# Geotechnical Engineering Report

**Proposed Johnson Student Center**

**Santa Ana, California**

November 21, 2016

Terracon Project No. 60145100

**Prepared for:**

RSCCD Facility Planning, District
Construction and Support Services
Santa Ana, California

**Prepared by:**

Terracon Consultants, Inc.
Irvine, California

November 21, 2016

RSCCD Facility Planning, District
Construction and Support Services
2323 N. Broadway, Suite 112,
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Attn: Ms. Allison Coburn
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**Re: Geotechnical Engineering Report**
**Proposed Johnson Student Center - Santa Ana College**
**1530 West 17th Street, Santa Ana, California.**
**Terracon Project No. 60145100**

Dear Ms. Coburn

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with our proposal for engineering services, P60140342 dated November 24, 2014. Furthermore, additional geotechnical services were performed in general accordance with our contract amendment dated July 18, 2016.

This Geotechnical Engineering Report presents the results of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and flatwork 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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## EXECUTIVE SUMMARY

A geotechnical site exploration has been performed for the proposed building to be located within Santa Ana College at 1530 West 17th Street, Santa Ana, California. Terracon's geotechnical scope of work included the advancement of eight (8) test borings to approximate depths of 21½ to 61½ feet below the ground surface (bgs) and two (2) Cone Penetration Test (CPT) soundings to an approximate depth of 50 feet bgs. In addition, three (3) borings were advanced to approximate depths ranging between 5 and 9.2 feet bgs and utilized for percolation testing.

Due to the presence of previous buildings onsite and the undetermined footprint of the proposed building at earlier stages, field exploration was separated into two phases. Phase I was performed on January 19 2015, and Phase II was performed on September 9, 2016.

Based on the information obtained from our subsurface exploration, the site is suitable for development of the proposed project provided our report recommendations are implemented during the design and construction phases of this project. The following geotechnical considerations were identified:

- The on-site surface materials consisted of concrete with approximate thickness of 3 to 6½ inches. At the locations performed within the existing building, 2 inches of sand layer overlying a plastic vapor barrier were encountered beneath the concrete floor slab. In general, the subsurface conditions encountered fill materials in multiple borings across the site, to depths ranging between approximately 2 and 5 feet. The fill materials in each boring consisted of sand with variable amounts of silt and clay. The native materials encountered in the borings and cone penetration tests generally consisted of lean clay with variable amounts of sand with interbedded layers of sand through the maximum depth of exploration.
- Groundwater was encountered in boring B-1 at an approximate depth of 25 feet at the time of drilling and at an approximate depth of 38 feet bgs in boring J-8 48-hours after the boring was completed. Based on published data, historical groundwater is anticipated to be approximately 35 feet bgs.
- Our analysis has concluded that the seismically-induced settlement of partially saturated and saturated sands is estimated to be less than ½ of an inch.
- The proposed two-story building may be supported on shallow foundations bearing on engineered fill.
- The engineered fill should comprise of approved on-site granular materials and low volume change import soils. The on-site near surface clayey soils should not be used as engineered fill in structural areas. The minimum depth of fill and over-excavation should be 5 feet below the existing grade or 3 feet below the bottom of the deepest foundation, whichever is greater.
- The on-site surface and near surface granular materials are expected to exhibit low expansion potential when subjected to light loading conditions such as those imposed by floor slabs. However the on-site surface and near surface clayey materials are expected to exhibit medium expansion potential. Therefore, construction of floor slabs directly on engineered fill consisting of approved on-site granular materials and low volume change import soils is recommended for the project.
- The 2016 California Building Code (CBC) seismic site classification for this site is D.
- 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 construction.

This geotechnical executive summary should be used in conjunction with the entire report for design and/or construction purposes. It should be recognized that specific details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled General Comments should be read for an understanding of the report limitations.

# GEOTECHNICAL ENGINEERING REPORT
# PROPOSED JOHNSON STUDENT CENTER
# 1530 WEST 17TH STREET
# SANTA ANA, CALIFORNIA

**Terracon Project No. 60145100**
**November 17, 2016**

## 1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the proposed building addition for the Johnson Student Center located within Santa Ana College at 1530 West 17th Street, Santa Ana, California. The Site Location Plan (Exhibit A-1) is included in Appendix A of this report. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- earthwork
- seismic considerations
- groundwater conditions
- foundation design and construction
- floor slab design and construction

Terracon's geotechnical scope of work included the advancement of eight (8) test borings to approximate depths ranging from 21½ to 61½ feet below the ground surface (bgs) and two (2) Cone Penetration Test (CPT) soundings to an approximate depth of 50 feet bgs. In addition, three (3) borings were advanced to approximate depths ranging between 5 and 9.2 feet bgs and utilized for percolation testing.

Due to the presence of previous buildings onsite and the undetermined footprint of the proposed building at earlier stages, field exploration was separated into two phases. Phase I was performed on January 19 2015, and Phase II was performed on September 9, 2016.

Logs of the borings along with a Boring Location Plan (Exhibit A-2) are included in Appendix A of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B of this report. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

## 2.0 PROJECT INFORMATION

### 2.1 Project Description

| ITEM | DESCRIPTION |
|---|---|
| **Site layout** | Refer to the Boring Location Plan (Exhibit A-2 in Appendix A). |

| ITEM | DESCRIPTION |
|---|---|
| **Structures** | The proposed site development will include the construction of a two-story building. The structures will encompass a gross area of approximately 64,755 square feet, with a footprint of approximately 32,400 square feet. |
| **Construction** | We assume the college building will be two-story, steel structures with concrete slab-on-grade floors, and will be supported on shallow spread footing foundation system. The interior floors are assumed to consist of a reinforced concrete slab-on-grade. |
| **Maximum loads (assumed)** | Column Load – 150 to 220 kips (Static)<br>300 to 400 kips (Seismic)<br>Continuous Wall Load – 2 klf.<br>Uniform Floor Slab Load – 150 psf max |
| **Grading** | Over-excavating beneath the proposed foundations and backfill to bring the site to grade. |

## 2.2 Site Location and Description

| Item | Description |
|---|---|
| **Location** | The project is located within the existing Santa Ana College at 1530 West 17th Street in the City of Santa Ana, California. |
| **Existing site features** | The site is currently developed with Building "U" which is comprised of two stories and two separate structures:<br>Campus Center Building is a two-story building which includes the student center building with an approximate footprint area of 18,000 SF, and a 4,000 SF learning center addition that was added at a later stage.<br>Bookstore Building is a two-story building with an approximate footprint area of 5,200 SF.<br>The buildings are surrounded by hardscape and landscape. |
| **Surrounding developments** | North: Concrete pavement follow by Russell Hall building<br>East: Neally Library building<br>West: Fitness center<br>South: Auto shop/quick center |
| **Current ground cover** | Asphalt pavements and concrete flatwork. |
| **Existing topography** | The site is relatively flat. |

## 2.3 Background

At the time of preparation of this report, we have been provided with the following documents:

- Report of Geotechnical Engineering and Engineering Geology Investigation Prepared By Koury Geotechnical Services, Inc. and dated February 22, 2011.

- Architectural and Mechanical plans for the Johnson Campus Center Addition prepared by Garcia and Associates and dated September 18, 1987.

Based on our review of these documents, the existing building is comprised of two stories and two separate structures:

- Campus Center Building is a two-story building which includes the student center building with an approximate footprint area of 18,000 SF, and a 4,000 SF learning center addition that was added at a later stage.
- Bookstore Building is a two-story building with an approximate footprint area of 5,200 SF.

It is our understanding that the two buildings are structurally independent and are constructed on different foundation systems. The main Campus Center Building, which occupies the majority of footprint of Building U, is being supported on 20-in diameter cast-in-place concrete piles with an embedment depth ranging between 36 and 40 feet. The Bookstore structure is being supported on conventional shallow spread/strip footings with an approximate embedment of 24 inches.

# 3.0 SUBSURFACE CONDITIONS

## 3.1 Site Geology

The site is situated within the Peninsular Ranges Geomorphic Province in Southern California. Geologic structures within this Province trend mostly northwest, in contrast to the prevailing east-west trend in the neighboring Transverse Ranges Geomorphic Province to the north. The Peninsular Range Province extends into Baja California, and is bounded by the Colorado Desert to the east, the Pacific Ocean to the west and the San Gabriel and San Bernardino mountains to the north.[1,2] The surficial geologic unit mapped at the site consists of young alluvial fan deposits (Exhibit A-3) of Holocene to Late Pleistocene age.[3]

## 3.2 Typical Subsurface Profile

Specific conditions encountered at the boring locations are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for the borings can be found on the boring logs included in Appendix A. The on-site surface materials consisted of concrete with approximate thickness of 3 to 6½ inches. At the locations performed within the existing building, 2 inches of sand layer overlying a plastic vapor barrier was encountered beneath the concrete floor slab. In general, the subsurface conditions encountered fill materials in multiple

[1] Harden, D. R., "*California Geology, Second Edition*," Pearson Prentice Hall, 2004.
[2] Norris, R. M. and Webb, R. W., *"Geology of California, Second Edition,"* John Wiley & Sons, Inc., 1990.
[3] *California Geological Survey, Geologic Compilation of Quaternary Surficial Deposits in Southern California, Special Report 217, Revised, Plate 16-Santa Ana 30' x 60' Quadrangle (Revised), compiled December 2012.*

borings across the site, to depths ranging between approximately 2 and 5 feet bgs. The fill materials in each boring consisted of sand with variable amounts of silt and clay. The native materials encountered in the borings and cone penetration tests generally consisted of lean clay with variable amounts of sand with interbedded layers of sand through the maximum depth of exploration.

Laboratory tests were conducted on selected soil samples, and the test results are presented in Appendix B and on the boring logs. Atterberg limits test results indicated that near-surface soils have low to medium plasticity. A direct shear test was performed on clayey sand and sandy lean clay materials at an approximate depth of 3 feet bgs, and resulted in an ultimate friction angle ranging between 27 and 28-degrees and a corresponding cohesion value ranging from approximately 630 to 1,044 pounds per square foot (psf). Expansion Index testing of clayey sand and lean clay soils encountered at a depth of approximately 1 foot bgs indicated near surface soils will have an expansion index of 10 and 55, respectively.

## 3.3 Groundwater

Groundwater was observed in boring B-1 at a depth of approximately 25 feet bgs, at the time of field exploration and at an approximate depth of 38 feet bgs in boring J-8 48-hours after the boring was completed. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations.

In clayey soils with low permeability, the accurate determination of groundwater level may not be possible without long-term observation. Long-term observation after drilling could not be performed, as borings were backfilled immediately upon completion due to safety concerns. Groundwater levels can best be determined by implementation of a groundwater monitoring plan. Such a plan would include installation of groundwater monitoring wells, and periodic measurement of groundwater levels over a sufficient period of time.

Previous Preliminary Geotechnical Engineering Report prepared by Koury Geotechnical Services indicates that groundwater was encountered at depths between 39 and 52 feet bgs at the project site.

Based on regional data recorded from 2006 to 2008, the historical highest groundwater level in the project vicinity ranged in depth between 42 and 52 feet bgs.[4]

Based on historical high groundwater level maps published by the California Geological Survey (CGS), the groundwater level in the project vicinity is approximately 35 feet bgs.[5] The historical groundwater contour map is presented in Exhibit A-4.

[4] Groundwater level measured approximately 1/3 mile southeast of site in monitoring well # T0605985148 and well # T10000000219

[5] Seismic Hazard Zone Report for the Anaheim 7.5-Minute Quadrangle, Orange County, California, by California Division of Mines and Geology (CDMG), dated 1998.

## 3.4 Seismic Considerations

### 3.4.1 Seismic Site Class and Parameters

| DESCRIPTION | VALUE |
|---|---|
| 2016 California Building Code Site Classification (CBC) [1] | D |
| Site Latitude | N 33.7585° |
| Site Longitude | W -117.8885° |
| $S_s$ Spectral Acceleration for a Short Period | 1.457g |
| $S_1$ Spectral Acceleration for a 1-Second Period | 0.534g |
| $F_a$ Site Coefficient for a Short Period | 1.0 |
| $F_v$ Site Coefficient for a 1-Second Period | 1.5 |

[1] Note: The 2016 California Building Code (CBC) requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100 foot soil exploration. However, previous exploration on site including Refraction Micro-tremor geophysical surveys provided shear wave velocity values for 100 feet bgs.

### 3.4.2 Faulting and Estimated Ground Motions

The site is located in Southern California, which is a seismically active area. The type and magnitude of seismic hazards affecting the site are dependent on the distance to causative faults, the intensity, and the magnitude of the seismic event. The table below indicates the distance of the fault zones and the associated maximum credible earthquake that can be produced by nearby seismic events, as calculated using the USGS Earthquake Hazard Program 2002 interactive deaggregations. The San Joaquin Hills Thrust Fault, which is located approximately 7.9 kilometers from the site, is considered to have the most significant effect at the site from a design standpoint.

| Characteristics and Estimated Earthquakes for Regional Faults | | |
|---|---|---|
| **Fault Name** | **Approximate Distance to Site (kilometers)** | **Maximum Credible Earthquake (MCE) Magnitude** |
| San Joaquin Hills Thrust | 7.9 | 6.57 |
| San Joaquin Hills Thrust GR M | 8.3 | 6.52 |
| Newport-Inglewood | 13.4 | 7.02 |

Based on the ASCE 7-10 Standard, the peak ground acceleration at the subject site is approximately 0.528g. Based on the USGS 2002 interactive deaggregations, the project site has a modal magnitude of 6.60.

The site is not located within an Alquist-Priolo Earthquake Fault Zone based on our review of the State Fault Hazard Maps.[6] The nearest zoned fault segment is in the Newport-Inglewood Fault Zone located approximately 13.4 km southwest of the site. Two pre-Quaternary age faults of this fault zone are south of the site as shown in Exhibit A-3

### 3.4.3 Historic Earthquakes

Historically, the San Andreas Fault Zone Complex has rendered many earthquakes of the magnitude range of 5.0Mw or greater ('Mw' is the Moment Magnitude as defined by the USGS) that may have affected the project site. These major quakes have been estimated to be in the range of 5.0Mw to 6.6Mw. Each of these major quakes has rendered light to moderate damage to buildings and roads. For reference purposes, a summary of the significant (>5.0Mw) earthquakes that affected the site (within 50 km) are provided below.

| Date | Quake Moment Magnitude (Mw) | Depth (km) | Approximate Distance | Bearing |
|---|---|---|---|---|
| 4/21/1918 | 6.7 | 10 | 51.1 km (31.8 mi) | S73E |
| 3/11/1933 | 6.4 | 10 | 34.8 km (21.6 mi) | S59W |
| 2/9/1971 | 6.7 | 5 | 79.2 km (49.2 mi) | N32W |
| 1/1/1979 | 5.1 | 11 | 89.1 km (55.4 mi) | N73W |
| 7/13/1986 | 5.8 | 10 | 69.7 km (43.3 mi) | S1E |
| 10/1/1987 | 5.9 | 10 | 34.0 km (21.1 mi) | N27W |
| 10/4/1987 | 5.2 | 8 | 36.1 km (22.4 mi) | N28W |
| 10/4/1987 | 5.2 | 8 | 36.1 km (22.4 mi) | N28W |
| 11/20/1988 | 5 | 6 | 29.7 km (18.5 mi) | S30W |
| 1/19/1989 | 5.2 | 12 | 82.9 km (51.5 mi) | N75W |
| 4/7/1989 | 5 | 13 | 12.3 km (7.6 mi) | S4W |
| 2/28/1990 | 5.7 | 5 | 39.6 km (24.6 mi) | N22E |
| 6/28/1991 | 5.7 | 11 | 46.2 km (28.7 mi) | N10W |
| 1/17/1994 | 5.9 | 9.8 | 102.3 km (63.6 mi) | N49W |
| 1/17/1994 | 5 | 14.8 | 83.8 km (52.1 mi) | N46W |
| 1/17/1994 | 6.7 | 18.4 | 82.0 km (50.9 mi) | N49W |
| 1/29/1994 | 5.3 | 1 | 90.1 km (56.0 mi) | N45W |
| 3/20/1994 | 5.3 | 13.1 | 76.9 km (47.8 mi) | N45W |
| 7/29/2008 | 5.5 | 14.7 | 22.2 km (13.8 mi) | N28E |
| 3/29/2014 | 5.1 | 4.77 | 15.7 km (9.8 mi) | N7W |

[6] California Department of Conservation, Division of Mines and Geology (CDMG), *"Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Southern Region"*, CDMG Compact Disc 2000-003, 2000.

### 3.4.4 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. Liquefaction is typically a hazard where loose sandy soils exist below groundwater. The California Geologic Survey (CGS), formerly known as the California Department of Mines and Geology (CDMG) prior to 2001 and hereafter referred to as the California Geological Survey (CGS), has designated certain areas within southern California 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. The project site is located within a potential liquefaction hazard zone as designated by the CGS (1999, Exhibit A-5).

Materials encountered at the project site generally consist of loose to medium dense granular material and interbedded medium stiff to very stiff cohesive soils. Groundwater was encountered in test boring B-1 at the time of field exploration at a depth of approximately 25 feet bgs (below the ground surface).

Liquefaction analysis for the site was performed in accordance with the CGS Special Publication 117. The liquefaction study utilized the software "LiquefyPro" by CivilTech Software and calculated liquefaction assuming a depth to groundwater of 25 feet bgs. This analysis was based on the soils data from the CPT logs and laboratory test results. Maximum acceleration was calculated using the Peak Ground Acceleration ($PGA_M$) as per ASCE 7-10 (Equation 11.8-1).

Liquefaction potential was calculated from the ground surface to a depth of 50 feet bgs. The factor of safety was greater than 1.2 with the exception of multiple thin layers within the upper 50 feet.

Based on calculation results, seismically-induced settlement of saturated and dry sands is estimated to be less that ½ of an inch, and differential settlement is estimated to be less than ¼ of an inch. Liquefaction potential analysis is attached to Appendix D of this report.

## 3.5 Percolation Test Results

Three (3) in-situ percolation tests (using falling head borehole permeability) were performed to approximate depths of 5 and 9.2 bgs. A 2-inch thick layer of gravel was placed in the bottom of each boring after the borings were drilled to investigate the soil profile. A 3-inch diameter perforated pipe was installed on top of the gravel layer in each boring. 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. Testing began after all the water was percolated through the test hole. At the beginning of each test, the pipes were refilled with water, and readings were taken at designated time intervals. Percolation rates are provided in the following table:

| TEST RESULTS | | | | |
|---|---|---|---|---|
| Test Location (depth in feet bgs) | Soil Classification | Percolation Rate (in/hr) | Correlated Infiltration Rate* (in/hr) | Average Water Head, (inches) |
| P-1 (9.17) | Silty Clayey Sand over Sandy Silty Clay | 2.00 | <0.1 | 60 |
| P-2 (5) | Silty Clayey Sand | >100 | >5.00 | 42 |
| P-3 (5) | Silty Clayey Sand | >100 | >5.00 | 37 |

*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 field test results are not intended to be design rates. They represent the result of our tests, at the depths and locations indicated, as described above. The design rate should be determined by the designer by applying an appropriate factor of safety. With time, the bottoms of infiltration systems tend to plug with organics, sediments, and other debris. Long term maintenance will likely be required to remove these deleterious materials to help reduce decreases in actual percolation rates.

The percolation test was 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 a minimum of 10 feet from any existing or proposed foundation system

## 3.6 Corrosion Potential

Results of soluble sulfate testing indicate that ASTM Type I/II Portland cement may be used for all concrete on and below grade. Foundation concrete may be designed for low sulfate exposure in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

Laboratory test results indicate the on-site soils have a pH ranging between approximately 7.99 and 8.59, a minimum resistivity ranging between approximately 553 and 1,164 ohm-cm, a chloride content ranging between approximately 75 and 325 ppm, a water soluble sulfate content ranging between approximately 0.01% and 0.04%, Red-Ox potential ranging between approximately 581 to 674 mV, and negligible sulfides, as shown on the attached Results of Corrosivity Analysis sheet in Appendix B. These values should be used to evaluate corrosive potential of the on-site soils to underground ferrous metals.

Refer to the Results of Corrosivity Analysis in Appendix B for the complete results of the corrosivity testing conducted in conjunction with this geotechnical exploration.

# 4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

## 4.1 Geotechnical Considerations

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided our recommendations are implemented on the design and construction phases of the project. Based on the geotechnical engineering analyses, subsurface exploration, and laboratory test results, we recommend that the proposed buildings be supported on a spread footing foundation system bearing on engineered fill.

Our explorations indicate that approximately 2 to 4 feet of undocumented fill material was encountered in multiple borings on-site. The fill materials on each of these four borings were comprised of sand with variable amounts of silt and clay. We assume that the upper fill materials encountered in the borings were placed during the grading and construction of the existing building. Based on the relative density of the fill materials and field blow counts, it is apparent that the fill materials did not receive adequate compaction effort during placement.

We recommend that all fill materials within the footprint of the proposed building be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction. After removal of undocumented fill within the proposed building footprint, foundations and floor slab areas should be supported on a minimum of 3 feet of engineered fill. Exterior flat work can be supported on existing fill prepared per the recommendations provided in this report.

Support of exterior flatwork on or above existing fill soils is discussed in this report; however, even with the recommended construction testing services, there is an inherent risk for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. Supporting exterior flatwork or pavements on undocumented fill materials may result in excessive movements. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill, but can be reduced by performing additional testing and evaluation.

The on-site clayey materials are expected to exhibit “medium” expansion potential when subjected to typical footing and floor slab loading conditions. Due to the expansion potential of on-site soils, footings and interior floor slabs should bear on engineered fill comprised of low-volume change materials extending to a minimum depth of 3 feet below the bottom of footings, 5 feet below existing grade, or to the depth of the fill materials whichever is greater.

The project site is located within a potential liquefaction hazard zone as designated by the CGS (CDMG, 1999, Exhibit A-5). Our analysis has concluded that multiple thin layers of soils are liquefiable within the upper 50 feet bgs with a seismic induced settlement of saturated and dry sands estimated to be less that ½ of an inch, and differential settlement is estimated to be less than ¼ of an inch.

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 (which are presented in Appendices A and B), engineering analyses, and our current understanding of the proposed project.

## 4.2 Earthwork

The following presents recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for the design and construction of earth supported elements including, foundations, slabs, and flatwork are contingent upon following the recommendations outlined in this section. All grading for each structure should incorporate the limits of the proposed structure plus a lateral distance of 3 feet beyond the edges.

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.

### 4.2.1 Site Preparation

Strip and remove existing vegetation and other deleterious materials from proposed building and improvement areas. This should include the removal of any buried concrete slabs, flatwork or buried footings that may exist within the area of the proposed construction. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

Demolition of the existing buildings should include complete removal of all foundation systems and floor slabs within the proposed construction area. This should include removal of any loose backfill found adjacent to existing foundations. All materials derived from the demolition of existing structures should be removed from the site, and not be allowed for use in any on-site fills.

We recommend drilled shafts which support a portion of the existing building be removed or demolished. In the event the removal of such deep foundations is not feasible, they should be saw-cut or removed to a minimum of 5 feet below ground surface. If the proposed footing locations overlap existing shaft locations, Terracon should be notified.

Although evidence of fill materials was not observed during the site reconnaissance, fill materials associated with the construction of the existing building could be encountered during construction. Evidence of utilities and subsurface facilities was observed during our field exploration. If fill materials and/or utilities encountered during construction, such materials and facilities should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

### 4.2.2 Subgrade Preparation

Due to the presence of fill materials, expansion potential and low bearing capacity of near surface clayey soils, and the anticipated disturbance of onsite materials during the demolition of the existing building, the proposed shallow foundations and floor slabs should bear on engineered fill. The engineered fill should comprise of low expansion soils. The minimum depth of fill and over-excavation should be 5 feet below the existing grade, the depth of the fill materials or 3 feet below the bottom of the deepest foundation, whichever is greater.

Care should be taken to prevent wetting or drying of the bearing materials during construction. Wet, dry, or loose/disturbed material at the bottom of the footing excavations should be removed before foundation concrete is placed. Place a lean concrete mud-mat over the bearing soils if the excavations must remain open for an extended period of time.

Exposed areas which will receive fill, once properly cleared, should be scarified to a minimum depth of 10 inches, moisture conditioned, and compacted per the compaction requirements in Section 4.2.4.

Subgrade materials beneath exterior slabs and flatwork should be scarified, moisture conditioned, and compacted to a minimum depth of 10 inches. The moisture content and compaction of subgrade soils should be maintained until flatwork construction.

### 4.2.3 Fill Materials and Placement

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.

It is anticipated that the undocumented fill materials beneath the proposed building are going to be excavated. Near-surface soils varied between sandy and clayey soils on-site. Only the on-site sandy materials are considered suitable for use as engineered fill, provided that the

materials are processed and oversized particles, debris and other unsuitable materials are removed.

On-site processed granular soils may be used as engineered fill materials in the following areas:

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

On-site clayey soils may be used for general site grading in non-structural areas.

Imported soils for use as fill material within proposed building and structure areas should conform to low volume change materials as indicated in the following recommendations:

| Gradation | Percent Finer by Weight (ASTM C 136) |
|---|---|
| 3” | 100 |
| No. 4 Sieve | 50 to 100 |
| No. 200 Sieve | 15 to 40 |

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

*ASTM D 4829

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 ten inches in loose thickness.

### 4.2.4 Compaction Requirements

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

| 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 |
| Approved on-site granular soils or imported materials: | | | |
| Beneath slabs: | 90% | -1% | +3% |
| Utility Trenches in structural areas*: | 90% | -1% | +3% |

| 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 |
| Beneath foundations: | 90% | -1% | +3% |
| On-site soils | | | |
| Bottom of excavations to receive fill: | 90% | 0% | +4% |
| Miscellaneous backfill: | 90% | 0% | +4% |
| Aggregate base (beneath flatwork): | 95% | -2% | +2% |

* The upper 12 inches beneath flatwork and structural elements should be compacted to a minimum of 95%.

### 4.2.5 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 flatwork, 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.

### 4.2.6 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:

- exterior slabs should be supported directly on subgrade fill (not ABC) with no, or very low expansion potential;
- strict moisture-density control during placement of subgrade fills;
- maintain proper subgrade moisture until placement of slabs;
- placement of effective control joints on relatively close centers and isolation joints between slabs and other structural elements;
- provision for adequate drainage in areas adjoining the slabs;

- use of designs which allow vertical movement between the exterior slabs and adjoining structural elements.

For typical pedestrian traffic loads a 4-inch thick concrete slab may be used.

### 4.2.7 Shrinkage

For balancing grading onsite, estimated shrink factor of granular soils when used as compacted fill following recommendations in this report ranges between 0.85% and 0.90%. Shrinkage factors are based on converting materials in its loose state to materials after compaction.

### 4.2.8 Construction Considerations

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. On-site clayey soils may pump, and unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. The use of light construction equipment would aid in reducing subgrade disturbance. The use of remotely operated equipment, such as a backhoe, would be beneficial to perform cuts and reduce subgrade disturbance. Should unstable subgrade conditions develop stabilization measures will need to be employed.

At the time of our study, moisture contents of the surface and near-surface materials ranged from about 6 percent to 17 percent. Based on these moisture contents, some moisture conditioning will likely be needed for the project. The soils may need to be dried by aeration during dry weather conditions, or an additive, such as lime, cement, or kiln dust, may be needed to stabilize the soil.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and flatwork. 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 construction.

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.

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

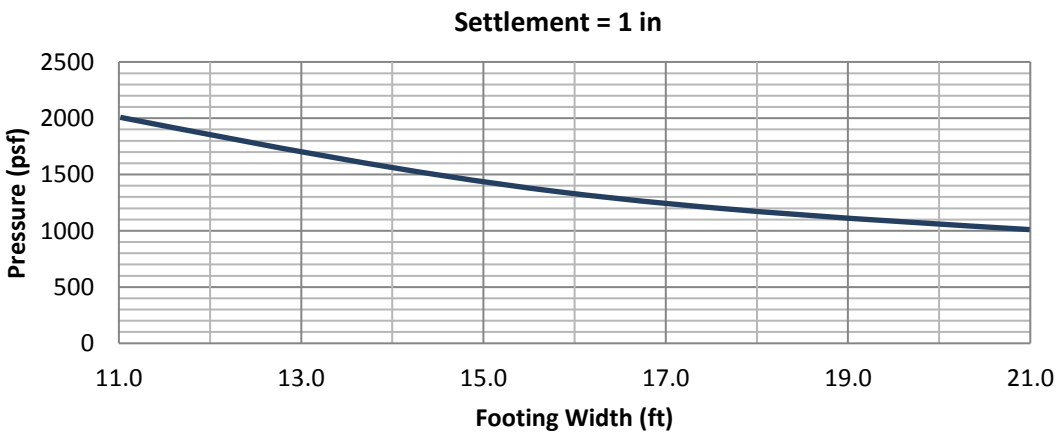
which would be expected during the drier summer and fall months. This could include diversion of surface runoff around exposed soils and draining of ponded water on the site. Once subgrades are established, it may be necessary to protect the exposed subgrade soils from construction traffic.

