Geotechnical Engineering Report

Proposed Science Center

Santa Ana, California

June 27, 2016

Terracon Project No. 60145101

Prepared for:

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

Prepared by:

Terracon Consultants, Inc.
Irvine, California

June 27, 2016

RSCCD Facility Planning, District
Construction and Support Services
2323 N. Broadway, Suite 112, Santa Ana, CA 92706

Attn: Ms. Allison Coburn
Facilities Project Manager
P: (714) 480-7530
E: Coburn_allison@rsccd.edu

Re: Geotechnical Engineering Report
Proposed Science Center - Santa Ana College
1530 West 17th Street, Santa Ana, California.
Terracon Project No. 60145101

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 January 11, 2016.

This Geotechnical Engineering Report presents the results of all of the subsurface explorations performed at the site, 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 exploration has been performed for the proposed project 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 approximate depths of 50 feet bgs. In addition, three (3) borings were advanced to approximate depths ranging between 5 and 15 bgs and utilized for percolations testing.

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 23, 2015 and Phase II was performed on January 18, 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 surface 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 at approximately 24 feet below ground surface in boring B-1 at the time of drilling. Based on published data, historical groundwater is anticipated to be at a depth of about 35 feet bgs.
- Our analysis has concluded that the seismically-induced settlement of partially saturated and saturated sands is estimated to be on the order of ½ of an inch.
- It is our understanding that proposed Science Center building will be three-stories while the proposed greenhouse building is to be one-story.
- Due to the low bearing capacity of the on-site soils and the anticipated column loads provided by the structural engineer, a deep foundation system, such as drilled shafts, should be used to support the Science Center building.
- Shallow foundations bearing on engineered fill may be used to support the greenhouse building and minor on-site structures.
- The engineered fill may comprise of onsite low expansion soils encountered within the upper materials onsite. The minimum depth of fill and over-excavation should be 4 feet below the existing grade or 2 feet below the bottom of the deepest foundation, whichever is greater.
- The on-site clayey materials are expected to exhibit "medium" expansion potential when subjected to light loading conditions. Due to the expansion potential of on-site soils, interior floor slabs should bear on a minimum of 18 inches of engineered fill comprised of imported low-volume change materials.
- The 2013 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 SCIENCE CENTER
1530 WEST 17TH STREET
SANTA ANA, CALIFORNIA

Terracon Project No. 60145101
June 27, 2016

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the proposed building to be 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
- pavement design and construction
- groundwater conditions
- foundation design and construction
- floor slab design and construction
- Infiltration system

Our geotechnical engineering scope of work for this project included the advancement of a total 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 approximate depths of 50 feet bgs. In addition, three (3) borings were advanced to approximate depths ranging between 5 and 15 feet bgs and utilized for percolation testing. 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 23, 2015 and Phase II was performed on January 18, 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 following: n A three-story building, the structure will occupy a building footprint of approximately 21,000 square feet. n A greenhouse building. In addition there will be associated parking and driveways surrounding the school building, and related site work.
Construction	We assume the science center building will be a three-story, steel structure with a 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. It is our understanding that the Greenhouse building will be a prefabricated structure with concrete slab-on-grade floors and will be supported on shallow spread footing foundation system.
Maximum loads (assumed)	Column Load – 150 to 200 kips. Continuous Wall Load – 2 klf. Uniform Floor Slab Load – 150 psf max
Grading	Over-Excavating beneath the proposed foundations and to demolish and remove existing foundations and backfill to bring the site to grade.
Paving	It is anticipated that new asphalt and Portand cement concrete pavements will be associated with surrounding parking lots and driveways/fire lanes. Assumed Traffic Index (TI): Automobile Parking Areas……..5.0 Driveways and Fire Lanes……....7.0

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. Latitude: 33.7575° N; Longitude: 117.8876° W
Existing site features	The site is currently developed with Building “J” which is comprised of three separate one-story structures. The buildings are surrounded by hardscape and landscape.
Surrounding developments	North: Neally Library East: Asphalt pavement West: Middle college high school South: Campus drive
Current ground cover	Asphalt pavements and concrete flatwork.
Existing topography	The site is relatively flat.

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 asphalt concrete with approximate thickness of 2 to 5½ inches overlaying aggregate base with approximate thickness of 4 to 6 inches. Based on the results of the borings, subsurface conditions on the project site can be generalized as sandy lean clay soils with interbedded layers of granular materials through the maximum depth of exploration. Aggregate base was not encountered in boring B-2. Borings BN-7, BN-8, Perc 2 and Perc 3 were placed within landscape areas.

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 medium plasticity. Direct shear tests were performed on clayey sand materials at an approximate depth ranging from 3 to 5 feet bgs, and resulted in an ultimate friction angle of 29º to 30º and a corresponding cohesion value of 432 to 539 pounds per square foot (psf). Expansion index (EI) testing on near surface soils indicates an expansion index of 25 to 62.

3.3 Groundwater

Groundwater was observed in boring B-1 at a depth of approximately 24 feet bgs, at the time of field exploration. 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

[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.*

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 for the nearby proposed Johnson building indicates that groundwater was encountered between 39 and 52 feet at the project site.

Based on regional data recorded from 2008 to 2011, the historical highest groundwater level in the project vicinity is ranging 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 below the ground surface.[5] The historical groundwater contour map is presented in Exhibit A-4.

3.4 Seismic Considerations

3.4.1 Seismic Site Class and Parameters

Based on CBC Table 1613.5.2, any profile containing soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils should have a site classification “F”. However, the thin liquefiable layers indicated in the liquefaction analysis seemed to be localized and discontinuous among the soil profiles of CPT-01 thru CPT-02. Based on the discontinuity and thickness of liquefiable layers and the anticipated amount of settlement, the project site may have a site classification “D”.

Furthermore, for structures with fundamental periods of vibration less than 0.5 of a second, Section 20.3.1 of ASCE 7-10 allows the site coefficients (Fa and Fv) to be determined assuming that liquefaction does not occur. The following parameters assume that the fundamental period of vibration for the proposed buildings is less than 0.5 of a second. Structure’s fundamental period should be verified by the structural engineer.

DESCRIPTION	VALUE
2013 California Building Code Site Classification (CBC) [1]	D
Site Latitude	33.7575° N
Site Longitude	117.8876° W
S_s Spectral Acceleration for a Short Period	1.457g
S_1 Spectral Acceleration for a 1-Second Period	0.534g

[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, Los Angeles County, California, by California Division of Mines and Geology (CDMG), dated 1998.

F_a Site Coefficient for a Short Period	1.0
F_v Site Coefficient for a 1-Second Period	1.5

[1] Note: The 2013 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 Microtremor 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 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 kilometers southwest of the site. Two pre-Quaternary age fault strands of this fault zone are southerly of the site (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

[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.

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	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

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 groundwater table. The project site is located within a potential liquefaction hazard zone as designated by the CGS (1999).

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 24 feet bgs.

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 24 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 1.3 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 on the order of 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 15 feet below the ground surface (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 has percolated through the test hole. At the beginning of each test, the pipes were refilled with water and readings were taken at ½-hour time intervals. Percolation rates are provided in the following table:

TEST RESULTS				
Test Location (depth [feet])	Soil Classification	Percolation Rate, (in/hr)	Correlated Infiltration Rate*, (in/hr)	Average Water Head (inches)
P-1 (5)	Clayey Sand	51½	1.96	44
P-2 (10)	Clayey Sand over Silty Sand	>100	>5.00	32
P-3 (15)	Sandy Lean Clay	13	0.14	157

*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.

Based on the boring logs and test results, boring P-2 encountered a layer of loose granular materials between 5 and 10 feet below ground surface which affected the infiltration test results. It is our opinion that any future design should rely on the test results obtained from P-1 and P-3 only. The bottoms of proposed infiltration systems should be a minimum of 10 feet above the anticipated groundwater depth of 24 feet bgs.

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 from 7.90 to 8.43, a minimum resistivity ranging from 698 to 1,436 ohm-cm, a chloride content ranging from 25 to 133 mg/kg, water soluble sulfate content ranged from 0.02 to 0.08%, Red-Ox potential ranging from +574 mV to +667 mV, and negligible sulfides, as shown on the attached Results of Corrosivity Analysis sheet in Appendix B.

Based on guidelines published by the Bureau of Reclamation, the electrical resistivity values indicate the on-site soils are considered moderately to very corrosive. As a minimum, buried metal piping should be protected with suitable coatings, wrappings, or seals. As an alternative, utility piping may be buried in PVC lined trenches and backfilled with clean sand. The width of the trenches should be a minimum of three times the diameter of the pipes.

The corrosion results should be used to evaluate the corrosive potential of the on-site soils to underground ferrous metals and design adequate corrosion protection systems. A corrosion consultant should be retained if a more detailed evaluation or a protection system is desired.

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.

The on-site clayey materials are expected to exhibit “medium” expansion potential when subjected to light loading conditions. Due to the expansion potential of on-site soils, interior floor slabs should bear on a minimum of 18 inches of engineered fill comprised of low-volume change materials.

The objective of this report is to provide recommendations for the proposed building to be constructed within or near the outline of the existing building onsite. It is our understanding that the proposed Science Center building will be a three-story structure while the greenhouse will be one-story.

Due to the low bearing capacity of the on-site soils and the anticipated column loads provided by the structural engineer, a deep foundation system, such as drilled shafts, should be used to support the Science Center building. Shallow foundations bearing on engineered fill may be used to support the greenhouse building and minor on-site structures.

The project site is located within a potential liquefaction hazard zone as designated by the CGS (CDMG, 1999). 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 on the order of 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.

If the existing buildings are found to be supported on drilled shafts, the existing foundations should be removed or demolished. In the event the removal of such deep foundations is not feasible, they should be saw-cut or removed a minimum of 3 feet below the bottom level of the proposed foundations. Terracon should be notified if new foundations and existing drilled shafts overlap oin plan location.

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 low bearing capacity of the on-site soils and the anticipated column loads provided by the structural engineer, a deep foundation system, such as drilled shafts should be used to support the Science Center building.

Shallow foundations bearing on engineered fill may be used to support the greenhouse building and minor on-site structures. Due to the anticipated disturbance of onsite materials during the demolition of the existing buildings, any proposed shallow foundations and floor slabs should bear on engineered fill. The minimum depth of fill and over-excavation should be 4 feet bgs or 2 feet below the bottom of the deepest foundation, whichever is greater.
Due to the expansion potential of on-site near surface soils, engineered fill within 18 inches from the bottom of all floor slabs should consist of import low-volume change materials (EI<20). All grading for each structure should incorporate the limits of the proposed structure plus a lateral distance of 3 feet beyond the edges.

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, pavement, 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.

The on-site native soils are generally considered suitable for use as engineered fill for the following.

- general site grading
- beneath footings
- pavement areas
- exterior slab areas

Approved low volume change imported materials should be used as engineered fill for foundation backfill within a minimum depth of 18 inches beneath interior floor slabs.

Imported soils for use as fill material within the proposed building area 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 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
On-site materials or approved imported fill:			
Beneath foundations:	90%	0%	+4%
Beneath slabs:	90%	0%	+4%
Beneath pavement:	95%	0%	+4%
Utility trenches* :	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

A subgrade composed of compacted clayey materials will expand with increasing moisture content; therefore, exterior concrete slabs may heave, resulting in cracking or vertical offsets. The potential for damage would be greatest where exterior slabs are constructed adjacent to the building or other structural elements. If this potential movement or damage is not acceptable, then the following recommendations may be followed to reduce the potential for damage caused by movement:

- exterior slabs should be supported directly on a minimum of 18 inches Import Engineered Fill comprised of low volume change materials;
- 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.

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 10 percent to 25 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

It is our understanding that proposed Science Center building will be three-story building while the greenhouse will be one-story.

Due to the low bearing capacity of the on-site soils and the anticipated column loads provided by the structural engineer, a deep foundation system, such as drilled shafts should be used to support the Science Center building.

Shallow foundations bearing on engineered fill may be used to support the greenhouse building and minor on-site structures.

4.3.1 Shallow Spread Footing Foundations

DESCRIPTION	RECOMMENDATIONS
Proposed Structures	Greenhouse Building and Minor Structures
Foundation Type	Conventional Shallow Spread Footings
Bearing Material	Engineered fill extending to a minimum of 24 inches below foundations.
Allowable Bearing Pressure	Footing widths < 9 feet : 2,000 psf
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

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.

4.3.2 Deep Foundations

The proposed Science Center Building should be supported on drilled shafts. Total required embedment of the drilled shafts should be determined by the structural engineer based on structural loading and parameters provided in this report.

The allowable axial shaft capacities were determined using both end bearing and side friction components of resistance. Allowable skin friction, axial capacity, and estimated settlement charts are attached in Appendix E of this report. The allowable uplift capacities should only be based on the side friction of the shaft; however, the weight of the foundation should be added to these values to obtain the actual allowable uplift capacities for drilled shafts.

Recommended geotechnical parameters for lateral load analyses of drilled shaft foundations have been developed for use in the L-PILE computer program. Based on our review of the subsurface conditions within the outline of the building and the Standard Penetration Test (SPT) results, engineering properties have been estimated for the soils conditions as shown in the following table. We recommend that Terracon review the final drilled shaft design to verify that sufficient embedment is achieved.

Lateral Load Analyses Estimated Engineering Properties of Soils					
Top Depth Bottom Depth (ft)	Effective Unit Weight (pcf)	L-PILE/ GROUP Soil Type	Internal Friction f / Cohesion	Coeff. of Static Subgrade Reaction K_s (pcf)	e_{50}
2	125	Sand	33°	90**	0.009
5					
5	125	Stiff Clay Without Free Water	750 psf	100	0.010
24					
24	65	Stiff Clay With Free Water	800 psf	250*	0.010
52					
52	65	Stiff Clay With Free Water	2000 psf	750*	0.006
60					

* A maximum of 200 pci should be used for cyclic loading.

