outlined by Cal/OSHA for construction excavations (https://www.dir.ca.gov/title8/1541_1a.html).

## SEISMIC CONSIDERATIONS

### Seismic Design Parameters

The seismic design parameters, according to the 2019 CBC are provided in the following section based on the **site-specific method** of ASCE 7-16. The Site Classification (soil profile type) is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the California Building Code (CBC). We determined a characteristic shear wave velocity $Vs_{100}$ = 1155 feet per second [$Vs_{30}$ of 350 meters per second] for the site soil profile based on the average of two suites of CPT shear wave measurements extended to depths of 54 feet bgs and 69 feet bgs adjusted to 100 feet. This shear wave value is consistent with the high end of the range for ASCE 7-16 **Seismic Site Classification 'D'** at the C/D boundary condition. The site-specific $Vs_{30}$ value was used in deterministic models and the C/D boundary condition was used for determining probabilistic spectral values using the USGS Hazard Tool.

Subsurface explorations at this site were extended to a maximum depth of 69 feet. The site properties below the boring depths to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth. The seismic design parameters based on mapped and site-specific values are summarized in the following table according to site-specific method of ASCE 7-16, Chapter 21.

| Description | Value |
|---|---|
| 2019 CBC Site Classification [1] | D |
| Site Latitude | 34.1005 |
| Site Longitude | -117.2675 |
| Mapped Spectral Acceleration Parameters [2] | $S_S$ = 2.053 and $S_1$ = 0.806 |
| Site Coefficients | $F_A$ = 1.0[2] and $F_V$ = 1.7[3] |
| Site-specific Spectral Response Acceleration Parameters [4] | $SM_S$ = 2.493 and $SM_1$ = 1.989 |
| Design Spectral Acceleration Parameters [4] | $SD_S$ = 1.662 and $SD_1$ = 1.326 |
| Peak Ground Acceleration [4] | 0.885g |
| De-aggregated Magnitude [5] | 8.1 |

1. Seismic site classification in general accordance with the 2019 California Building Code, which refers to ASCE 7-16. Site class D used for determination of mapped values.
2. These values were obtained using online seismic design maps and tools provided by the 'ATC Hazards by Location' web-based application of Applied Technology Council.
3. ASCE 7-16 11.4.4
4. Site-specific values based on ASCE 7-16, 21.4 and 21.5
5. USGS Unified Hazard Tool https://earthquake.usgs.gov/hazards/interactive.

## Site-Specific Ground Motions

A site-specific ground motion study for the project was performed and included a ground motion hazard analysis. We performed this analysis in general conformance with Chapter 21 of ASCE 7-16.

The procedures outlined in ASCE 7-16 Chapters 11, 20 and 21 were utilized for preparation of site-specific spectra for the proposed project. The site is approximately 2.5 miles (4 kilometers) northeast of the mapped trace of the San Jacinto fault zone and 4.1 miles (6.6 kilometers) southwest of the San Andreas fault zone. The is located approximately 11.5 miles (18.5 kilometers) southeast of the Cucamonga fault. A Class C/D soil profile condition was utilized in the analysis. We prepared deterministic and probabilistic spectra and associated limiting spectra.

The site-specific response spectra in tabular and graphic forms and a discussion of methodology are included in this report.

Deterministic Spectrum

Deterministic MCE spectra based on scenario events on nearby faults and consistent with the Next Generation West 2 (NGA-West 2) attenuation relations (GMPEs) used for the 2014 USGS seismic source models were calculated. The fault properties used are summarized in the following table.

| Fault | Magnitude | Distance (km) | Direction | Type |
|---|---|---|---|---|
| Cucamonga | 6.7 | 18.5 | NW | reverse |
| San Jacinto | 7.88 | 4.0 | SW | Strike slip |
| San Andreas | 8.2 | 6.6 | NE | Strike slip |

We used $V_{S30}$ = 350 meters/second. Basin factors Z1.0 and Z2.5 were adapted from Southern California Earthquake Center (SCEC) Community Velocity Models (CVM S4 and H11) as compiled by Graves (2011). We evaluated the basin factors for the combination that resulted in highest amplitude at any spectral period for each contributing fault and compiled them for the deterministic spectrum. The resulting deterministic spectrum is controlled by the San Jacinto fault at periods from 0.02 to 2 seconds and the San Andreas fault at periods from PGA to 0.01 second and 3 to 5 seconds.

The equally-weighted spectral values from the attenuation relations of Abrahamson and others (ASK 2014), Boore and others (BSSA 2014), Campbell and Borzognia (CB 2014) and Chiou and Youngs (CY 2014) were used for the deterministic MCE spectra. The MCE spectrum represents $84^{th}$-percentile, 5-percent-damped spectral response acceleration in the direction of maximum horizontal response (maximum rotated) for each period. Maximum rotated values were obtained using the scaling factors of Shahi and Baker (2014). The deterministic $MCE_R$ spectrum and associated spectra are attached in tabular and graphic forms.

Probabilistic $MCE_R$ Spectrum

An $MCE_R$ spectrum was developed as a probabilistic spectrum using site class C/D values obtained with the USGS Hazard Tool (https://earthquake.usgs.gov/hazards/interactive/) web-based software application consistent with the Next Generation West 2 (NGA-West 2) attenuation relations (GMPEs). The equally-weighted spectral values from the attenuation relations of Abrahamson and others (ASK 2014), Boore and others (BSSA 2014), Campbell and Borzognia (CB 2014) and Chiou and Youngs (CY 2014) were used for the probabilistic spectrum. The values so obtained were scaled from geomean to maximum rotated values using the factors of Shahi and Baker (2014). Gridded seismic sources are included in the probabilistic model. The probabilistic MCE spectrum was converted to a risk-targeted spectrum ($MCE_R$) using the USGS Risk Targeted Ground Motion Calculator tool (https://code.usgs.gov/ghsc/hazdev/earthquake-rtgm-calculator).

Site-Specific $MCE_R$ Spectrum

The lesser of the values at any period from the deterministic $MCE_R$ and probabilistic $MCE_R$ spectra form the site-specific $MCE_R$ spectrum per ASCE 7-16 21.2.3. For the subject site, the deterministic spectrum controls the design spectrum at all periods.

Design Spectrum

A design response spectrum was determined according to the procedure outlined in ASCE 7-16, Section 21.3, and is equal to two-thirds of the response spectral accelerations of the site-specific $MCE_R$. The design spectrum is limited by a 'floor' at 80 percent of spectral acceleration determined according to ASCE 7-16, Section 11.4.6. For this site, the 'floor' condition was not applied. The recommended site-specific design response spectrum is attached in tabular and graphic forms.

## Peak Ground Acceleration (PGA)

According to ASCE 7-16, Section 11.4.8, the site-specific geometric mean ($MCE_G$) PGA used for evaluation of soil effects is based on the lesser of the site-specific deterministic and probabilistic PGA values with an adjustment to 80% of the code value if needed. The following table summarizes the PGA values considered for the project.

| Site-Specific PGA Values | |
|---|---|
| Code-Based Geometric Mean PGA | 0.946 |
| 80 Percent of Code-Based PGA | 0.757g |
| Probabilistic Geometric Mean PGA | 1.208g |
| Deterministic Geometric Mean PGA | 0.885g |
| Recommended Site-Specific PGA | 0.885g |

For the site-specific ($MCE_G$) PGA, the deterministic value is the lesser of the probabilistic and deterministic values and is greater than 80 percent of the code-based geometric mean PGA value. Therefore, we recommended a site-specific PGA value of 0.885g for evaluation of soil effects such as liquefaction or seismic settlement.

Based on the USGS Unified Hazard Tool, the project site has a de-aggregated modal magnitude of 8.1 at a distance of 5 kilometers with the majority of hazard contributed by the San Jacinto and San Andreas fault sources.

## LIQUEFACTION AND SEISMIC SETTLEMENT

### Liquefaction Potential

Liquefaction is a mode of ground failure that results from the generation of high pore-water pressures during earthquake ground shaking, causing loss of shear strength, and is typically a hazard where loose sandy soils exist below groundwater. San Bernardino County has designated certain areas as potential liquefaction hazard zones. These are areas considered at a risk of liquefaction-related ground failure during a seismic event, based upon mapped surficial deposits and the presence of a relatively shallow water table.

According to the County of San Bernardino(2010) and City of San Bernardino (2005), the site is located within an area identified as having a 'high' liquefaction potential. A study by Matti and Carson (1991) also identified a potential for liquefaction to occur in the area of the site.

The subsurface materials generally consist of Interbedded layers of well graded sand with gravel, silt with sand, poorly graded sand with silt, silty sand with gravel and poorly graded gravel extending to the maximum depth of the borings approximately 51½ feet bgs. Although groundwater was not encountered during the course of drilling, for evaluation of liquefaction analyses, we utitlized a groundwater depth of 5 feet bgs consistent with documented historic-high groundwater conditions and a conservative estimate of expected groundwater levels. The liquefaction evaluation was performed using the data from borings and CPT soundings.

### Seismic Settlement

To determine the amount of seismic settlement, we utilized the software "LiquefyPro" by CivilTech Software, seismic settlement was estimated using the soil profile from exploratory borings B-1, B-2, and B-3, and CPT soundings CPT-1, CPT-2B, CPT-3 and CPT-4. A Peak Ground Acceleration (PGA) of 0.885g and the de-aggregated mean magnitude of 8.1 were utilized as input into the liquefaction analysis program. Settlement analysis used the Ishihara / Yoshimine method and the fines percentage were corrected for liquefaction using the Modify Stark/Olson method.

Based on the calculation results, seismically induced settlement (dry sand and liquefaction settlement) is estimated to be on the order of 5 inches based on data from boring B-2. Seismic settlement is estimated to be 1¾ ,2 ¼ , 2¾ and 3½ inches based on data from CPT-1, CPT-2B, CPT-3 and CPT-4, respectively. The maximum differential seismic settlement could be on the order of half of total seismic settlement over a distance of 40 feet. Seismic settlements for dry sand and liquefaction (water table at 5 feet bgs) are summarized in the table below.

| Boring/CPT | Liquefaction Settlement (GW @ 5 feet) | Dry Seismic Settlement (GW @ 50 feet) | Anticipated Differential Settlement |
|---|---|---|---|
| B-1 | 3 ½ | 3 ½ | 1 ½ |
| B-2 | 5 | 4 ¾ | 2 ½ |
| B-3 | 4 ¼ | 3 ½ | 2 |
| CPT-1 | 1 ¼ | 1 ¾ | ¾ |
| CPT-2B | 2 ¼ | 2 ¼ | 1 |
| CPT-3 | 2 ¼ | 2 ¾ | 1 ¼ |
| CPT-4 | 3 ¼ | 3 ½ | 1 ½ |

## GEOTECHNICAL OVERVIEW

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing, engineering analyses, and our current understanding of the proposed project.

The subsurface materials generally consist of Interbedded layers of well graded sand with gravel, silt with sand, poorly graded sand with silt, silty sand with gravel and poorly graded gravel extending to the maximum depth of the borings approximately 51½ feet bgs. On-site subsurface soils are not expected to experience substantial volumetric changes (shrink/swell) with fluctuations in moisture content.

Groundwater seepage was not observed within the maximum depths of exploration during or at the completion of drilling.. Groundwater is not expected to affect shallow foundation construction on this site.

The **General Comments** section provides an understanding of the report limitations.

## EARTHWORK

The following recommendations include site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth supported elements including foundations, slabs, and pavements are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

### Site Preparation

Strip and remove existing vegetation, debris, pavements and other deleterious materials from proposed buildings and pavement areas. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction. The site should be initially graded to create a relatively level surface to receive fill and provide for a relatively uniform thickness of fill beneath proposed building structures.

Although there was no evidence of underground facilities such as septic tanks, cesspools, and basements, such features could be encountered during construction. If unexpected fills, utilities, or underground facilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

### Subgrade Preparation

Due to the presence of relatively loose soils and potential for seismic settlement in the upper zones of the on-site soils, we recommend that the proposed structures be supported on engineered fill extending to a minimum depth of 3 feet below the bottom of foundations, or 6 feet below existing grades, whichever is greater. Engineered fill placed beneath the entire footprint of the structures should extend horizontally a minimum distance of 5 feet beyond the outside edge of perimeter footings.

Subgrade soils beneath exterior slabs and pavements should be removed to a depth of 12 inches below the existing or proposed grades, whichever is deeper, and replaced with compacted engineered fill.

Exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 10 inches, moisture conditioned as necessary, and compacted per the compaction requirements in this report. Compacted fill soils should then be placed to the design grades, and the moisture content and compaction of soils should be maintained until slab, pavement, or proposed improvements are constructed.

Based upon the subsurface conditions determined from the geotechnical exploration, the on site soils are suitable for the proposed fill soils, and are anticipated to be relatively workable. However, the workability of the soils may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

### Excavation

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

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

### Fill Material Types

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than three inches in size. Pea gravel or other similar non-cementitious, poorly-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

Clean on-site soils or approved imported materials may be used as fill material for the following:

| | |
|---|---|
| ■ general site grading | ■ foundation backfill |
| ■ foundation areas | ■ pavement areas |
| ■ interior floor slab areas | ■ exterior slab areas |

If imported soils are used as fill materials to raise grades, these soils should conform to low volume change materials and should conform to the following requirements:

| Gradation | Percent Finer by Weight (ASTM C 136) |
|---|---|
| 3” | 100 |
| No. 4 Sieve | 50 - 100 |
| No. 200 Sieve | 20 - 50 |

- Liquid Limit ........ 30 (max)
- Plasticity Index ........ 15 (max)
- Maximum Expansive Index* ........ 20 (max)

*ASTM D 4829

The contractor shall notify the Geotechnical Engineer of import sources sufficiently ahead of their use so that the sources can be observed and approved as to the physical characteristic of the import material. For all import material, the contractor shall also submit current verified reports from a recognized analytical laboratory indicating that the import has a "not applicable" (Class S0) potential for sulfate attack based upon current ACI criteria and is "mildly corrosive" to ferrous metal and copper. The reports shall be accompanied by a written statement from the contractor that the laboratory test results are representative of all import material that will be brought to the job.

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed 10 inches loose thickness.

### Compaction Requirements

| Material Type and Location | Per the Modified Proctor Test (ASTM D 1557) | | |
|---|---|---|---|
| | Minimum Compaction Requirement (%) | Range of Moisture Contents for Compaction Above Optimum | |
| | | Minimum | Maximum |
| On-site soils and/or low volume change imported fill: | | | |
| Beneath foundations: | 90 | 0% | +3% |
| Beneath interior slabs: | 90 | 0% | +3% |
| Miscellaneous backfill: | 90 | 0% | +3% |
| Beneath pavements: | 95 | 0% | +3% |
| Utility Trenches*: | 90 | 0% | +3% |
| Bottom of excavation receiving fill: | 90 | 0% | +3% |
| Aggregate base (beneath pavements): | 95 | 0% | +3% |

* Upper 12 inches should be compacted to 95% within pavement and structural areas.

### Utility Trenches

We anticipate that the on-site soils will provide suitable support for underground utilities and piping that may be installed. Any soft and/or unsuitable material encountered at the bottom of excavations should be removed and be replaced with an adequate bedding material. A non-expansive granular material with a sand equivalent greater than 30 is recommended for bedding and shading of utilities, unless otherwise allowed by the utility manufacturer.

On-site materials are considered suitable for backfill of utility and pipe trenches from one foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

### Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction. Planters and other surface features which could retain water in areas adjacent to the building or pavements should be sealed or eliminated. In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately 5 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

We recommend a minimum horizontal setback distance of 10 feet from the perimeter of any building and the high-water elevation of the nearest storm-water retention basin.

Roof drainage should discharge into splash blocks or extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Sprinkler systems and landscaped irrigation should not be installed within 5 feet of foundation walls.

## Exterior Slab Design and Construction

Exterior slabs-on-grade, exterior architectural features, and utilities founded on, or in backfill may experience some movement due to the volume change of the backfill. To reduce the potential for damage caused by movement, we recommend:

- minimizing moisture increases in the backfill;
- controlling moisture-density during placement of backfill;
- using designs which allow vertical movement between the exterior features and adjoining structural elements;
- placing effective control joints on relatively close centers.

### Construction Considerations

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

Onsite soils contains zones of cohesionless sandy soils. Such soils have the tendency to cave and slough during excavations. Therefore, formwork may be needed for foundation excavations.

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

### Construction Observation and Testing

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proof-rolling, placement and compaction of controlled compacted fills, backfilling of excavations to the completed subgrade.

The exposed subgrade and each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event that unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

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

## SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

| Item | Description |
|---|---|
| **Foundation Support** | Engineered fill extending 3 foot below the bottom of foundations, or 6 feet below existing grades, whichever is greater. |
| **Net Allowable Bearing pressure [1, 2] (On-site soils or structural fill)** | 2,500 psf |
| **Minimum Foundation Dimensions** | Columns: 24 inches<br>Continuous: 18 inches |
| **Minimum Footing Depth** | 18" below finished grade |
| **Ultimate Passive Resistance [4]** | 375 pcf |
| **Ultimate Coefficient of Sliding Friction [5]** | 0.36 |
| **Estimated Total Static Settlement from Structural Loads [2]** | about 1 inch |
| **Estimated Differential Settlement [2, 6]** | About 1/2 of total settlement |

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied.
2. Values provided are for maximum loads noted in **Project Description**. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork**.
4. Use of passive earth pressures requires the footing forms be removed and compacted structural fill be placed against the vertical footing face. A factor of safety of 2.0 is recommended.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions. A factor of safety of 1.5 is recommended.
6. Differential settlements are as measured over a span of 40 feet.

## Mat Foundation Design Recommendations

| DESCRIPTION | RECOMENDATION |
|---|---|
| **Foundation Type** | Mat Foundation |
| **Bearing Material** | Engineered fill extending 3 feet below the bottom of foundations, or 6 feet below existing grades, whichever is greater. |
| **Maximum Net Allowable Bearing Pressure[1]** | 2,500 psf |
| **Mat Width (feet)** | 5 to 15 |
| **Modulus of Subgrade Reaction, kb** | 150 psi/in |
| **Minimum Embedment Depth Below Finished Grade** | 18 inches |

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the foundation base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions.