The individual contractor(s) is responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

## 4.3 Foundations

| DESCRIPTION | RECOMENDATION |
|---|---|
| **Foundation Type** | Conventional Shallow Spread Footings |
| **Bearing Material** | Engineered fill extending to a minimum of 36 inches below foundations, depth of fill materials, or 5 feet below existing grade, whichever is greater. |
| **Allowable Bearing Pressure** | 4,000 psf for foundation widths up to 6 feet<br>3,000 psf for foundation widths up to 8 feet<br>2,000 psf for foundation widths up to 11 feet<br>For footing widths > 11 feet, allowable bearing capacities should be determined by the chart below. |
| **Minimum Dimensions** | Walls: 18 inches; Columns: 24 inches |
| **Minimum Embedment Depth Below Finished Grade** | 18 inches |
| **Total Estimated Static Settlement** | 1-inch |
| **Estimated Differential Static Settlement** | ½ inch in 40 feet. |

Settlement calculations were performed utilizing Westergaard and Hough's methods[5] to estimate the allowable bearing pressure for various foundation widths with an allowable settlement of 1 inch.




[5]

Re

Based on the existing subsurface soil profile with 36 inches of engineered fill and for contact pressures and widths provided in the previous table, the total static settlement was less or equal to 1 inch. Typically, the total tolerated differential settlement among foundations is on the order of L/600. Such tolerance is based on the column beam connections and should be verified by the building structural engineer.

Finished grade is defined as the lowest adjacent grade within five feet of the foundation for perimeter (or exterior) footings. The allowable foundation bearing pressures apply to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

## 4.4 Floor Slab

| DESCRIPTION | VALUE |
|---|---|
| **Interior floor system** | Slab-on-grade concrete, minimum thickness of 4 inches under non-forklift wheel loads. Structural engineer should verify floor slab thicknesses and required reinforcement. |
| **Floor slab support** | Engineered fill extending to a minimum of 36 inches below foundations, depth of the existing fill materials, or 5 feet below existing grades, whichever is greater. |
| **Modulus of subgrade reaction** | 250 pounds per square inch per inch (psi/in) (The modulus was obtained based on engineered fill beneath floor slabs, and 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. |

In areas of exposed concrete, control joints should be saw cut into the slab after concrete placement in accordance with ACI Design Manual, Section 302.1R-37 8.3.12 (tooled control joints are not recommended). Additionally, dowels should be placed at the location of proposed construction joints. To control the width of cracking (should it occur) continuous slab reinforcement should be considered in exposed concrete slabs.

The use of a vapor retarder or barrier should be considered beneath concrete slabs on grade that will be covered with moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture to prevent moisture migration. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 and ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder/barrier. In general, a minimum of 2 inches of sand should be placed between the vapor retarder or barrier and the bottom of the concrete slab, unless the barrier manufacturer allows

for direct placement beneath the floor slab. The vapor retarder or barrier should be protected from ripping during construction.

## 4.5 Lateral Earth Pressures

For onsite clayey soils or on-site/imported granular soils and fill materials above any free water surface, recommended equivalent fluid pressures for foundation elements are:

| ITEM | Import/On-site Granular Soils | On-Site Clayey Soils |
|---|---|---|
| Active Case | 37 psf/ft | 40 psf/ft |
| Passive Case | 390 psf/ft | 360 psf/ft |
| At-Rest Case | 56 psf/ft | 60 psf/ft |
| Surcharge Pressure | 0.31*(Surcharge) | 0.33*(Surcharge) |
| Coefficient of Friction | 0.40 | 0.30 |

The lateral earth pressures herein do not include any factor of safety and are not applicable for submerged soils/hydrostatic loading. Additional recommendations may be necessary if such conditions are to be included in the design.

Fill against foundation and retaining walls should be compacted to densities recommended in the Earthwork section of this report. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors.

## 4.6 Pavements

### 4.6.1 Design Recommendations

Based on soil lithology and conditions, an estimated design R-Value of 15 was used to calculate the Asphalt Concrete (AC) pavement thickness sections and Portland Cement Concrete (PCC) pavement sections. R-value testing should be completed prior to pavement construction to verify the design R-value.

Assuming the pavement subgrades will be prepared as recommended within this report, the following pavement sections should be considered minimums for this project for the traffic indices assumed in the table below. As more specific traffic information becomes available, we should be contacted to reevaluate the pavement calculations.

| | Recommended Pavement Section Thickness (inches)* | |
|---|---|---|
| | Light (Automobile) Parking Assumed Traffic Index (TI) = 4.0 | Loading Dock and Truck Areas Assumed TI = 7.0 |
| Section I<br>Portland Cement Concrete | 5” Plain jointed PCC over 4” Class II Aggregate Base over 10” of scarified, moisture conditioned, and compacted | 6.5” Plain jointed PCC over 4” Class II Aggregate Base over 10” of scarified, |

| | Recommended Pavement Section Thickness (inches)* | |
|---|---|---|
| | **Light (Automobile) Parking Assumed Traffic Index (TI) = 4.0** | **Loading Dock and Truck Areas Assumed TI = 7.0** |
| (600 psi Flexural Strength) | materials | moisture conditioned, and compacted materials |
| Section II<br>Asphaltic Concrete | 3" AC over 6" Class II Aggregate Base over 10" of scarified, moisture conditioned, and compacted materials | 3" AC over 12" Class II Aggregate Base over 10" of scarified, moisture conditioned, and compacted materials |

* All materials should meet the CALTRANS Standard Specifications for Highway Construction.

* *Crushed miscellaneous base materials are not recommended to be use beneath pavement.

These pavement sections are considered minimal sections based upon the expected traffic and the existing subgrade conditions. However, they are expected to function with periodic maintenance and overlays, if good drainage is provided and maintained.

All concrete for rigid pavements should have a minimum flexural strength of 600 psi, and be placed with a maximum slump of four inches. Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

Preventative maintenance should be planned and provided for through an on-going pavement management program in order to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment.

Preventative maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing). Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements.

### 4.6.2 Construction Considerations

Materials and construction of pavements for the project should be in accordance with the requirements and specifications of the State of California Department of Transportation, or other approved local governing specifications.

Base course or pavement materials should not be placed when the surface is wet. Surface drainage should be provided away from the edge of paved areas to minimize lateral moisture transmission into the subgrade.

# 5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications, so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

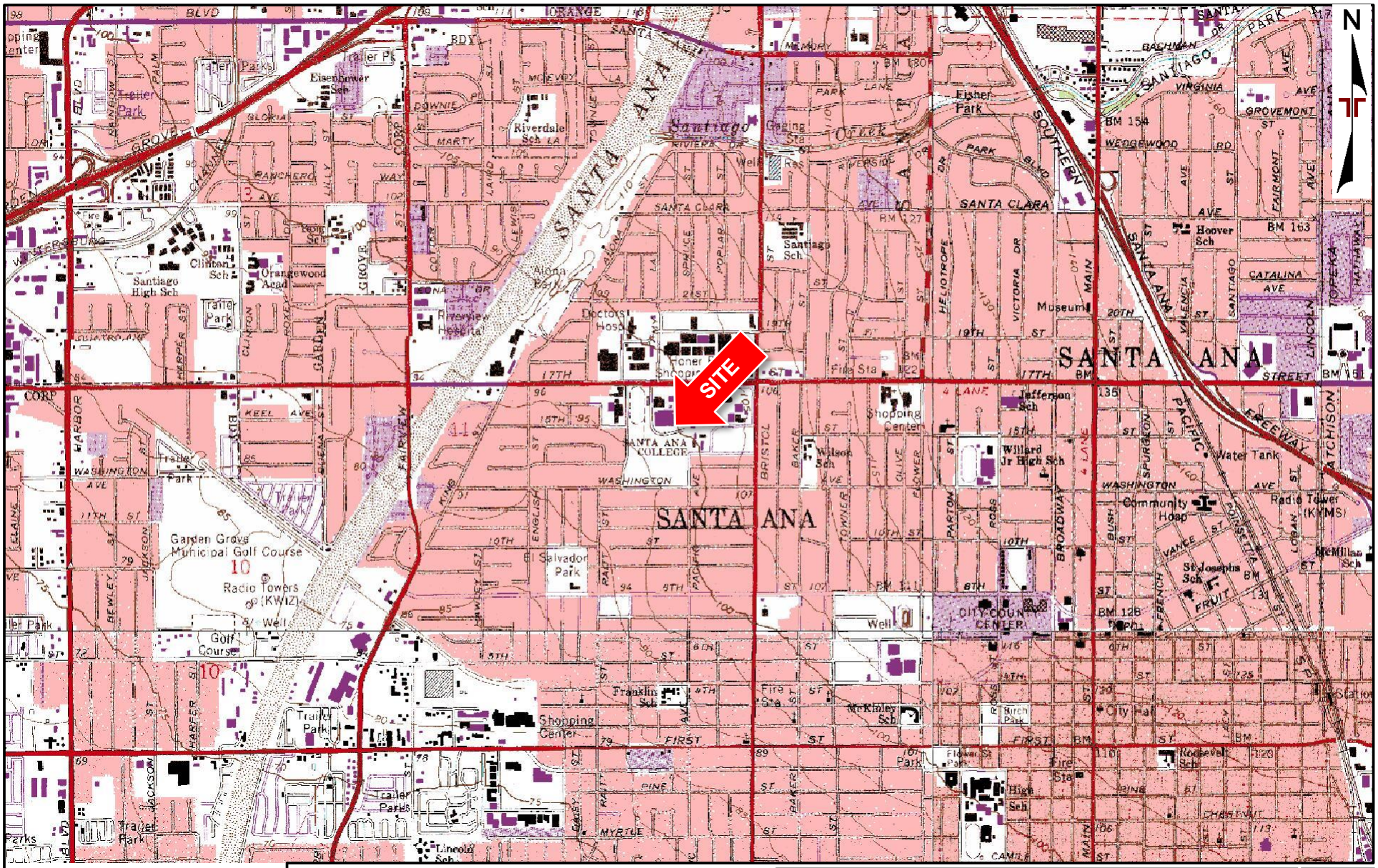
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project 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.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid, unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

# APPENDIX A

# FIELD EXPLORATION




TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: ANAHEIM, CA (1/1/1981), ORANGE, CA (1/1/1981), NEWPORT BEACH, CA (1/1/1981) and TUSTIN, CA (1/1/1981).
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

| | |
|---|---|
| Project Manager: | FH |
| Drawn by | SZ |
| Checked by | JM |
| Approved by | FH |

| | |
|---|---|
| Project No | 60145100 |
| Scale: | 1":2,100' |
| File Name: | A-1 |
| Date: | 1/21/2015 |

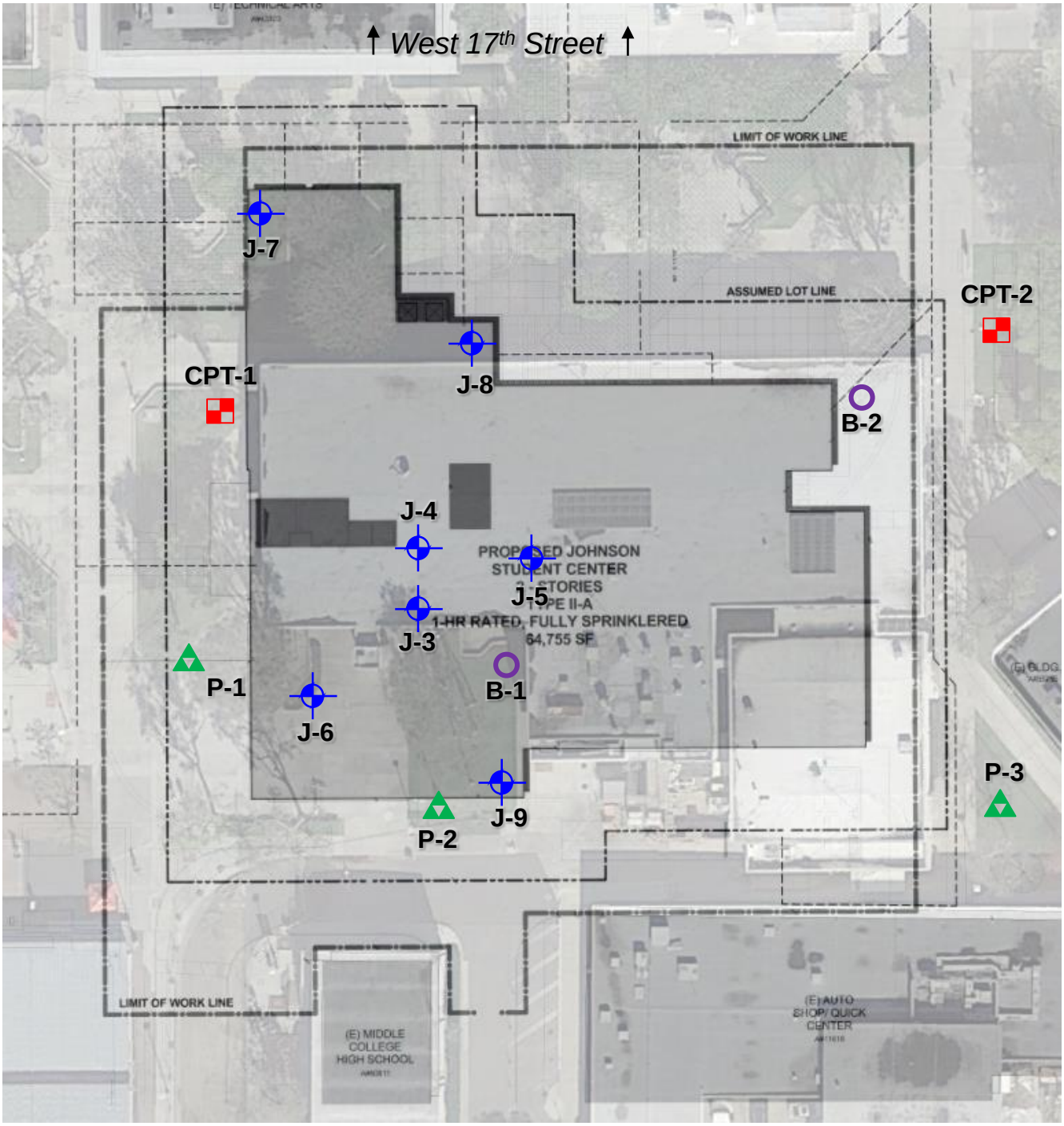
Terracon
2817 McGaw Ave.
Irvine, CA 92614

SITE LOCATION

Proposed Johnson Student Center
**1530 West 17th Street**
**Santa Ana, CA**

Exhibit

A-1




## LEGEND

- J-1 SOIL BORING APPROXIMATE LOCATION
- B-1 SOIL BORING APPROXIMATE LOCATION (JANUARY 9, 2015)
- P-1 PERCOLATION TEST APPROXIMATE LOCATION
- CPT-1 CONE PENETRATION TEST APPROXIMATE LOCATION (JANUARY 9, 2015)

N

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

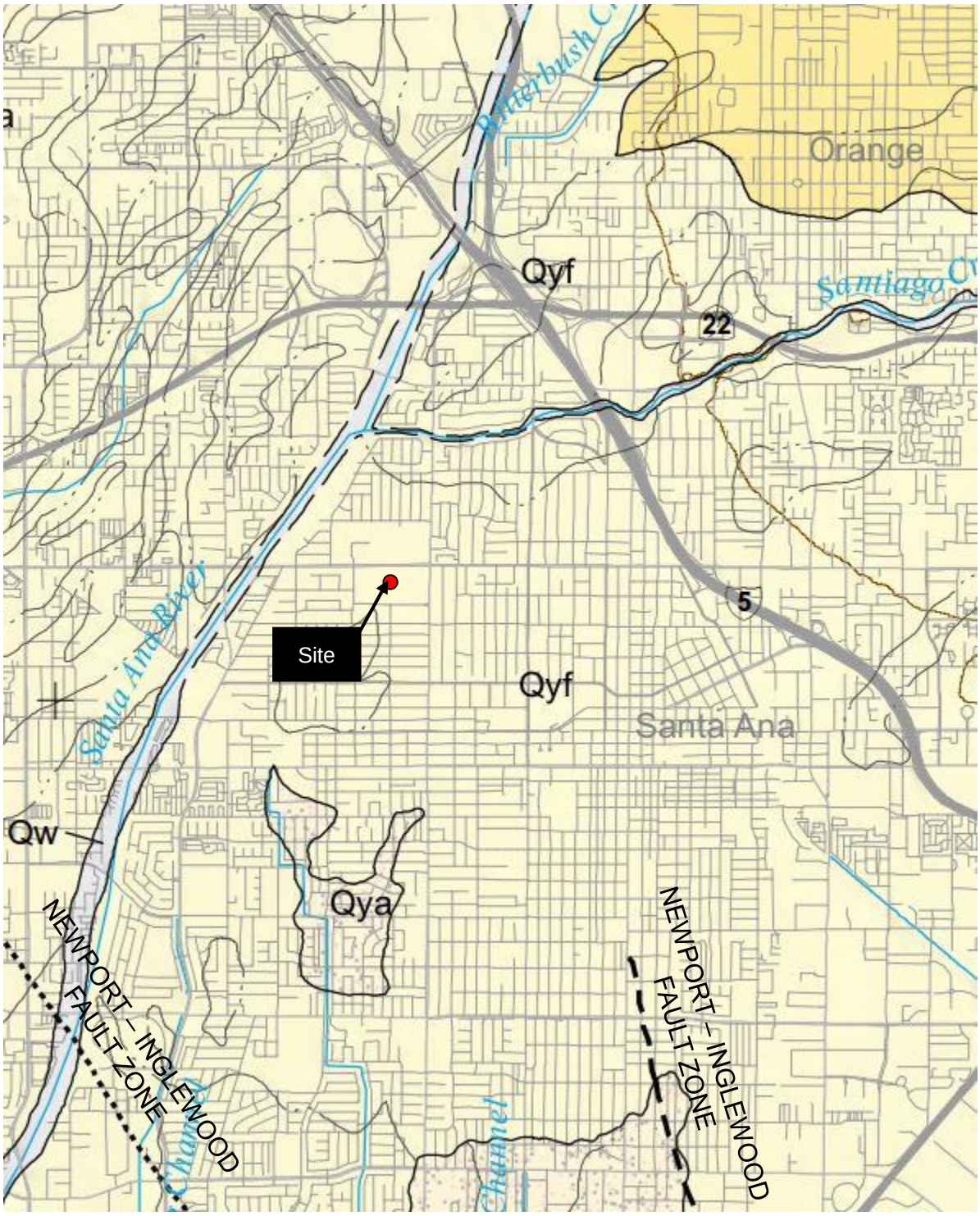
| | |
|---|---|
| Project Manager: | JM |
| Drawn by: | GA |
| Checked by: | JM |
| Approved by: | FH |
| Project No. | 60145100 |
| Scale: | 1" ~ 55' |
| File Name: | A-2 |
| Date: | 10/06/2016 |

Terracon
Consulting Engineers & Scientists
2817 McGaw Avenue Irvine, California 92614
PH. (949) 261-0051 FAX. (949) 261-6110

BORING LOCATION PLAN

**Johnson Student Center**
1530 West 17th Street
Santa Ana, CA

Exhibit
A-2




**LEGEND**

| | |
|---|---|
| Qyf | **Young Alluvial Fan Deposits** - unconsolidated to slightly consolidated, undissected to slightly dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon |

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

REFERENCE: CGS SPECIAL REPORT 217, PLATE 16

| | | | | |
|---|---|---|---|---|
| Project Manager: FH | Project No. 60145100 | Terracon Consulting Engineers & Scientists | GEOLOGIC MAP | Exhibit |
| Drawn by: JM | Scale: NTS | 2817 McGaw Avenue Irvine, California 92614 | **Proposed Johnson Student Center** | A-3 |
| Checked by: FH | File Name: A-3 | PH. (949) 261-0051 FAX. (949) 261-6110 | 1530 West 17th Street | |
| Approved by: FH | Date: 02/13/14 | | Santa Ana, CA | |

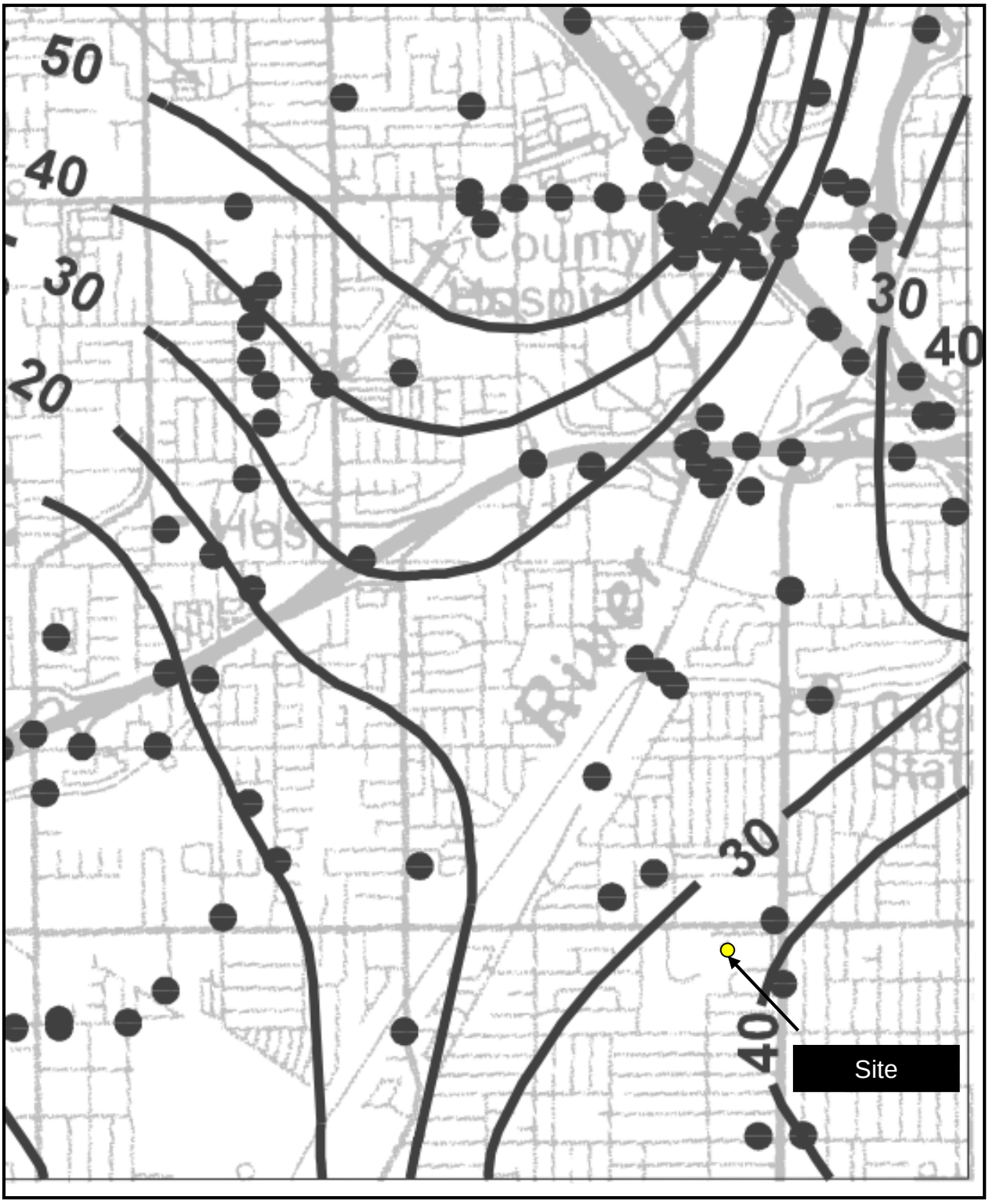


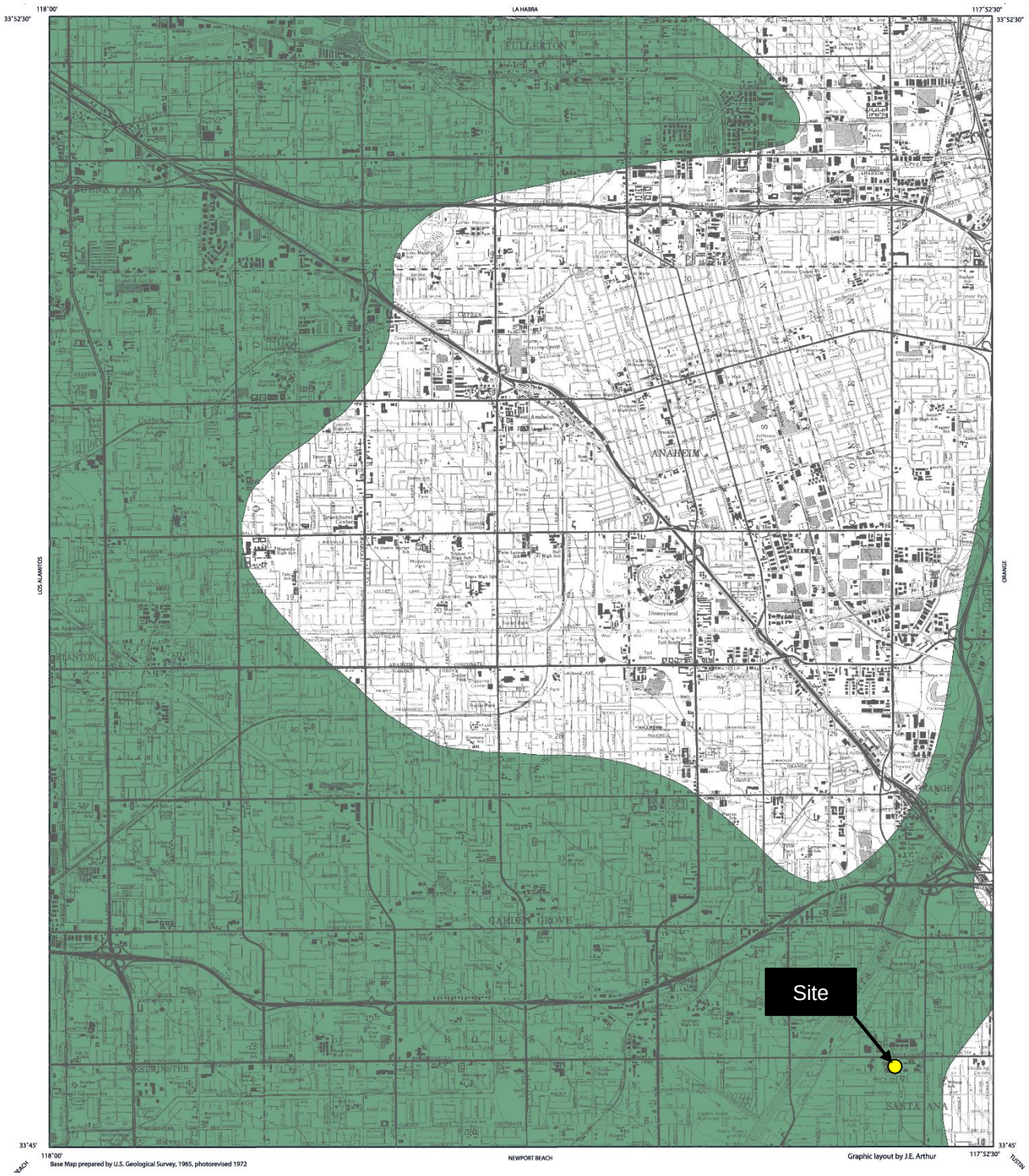

Plate 1.2 Historically Highest Ground Water Contours and Borehole Log Data Locations, Anaheim 7.5–minute Quadrangle.