** This value increases linearly with depth an amount equal to the modulus and is independent of shaft diameter.

The depth below ground surface indicated in the table above is referenced from the existing ground surface at the site at the time of the field exploration. If fill is placed to raise the site grades, the depths shown in the table above must be increased by the thickness of fill placed. The required depths of shaft embedment should also be determined for design lateral loads and overturning moments to determine the most critical design condition.

Lateral load design parameters are valid within the elastic range of the soil. The coefficients of subgrade reaction are ultimate values; therefore, appropriate factors of safety should be applied in the shaft design or deflection limits should be applied to the design.

It should be noted that the load capacities provided herein are based on the stresses induced in the supporting soils. The structural capacity of the shafts should be checked to assure that they can safely accommodate the combined stresses induced by axial and lateral forces. Furthermore, the response of the drilled shaft foundations to lateral loads is dependent upon the soil/structure interaction as well as the shaft's actual diameter, length, stiffness and "fixity" (fixed or free-head condition).

Based on the anticipated loads, and the results of our capacity analyses, we anticipate groups of drilled shafts will be required to support several columns. Per Section 1810.2.5 of the 2013 California Building Code, drilled shafts should be considered to work in group action if the horizontal spacing is less than three shaft diameters on center for axial behavior and less than eight shaft diameters for lateral loading behavior. The minimum spacing for these shafts should be 2 diameters on center; larger spacing will increase the group efficiency. For clusters greater than 4, the group efficiency should be checked using the "perimeter-shear" method which is the ratio of the perimeter of the group to the total number of individual shafts in the group. The equation for determining the group factors is presented below.

$$h = 1 - q\frac{(n-1)m + (m-1)n}{90mn}$$

h = group efficiency factor
m = number of rows of piles
n = number of piles per row
q = $\tan^{-1}$ (B/S)
B = diameter of single pile
S = center to center spacing of piles

$$P_{ag} = \eta\, N\, P_a$$

N = number of piles in group
P_a = allowable upward or downward capacity of single isolated pile
P_{ag}= allowable upward or downward capacity of the pile group

Care shall be exercised when installing shafts adjacent to recently poured shafts. A minimum of 8 hours shall elapse between installing shafts within 4 diameters of one another. Staggering the installation of the shafts within a group will be possible without major mobilization of drilling equipment.

4.3.3 Drilled Shaft Construction Considerations

Drilling to design depths should be possible with conventional single flight power augers. For drilled shaft depths above the depth of groundwater, temporary steel casing will likely be required to properly drill and clean shafts prior to concrete placement. For drilled shaft depths below groundwater level, we recommend the use of slurry drilling methods with polymers to keep the solids in suspension during the drilling.

Groundwater was observed in the test borings at an approximate depth of 24 feet bgs at the time of field exploration. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations.

Drilled shaft foundation concrete should be placed immediately after completion of drilling and cleaning. If foundation concrete cannot be placed in dry conditions, a tremie should be used for concrete placement. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

If casing is used for drilled shaft construction, it should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete to prevent infiltration of water or the creation of voids in shaft concrete. Shaft concrete should have a relatively high fluidity when placed in cased shaft holes or through a tremie. Shaft concrete with slump in the range of 6 to 8 inches is recommended.

We recommend that all drilled shaft installations be observed on a full-time basis by an experienced geotechnical engineer in order to evaluate that the soils encountered are consistent

with the recommended design parameters. If the subsurface soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

The contractor should check for gas and/or oxygen deficiency prior to any workers entering the excavation for observation and manual cleanup. All necessary monitoring and safety precautions as required by OSHA, State or local codes should be strictly enforced.

The contractor should check for gas and/or oxygen deficiency prior to any workers entering the excavation for observation and manual cleanup. All necessary monitoring and safety precautions as required by OSHA, State or local codes should be strictly enforced by the owner and the EPC.

4.4 Floor Slab

DESCRIPTION	VALUE
Interior floor system	Slab-on-grade concrete.
Floor slab support	Approved engineered fill extending to a minimum of 36 inches below shallow foundations, or 5 feet below existing grades, whichever is greater. The upper 18 inches should conform of low volume change imported materials (EI<20).
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.

4.5 Lateral Earth Pressures

For onsite granular soils or imported granular fill materials above any free water surface, recommended equivalent fluid pressures for foundation elements are:

ITEM	Import Granular Soils	On-Site 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) = 5.0	**On-site Driveways and Fire Lanes Assumed TI = 7.0**
Section I Portland Cement Concrete (600 psi Flexural Strength)	5” Plain jointed PCC over 4” Class II Aggregate Base over 10” of scarified, moisture conditioned, and compacted materials	6.5” Plain jointed PCC over 4” Class II Aggregate Base over 10” of scarified, moisture conditioned, and compacted materials
Section II Asphaltic Concrete	3” AC over 8” 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

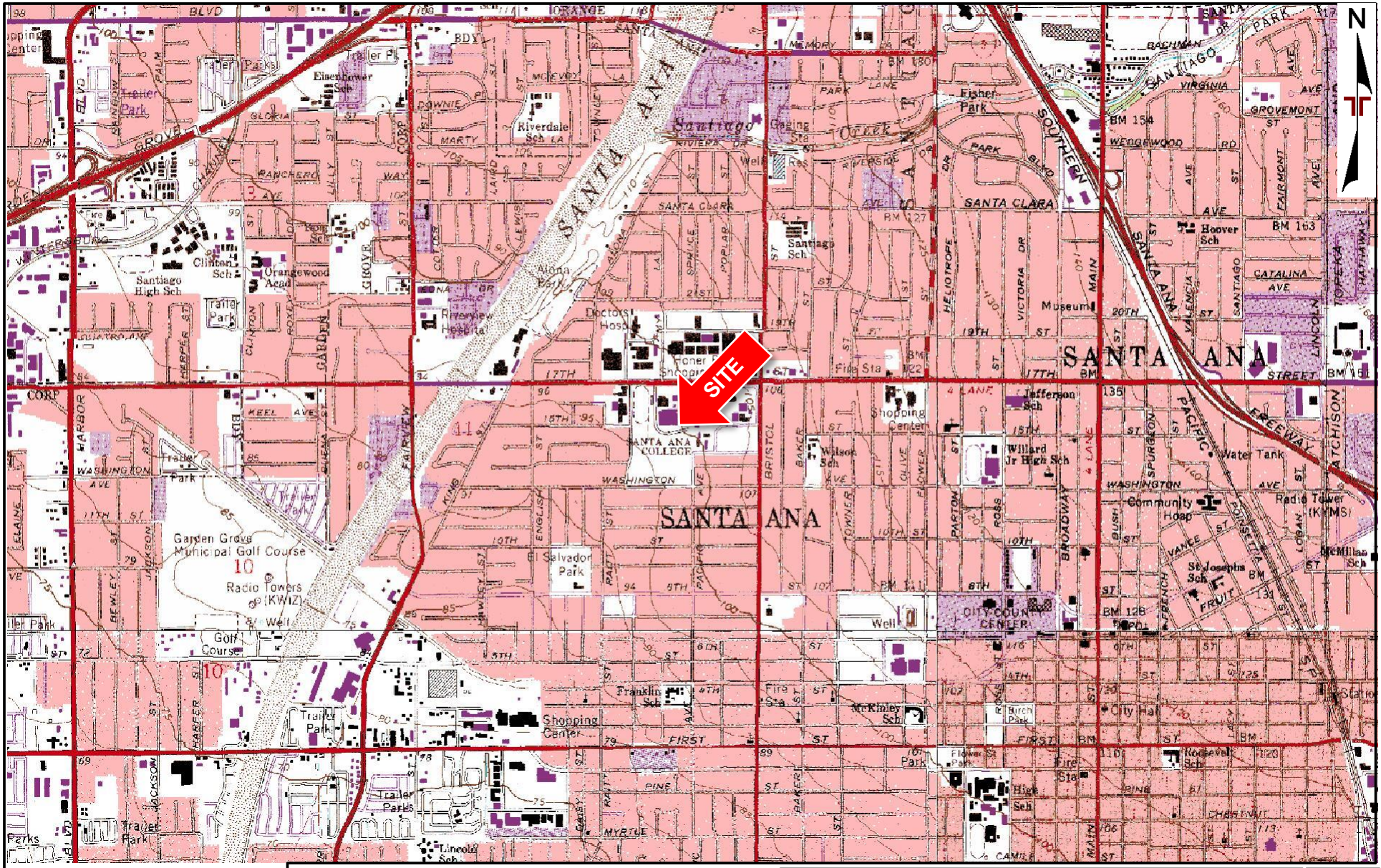
immediately notified so that further evaluation and supplemental recommendations can be provided.

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.	60145101
Scale:	1":2,100'
File Name:	A-1
Date:	1/21/2015

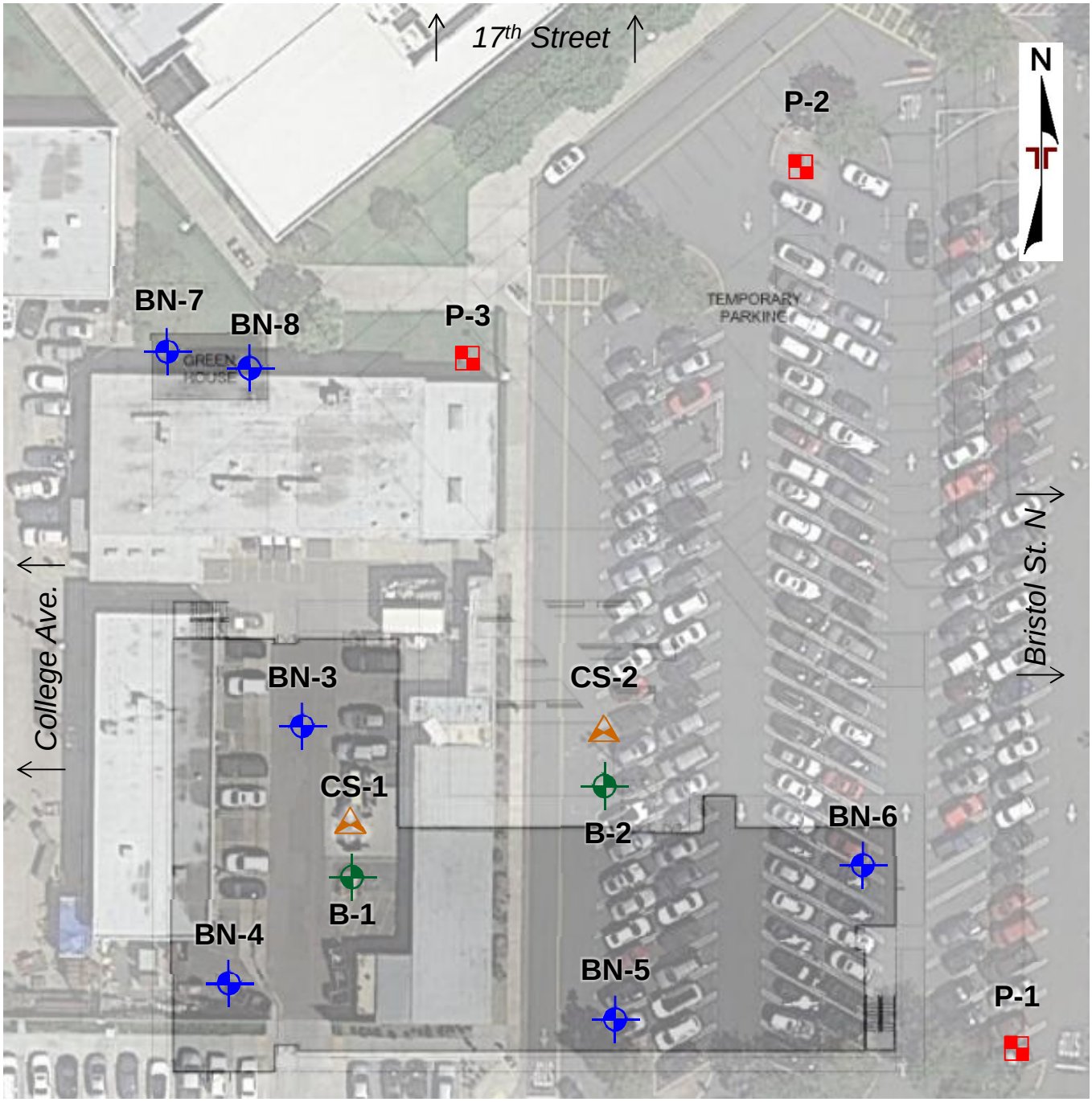
Terracon
2817 McGaw Ave.
Irvine, CA 92614

SITE LOCATION

Proposed Science Center
1530 West 17th Street
Santa Ana, CA

Exhibit

A-1



LEGEND

- B-1 — SOIL BORING PERFORMED ON JAN. 23, 2015 APPROXIMATE LOCATION
- BN-1 — SOIL BORING PERFORMED ON JAN. 18, 2016 APPROXIMATE LOCATION
- P-1 — BORING/PERCOLATION TEST APPROXIMATE LOCATION PERFORMED ON JAN. 18, 2016
- CS-1 — CORE PENETRATION SOUNDING PERFORMED ON JAN. 23, 2015