The subgrade modulus ($K_b$) for the mat is affected by the size of the mat foundation and would vary according the following equation:

$$K_b = Kv_1 \times (B+1)^2 / 4B^2$$

Where: $Kv_1$ is the modulus of vertical subgrade reaction
B is the width of the mat foundation.

Thus, for a footing width of B = 10 ft bearing on the onsite soils, the subgrade modulus would be:

$$K_b = 150 \times (10+1)^2 / (4\times 10^2) = 45 \text{ pci}$$

### Foundation Construction Considerations

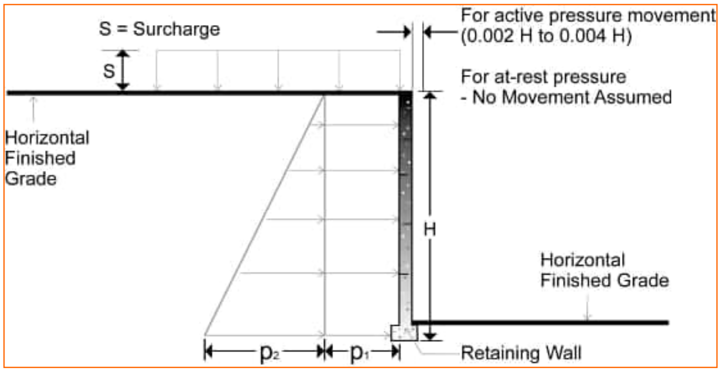
As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

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

## LATERAL EARTH PRESSURES

### Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The “at-rest” condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).




For on-site or import materials that are compacted as recommended in this report, we recommend the following preliminary lateral earth pressure parameters

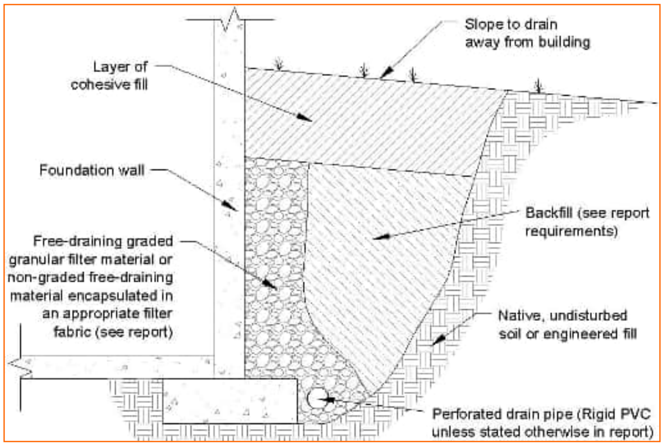
| ITEM[1,2] | EFFECTIVE FLUID PRESSURE[5] (UNSATURATED) [6] |
|---|---|
| Active ($K_a$) | 42 psf/ft |
| Passive ($K_p$) | 375 psf/ft |
| At-Rest ($K_0$) | 63 psf/ft |
| Surcharge Loads[3,4] | 0.33 x (S) psf |
| Coefficient of Friction** | 0.36 |
| Wall Foundation Support | Engineered fill extending 2-foot below the bottom of wall foundation |
| Net Allowable Bearing Pressure[7] | 2,200 psf |

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure conditions, wall movement in a range of 0.005H to 0.01H (H is the height of the wall) is required to fully mobilize passive earth pressures. If this scale of wall movement is not expected, a reduction factor of 50% may be used for passive earth pressure condition design.
2. Uniform, horizontal backfill, compacted to at least 90 percent of the ASTM D1557 maximum dry density, rendering a maximum unit weight of 125 pcf.
3. Uniform surcharge, where S is surcharge pressure. The project structural engineer should provide any surcharge loading.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values.
6. To achieve "Unsaturated" conditions, follow guidelines in Retaining Wall Drainage below. Terracon should be contacted if drainage systems will not be installed behind retaining walls or if the walls will be located below groundwater.
7. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied.

Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

### Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.




As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion, and is fastened to the wall prior to placing backfill.

### Subsurface Drainage for Below Grade Walls

Backfill behind retaining walls should consist of a soil of granularity sufficient that the backfill will properly drain. The granular soil should be classified per the USCS as GW, GP, SW, SP, SW-SM or SP-SM. Surface drainage should be provided to prevent ponding of water behind walls. A drainage system consisting of either or both of the following should be installed behind all retaining walls:

1. A 4-inch-diameter perforated PVC (Schedule 40) pipe or equivalent at the base of the stem encased in 2 cubic feet of granular drain material per linear foot of pipe or
2. Synthetic drains such as Enkadrain, Miradrain, Hydraway 300 or equivalent.

Perforations in the PVC pipe should be 3/8 inch in diameter and should be placed facing down. Granular drain material should be wrapped with filter cloth such as Mirafi 140 or equivalent to prevent clogging of the drains with fines. Walls should be waterproofed to prevent nuisance seepage and damage. Water should outlet to an approved drain.

## FLOOR SLABS

| DESCRIPTION | RECOMMENDATION |
|---|---|
| **Interior floor system** | Slab-on-grade concrete |
| **Floor slab support** | Reinforced engineered fill extending 3 feet below the bottom of associated foundations, or 6 feet below existing grades, whichever is greater. |

| DESCRIPTION | RECOMMENDATION |
|---|---|
| **Subbase** | Minimum 4-inches of Aggregate Base |
| **Modulus of subgrade reaction** | 150 pounds per square inch per inch (psi/in) (The modulus was obtained based on estimates obtained from NAVFAC 7.1 design charts). This value is for a small loaded area (1 Sq. ft or less) such as for forklift wheel loads or point loads and should be adjusted for larger loaded areas. |

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

## PAVEMENTS

### General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

### Pavement Design Parameters

Design of asphalt concrete (AC) pavements is based on the procedures outlined in the Caltrans "Highway Design Manual for Safety Roadside Rest Areas" (Caltrans, 2016). Design of Portland cement concrete (PCC) pavements are based upon American Concrete Institute (ACI) 330R-08; "Guide for Design and Construction of Concrete Parking Lots."

A laboratory R-value test was performed on one sample retrieved from the exploratory borings. The test resulted in R-value of 63. As recommended by Caltrans, a maximum design R-value of 50 was used for the design of pavement sections. A modulus of rupture of 600 psi was used for pavement concrete.

The structural sections are predicated upon proper compaction of the utility trench backfills and the subgrade soils as prescribed by in **Earthwork**, with the upper 12 inches of subgrade soils and all aggregate base material brought to a minimum relative compaction of 95 percent in accordance with ASTM D 1557 prior to paving. The aggregate base should meet Caltrans requirements for Class 2 base.

The pavement designs were based upon the results of preliminary sampling and testing and should be verified by additional sampling and testing (specifically R-value testing) during construction when the actual subgrade soils are exposed. Additionally, the preliminary sections provided are minimums based on procedures previously referenced. The project civil engineer should confirm minimum Traffic Indices and sections required by local agencies or jurisdictions if applicable.

### Pavement Section Thicknesses

The following table provides options for AC and PCC Sections:

| Asphalt Concrete Design | | |
|---|---|---|
| **Usage** | **Assumed Traffic Index** | **Recommended Structural Section** |
| Auto Parking Areas | 4.5 | 3" HMA[1]/4" Class 2 AB[2] |
| Auto Driveways | 5.5 | 3" HMA[1]/4" Class 2 AB[2] |
| Truck Delivery Areas | 7.0 | 4" HMA[1]/5" Class 2 AB[2] |
| Heavy Fire Truck Access | 8.0 | 4" HMA[1]/7" Class 2 AB[2] |

1. HMA = hot mix asphalt
2. AB = aggregate base

| Portland Cement Concrete Design | | | |
|---|---|---|---|
| Layer | Thickness (inches) | | |
| | Light Duty[1] | Medium Duty[2] | Dumpster Pad[3] |
| PCC | 5.0 | 6.0 | 7.5 |
| Aggregate Base [4] | -- | -- | -- |

1. Car Parking and Access Lanes, Average Daily Truck Traffic (ADTT) = 1 (Category A).
2. Truck Parking Areas, Multiple Units, ADTT = 25 (Category B)
3. In areas of anticipated heavy traffic, fire trucks, delivery trucks, or concentrated loads (e.g., dumpster pads), and areas with repeated turning or maneuvering of heavy vehicles, ADTT = 700 (Category C).
4. Aggregate base is not required. Compacted on-site material is considered competent.

Recommended structural sections were calculated based on assumed TIs and our preliminary sampling and testing.

Terracon does not practice traffic engineering. We recommend that the project civil engineer or traffic engineer verify that the TIs and ADTT traffic indices used are appropriate for this project.

### Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

### Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2 percent.
- Subgrade and pavement surfaces should have a minimum 2 percent slope to promote proper surface drainage.
- Install below pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

## STORM WATER MANAGEMENT

Three in-situ infiltration tests (falling head borehole permeability) were performed at approximate depths of 5 and 10 feet bgs within boreholes drilled with an 8-inch diameter auger. The objective of the testing is to provide infiltration rates for designing the proposed infiltration system. A 2-inch thick, 3/4-inch gravel layer was placed in the bottom of each boring after the borings were drilled to investigate the soil profile. Three-inch diameter perforated pipes were installed on top of the gravel layer and gravel was used to backfill between the perforated pipes and the boring sidewall. The borings were then filled with water for a pre-soak period.

At the beginning of each test, the pipes were refilled with water and readings were taken at periodic time intervals as the water level dropped. The soil at the percolation test locations was classified in the field using a visual/manual procedure. The infiltration velocity is presented as the infiltration rate and is summarized in the following table. The infiltration rates provided do not include safety factors.

| Test Location | Boring Depth (ft.) [1] | Test Depth Range (ft.) [1] | Soil Type | Water Head (ft) | Percolation Rate Average (in./hr.) | Infiltration Rate Average (in./hr.) [2] |
|---|---|---|---|---|---|---|
| P-1 | 5 | 0 to 5 | SM | 5 | 205.2 | 3.91 |
| P-2 | 10 | 5 to 10 | SP-SM | 5 | 271.8 | 13.81 |
| P-3 | 5 | 0 to 5 | SP-SM | 5 | 19.2 | 0.33 |

1. Below existing ground surface.
2. If proposed infiltration system will mainly rely on vertical downward seepage, the correlated infiltration rates should be used. The correlated infiltration rates were calculated using the Porchet method.

The above infiltration rates determined by the percolation test method are based on field test results utilizing clear water. Infiltration rates can be affected by silt buildup, debris, degree of soil saturation, site variability and other factors. The rate obtained at specific location and depth is representative of the location and depth tested and may not be representative of the entire site. Application of an appropriate safety factor is prudent to account for subsoil inconsistencies, possible compaction related to site grading, and potential silting of the percolating soils, depending on the application.

The design engineer should also check with the local agency for the limitation of the infiltration rate allowed in the design. If the maximum allowable design infiltration rate is lower than the above recommended rate, the maximum allowable design infiltration rate should be used. The designer of the basins should also consider other possible site variability in the design.

The percolation tests were performed with clear water, whereas the storm water will likely not be clear, but may contain organics, fines, and grease/oil. The presence of these deleterious materials will tend to decrease the rate that water percolates from the infiltration systems. Design of the storm water infiltration systems should account for the presence of these materials and should incorporate structures/devices to remove these deleterious materials.

Based on the soils encountered in our borings, we expect the percolation rates of the soils could be different than measured in the field due to variations in fines and gravel content. The design elevation and size of the proposed infiltration system should account for this expected variability in infiltration rates.

Infiltration testing should be performed after construction of the infiltration system to verify the design infiltration rates. It should be noted that siltation and vegetation growth along with other factors may affect the infiltration rates of the infiltration areas. The actual infiltration rate may vary from the values reported here. Infiltration systems should be located at least 10 feet from any existing or proposed foundation system.

## CORROSIVITY

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

| Boring | Depth (feet) | Soluble Sulfate (mg/kg) | Soluble Chloride (mg/kg) | Total Salts (mg/kg) | pH | Resistivity (as-received) (Ohm-cm) | Resistivity (saturated) (Ohm-cm) |
|---|---|---|---|---|---|---|---|
| **B-3** | 2 to 5 | 83 | 30 | 356 | 7.36 | 57,230 | 2,716 |

Results of soluble sulfate testing indicate samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 4.3.1 of the ACI Design Manual. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

For protection against corrosion to buried metals, Terracon recommends that an experienced corrosion engineer be retained to design a suitable corrosion protection system for underground metal structures or components.

If corrosion of buried metal is critical, it should be protected using a non-corrosive backfill, wrapping, coating, sacrificial anodes, or a combination of these methods, as designed by a qualified corrosion engineer.

## GENERAL COMMENTS

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

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

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

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

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# ATTACHMENTS

# EXPLORATION AND TESTING PROCEDURES

## Field Exploration

Terracon conducted six (6) soil-testing borings. These borings were drilled at the locations and to depths indicated in the table below.

| Boring Number | Boring Depth (feet) [1] | Location |
|---|---|---|
| B-1, B-2, and B-3 | 51 ½ | Building pad |
| B-4 to B-9 | 6 ½ to 11 ½ | Parking/driveways |
| CPT-1 | 69 | Building pad |
| CPT-2[2] | 18 | Building pad |
| CPT-2A[2] | 17 | Building pad |
| CPT-2B | 53 | Building pad |
| CPT-3 | 53 | Building pad |
| CPT-4 | 52 | Building pad |
| P-1, P-2, and P-3 | 5 to 10 | Infiltration area |

1. Below ground surface.
2. Shallow refusals were encountered at the locations of CPT-2 and CPT-2A, therefore another offset CPT was conducted at the location of CPT-2B

**Boring Layout and Elevations:** Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from the Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

**Subsurface Exploration Procedures:** We advance the borings with a truck-mounted drill rig using hollow-stem augers. Both a standard penetration test (SPT) sampler (2-inch outer diameter and 1-3/8-inch inner diameter) and a modified California ring-lined sampler (3-inch outer diameter and 2-3/8-inch inner diameter) are utilized in our investigation. The penetration resistance is recorded on the boring logs as the number of hammer blows used to advance the sampler in 6-inch increments (or less if noted). The samplers are driven with an automatic hammer that drops a 140-pound weight 30 inches for each blow. After the required seating, samplers are advanced up to 18 inches, providing up to three sets of blowcounts at each sampling interval. The sampling depths, penetration distances, and other sampling information are recorded on the field boring logs. The recorded blows are raw numbers without any corrections for hammer type (automatic vs. manual cathead) or sampler size (ring sampler vs. SPT sampler). Relatively undisturbed and bulk samples of the soils encountered are placed in sealed containers and returned to the laboratory for testing and evaluation.

We observe and record groundwater levels during drilling and sampling. For safety purposes, all borings are backfilled with auger cuttings after their completion.

Our exploration team prepares field boring logs as part of the drilling operations. These field logs include visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs are prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

**Laboratory Testing**

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- Water (Moisture) Content of Soil by Mass
- Laboratory Determination of Density (Unit Weight) of Soil Specimens
- Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
- Modified Proctor test
- R-value test
- Hydro-consolidation test
- Corrosivity suite test

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

# SITE LOCATION AND EXPLORATION PLANS

**SITE LOCATION**

SBC Valley Communication Center ■ San Bernardino, San Bernardino County, California
February 24, 2022 ■ Terracon Project No. CB215173