● Borehole Site

30 Depth to ground water in feet

REFERENCE: Seismic Hazard Zone Report for the Anaheim 7.5-Minute Quadrangle, Los Angeles County, California, by California Division of Mines and Geology (CDMG), dated 1998].

| | | | | |
|---|---|---|---|---|
| Project Manager: FH | Project No. 60145100 | Terracon Consulting Engineers & Scientists | GROUNDWATER CONTOUR MAP | Exhibit |
| Drawn by: JM | Scale: NTS | 2817 McGaw Avenue Irvine, California 92614 | **Proposed Johnson Student Center** | A-4 |
| Checked by: FH | File Name: A-4 | PH. (949) 261-0051 FAX. (949) 261-6110 | 1530 West 17th Street | |
| Approved by: FH | Date: 02/13/15 | | Santa Ana, CA | |




STATE OF CALIFORNIA

## SEISMIC HAZARD ZONES

Delineated in compliance with
Chapter 7.8, Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

ANAHEIM QUADRANGLE

**Liquefaction**

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

REFERENCE: Seismic Hazards Zones Map of the Anaheim7.5 Minute Quadrangle, California, by California Division of Mines and Geology (CDMG), dated 1999)

| | |
|---|---|
| Project Manager: | FH |
| Drawn by: | JM |
| Checked by: | FH |
| Approved by: | FH |
| Project No. | 60145100 |
| Scale: | NTS |
| File Name: | A-5 |
| Date: | 02/13/15 |

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# SEISMIC HAZARD MAP

**Proposed Johnson Student Center**
1530 West 17th Street
Santa Ana, CA

Exhibit
A-5

Johnson_Student_ Geographic Deagg. Seismic Hazard
for 0.00-s Spectral Accel, 0.5613 g
PGA Exceedance Return Time: 2475 years
Max. significant source distance 30. km.
Red lines represent Quaternary fault locations
Gridded-source hazard accum. in 5° intervals
Rock site. Average Vs=760 m/s top 30 m

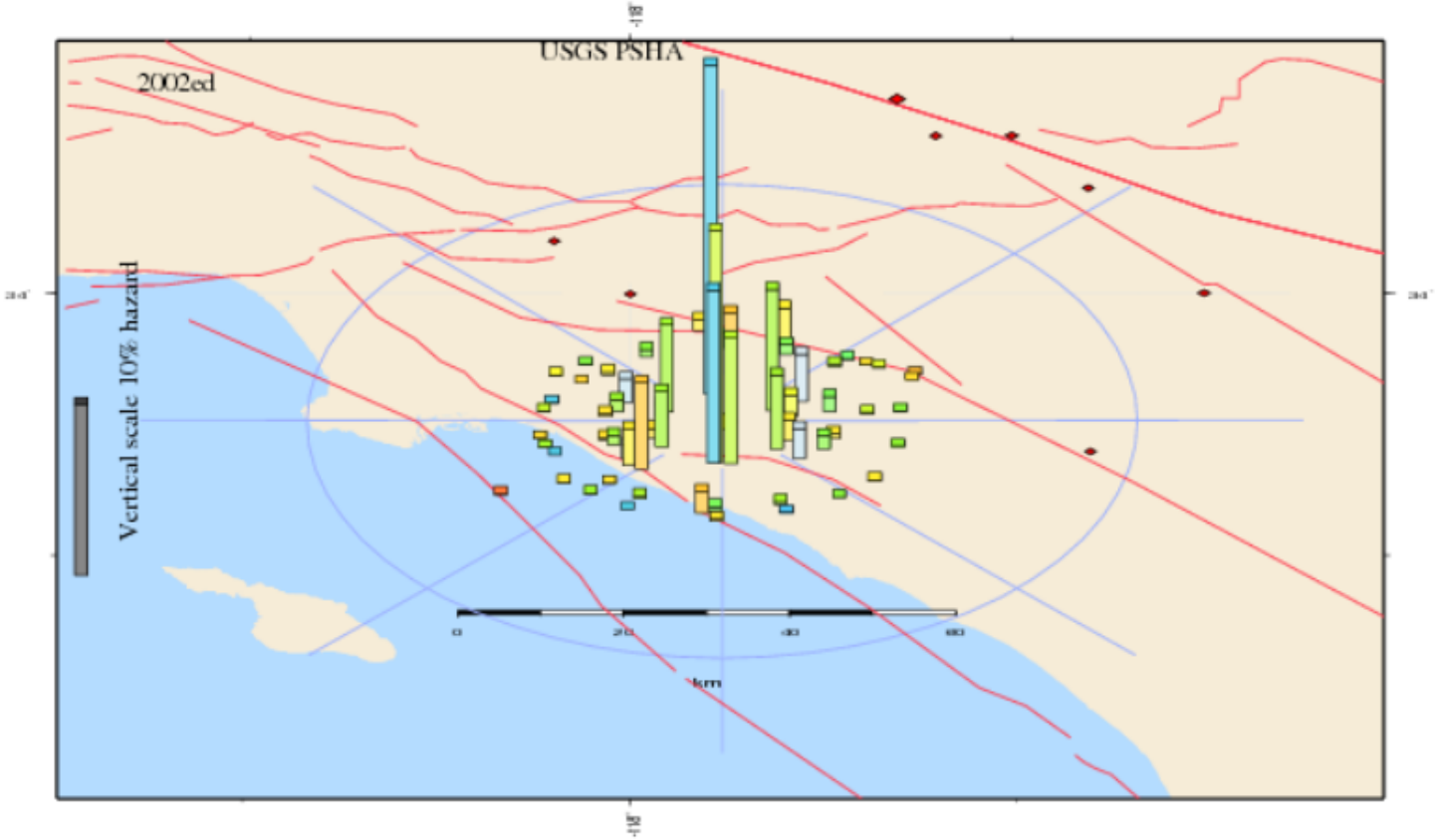


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

| | |
|---|---|
| Project Manager: | FH |
| Drawn by: | JM |
| Checked by: | FH |
| Approved by: | FH |

| | |
|---|---|
| Project No. | 60145100 |
| Scale: | AS SHOWN |
| File Name: | A-6 |
| Date: | 02/13/15 |


Terracon
Consulting Engineers & Scientists
2817 McGaw Avenue Irvine, CA 92614
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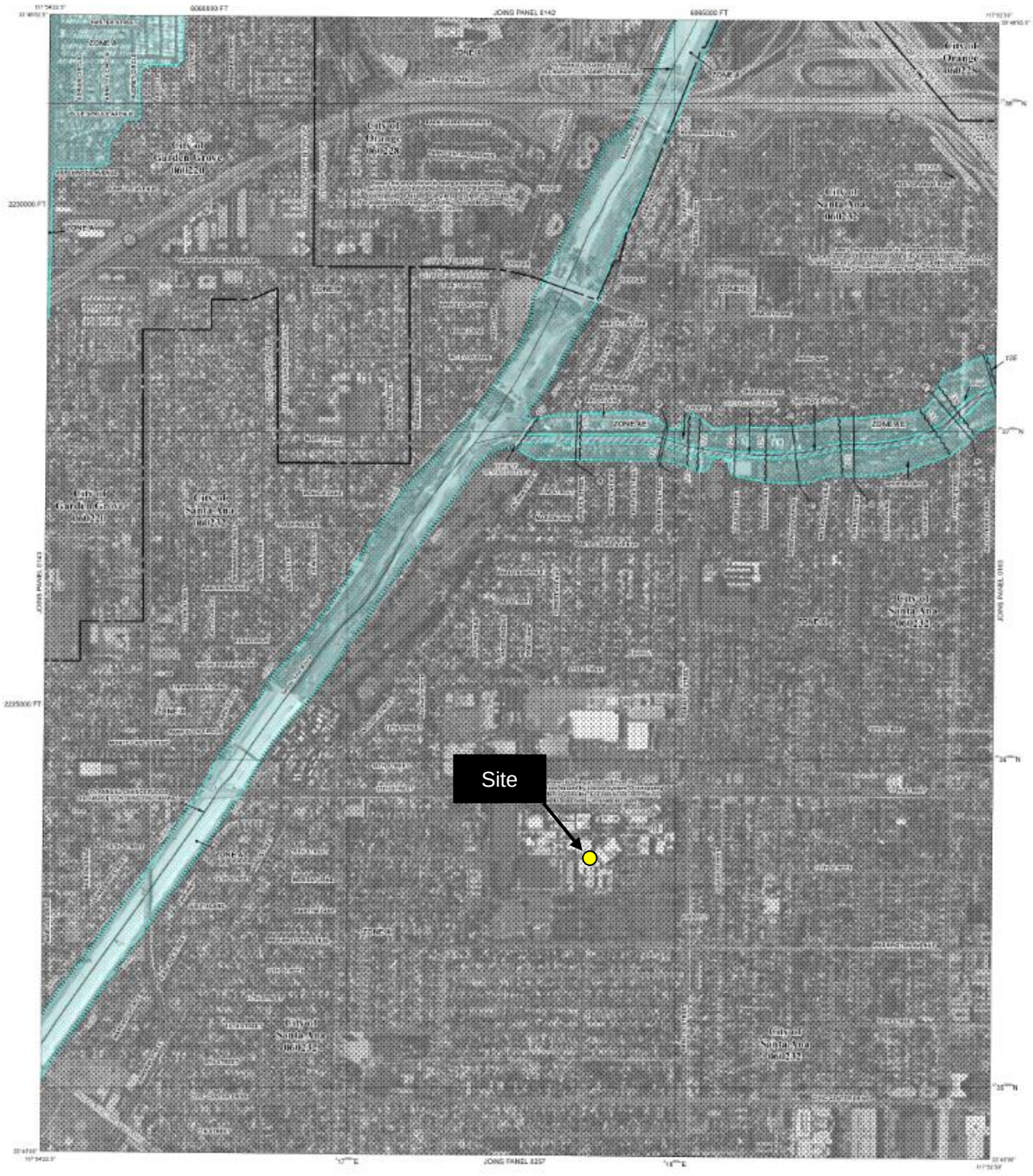
GEOGRAPHIC DEAGGREGATION MAP

**Proposed Johnson Student Center**
1530 West 17th Street
Santa Ana, CA

Exhibit
A-6




ZONE X

OTHER FLOOD AREAS

Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

REFERENCE: Federal Emergency Management Agency Flood Insurance Rate Map, Panel 144 of 539, Map Number 06059C0144J, Revised December 3, 2009

| | | | | |
|---|---|---|---|---|
| Project Manager: FH | Project No. 60145100 | Terracon Consulting Engineers & Scientists<br>2817 McGaw Avenue Irvine, California 92614<br>PH. (949) 261-0051 FAX. (949) 261-6110 | FLOOD ZONE HAZARD MAP<br>**Proposed Johnson Student Center**<br>1530 West 17th Street<br>Santa Ana, CA | Exhibit<br>A-7 |
| Drawn by: JM | Scale: NTS | | | |
| Checked by: FH | File Name: A-7 | | | |
| Approved by: FH | Date: 02/20/15 | | | |

## Field Exploration Description

A total of eleven (11) test borings were advanced to approximate depths of 5 to 61½ feet below the ground surface (bgs) and two (2) Cone Penetration Test (CPT) soundings to an approximate depth of 50 feet bgs at the approximate locations shown on the attached Boring Location Diagram, Exhibit A-2. Three of these locations were used for percolation testing. The test borings were advanced with a truck-mounted Mobile B-61 drill rig and Limited Access Track Mounted Rig. Groundwater was observed in boring B-1 at a depth of approximately 25 feet, at the time of field exploration and at an approximate depth of 38 feet in boring J-8 48-hours after the boring was completed. CPT soundings were advanced with a 30-ton truck providing the reaction weight for pushing the cone assembly into the ground at a constant rate of 20-mm per second (approximately four feet per minute). The cone tip resistance and sleeve friction resistance were recorded every 2-cm (approximately ¾-inch) and stored in digital form. Due to the presence of previous buildings onsite and the undetermined footprint of the proposed building, field exploration was separated into two phases. Phase I was performed on January 19 2015, and Phase II was performed on September 9, 2016.

The borings were located in the field by using the proposed site plan, an aerial photograph of the site, and a handheld GPS unit. The accuracy of boring locations should only be assumed to the level implied by the method used.

Continuous lithologic logs of the borings were recorded by the field engineer during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon or ring-barrel samplers. Bulk samples of subsurface materials were also obtained. Groundwater conditions were evaluated in the borings at the time of site exploration.

Penetration resistance measurements were obtained by driving the split-spoon and ring-barrel samplers into the subsurface materials with a 140-pound automatic hammer falling 30 inches. The penetration resistance value is a useful index in estimating the consistency or relative density of materials encountered.

An automatic hammer was generally used to advance the split-barrel sampler in the borings performed on this site. However, Boring B-2 utilized a safety hammer with a manual release mechanism. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a manual release. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with auger cuttings prior to the drill crew leaving the site.

# BORING LOG NO. B-1



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SILTY CLAYEY SAND (SC-SM)**, yellowish-brown to gray, 0.2 ppm | | | | | | | | | 14 | | 24-19-5 | 29 |
| | 2.5 | | | | | | | | | | | | |
| | **CLAYEY SAND (SC)**, yellowish-brown to gray, medium dense, 0.2 ppm | | | | 16-13-18 | | | | | 15 | 115 | | |
| | 0.8 ppm | 5 | | | 8-13-16 | | | | | 13 | 119 | | |
| | 0.2 ppm | | | | 8-10-10 | | | | | 10 | 111 | | |
| | 10.0 | | | | | | | | | | | | |
| | **SANDY LEAN CLAY (CL)**, brown, medium stiff, 0.4 ppm | 10 | | | 3-2-4<br>N=6 | | | | | | | | |
| | very stiff, 0.4 ppm | 15 | | | 6-12-13 | | | | | 18 | 108 | | |
| | medium stiff to stiff, 0.7 ppm | 20 | | | 2-3-5<br>N=8 | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *Ground water encountered @ 25'*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 1/19/2015 | Boring Completed: 1/19/2015

Drill Rig: CME-75 | Driller: Jet Drilling

Project No.: 60145100 | Exhibit: A-11

# BORING LOG NO. B-1



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SANDY LEAN CLAY (CL)**, brown, medium stiff, 0.4 ppm *(continued)*<br>23.0 | | | | | | | | | | | | |
| | **SILTY SAND (SM)**, brown, loose, 0.7 ppm<br>25.0 | 25 | ▽ | | | | | | | | | | |
| | **SILTY CLAY (CL-ML)**, brown, stiff, 0.8 ppm | | | | 8-7-5 | | | | | 27 | 95 | | |
| | | 30 | | | 3-5-6<br>N=11 | | | | | | | | |
| | 35.0 | | | | | | | | | | | | |
| | **SANDY LEAN CLAY (CL)**, brown, very stiff, 0.8 ppm | 35 | | | 5-8-11 | | | | | 20 | 109 | | |
| | stiff to very stiff, 0.9 ppm | 40 | | | 0-7-8<br>N=15 | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *Ground water encountered @ 25'*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 1/19/2015 | Boring Completed: 1/19/2015

Drill Rig: CME-75 | Driller: Jet Drilling

Project No.: 60145100 | Exhibit: A-11

# BORING LOG NO. B-1



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SANDY LEAN CLAY (CL)**, brown, very stiff, 0.8 ppm *(continued)* | | | | | | | | | | | | |
| | 0.8 ppm | 45 | | | 7-13-14 | | | | | 22 | 103 | | |
| | 0.8 ppm | 50 | | | 6-10-12<br>N=22 | | | | | | | | |
| | 0.9 ppm | 55 | | | 10-12-15 | | | | | 18 | 108 | | |
| | trace gravel, 0.9 ppm | 60 | | | 9-9-9<br>N=18 | | | | | | | | |
| | 61.5<br>***Boring Terminated at 61.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *Ground water encountered @ 25'*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 1/19/2015 | Boring Completed: 1/19/2015

Drill Rig: CME-75 | Driller: Jet Drilling

Project No.: 60145100 | Exhibit: A-11

# BORING LOG NO. B-2



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.5 **CONCRETE**, 6" thickness | | | | | | | | | | | | |
| | **CLAYEY SAND (SC)**, brown, 0.5 ppm | | | | | 10 | | | | 9 | | 29-19-10 | 42 |
| | 2.5 **SANDY LEAN CLAY (CL)**, brown to gray, hard, 0.8 ppm | | | | 43-50/5" | | | | | 10 | | | |
| | 3.2 ppm | 5 | | | 36-50/4" | | | | | 13 | 111 | | |
| | 0.9 ppm | | | | 20-36-42 | | | | | 10 | 99 | | |
| | very stiff, 1.0 ppm | 10 | | | 10-10-14<br>N=24 | | | | | | | | |
| | hard, 0.9 ppm | 15 | | | 25-50/4" | | | | | 19 | 101 | | |
| | 1.1 ppm | 20 | | | 12-14-18<br>N=32 | | | | | | | | |
| | 21.5 ***Boring Terminated at 21.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Manual SPT Safety Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 1/19/2015 | Boring Completed: 1/19/2015
Drill Rig: LAR | Driller: Jet Drilling
Project No.: 60145100 | Exhibit: A-12

# BORING LOG NO. J-3



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.3 **CONCRETE**, 4" thickness | | | | | | | | | | | | |
| | 0.5 **FILL - POORLY GRADED SAND**, 2" thickness, vapor barrier encountered below sand layer<br>**FILL - SANDY SILT (ML)**, dark brown, pieces of bricks and concrete encountered | | | | | | | | | | | NP | 70 |
| | 5.0 **SILTY SAND (SM)**, light brown, medium dense | 5 | | | 8-11-13 | | | | | 7 | 110 | 21-18-3 | 32 |
| | 10.0 **LEAN CLAY WITH SILT (CL)**, brown, medium stiff | 10 | | | 3-5-7<br>N=12 | | | | | | | | |
| | medium stiff | 15 | | | 7-14-14 | | | | | 17 | 96 | | |
| | soft | 20 | | | 3-3-4<br>N=7 | | | | | | | | |
| | 21.5 ***Boring Terminated at 21.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
The estimated depth of the fill materials should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

**WATER LEVEL OBSERVATIONS**
*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-13

# BORING LOG NO. J-4



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.3 **CONCRETE**, 6.5" thickness | | | | | | | | | | | | |
| | 0.5 **FILL - POORLY GRADED SAND**, 2" thickness, vapor barrier encountered below sand layer | | | | | | | | | | | | |
| | **FILL - SANDY LEAN CLAY (CL)**, dark brown, pieces of bricks and concrete encountered | | | | | | | | | | | | |
| | very stiff | 5 | | | 6-10-13 | | | | | | | | |
| | 7.5 **SANDY SILTY CLAY (CL)**, brown | | | | | | | | | | | | |
| | stiff | 10 | | | 5-7-10 | | | | | 24 | 96 | | |
| | | 15 | | | 4-8-6<br>N=14 | | | | | | | | |
| | 16.0 **SILTY SAND (SM)**, brown, medium dense | | | | | | | | | | | | |
| | 18.0 **SANDY LEAN CLAY (CL)**, brown, stiff | 20 | | | 4-7-9 | | | | | 23 | 91 | | |
| | 21.5 ***Boring Terminated at 21.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
The estimated depth of the fill materials should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

**WATER LEVEL OBSERVATIONS**
*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-14

# BORING LOG NO. J-5



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.5 **CONCRETE**, 6" thickness | | | | | | | | | | | | |
| | 0.7 **POORLY GRADED SAND**, 2" thickness, vapor barrier encountered below sand layer | | | | | | | | | | | | |
| | **SILTY CLAY (CL-ML)**, brown | 5 | | | 5-9-14 | | | | | 17 | 107 | | |
| | 10.0 **LEAN CLAY WITH SILT (CL)**, brown, medium dense | 10 | | | 2-4-6<br>N=10 | | | | | | | | |
| | 15.0 **SANDY SILT (ML)**, medium stiff | 15 | | | 9-8-4 | | | | | 5 | 111 | | |
| | 20.0 **LEAN CLAY (CL)**<br>stiff | 20 | | | 2-3-4<br>N=7 | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-15

# BORING LOG NO. J-5



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LEAN CLAY (CL)** *(continued)* | | | | | | | | | | | | |
| | medium stiff | 25 | | | 2-5-8 | | | | | 26 | 99 | | |
| | | 30 | | | 3-3-5<br>N=8 | | | | | | | | |
| | | 35 | | | 5-8-9 | | | | | 19 | 110 | | |
| | | 40 | | | 3-3-3<br>N=6 | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016

Drill Rig: LAR | Driller: Cal Pac

Project No.: 60145100 | Exhibit: A-15

# BORING LOG NO. J-5



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **LEAN CLAY (CL)** *(continued)* | 45 | | | | | | | | | | | |
| | | | | X | 3-4-5<br>N=9 | | | | | | | | |
| | | 50 | | X | 4-8-10<br>N=18 | | | | | | | | |
| | 51.5 | | | | | | | | | | | | |
| | ***Boring Terminated at 51.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016

Drill Rig: LAR | Driller: Cal Pac

Project No.: 60145100 | Exhibit: A-15

# BORING LOG NO. J-6



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.3 **CONCRETE**, 3" thickness | | | | | | | | | | | | |
| | **SILTY CLAY WITH SAND (CL-ML)**, trace gravel, brown to light brown | | | | | | | | | | | | |
| | 5.0 | 5 | | | | | | | | | | | |
| | **SILTY CLAYEY SAND (SC-SM)**, light brown, medium dense | | | | 8-14-23 | | | | | 6 | 115 | | |
| | 7.5 | | | | | | | | | | | | |
| | **LEAN CLAY WITH SILT (CL)**, with sand, gray to brown, stiff | | | | 6-11-14 | | | | | 19 | 106 | | |
| | medium stiff | 10 | | | 3-4-7<br>N=11 | | | | | | | | |
| | 16.0 | 15 | | | 11-16-16 | | | | | | | | |
| | **SILTY SAND (SM)**, tan, medium dense | | | | | | | | | | | | |
| | 20.0 | 20 | | | 3-4-6<br>N=10 | | | | | | | | |
| | **LEAN CLAY WITH SILT (CL)**, with sand, grayish-brown, stiff | | | | | | | | | | | | |
| | 21.5 | | | | | | | | | | | | |
| | ***Boring Terminated at 21.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-16

# BORING LOG NO. J-7



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SILTY CLAYEY SAND (SC-SM)**, trace gravel, brown to light brown | | | | | | | | | | | 24-18-7 | 41 |
| | medium dense | | | | 13-24-24 | | | | | 8 | 112 | | |
| | 5.0 **SILTY CLAYEY SAND (SC-SM)**, light brown, loose | 5 | | | 4-5-7 | | | | | 12 | 109 | | |
| | 7.5 **LEAN CLAY WITH SILT (CL)**, with sand, gray to brown, very stiff | | | | 8-11-12<br>N=23 | | | | | | | | |
| | | 10 | | | 11-13-14 | | | | | 6 | 112 | | |
| | stiff to very stiff | 15 | | | 4-5-10<br>N=15 | | | | | | | | |
| | 16.0 **SILTY SAND (SM)**, medium dense | | | | | | | | | | | | |
| | 20.0 **LEAN CLAY WITH SILT (CL)**, with sand, stiff | 20 | | | 5-9-17 | | | | | 20 | 106 | | |
| | 21.5 ***Boring Terminated at 21.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-17

# BORING LOG NO. J-8



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.3 **CONCRETE**, 3" thickness | | | | | | | | | | | | |
| | **FILL - SANDY LEAN CLAY (CL)**, light brown to dark brown, pieces of brick and gravel encountered | | | | | 55 | | | | | | | |
| | very stiff | | | | 7-12-18 | | | | | 15 | 112 | | |
| | 5.0 | | | | | | | | | | | | |
| | **SANDY LEAN CLAY (CL)**, trace gravel, light brown to dark brown, stiff | 5 | | | 3-5-7<br>N=12 | | | | | | | 33-21-12 | 56 |
| | | | | | 5-7-10 | | | | | 19 | 101 | | |
| | | 10 | | | 2-3-5<br>N=8 | | | | | | | | |
| | 15.0 | | | | | | | | | | | | |
| | **CLAYEY SAND (SC)**, light brown | 15 | | | 7-11-9 | | | | | 13 | 105 | | |
| | 16.0 | | | | | | | | | | | | |
| | **SILTY SAND (SM)**, light brown | | | | | | | | | | | | |
| | 20.0 | 20 | | | 2-2-4<br>N=6 | | | | | | | | |
| | **SANDY LEAN CLAY (CL)**, brown | | | | | | | | | | | | |
| | 22.0 | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:
The estimated depth of the fill materials should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

**WATER LEVEL OBSERVATIONS**

*Groundwater encountered at 38' 48 hour after drilling*

Terracon
2817 McGaw Ave
Irvine, CA

| | |
|---|---|
| Boring Started: 9/9/2016 | Boring Completed: 9/9/2016 |
| Drill Rig: LAR | Driller: Cal Pac |
| Project No.: 60145100 | Exhibit: A-18 |

# BORING LOG NO. J-8



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SILTY CLAYEY SAND (SC-SM)**, light brown | | | | | | | | | | | | |
| | 25.5 | 25 | | | | | | | | | | | |
| | **SANDY LEAN CLAY (CL)**, brown to gray | | | | 3-10-7 | | | | | 17 | 105 | | |
| | stiff | 30 | | | 3-4-6<br>N=10 | | | | | | | | |
| | very stiff | 35 | | | 4-6-11 | | | | | 14 | 115 | | |
| | stiff | 40 | | | 3-6-8<br>N=14 | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*Groundwater encountered at 38' 48 hour after drilling*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-18

# BORING LOG NO. J-8



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SANDY LEAN CLAY (CL)**, brown to gray *(continued)*<br>very stiff | 45 | | | | | | | | | | | |
| | | | | | 5-7-14 | | | | | 21 | 108 | | |
| | | 50 | | | 4-8-16<br>N=24 | | | | | | | | |
| | 51.5<br>***Boring Terminated at 51.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*Groundwater encountered at 38' 48 hour after drilling*

Terracon
2817 McGaw Ave
Irvine, CA

Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-18

# BORING LOG NO. J-9



**PROJECT:** Johnson Student Center

**CLIENT:** RSCCD Facility Planning, District
Santa Ana, CA

**SITE:** 1530 West 17th Street
Santa Ana, CA

| GRAPHIC LOG | LOCATION See Exhibit A-2<br>DEPTH | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | FIELD TEST RESULTS | Expansion Index | STRENGTH TEST: TEST TYPE | STRENGTH TEST: COMPRESSIVE STRENGTH (psf) | STRENGTH TEST: STRAIN (%) | WATER CONTENT (%) | DRY UNIT WEIGHT (pcf) | ATTERBERG LIMITS: LL-PL-PI | PERCENT FINES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **SANDY LEAN CLAY (CL)**, with gravel, dark brown | | | | | | | | | | | 32-20-12 | 61 |
| | very stiff | | | | 15-20-20 | | | | | 13 | 114 | | |
| | | 5 | | | 11-13-14 | | | | | 7 | 112 | | |
| | stiff | | | | 4-6-8<br>N=14 | | | | | | | 35-21-13 | 54 |
| | | 10 | | | 4-5-9 | | | | | 16 | 103 | | |
| | very stiff | 15 | | | 4-7-9<br>N=16 | | | | | | | | |
| | stiff | 20 | | | 5-6-7 | | | | | 22 | 96 | | |
| | 21.5<br>***Boring Terminated at 21.5 Feet*** | | | | | | | | | | | | |

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

Hammer Type: Automatic SPT Hammer

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*Groundwater not encountered*

Terracon
2817 McGaw Ave
Irvine, CA

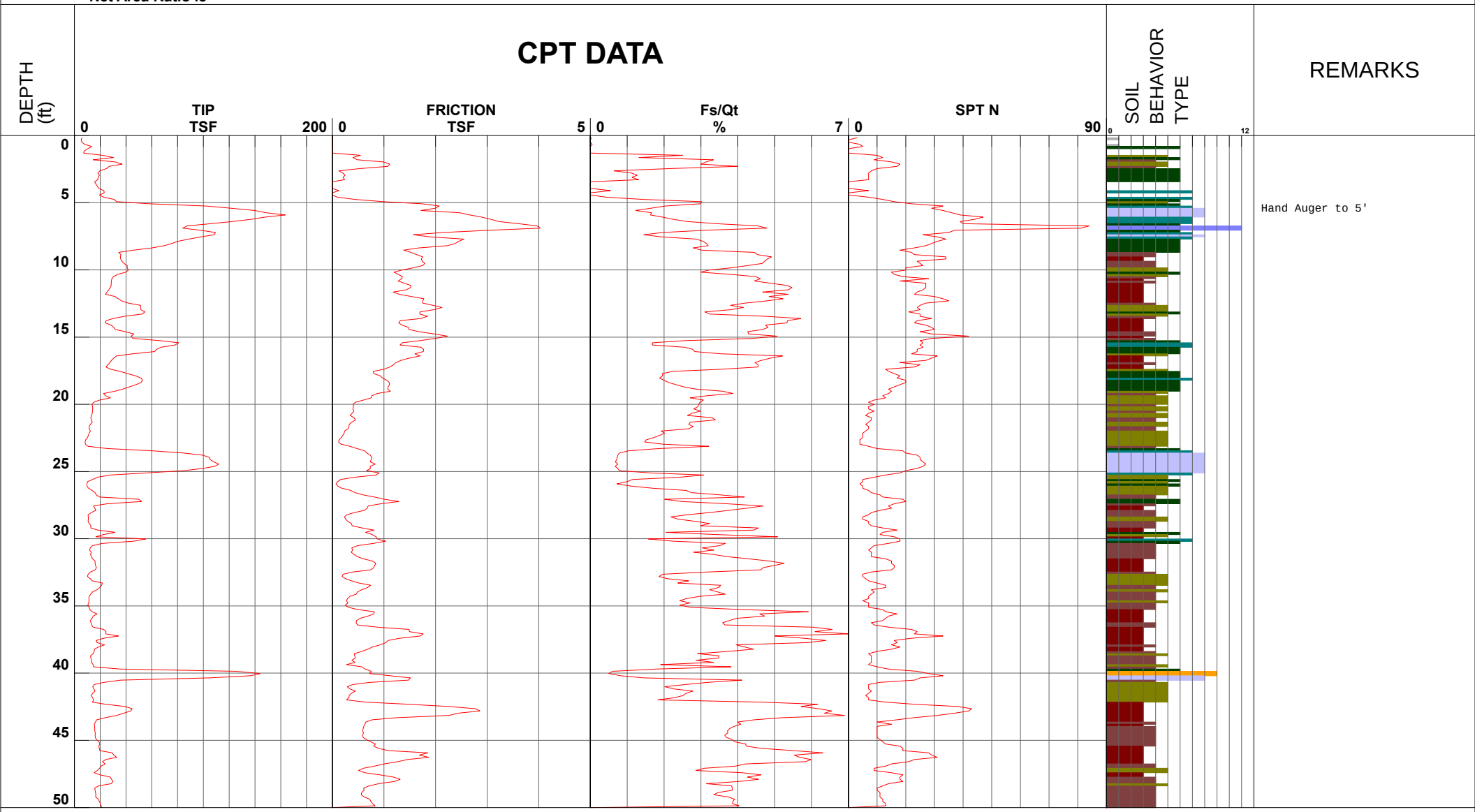
Boring Started: 9/9/2016 | Boring Completed: 9/9/2016
Drill Rig: LAR | Driller: Cal Pac
Project No.: 60145100 | Exhibit: A-19