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

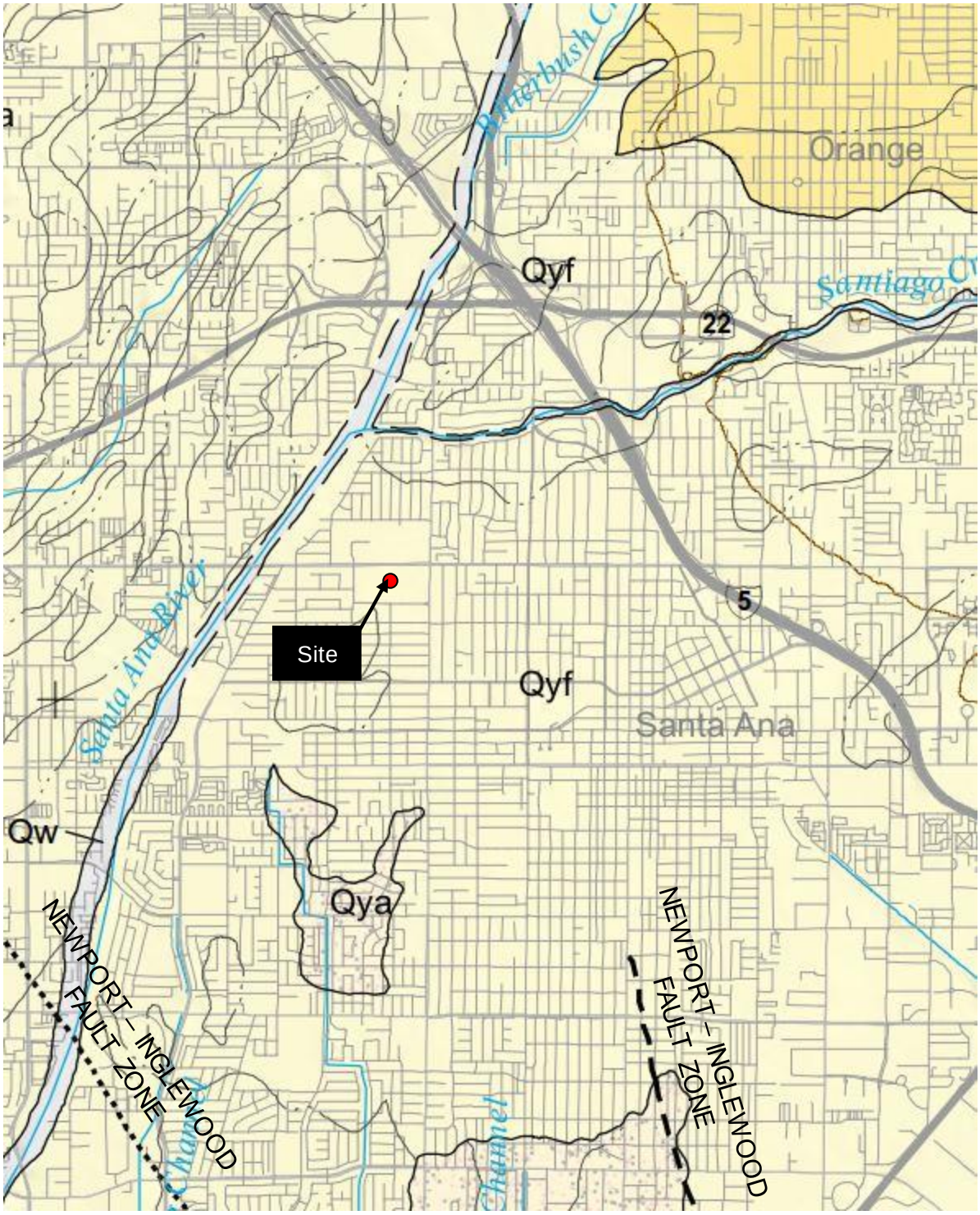
Project Manager:	JM
Drawn by:	GA
Checked by:	JM
Approved by:	FH
Project No.	60145101
Scale:	1" ~ 50'
File Name:	A-2
Date:	01/21/2016

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

BORING AND TEST LOCATION PLAN

Proposed Science 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. 60145101	Terracon Consulting Engineers & Scientists	GEOLOGIC MAP
Drawn by: JM	Scale: NTS	2817 McGaw Avenue Irvine, California 92614	**Proposed Science Center**
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**

Exhibit A-3

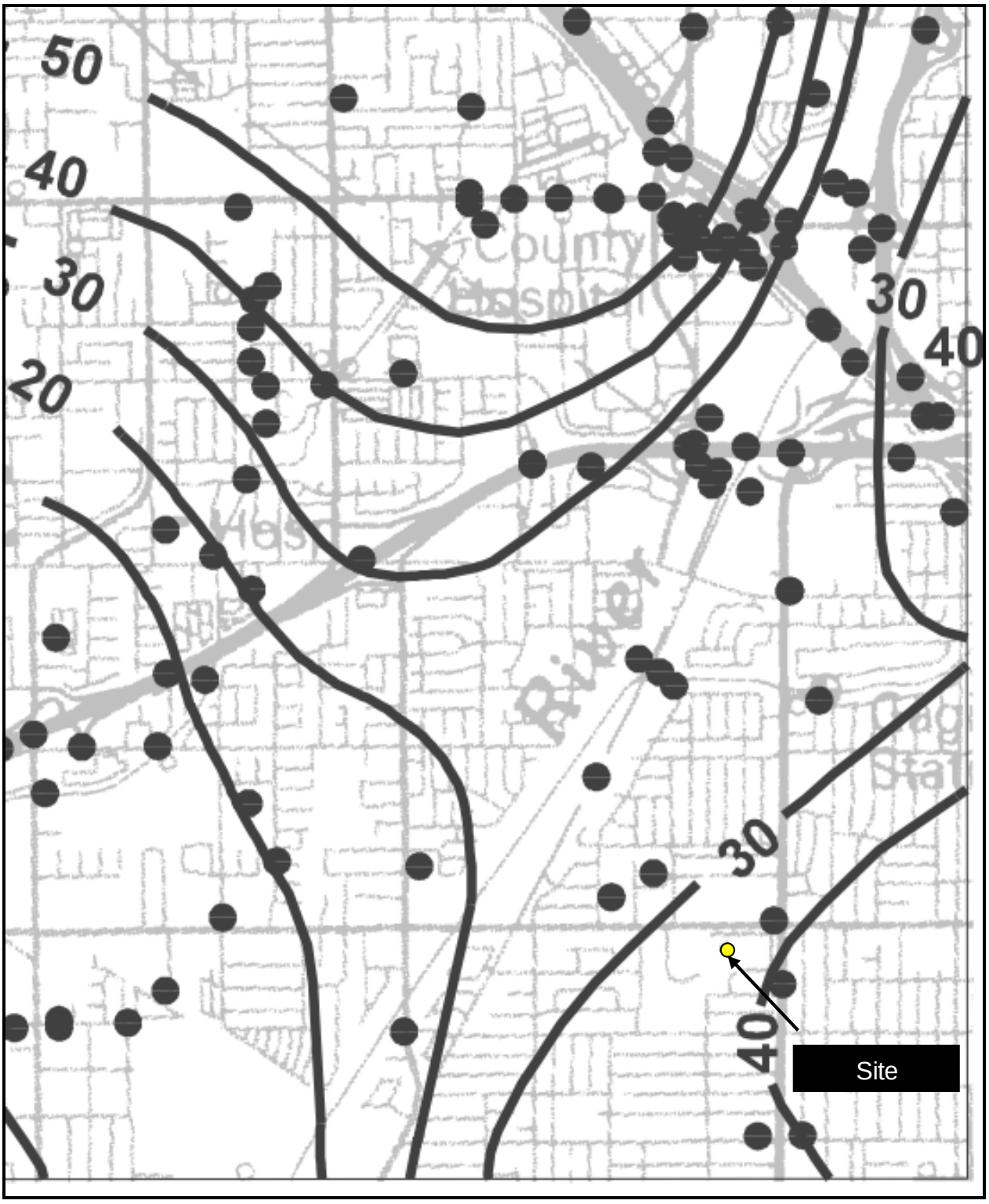


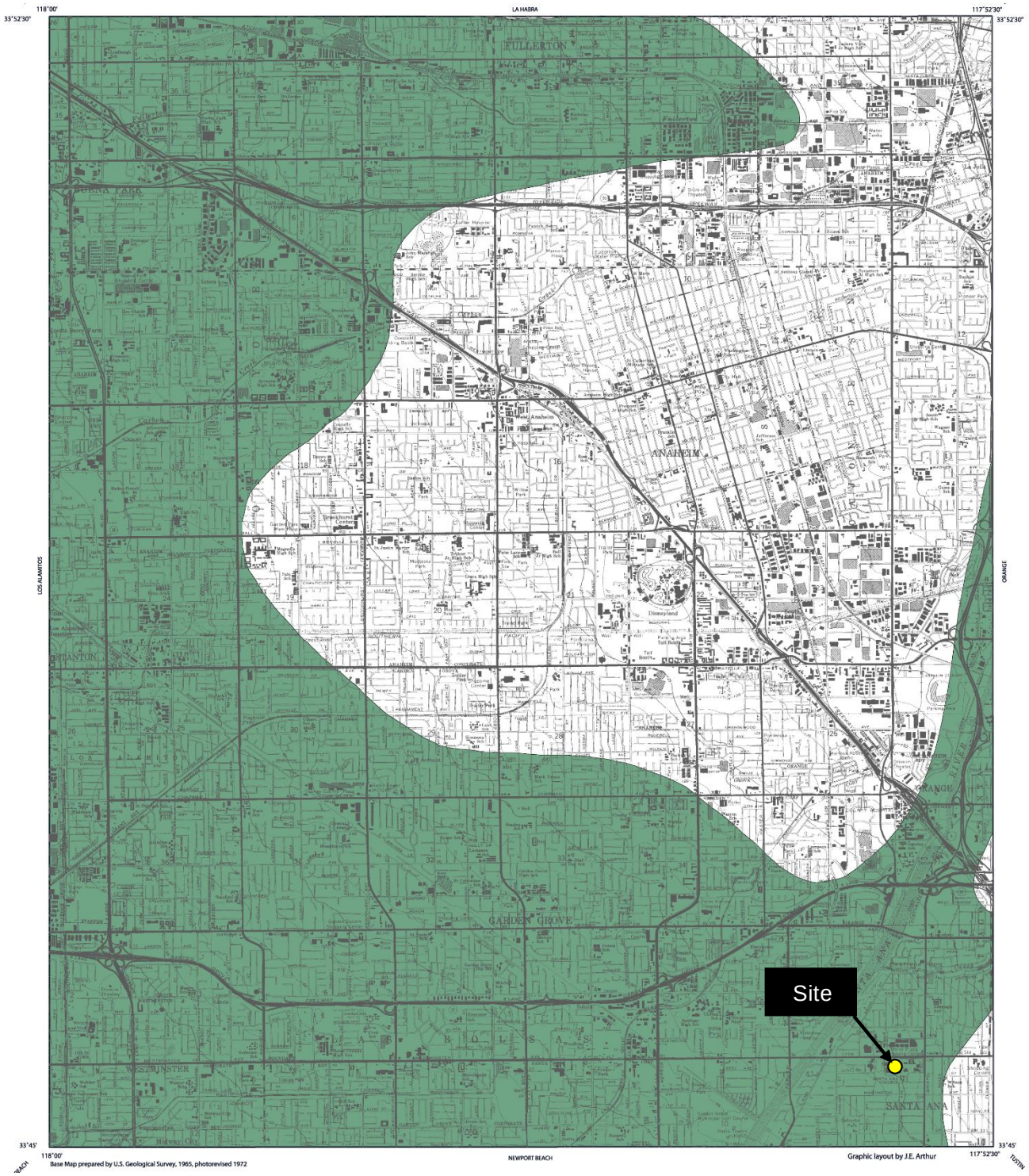
Plate 1.2 Historically Highest Ground Water Contours and Borehole Log Data Locations, Anaheim 7.5–minute Quadrangle.

● 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. 60145101	Terracon Consulting Engineers & Scientists	GROUNDWATER CONTOUR MAP	Exhibit
Drawn by: JM	Scale: NTS	2817 McGaw Avenue Irvine, California 92614	**Proposed Science 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 Anaheim 7.5 Minute Quadrangle, California, by California Division of Mines and Geology (CDMG), dated 1999)

Project Manager: FH	Project No. 60145101	Terracon Consulting Engineers & Scientists	SEISMIC HAZARD MAP
Drawn by: JM	Scale: NTS	2817 McGaw Avenue Irvine, California 92614	**Proposed Science Center**
Checked by: FH	File Name: A-5	PH. (949) 261-0051 FAX. (949) 261-6110	**1530 West 17th Street**
Approved by: FH	Date: 02/13/15		**Santa Ana, CA**

Exhibit

A-5

STEM_Building Geographic Deagg. Seismic Hazard
for 0.00-s Spectral Accel, 0.5623 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