Terracon GeoReport

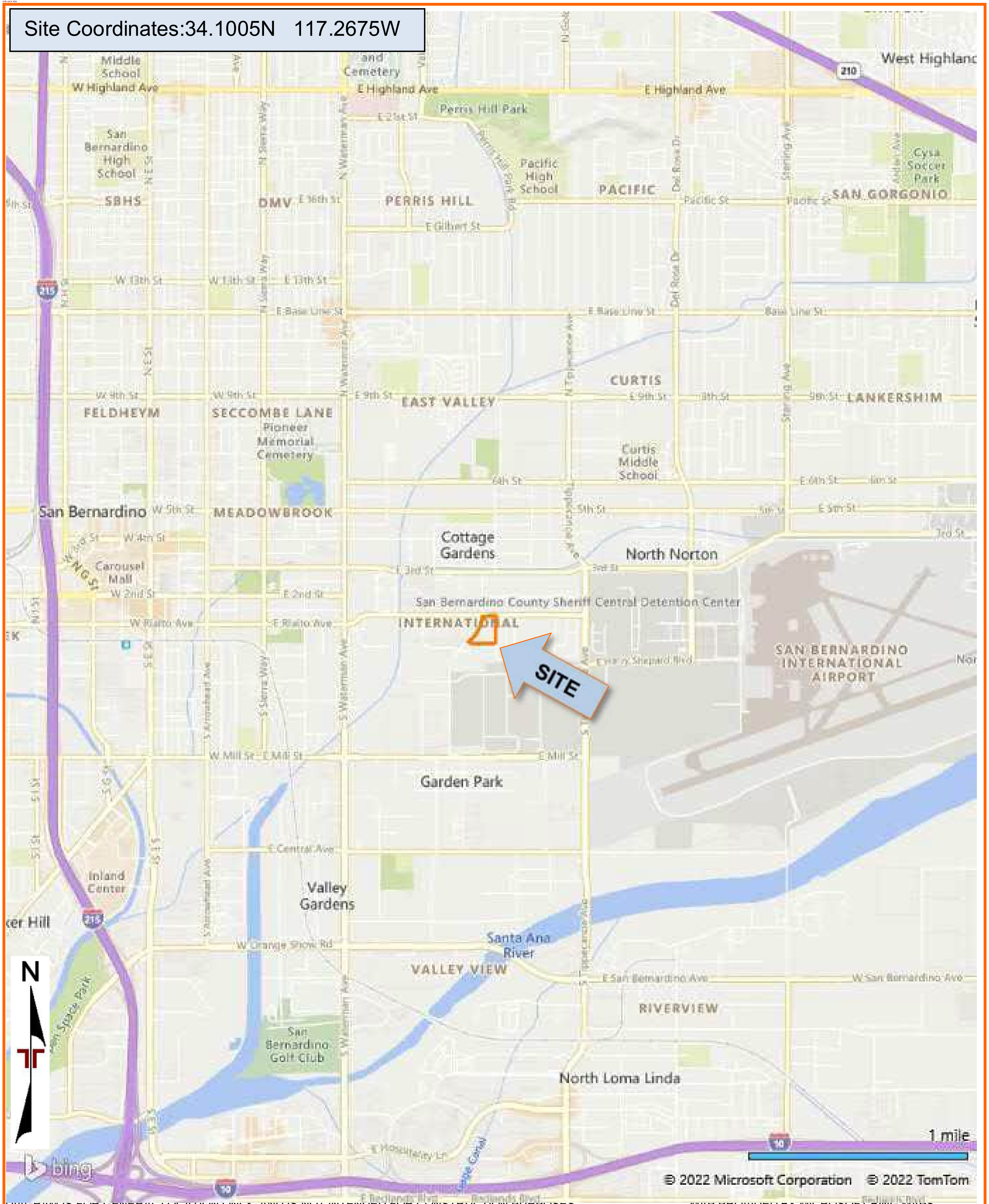



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

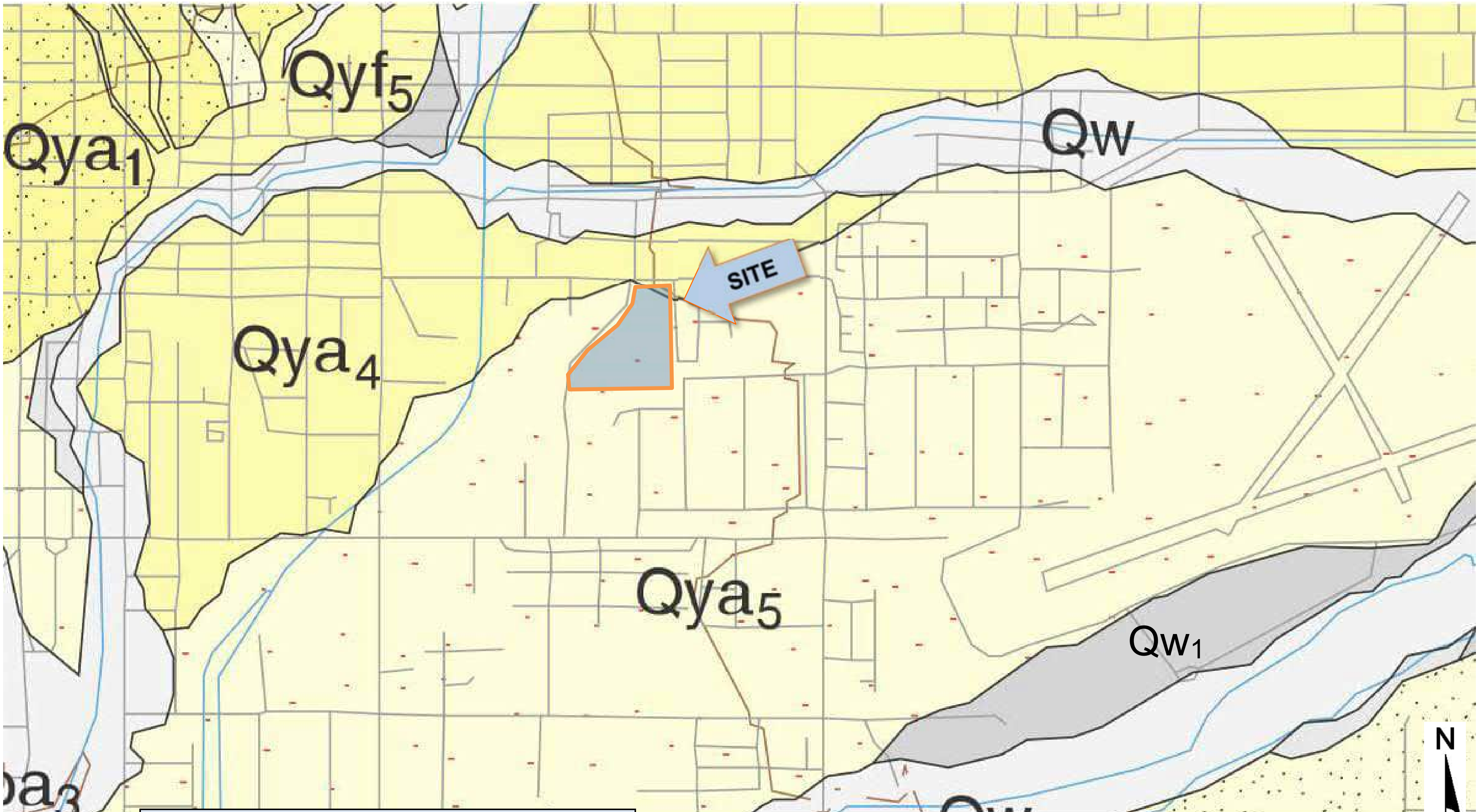
MAP PROVIDED BY MICROSOFT BING MAPS

# EXPLORATION PLAN

SBC Valley Communication Center ■ San Bernardino, San Bernardino County, California
February 24, 2022 ■ Terracon Project No. CB215173

# SUPPLEMENTAL FIGURES

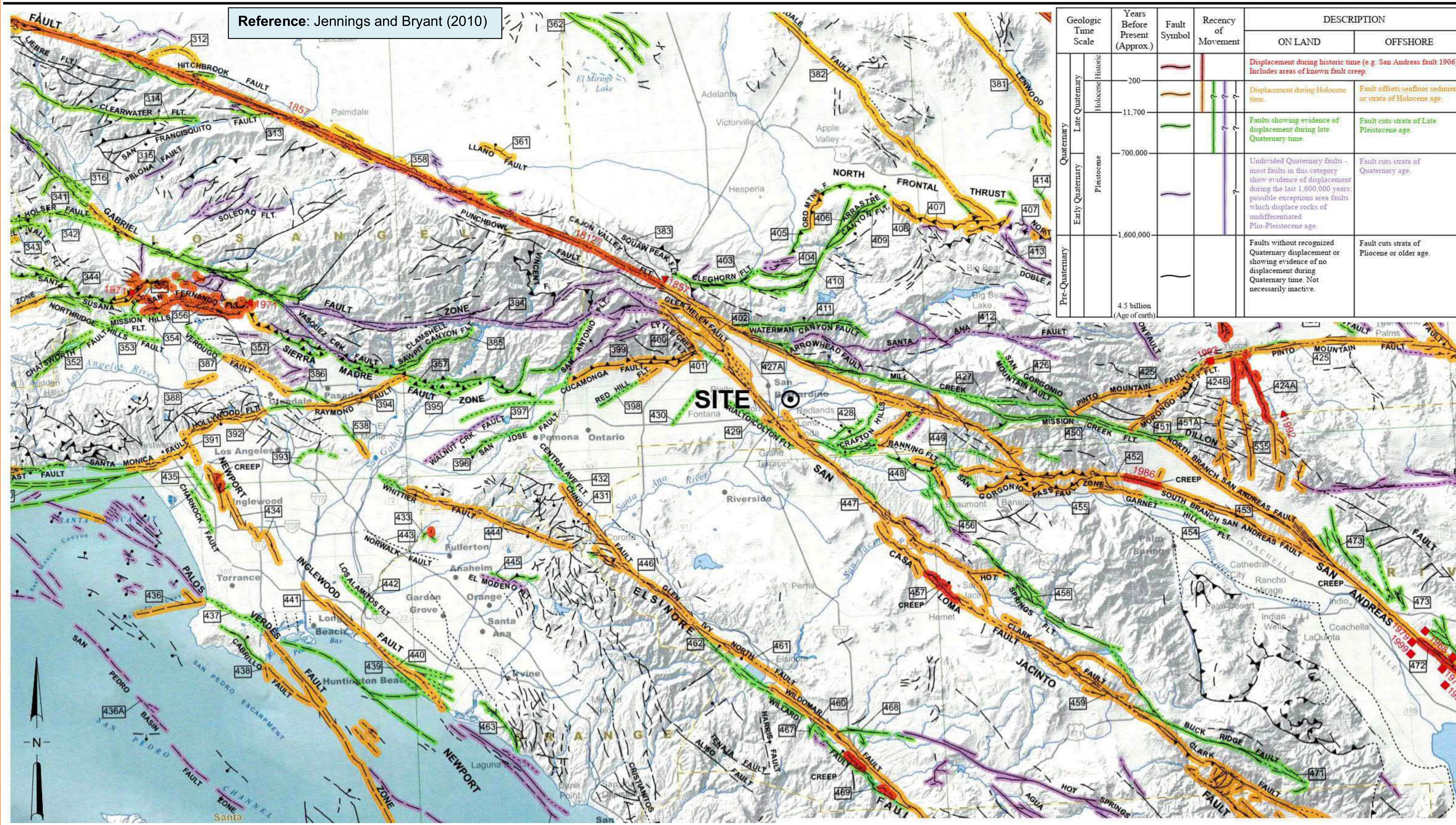
**Contents:**




**Geologic Units:**

Qw, Qw1 very young wash deposits
Qya1, 5 young axial channel deposits
Qyf5 young alluvial-fan deposits

**Reference**: Morton and Miller (2006)

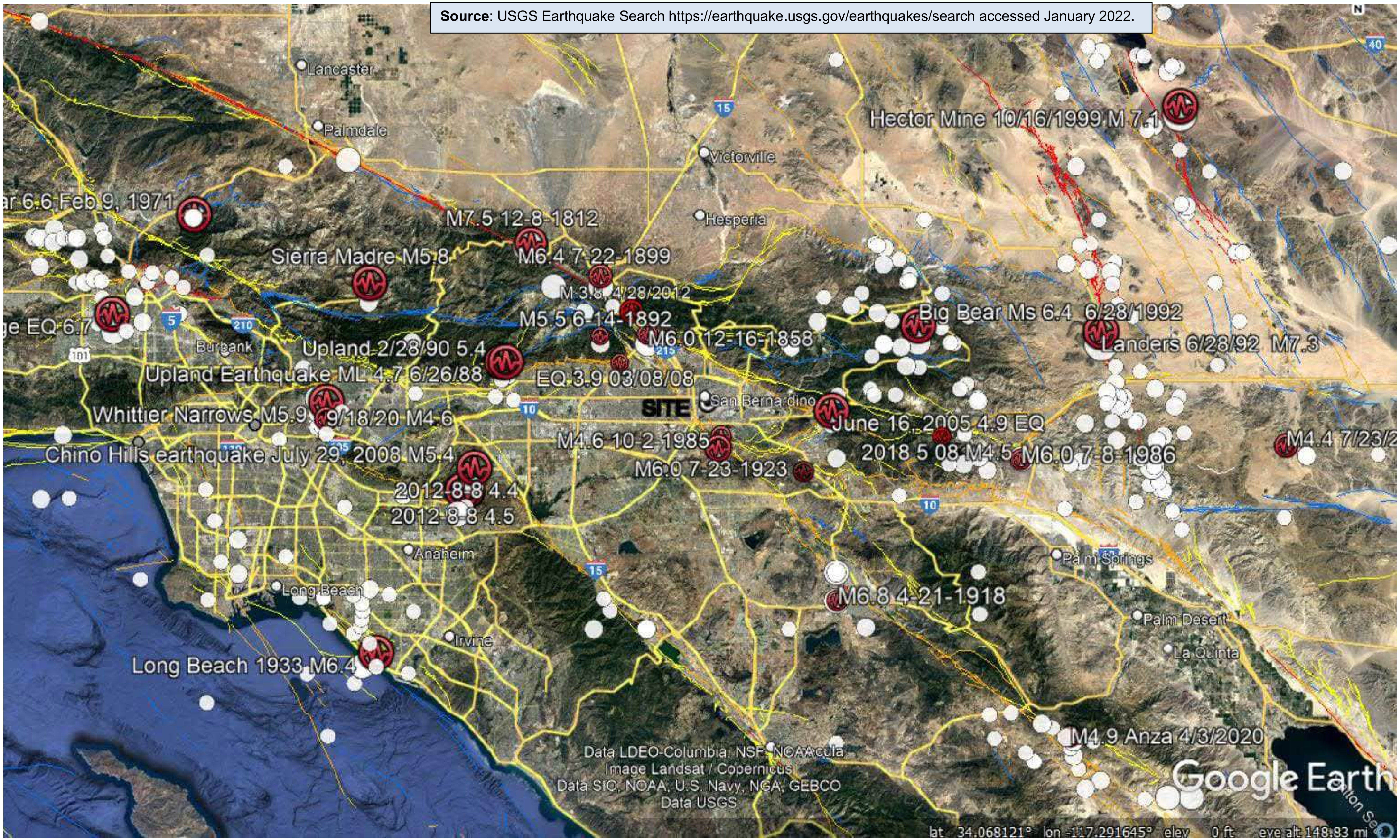


Reference: Jennings and Bryant (2010)
SITE
Geologic Time Scale
Years Before Present (Approx.)
Fault Symbol
Recency of Movement
DESCRIPTION
ON LAND
OFFSHORE
Quaternary
Late Quaternary
Early Quaternary
Historic
Holocene
Pleistocene
Pre-Quaternary
200
11,700
700,000
1,600,000
4.5 billion (Age of earth)
Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.
Displacement during Holocene time.
Fault offsets seafloor sediments or strata of Holocene age.
Faults showing evidence of displacement during late Quaternary time.
Fault cuts strata of Late Pleistocene age.
Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions area faults which displace rocks of undifferentiated Plio-Pleistocene age.
Fault cuts strata of Quaternary age.
Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.
Fault cuts strata of Pliocene or older age.
SAN ANDREAS
SAN JACINTO FAULT
ELSINORE
CUCAMONGA FAULT
SIERRA MADRE
NORTH FRONTAL THRUST
Riverside
Fontana
Ontario
Pomona
Los Angeles
Palmdale
Victorville
Hesperia
Redlands
-N-

**REGIONAL SEISMICITY MAP**

SBC Valley Communication Center ■ San Bernardino, San Bernardino County, California

February 24, 2022 ■ Terracon Project No. CB215173



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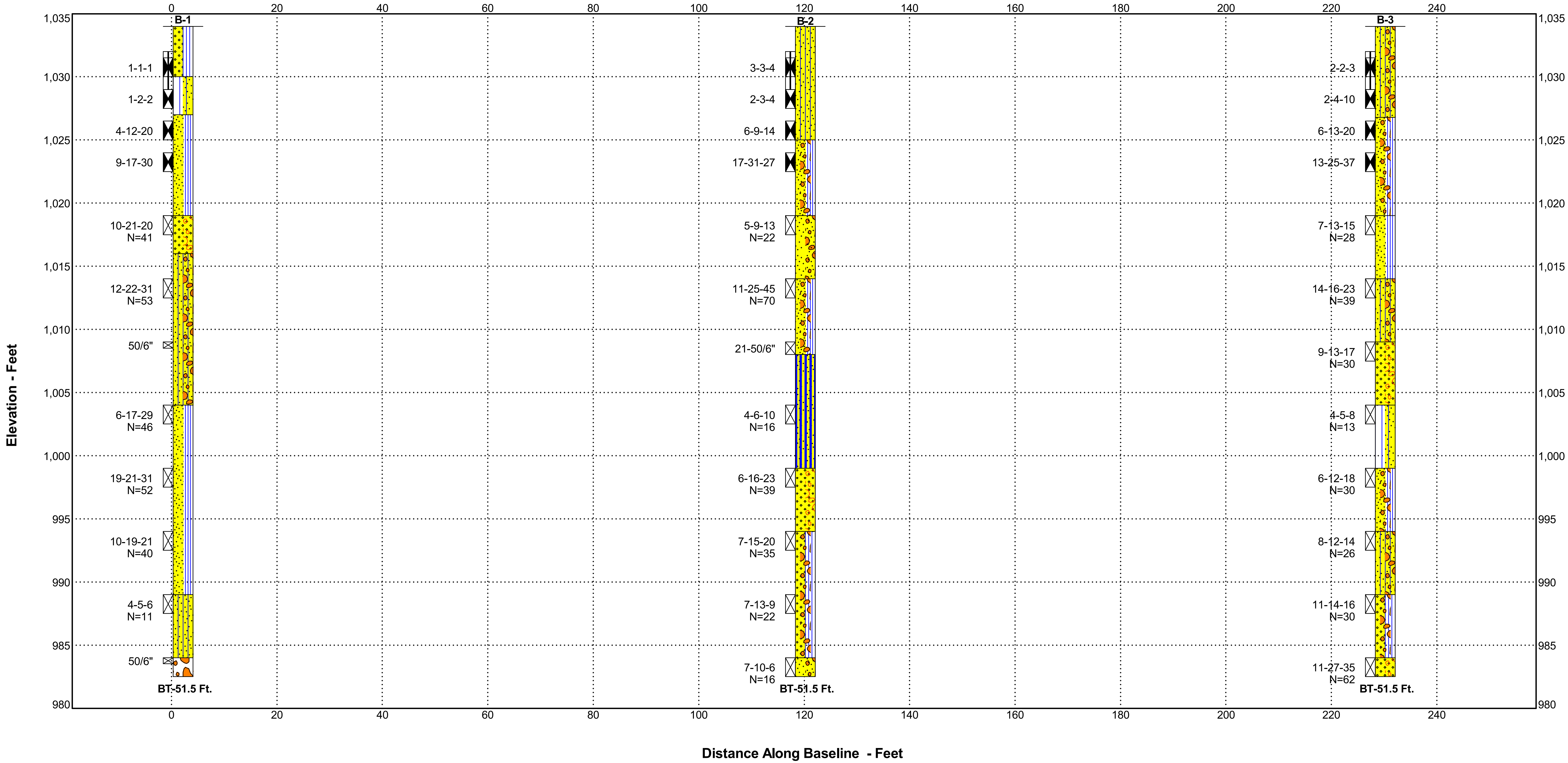



## Explanation

B-1 — Borehole Number
Moisture Content — %w
LL PL — Liquid and Plastic Limits
Sampling (See General Notes)
Borehole Lithology
AR BT — Borehole Termination Type

Water Level Reading at time of drilling.
Water Level Reading after drilling.