# Terracon-Irvine

| | | | | | |
|---|---|---|---|---|---|
| Project | Johnson/Stem | Operator | DG-BH | Filename | SDF(206).cpt |
| Job Number | 60145100/6145101 | Cone Number | DSG0906 | GPS | |
| Hole Number | CJ-01 | Date and Time | 1/24/2015 10:41:17 AM | Maximum Depth | 50.20 ft |
| EST GW Depth During Test | | >50.00 ft | | | |

Net Area Ratio .8

## CPT DATA




REMARKS

Hand Auger to 5'

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

Cone Size 10cm squared

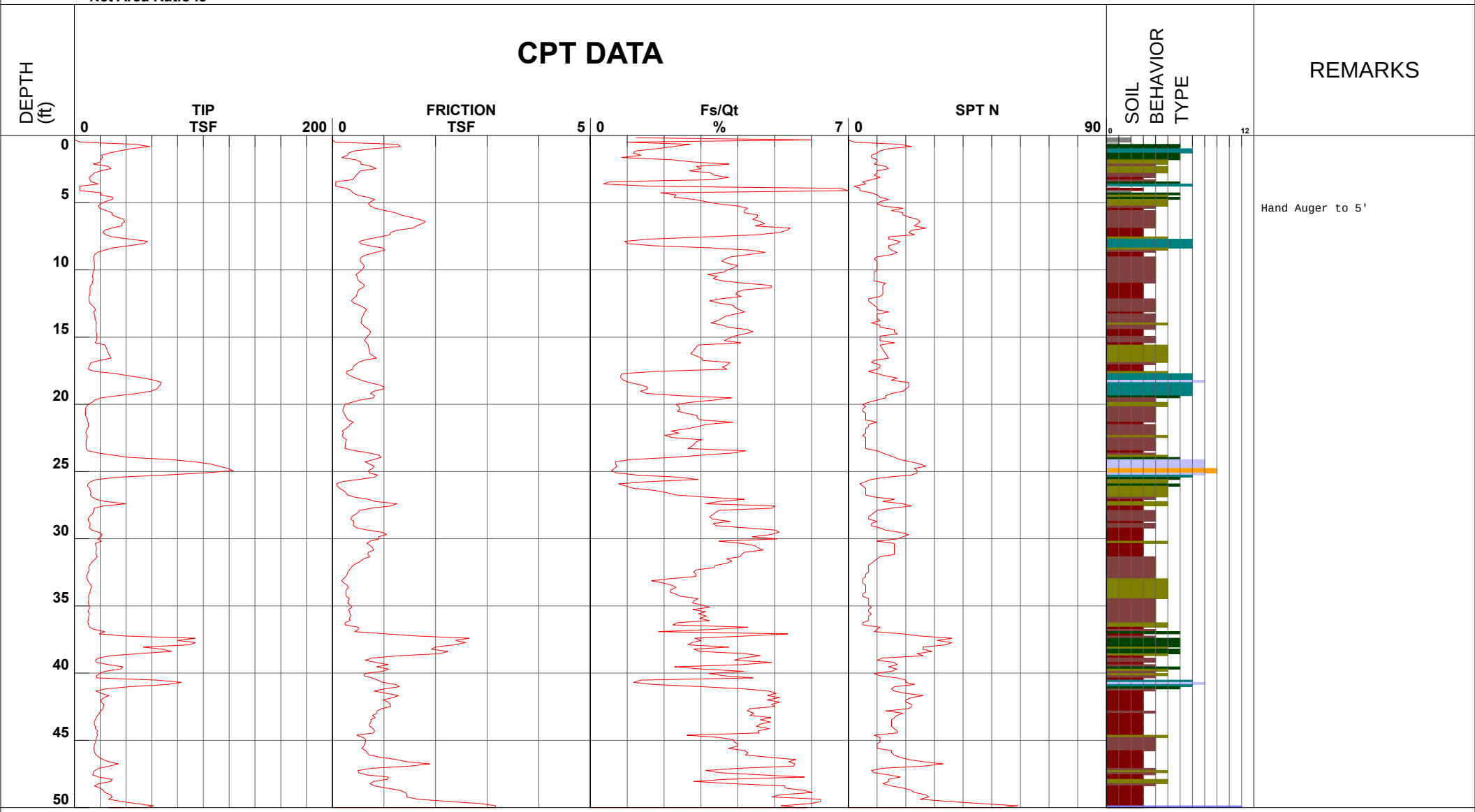
S*Soil behavior type and SPT based on data from UBC-1983

# Terracon-Irvine

| | | | | | |
|---|---|---|---|---|---|
| Project | Johnson/Stem | Operator | DG-BH | Filename | SDF(207).cpt |
| Job Number | 60145100/6145101 | Cone Number | DSG0906 | GPS | |
| Hole Number | CJ-02 | Date and Time | 1/24/2015 12:00:06 PM | Maximum Depth | 50.85 ft |
| EST GW Depth During Test | | >50.00 ft | | | |

Net Area Ratio .8

## CPT DATA




REMARKS

Hand Auger to 5'

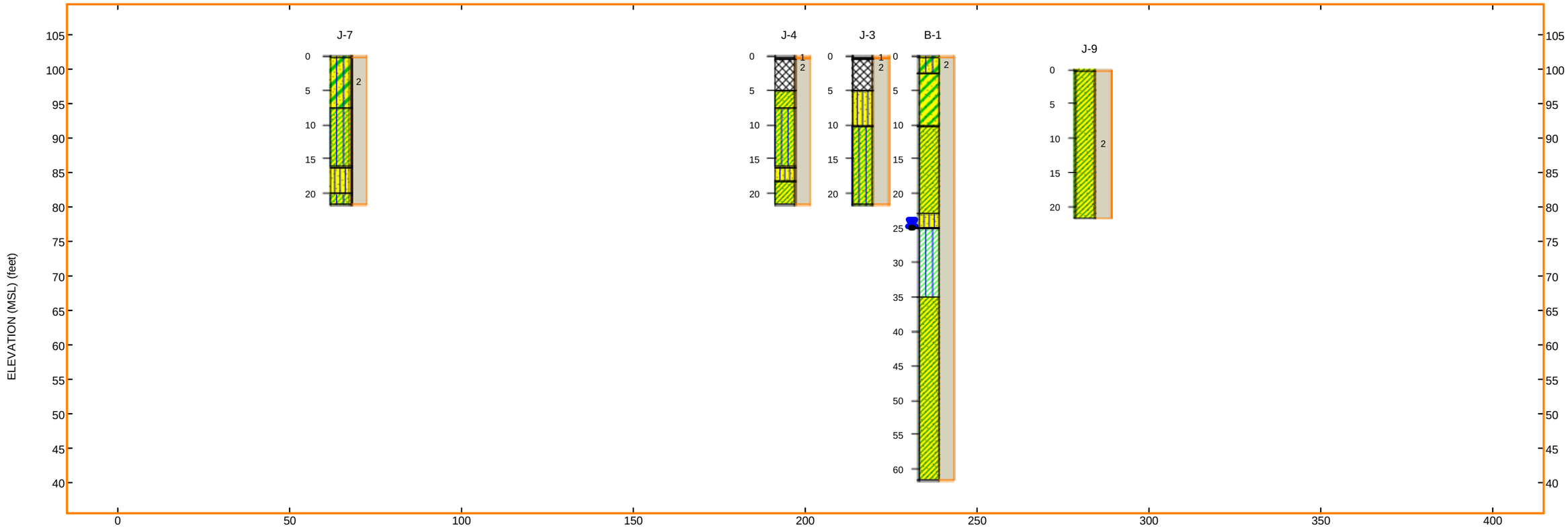
1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

Cone Size 10cm squared

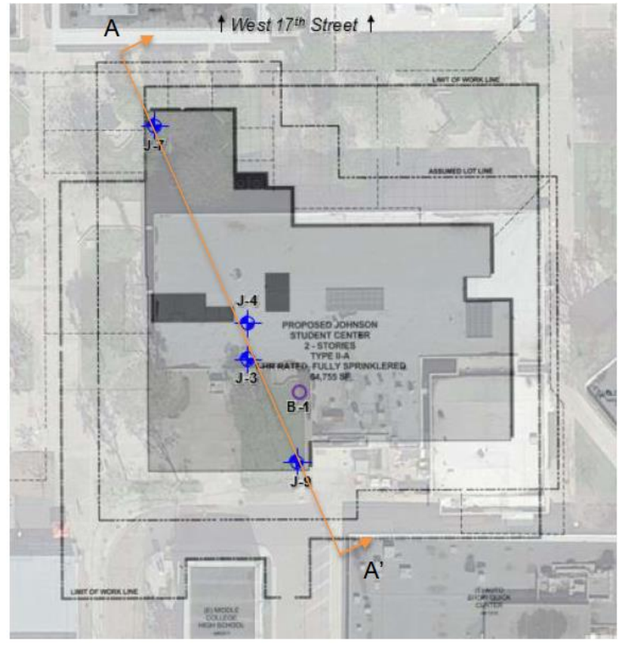
S*Soil behavior type and SPT based on data from UBC-1983

GEOTECHNICAL MODEL
Johnson Student Center ■ SANTA ANA, CA
10/7/2016 ■ Terracon Project No. 60145100

Terracon GeoReport




Silty Clayey Sand
Clayey Sand
Sandy Lean Clay
Silty Sand
Silty Clay
Concrete
Fill (made ground)
Sandy Silty Clay




NOTES:
See boring logs for more detailed conditions specific to each boring.
GeoModel provided for illustration purposes only. Actual subsurface conditions between borings will vary.

Layering shown on this figure has been developed by the geotechnical engineer for purposes of characterization of subsurface conditions as required for the subsequent geotechnical engineering for this project.

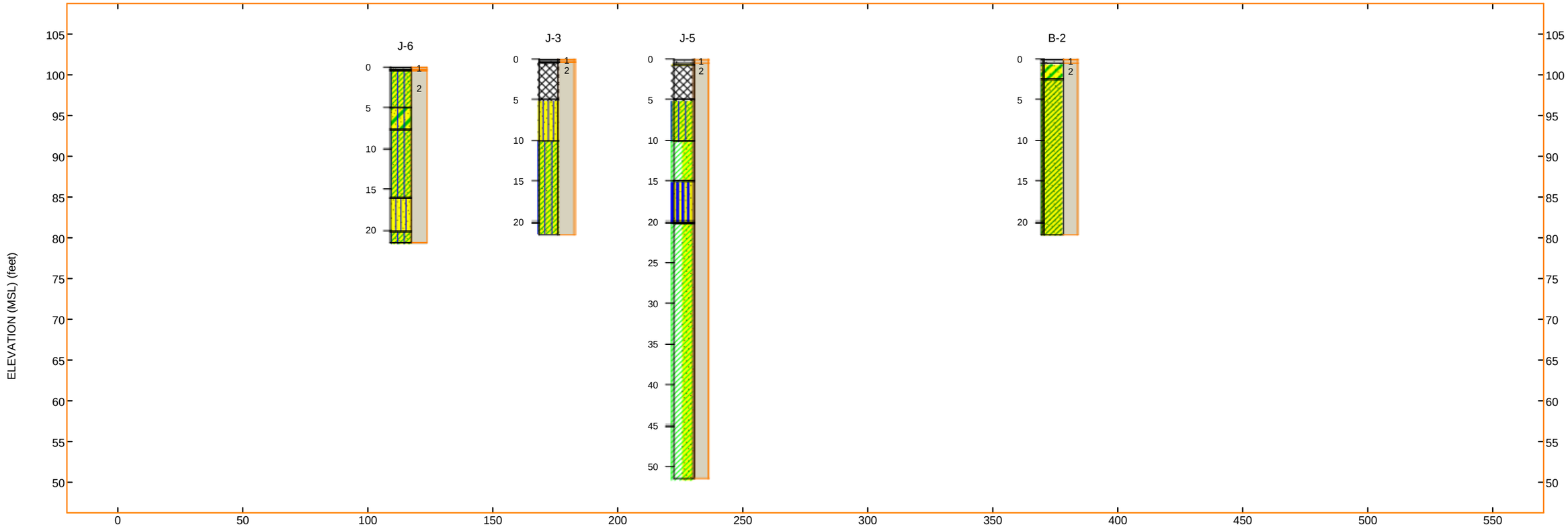
LEGEND
First Water Observation
Second Water Observation
Final Water Observation

# GEOTECHNICAL MODEL

Johnson Student Center ■ SANTA ANA, CA

10/7/2016 ● Terracon Project No. 60145100

Terracon GeoReport




Concrete

Clayey Sand

Sandy Lean Clay

Fill (made ground)

Silty Sand

Sandy Silty Clay

Poorly-graded Sand

Lean Clay with Sand

Sandy Silt

Silty Clayey Sand

NOTES:

See boring logs for more detailed conditions specific to each boring.

GeoModel provided for illustration purposes only. Actual subsurface conditions between borings will vary.

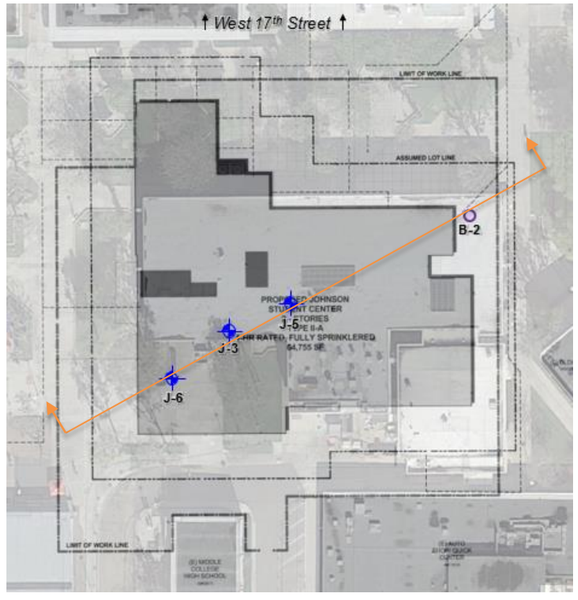
Layering shown on this figure has been developed by the geotechnical engineer for purposes of characterization of subsurface conditions as required for the subsequent geotechnical engineering for this project.

LEGEND

First Water Observation

Second Water Observation

Final Water Observation



# APPENDIX B

# LABORATORY TESTING

## Laboratory Testing

Samples retrieved during the field exploration were taken to a DSA certified laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix C. At that time, the field descriptions were confirmed or modified as necessary, and an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials.

Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

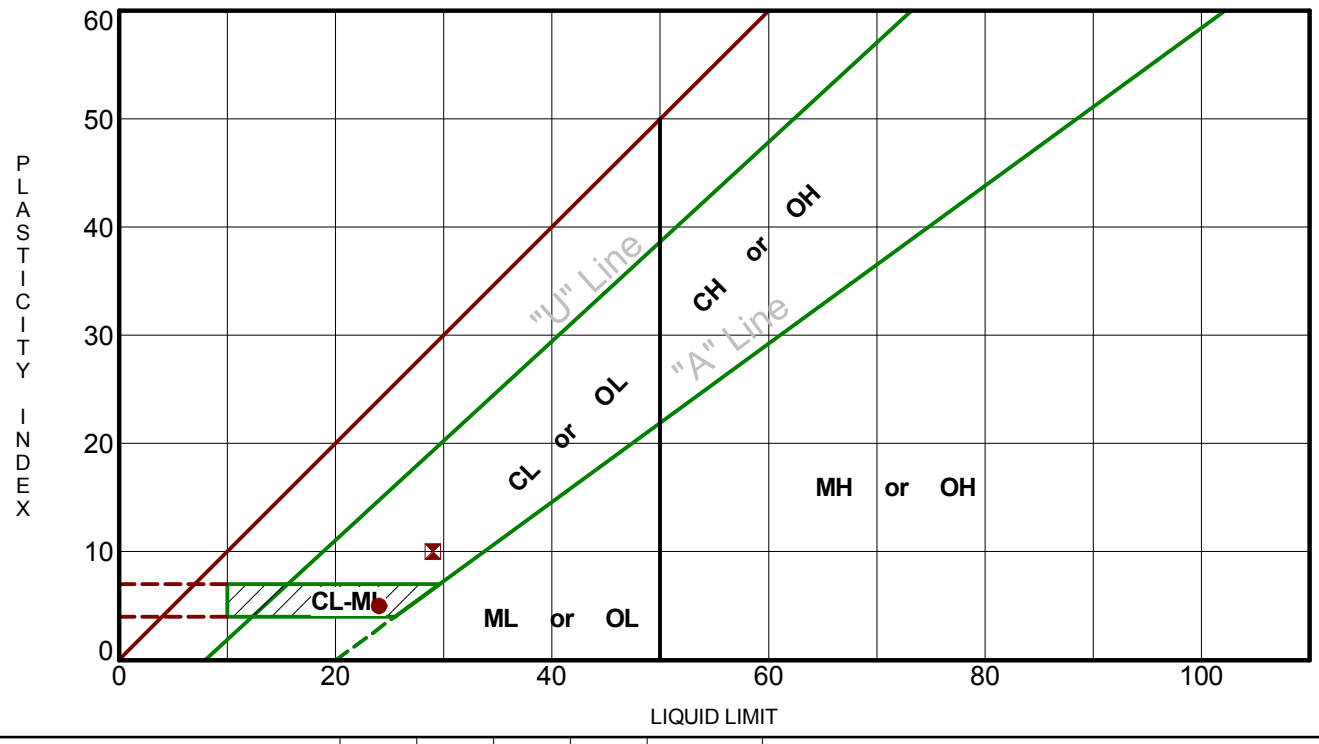
Selected soil samples obtained from the site were tested for the following engineering properties:

- ASTM D7263 Dry Density
- CT422 Chloride Content
- CT643 pH
- ASTM C136 Grain Size Distribution
- ASTM D4318 Atterberg Limits
- ASTM D4829 Expansion Index
- ASTM D2216 Moisture Content
- CT417 Soluble Sulfates
- CT643 Minimum Resistivity
- ASTM D4546 Collapse/Swell Potential
- ASTM D3080 Direct Shear

Procedural 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.

# ATTERBERG LIMITS RESULTS

**ASTM D4318**




| Boring ID | Depth (Ft) | LL | PL | PI | Fines | USCS | Description |
|---|---|---|---|---|---|---|---|
| ● B-1 | 1.0 | 24 | 19 | 5 | 29 | SC-SM | SILTY CLAYEY SAND |
| ⊠ B-2 | 1.0 | 29 | 19 | 10 | 42 | SC | CLAYEY SAND |

PROJECT: Proposed Johnson Student Center

SITE: 1530 West 17th Street
Santa Ana, CA

Terracon
2817 McGaw Avenue
Irvine, California

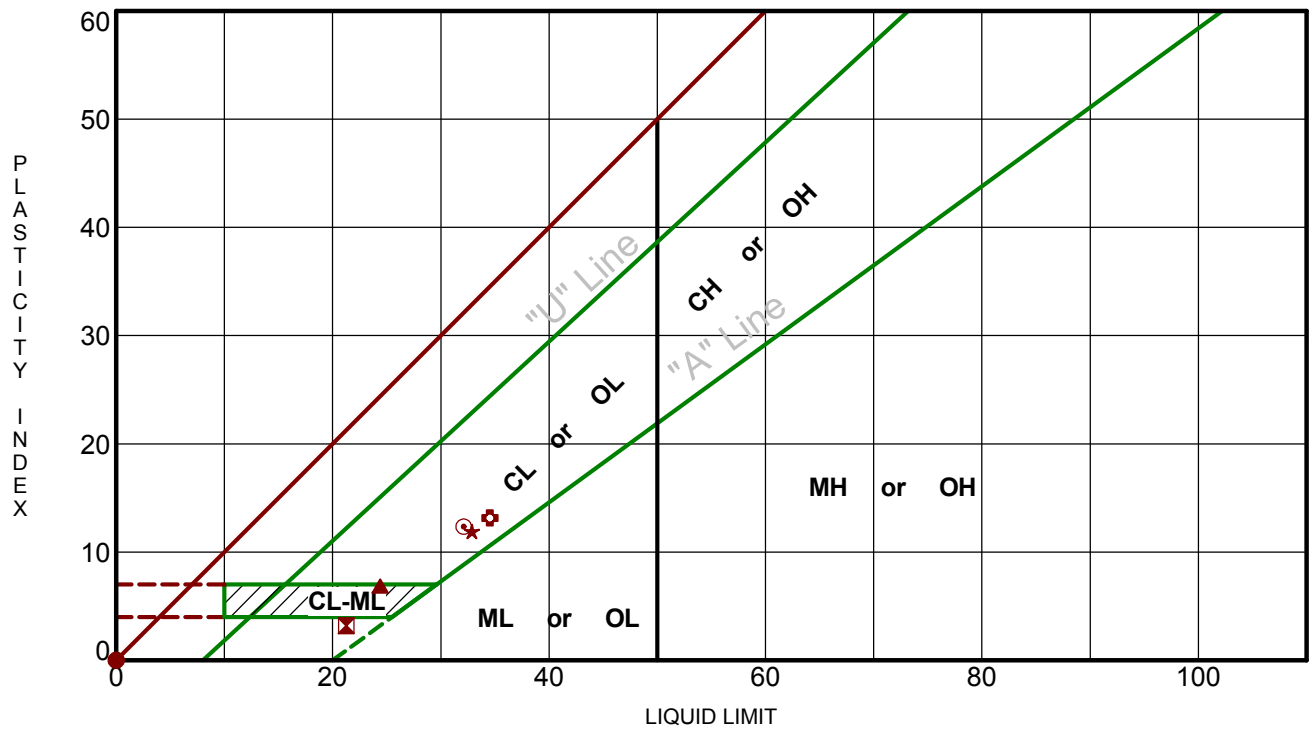
PROJECT NUMBER: 60145100

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

EXHIBIT: B-2

# ATTERBERG LIMITS RESULTS

**ASTM D4318**




| Boring ID | | Depth | LL | PL | PI | Fines | USCS | Description |
|---|---|---|---|---|---|---|---|---|
| ● | J-3 | 0.5 - 5 | NP | NP | NP | 70 | ML | SILT with SAND |
| ⊠ | J-3 | 5 - 6.5 | 21 | 18 | 3 | 32 | SM | SILTY SAND |
| ▲ | J-7 | 0 - 2.5 | 24 | 18 | 6 | 41 | SC-SM | SILTY, CLAYEY SAND |
| ★ | J-8 | 5 - 6.5 | 33 | 21 | 12 | 56 | CL | SANDY LEAN CLAY |
| ⊙ | J-9 | 0 - 2.5 | 32 | 20 | 12 | 61 | CL | SANDY LEAN CLAY |
| ✿ | J-9 | 7.5 - 9 | 35 | 21 | 14 | 54 | CL | SANDY LEAN CLAY |

PROJECT: Johnson Student Center

SITE: 1530 West 17th Street
Santa Ana, CA

Terracon
2817 McGaw Ave
Irvine, CA

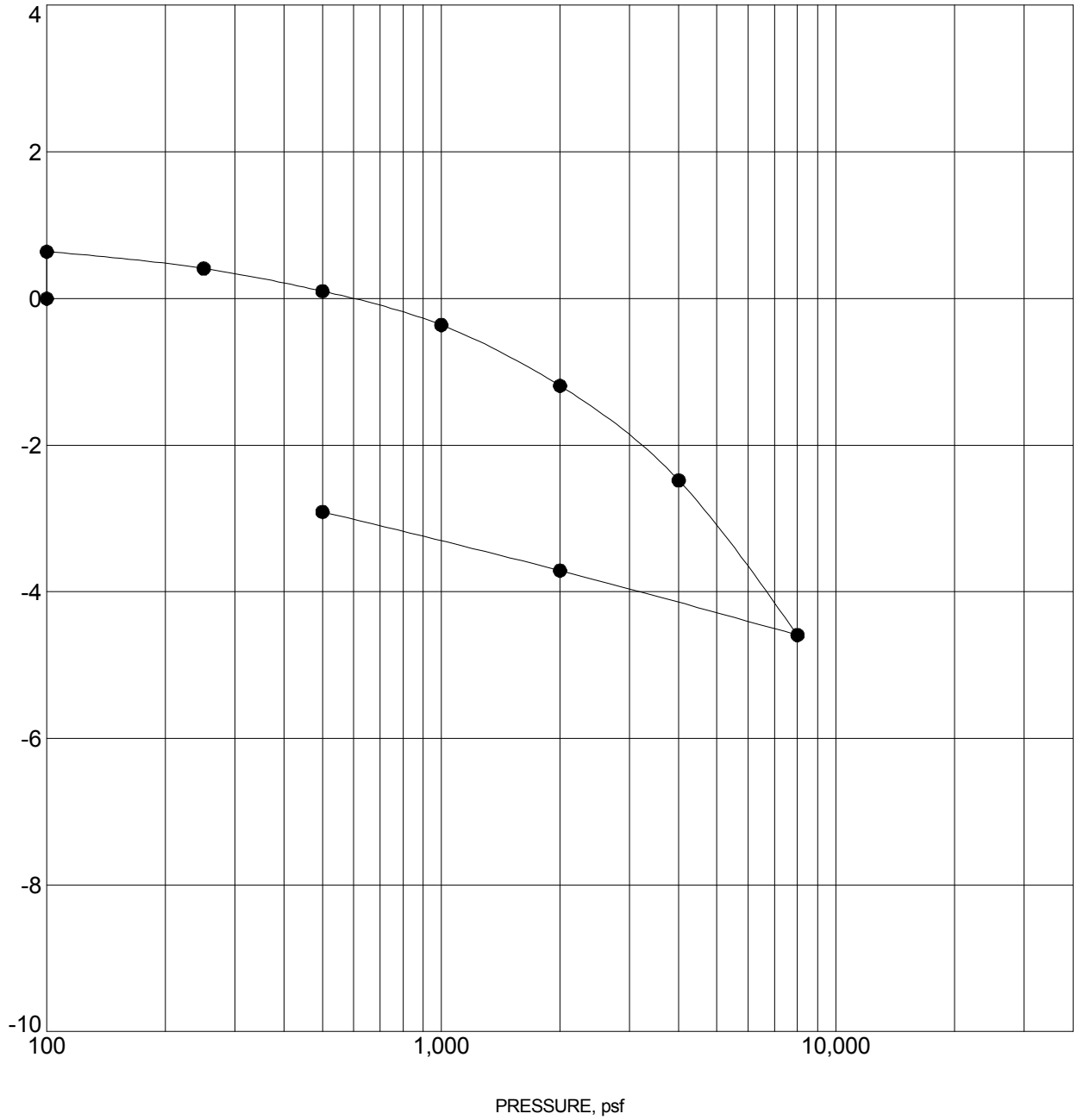
PROJECT NUMBER: 60145100

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

EXHIBIT: B-2

# SWELL CONSOLIDATION TEST

**ASTM D4546**



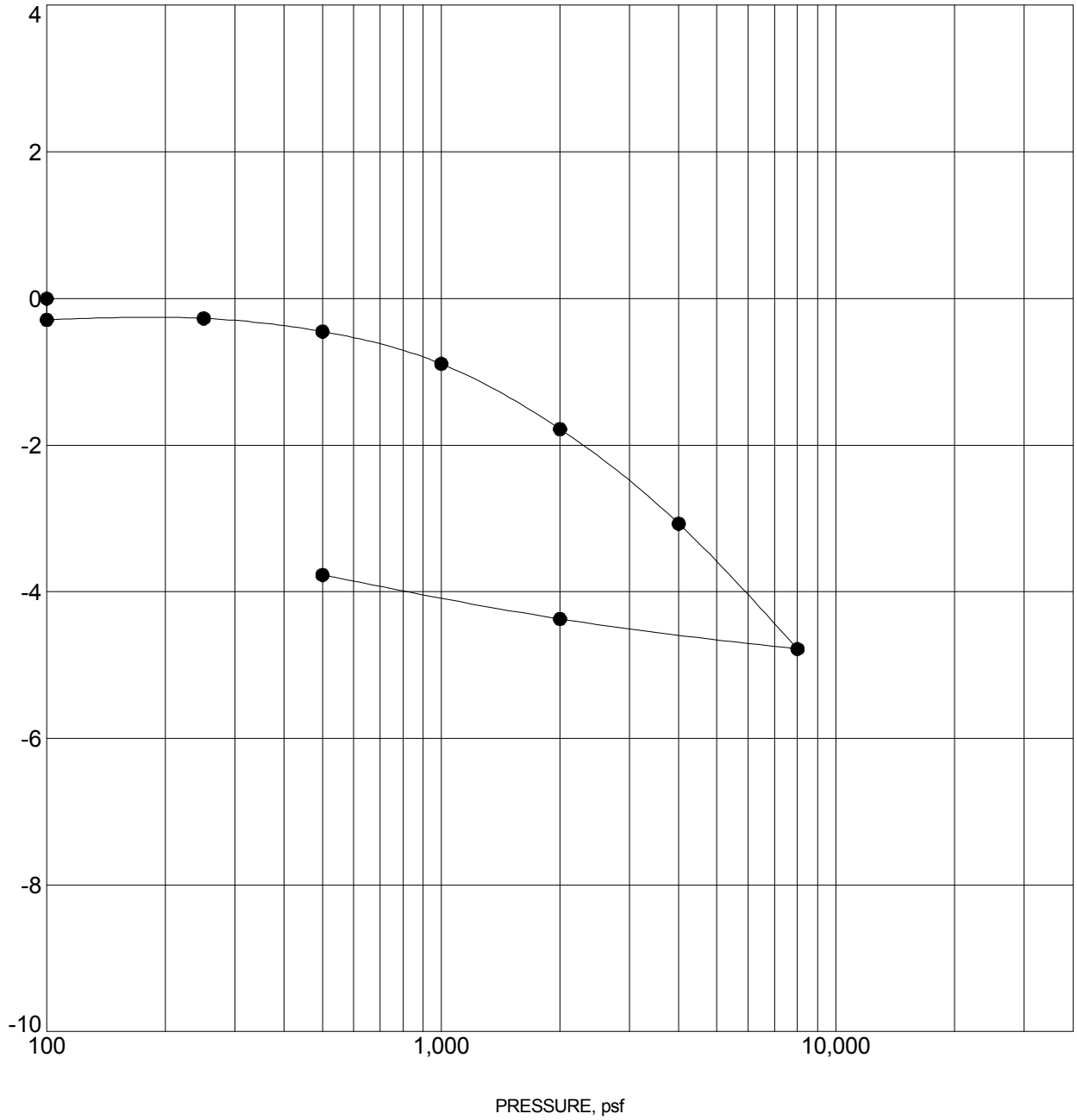

| Specimen Identification | | | Classification | $\gamma_d$, pcf | WC, % |
|---|---|---|---|---|---|
| ● | B-1 | 15.0 ft | SANDY LEAN CLAY | 108 | 18 |