7.9
7.6
7.3
7.0
6.7 M
6.4
6.1
5.8
5.5

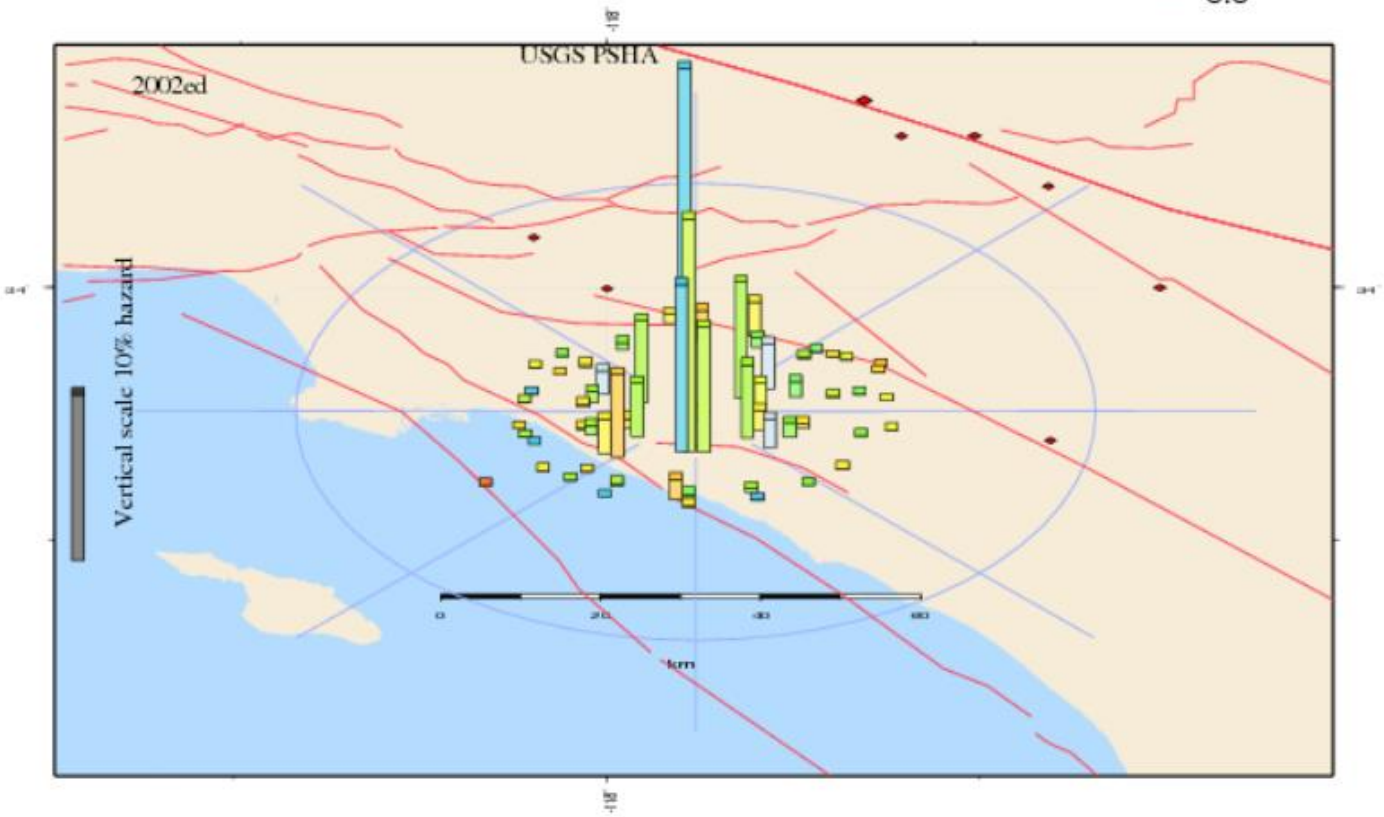


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: FH	Project No. 60145101
Drawn by: JM	Scale: AS SHOWN
Checked by: FH	File Name: A-6
Approved by: FH	Date: 02/13/15

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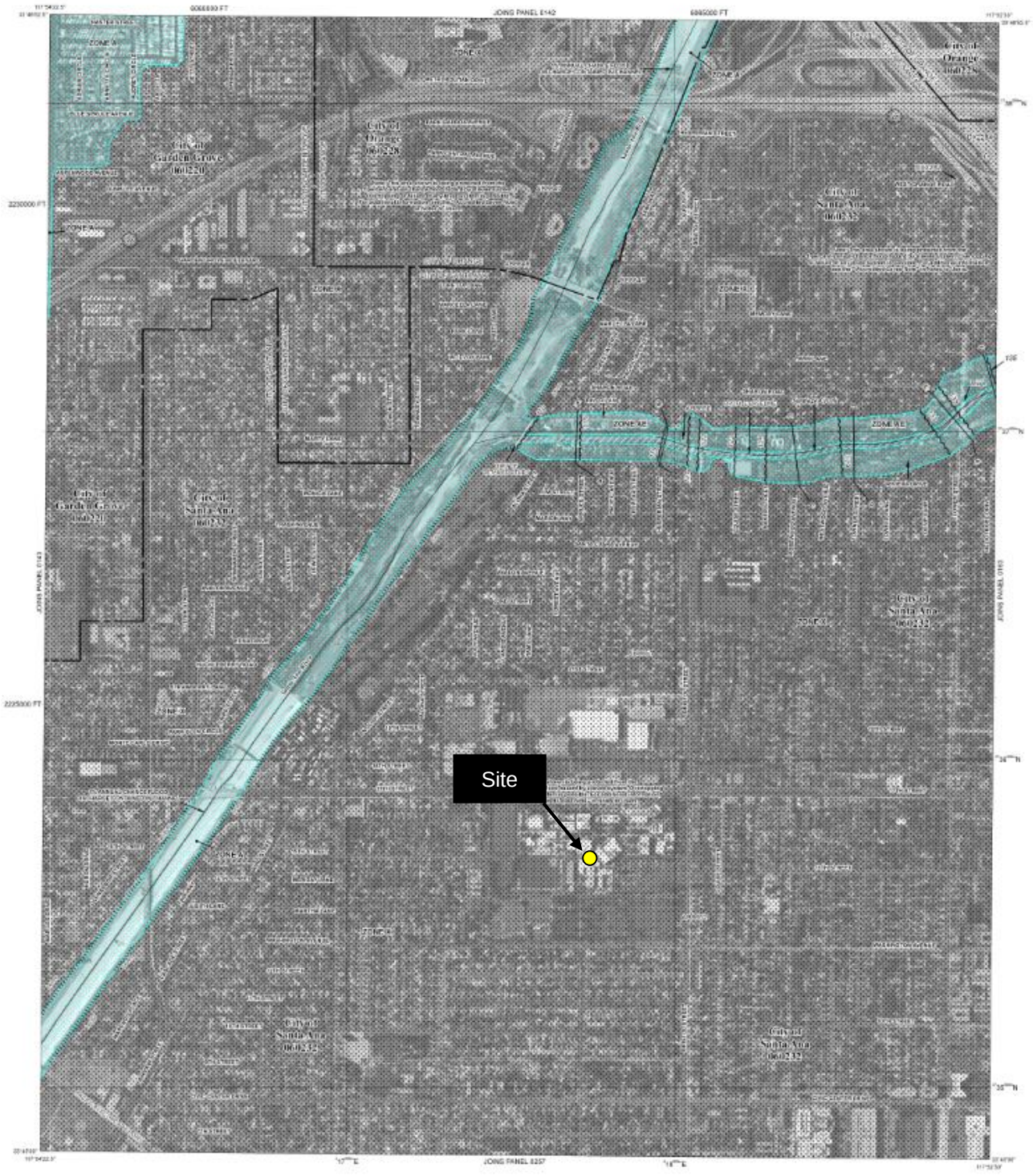
GEOGRAPHIC DEAGGREGATION MAP

Proposed Science 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. 60145101	Terracon Consulting Engineers & Scientists 2817 McGaw Avenue Irvine, California 92614 PH. (949) 261-0051 FAX. (949) 261-6110	FLOOD ZONE HAZARD MAP **Proposed Science Center** 1530 West 17th Street Santa Ana, CA	Exhibit 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 approximate depths of 50 feet bgs at the approximate locations shown on the attached Boring Location Diagram, Exhibit A-2. In addition, three (3) of the locations were utilized for percolation testing. The test borings were advanced with a truck-mounted Mobile B-61 drill rig. Groundwater was not encountered at the time of the field exploration. 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 23, 2015 and Phase II was performed on January 18, 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 used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. 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: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75744° Longitude: -117.88763°

DEPTH	GRAPHIC LOG	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
0.2		**ASPHALT CONCRETE**, 2" thickness											
0.6		**AGGREGATE BASE COURSE**, 5" thickness											
		SANDY LEAN CLAY (CL), dark brown, very stiff, 0.5 ppm								13		31-20-11	52
						5-9-12				13	116		
		brown, stiff, 0.6 ppm	5			6-6-8				20	106		
						3-6-7				22	97		
		medium stiff	10			3-3-3 N=6							
15.0		**POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM)**, brown to tan, medium dense	15			7-16-10				2			
20.0		**SANDY LEAN CLAY (CL)**, brown, medium stiff	20			2-2-3 N=5							

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 @ 24'

Terracon
2817 McGaw Avenue
Irvine, California

Boring Started: 1/23/2015 Boring Completed: 1/23/2015

Drill Rig: B-61 Driller: Jet Drilling

Project No.: 60145101 Exhibit: A-9

BORING LOG NO. B-1

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75744° Longitude: -117.88763°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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 *(continued)*		▽									
	25.0	25										
	CLAYEY SAND (SC), brown to gray, loose				8-7-7				15	117		
	30.0	30										
	SANDY LEAN CLAY (CL), brown to gray, medium stiff				2-3-5 N=8							
	very stiff	35			7-10-13				13	120		
	medium stiff	40			2-3-5 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

▽ *Groundwater encountered @ 24'*

Terracon
2817 McGaw Avenue
Irvine, California

Boring Started: 1/23/2015 Boring Completed: 1/23/2015

Drill Rig: B-61 Driller: Jet Drilling

Project No.: 60145101 Exhibit: A-9

BORING LOG NO. B-1

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75744° Longitude: -117.88763°

DEPTH	GRAPHIC LOG	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
45				4-7-10				18	112		
50				4-3-4 N=7							
55				5-8-10				19	110		
60				8-9-8 N=17							

SANDY LEAN CLAY (CL), brown to gray, medium stiff *(continued)*

stiff

medium stiff

stiff

very stiff

61.5

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

Groundwater encountered @ 24'

Terracon
2817 McGaw Avenue
Irvine, California

Boring Started: 1/23/2015 Boring Completed: 1/23/2015

Drill Rig: B-61 Driller: Jet Drilling

Project No.: 60145101 Exhibit: A-9

BORING LOG NO. B-2

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75754° Longitude: -117.88735°

DEPTH	GRAPHIC LOG		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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		**ASPHALT CONCRETE**, 5.5" thickness											
		SANDY LEAN CLAY (CL), dark brown, stiff, 0.3 ppm				8-7-6				17	108		
5.0		**SILTY SAND (SM)**, brown, medium dense	5			6-9-14				10	121		
7.5		**SANDY LEAN CLAY (CL)**, brown, stiff				3-4-7				25	96		
		medium stiff	10			2-3-4 N=7							
15.0		**SILTY SAND (SM)**, brown, medium dense	15			9-11-16				9	113		
20.0		**SANDY LEAN CLAY (CL)**, brown, medium stiff	20			3-3-4 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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
2817 McGaw Avenue
Irvine, California

Boring Started: 1/23/2015 | Boring Completed: 1/23/2015

Drill Rig: B-61 | Driller: Jet Drilling

Project No.: 60145101 | Exhibit: A-10

BORING LOG NO. BN-3

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75758° Longitude: -117.88769°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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												
ASPHALT CONCRETE, 4" Thickness												
0.8												
AGGREGATE BASE COURSE, 6" Thickness												
SANDY LEAN CLAY (CL), trace gravel, dark brown, medium stiff					2-3-5				20	100		
5.0												
SILTY CLAY (CL-ML), trace sand, grayish-brown, stiff		5			4-5-9				18	107		
medium stiff					1-2-3 N=5							
15.0		10			1-3-3 N=6							
SANDY SILT (ML), trace clay, brown, medium stiff		15			2-3-3 N=6							
20.0												
SILTY CLAY (ML), with sand, grayish-brown, medium stiff		20			1-3-4 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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
2817 McGaw Avenue
Irvine, California

Boring Started: 1/18/2016 Boring Completed: 1/18/2016

Drill Rig: B-61 Driller: Cal Pac

Project No.: 60145101 Exhibit: A-11

BORING LOG NO. BN-4

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75734° Longitude: -117.88777°

DEPTH	GRAPHIC LOG	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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		**ASPHALT CONCRETE**, 3" Thickness											
0.6		**AGGREGATE BASE COURSE**, 4" Thickness											
		SANDY LEAN CLAY (CL), trace gravel, stiff										32-17-15	59
						3-6-7				18	107		
		tan brown, thin layer of sand encountered											
5.0		**SILTY CLAY (CL-ML)**, with sand, grayish-brown, medium stiff	5			2-3-4 N=7							
		stiff				3-4-6				23	101		
10.0		**SILTY SAND (SM)**, trace clay, grayish-brown, loose	10			2-3-2 N=5							
			15			3-2-2 N=4							
20.0		**SANDY LEAN CLAY (CL)**, dark brown, medium stiff	20			3-2-5 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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
2817 McGaw Avenue
Irvine, California

Boring Started: 1/18/2016 Boring Completed: 1/18/2016

Drill Rig: B-61 Driller: Cal Pac

Project No.: 60145101 Exhibit: A-12

BORING LOG NO. BN-5

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.7573° Longitude: -117.88735°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
0.4												
0.8	**ASPHALT CONCRETE**, 5" Thickness											
	AGGREGATE BASE COURSE, 4" Thickness											
	SANDY LEAN CLAY (CL), trace gravel, dark brown, stiff				4-6-11				16	102		
	tan to gray	5			5-5-5 N=10						29-21-8	59
					5-7-9				12	108		
	brown, medium stiff to stiff	10			2-3-5 N=8							
15.0												
	SILTY SAND (SM), trace gravel, tan brown, loose	15			3-4-5 N=9							
20.0												
	SANDY LEAN CLAY (CL), grayish-brown, stiff	20			3-3-6 N=9							
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 Avenue
Irvine, California

Boring Started: 1/18/2016 Boring Completed: 1/18/2016

Drill Rig: B-61 Driller: Cal Pac

Project No.: 60145101 Exhibit: A-13

BORING LOG NO. BN-6

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District Santa Ana, CA

SITE: 1530 West 17th Street Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75745° Longitude: -117.88708°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
0.4												
0.8											31-16-15	57
					3-5-7				17	105		
		5			3-6-8				8	110		
					2-2-3 N=5							
		10			2-2-4 N=6							
15.0		15			3-3-9 N=12							
20.0		20			3-3-4 N=7							
21.5												

0.4 **ASPHALT CONCRETE**, 5" Thickness

0.8 **AGGREGATE BASE COURSE**, 4" Thickness

SANDY LEAN CLAY (CL), with silt, trace gravel, dark brown to brown, stiff

brown to gray, medium stiff

15.0 **SILTY SAND (SM)**, trace gravel, tan to brown, medium dense

20.0 **SANDY LEAN CLAY (CL)**, with silt, brown to gray, medium 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 Avenue
Irvine, California

Boring Started: 1/18/2016 Boring Completed: 1/18/2016

Drill Rig: B-61 Driller: Cal Pac

Project No.: 60145101 Exhibit: A-14

BORING LOG NO. BN-7

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

SITE: 1530 West 17th Street
Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75792° Longitude: -117.88786°