Well-graded Sand with Silt · Silt with Sand · Poorly-graded Sand with Silt · Well-graded Sand with Gravel · Silty Sand with Gravel

Silty Sand · Poorly-graded Gravel · Poorly-graded Sand with Silt and Gravel · Poorly-graded Sand with Gravel · Sandy Silt

NOTES:
See Exploration Plan for orientation of soil profile.
See General Notes in Supporting Information for symbols and soil classifications.
Soils profile provided for illustration purposes only.
Soils between borings may differ
AR - Auger Refusal
BT - Boring Termination

| | | |
|---|---|---|
| **Project No.:** CB215173 | Terracon<br>1355 E Cooley Dr, Ste C<br>Colton, CA | **SUBSURFACE PROFILE** |
| **Date:** 2/14/2022 | | Section A-A'<br>VALLEY COMMUNICATION CENTER (PROJECT 10.10.0181)<br>837 E. RIALTO AVENUE<br>SAN BERNARDINO, CA |
| **Scale:** N.T.S. | | |

# EXPLORATION RESULTS

# BORING LOG NO. B-1



**PROJECT: Valley Communication Center (Project 10.10.0181)**

**CLIENT: County of San Bernardino CA San Bernardino, CA**

**SITE: 837 E. Rialto Avenue San Bernardino, CA**

LOCATION See Exploration Plan

Latitude: 34.1007° Longitude: -117.2674°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **WELL GRADED SAND WITH GRAVEL (SW-SM)**, with few gravel up to 1/2", fine to medium grained, brown, very loose | | | | | | | | |
| | decomposed roots | | | | 1-1-1 | 4.6 | 96 | | 6 11 |
| 4.0 | **SILT WITH SAND (ML)**, fine grained, yellowish brown, soft | 5 | | | 1-2-2 | 33.6 | 56 | | 74 |
| 7.0 | **POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, yellowish brown, medium dense | | | | 4-12-20 | 5.7 | 96 | | 11 |
| | | 10 | | | 9-17-30 | 5.4 | 97 | | 11 |
| 15.0 | **WELL GRADED SAND WITH GRAVEL (SW)**, with gravel up to 3", fine to coarse grained, reddish gray, dense | 15 | | | 10-21-20 N=41 | | | | 2 |
| 18.0 | **SILTY SAND WITH GRAVEL (SM)**, with gravel up to 3", fine to coarse grained, reddish gray, very dense | 20 | | | 12-22-31 N=53 | | | | 13 |
| | | 25 | | | 50/6" | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-11-2022 | Boring Completed: 01-11-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-1



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**SITE:** 837 E. Rialto Avenue San Bernardino, CA

**CLIENT:** County of San Bernardino CA San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1007° Longitude: -117.2674°

| GRAPHIC LOG / DEPTH | MATERIAL DESCRIPTION | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with gravel up to 3", fine to coarse grained, reddish gray, very dense *(continued)* | | | | | | | | |
| 30.0 | **POORLY GRADED SAND WITH SILT (SW-SM)**, with few gravel up to 1/4", yellowish brown, dense | 30 | | X | 6-17-29 N=46 | | | | |
| | very dense | 35 | | X | 19-21-31 N=52 | | | | 6 |
| | dense | 40 | | X | 10-19-21 N=40 | | | | 5 |
| 45.0 | **SILTY SAND (SM)**, fine grained, olive brown, medium dense | 45 | | X | 4-5-6 N=11 | | | | 30 |
| 50.0 | **POORLY GRADED GRAVEL (GP)**, very dense | 50 | | X | 50/6" | | | | |
| 51.5 | ***Boring Terminated at 51.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-11-2022 | Boring Completed: 01-11-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-2



**PROJECT:** **Valley Communication Center (Project 10.10.0181)**

**CLIENT:** **County of San Bernardino CA**
**San Bernardino, CA**

**SITE:** **837 E. Rialto Avenue**
**San Bernardino, CA**

LOCATION See Exploration Plan

Latitude: 34.1005° Longitude: -117.2672°

| DEPTH (Ft.) | DESCRIPTION | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|
| 0.0 | **SILTY SAND (SM)**, with few gravel up to 1/2", fine to coarse grained, brown, loose | | | | | | |
| | fine grained | X | 3-3-4 | 7.5 | 104 | | 38 |
| 5 | | X | 2-3-4 | 6.7 | 100 | | 26 |
| | medium dense | X | 6-9-14 | 10.2 | 91 | | 43 |
| 9.0 | **POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with gravel up to 2", fine to coarse grained, reddish brown, medium dense | | | | | | |
| 10 | | X | 17-31-27 | 1.3 | | | 6 |
| 15.0 | **POORLY GRADED SAND WITH GRAVEL (SP)**, with gravel up to 2", fine to coarse grained, reddish brown, medium dense | X | 5-9-13<br>N=22 | | | | 4 |
| 20.0 | **POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with gravel up to 2", fine to coarse grained, reddish brown, very dense | X | 11-25-45<br>N=70 | | | | 6 |
| 25 | | X | 21-50/6" | | | | 10 |
| 26.0 | **SANDY SILT (ML)**, with clay, fine grained, bluish gray, very stiff | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-14-2022 | Boring Completed: 01-14-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-2



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1005° Longitude: -117.2672°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SANDY SILT (ML)**, with clay, fine grained, bluish gray, very stiff *(continued)* | | | | | | | | |
| | | 30 | | X | 4-6-10 N=16 | | | | 68 |
| 35.0 | **WELL GRADED SAND WITH GRAVEL (SW)**, with gravel up to 2", fine to coarse grained, reddish brown, dense | 35 | | X | 6-16-23 N=39 | | | | 4 |
| 40.0 | **WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, with gravel up to 2", fine to coarse grained, reddish brown, dense | 40 | | X | 7-15-20 N=35 | | | | 6 |
| | fine to medium grained, yellowish brown, medium dense | 45 | | X | 7-13-9 N=22 | | | | 5 |
| 50.0 | **POORLY GRADED SAND WITH GRAVEL (SP)**, with gravel up to 2", fine to medium grained, yellowish brown, medium dense | 50 | | X | 7-10-6 N=16 | | | | 4 |
| 51.5 | ***Boring Terminated at 51.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-14-2022 | Boring Completed: 01-14-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-3

**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1002° Longitude: -117.2671°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine grained, brown, very loose | | | | 2-2-3 | 13.5 | 73 | | |
| | loose | 5 | | | 2-4-10 | 1.5 | 91 | | 20 |
| 7.2 | **POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with gravel up to 2", fine to medium grained, yellowish brown, medium dense | | | | 6-13-20 | 2.6 | | | |
| | dense | 10 | | | 13-25-37 | 0.7 | 109 | | |
| 15.0 | **POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, yellowish brown, medium dense | 15 | | | 7-13-15 N=28 | | | | 7 |
| 20.0 | **SILTY SAND WITH GRAVEL (SM)**, with gravel up to 2", fine to coarse grained, brown, dense | 20 | | | 14-16-23 N=39 | | | | |
| 25.0 | **WELL GRADED SAND WITH GRAVEL (SW)**, with gravel up to 2", fine to coarse grained, brown, dense | 25 | | | 9-13-17 N=30 | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-14-2022 | Boring Completed: 01-14-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-3

**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1002° Longitude: -117.2671°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| 30.0 | **WELL GRADED SAND WITH GRAVEL (SW)**, with gravel up to 2", fine to coarse grained, brown, dense *(continued)* | | | | | | | | |
| 35.0 | **SILT WITH SAND (ML)**, with clay, fine grained, bluish gray, stiff | 30 | | X | 4-5-8 N=13 | | | | 83 |
| 40.0 | **POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, with gravel up to 1/2", fine to medium grained, yellowish brown, dense | 35 | | X | 6-12-18 N=30 | | | | |
| 45.0 | **SILTY SAND WITH GRAVEL (SM)**, with gravel up to 1/2", fine to medium grained, brown, medium dense | 40 | | X | 8-12-14 N=26 | | | | |
| 50.0 | **WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, with gravel up to 1/2", fine to coarse grained, yellowish brown, dense | 45 | | X | 11-14-16 N=30 | | | | 8 |
| 51.5 | **WELL GRADED SAND WITH GRAVEL (SW)**, with gravel up to 1", fine to coarse grained, yellowish brown, very dense | 50 | | X | 11-27-35 N=62 | | | | |

***Boring Terminated at 51.5 Feet***

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

Boring Started: 01-14-2022 | Boring Completed: 01-14-2022
Drill Rig: CME 75 | Driller: Martini Drilling
Project No.: CB215173

# BORING LOG NO. B-4



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1013° Longitude: -117.2676°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine to medium grained, brown, loose | | | | | | | | |
| | dark brown, medium dense | | | | 8-11-14 | 7.8 | 106 | | 24 |
| 5.0 | **WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, with gravel up to 3", fine to coarse grained, reddish gray, very dense | 5 | | | 7-13-50/6" | 3.3 | 110 | | |
| 6.5 | ***Boring Terminated at 6.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-10-2022 | Boring Completed: 01-10-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-5



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1011° Longitude: -117.2672°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, with few gravel up to 1/2", fine to medium grained, brown, loose | | | | | | | | |
| | dark brown | | | | 3-5-6 | 5.0 | 94 | | 11 |
| | | 5 | | | 6-7-8 | | | | |
| | with gravel up to 3", fine to coarse grained, reddish gray, medium dense | | | | 24-28-23 | 1.5 | 118 | | |
| 11.5 | | 10 | | | 7-15-21 | 2.2 | 112 | | |
| | ***Boring Terminated at 11.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-10-2022 | Boring Completed: 01-10-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-6



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1009° Longitude: -117.2669°

| GRAPHIC LOG | DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2" and decomposed organics, fine to medium grained, brown, loose | | | | | | | | |
| | 2.3 | | | | | | | | |
| | **WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, with gravel up to 1/2", fine to coarse grained, dark brown, very loose | | | | 1-2-3 | 13.5 | 64 | | 10 |
| | loose | 5 | | | 3-5-11 | 5.3 | 102 | | |
| | 6.5 | | | | | | | | |
| | ***Boring Terminated at 6.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-10-2022 | Boring Completed: 01-10-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-7



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1000° Longitude: -117.2682°

| GRAPHIC LOG | DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine to medium grained, brown, medium dense | | | | | | | | |
| | 3.0 | | | | 4-5-7 | 1.4 | | | 4 |
| | **POORLY GRADED SAND (SP)**, fine grained, yellowish brown, loose | 5 | | | 3-6-6 | 9.5 | 94 | | |
| | 6.5 | | | | | | | | |
| | ***Boring Terminated at 6.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-10-2022 | Boring Completed: 01-10-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. B-8



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA, San Bernardino, CA

**SITE:** 837 E. Rialto Avenue, San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.0999° Longitude: -117.2676°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine to medium grained, brown, loose | | | | | | | | |
| | dark brown | | | | 2-3-5 | 16.8 | 91 | | 36 |
| 5.0 | **POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, yellowish brown, very loose | 5 | | | 1-2-3 | 30.3 | 56 | | |
| 6.0 | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 3", fine to coarse grained, reddish brown, dense | | | | | | | | 33 |
| | | | | | 16-32-37 | 1.6 | 111 | | |
| 10.2 | ***Boring Terminated at 10.2 Feet*** | 10 | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

Boring Started: 01-10-2022

Boring Completed: 01-10-2022

Drill Rig: CME 75

Driller: Martini Drilling

Project No.: CB215173

# BORING LOG NO. B-9



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**SITE:** 837 E. Rialto Avenue, San Bernardino, CA

**CLIENT:** County of San Bernardino CA, San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.0997° Longitude: -117.2669°

| GRAPHIC LOG | DEPTH | DESCRIPTION | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine to medium grained, brown, very loose | | | | | | | | |
| | | dark brown | | | | 2-2-3 | 18.4 | 80 | | |
| | 5.0 | **POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, yellowish brown, loose | 5 | | | 2-3-4 | 3.8 | 68 | | |
| | 6.5 | ***Boring Terminated at 6.5 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-10-2022 | Boring Completed: 01-10-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. P-1

**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA
San Bernardino, CA

**SITE:** 837 E. Rialto Avenue
San Bernardino, CA

| GRAPHIC LOG | LOCATION See Exploration Plan<br>Latitude: 34.0997° Longitude: -117.2687°<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine to medium grained, brown<br>dark brown | | | | | | | | 42 |
| | 5.2 | 5 | | | | | | | |
| | ***Boring Terminated at 5.2 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-10-2022 | Boring Completed: 01-10-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. P-2



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA, San Bernardino, CA

**SITE:** 837 E. Rialto Avenue, San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.0999° Longitude: -117.2685°

| GRAPHIC LOG | DEPTH | DESCRIPTION | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine to medium grained, brown<br>dark brown | | | | | | | | |
| | 5.0 | **POORLY GRADED SAND WITH SILT (SP-SM)**, fine grained, yellowish brown | 5 | | | | | | | 9 |
| | 10.2 | ***Boring Terminated at 10.2 Feet*** | 10 | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

1355 E Cooley Dr, Ste C
Colton, CA

| | |
|---|---|
| Boring Started: 01-10-2022 | Boring Completed: 01-10-2022 |
| Drill Rig: CME 75 | Driller: Martini Drilling |
| Project No.: CB215173 | |

# BORING LOG NO. P-3



**PROJECT:** Valley Communication Center (Project 10.10.0181)

**CLIENT:** County of San Bernardino CA, San Bernardino, CA

**SITE:** 837 E. Rialto Avenue, San Bernardino, CA

LOCATION See Exploration Plan

Latitude: 34.1007° Longitude: -117.2679°

| DEPTH | Description | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|
| | **SILTY SAND WITH GRAVEL (SM)**, with few gravel up to 1/2", fine to medium grained, brown | | | | | | | | |
| | dark brown | | | | | | | | 25 |
| 4.0 | | | | | | | | | |
| 5.2 | **POORLY GRADED SAND WITH SILT (SP-SM)**, fine to medium grained, brown | 5 | | | | | | | |
| | ***Boring Terminated at 5.2 Feet*** | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
8" Hollow-Stem

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

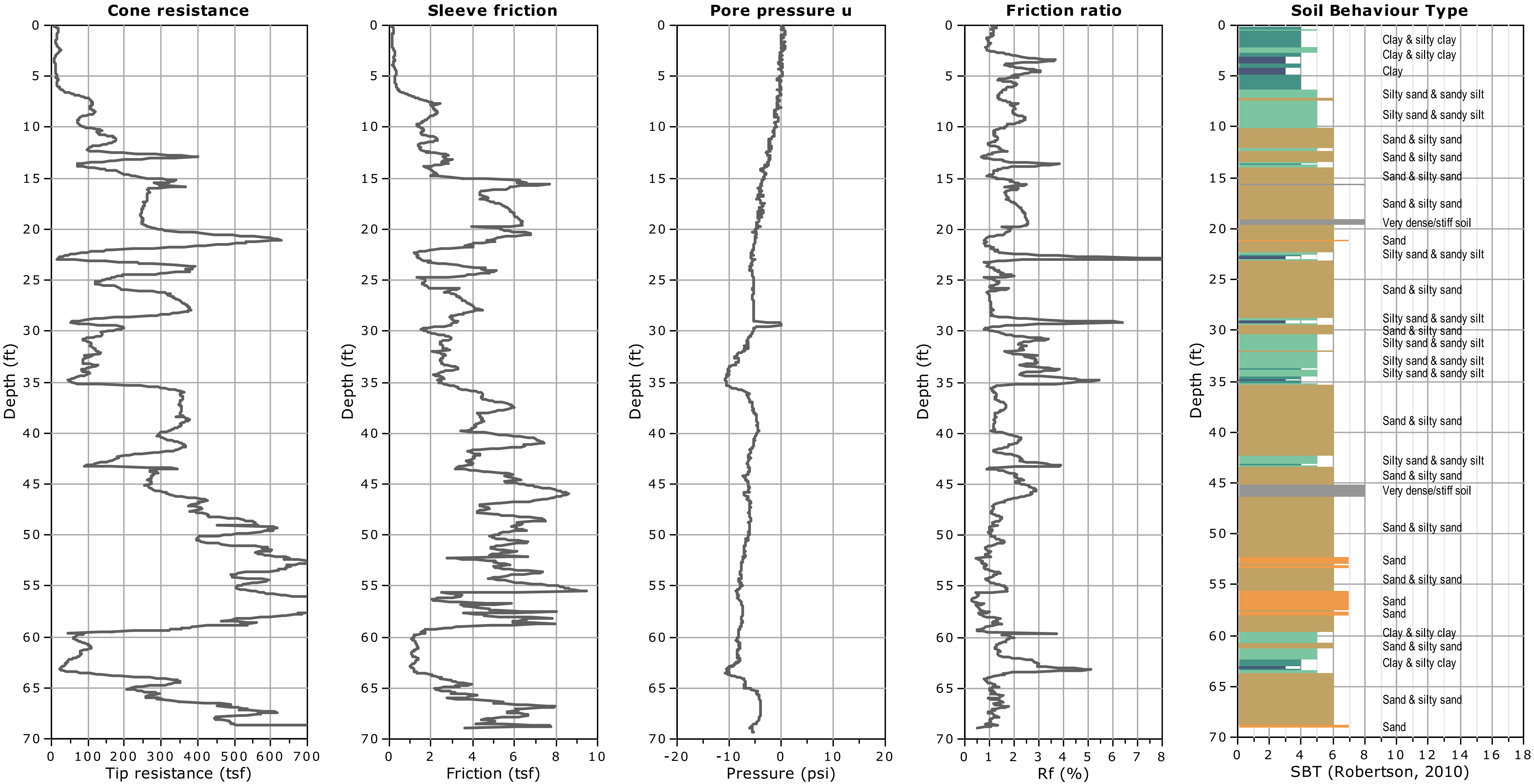
Terracon
1355 E Cooley Dr, Ste C
Colton, CA

Boring Started: 01-10-2022
Boring Completed: 01-10-2022
Drill Rig: CME 75
Driller: Martini Drilling
Project No.: CB215173