NOTES: water added @ 100 pcf

| | | |
|---|---|---|
| PROJECT: Proposed Johnson Student Center | Terracon<br>2817 McGaw Avenue<br>Irvine, California | PROJECT NUMBER: 60145100 |
| SITE: 1530 West 17th Street<br>Santa Ana, CA | | CLIENT: RSCCD Facility Planning, District<br>Santa Ana, CA |
| | | EXHIBIT: B-3 |

# SWELL CONSOLIDATION TEST

**ASTM D4546**



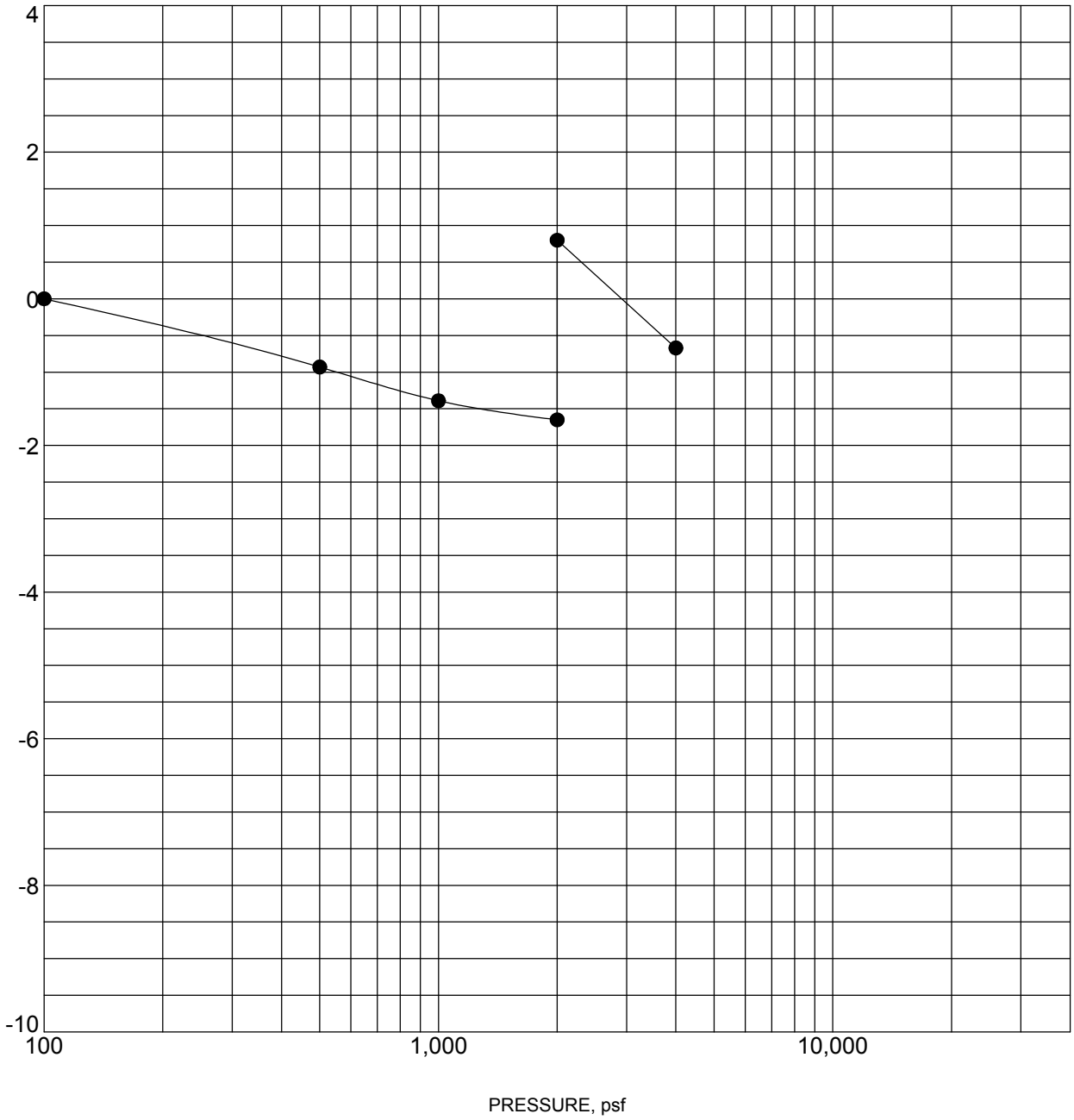

| Specimen Identification | | | Classification | $\gamma_d$, pcf | WC, % |
|---|---|---|---|---|---|
| ● | B-1 | 35.0 ft | SANDY LEAN CLAY | 109 | 20 |

NOTES: water added @ 100 pcf

| | | |
|---|---|---|
| PROJECT: Proposed Johnson Student Center | Terracon<br>2817 McGaw Avenue<br>Irvine, California | PROJECT NUMBER: 60145100 |
| SITE: 1530 West 17th Street<br>Santa Ana, CA | | CLIENT: RSCCD Facility Planning, District<br>Santa Ana, CA |
| | | EXHIBIT: B-4 |

# SWELL CONSOLIDATION TEST

**ASTM D4546**



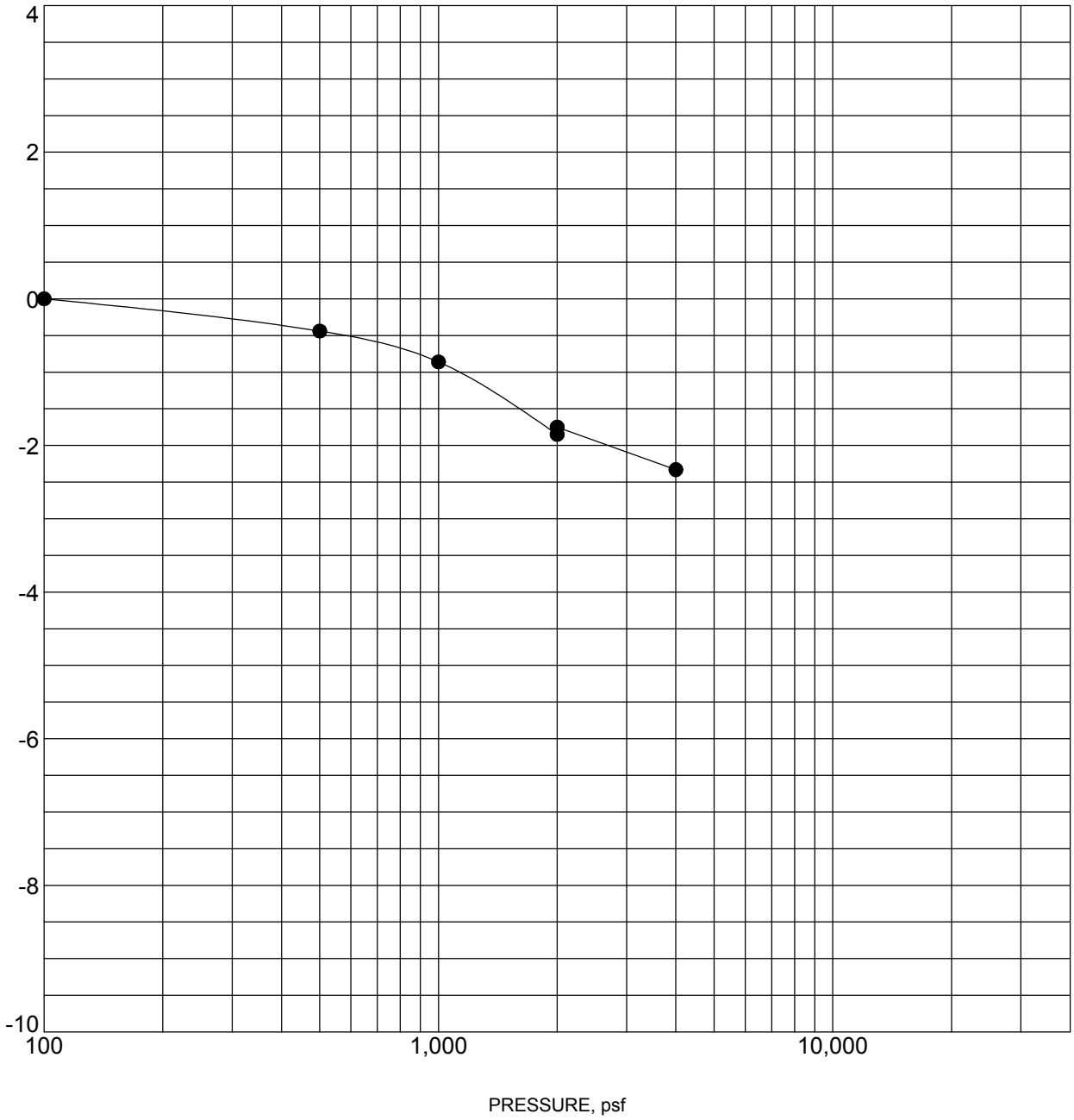

| Specimen Identification | | | Classification | $\gamma_d$, pcf | WC, % |
|---|---|---|---|---|---|
| ● | J-9 | 2.5 ft | SANDY LEAN CLAY | 114 | 13 |

NOTES: Water added at 2000 psf

| | | |
|---|---|---|
| PROJECT: Johnson Student Center | | PROJECT NUMBER: 60145100 |
| SITE: 1530 West 17th Street<br>Santa Ana, CA | Terracon<br>2817 McGaw Ave<br>Irvine, CA | CLIENT: RSCCD Facility Planning, District<br>Santa Ana, CA |
| | | EXHIBIT: B-5 |

# SWELL CONSOLIDATION TEST

**ASTM D4546**

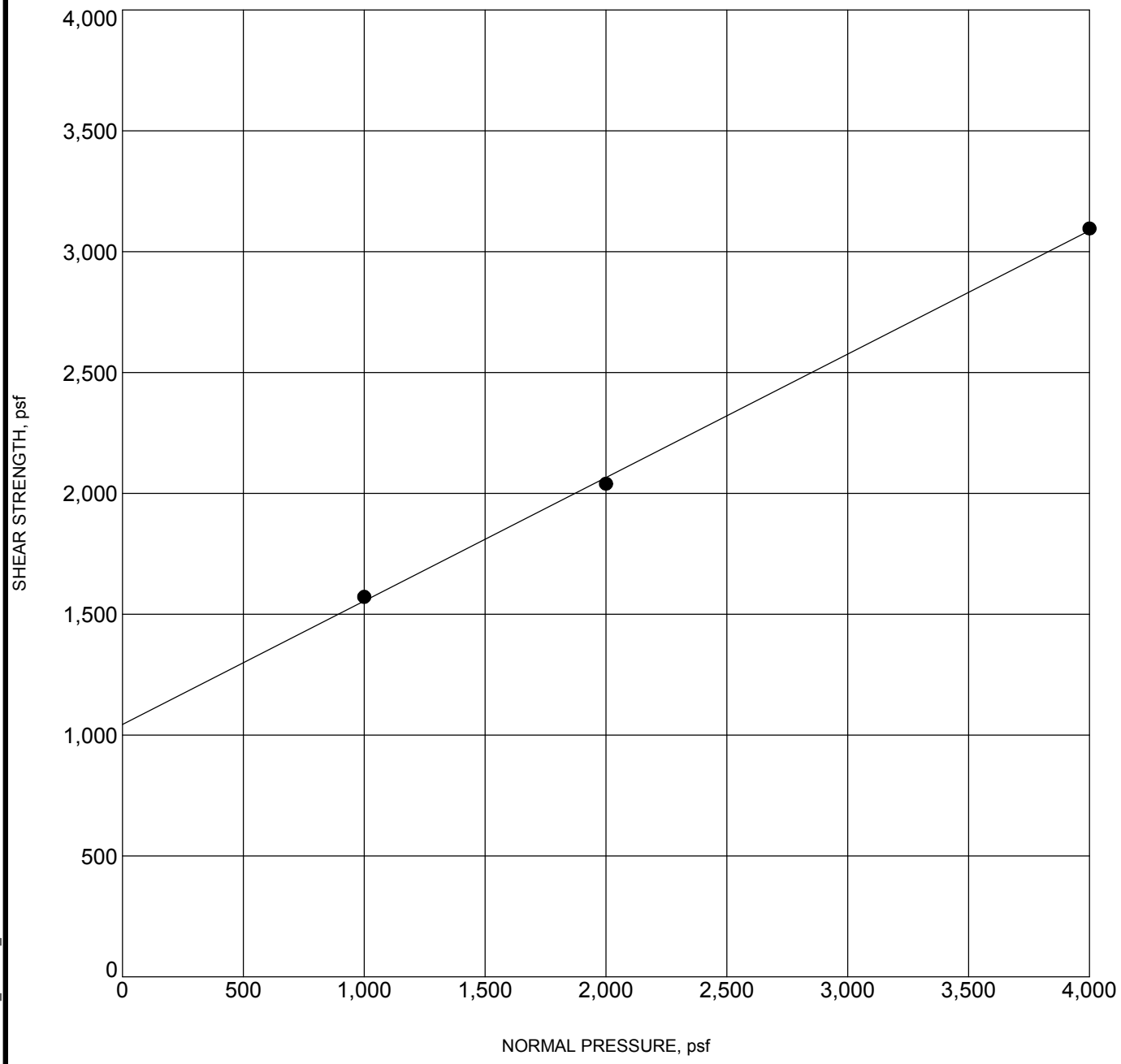



| Specimen Identification | | | Classification | $\gamma_d$, pcf | WC, % |
|---|---|---|---|---|---|
| ● | J-7 | 2.5 ft | FILL- SILTY CLAYEY SAND | 112 | 8 |

NOTES: Water added at 2000 psf

| | | |
|---|---|---|
| PROJECT: Johnson Student Center | Terracon<br>2817 McGaw Ave<br>Irvine, CA | PROJECT NUMBER: 60145100 |
| SITE: 1530 West 17th Street<br>Santa Ana, CA | | CLIENT: RSCCD Facility Planning, District<br>Santa Ana, CA |
| | | EXHIBIT: B-4 |

# DIRECT SHEAR TEST ASTM D3080




| Specimen Identification | Classification | $\gamma_d$, pcf | WC,% | c, psf | $\phi$° |
|---|---|---|---|---|---|
| ● J-8 2.5ft | **FILL- SANDY LEAN CLAY (CL)** | **112** | **15** | **1044** | **27** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

PROJECT: Johnson Student Center

SITE: 1530 West 17th Street
Santa Ana, CA

Terracon
2817 McGaw Ave
Irvine, CA

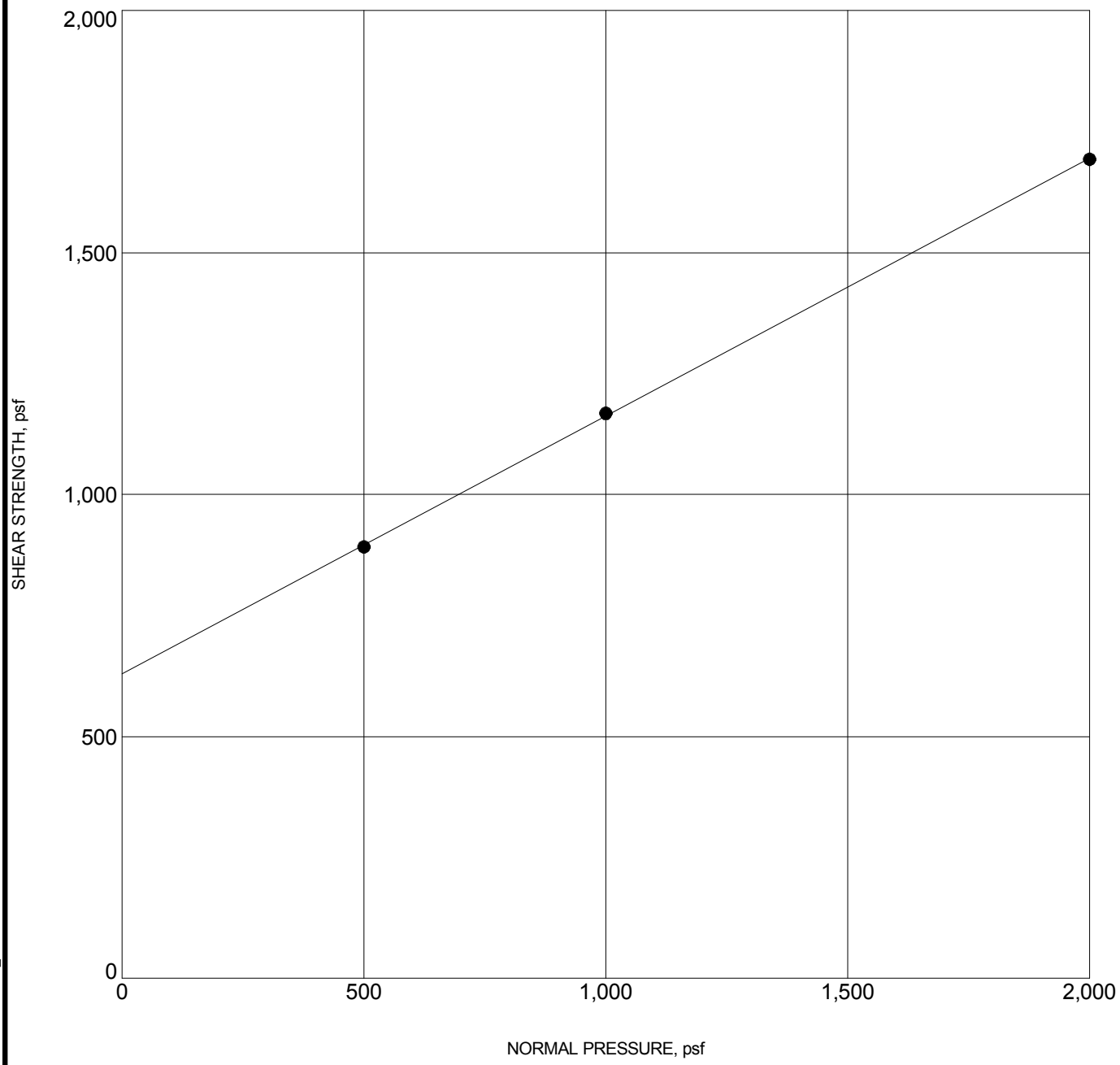
PROJECT NUMBER: 60145100

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

EXHIBIT: B-3

# DIRECT SHEAR TEST

**ASTM D3080**




| Specimen Identification | Classification | $\gamma_d$, pcf | WC,% | c, psf | $\phi$° |
|---|---|---|---|---|---|
| ● **B-1 2.5ft** | **CLAYEY SAND** | **115** | **15** | **630** | **28** |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

PROJECT: Proposed Johnson Student Center

SITE: 1530 West 17th Street
Santa Ana, CA

Terracon
2817 McGaw Avenue
Irvine, California

PROJECT NUMBER: 60145100

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

EXHIBIT: B-5

# CHEMICAL LABORATORY TEST REPORT

**Project Number:** 60145100
**Service Date:** 02/05/15
**Report Date:** 02/05/15
**Task:**

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

## Client

## Project

RSCCD: Johnson Student Center
Santa Ana, CA

**Sample Submitted By:** Terracon (60) **Date Received:** 2/4/2015 Lab No.: 15-0070

## *Results of Corrosivity Analysis*

| | |
|---|---|
| ***Sample Number*** | |
| ***Sample Location*** | B-1 |
| ***Sample Depth (ft.)*** | 1.0-2.0 |
| pH Analysis, AWWA 4500 H | 7.99 |
| Water Soluble Sulfate (SO4), AWWA 4500 E (percent %) | 0.04 |
| Sulfides, AWWA 4500-S D, (mg/kg) | Nil |
| Red-Ox, AWWA 2580, (mV) | +581 |
| Total Salts, AWWA 2510, (mg/kg) | 2324 |
| Chlorides, AWWA 4500 Cl B, (mg/kg) | 250 |
| Resistivity, ASTM G-57, (ohm-cm) | 601 |

**Analyzed By:** Kurt D. Ergun
Chemist

# CHEMICAL LABORATORY TEST REPORT

**Project Number:** 60145100
**Service Date:** 09/19/16
**Report Date:** 09/19/16
**Task:**

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

## Client

## Project

RSCCD: Johnson Student Center
Santa Ana, CA

**Sample Submitted By:** Terracon (60) **Date Received:** 9/16/2016 **Lab No.: 16-0851**

## *Results of Corrosion Analysis*

| | | | |
|---|---|---|---|
| ***Sample Number*** | | | |
| ***Sample Location*** | J-5 | J-7 | J-9 |
| ***Sample Depth (ft.)*** | 0.0 | 0.0 | 0.0 |
| pH Analysis, AWWA 4500 H | 8.59 | 8.37 | 8.12 |
| Water Soluble Sulfate (SO4), AWWA 4500 E (percent %) | 0.01 | 0.01 | 0.04 |
| Sulfides, AWWA 4500-S D, (mg/kg) | Nil | Nil | Nil |
| Red-Ox, AWWA 2580, (mV) | +645 | +674 | +666 |
| Total Salts, AWWA 2510, (mg/kg) | 1652 | 1366 | 3590 |
| Chlorides, AWWA 4500 Cl B, (mg/kg) | 75 | 125 | 325 |
| Resistivity, ASTM G-57, (ohm-cm) | 1154 | 1164 | 553 |

**Analyzed By:** Kurt D. Ergun

Kurt D. Ergun
Chemist

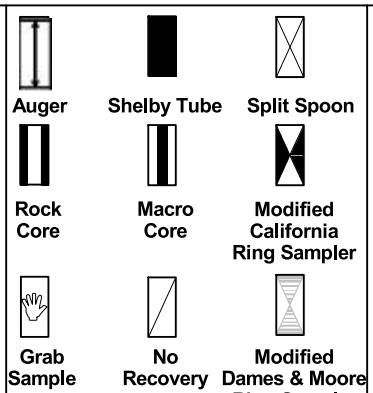
# APPENDIX C

# SUPPORTING DOCUMENTS

# GENERAL NOTES

## DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

**SAMPLING**




**WATER LEVEL**

**Water Initially Encountered**

**Water Level After a Specified Period of Time**

**Water Level After a Specified Period of Time**

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**

| | |
|---|---|
| **(HP)** | **Hand Penetrometer** |
| **(T)** | **Torvane** |
| **(b/f)** | **Standard Penetration Test (blows per foot)** |
| **N** | **N value** |
| **(PID)** | **Photo-Ionization Detector** |
| **(OVA)** | **Organic Vapor Analyzer** |
| (WOH) | Weight of Hammer |

## DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

## LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. 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 Includes gravels, sands and silts. | | | **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 (Density)** | **Standard Penetration or N-Value Blows/Ft.** | **Ring Sampler Blows/Ft.** | **Descriptive Term (Consistency)** | **Unconfined Compressive Strength, Qu, psf** | **Standard Penetration or N-Value Blows/Ft.** | **Ring Sampler Blows/Ft.** |
| Very Loose | 0 - 3 | 0 - 6 | Very Soft | less than 500 | 0 - 1 | < 3 |
| Loose | 4 - 9 | 7 - 18 | Soft | 500 to 1,000 | 2 - 4 | 3 - 4 |
| Medium Dense | 10 - 29 | 19 - 58 | Medium-Stiff | 1,000 to 2,000 | 4 - 8 | 5 - 9 |
| Dense | 30 - 50 | 59 - 98 | Stiff | 2,000 to 4,000 | 8 - 15 | 10 - 18 |
| Very Dense | > 50 | ≥ 99 | Very Stiff | 4,000 to 8,000 | 15 - 30 | 19 - 42 |
| | | | Hard | > 8,000 | > 30 | > 42 |

### RELATIVE PROPORTIONS OF SAND AND GRAVEL

| Descriptive Term(s) of other constituents | Percent of Dry Weight |
|---|---|
| Trace | < 15 |
| With | 15 - 29 |
| Modifier | > 30 |

### GRAIN SIZE TERMINOLOGY

| Major Component of Sample | Particle Size |
|---|---|
| Boulders | Over 12 in. (300 mm) |
| Cobbles | 12 in. to 3 in. (300mm to 75mm) |
| Gravel | 3 in. to #4 sieve (75mm to 4.75 mm) |
| Sand | #4 to #200 sieve (4.75mm to 0.075mm |
| Silt or Clay | Passing #200 sieve (0.075mm) |

### RELATIVE PROPORTIONS OF FINES

| Descriptive Term(s) of other constituents | Percent of Dry Weight |
|---|---|
| Trace | < 5 |
| With | 5 - 12 |
| Modifier | > 12 |

### PLASTICITY DESCRIPTION

| Term | Plasticity Index |
|---|---|
| Non-plastic | 0 |
| Low | 1 - 10 |
| Medium | 11 - 30 |
| High | > 30 |

Terracon

# UNIFIED SOIL CLASSIFICATION SYSTEM

| 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 $1 > Cc > 3$ [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 $1 > Cc > 3$ [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" line [J] | | 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.