DEPTH	GRAPHIC LOG	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
0.4		**ASPHALT CONCRETE**, 5" Thickness											
0.8		**AGGREGATE BASE COURSE**, 4" Thickness											
		LEAN CLAY WITH SAND (CL), trace silt, dark brown, stiff										39-21-18	78
						3-4-7				25	100		
		trace gravel, tan brown, medium stiff	5			2-2-2 N=4							
7.5													
		SILTY CLAY (CL-ML), trace gravel, grayish-brown, medium stiff				3-4-5				27	94		
10.0													
		LEAN CLAY WITH SILT (CL), trace sand, grayish-brown, medium stiff	10			3-4-3 N=7							
15.0													
		SILTY SAND (SM), trace clay, tan brown, medium dense	15			3-5-5 N=10							
20.0													
		SILTY CLAY (CL-ML), dark brown, medium stiff	20			1-3-4 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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
2817 McGaw Avenue
Irvine, California

Boring Started: 1/18/2016 | Boring Completed: 1/18/2016

Drill Rig: B-61 | Driller: Cal Pac

Project No.: 60145101 | Exhibit: A-15

BORING LOG NO. BN-8

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

SITE: 1530 West 17th Street
Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75791° Longitude: -117.88775°

DEPTH	GRAPHIC LOG	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
				2-4-6				25	91		
5											
				3-11-17				17	115		
7.5											
				3-2-2 N=4							
10.0											
10				2-3-3 N=6							
15.0											
15				3-4-6 N=10							
20				2-3-5 N=8							
21.5											

SANDY LEAN CLAY (CL), trace silt, dark brown, stiff

very stiff

SANDY SILT (ML), with clay, grayish-brown, soft to medium stiff

SILTY CLAY (CL-ML), trace sand, dark brown, medium stiff

SILT (ML), with sand, grayish-brown, stiff

with clay, micaceous

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 Avenue
Irvine, California

Boring Started: 1/18/2016 Boring Completed: 1/18/2016

Drill Rig: B-61 Driller: Cal Pac

Project No.: 60145101 Exhibit: A-16

BORING LOG NO. Perc-1

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

SITE: 1530 West 17th Street
Santa Ana, California

GRAPHIC LOG	LOCATION / DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
	See Exhibit A-2 Latitude: 33.75728° Longitude: -117.88691°											
	DEPTH											
	0.3 **ASPHALT CONCRETE**, 4" Thickness											
	0.7 **AGGREGATE BASE COURSE**, 4" Thickness											
	CLAYEY SAND (SC), dark brown											
	5.0 ***Boring Terminated at 5 Feet***	5										

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 Avenue
Irvine, California

Boring Started: 1/18/2016 | Boring Completed: 1/18/2016

Drill Rig: B-61 | Driller: Cal Pac

Project No.: 60145101 | Exhibit: A-17

BORING LOG NO. Perc-2

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

SITE: 1530 West 17th Street
Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75809° Longitude: -117.88715°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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
	CLAYEY SAND (SC), dark brown											
	loose				5-6-7 N=13							
	6.0	5										
	SILTY SAND (SM), tan to brown, loose				3-4-4 N=8							
	10.0	10										
	Boring Terminated at 10 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 Avenue
Irvine, California

Boring Started: 1/18/2016 Boring Completed: 1/18/2016

Drill Rig: B-61 Driller: Cal Pac

Project No.: 60145101 Exhibit: A-18

BORING LOG NO. Perc-3

PROJECT: Proposed Science Center

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

SITE: 1530 West 17th Street
Santa Ana, California

LOCATION See Exhibit A-2

Latitude: 33.75791° Longitude: -117.88751°

DEPTH	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	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 silt, dark brown, medium stiff				2-3-3 N=6							
		5										
	grayish-brown, micaceous				1-2-2 N=4							
		10										
					1-3-3 N=6							
15.0		15										
	Boring Terminated at 15 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 Avenue
Irvine, California

Boring Started: 1/18/2016 Boring Completed: 1/18/2016

Drill Rig: B-61 Driller: Cal Pac

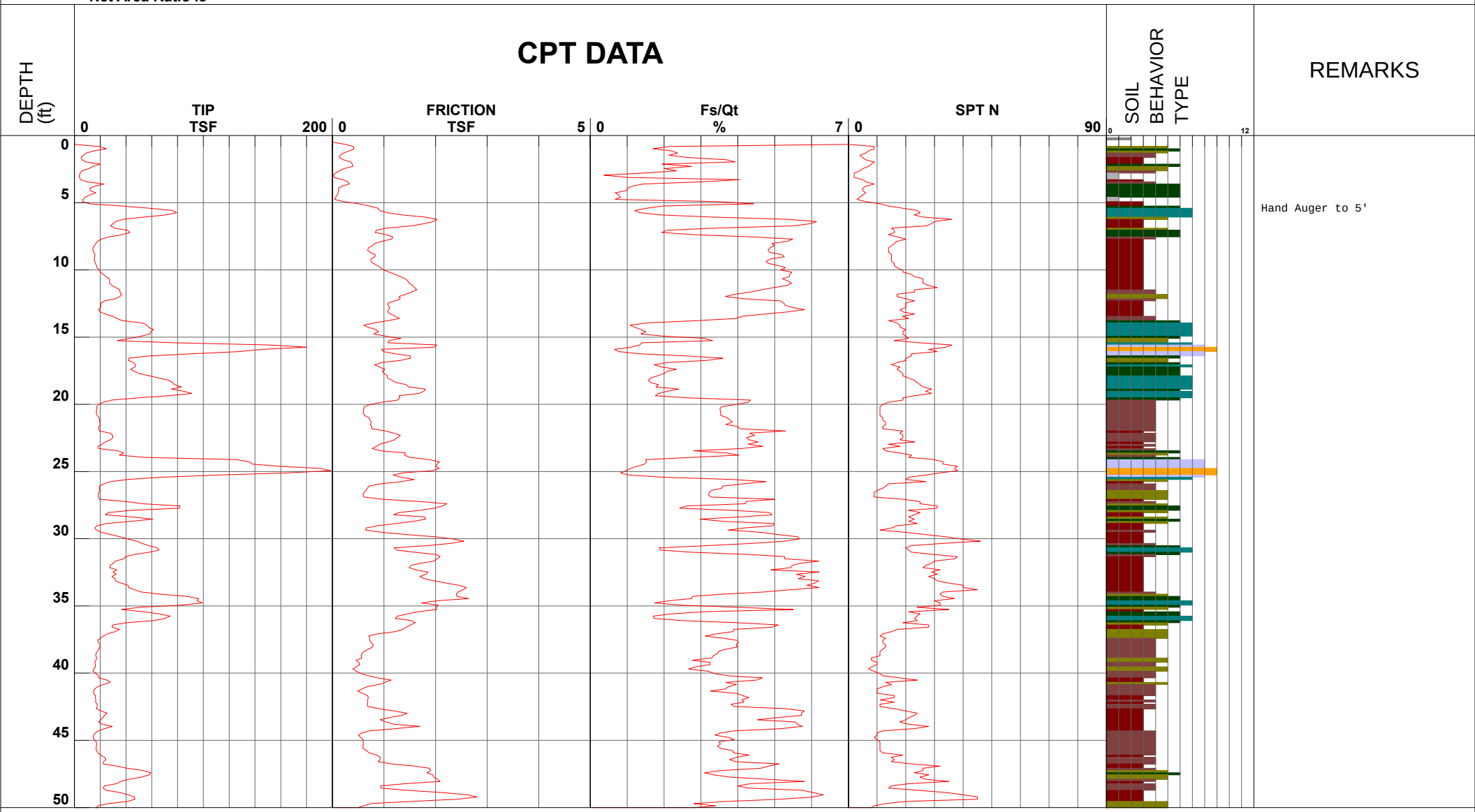
Project No.: 60145101 Exhibit: A-19

Terracon-Irvine

Project	Science Center	Operator	DG-BH	Filename	SDF(204).cpt
Job Number	60145100/6145101	Cone Number	DSG0906	GPS	
Hole Number	CS-01	Date and Time	1/24/2015 8:59:26 AM	Maximum Depth	50.52 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

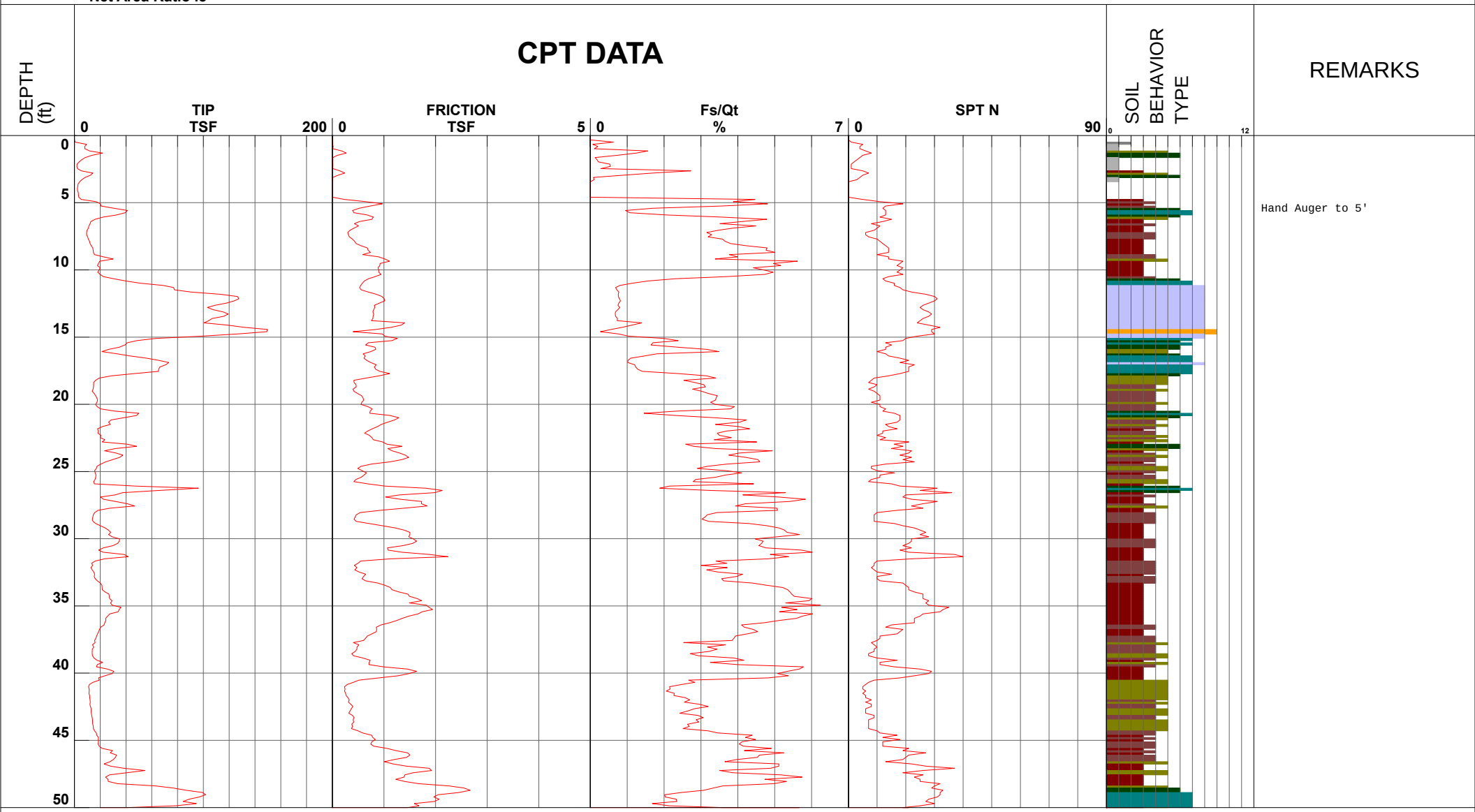
S*Soil behavior type and SPT based on data from UBC-1983

Terracon-Irvine

Project	Science Center	Operator	DG-BH	Filename	SDF(205).cpt
Job Number	60145100/6145101	Cone Number	DSG0906	GPS	
Hole Number	CS-02	Date and Time	1/24/2015 9:52:11 AM	Maximum Depth	50.52 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

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.