**Kehoe Testing and Engineering**
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

**Project:** **Terracon Consultants / Valley Communication Center**
**Location:** **San Bernadino, CA**

**CPT-1**
Total depth: 69.36 ft, Date: 1/4/2022



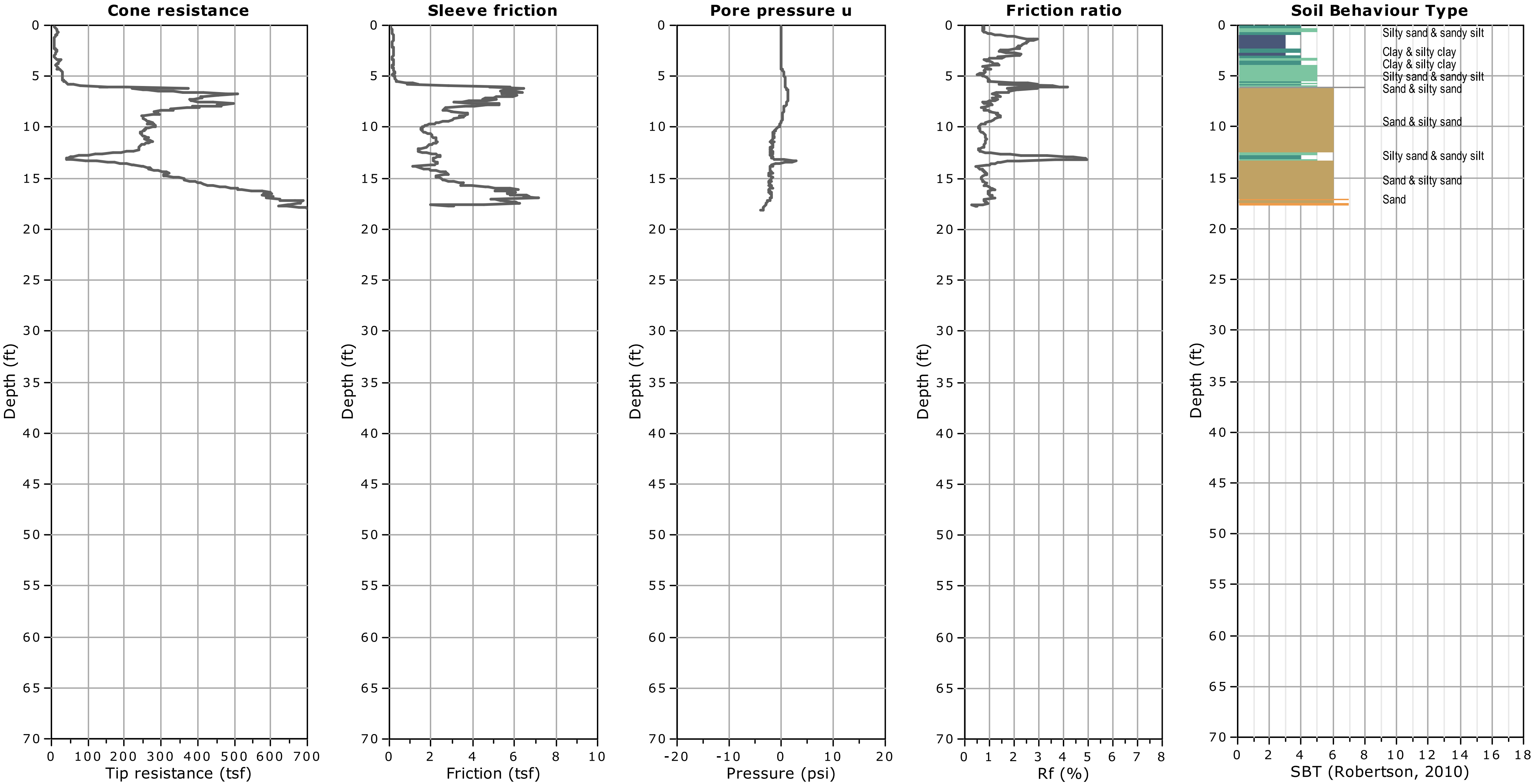
**Kehoe Testing and Engineering**
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

**Project:** Terracon Consultants / Valley Communication Center

**Location:** San Bernadino, CA

**CPT-2**

Total depth: 18.18 ft, Date: 1/4/2022



Kehoe Testing and Engineering
714-901-7270
steve@kehoetesting.com
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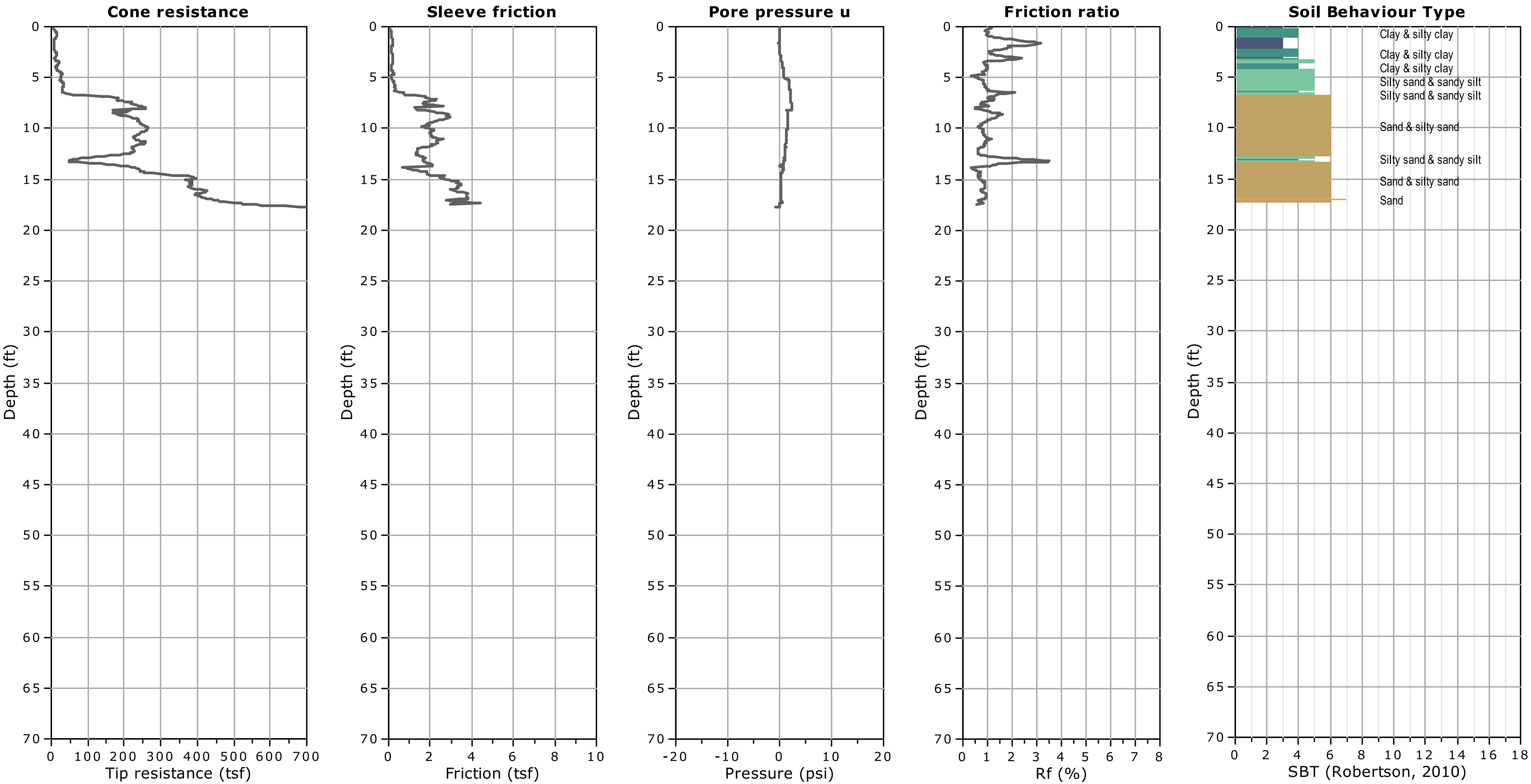
**Project:** Terracon Consultants / Valley Communication Center

**Location:** San Bernadino, CA

**CPT-2A**

Total depth: 17.78 ft, Date: 1/4/2022



**Kehoe Testing and Engineering**
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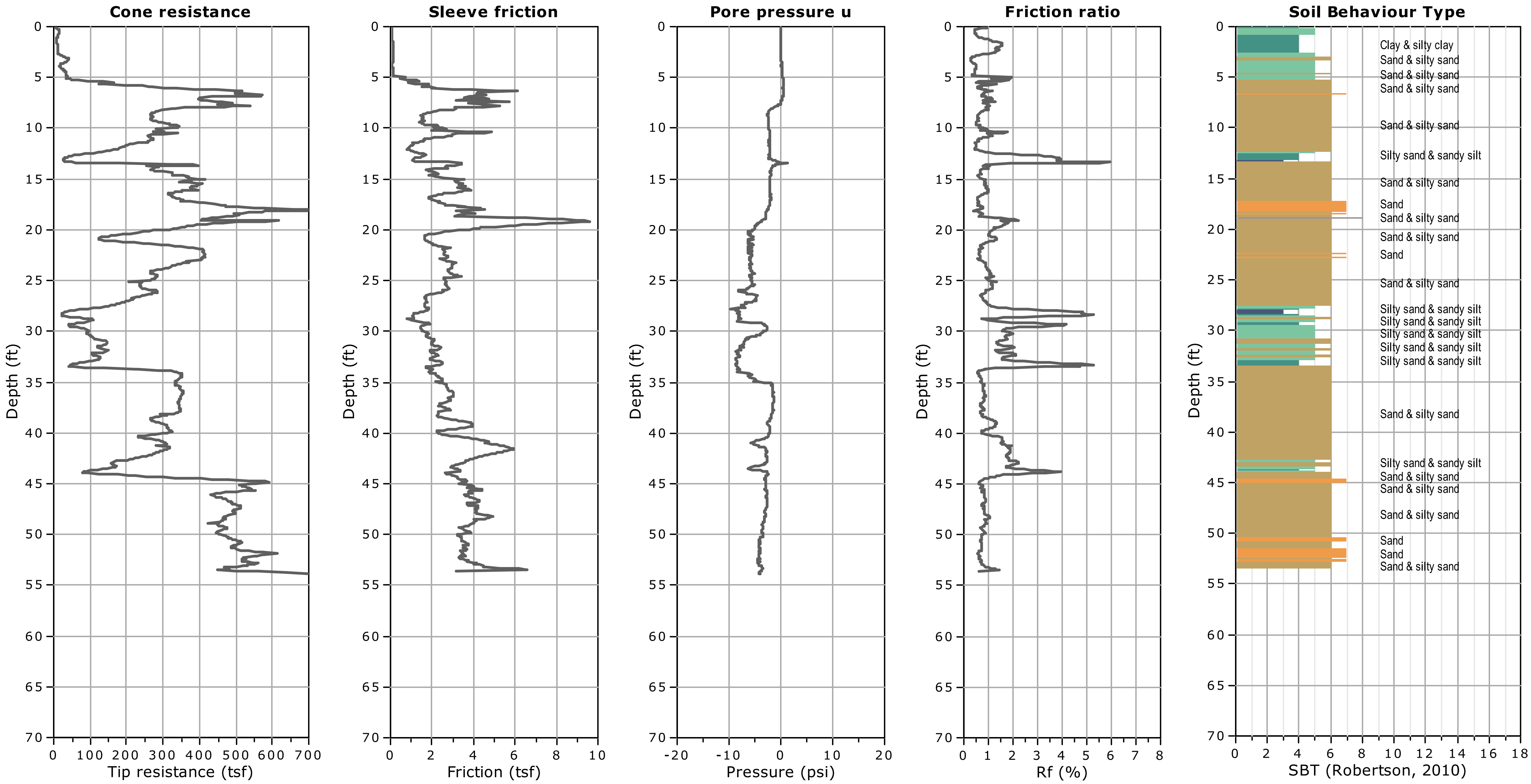
**Project:** Terracon Consultants / Valley Communication Center

**Location:** San Bernadino, CA

**CPT-2B**

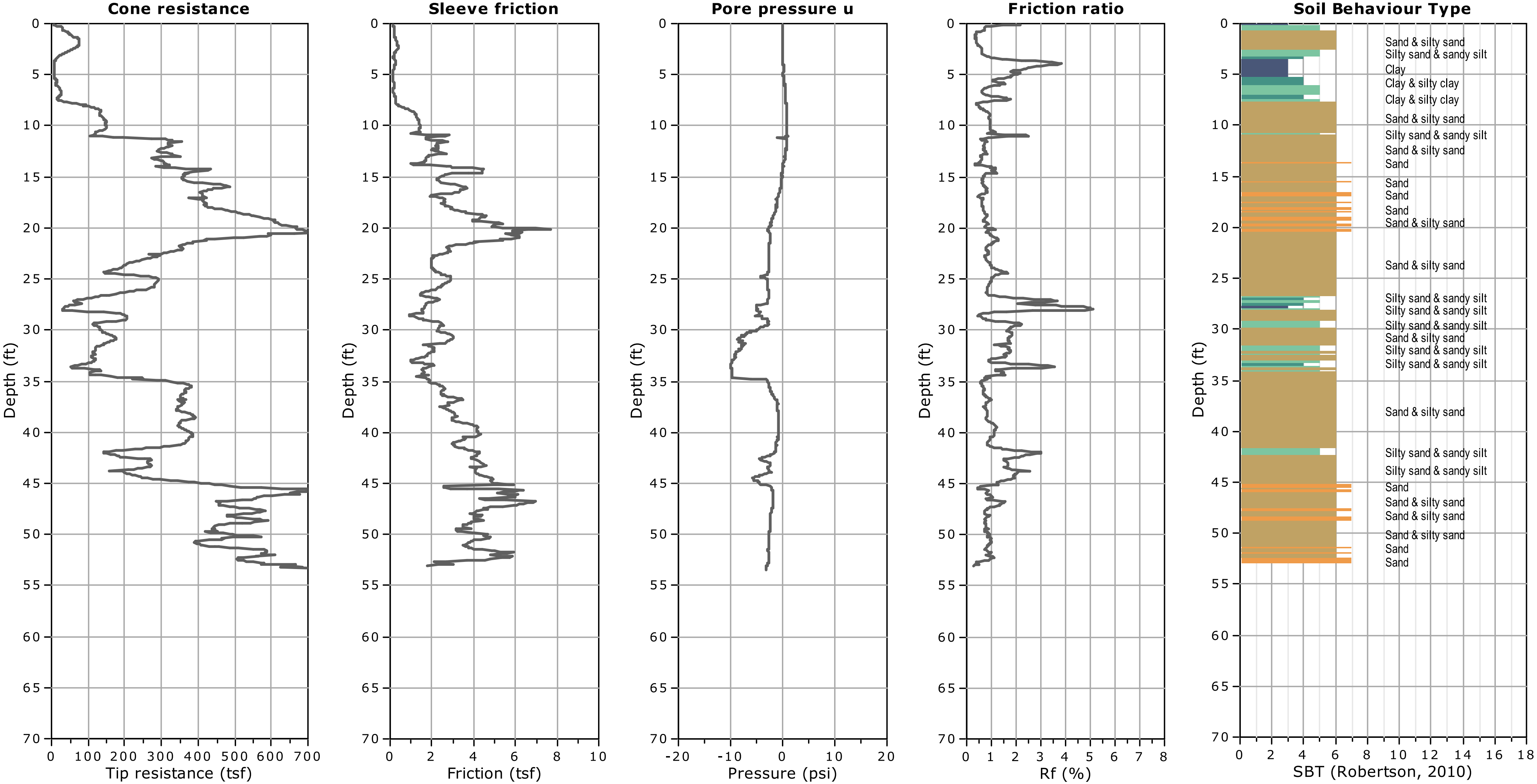
Total depth: 53.94 ft, Date: 1/4/2022



**Kehoe Testing and Engineering**
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

**Project:** **Terracon Consultants / Valley Communication Center**
**Location:** **San Bernadino, CA**

**CPT-3**
Total depth: 53.42 ft, Date: 1/4/2022



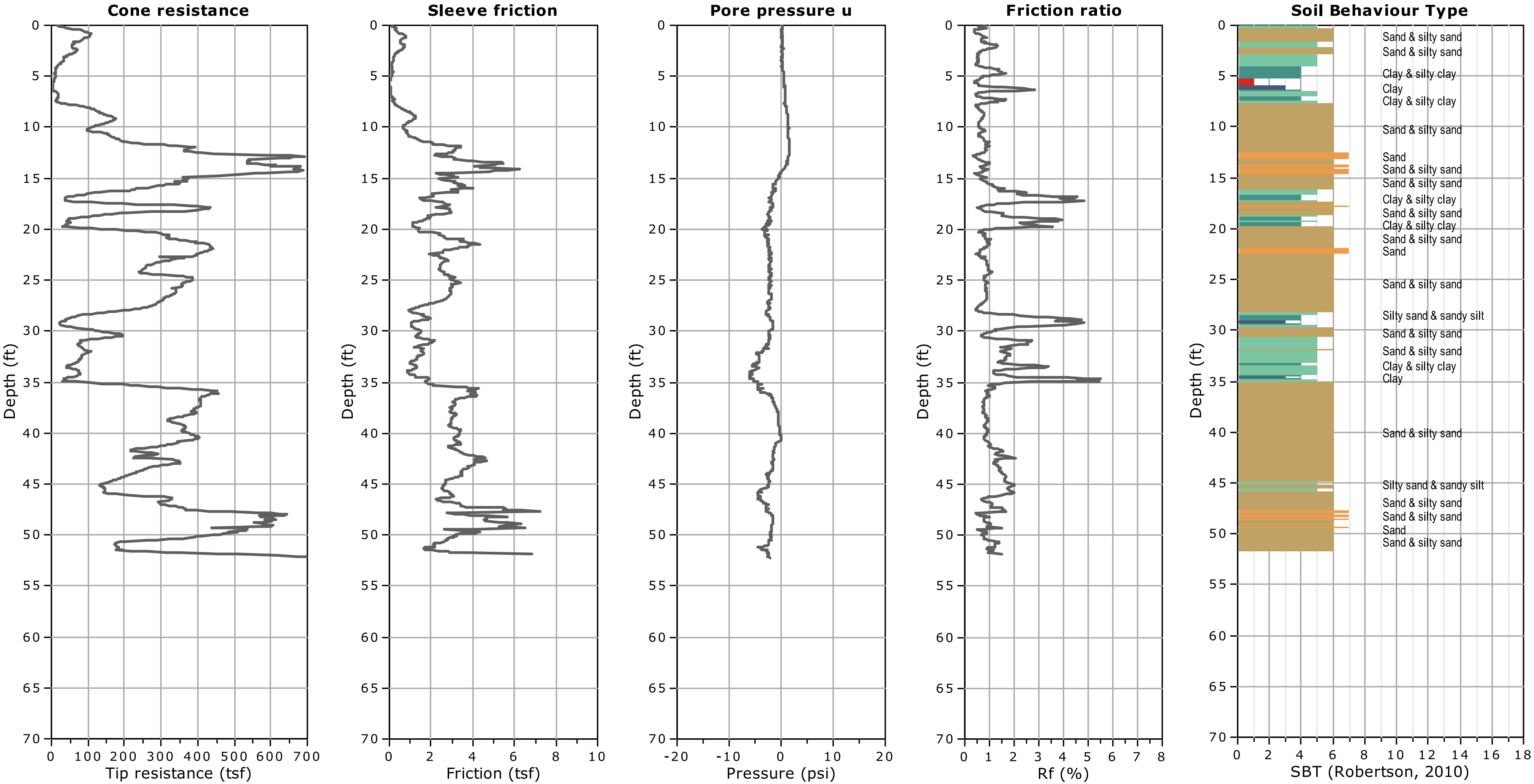
**Kehoe Testing and Engineering**
714-901-7270
steve@kehoetesting.com
www.kehoetesting.com