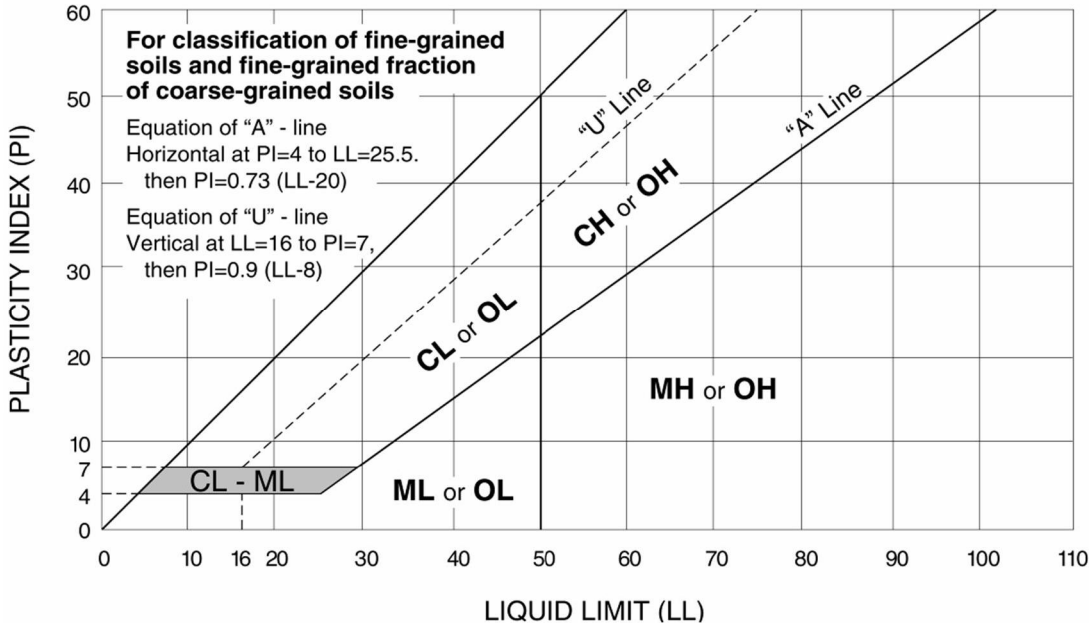



Exhibit C-2

# Design Maps Detailed Report

ASCE 7-10 Standard (33.75853°N, 117.8885°W)

Site Class D – “Stiff Soil”, Risk Category I/II/III

## Section 11.4.1 — Mapped Acceleration Parameters

Note: Ground motion values provided below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain $S_s$) and 1.3 (to obtain $S_1$). Maps in the 2010 ASCE-7 Standard are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

| | |
|---|---|
| From Figure 22-1 [1] | $S_S$ = 1.457 g |
| From Figure 22-2 [2] | $S_1$ = 0.534 g |

## Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

| Site Class | $\overline{v}_s$ | $\overline{N}$ or $\overline{N}_{ch}$ | $\overline{s}_u$ |
|---|---|---|---|
| A. Hard Rock | >5,000 ft/s | N/A | N/A |
| B. Rock | 2,500 to 5,000 ft/s | N/A | N/A |
| C. Very dense soil and soft rock | 1,200 to 2,500 ft/s | >50 | >2,000 psf |
| D. Stiff Soil | 600 to 1,200 ft/s | 15 to 50 | 1,000 to 2,000 psf |
| E. Soft clay soil | <600 ft/s | <15 | <1,000 psf |
| | Any profile with more than 10 ft of soil having the characteristics:<br>• Plasticity index *PI* > 20,<br>• Moisture content *w* ≥ 40%, and<br>• Undrained shear strength $\overline{s}_u$ < 500 psf | | |
| F. Soils requiring site response analysis in accordance with Section 21.1 | See Section 20.3.1 | | |

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

## Section 11.4.3 — Site Coefficients and Risk–Targeted Maximum Considered Earthquake ($MCE_R$) Spectral Response Acceleration Parameters

Table 11.4–1: Site Coefficient $F_a$

| Site Class | Mapped $MCE_R$ Spectral Response Acceleration Parameter at Short Period | | | | |
|---|---|---|---|---|---|
| | $S_S \leq 0.25$ | $S_S = 0.50$ | $S_S = 0.75$ | $S_S = 1.00$ | $S_S \geq 1.25$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 |
| D | 1.6 | 1.4 | 1.2 | 1.1 | 1.0 |
| E | 2.5 | 1.7 | 1.2 | 0.9 | 0.9 |
| F | See Section 11.4.7 of ASCE 7 | | | | |

Note: Use straight–line interpolation for intermediate values of $S_S$

For Site Class = D and $S_S$ = 1.457 g, $F_a$ = 1.000

Table 11.4–2: Site Coefficient $F_v$

| Site Class | Mapped $MCE_R$ Spectral Response Acceleration Parameter at 1–s Period | | | | |
|---|---|---|---|---|---|
| | $S_1 \leq 0.10$ | $S_1 = 0.20$ | $S_1 = 0.30$ | $S_1 = 0.40$ | $S_1 \geq 0.50$ |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.7 | 1.6 | 1.5 | 1.4 | 1.3 |
| D | 2.4 | 2.0 | 1.8 | 1.6 | 1.5 |
| E | 3.5 | 3.2 | 2.8 | 2.4 | 2.4 |
| F | See Section 11.4.7 of ASCE 7 | | | | |

Note: Use straight–line interpolation for intermediate values of $S_1$

For Site Class = D and $S_1$ = 0.534 g, $F_v$ = 1.500

| | |
|---|---|
| Equation (11.4–1): | $S_{MS} = F_a S_S = 1.000 \times 1.457 = 1.457$ g |
| Equation (11.4–2): | $S_{M1} = F_v S_1 = 1.500 \times 0.534 = 0.801$ g |

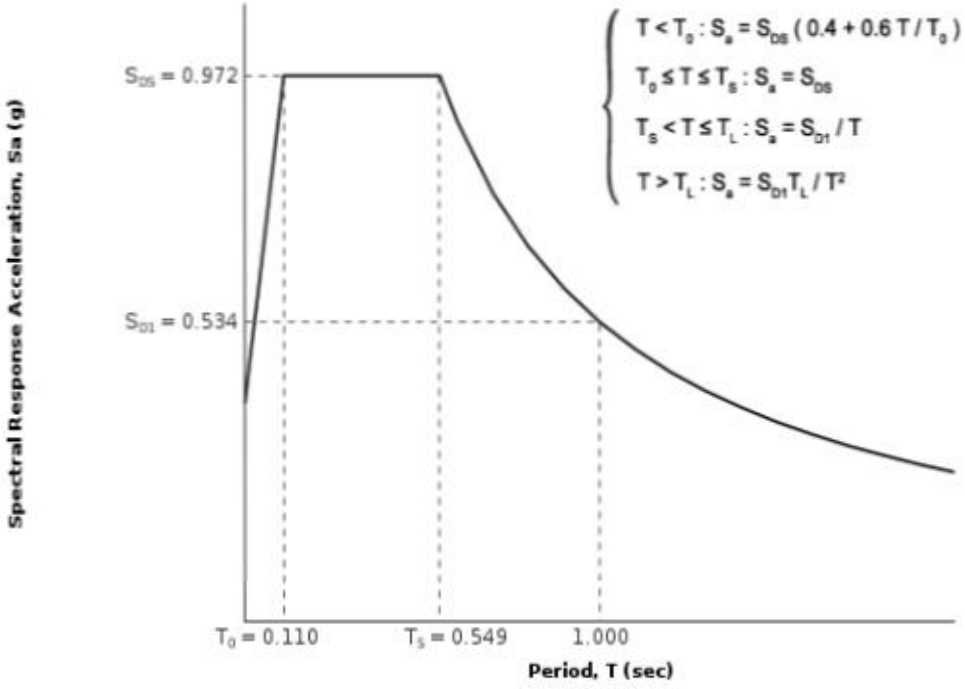
## Section 11.4.4 — Design Spectral Acceleration Parameters

| | |
|---|---|
| Equation (11.4–3): | $S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 1.457 = 0.972$ g |
| Equation (11.4–4): | $S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 0.801 = 0.534$ g |

## Section 11.4.5 — Design Response Spectrum

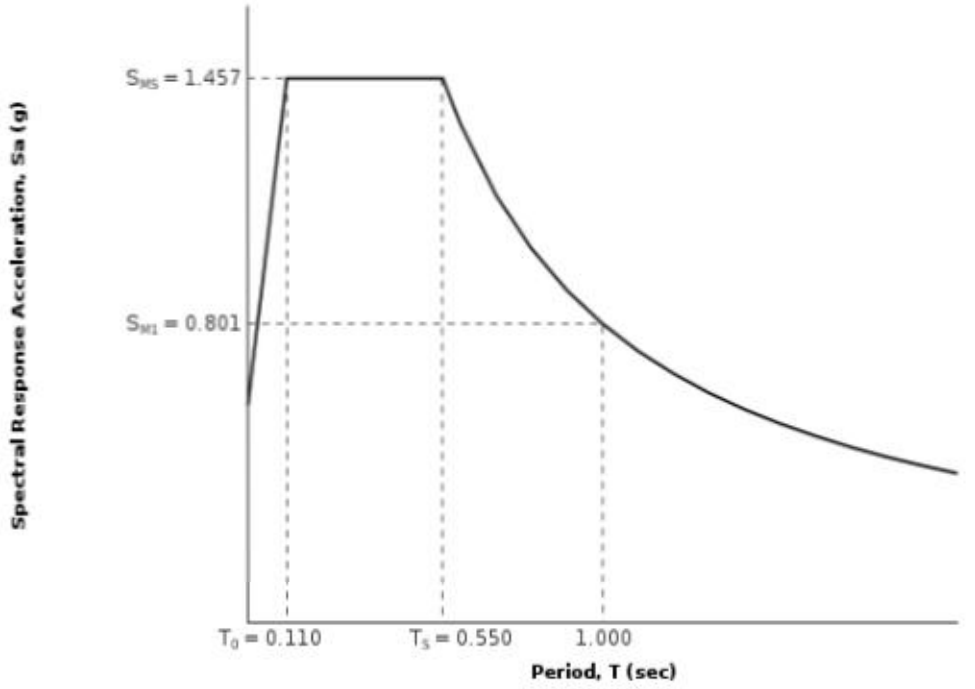
| | |
|---|---|
| From Figure 22-12 [3] | $T_L$ = 8 seconds |

Figure 11.4–1: Design Response Spectrum



## Section 11.4.6 — Risk-Targeted Maximum Considered Earthquake ($MCE_R$) Response Spectrum

The $MCE_R$ Response Spectrum is determined by multiplying the design response spectrum above by 1.5.



## Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4] PGA = 0.528

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.000 \times 0.528 = 0.528$ g

Table 11.8–1: Site Coefficient $F_{PGA}$

| Site Class | Mapped MCE Geometric Mean Peak Ground Acceleration, PGA | | | | |
|---|---|---|---|---|---|
| | PGA ≤ 0.10 | PGA = 0.20 | PGA = 0.30 | PGA = 0.40 | PGA ≥ 0.50 |
| A | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| B | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| C | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 |
| D | 1.6 | 1.4 | 1.2 | 1.1 | 1.0 |
| E | 2.5 | 1.7 | 1.2 | 0.9 | 0.9 |
| F | See Section 11.4.7 of ASCE 7 | | | | |

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.528 g, $F_{PGA}$ = 1.000

## Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5] $C_{RS}$ = 1.027

From Figure 22-18 [6] $C_{R1}$ = 1.064

## Section 11.6 — Seismic Design Category

Table 11.6-1 Seismic Design Category Based on Short Period Response Acceleration Parameter

| VALUE OF $S_{DS}$ | RISK CATEGORY | | |
|---|---|---|---|
| | I or II | III | IV |
| $S_{DS} < 0.167g$ | A | A | A |
| $0.167g \leq S_{DS} < 0.33g$ | B | B | C |
| $0.33g \leq S_{DS} < 0.50g$ | C | C | D |
| $0.50g \leq S_{DS}$ | D | D | D |

For Risk Category = I and $S_{DS}$ = 0.972 g, Seismic Design Category = D

Table 11.6-2 Seismic Design Category Based on 1-S Period Response Acceleration Parameter

| VALUE OF $S_{D1}$ | RISK CATEGORY | | |
|---|---|---|---|
| | I or II | III | IV |
| $S_{D1} < 0.067g$ | A | A | A |
| $0.067g \leq S_{D1} < 0.133g$ | B | B | C |
| $0.133g \leq S_{D1} < 0.20g$ | C | C | D |
| $0.20g \leq S_{D1}$ | D | D | D |

For Risk Category = I and $S_{D1}$ = 0.534 g, Seismic Design Category = D

Note: When $S_1$ is greater than or equal to 0.75g, the Seismic Design Category is E for buildings in Risk Categories I, II, and III, and F for those in Risk Category IV, irrespective of the above.

Seismic Design Category ≡ “the more severe design category in accordance with Table 11.6-1 or 11.6-2” = D

---

Note: See Section 11.6 for alternative approaches to calculating Seismic Design Category.

## References


1. *Figure 22-1*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-1.pdf
2. *Figure 22-2*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-2.pdf
3. *Figure 22-12*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-12.pdf
4. *Figure 22-7*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-7.pdf
5. *Figure 22-17*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-17.pdf
6. *Figure 22-18*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/2010_ASCE-7_Figure_22-18.pdf

# APPENDIX D

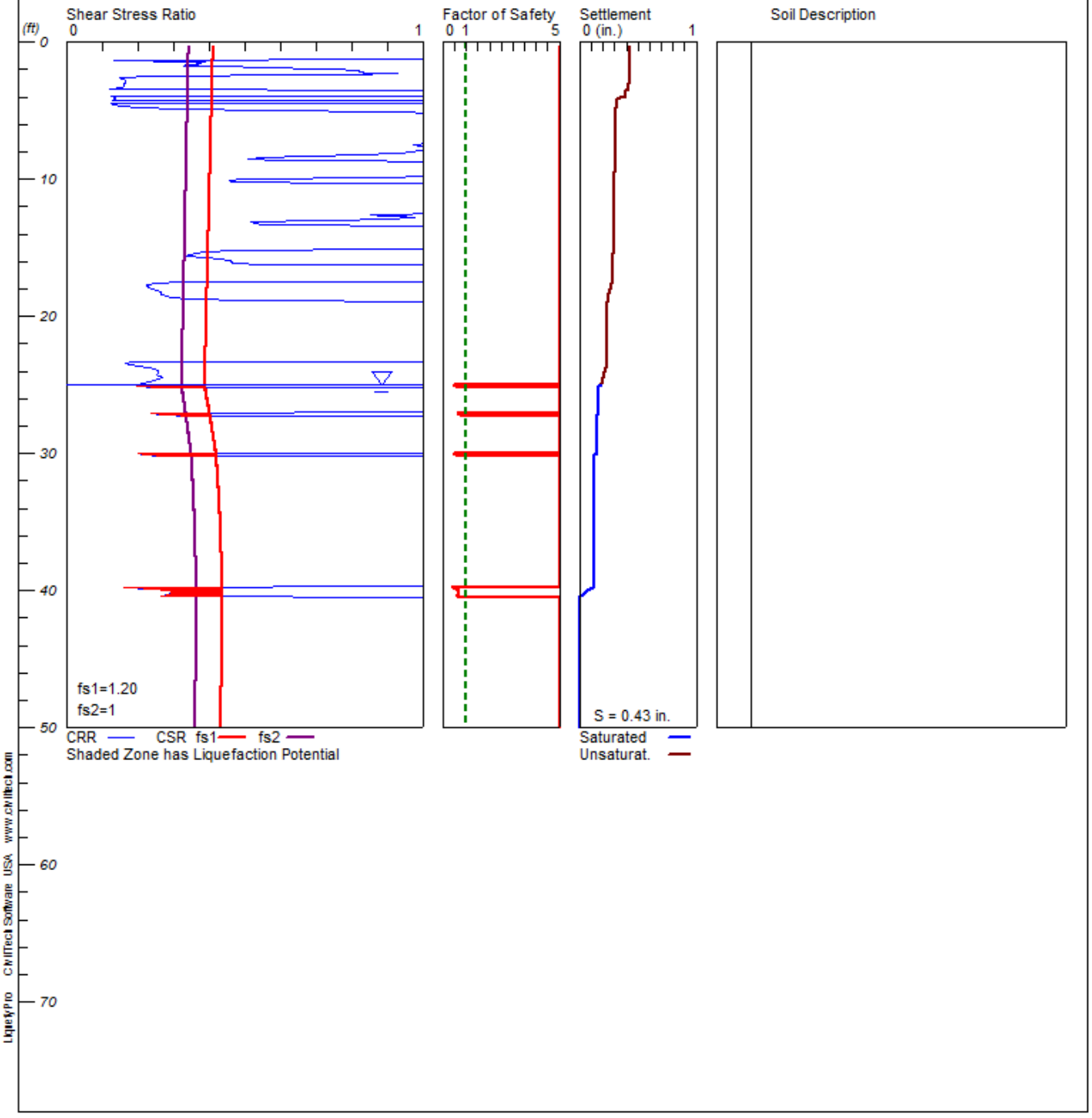
# LIQUEFACTION ANALYSIS

# LIQUEFACTION ANALYSIS

## Johnson

***Hole No.=CJ-1  Water Depth=25 ft  Surface Elev.=103***

***Magnitude=6.6***
***Acceleration=0.528g***



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LIQUEFACTION ANALYSIS SUMMARY



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Input Data:

Surface Elev.=103
Hole No.=CJ-1
Depth of Hole=50.00 ft
Water Table during Earthquake= 25.00 ft
Water Table during In-Situ Testing= 25.00 ft
Max. Acceleration=0.53 g
Earthquake Magnitude=6.60
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. CPT Calculation Method: Modify Robertson*
2. Settlement Analysis Method: Tokimatsu, M-correction
3. Fines Correction for Liquefaction: Stark/Olson et al.*
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
9. User request factor of safety (apply to CSR) , User= 1.2
   Plot two CSR (fs1=User, fs2=1)
10. Use Curve Smoothing: Yes*

* Recommended Options

In-Situ Test Data:

| Depth ft | qc atm | fs atm | Rf pcf | gamma % | Fines mm | D50 |
|---|---|---|---|---|---|---|
| 0.33 | 5.20 | 0.00 | 0.00 | 115.00 | 0.00 | 0.50 |
| 0.49 | 5.70 | 0.00 | 0.00 | 115.00 | 0.00 | 0.50 |
| 0.66 | 7.90 | 0.00 | 0.00 | 120.00 | 0.00 | 0.50 |
| 0.82 | 13.40 | 0.00 | 0.00 | 120.00 | 0.00 | 0.50 |
| 0.98 | 10.40 | 0.00 | 0.00 | 120.00 | 0.00 | 0.50 |
| 1.15 | 7.50 | 0.00 | 0.00 | 120.00 | 0.00 | 0.50 |
| 1.31 | 7.20 | 0.00 | 0.00 | 120.00 | 0.00 | 0.50 |
| 1.48 | 21.80 | 0.50 | 2.29 | 115.00 | 0.00 | 0.50 |
| 1.64 | 30.30 | 0.40 | 1.32 | 120.00 | 0.00 | 0.50 |
| 1.80 | 14.60 | 0.50 | 3.42 | 115.00 | 0.00 | 0.50 |
| 1.97 | 31.40 | 1.00 | 3.18 | 115.00 | 0.00 | 0.50 |
| 2.13 | 37.00 | 1.10 | 2.97 | 115.00 | 0.00 | 0.50 |
| 2.30 | 26.90 | 1.10 | 4.09 | 115.00 | 0.00 | 0.50 |
| 2.46 | 24.80 | 0.50 | 2.02 | 120.00 | 0.00 | 0.50 |
| 2.62 | 19.80 | 0.10 | 0.51 | 120.00 | 0.00 | 0.50 |
| 2.79 | 18.20 | 0.20 | 1.10 | 120.00 | 0.00 | 0.50 |
| 2.95 | 19.40 | 0.20 | 1.03 | 120.00 | 0.00 | 0.50 |
| 3.12 | 18.40 | 0.20 | 1.09 | 120.00 | 0.00 | 0.50 |
| 3.28 | 18.10 | 0.20 | 1.10 | 120.00 | 0.00 | 0.50 |
| 3.45 | 15.70 | 0.00 | 0.00 | 120.00 | 0.00 | 0.50 |
| 3.61 | 16.60 | 0.00 | 0.00 | 120.00 | 0.00 | 0.50 |
| 3.77 | 17.80 | 0.00 | 0.00 | 125.00 | 0.00 | 0.50 |
| 3.94 | 18.80 | 0.00 | 0.00 | 125.00 | 0.00 | 0.50 |
| 4.10 | 22.90 | 0.10 | 0.44 | 120.00 | 0.00 | 0.50 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.27 | 23.20 | 0.00 | 0.00 | 125.00 | 0.00 | 0.50 |
| 4.43 | 19.40 | 0.00 | 0.00 | 125.00 | 0.00 | 0.50 |
| 4.59 | 22.80 | 0.10 | 0.44 | 120.00 | 0.00 | 0.50 |
| 4.76 | 30.80 | 0.40 | 1.30 | 120.00 | 0.00 | 0.50 |
| 4.92 | 32.70 | 1.00 | 3.06 | 115.00 | 0.00 | 0.50 |
| 5.09 | 58.30 | 1.70 | 2.92 | 120.00 | 0.00 | 0.50 |
| 5.25 | 102.30 | 2.10 | 2.05 | 125.00 | 0.00 | 0.50 |
| 5.41 | 121.70 | 2.00 | 1.64 | 125.00 | 0.00 | 0.50 |
| 5.58 | 139.80 | 1.70 | 1.22 | 125.00 | 0.00 | 0.50 |
| 5.74 | 148.50 | 2.50 | 1.68 | 125.00 | 0.00 | 0.50 |
| 5.91 | 163.50 | 2.70 | 1.65 | 125.00 | 0.00 | 0.50 |
| 6.07 | 147.90 | 2.90 | 1.96 | 125.00 | 0.00 | 0.50 |
| 6.23 | 137.10 | 3.10 | 2.26 | 125.00 | 0.00 | 0.50 |
| 6.40 | 122.40 | 3.20 | 2.61 | 120.00 | 0.00 | 0.50 |
| 6.56 | 105.70 | 3.60 | 3.41 | 115.00 | 0.00 | 0.50 |
| 6.73 | 87.30 | 4.00 | 4.58 | 120.00 | 0.00 | 0.50 |
| 6.89 | 84.10 | 4.00 | 4.76 | 120.00 | 0.00 | 0.50 |
| 7.05 | 97.90 | 3.00 | 3.06 | 120.00 | 0.00 | 0.50 |
| 7.22 | 109.30 | 2.10 | 1.92 | 125.00 | 0.00 | 0.50 |
| 7.38 | 108.40 | 1.60 | 1.48 | 125.00 | 0.00 | 0.50 |
| 7.55 | 98.30 | 1.90 | 1.93 | 120.00 | 0.00 | 0.50 |
| 7.71 | 88.70 | 2.50 | 2.82 | 120.00 | 0.00 | 0.50 |
| 7.87 | 80.20 | 2.40 | 2.99 | 120.00 | 0.00 | 0.50 |
| 8.04 | 75.40 | 2.40 | 3.18 | 120.00 | 0.00 | 0.50 |
| 8.20 | 69.70 | 2.20 | 3.16 | 120.00 | 0.00 | 0.50 |
| 8.37 | 60.20 | 1.70 | 2.82 | 120.00 | 0.00 | 0.50 |
| 8.53 | 45.80 | 1.40 | 3.06 | 115.00 | 0.00 | 0.50 |
| 8.69 | 34.30 | 1.50 | 4.37 | 115.00 | 0.00 | 0.50 |
| 8.86 | 36.00 | 1.60 | 4.44 | 115.00 | 0.00 | 0.50 |
| 9.02 | 35.60 | 1.70 | 4.78 | 115.00 | 0.00 | 0.50 |
| 9.19 | 35.90 | 1.70 | 4.74 | 115.00 | 0.00 | 0.50 |
| 9.35 | 36.80 | 1.70 | 4.62 | 115.00 | 0.00 | 0.50 |
| 9.51 | 38.40 | 1.80 | 4.69 | 115.00 | 0.00 | 0.50 |
| 9.68 | 41.00 | 1.80 | 4.39 | 115.00 | 0.00 | 0.50 |
| 9.84 | 40.90 | 1.60 | 3.91 | 115.00 | 0.00 | 0.50 |
| 10.01 | 41.80 | 1.30 | 3.11 | 115.00 | 0.00 | 0.50 |
| 10.17 | 39.90 | 1.20 | 3.01 | 115.00 | 0.00 | 0.50 |
| 10.34 | 33.60 | 1.30 | 3.87 | 115.00 | 0.00 | 0.50 |
| 10.50 | 30.30 | 1.40 | 4.62 | 115.00 | 0.00 | 0.50 |
| 10.66 | 29.10 | 1.30 | 4.47 | 115.00 | 0.00 | 0.50 |
| 10.83 | 28.60 | 1.30 | 4.55 | 115.00 | 0.00 | 0.50 |
| 10.99 | 28.60 | 1.40 | 4.90 | 115.00 | 0.00 | 0.50 |
| 11.16 | 28.50 | 1.50 | 5.26 | 115.00 | 0.00 | 0.50 |
| 11.32 | 27.70 | 1.50 | 5.42 | 115.00 | 0.00 | 0.50 |
| 11.48 | 26.70 | 1.40 | 5.24 | 115.00 | 0.00 | 0.50 |
| 11.65 | 25.30 | 1.20 | 4.74 | 115.00 | 0.00 | 0.50 |
| 11.81 | 24.10 | 1.30 | 5.39 | 115.00 | 0.00 | 0.50 |
| 11.98 | 31.60 | 1.50 | 4.75 | 115.00 | 0.00 | 0.50 |
| 12.14 | 34.00 | 1.80 | 5.29 | 115.00 | 0.00 | 0.50 |
| 12.30 | 36.60 | 1.80 | 4.92 | 115.00 | 0.00 | 0.50 |
| 12.47 | 41.80 | 1.80 | 4.31 | 115.00 | 0.00 | 0.50 |
| 12.63 | 51.30 | 2.00 | 3.90 | 115.00 | 0.00 | 0.50 |
| 12.80 | 51.20 | 2.10 | 4.10 | 115.00 | 0.00 | 0.50 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 12.96 | 51.60 | 2.00 | 3.88 | 115.00 | 0.00 | 0.50 |
| 13.12 | 54.60 | 1.70 | 3.11 | 115.00 | 0.00 | 0.50 |
| 13.29 | 52.40 | 1.70 | 3.24 | 115.00 | 0.00 | 0.50 |
| 13.45 | 38.80 | 1.80 | 4.64 | 115.00 | 0.00 | 0.50 |
| 13.62 | 30.10 | 1.70 | 5.65 | 115.00 | 0.00 | 0.50 |
| 13.78 | 24.70 | 1.30 | 5.26 | 115.00 | 0.00 | 0.50 |
| 13.94 | 24.10 | 1.30 | 5.39 | 115.00 | 0.00 | 0.50 |
| 14.11 | 28.40 | 1.30 | 4.58 | 115.00 | 0.00 | 0.50 |
| 14.27 | 30.60 | 1.50 | 4.90 | 115.00 | 0.00 | 0.50 |
| 14.44 | 31.70 | 1.50 | 4.73 | 115.00 | 0.00 | 0.50 |
| 14.60 | 39.40 | 1.70 | 4.31 | 115.00 | 0.00 | 0.50 |
| 14.76 | 46.10 | 2.00 | 4.34 | 115.00 | 0.00 | 0.50 |
| 14.93 | 44.00 | 2.20 | 5.00 | 115.00 | 0.00 | 0.50 |
| 15.09 | 45.50 | 2.00 | 4.40 | 115.00 | 0.00 | 0.50 |
| 15.26 | 66.40 | 1.70 | 2.56 | 120.00 | 0.00 | 0.50 |
| 15.42 | 80.70 | 1.40 | 1.73 | 120.00 | 0.00 | 0.50 |
| 15.58 | 78.10 | 1.30 | 1.66 | 120.00 | 0.00 | 0.50 |
| 15.75 | 67.20 | 1.70 | 2.53 | 120.00 | 0.00 | 0.50 |
| 15.91 | 63.70 | 1.80 | 2.83 | 120.00 | 0.00 | 0.50 |
| 16.08 | 62.10 | 1.80 | 2.90 | 120.00 | 0.00 | 0.50 |
| 16.24 | 45.10 | 1.60 | 3.55 | 115.00 | 0.00 | 0.50 |
| 16.40 | 32.60 | 1.70 | 5.21 | 115.00 | 0.00 | 0.50 |
| 16.57 | 30.40 | 1.50 | 4.93 | 115.00 | 0.00 | 0.50 |
| 16.73 | 28.70 | 1.30 | 4.53 | 115.00 | 0.00 | 0.50 |
| 16.90 | 27.50 | 1.20 | 4.36 | 115.00 | 0.00 | 0.50 |
| 17.06 | 26.00 | 1.20 | 4.62 | 115.00 | 0.00 | 0.50 |
| 17.23 | 24.50 | 1.10 | 4.49 | 115.00 | 0.00 | 0.50 |
| 17.39 | 28.10 | 1.00 | 3.56 | 115.00 | 0.00 | 0.50 |
| 17.55 | 35.40 | 0.80 | 2.26 | 115.00 | 0.00 | 0.50 |
| 17.72 | 41.10 | 0.80 | 1.95 | 120.00 | 0.00 | 0.50 |
| 17.88 | 47.40 | 0.90 | 1.90 | 120.00 | 0.00 | 0.50 |
| 18.05 | 51.70 | 1.00 | 1.93 | 120.00 | 0.00 | 0.50 |
| 18.21 | 52.80 | 1.10 | 2.08 | 120.00 | 0.00 | 0.50 |
| 18.37 | 51.80 | 1.10 | 2.12 | 120.00 | 0.00 | 0.50 |
| 18.54 | 47.70 | 1.10 | 2.31 | 120.00 | 0.00 | 0.50 |
| 18.70 | 42.60 | 1.10 | 2.58 | 115.00 | 0.00 | 0.50 |
| 18.87 | 37.50 | 1.10 | 2.93 | 115.00 | 0.00 | 0.50 |
| 19.03 | 31.40 | 1.10 | 3.50 | 115.00 | 0.00 | 0.50 |
| 19.19 | 22.60 | 0.90 | 3.98 | 115.00 | 0.00 | 0.50 |
| 19.36 | 24.20 | 0.80 | 3.31 | 115.00 | 0.00 | 0.50 |
| 19.52 | 28.00 | 0.80 | 2.86 | 115.00 | 0.00 | 0.50 |
| 19.69 | 19.70 | 0.60 | 3.05 | 115.00 | 0.00 | 0.50 |
| 19.85 | 15.00 | 0.40 | 2.67 | 115.00 | 0.00 | 0.50 |
| 20.01 | 13.70 | 0.40 | 2.92 | 115.00 | 0.00 | 0.50 |
| 20.18 | 14.10 | 0.40 | 2.84 | 115.00 | 0.00 | 0.50 |
| 20.34 | 14.20 | 0.40 | 2.82 | 115.00 | 0.00 | 0.50 |
| 20.51 | 13.90 | 0.40 | 2.88 | 115.00 | 0.00 | 0.50 |
| 20.67 | 13.90 | 0.40 | 2.88 | 115.00 | 0.00 | 0.50 |
| 20.83 | 13.20 | 0.30 | 2.27 | 115.00 | 0.00 | 0.50 |
| 21.00 | 12.80 | 0.40 | 3.13 | 115.00 | 0.00 | 0.50 |
| 21.16 | 13.20 | 0.40 | 3.03 | 115.00 | 0.00 | 0.50 |
| 21.33 | 13.90 | 0.40 | 2.88 | 115.00 | 0.00 | 0.50 |
| 21.49 | 12.30 | 0.30 | 2.44 | 115.00 | 0.00 | 0.50 |