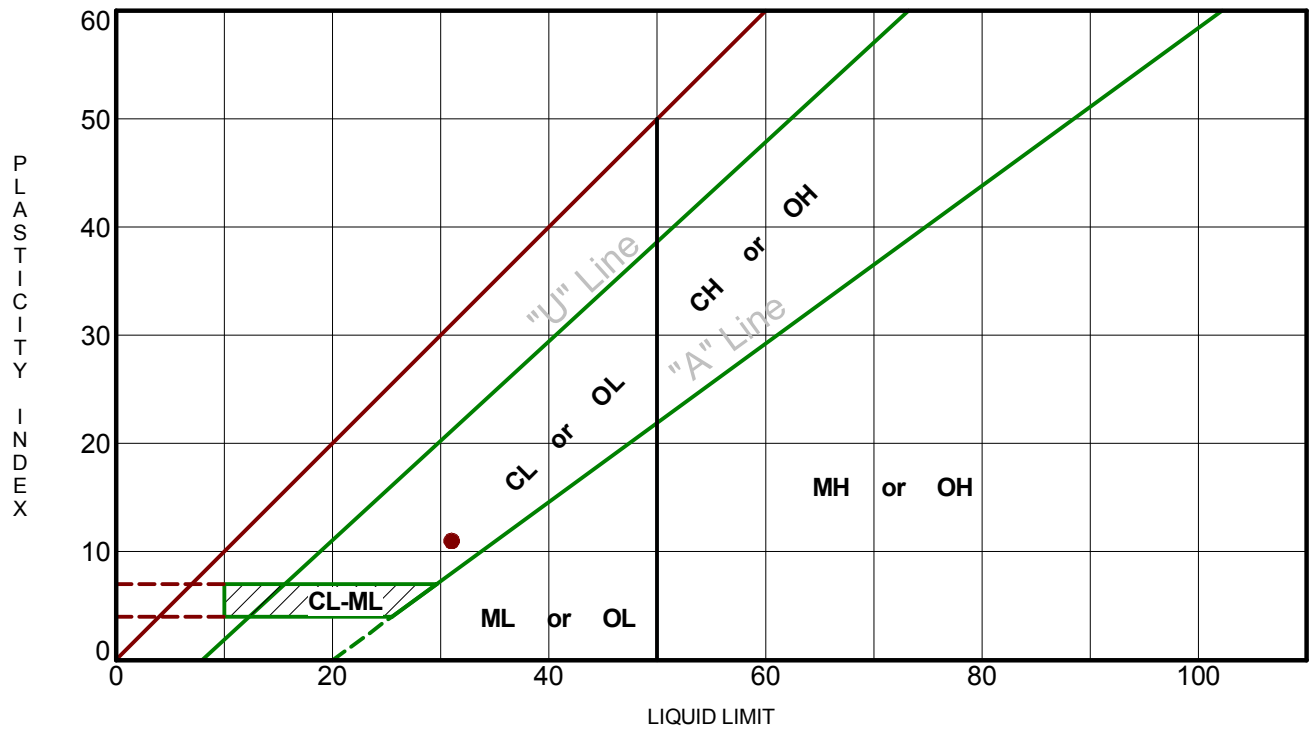
Selected soil samples obtained from the site were tested for the following engineering properties:

- 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**	**2.0**	**31**	**20**	**11**	**52**	**CL**	**SANDY LEAN CLAY**

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ATTERBERG LIMITS BORING LOG.GPJ TERRACON2012.GDT 2/10/15

PROJECT: Proposed Science Center

SITE: 1530 West 17th Street
Santa Ana, California

Terracon
2817 McGaw Avenue
Irvine, California

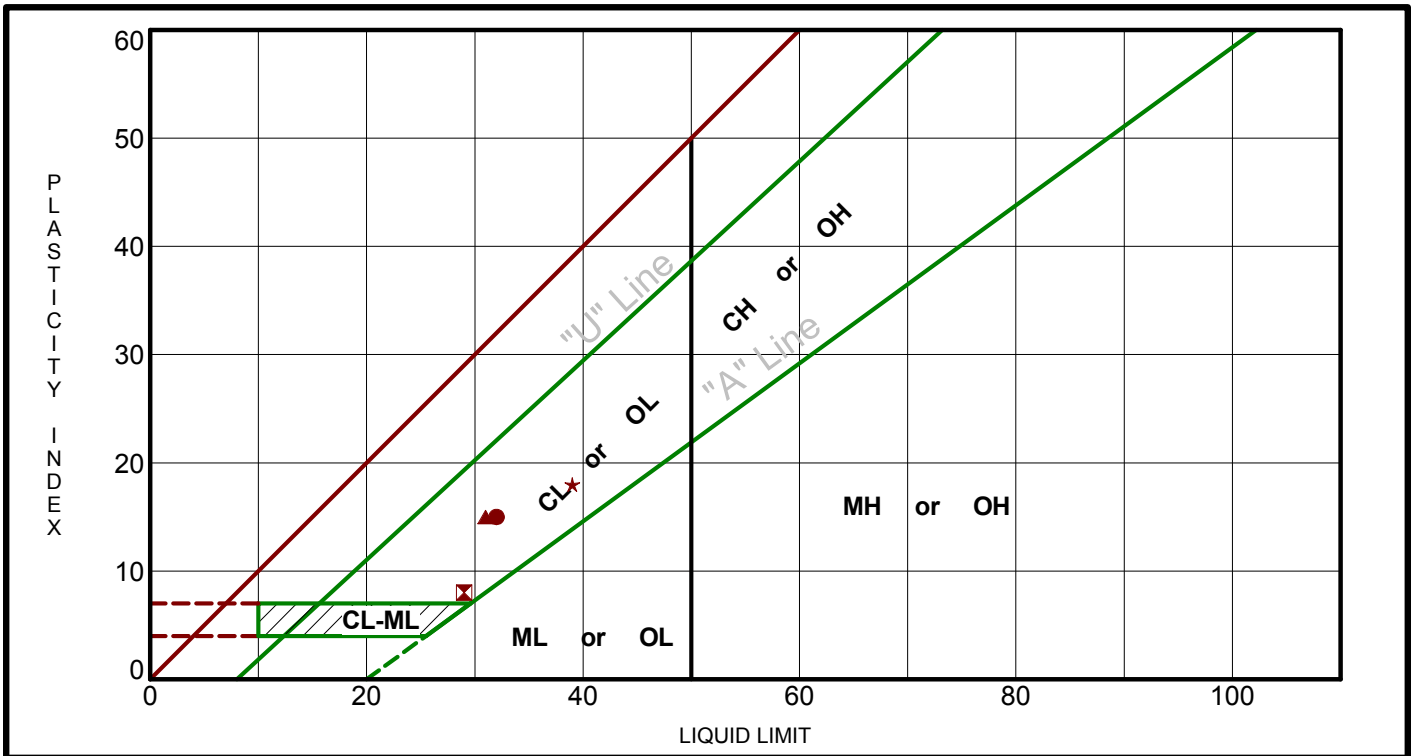
PROJECT NUMBER: 60145101

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
● BN-4	0 - 2.5	32	17	15	59	CL	SANDY LEAN CLAY
⊠ BN-5	5 - 6.5	29	21	8	59	CL	SANDY LEAN CLAY
▲ BN-6	0 - 2.5	31	16	15	57	CL	SANDY LEAN CLAY
★ BN-7	0 - 2.5	39	21	18	78	CL	LEAN CLAY WITH SAND

PROJECT: Proposed Science Center

SITE: 1530 West 17th Street
Santa Ana, California

Terracon
2817 McGaw Avenue
Irvine, California

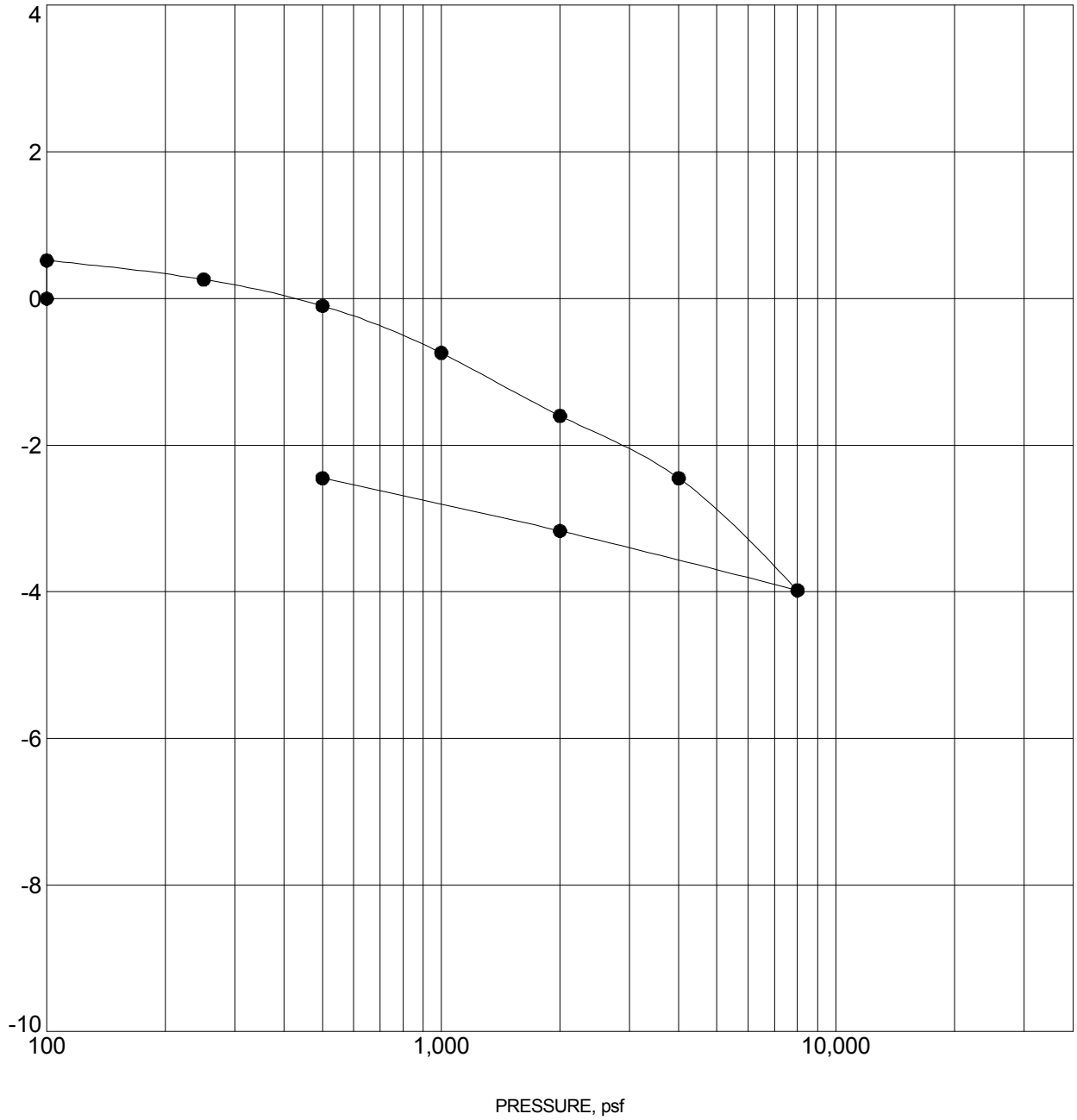
PROJECT NUMBER: 60145101

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

EXHIBIT: B-3

SWELL CONSOLIDATION TEST

ASTM D4546



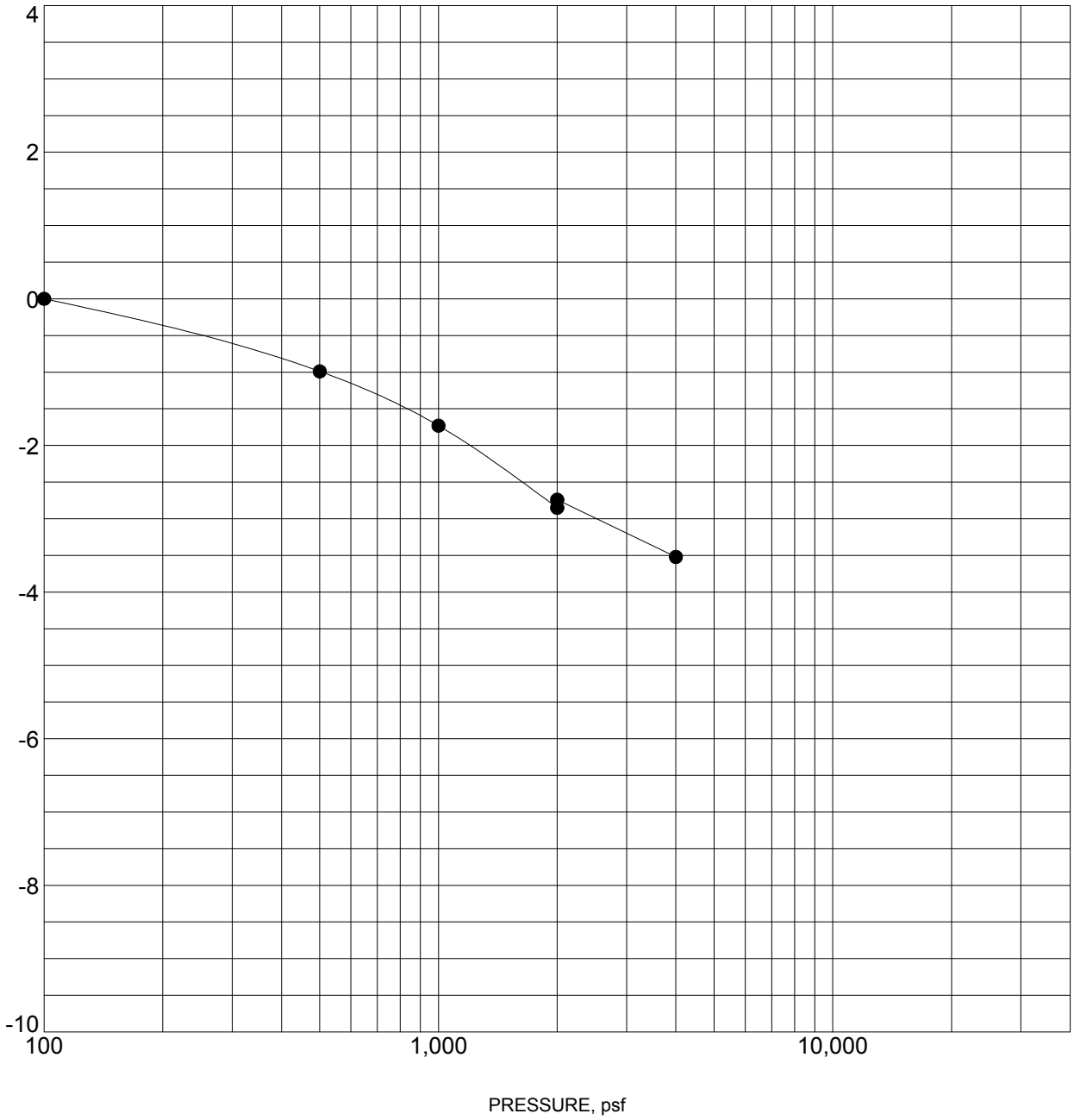
Specimen Identification			Classification	γ_d, pcf	WC, %
●	B-2	7.5 ft	SANDY LEAN CLAY	96	25

NOTES:

PROJECT: Proposed Science Center	Terracon 2817 McGaw Avenue Irvine, California	PROJECT NUMBER: 60145101
SITE: 1530 West 17th Street Santa Ana, California		CLIENT: RSCCD Facility Planning, District Santa Ana, CA
		EXHIBIT: B-4