**Project:** Terracon Consultants / Valley Communication Center

**Location:** San Bernadino, CA

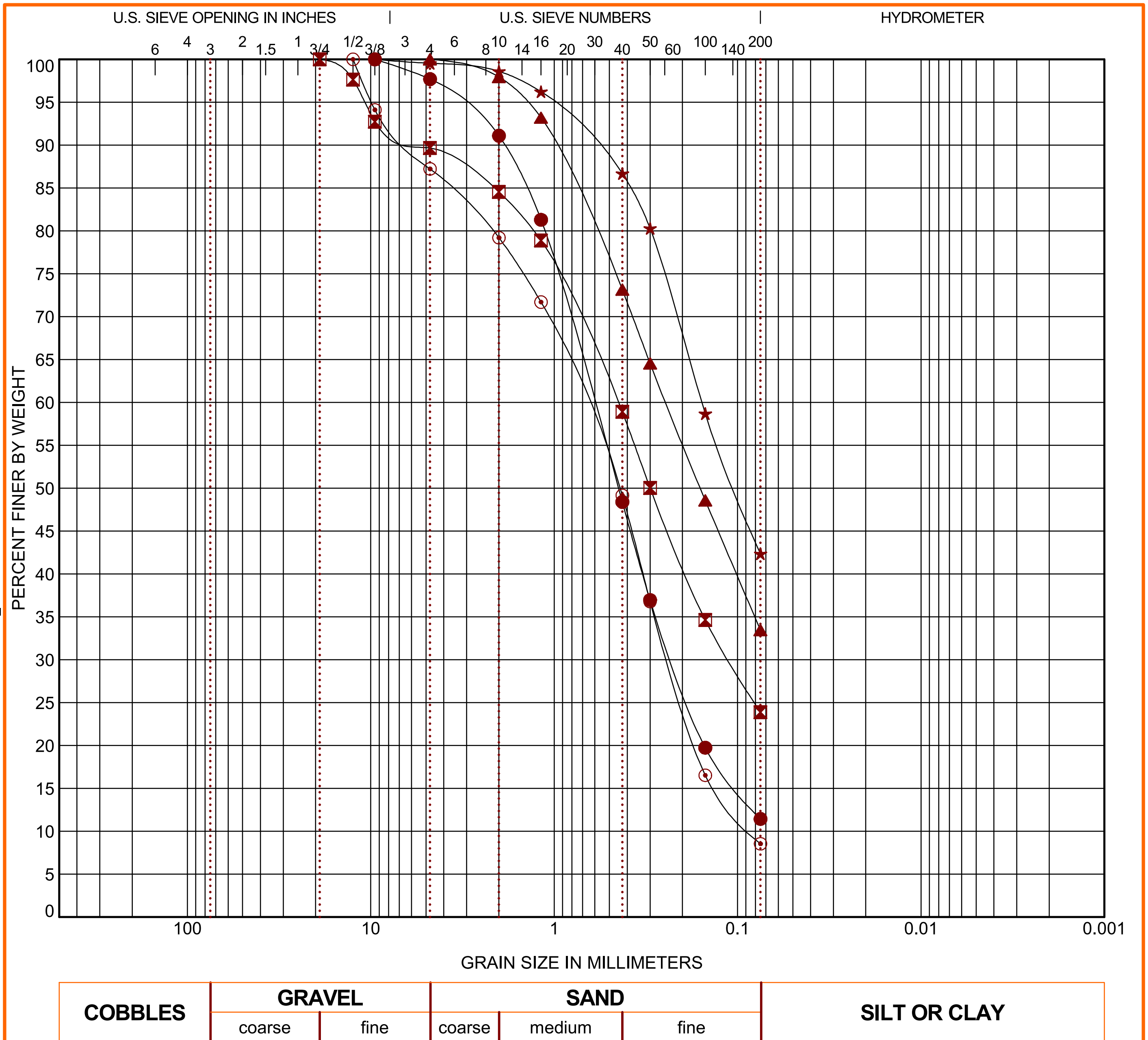
**CPT-4**

Total depth: 52.23 ft, Date: 1/4/2022



# GRAIN SIZE DISTRIBUTION

**ASTM D422 / ASTM C136**




| Boring ID | | Depth | USCS Classification | WC (%) | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|---|
| ● | B-1 | 2 - 5 | | | | | | 1.27 | 9.16 |
| ⊠ | B-4 | 2 - 5 | | | | | | | |
| ▲ | B-8 | 5.5 - 10 | | | | | | | |
| ★ | P-1 | 0 - 5 | | | | | | | |
| ⊙ | P-2 | 5 - 10 | | | | | | 0.96 | 8.16 |

| Boring ID | | Depth | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | %Cobbles | %Gravel | %Sand | %Silt | %Fines | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-1 | 2 - 5 | 9.5 | 0.609 | 0.227 | | 0.0 | 2.3 | 86.3 | | 11.4 | |
| ⊠ | B-4 | 2 - 5 | 19 | 0.449 | 0.111 | | 0.0 | 10.3 | 65.8 | | 23.9 | |
| ▲ | B-8 | 5.5 - 10 | 4.75 | 0.246 | | | 0.0 | 0.0 | 66.5 | | 33.5 | |
| ★ | P-1 | 0 - 5 | 9.5 | 0.156 | | | 0.0 | 0.5 | 57.2 | | 42.4 | |
| ⊙ | P-2 | 5 - 10 | 12.5 | 0.695 | 0.238 | 0.085 | 0.0 | 12.8 | 78.7 | | 8.5 | |

PROJECT: Valley Communication Center (Project 10.10.0181)

SITE: 837 E. Rialto Avenue San Bernardino, CA

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

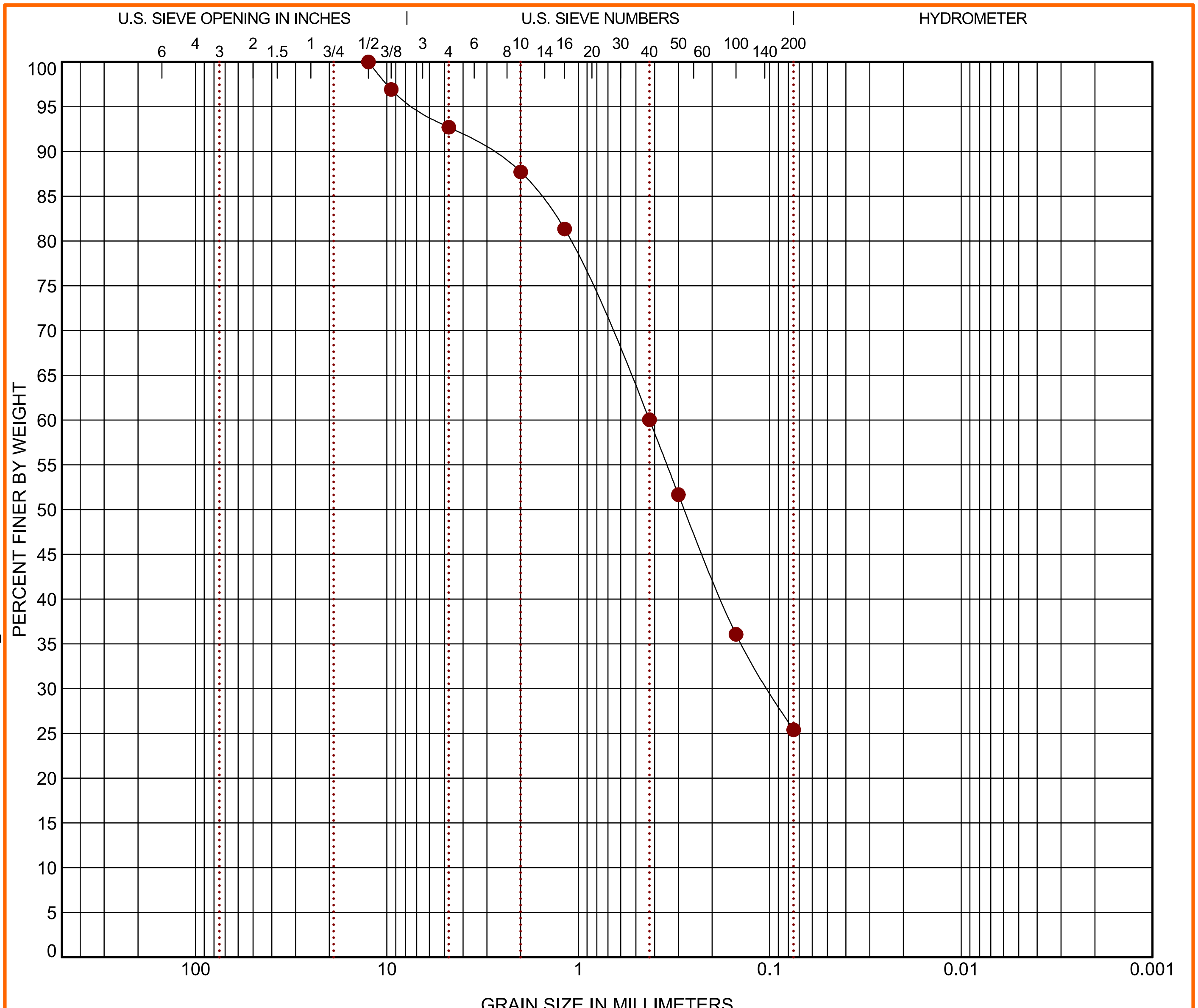
PROJECT NUMBER: CB215173

CLIENT: County of San Bernardino CA San Bernardino, CA

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 CB215173 VALLEY COMMUNICAT.GPJ TERRACON_DATATEMPLATE.GDT 1/28/22

# GRAIN SIZE DISTRIBUTION

**ASTM D422 / ASTM C136**




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Boring ID | Depth | USCS Classification | WC (%) | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|---|
| ● | P-3 | 0 - 5 | | | | | | | |

| | Boring ID | Depth | $D_{100}$ | $D_{60}$ | $D_{30}$ | $D_{10}$ | %Cobbles | %Gravel | %Sand | %Silt | %Fines | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ● | P-3 | 0 - 5 | 12.5 | 0.424 | 0.101 | | 0.0 | 7.3 | 67.3 | | 25.4 | |

PROJECT: Valley Communication Center
(Project 10.10.0181)

SITE: 837 E. Rialto Avenue
San Bernardino, CA

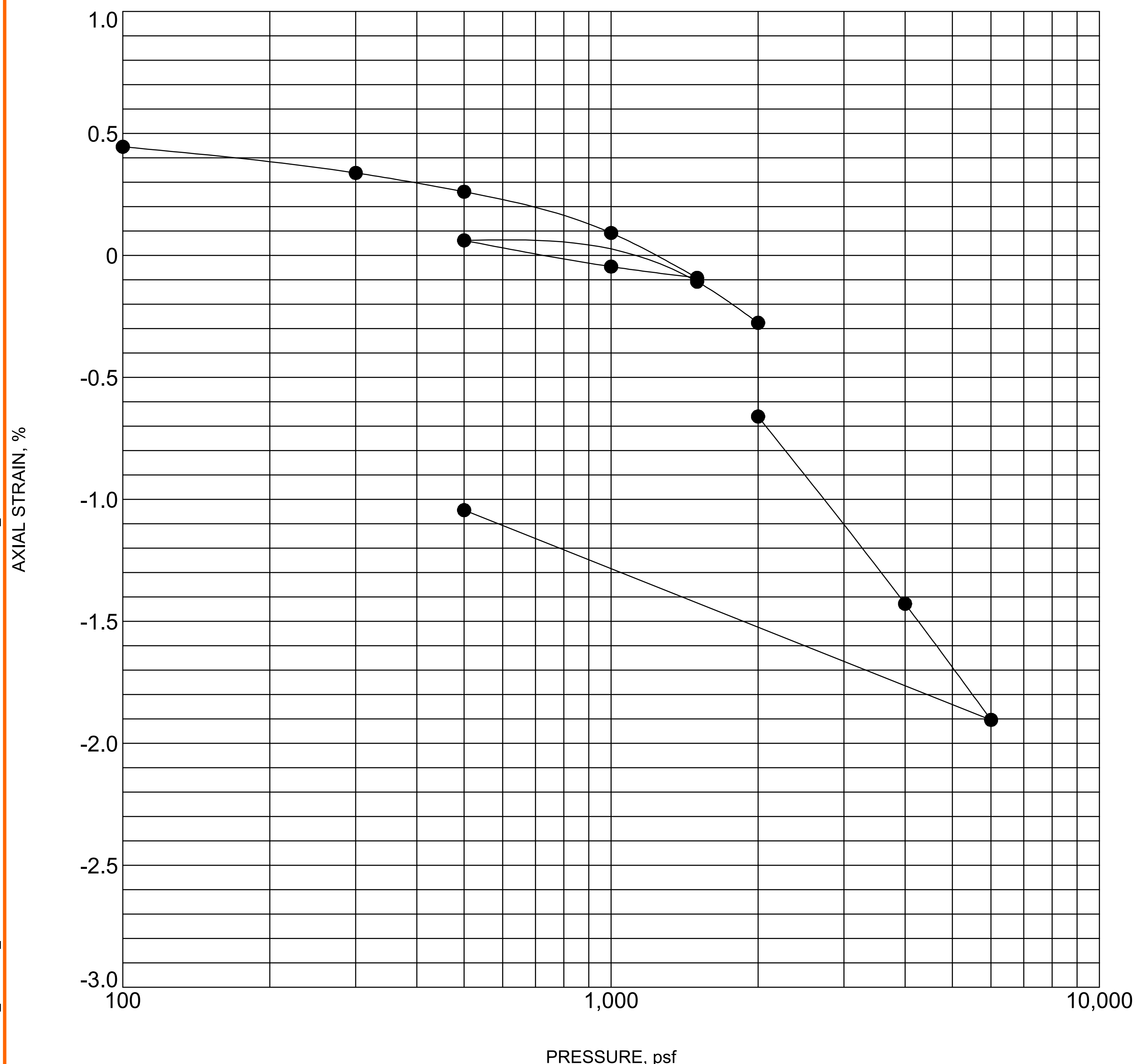
Terracon
1355 E Cooley Dr, Ste C
Colton, CA

PROJECT NUMBER: CB215173

CLIENT: County of San Bernardino CA
San Bernardino, CA

# SWELL CONSOLIDATION TEST

**ASTM D2435**




| Specimen Identification | | Classification | $\gamma_d$, pcf | WC, % |
|---|---|---|---|---|
| ● | B-1 (50) 7.5 - 9 ft | | 90 | 5.5 |

NOTES:

PROJECT: Valley Communication Center (Project 10.10.0181)