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|---|---|---|---|---|---|---|
| 21.65 | 11.50 | 0.30 | 2.61 | 115.00 | 0.00 | 0.50 |
| 21.82 | 11.40 | 0.30 | 2.63 | 115.00 | 0.00 | 0.50 |
| 21.98 | 12.40 | 0.20 | 1.61 | 115.00 | 0.00 | 0.50 |
| 22.15 | 11.40 | 0.20 | 1.75 | 115.00 | 0.00 | 0.50 |
| 22.31 | 10.80 | 0.20 | 1.85 | 115.00 | 0.00 | 0.50 |
| 22.47 | 10.10 | 0.20 | 1.98 | 115.00 | 0.00 | 0.50 |
| 22.64 | 8.70 | 0.10 | 1.15 | 115.00 | 0.00 | 0.50 |
| 22.80 | 8.20 | 0.10 | 1.22 | 115.00 | 0.00 | 0.50 |
| 22.97 | 8.60 | 0.20 | 2.33 | 115.00 | 0.00 | 0.50 |
| 23.13 | 10.60 | 0.30 | 2.83 | 115.00 | 0.00 | 0.50 |
| 23.30 | 25.50 | 0.50 | 1.96 | 115.00 | 0.00 | 0.50 |
| 23.46 | 60.10 | 0.60 | 1.00 | 120.00 | 0.00 | 0.50 |
| 23.62 | 84.60 | 0.70 | 0.83 | 125.00 | 0.00 | 0.50 |
| 23.79 | 99.40 | 0.70 | 0.70 | 125.00 | 0.00 | 0.50 |
| 23.95 | 104.50 | 0.80 | 0.77 | 125.00 | 0.00 | 0.50 |
| 24.12 | 105.30 | 0.80 | 0.76 | 125.00 | 0.00 | 0.50 |
| 24.28 | 108.00 | 0.70 | 0.65 | 125.00 | 0.00 | 0.50 |
| 24.44 | 112.00 | 0.80 | 0.71 | 125.00 | 0.00 | 0.50 |
| 24.61 | 108.90 | 0.70 | 0.64 | 125.00 | 0.00 | 0.50 |
| 24.77 | 99.70 | 0.70 | 0.70 | 125.00 | 0.00 | 0.50 |
| 24.94 | 84.60 | 0.70 | 0.83 | 125.00 | 0.00 | 0.50 |
| 25.10 | 56.20 | 0.90 | 1.60 | 120.00 | 0.00 | 0.50 |
| 25.26 | 27.50 | 0.80 | 2.91 | 115.00 | 0.00 | 0.50 |
| 25.43 | 17.90 | 0.40 | 2.23 | 115.00 | 0.00 | 0.50 |
| 25.59 | 14.10 | 0.20 | 1.42 | 115.00 | 0.00 | 0.50 |
| 25.76 | 10.20 | 0.10 | 0.98 | 115.00 | 0.00 | 0.50 |
| 25.92 | 9.60 | 0.10 | 1.04 | 115.00 | 0.00 | 0.50 |
| 26.08 | 9.70 | 0.10 | 1.03 | 115.00 | 0.00 | 0.50 |
| 26.25 | 10.90 | 0.20 | 1.83 | 115.00 | 0.00 | 0.50 |
| 26.41 | 13.70 | 0.40 | 2.92 | 115.00 | 0.00 | 0.50 |
| 26.58 | 16.00 | 0.40 | 2.50 | 115.00 | 0.00 | 0.50 |
| 26.74 | 17.00 | 0.60 | 3.53 | 115.00 | 0.00 | 0.50 |
| 26.90 | 19.60 | 0.80 | 4.08 | 115.00 | 0.00 | 0.50 |
| 27.07 | 49.90 | 1.00 | 2.00 | 120.00 | 0.00 | 0.50 |
| 27.23 | 52.10 | 1.30 | 2.50 | 115.00 | 0.00 | 0.50 |
| 27.40 | 25.40 | 0.90 | 3.54 | 115.00 | 0.00 | 0.50 |
| 27.56 | 14.80 | 0.70 | 4.73 | 115.00 | 0.00 | 0.50 |
| 27.72 | 15.90 | 0.70 | 4.40 | 115.00 | 0.00 | 0.50 |
| 27.89 | 16.60 | 0.60 | 3.61 | 115.00 | 0.00 | 0.50 |
| 28.05 | 13.20 | 0.40 | 3.03 | 115.00 | 0.00 | 0.50 |
| 28.22 | 10.60 | 0.30 | 2.83 | 115.00 | 0.00 | 0.50 |
| 28.38 | 10.70 | 0.20 | 1.87 | 115.00 | 0.00 | 0.50 |
| 28.54 | 10.80 | 0.30 | 2.78 | 115.00 | 0.00 | 0.50 |
| 28.71 | 10.50 | 0.30 | 2.86 | 115.00 | 0.00 | 0.50 |
| 28.87 | 11.40 | 0.40 | 3.51 | 115.00 | 0.00 | 0.50 |
| 29.04 | 12.90 | 0.40 | 3.10 | 115.00 | 0.00 | 0.50 |
| 29.20 | 12.60 | 0.60 | 4.76 | 115.00 | 0.00 | 0.50 |
| 29.36 | 18.20 | 0.80 | 4.40 | 115.00 | 0.00 | 0.50 |
| 29.53 | 31.50 | 0.60 | 1.90 | 115.00 | 0.00 | 0.50 |
| 29.69 | 22.40 | 0.80 | 3.57 | 115.00 | 0.00 | 0.50 |
| 29.86 | 16.70 | 0.80 | 4.79 | 115.00 | 0.00 | 0.50 |
| 30.02 | 55.30 | 0.90 | 1.63 | 120.00 | 0.00 | 0.50 |
| 30.19 | 46.20 | 1.00 | 2.16 | 115.00 | 0.00 | 0.50 |

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|---|---|---|---|---|---|---|
| 30.35 | 21.80 | 0.80 | 3.67 | 115.00 | 0.00 | 0.50 |
| 30.51 | 14.00 | 0.50 | 3.57 | 115.00 | 0.00 | 0.50 |
| 30.68 | 12.30 | 0.40 | 3.25 | 115.00 | 0.00 | 0.50 |
| 30.84 | 11.80 | 0.40 | 3.39 | 115.00 | 0.00 | 0.50 |
| 31.01 | 13.00 | 0.40 | 3.08 | 115.00 | 0.00 | 0.50 |
| 31.17 | 12.50 | 0.40 | 3.20 | 115.00 | 0.00 | 0.50 |
| 31.33 | 13.10 | 0.50 | 3.82 | 115.00 | 0.00 | 0.50 |
| 31.50 | 14.00 | 0.60 | 4.29 | 115.00 | 0.00 | 0.50 |
| 31.66 | 16.00 | 0.80 | 5.00 | 115.00 | 0.00 | 0.50 |
| 31.83 | 16.00 | 0.80 | 5.00 | 115.00 | 0.00 | 0.50 |
| 31.99 | 16.40 | 0.80 | 4.88 | 115.00 | 0.00 | 0.50 |
| 32.15 | 17.10 | 0.80 | 4.68 | 115.00 | 0.00 | 0.50 |
| 32.32 | 16.10 | 0.70 | 4.35 | 115.00 | 0.00 | 0.50 |
| 32.48 | 12.50 | 0.40 | 3.20 | 115.00 | 0.00 | 0.50 |
| 32.65 | 10.70 | 0.20 | 1.87 | 115.00 | 0.00 | 0.50 |
| 32.81 | 10.10 | 0.20 | 1.98 | 115.00 | 0.00 | 0.50 |
| 32.97 | 12.30 | 0.30 | 2.44 | 115.00 | 0.00 | 0.50 |
| 33.14 | 13.80 | 0.40 | 2.90 | 115.00 | 0.00 | 0.50 |
| 33.30 | 21.80 | 0.50 | 2.29 | 115.00 | 0.00 | 0.50 |
| 33.47 | 21.10 | 0.70 | 3.32 | 115.00 | 0.00 | 0.50 |
| 33.63 | 19.60 | 0.70 | 3.57 | 115.00 | 0.00 | 0.50 |
| 33.79 | 17.60 | 0.60 | 3.41 | 115.00 | 0.00 | 0.50 |
| 33.96 | 14.10 | 0.50 | 3.55 | 115.00 | 0.00 | 0.50 |
| 34.12 | 12.60 | 0.50 | 3.97 | 115.00 | 0.00 | 0.50 |
| 34.29 | 11.50 | 0.30 | 2.61 | 115.00 | 0.00 | 0.50 |
| 34.45 | 11.30 | 0.30 | 2.65 | 115.00 | 0.00 | 0.50 |
| 34.61 | 11.30 | 0.30 | 2.65 | 115.00 | 0.00 | 0.50 |
| 34.78 | 11.20 | 0.30 | 2.68 | 115.00 | 0.00 | 0.50 |
| 34.94 | 10.30 | 0.30 | 2.91 | 115.00 | 0.00 | 0.50 |
| 35.11 | 11.50 | 0.30 | 2.61 | 115.00 | 0.00 | 0.50 |
| 35.27 | 12.00 | 0.50 | 4.17 | 115.00 | 0.00 | 0.50 |
| 35.43 | 13.80 | 0.80 | 5.80 | 115.00 | 0.00 | 0.50 |
| 35.60 | 17.50 | 0.80 | 4.57 | 115.00 | 0.00 | 0.50 |
| 35.76 | 14.60 | 0.70 | 4.79 | 115.00 | 0.00 | 0.50 |
| 35.93 | 13.50 | 0.50 | 3.70 | 115.00 | 0.00 | 0.50 |
| 36.09 | 12.50 | 0.50 | 4.00 | 115.00 | 0.00 | 0.50 |
| 36.26 | 12.80 | 0.50 | 3.91 | 115.00 | 0.00 | 0.50 |
| 36.42 | 13.40 | 0.50 | 3.73 | 115.00 | 0.00 | 0.50 |
| 36.58 | 14.50 | 0.90 | 6.21 | 115.00 | 0.00 | 0.50 |
| 36.75 | 22.70 | 1.50 | 6.61 | 115.00 | 0.00 | 0.50 |
| 36.91 | 24.50 | 1.50 | 6.12 | 115.00 | 0.00 | 0.50 |
| 37.08 | 24.20 | 1.80 | 7.44 | 115.00 | 0.00 | 0.50 |
| 37.24 | 34.10 | 1.70 | 4.99 | 115.00 | 0.00 | 0.50 |
| 37.40 | 22.70 | 1.30 | 5.73 | 115.00 | 0.00 | 0.50 |
| 37.57 | 16.90 | 1.10 | 6.51 | 115.00 | 0.00 | 0.50 |
| 37.73 | 17.60 | 1.00 | 5.68 | 115.00 | 0.00 | 0.50 |
| 37.90 | 23.40 | 0.90 | 3.85 | 115.00 | 0.00 | 0.50 |
| 38.06 | 18.50 | 0.80 | 4.32 | 115.00 | 0.00 | 0.50 |
| 38.22 | 15.50 | 0.70 | 4.52 | 115.00 | 0.00 | 0.50 |
| 38.39 | 15.30 | 0.60 | 3.92 | 115.00 | 0.00 | 0.50 |
| 38.55 | 14.60 | 0.40 | 2.74 | 115.00 | 0.00 | 0.50 |
| 38.72 | 12.50 | 0.40 | 3.20 | 115.00 | 0.00 | 0.50 |
| 38.88 | 12.80 | 0.40 | 3.13 | 115.00 | 0.00 | 0.50 |

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|---|---|---|---|---|---|---|
| 39.04 | 13.20 | 0.40 | 3.03 | 115.00 | 0.00 | 0.50 |
| 39.21 | 13.10 | 0.40 | 3.05 | 115.00 | 0.00 | 0.50 |
| 39.37 | 14.50 | 0.30 | 2.07 | 115.00 | 0.00 | 0.50 |
| 39.54 | 14.90 | 0.60 | 4.03 | 115.00 | 0.00 | 0.50 |
| 39.70 | 35.70 | 0.60 | 1.68 | 115.00 | 0.00 | 0.50 |
| 39.86 | 125.60 | 0.80 | 0.64 | 125.00 | 0.00 | 0.50 |
| 40.03 | 143.90 | 0.70 | 0.49 | 125.00 | 0.00 | 0.50 |
| 40.19 | 136.50 | 1.10 | 0.81 | 125.00 | 0.00 | 0.50 |
| 40.36 | 104.40 | 1.50 | 1.44 | 120.00 | 0.00 | 0.50 |
| 40.52 | 35.90 | 1.50 | 4.18 | 115.00 | 0.00 | 0.50 |
| 40.68 | 23.00 | 0.70 | 3.04 | 115.00 | 0.00 | 0.50 |
| 40.85 | 15.40 | 0.40 | 2.60 | 115.00 | 0.00 | 0.50 |
| 41.01 | 14.20 | 0.30 | 2.11 | 115.00 | 0.00 | 0.50 |
| 41.18 | 15.10 | 0.30 | 1.99 | 115.00 | 0.00 | 0.50 |
| 41.34 | 16.00 | 0.40 | 2.50 | 115.00 | 0.00 | 0.50 |
| 41.50 | 14.20 | 0.40 | 2.82 | 115.00 | 0.00 | 0.50 |
| 41.67 | 13.00 | 0.30 | 2.31 | 115.00 | 0.00 | 0.50 |
| 41.83 | 14.10 | 0.30 | 2.13 | 115.00 | 0.00 | 0.50 |
| 42.00 | 15.00 | 0.30 | 2.00 | 115.00 | 0.00 | 0.50 |
| 42.16 | 13.90 | 0.60 | 4.32 | 115.00 | 0.00 | 0.50 |
| 42.32 | 23.90 | 1.50 | 6.28 | 115.00 | 0.00 | 0.50 |
| 42.49 | 39.40 | 2.30 | 5.84 | 115.00 | 0.00 | 0.50 |
| 42.65 | 44.80 | 2.80 | 6.25 | 115.00 | 0.00 | 0.50 |
| 42.82 | 43.70 | 2.90 | 6.64 | 115.00 | 0.00 | 0.50 |
| 42.98 | 38.40 | 2.40 | 6.25 | 115.00 | 0.00 | 0.50 |
| 43.15 | 32.80 | 2.30 | 7.01 | 115.00 | 0.00 | 0.50 |
| 43.31 | 24.10 | 1.30 | 5.39 | 115.00 | 0.00 | 0.50 |
| 43.47 | 17.40 | 0.80 | 4.60 | 115.00 | 0.00 | 0.50 |
| 43.64 | 16.30 | 0.60 | 3.68 | 115.00 | 0.00 | 0.50 |
| 43.80 | 15.40 | 0.60 | 3.90 | 115.00 | 0.00 | 0.50 |
| 43.97 | 15.60 | 0.60 | 3.85 | 115.00 | 0.00 | 0.50 |
| 44.13 | 15.80 | 0.60 | 3.80 | 115.00 | 0.00 | 0.50 |
| 44.29 | 15.80 | 0.60 | 3.80 | 115.00 | 0.00 | 0.50 |
| 44.46 | 16.20 | 0.60 | 3.70 | 115.00 | 0.00 | 0.50 |
| 44.62 | 16.10 | 0.60 | 3.73 | 115.00 | 0.00 | 0.50 |
| 44.79 | 16.20 | 0.60 | 3.70 | 115.00 | 0.00 | 0.50 |
| 44.95 | 17.10 | 0.70 | 4.09 | 115.00 | 0.00 | 0.50 |
| 45.11 | 19.10 | 0.70 | 3.66 | 115.00 | 0.00 | 0.50 |
| 45.28 | 19.80 | 0.80 | 4.04 | 115.00 | 0.00 | 0.50 |
| 45.44 | 18.90 | 0.80 | 4.23 | 115.00 | 0.00 | 0.50 |
| 45.61 | 19.30 | 0.90 | 4.66 | 115.00 | 0.00 | 0.50 |
| 45.77 | 19.70 | 1.10 | 5.58 | 115.00 | 0.00 | 0.50 |
| 45.93 | 29.30 | 1.80 | 6.14 | 115.00 | 0.00 | 0.50 |
| 46.10 | 30.50 | 1.70 | 5.57 | 115.00 | 0.00 | 0.50 |
| 46.26 | 32.90 | 1.90 | 5.78 | 115.00 | 0.00 | 0.50 |
| 46.43 | 24.30 | 1.50 | 6.17 | 115.00 | 0.00 | 0.50 |
| 46.59 | 21.80 | 1.30 | 5.96 | 115.00 | 0.00 | 0.50 |
| 46.75 | 23.80 | 1.00 | 4.20 | 115.00 | 0.00 | 0.50 |
| 46.92 | 20.70 | 0.80 | 3.86 | 115.00 | 0.00 | 0.50 |
| 47.08 | 19.50 | 0.60 | 3.08 | 115.00 | 0.00 | 0.50 |
| 47.25 | 17.80 | 0.50 | 2.81 | 115.00 | 0.00 | 0.50 |
| 47.41 | 15.30 | 0.60 | 3.92 | 115.00 | 0.00 | 0.50 |
| 47.57 | 19.90 | 0.90 | 4.52 | 115.00 | 0.00 | 0.50 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 47.74 | 27.80 | 1.20 | 4.32 | 115.00 | 0.00 | 0.50 |
| 47.90 | 28.80 | 1.30 | 4.51 | 115.00 | 0.00 | 0.50 |
| 48.07 | 29.90 | 1.20 | 4.01 | 115.00 | 0.00 | 0.50 |
| 48.23 | 28.50 | 0.90 | 3.16 | 115.00 | 0.00 | 0.50 |
| 48.39 | 18.60 | 0.70 | 3.76 | 115.00 | 0.00 | 0.50 |
| 48.56 | 15.80 | 0.60 | 3.80 | 115.00 | 0.00 | 0.50 |
| 48.72 | 16.00 | 0.60 | 3.75 | 115.00 | 0.00 | 0.50 |
| 48.89 | 16.40 | 0.60 | 3.66 | 115.00 | 0.00 | 0.50 |
| 49.05 | 16.70 | 0.60 | 3.59 | 115.00 | 0.00 | 0.50 |
| 49.22 | 16.50 | 0.60 | 3.64 | 115.00 | 0.00 | 0.50 |
| 49.38 | 18.50 | 0.70 | 3.78 | 115.00 | 0.00 | 0.50 |
| 49.54 | 19.30 | 0.70 | 3.63 | 115.00 | 0.00 | 0.50 |
| 49.71 | 20.10 | 0.80 | 3.98 | 115.00 | 0.00 | 0.50 |
| 49.87 | 20.50 | 0.80 | 3.90 | 115.00 | 0.00 | 0.50 |

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Modify Robertson method generates Fines from qc/fs. Inputted Fines are not relevant.

Output Results:

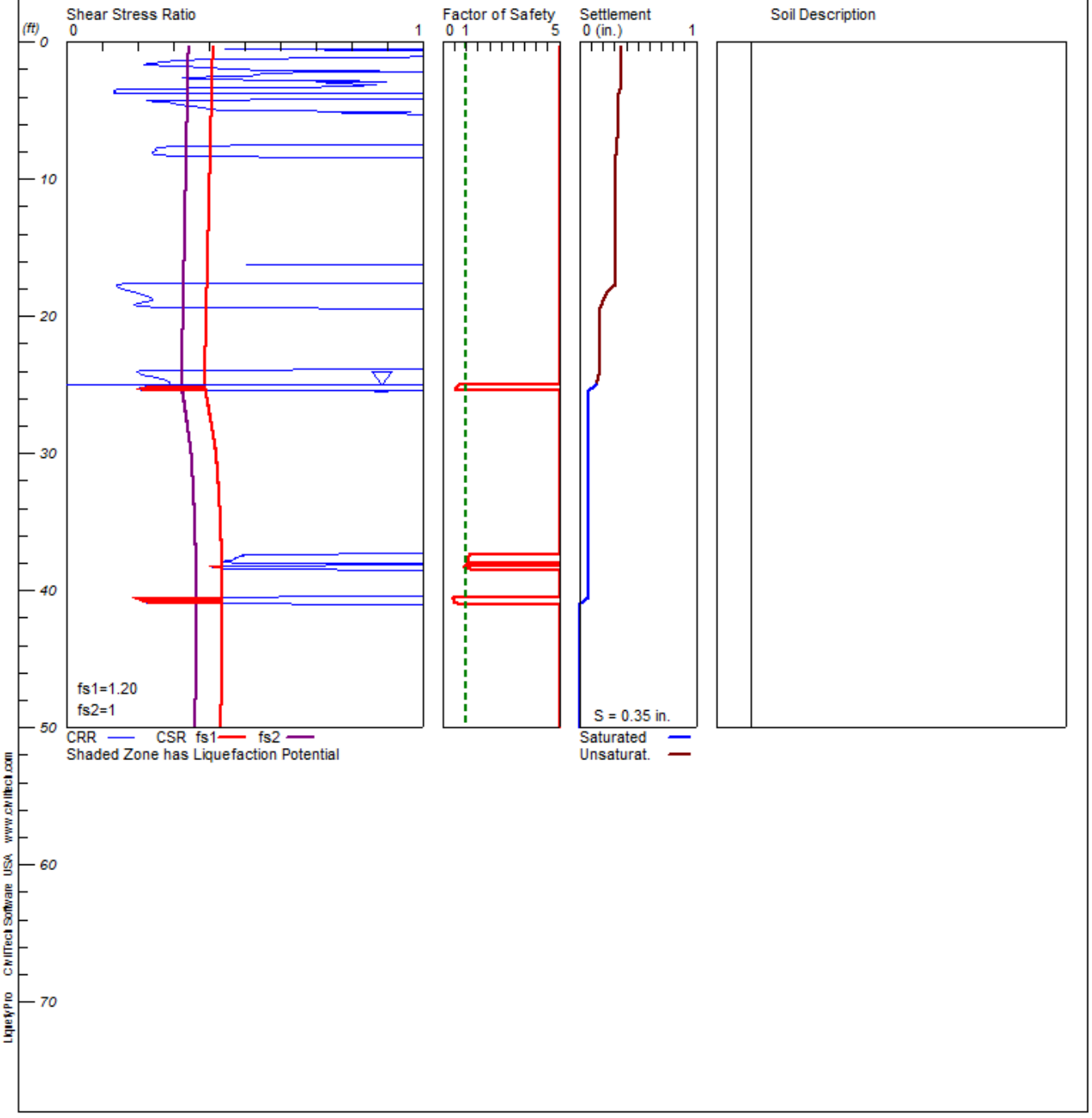
Settlement of Saturated Sands=0.18 in.
Settlement of Unsaturated Sands=0.25 in.
Total Settlement of Saturated and Unsaturated Sands=0.43 in.
Differential Settlement=0.215 to 0.284 in.

# LIQUEFACTION ANALYSIS

## Johnson

***Hole No.=CJ-2  Water Depth=25 ft  Surface Elev.=103***

***Magnitude=6.6***
***Acceleration=0.528g***



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LIQUEFACTION ANALYSIS SUMMARY
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Input Data:

Surface Elev.=103
Hole No.=CJ-2
Depth of Hole=50.00 ft
Water Table during Earthquake= 25.00 ft
Water Table during In-Situ Testing= 25.00 ft
Max. Acceleration=0.53 g
Earthquake Magnitude=6.60
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. CPT Calculation Method: Modify Robertson*
2. Settlement Analysis Method: Tokimatsu, M-correction
3. Fines Correction for Liquefaction: Stark/Olson et al.*
4. Fine Correction for Settlement: During Liquefaction*
5. Settlement Calculation in: All zones*
9. User request factor of safety (apply to CSR) , User= 1.2
   Plot two CSR (fs1=User, fs2=1)
10. Use Curve Smoothing: Yes*
* Recommended Options