SWELL CONSOLIDATION TEST

ASTM D4546



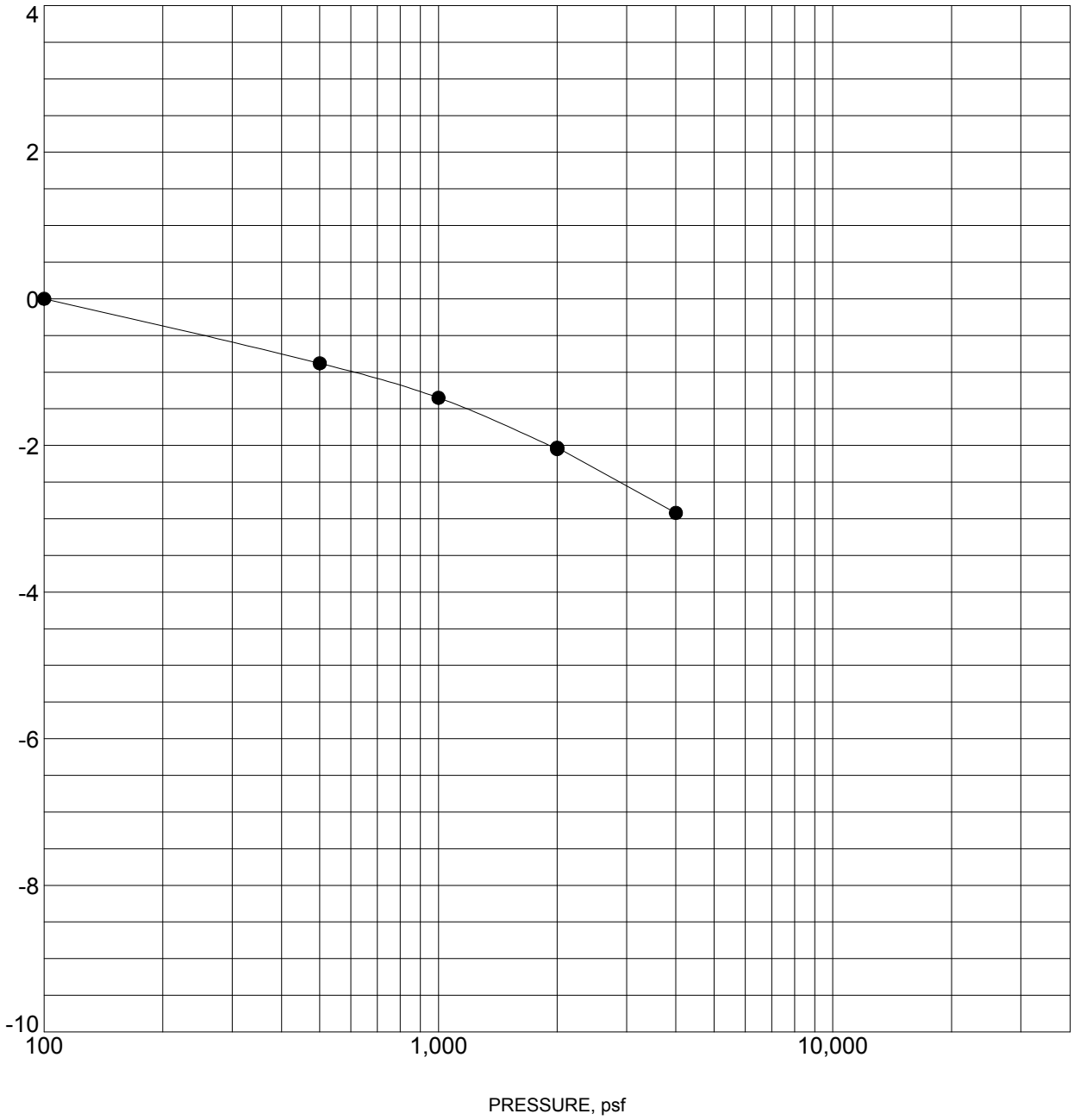
Specimen Identification			Classification	γ_d, pcf	WC, %
●	BN-3	2.5 ft	SANDY LEAN CLAY	100	20

NOTES:

PROJECT: Proposed Science Center		PROJECT NUMBER: 60145101
SITE: 1530 West 17th Street Santa Ana, California	Terracon 2817 McGaw Avenue Irvine, California	CLIENT: RSCCD Facility Planning, District Santa Ana, CA
		EXHIBIT: B-5

SWELL CONSOLIDATION TEST

ASTM D4546



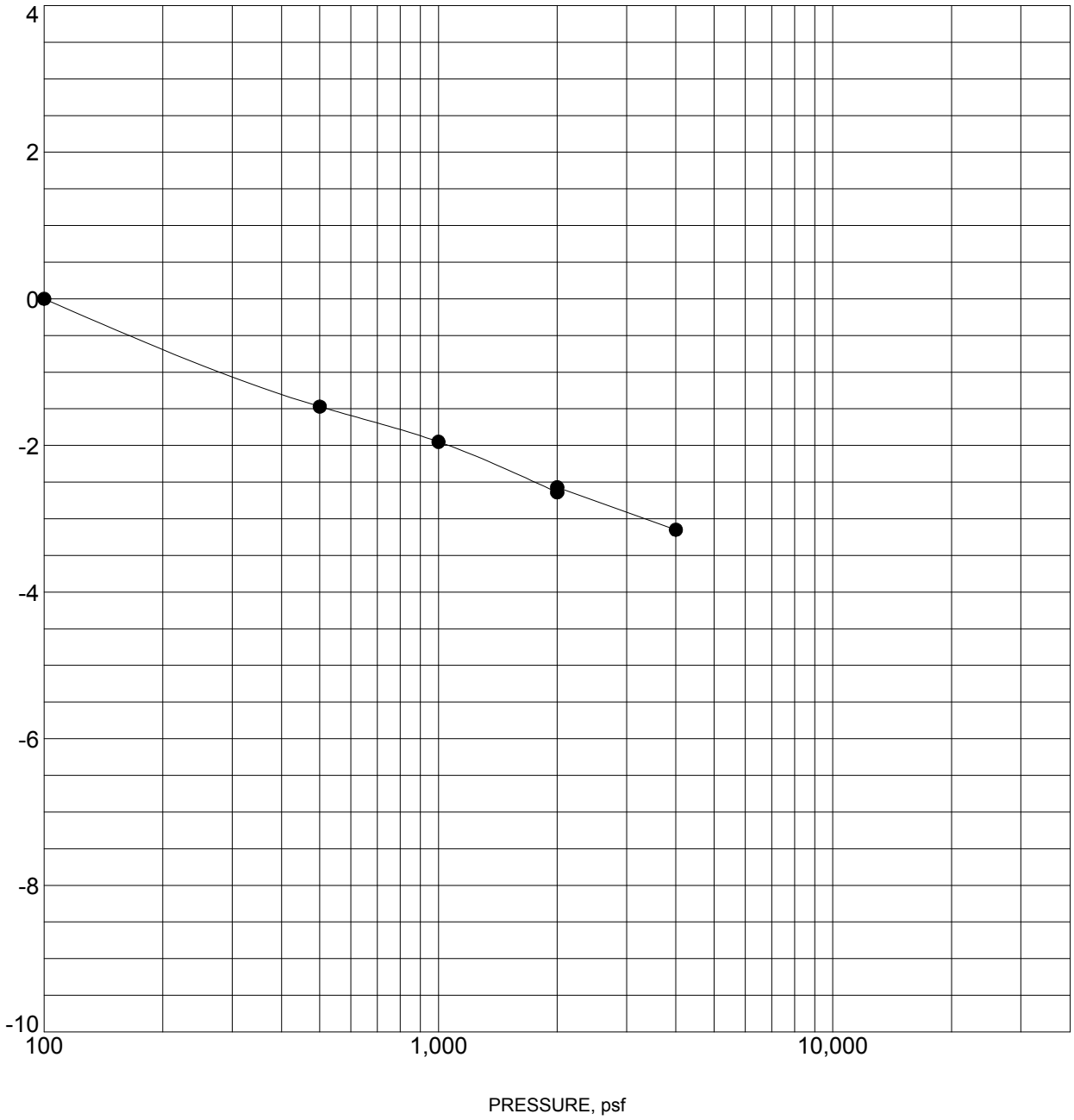
Specimen Identification			Classification	γ_d, pcf	WC, %
●	BN-3	5.0 ft	SILTY CLAY	107	18

NOTES:

PROJECT: Proposed Science Center		PROJECT NUMBER: 60145101
SITE: 1530 West 17th Street Santa Ana, California	Terracon 2817 McGaw Avenue Irvine, California	CLIENT: RSCCD Facility Planning, District Santa Ana, CA
		EXHIBIT: B-6

SWELL CONSOLIDATION TEST

ASTM D4546



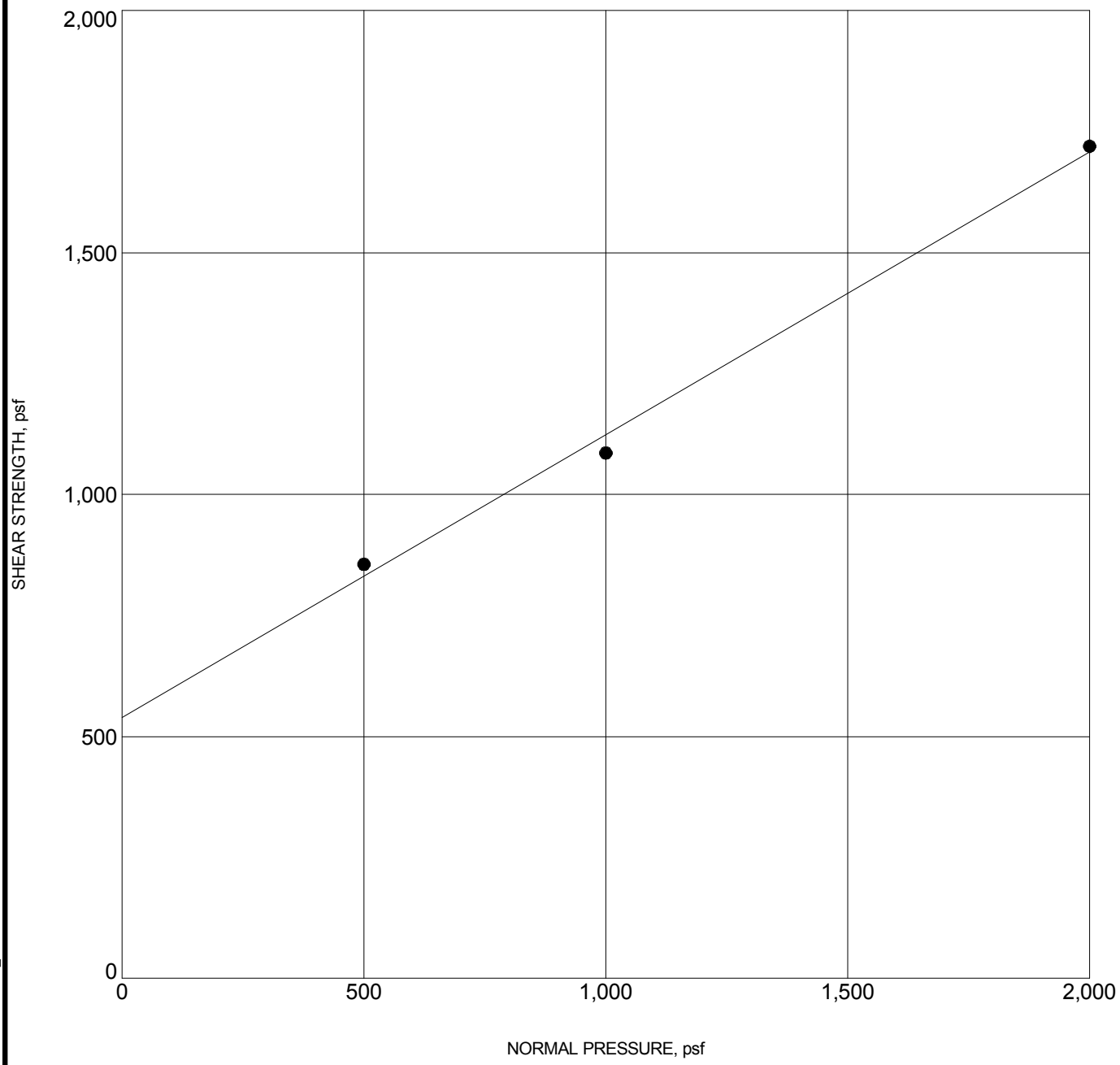
Specimen Identification			Classification	γ_d, pcf	WC, %
●	BN-8	2.5 ft	SANDY LEAN CLAY	91	25

NOTES:

PROJECT: Proposed Science Center		PROJECT NUMBER: 60145101
SITE: 1530 West 17th Street Santa Ana, California	Terracon 2817 McGaw Avenue Irvine, California	CLIENT: RSCCD Facility Planning, District Santa Ana, CA
		EXHIBIT: B-7

DIRECT SHEAR TEST

ASTM D3080



Specimen Identification	Classification	γ_d, pcf	WC,%	c, psf	ϕ°
● **B-1 2.5ft**	**SANDY LEAN CLAY**	**116**	**13**	**539**	**30**