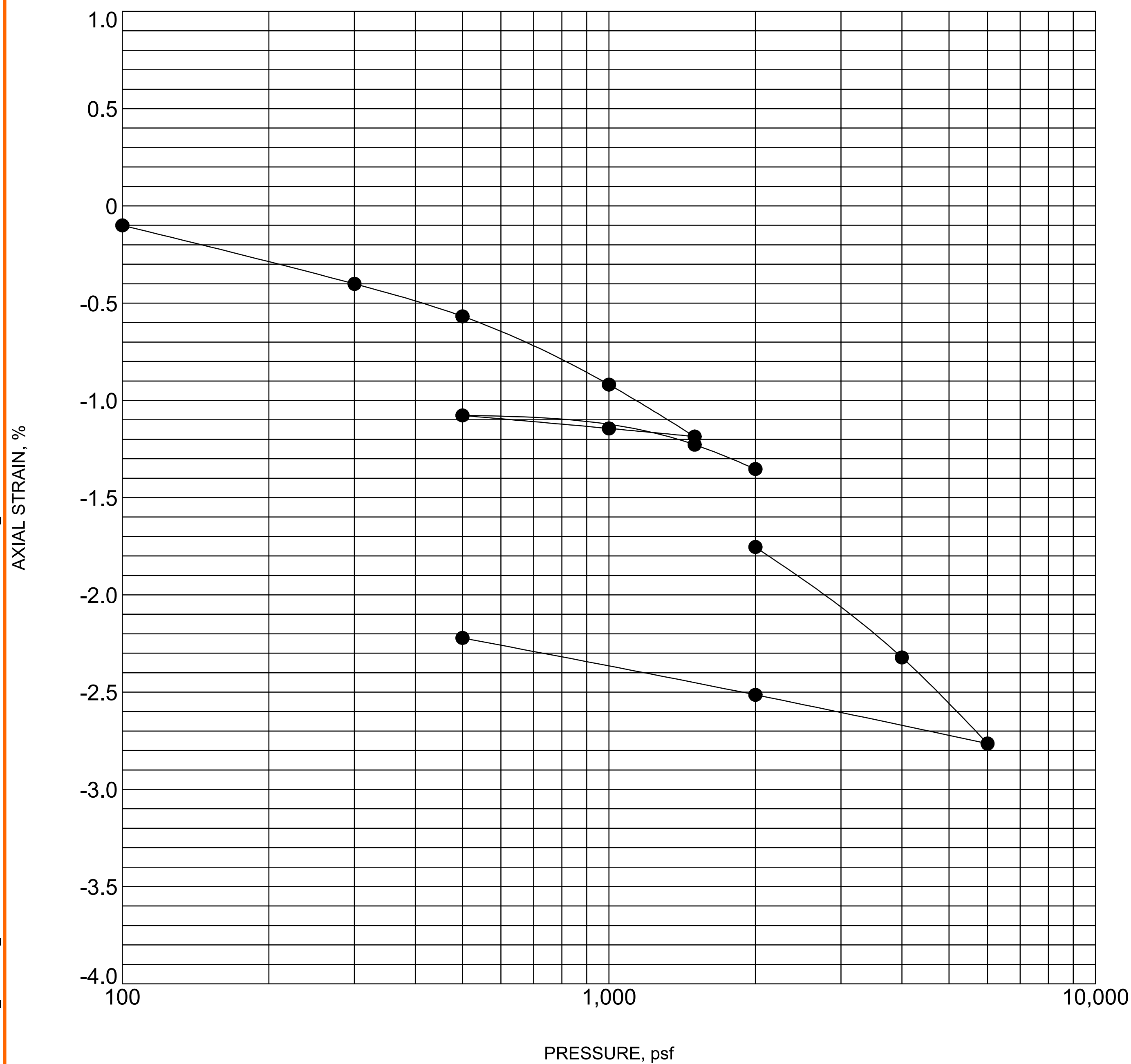
SITE: 837 E. Rialto Avenue San Bernardino, CA

Terracon
1355 E Cooley Dr, Ste C
Colton, CA

PROJECT NUMBER: CB215173

CLIENT: County of San Bernardino CA San Bernardino, CA

# SWELL CONSOLIDATION TEST
**ASTM D2435**




| Specimen Identification | | Classification | $\gamma_d$, pcf | WC, % |
|---|---|---|---|---|
| ● | B-3 (50)10 - 11.5 ft | | 104 | 1.5 |

NOTES:

PROJECT: Valley Communication Center (Project 10.10.0181)

SITE: 837 E. Rialto Avenue San Bernardino, CA

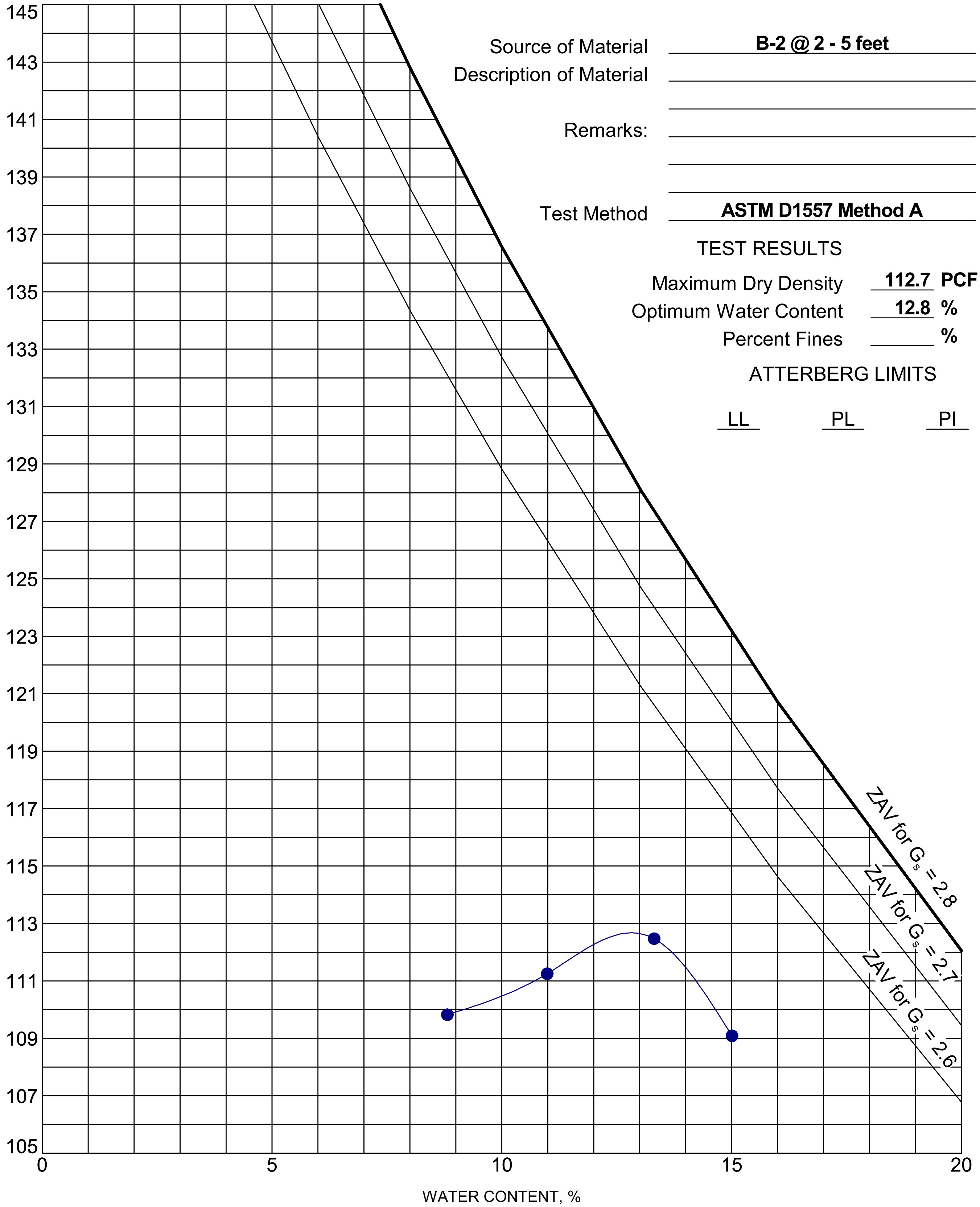
Terracon
1355 E Cooley Dr, Ste C
Colton, CA

PROJECT NUMBER: CB215173

CLIENT: County of San Bernardino CA San Bernardino, CA

# MOISTURE-DENSITY RELATIONSHIP

**ASTM D698/D1557**




Source of Material: **B-2 @ 2 - 5 feet**

Description of Material:

Remarks:

Test Method: **ASTM D1557 Method A**

TEST RESULTS

Maximum Dry Density **112.7 PCF**

Optimum Water Content **12.8 %**

Percent Fines **%**

ATTERBERG LIMITS

| LL | PL | PI |
|---|---|---|
| | | |



| | | |
|---|---|---|
| PROJECT: Valley Communication Center (Project 10.10.0181) | Terracon<br>1355 E Cooley Dr, Ste C<br>Colton, CA | PROJECT NUMBER: CB215173 |
| SITE: 837 E. Rialto Avenue San Bernardino, CA | | CLIENT: County of San Bernardino CA San Bernardino, CA |

Job No.: CB215173

# PERCOLATION TEST DATA

BORING NUMBER: P-1
LOT No: N/A
TRACT No: N/A

CLIENT: County of San Bernardino
PROJECT: SBC Valley Communications Center

DATE OF DRILLING: January 10, 2022
DATE OF PRESOAK: January 17, 2022
DATE OF TEST: January 17, 2022
TESTED BY: GA

DEPTH BEFORE (ft.): 5.0
DEPTH AFTER (ft.): 5.0
PVC PIPE DIA. (in.): 3.0
PERC HOLE DIA. (in.): 8.0

| Time Interval (min.) | Total Elapsed Time (min.) | Initial Water Level (in.) | Final Water Level (in.) | Change in Water Level (in.) | Initial Hole Depth (in.) | Final Hole Depth (in.) | Percolation Rate (in/hr) | Infiltration rate (Porchet Method) (in/hr) |
|---|---|---|---|---|---|---|---|---|
| 30 | 30 | 0.0 | 60.0 | 60.0 | 120.0 | 120.0 | 120.0 | 2.61 |
| 30 | 60 | 0.0 | 60.0 | 60.0 | 120.0 | 120.0 | 120.0 | 2.61 |
| 30 | 90 | 0.0 | 60.0 | 60.0 | 120.0 | 120.0 | 120.0 | 2.61 |
| 30 | 120 | 0.0 | 60.0 | 60.0 | 120.0 | 120.0 | 120.0 | 2.61 |
| 10 | 130 | 0.0 | 36.9 | 36.9 | 120.0 | 120.0 | 221.4 | 4.28 |
| 10 | 140 | 0.0 | 38.1 | 38.1 | 120.0 | 120.0 | 228.6 | 4.44 |
| 10 | 150 | 0.0 | 38.4 | 38.4 | 120.0 | 120.0 | 230.4 | 4.48 |
| 10 | 160 | 0.0 | 35.4 | 35.4 | 120.0 | 120.0 | 212.4 | 4.07 |
| 10 | 170 | 0.0 | 34.5 | 34.5 | 120.0 | 120.0 | 207.0 | 3.95 |
| 10 | 180 | 0.0 | 34.2 | 34.2 | 120.0 | 120.0 | 205.2 | 3.91 |

Job No.: CB215173

# PERCOLATION TEST DATA

BORING NUMBER: P-2
LOT No: N/A
TRACT No: N/A

CLIENT: County of San Bernardino
PROJECT: SBC Valley Communications Center

DATE OF DRILLING: January 10, 2022
DATE OF PRESOAK: January 17, 2022
DATE OF TEST: January 17, 2022
TESTED BY: GA

DEPTH BEFORE (ft.): 10.0
DEPTH AFTER (ft.): 10.0
PVC PIPE DIA. (in.): 3.0
PERC HOLE DIA. (in.): 8.0

| Time Interval (min.) | Total Elapsed Time (min.) | Initial Water Level (in.) | Final Water Level (in.) | Change in Water Level (in.) | Initial Hole Depth (in.) | Final Hole Depth (in.) | Percolation Rate (in/hr) | Infiltration rate (Porchet Method) (in/hr) |
|---|---|---|---|---|---|---|---|---|
| 30 | 30 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 30 | 60 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 30 | 90 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 30 | 120 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 10 | 130 | 60.0 | 103.8 | 43.8 | 120.0 | 120.0 | 262.8 | 13.11 |
| 10 | 140 | 60.0 | 102.9 | 42.9 | 120.0 | 120.0 | 257.4 | 12.70 |
| 10 | 150 | 60.0 | 103.5 | 43.5 | 120.0 | 120.0 | 261.0 | 12.97 |
| 10 | 160 | 60.0 | 104.4 | 44.4 | 120.0 | 120.0 | 266.4 | 13.39 |
| 10 | 170 | 60.0 | 104.1 | 44.1 | 120.0 | 120.0 | 264.6 | 13.25 |
| 10 | 180 | 60.0 | 105.3 | 45.3 | 120.0 | 120.0 | 271.8 | 13.81 |

Job No.: CB215173

# PERCOLATION TEST DATA

BORING NUMBER: P-3
LOT No: N/A
TRACT No: N/A

CLIENT: County of San Bernardino
PROJECT: SBC Valley Communications Center

DATE OF DRILLING: January 10, 2022
DATE OF PRESOAK: January 19, 2022
DATE OF TEST: January 19, 2022
TESTED BY: GA

DEPTH BEFORE (ft.): 5.0
DEPTH AFTER (ft.): 5.0
PVC PIPE DIA. (in.): 3.0
PERC HOLE DIA. (in.): 8.0

| Time Interval (min.) | Total Elapsed Time (min.) | Initial Water Level (in.) | Final Water Level (in.) | Change in Water Level (in.) | Initial Hole Depth (in.) | Final Hole Depth (in.) | Percolation Rate (in/hr) | Infiltration rate (Porchet Method) (in/hr) |
|---|---|---|---|---|---|---|---|---|
| 30 | 30 | 0.0 | 16.5 | 16.5 | 120.0 | 120.0 | 33.0 | 0.58 |
| 30 | 60 | 0.0 | 15.6 | 15.6 | 120.0 | 120.0 | 31.2 | 0.55 |
| 30 | 90 | 0.0 | 15.0 | 15.0 | 120.0 | 120.0 | 30.0 | 0.52 |
| 30 | 120 | 0.0 | 13.5 | 13.5 | 120.0 | 120.0 | 27.0 | 0.47 |
| 30 | 150 | 0.0 | 12.6 | 12.6 | 120.0 | 120.0 | 25.2 | 0.44 |
| 30 | 180 | 0.0 | 11.7 | 11.7 | 120.0 | 120.0 | 23.4 | 0.40 |
| 30 | 210 | 0.0 | 11.4 | 11.4 | 120.0 | 120.0 | 22.8 | 0.39 |
| 30 | 240 | 0.0 | 10.8 | 10.8 | 120.0 | 120.0 | 21.6 | 0.37 |
| 30 | 270 | 0.0 | 10.5 | 10.5 | 120.0 | 120.0 | 21.0 | 0.36 |
| 30 | 300 | 0.0 | 10.2 | 10.2 | 120.0 | 120.0 | 20.4 | 0.35 |
| 30 | 330 | 0.0 | 10.2 | 10.2 | 120.0 | 120.0 | 20.4 | 0.35 |
| 30 | 360 | 0.0 | 9.6 | 9.6 | 120.0 | 120.0 | 19.2 | 0.33 |

Job No.: CB215173

# PERCOLATION TEST DATA

BORING NUMBER: P-4
LOT No: N/A
TRACT No: N/A

CLIENT: County of San Bernardino
PROJECT: SBC Valley Communications Center

DATE OF DRILLING: January 10, 2022
DATE OF PRESOAK: January 19, 2022
DATE OF TEST: January 19, 2022
TESTED BY: GA

DEPTH BEFORE (ft.): 10.0
DEPTH AFTER (ft.): 10.0
PVC PIPE DIA. (in.): 3.0
PERC HOLE DIA. (in.): 8.0

| Time Interval (min.) | Total Elapsed Time (min.) | Initial Water Level (in.) | Final Water Level (in.) | Change in Water Level (in.) | Initial Hole Depth (in.) | Final Hole Depth (in.) | Percolation Rate (in/hr) | Infiltration rate (Porchet Method) (in/hr) |
|---|---|---|---|---|---|---|---|---|
| 30 | 30 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 30 | 60 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 30 | 90 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 30 | 120 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 120.0 | 7.50 |
| 6.38 | 126.38 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 564.3 | 35.27 |
| 6.17 | 132.55 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 583.5 | 36.47 |
| 6.12 | 138.67 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 588.2 | 36.76 |
| 5.83 | 144.5 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 617.5 | 38.59 |
| 5.78 | 150.28 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 622.8 | 38.93 |
| 5.7 | 155.98 | 60.0 | 120.0 | 60.0 | 120.0 | 120.0 | 631.6 | 39.47 |

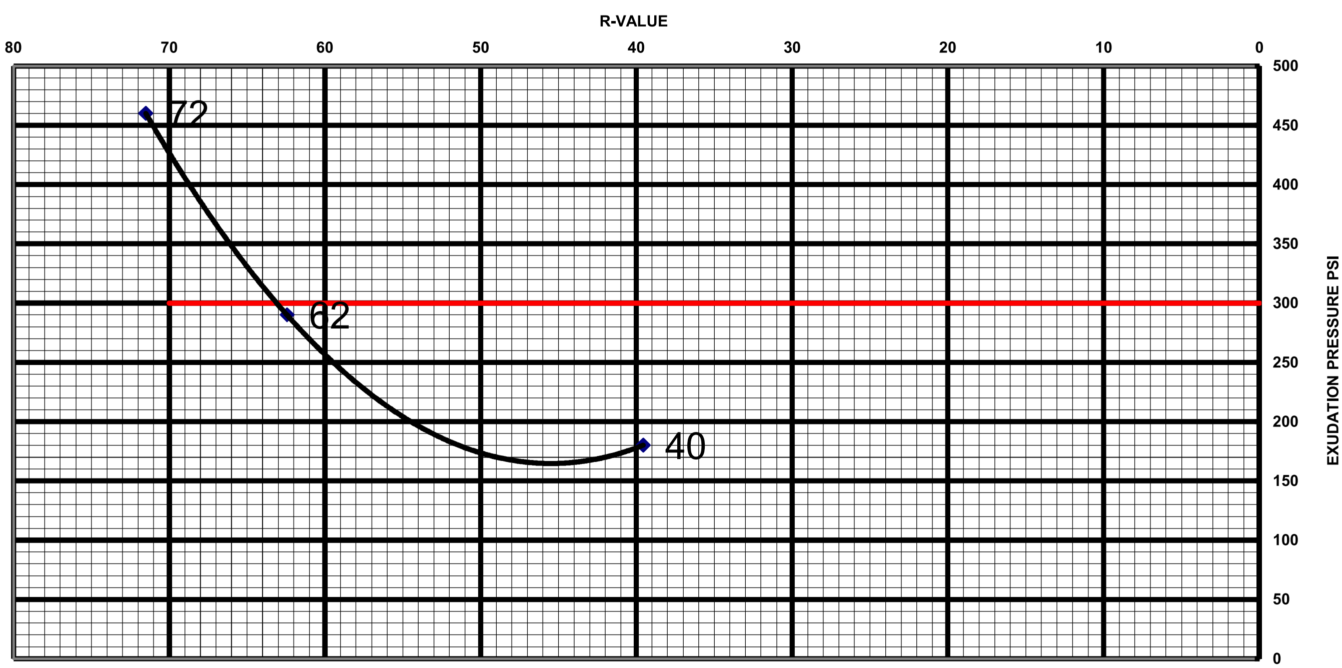
Job No. CB215173
Date. 1/26/2022

**LABORATORY RECORD OF TESTS MADE ON**
**BASE, SUBBASE, AND BASEMENT SOILS**

**CLIENT:** **County of San Bernardino**
**PROJECT** **Valley Communication Center**
**LOCATION:**
**R-VALUE # :** **4A**
**T.I. :**

| | A | B | C | D |
|---|---|---|---|---|
| COMPACTOR AIR PRESSURE P.S.I. | 350 | 350 | 350 | |
| INITIAL MOISTURE % | 10.1 | 10.1 | 10.1 | |
| WATER ADDED, ML | 20 | 10 | 0 | |
| WATER ADDED % | 1.9 | 1.0 | 0.0 | |
| MOISTURE AT COMPACTION % | 12.0 | 11.1 | 10.1 | |
| HEIGHT OF BRIQUETTE | 2.52 | 2.49 | 2.51 | |
| WET WEIGHT OF BRIQUETTE | 1136 | 1127 | 1127 | |
| DENSITY LB. PER CU.FT. | 121.9 | 123.5 | 123.6 | |
| STABILOMETER PH AT 1000 LBS. | 38 | 23 | 18 | |
| 2000 LBS. | 67 | 37 | 29 | |
| DISPLACEMENT | 5.30 | 5.00 | 4.50 | |
| R-VALUE | 40 | 62 | 72 | |
| EXUDATION PRESSURE | 180 | 290 | 460 | |
| THICK. INDICATED BY STAB. | 0.00 | 0.00 | 0.00 | |
| EXPANSION PRESSURE | 0 | 0 | 0 | |
| THICK. INDICATED BY E.P. | 0.00 | 0.00 | 0.00 | |