In-Situ Test Data:

| Depth ft | qc atm | fs atm | Rf pcf | gamma % | Fines mm | D50 |
|---|---|---|---|---|---|---|
| 0.33 | 1.10 | 0.00 | 0.00 | 100.00 | 0.00 | 0.50 |
| 0.49 | 4.70 | 0.00 | 0.00 | 115.00 | 0.00 | 0.50 |
| 0.66 | 47.00 | 1.30 | 2.77 | 120.00 | 0.00 | 0.50 |
| 0.82 | 58.20 | 1.30 | 2.23 | 120.00 | 0.00 | 0.50 |
| 0.98 | 43.80 | 0.80 | 1.83 | 120.00 | 0.00 | 0.50 |
| 1.15 | 34.70 | 0.40 | 1.15 | 120.00 | 0.00 | 0.50 |
| 1.31 | 26.80 | 0.30 | 1.12 | 120.00 | 0.00 | 0.50 |
| 1.48 | 21.00 | 0.30 | 1.43 | 120.00 | 0.00 | 0.50 |
| 1.64 | 21.80 | 0.20 | 0.92 | 120.00 | 0.00 | 0.50 |
| 1.80 | 20.40 | 0.50 | 2.45 | 115.00 | 0.00 | 0.50 |
| 1.97 | 20.00 | 0.60 | 3.00 | 115.00 | 0.00 | 0.50 |
| 2.13 | 14.70 | 0.60 | 4.08 | 115.00 | 0.00 | 0.50 |
| 2.30 | 26.30 | 0.80 | 3.04 | 115.00 | 0.00 | 0.50 |
| 2.46 | 28.30 | 0.80 | 2.83 | 115.00 | 0.00 | 0.50 |
| 2.62 | 20.40 | 0.50 | 2.45 | 115.00 | 0.00 | 0.50 |
| 2.79 | 15.40 | 0.50 | 3.25 | 115.00 | 0.00 | 0.50 |
| 2.95 | 13.70 | 0.50 | 3.65 | 115.00 | 0.00 | 0.50 |
| 3.12 | 11.40 | 0.40 | 3.51 | 115.00 | 0.00 | 0.50 |
| 3.28 | 12.00 | 0.40 | 3.33 | 115.00 | 0.00 | 0.50 |
| 3.45 | 13.00 | 0.10 | 0.77 | 120.00 | 0.00 | 0.50 |
| 3.61 | 18.60 | 0.10 | 0.54 | 120.00 | 0.00 | 0.50 |
| 3.77 | 4.00 | 0.10 | 2.50 | 115.00 | 0.00 | 0.50 |
| 3.94 | 4.10 | 0.30 | 7.32 | 115.00 | 0.00 | 0.50 |
| 4.10 | 4.20 | 0.40 | 9.52 | 100.00 | 0.00 | 0.50 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.27 | 20.70 | 0.40 | 1.93 | 120.00 | 0.00 | 0.50 |
| 4.43 | 20.20 | 0.50 | 2.48 | 115.00 | 0.00 | 0.50 |
| 4.59 | 29.60 | 0.70 | 2.36 | 120.00 | 0.00 | 0.50 |
| 4.76 | 29.10 | 0.80 | 2.75 | 115.00 | 0.00 | 0.50 |
| 4.92 | 23.80 | 0.70 | 2.94 | 115.00 | 0.00 | 0.50 |
| 5.09 | 20.30 | 0.70 | 3.45 | 115.00 | 0.00 | 0.50 |
| 5.25 | 18.50 | 0.70 | 3.78 | 115.00 | 0.00 | 0.50 |
| 5.41 | 19.60 | 0.80 | 4.08 | 115.00 | 0.00 | 0.50 |
| 5.58 | 24.20 | 1.00 | 4.13 | 115.00 | 0.00 | 0.50 |
| 5.74 | 29.10 | 1.20 | 4.12 | 115.00 | 0.00 | 0.50 |
| 5.91 | 29.30 | 1.30 | 4.44 | 115.00 | 0.00 | 0.50 |
| 6.07 | 33.20 | 1.50 | 4.52 | 115.00 | 0.00 | 0.50 |
| 6.23 | 38.10 | 1.70 | 4.46 | 115.00 | 0.00 | 0.50 |
| 6.40 | 39.10 | 1.80 | 4.60 | 115.00 | 0.00 | 0.50 |
| 6.56 | 36.90 | 1.70 | 4.61 | 115.00 | 0.00 | 0.50 |
| 6.73 | 36.50 | 1.60 | 4.38 | 115.00 | 0.00 | 0.50 |
| 6.89 | 28.70 | 1.60 | 5.57 | 115.00 | 0.00 | 0.50 |
| 7.05 | 23.50 | 1.30 | 5.53 | 115.00 | 0.00 | 0.50 |
| 7.22 | 22.10 | 1.10 | 4.98 | 115.00 | 0.00 | 0.50 |
| 7.38 | 24.50 | 1.10 | 4.49 | 115.00 | 0.00 | 0.50 |
| 7.55 | 29.10 | 0.90 | 3.09 | 115.00 | 0.00 | 0.50 |
| 7.71 | 42.50 | 0.70 | 1.65 | 120.00 | 0.00 | 0.50 |
| 7.87 | 56.60 | 0.50 | 0.88 | 125.00 | 0.00 | 0.50 |
| 8.04 | 54.00 | 0.50 | 0.93 | 125.00 | 0.00 | 0.50 |
| 8.20 | 42.60 | 0.70 | 1.64 | 120.00 | 0.00 | 0.50 |
| 8.37 | 29.70 | 1.00 | 3.37 | 115.00 | 0.00 | 0.50 |
| 8.53 | 23.50 | 1.00 | 4.26 | 115.00 | 0.00 | 0.50 |
| 8.69 | 17.80 | 0.80 | 4.49 | 115.00 | 0.00 | 0.50 |
| 8.86 | 15.70 | 0.70 | 4.46 | 115.00 | 0.00 | 0.50 |
| 9.02 | 15.10 | 0.60 | 3.97 | 115.00 | 0.00 | 0.50 |
| 9.19 | 14.80 | 0.50 | 3.38 | 115.00 | 0.00 | 0.50 |
| 9.35 | 15.10 | 0.50 | 3.31 | 115.00 | 0.00 | 0.50 |
| 9.51 | 15.50 | 0.60 | 3.87 | 115.00 | 0.00 | 0.50 |
| 9.68 | 15.50 | 0.60 | 3.87 | 115.00 | 0.00 | 0.50 |
| 9.84 | 15.60 | 0.60 | 3.85 | 115.00 | 0.00 | 0.50 |
| 10.01 | 15.30 | 0.60 | 3.92 | 115.00 | 0.00 | 0.50 |
| 10.17 | 14.50 | 0.50 | 3.45 | 115.00 | 0.00 | 0.50 |
| 10.34 | 14.30 | 0.50 | 3.50 | 115.00 | 0.00 | 0.50 |
| 10.50 | 14.10 | 0.50 | 3.55 | 115.00 | 0.00 | 0.50 |
| 10.66 | 14.60 | 0.50 | 3.42 | 115.00 | 0.00 | 0.50 |
| 10.83 | 14.20 | 0.50 | 3.52 | 115.00 | 0.00 | 0.50 |
| 10.99 | 13.80 | 0.60 | 4.35 | 115.00 | 0.00 | 0.50 |
| 11.16 | 12.70 | 0.60 | 4.72 | 115.00 | 0.00 | 0.50 |
| 11.32 | 12.10 | 0.60 | 4.96 | 115.00 | 0.00 | 0.50 |
| 11.48 | 12.20 | 0.50 | 4.10 | 115.00 | 0.00 | 0.50 |
| 11.65 | 12.10 | 0.50 | 4.13 | 115.00 | 0.00 | 0.50 |
| 11.81 | 12.00 | 0.50 | 4.17 | 115.00 | 0.00 | 0.50 |
| 11.98 | 11.30 | 0.50 | 4.42 | 115.00 | 0.00 | 0.50 |
| 12.14 | 11.30 | 0.40 | 3.54 | 115.00 | 0.00 | 0.50 |
| 12.30 | 11.40 | 0.40 | 3.51 | 115.00 | 0.00 | 0.50 |
| 12.47 | 12.00 | 0.40 | 3.33 | 115.00 | 0.00 | 0.50 |
| 12.63 | 13.60 | 0.50 | 3.68 | 115.00 | 0.00 | 0.50 |
| 12.80 | 15.40 | 0.60 | 3.90 | 115.00 | 0.00 | 0.50 |

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|---|---|---|---|---|---|---|
| 12.96 | 16.40 | 0.70 | 4.27 | 115.00 | 0.00 | 0.50 |
| 13.12 | 15.00 | 0.60 | 4.00 | 115.00 | 0.00 | 0.50 |
| 13.29 | 15.50 | 0.60 | 3.87 | 115.00 | 0.00 | 0.50 |
| 13.45 | 16.00 | 0.60 | 3.75 | 115.00 | 0.00 | 0.50 |
| 13.62 | 15.90 | 0.60 | 3.77 | 115.00 | 0.00 | 0.50 |
| 13.78 | 16.60 | 0.60 | 3.61 | 115.00 | 0.00 | 0.50 |
| 13.94 | 17.00 | 0.60 | 3.53 | 115.00 | 0.00 | 0.50 |
| 14.11 | 16.80 | 0.60 | 3.57 | 115.00 | 0.00 | 0.50 |
| 14.27 | 17.00 | 0.60 | 3.53 | 115.00 | 0.00 | 0.50 |
| 14.44 | 16.80 | 0.70 | 4.17 | 115.00 | 0.00 | 0.50 |
| 14.60 | 16.80 | 0.70 | 4.17 | 115.00 | 0.00 | 0.50 |
| 14.76 | 17.30 | 0.70 | 4.05 | 115.00 | 0.00 | 0.50 |
| 14.93 | 17.50 | 0.70 | 4.00 | 115.00 | 0.00 | 0.50 |
| 15.09 | 17.30 | 0.70 | 4.05 | 115.00 | 0.00 | 0.50 |
| 15.26 | 17.10 | 0.60 | 3.51 | 115.00 | 0.00 | 0.50 |
| 15.42 | 16.20 | 0.70 | 4.32 | 115.00 | 0.00 | 0.50 |
| 15.58 | 23.80 | 0.70 | 2.94 | 115.00 | 0.00 | 0.50 |
| 16.24 | 26.70 | 0.70 | 2.62 | 115.00 | 0.00 | 0.50 |
| 16.57 | 28.30 | 0.90 | 3.18 | 115.00 | 0.00 | 0.50 |
| 16.73 | 19.70 | 0.60 | 3.05 | 115.00 | 0.00 | 0.50 |
| 16.90 | 13.20 | 0.50 | 3.79 | 115.00 | 0.00 | 0.50 |
| 17.06 | 12.00 | 0.40 | 3.33 | 115.00 | 0.00 | 0.50 |
| 17.23 | 11.20 | 0.40 | 3.57 | 115.00 | 0.00 | 0.50 |
| 17.39 | 10.80 | 0.40 | 3.70 | 115.00 | 0.00 | 0.50 |
| 17.55 | 15.10 | 0.30 | 1.99 | 115.00 | 0.00 | 0.50 |
| 17.72 | 31.80 | 0.30 | 0.94 | 120.00 | 0.00 | 0.50 |
| 17.88 | 42.30 | 0.30 | 0.71 | 120.00 | 0.00 | 0.50 |
| 18.05 | 53.60 | 0.40 | 0.75 | 120.00 | 0.00 | 0.50 |
| 18.21 | 62.50 | 0.60 | 0.96 | 120.00 | 0.00 | 0.50 |
| 18.37 | 67.10 | 0.70 | 1.04 | 120.00 | 0.00 | 0.50 |
| 18.54 | 66.70 | 0.90 | 1.35 | 120.00 | 0.00 | 0.50 |
| 18.70 | 65.20 | 1.00 | 1.53 | 120.00 | 0.00 | 0.50 |
| 18.87 | 63.80 | 1.00 | 1.57 | 120.00 | 0.00 | 0.50 |
| 19.03 | 59.00 | 0.80 | 1.36 | 120.00 | 0.00 | 0.50 |
| 19.19 | 48.50 | 0.70 | 1.44 | 120.00 | 0.00 | 0.50 |
| 19.36 | 33.60 | 0.80 | 2.38 | 115.00 | 0.00 | 0.50 |
| 19.52 | 20.80 | 0.80 | 3.85 | 115.00 | 0.00 | 0.50 |
| 19.69 | 15.80 | 0.50 | 3.16 | 115.00 | 0.00 | 0.50 |
| 19.85 | 13.90 | 0.40 | 2.88 | 115.00 | 0.00 | 0.50 |
| 20.01 | 10.70 | 0.20 | 1.87 | 115.00 | 0.00 | 0.50 |
| 20.18 | 9.40 | 0.20 | 2.13 | 115.00 | 0.00 | 0.50 |
| 20.34 | 8.50 | 0.20 | 2.35 | 115.00 | 0.00 | 0.50 |
| 20.51 | 8.60 | 0.20 | 2.33 | 115.00 | 0.00 | 0.50 |
| 20.67 | 8.70 | 0.20 | 2.30 | 115.00 | 0.00 | 0.50 |
| 20.83 | 8.70 | 0.30 | 3.45 | 115.00 | 0.00 | 0.50 |
| 21.00 | 9.50 | 0.30 | 3.16 | 115.00 | 0.00 | 0.50 |
| 21.16 | 10.10 | 0.30 | 2.97 | 115.00 | 0.00 | 0.50 |
| 21.33 | 10.50 | 0.40 | 3.81 | 115.00 | 0.00 | 0.50 |
| 21.49 | 10.90 | 0.30 | 2.75 | 115.00 | 0.00 | 0.50 |
| 21.65 | 11.10 | 0.30 | 2.70 | 115.00 | 0.00 | 0.50 |
| 21.82 | 9.90 | 0.30 | 3.03 | 115.00 | 0.00 | 0.50 |
| 21.98 | 9.10 | 0.20 | 2.20 | 115.00 | 0.00 | 0.50 |
| 22.15 | 8.90 | 0.20 | 2.25 | 115.00 | 0.00 | 0.50 |

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|---|---|---|---|---|---|---|
| 22.31 | 9.60 | 0.20 | 2.08 | 115.00 | 0.00 | 0.50 |
| 22.47 | 9.60 | 0.20 | 2.08 | 115.00 | 0.00 | 0.50 |
| 22.64 | 9.20 | 0.30 | 3.26 | 115.00 | 0.00 | 0.50 |
| 22.80 | 9.00 | 0.30 | 3.33 | 115.00 | 0.00 | 0.50 |
| 22.97 | 9.10 | 0.30 | 3.30 | 115.00 | 0.00 | 0.50 |
| 23.13 | 9.00 | 0.20 | 2.22 | 115.00 | 0.00 | 0.50 |
| 23.30 | 9.30 | 0.20 | 2.15 | 115.00 | 0.00 | 0.50 |
| 23.46 | 10.60 | 0.40 | 3.77 | 115.00 | 0.00 | 0.50 |
| 23.62 | 18.50 | 0.70 | 3.78 | 115.00 | 0.00 | 0.50 |
| 23.79 | 29.90 | 0.90 | 3.01 | 115.00 | 0.00 | 0.50 |
| 23.95 | 42.00 | 0.90 | 2.14 | 115.00 | 0.00 | 0.50 |
| 24.12 | 75.00 | 0.80 | 1.07 | 120.00 | 0.00 | 0.50 |
| 24.28 | 93.40 | 0.60 | 0.64 | 125.00 | 0.00 | 0.50 |
| 24.44 | 106.10 | 0.70 | 0.66 | 125.00 | 0.00 | 0.50 |
| 24.61 | 112.20 | 0.80 | 0.71 | 125.00 | 0.00 | 0.50 |
| 24.77 | 119.20 | 0.80 | 0.67 | 125.00 | 0.00 | 0.50 |
| 24.94 | 122.80 | 0.70 | 0.57 | 125.00 | 0.00 | 0.50 |
| 25.10 | 101.30 | 0.70 | 0.69 | 125.00 | 0.00 | 0.50 |
| 25.26 | 70.20 | 0.90 | 1.28 | 120.00 | 0.00 | 0.50 |
| 25.43 | 33.50 | 0.80 | 2.39 | 115.00 | 0.00 | 0.50 |
| 25.59 | 17.50 | 0.50 | 2.86 | 115.00 | 0.00 | 0.50 |
| 25.76 | 12.50 | 0.20 | 1.60 | 115.00 | 0.00 | 0.50 |
| 25.92 | 10.60 | 0.10 | 0.94 | 115.00 | 0.00 | 0.50 |
| 26.08 | 10.20 | 0.10 | 0.98 | 115.00 | 0.00 | 0.50 |
| 26.25 | 11.80 | 0.10 | 0.85 | 115.00 | 0.00 | 0.50 |
| 26.41 | 12.20 | 0.20 | 1.64 | 115.00 | 0.00 | 0.50 |
| 26.58 | 12.80 | 0.30 | 2.34 | 115.00 | 0.00 | 0.50 |
| 26.74 | 12.40 | 0.30 | 2.42 | 115.00 | 0.00 | 0.50 |
| 26.90 | 13.60 | 0.40 | 2.94 | 115.00 | 0.00 | 0.50 |
| 27.07 | 16.50 | 0.70 | 4.24 | 115.00 | 0.00 | 0.50 |
| 27.23 | 24.10 | 0.80 | 3.32 | 115.00 | 0.00 | 0.50 |
| 27.40 | 40.00 | 1.30 | 3.25 | 115.00 | 0.00 | 0.50 |
| 27.56 | 22.60 | 1.10 | 4.87 | 115.00 | 0.00 | 0.50 |
| 27.72 | 15.30 | 0.80 | 5.23 | 115.00 | 0.00 | 0.50 |
| 27.89 | 15.10 | 0.50 | 3.31 | 115.00 | 0.00 | 0.50 |
| 28.05 | 14.70 | 0.50 | 3.40 | 115.00 | 0.00 | 0.50 |
| 28.22 | 13.10 | 0.40 | 3.05 | 115.00 | 0.00 | 0.50 |
| 28.38 | 11.40 | 0.40 | 3.51 | 115.00 | 0.00 | 0.50 |
| 28.54 | 10.70 | 0.40 | 3.74 | 115.00 | 0.00 | 0.50 |
| 28.71 | 10.90 | 0.40 | 3.67 | 115.00 | 0.00 | 0.50 |
| 28.87 | 12.30 | 0.40 | 3.25 | 115.00 | 0.00 | 0.50 |
| 29.04 | 11.90 | 0.40 | 3.36 | 115.00 | 0.00 | 0.50 |
| 29.20 | 11.40 | 0.50 | 4.39 | 115.00 | 0.00 | 0.50 |
| 29.36 | 13.60 | 0.70 | 5.15 | 115.00 | 0.00 | 0.50 |
| 29.53 | 19.00 | 1.00 | 5.26 | 115.00 | 0.00 | 0.50 |
| 29.69 | 21.50 | 1.10 | 5.12 | 115.00 | 0.00 | 0.50 |
| 29.86 | 20.40 | 0.90 | 4.41 | 115.00 | 0.00 | 0.50 |
| 30.02 | 17.80 | 0.90 | 5.06 | 115.00 | 0.00 | 0.50 |
| 30.19 | 20.90 | 0.70 | 3.35 | 115.00 | 0.00 | 0.50 |
| 30.35 | 16.30 | 0.70 | 4.29 | 115.00 | 0.00 | 0.50 |
| 30.51 | 16.50 | 0.70 | 4.24 | 115.00 | 0.00 | 0.50 |
| 30.68 | 17.10 | 0.80 | 4.68 | 115.00 | 0.00 | 0.50 |
| 30.84 | 17.00 | 0.80 | 4.71 | 115.00 | 0.00 | 0.50 |

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| 31.01 | 16.60 | 0.70 | 4.22 | 115.00 | 0.00 | 0.50 |
| 31.17 | 16.70 | 0.70 | 4.19 | 115.00 | 0.00 | 0.50 |
| 31.33 | 17.80 | 0.70 | 3.93 | 115.00 | 0.00 | 0.50 |
| 31.50 | 16.30 | 0.60 | 3.68 | 115.00 | 0.00 | 0.50 |
| 31.66 | 14.40 | 0.60 | 4.17 | 115.00 | 0.00 | 0.50 |
| 31.83 | 12.80 | 0.50 | 3.91 | 115.00 | 0.00 | 0.50 |
| 31.99 | 11.70 | 0.40 | 3.42 | 115.00 | 0.00 | 0.50 |
| 32.15 | 10.90 | 0.40 | 3.67 | 115.00 | 0.00 | 0.50 |
| 32.32 | 11.50 | 0.30 | 2.61 | 115.00 | 0.00 | 0.50 |
| 32.48 | 10.80 | 0.30 | 2.78 | 115.00 | 0.00 | 0.50 |
| 32.65 | 10.00 | 0.30 | 3.00 | 115.00 | 0.00 | 0.50 |
| 32.81 | 9.20 | 0.30 | 3.26 | 115.00 | 0.00 | 0.50 |
| 32.97 | 9.80 | 0.20 | 2.04 | 115.00 | 0.00 | 0.50 |
| 33.14 | 10.70 | 0.20 | 1.87 | 115.00 | 0.00 | 0.50 |
| 33.30 | 11.40 | 0.20 | 1.75 | 115.00 | 0.00 | 0.50 |
| 33.47 | 13.10 | 0.30 | 2.29 | 115.00 | 0.00 | 0.50 |
| 33.63 | 13.30 | 0.30 | 2.26 | 115.00 | 0.00 | 0.50 |
| 33.79 | 12.50 | 0.30 | 2.40 | 115.00 | 0.00 | 0.50 |
| 33.96 | 12.10 | 0.30 | 2.48 | 115.00 | 0.00 | 0.50 |
| 34.12 | 11.40 | 0.30 | 2.63 | 115.00 | 0.00 | 0.50 |
| 34.29 | 11.10 | 0.30 | 2.70 | 115.00 | 0.00 | 0.50 |
| 34.45 | 11.30 | 0.30 | 2.65 | 115.00 | 0.00 | 0.50 |
| 34.61 | 10.90 | 0.30 | 2.75 | 115.00 | 0.00 | 0.50 |
| 34.78 | 10.80 | 0.30 | 2.78 | 115.00 | 0.00 | 0.50 |
| 34.94 | 11.40 | 0.30 | 2.63 | 115.00 | 0.00 | 0.50 |
| 35.11 | 11.80 | 0.40 | 3.39 | 115.00 | 0.00 | 0.50 |
| 35.27 | 11.20 | 0.30 | 2.68 | 115.00 | 0.00 | 0.50 |
| 35.43 | 10.70 | 0.30 | 2.80 | 115.00 | 0.00 | 0.50 |
| 35.60 | 11.70 | 0.30 | 2.56 | 115.00 | 0.00 | 0.50 |
| 35.76 | 11.20 | 0.40 | 3.57 | 115.00 | 0.00 | 0.50 |
| 35.93 | 11.10 | 0.30 | 2.70 | 115.00 | 0.00 | 0.50 |
| 36.09 | 10.60 | 0.30 | 2.83 | 115.00 | 0.00 | 0.50 |
| 36.26 | 10.50 | 0.20 | 1.90 | 115.00 | 0.00 | 0.50 |
| 36.42 | 11.10 | 0.20 | 1.80 | 115.00 | 0.00 | 0.50 |
| 36.58 | 11.80 | 0.50 | 4.24 | 115.00 | 0.00 | 0.50 |
| 36.75 | 15.00 | 0.50 | 3.33 | 115.00 | 0.00 | 0.50 |
| 36.91 | 23.40 | 0.40 | 1.71 | 115.00 | 0.00 | 0.50 |
| 37.08 | 19.40 | 1.00 | 5.15 | 115.00 | 0.00 | 0.50 |
| 37.24 | 38.90 | 1.60 | 4.11 | 115.00 | 0.00 | 0.50 |
| 37.40 | 93.40 | 2.70 | 2.89 | 120.00 | 0.00 | 0.50 |
| 37.57 | 79.80 | 2.40 | 3.01 | 115.00 | 0.00 | 0.50 |
| 37.73 | 93.70 | 2.60 | 2.77 | 120.00 | 0.00 | 0.50 |
| 37.90 | 89.30 | 2.40 | 2.69 | 120.00 | 0.00 | 0.50 |
| 38.06 | 53.30 | 2.00 | 3.75 | 115.00 | 0.00 | 0.50 |
| 38.22 | 68.10 | 1.90 | 2.79 | 115.00 | 0.00 | 0.50 |
| 38.39 | 75.20 | 2.20 | 2.93 | 115.00 | 0.00 | 0.50 |
| 38.55 | 49.70 | 2.10 | 4.23 | 115.00 | 0.00 | 0.50 |
| 38.72 | 27.70 | 1.30 | 4.69 | 115.00 | 0.00 | 0.50 |
| 38.88 | 18.80 | 0.80 | 4.26 | 115.00 | 0.00 | 0.50 |
| 39.04 | 16.30 | 0.60 | 3.68 | 115.00 | 0.00 | 0.50 |
| 39.21 | 17.10 | 0.80 | 4.68 | 115.00 | 0.00 | 0.50 |
| 39.37 | 26.10 | 1.10 | 4.21 | 115.00 | 0.00 | 0.50 |
| 39.54 | 37.70 | 0.90 | 2.39 | 115.00 | 0.00 | 0.50 |

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| 39.70 | 35.90 | 1.10 | 3.06 | 115.00 | 0.00 | 0.50 |
| 39.86 | 23.40 | 1.00 | 4.27 | 115.00 | 0.00 | 0.50 |
| 40.03 | 19.60 | 0.60 | 3.06 | 115.00 | 0.00 | 0.50 |
| 40.19 | 16.90 | 0.60 | 3.55 | 115.00 | 0.00 | 0.50 |
| 40.36 | 17.40 | 0.80 | 4.60 | 115.00 | 0.00 | 0.50 |
| 40.52 | 64.00 | 0.90 | 1.41 | 120.00 | 0.00 | 0.50 |
| 40.68 | 82.90 | 1.00 | 1.21 | 120.00 | 0.00 | 0.50 |
| 40.85 | 71.90 | 1.20 | 1.67 | 120.00 | 0.00 | 0.50 |
| 41.01 | 42.70 | 1.30 | 3.04 | 115.00 | 0.00 | 0.50 |
| 41.18 | 23.80 | 1.00 | 4.20 | 115.00 | 0.00 | 0.50 |
| 41.34 | 16.70 | 0.80 | 4.79 | 115.00 | 0.00 | 0.50 |
| 41.50 | 20.80 | 1.00 | 4.81 | 115.00 | 0.00 | 0.50 |
| 41.67 | 26.60 | 1.30 | 4.89 | 115.00 | 0.00 | 0.50 |
| 41.83 | 23.00 | 1.20 | 5.22 | 115.00 | 0.00 | 0.50 |
| 42.00 | 20.50 | 1.00 | 4.88 | 115.00 | 0.00 | 0.50 |
| 42.16 | 21.00 | 1.10 | 5.24 | 115.00 | 0.00 | 0.50 |
| 42.32 | 22.70 | 1.10 | 4.85 | 115.00 | 0.00 | 0.50 |
| 42.49 | 22.60 | 1.10 | 4.87 | 115.00 | 0.00 | 0.50 |
| 42.65 | 22.10 | 1.00 | 4.52 | 115.00 | 0.00 | 0.50 |
| 42.82 | 20.40 | 0.90 | 4.41 | 115.00 | 0.00 | 0.50 |
| 42.98 | 19.40 | 0.90 | 4.64 | 115.00 | 0.00 | 0.50 |
| 43.15 | 18.00 | 0.80 | 4.44 | 115.00 | 0.00 | 0.50 |
| 43.31 | 17.00 | 0.80 | 4.71 | 115.00 | 0.00 | 0.50 |
| 43.47 | 16.10 | 0.70 | 4.35 | 115.00 | 0.00 | 0.50 |
| 43.64 | 15.40 | 0.80 | 5.19 | 115.00 | 0.00 | 0.50 |
| 43.80 | 15.60 | 0.70 | 4.49 | 115.00 | 0.00 | 0.50 |
| 43.97 | 16.10 | 0.70 | 4.35 | 115.00 | 0.00 | 0.50 |
| 44.13 | 16.30 | 0.80 | 4.91 | 115.00 | 0.00 | 0.50 |
| 44.29 | 18.00 | 0.80 | 4.44 | 115.00 | 0.00 | 0.50 |
| 44.46 | 17.40 | 0.80 | 4.60 | 115.00 | 0.00 | 0.50 |
| 44.62 | 18.00 | 0.50 | 2.78 | 115.00 | 0.00 | 0.50 |
| 44.79 | 17.00 | 0.60 | 3.53 | 115.00 | 0.00 | 0.50 |
| 44.95 | 16.70 | 0.60 | 3.59 | 115.00 | 0.00 | 0.50 |
| 45.11 | 16.50 | 0.60 | 3.64 | 115.00 | 0.00 | 0.50 |
| 45.28 | 15.60 | 0.60 | 3.85 | 115.00 | 0.00 | 0.50 |
| 45.44 | 15.30 | 0.60 | 3.92 | 115.00 | 0.00 | 0.50 |
| 45.61 | 15.20 | 0.60 | 3.95 | 115.00 | 0.00 | 0.50 |
| 45.77 | 15.40 | 0.60 | 3.90 | 115.00 | 0.00 | 0.50 |
| 45.93 | 15.80 | 0.70 | 4.43 | 115.00 | 0.00 | 0.50 |
| 46.10 | 17.00 | 0.70 | 4.12 | 115.00 | 0.00 | 0.50 |
| 46.26 | 19.10 | 0.90 | 4.71 | 115.00 | 0.00 | 0.50 |
| 46.43 | 22.30 | 1.20 | 5.38 | 115.00 | 0.00 | 0.50 |
| 46.59 | 26.60 | 1.40 | 5.26 | 115.00 | 0.00 | 0.50 |
| 46.75 | 34.00 | 1.90 | 5.59 | 115.00 | 0.00 | 0.50 |
| 46.92 | 27.00 | 1.50 | 5.56 | 115.00 | 0.00 | 0.50 |
| 47.08 | 19.10 | 0.80 | 4.19 | 115.00 | 0.00 | 0.50 |
| 47.25 | 15.90 | 0.50 | 3.14 | 115.00 | 0.00 | 0.50 |
| 47.41 | 14.60 | 0.50 | 3.42 | 115.00 | 0.00 | 0.50 |
| 47.57 | 14.20 | 0.70 | 4.93 | 115.00 | 0.00 | 0.50 |
| 47.74 | 18.70 | 1.10 | 5.88 | 115.00 | 0.00 | 0.50 |
| 47.90 | 29.20 | 1.10 | 3.77 | 115.00 | 0.00 | 0.50 |
| 48.07 | 28.40 | 0.80 | 2.82 | 115.00 | 0.00 | 0.50 |
| 48.23 | 18.80 | 0.70 | 3.72 | 115.00 | 0.00 | 0.50 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 48.39 | 15.50 | 0.80 | 5.16 | 115.00 | 0.00 | 0.50 |
| 48.56 | 19.90 | 1.00 | 5.03 | 115.00 | 0.00 | 0.50 |
| 48.72 | 22.40 | 1.30 | 5.80 | 115.00 | 0.00 | 0.50 |
| 48.89 | 23.60 | 1.40 | 5.93 | 115.00 | 0.00 | 0.50 |
| 49.05 | 27.90 | 1.40 | 5.02 | 115.00 | 0.00 | 0.50 |
| 49.22 | 29.30 | 1.40 | 4.78 | 115.00 | 0.00 | 0.50 |
| 49.38 | 26.50 | 1.70 | 6.42 | 115.00 | 0.00 | 0.50 |
| 49.54 | 36.00 | 2.30 | 6.39 | 115.00 | 0.00 | 0.50 |
| 49.71 | 47.80 | 2.90 | 6.07 | 115.00 | 0.00 | 0.50 |
| 49.87 | 61.20 | 3.20 | 5.23 | 115.00 | 0.00 | 0.50 |

Modify Robertson method generates Fines from qc/fs. Inputted Fines are not relevant.

Output Results:

Settlement of Saturated Sands=0.14 in.
Settlement of Unsaturated Sands=0.21 in.
Total Settlement of Saturated and Unsaturated Sands=0.35 in.
Differential Settlement=0.177 to 0.234 in.