**EXUDATION CHART**




**R-Value:** **63**

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Terracon GeoReport

**Client**
County of San Bernadino CA

**Project**
Valley Communication Center (Project 10.10.0181)

**Sample Submitted By:** Terracon (CB) **Date Received:** 1/28/2022 **Lab No.: 22-0069**

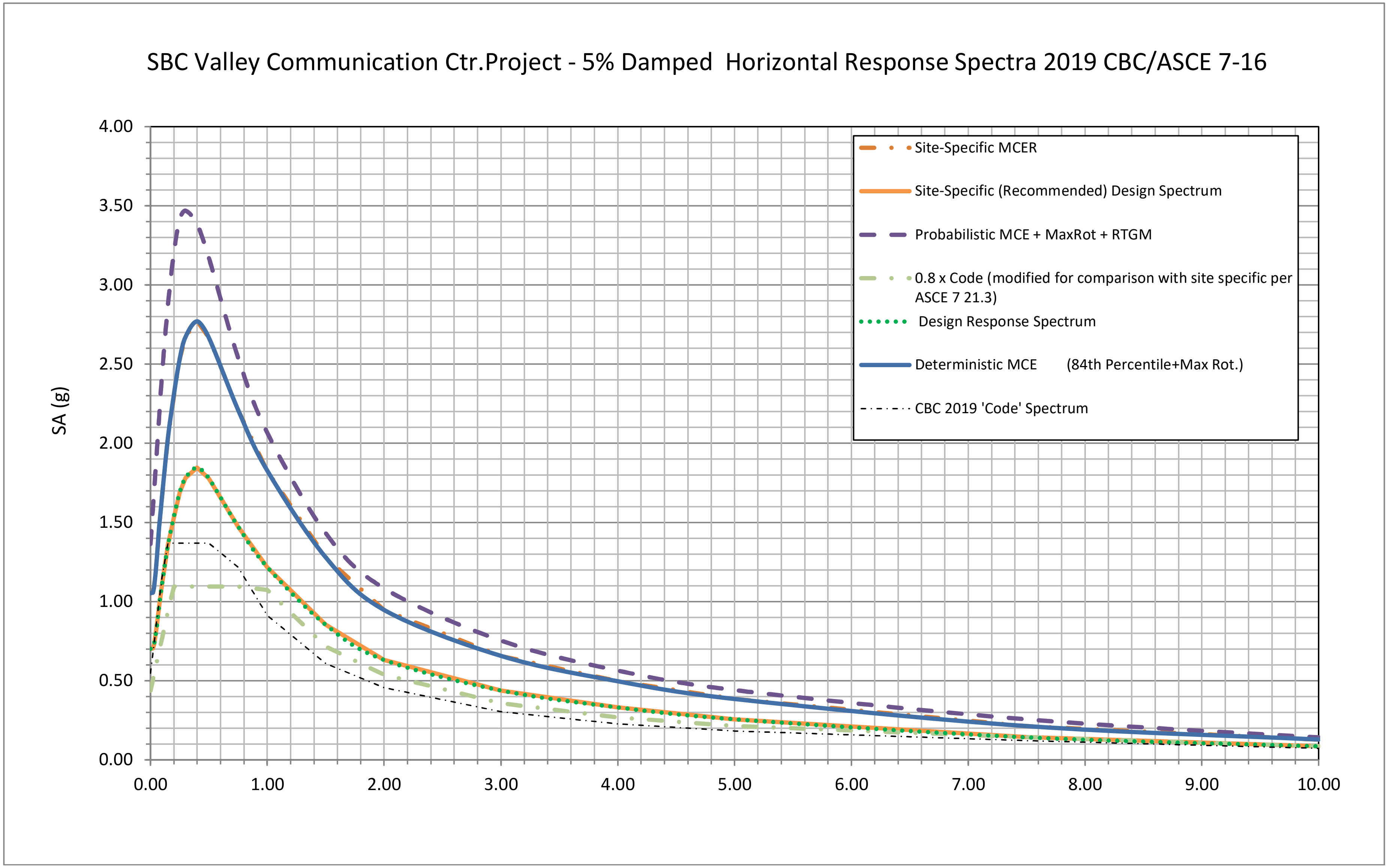
## Results of Corrosion Analysis

| | |
|---|---|
| **Sample Number** | B3-A |
| **Sample Location** | B-3(50) |
| **Sample Depth (ft.)** | 2.0-5.0 |
| pH Analysis, ASTM G 51 | 7.36 |
| Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg) | 83 |
| Chlorides, ASTM D 512, (mg/kg) | 30 |
| Total Salts, AWWA 2540, (mg/kg) | 356 |
| As-Received Resistivity, ASTM G 57, (ohm-cm) | 57230 |
| Saturated Minimum Resistivity, ASTM G 57, (ohm-cm) | 2716 |

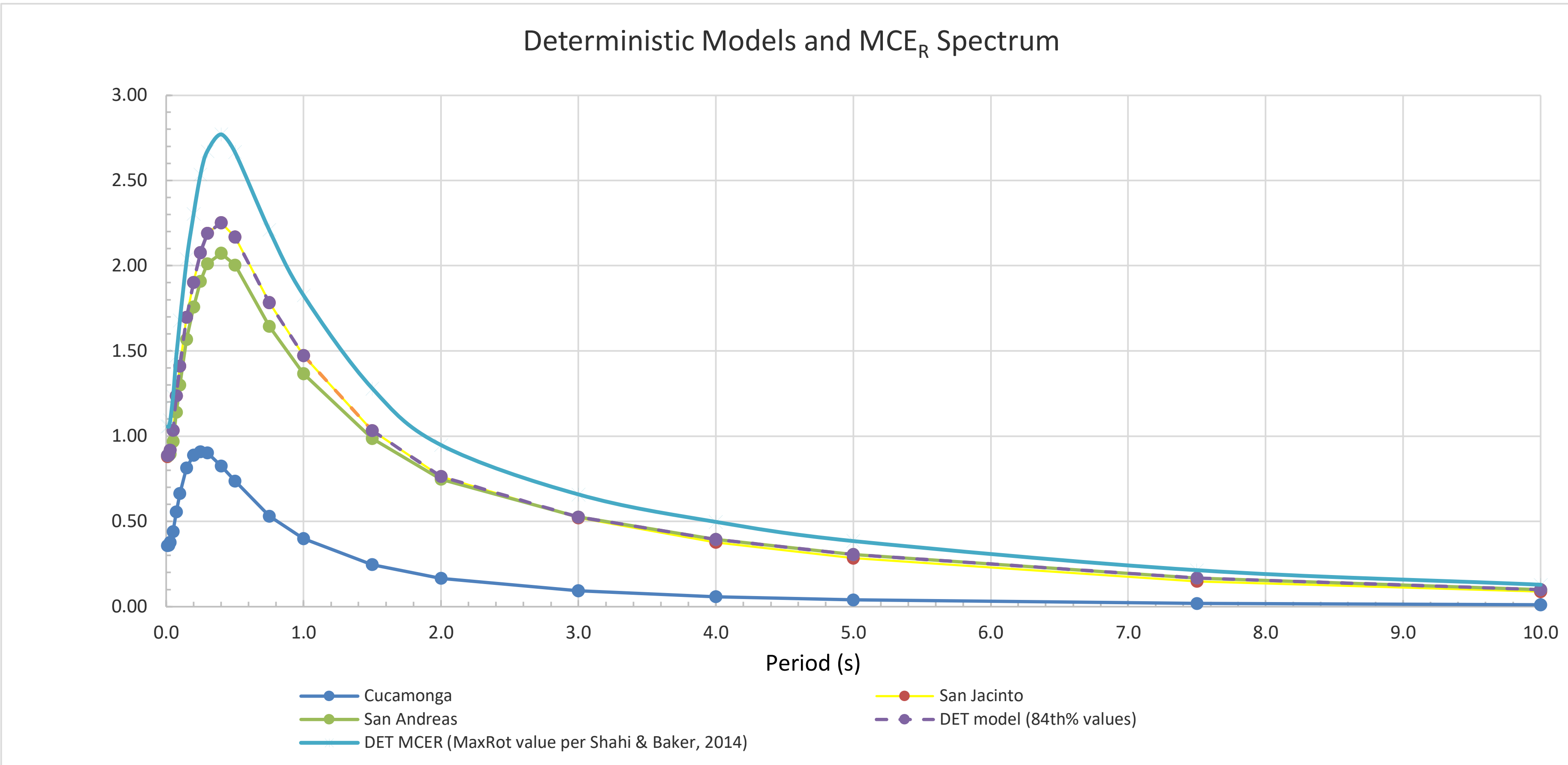
**Analyzed By:** N. Campo

Nathan Campo
Engineering Technician II

| SBC Valley Communication Ctr. Project - Site-Specific Response Spectra 2019 CBC/ASCE 7-16 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Period (sec) | Deterministic MCE (84th Percentile+Max Rot.) | Probabilistic MCE + MaxRot + RTGM | Site-Specific $MCE_R$ | 0.8 x Code (modified for comparison with site specific per ASCE 7 21.3) | Design Response Spectrum | Site-Specific (Recommended) Design Spectrum | CBC 2019 'Code' Spectrum |
| 0.000 | 1.053 | 1.364 | 1.053 | 0.438 | 0.702 | 0.702 | 0.548 |
| 0.010 | 1.056 | 1.472 | 1.056 | 0.472 | 0.704 | 0.704 | 0.609 |
| 0.020 | 1.057 | 1.580 | 1.057 | 0.505 | 0.705 | 0.705 | 0.671 |
| 0.030 | 1.093 | 1.688 | 1.093 | 0.539 | 0.728 | 0.728 | 0.732 |
| 0.050 | 1.230 | 1.905 | 1.230 | 0.606 | 0.820 | 0.820 | 0.856 |
| 0.075 | 1.472 | 2.175 | 1.472 | 0.689 | 0.981 | 0.981 | 1.009 |
| 0.100 | 1.679 | 2.445 | 1.679 | 0.773 | 1.119 | 1.119 | 1.163 |
| 0.150 | 2.038 | 2.879 | 2.038 | 0.940 | 1.359 | 1.359 | 1.369 |
| 0.200 | 2.303 | 3.202 | 2.303 | 1.095 | 1.535 | 1.535 | 1.369 |
| 0.250 | 2.534 | 3.414 | 2.534 | 1.095 | 1.690 | 1.690 | 1.369 |
| 0.300 | 2.673 | 3.470 | 2.673 | 1.095 | 1.782 | 1.782 | 1.369 |
| 0.400 | 2.771 | 3.383 | 2.771 | 1.095 | 1.847 | 1.847 | 1.369 |
| 0.500 | 2.668 | 3.171 | 2.668 | 1.095 | 1.779 | 1.779 | 1.369 |
| 0.750 | 2.211 | 2.541 | 2.211 | 1.095 | 1.474 | 1.474 | 1.217 |
| 1.000 | 1.826 | 2.066 | 1.826 | 1.074 | 1.218 | 1.218 | 0.913 |
| 1.500 | 1.280 | 1.432 | 1.280 | 0.716 | 0.853 | 0.853 | 0.609 |
| 2.000 | 0.947 | 1.084 | 0.947 | 0.537 | 0.631 | 0.631 | 0.457 |
| 3.000 | 0.657 | 0.754 | 0.657 | 0.358 | 0.438 | 0.438 | 0.304 |
| 4.000 | 0.497 | 0.564 | 0.497 | 0.269 | 0.332 | 0.332 | 0.228 |
| 5.000 | 0.385 | 0.441 | 0.385 | 0.215 | 0.257 | 0.257 | 0.183 |
| 7.500 | 0.213 | 0.256 | 0.213 | 0.143 | 0.142 | 0.143 | 0.122 |
| 10.000 | 0.128 | 0.142 | 0.128 | 0.086 | 0.085 | 0.086 | 0.073 |


SBC Valley Communication Ctr.Project - 5% Damped Horizontal Response Spectra 2019 CBC/ASCE 7-16
SA (g)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Site-Specific MCER
Site-Specific (Recommended) Design Spectrum
Probabilistic MCE + MaxRot + RTGM
0.8 x Code (modified for comparison with site specific per ASCE 7 21.3)
Design Response Spectrum
Deterministic MCE (84th Percentile+Max Rot.)
CBC 2019 'Code' Spectrum

| Deterministic Models and $MCE_R$ Spectrum | | | | | |
|---|---|---|---|---|---|
| Period | Cucamonga | San Jacinto | San Andreas | DET model (84th% values) | DET $MCE_R$ (MaxRot value per Shahi & Baker, 2014) |
| 0.01 | 0.358 | 0.880 | 0.887 | 0.887 | 1.056 |
| 0.02 | 0.359 | 0.888 | 0.886 | 0.888 | 1.057 |
| 0.03 | 0.376 | 0.918 | 0.897 | 0.918 | 1.093 |
| 0.05 | 0.439 | 1.033 | 0.969 | 1.033 | 1.230 |
| 0.075 | 0.556 | 1.237 | 1.140 | 1.237 | 1.472 |
| 0.1 | 0.664 | 1.411 | 1.301 | 1.411 | 1.679 |
| 0.15 | 0.814 | 1.699 | 1.568 | 1.699 | 2.038 |
| 0.2 | 0.889 | 1.903 | 1.758 | 1.903 | 2.303 |
| 0.25 | 0.908 | 2.077 | 1.909 | 2.077 | 2.534 |
| 0.3 | 0.902 | 2.191 | 2.012 | 2.191 | 2.673 |
| 0.4 | 0.826 | 2.253 | 2.073 | 2.253 | 2.771 |
| 0.5 | 0.736 | 2.169 | 2.005 | 2.169 | 2.668 |
| 0.75 | 0.531 | 1.783 | 1.645 | 1.783 | 2.211 |
| 1 | 0.399 | 1.473 | 1.367 | 1.473 | 1.826 |
| 1.5 | 0.246 | 1.032 | 0.986 | 1.032 | 1.280 |
| 2 | 0.166 | 0.764 | 0.747 | 0.764 | 0.947 |
| 3 | 0.093 | 0.521 | 0.526 | 0.526 | 0.657 |
| 4 | 0.058 | 0.377 | 0.395 | 0.395 | 0.497 |
| 5 | 0.039 | 0.284 | 0.305 | 0.305 | 0.385 |
| 7.5 | 0.018 | 0.148 | 0.167 | 0.167 | 0.213 |
| 10 | 0.010 | 0.088 | 0.099 | 0.099 | 0.128 |



Deterministic Models and $MCE_R$ Spectrum
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Period (s)
Cucamonga
San Andreas
DET MCER (MaxRot value per Shahi & Baker, 2014)
San Jacinto
DET model (84th% values)

# SUPPORTING INFORMATION

**Contents:**

# GENERAL NOTES
## DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Terracon GeoReport

### SAMPLING

- Auger Cuttings
- Modified California Ring Sampler
- Grab Sample
- Standard Penetration Test

### WATER LEVEL

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time
- Cave In Encountered

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

### FIELD TESTS

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

## DESCRIPTIVE SOIL CLASSIFICATION

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

## LOCATION AND ELEVATION NOTES

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

## STRENGTH TERMS

**RELATIVE DENSITY OF COARSE-GRAINED SOILS**

(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

| Descriptive Term (Density) | Standard Penetration or N-Value Blows/Ft. | Ring Sampler Blows/Ft. |
|---|---|---|
| Very Loose | 0 - 3 | 0 - 6 |
| Loose | 4 - 9 | 7 - 18 |
| Medium Dense | 10 - 29 | 19 - 58 |
| Dense | 30 - 50 | 59 - 98 |
| Very Dense | > 50 | > 99 |

**CONSISTENCY OF FINE-GRAINED SOILS**

(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

| Descriptive Term (Consistency) | Unconfined Compressive Strength Qu, (tsf) | Standard Penetration or N-Value Blows/Ft. | Ring Sampler Blows/Ft. |
|---|---|---|---|
| Very Soft | less than 0.25 | 0 - 1 | < 3 |
| Soft | 0.25 to 0.50 | 2 - 4 | 3 - 4 |
| Medium Stiff | 0.50 to 1.00 | 4 - 8 | 5 - 9 |
| Stiff | 1.00 to 2.00 | 8 - 15 | 10 - 18 |
| Very Stiff | 2.00 to 4.00 | 15 - 30 | 19 - 42 |
| Hard | > 4.00 | > 30 | > 42 |

## RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

# UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[Q] PI plots below "A" line.