PROJECT: Proposed Science Center

SITE: 1530 West 17th Street
Santa Ana, California

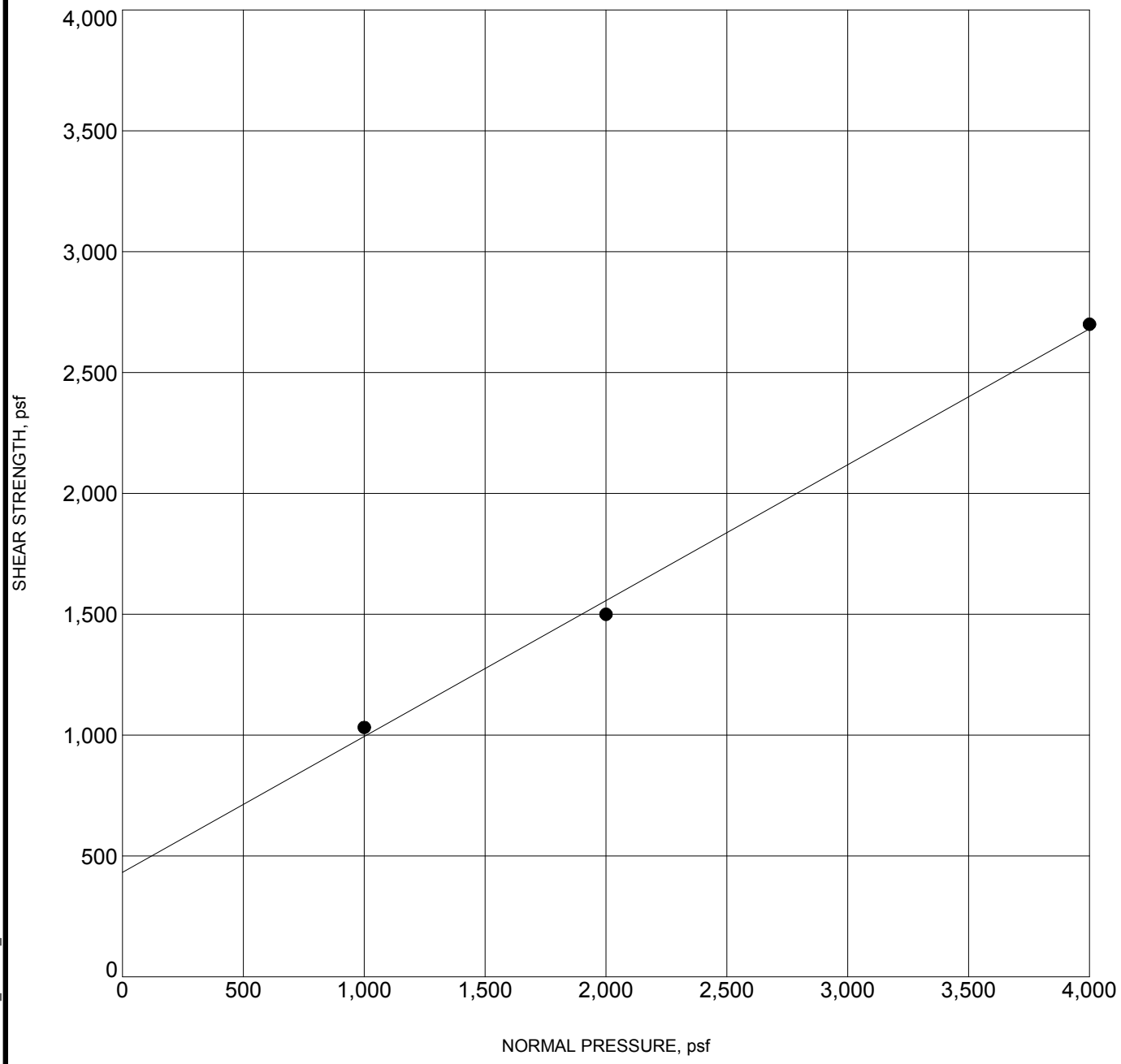
Terracon
2817 McGaw Avenue
Irvine, California

PROJECT NUMBER: 60145101

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

EXHIBIT: B-8

DIRECT SHEAR TEST ASTM D3080



Specimen Identification	Classification	γ_d, pcf	WC,%	c, psf	$\phi°$
● **BN-6 5.0ft**	**SANDY LEAN CLAY (CL)**	**110**	**8**	**432**	**29**

PROJECT: Proposed Science Center

SITE: 1530 West 17th Street
Santa Ana, California

Terracon
2817 McGaw Avenue
Irvine, California

PROJECT NUMBER: 60145101

CLIENT: RSCCD Facility Planning, District
Santa Ana, CA

EXHIBIT: B-9

NEIL O. ANDERSON
AND ASSOCIATES
A Terracon COMPANY

Expansion Index of Soils

ASTM D 4829

JOB NUMBER	60145101	DATE RECEIVED	1/30/2015
JOB NAME	Proposed Science Center	DATE TESTED	2/18/2015
SAMPLE ID	B2 @ 1-2'	TECHNICIAN	Joe Edwards
SAMPLE INFO	Dark Brown Sandy Silty Clay	PROJ. MANAGER	

Moisture Specimen	
Tare #	103
Tare Wt. (gms)	186.9
Tare + Wet Soil (gms)	703.2
Tare + Dry Soil (gms)	640.1
% Moisture	13.9

Expansion Index Sample Moisture Adjustment	
Original Sample Wt. Wet (gms)	1231.5
Original Sample Wt. Dry (gms)	1081.0
Final Sample Wt. Wet (gms)	1188.5
Test Sample % Moisture	9.9

Expansion Index Sample Test Data			
Specimen Height (mm)	25.40		
Exp. Ring Wt. (gms)	200.5		
Ring + Specimen (gms)	602.5		
Wet Density of Specimen (lbs/cf)	121.9		
Dry Density of Specimen (lbs/cf)	110.9	% Saturation must be 48.0-52.0	
% Saturation	52.0	TRUE	

Expansion Test Data				
Reading #	Time	Date	Dial Reading (in)	Δ In Height (mm)
Initial	8:34	2/18/2015	0	
10 min	8:44	2/18/2015	0.0059	0.150
30 min	9:04	2/18/2015	0.0121	0.157
60 min	9:34	2/18/2015	0.0162	0.104
120 min	10:34	2/18/2015	0.0208	0.117
180 min	11:34	2/18/2015	0.0226	0.046
Final	17:00	2/18/2015	0.0254	0.645

Expansion Index	

NOTES:

Terracon
Consulting Engineers & Scientists

Expansion Index

Project: Proposed Science Center
Proj. No.: 60145101
Tested By: GeoLogic **Date:** 2/5/2016

Sample and Soil Information	
Boring No.:	BN-8
Sample No.:	NA
Sample Depth:	1'-5'
Soil Classification (USCS Symbol):	Sandy Lean Clay (CL)

Test Standard Used	
	UBC 18-2
X	ASTM D 4829

Weight Prior to Screening	NA	g
Weight After Screening	NA	g
Percent Retained on #4 Sieve	NA	%

Moisture Determination	Units	Initial	Final
Assumed Moisture Content	%		
Tare Weight	g	219.6	219.6
Weight of Soil (Wet) + Tare	g	585.1	629.6
Weight of Soil (Dry) + Tare	g	-	-
Moisture Content	%	13.5%	27.3%
Density Determination			
Weight of Soil + Ring (Wet)	g		
Weight of Ring	g		
Wet Weight of Soil	g		
Wet Density	pcf	0.0	
Final Sample Height	in		
Final Volume	ft^3		
Final Wet Density	pcf		
Dry Density	pcf	97.6	97.6
Degree of Saturation (G_s = 2.7)	%	50.2	101.5

Initial Dry Density	97.6	pcf
Initial MC	13.5	%
Initial Saturation	**50.2**	%
Final Dry Density	97.6	pcf
Final MC	27.3	%
Final Saturation	**101.5**	%

	Date	Time	Dial Reading	Deflection
Start	2/5/2016	15:00	0.3919	
Add Water (After 10 minutes)				-
				-
				-
				-
				-
				-
				-
19 hours	**2/6/2016**	**10:00**	**0.3276**	**0.0643**

Expansion Index, EI	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

EI	Measured Expansion Index =	64	Recommend to use EI =	**64**
EI_{50}	Expansion Index =	64		

Exhibit B-11

CHEMICAL LABORATORY TEST REPORT

Project Number: 60145101
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: Proposed Science Center

Sample Submitted By: Terracon (60) **Date Received:** 2/4/2015 Lab No.: 15-0071

Results of Corrosivity Analysis

Sample Number	
Sample Location	B-1
Sample Depth (ft.)	1.0-2.0
pH Analysis, AWWA 4500 H	8.43
Water Soluble Sulfate (SO4), AWWA 4500 E (percent %)	0.02
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Red-Ox, AWWA 2580, (mV)	+574
Total Salts, AWWA 2510, (mg/kg)	1204
Chlorides, AWWA 4500 Cl B, (mg/kg)	25
Resistivity, ASTM G-57, (ohm-cm)	1261

Analyzed By: Kurt D. Ergun

Kurt D. Ergun
Chemist

CHEMICAL LABORATORY TEST REPORT

Project Number: 60145101
Service Date: 01/28/16
Report Date: 01/29/16
Task:

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

Client

Project
RSCCD: Science Center Project

Sample Submitted By: Terracon (60) **Date Received:** 1/29/2016 **Lab No.: 16-0088**

Results of Corrosivity Analysis

Sample Number		
Sample Location	BN-4	BN-7
Sample Depth (ft.)	0.0	0.0
pH Analysis, AWWA 4500 H	8.14	7.90
Water Soluble Sulfate (SO4), AWWA 4500 E (percent %)	0.02	0.08
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil
Red-Ox, AWWA 2580, (mV)	+667	+646
Total Salts, AWWA 2510, (mg/kg)	1490	3086
Chlorides, AWWA 4500 Cl B, (mg/kg)	25	133
Resistivity, ASTM G-57, (ohm-cm)	1436	698

Analyzed By: Kurt D. Ergun
Chemist

APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING


Auger


Shelby Tube


Split Spoon


Rock Core


Macro Core


Modified California Ring Sampler


Grab Sample


No Recovery


Modified Dames & Moore Ring Sampler

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 Hamme

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

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.

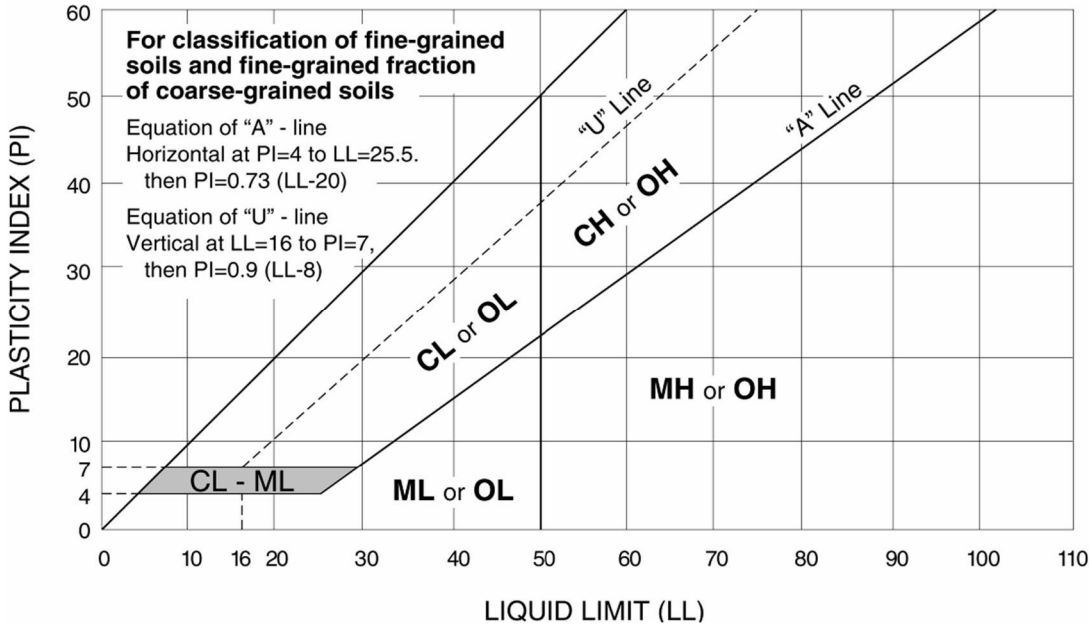
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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.



Terracon

Exhibit C-2

USGS Design Maps Detailed Report

ASCE 7-10 Standard (33.75756°N, 117.88768°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: • Plasticity index PI > 20, • Moisture content w ≥ 40%, and • 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

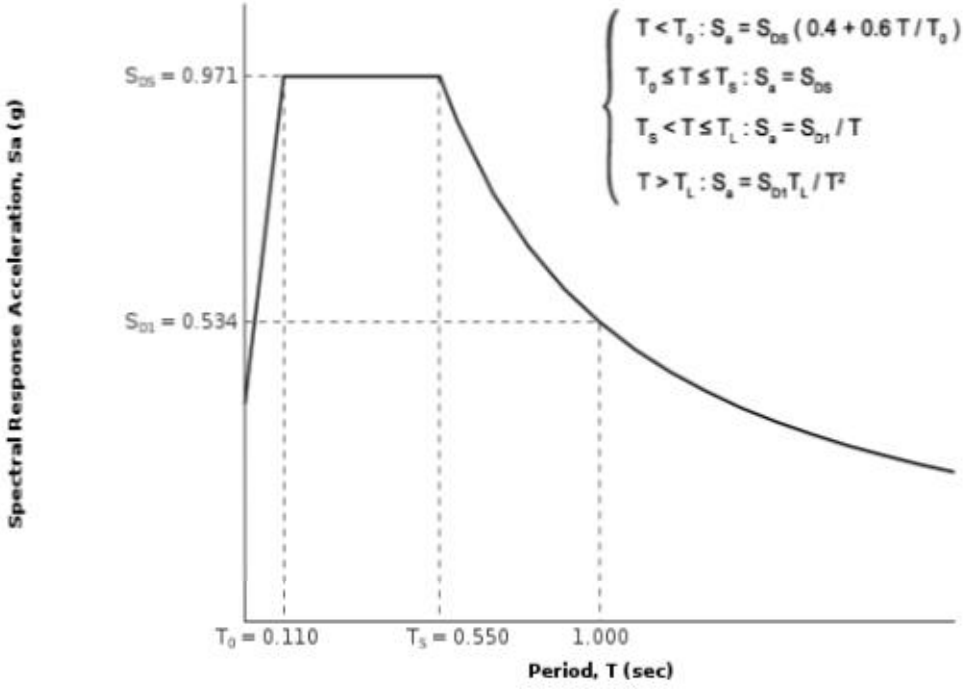
Equation (11.4–3): $S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 1.457 = 0.971$ g

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

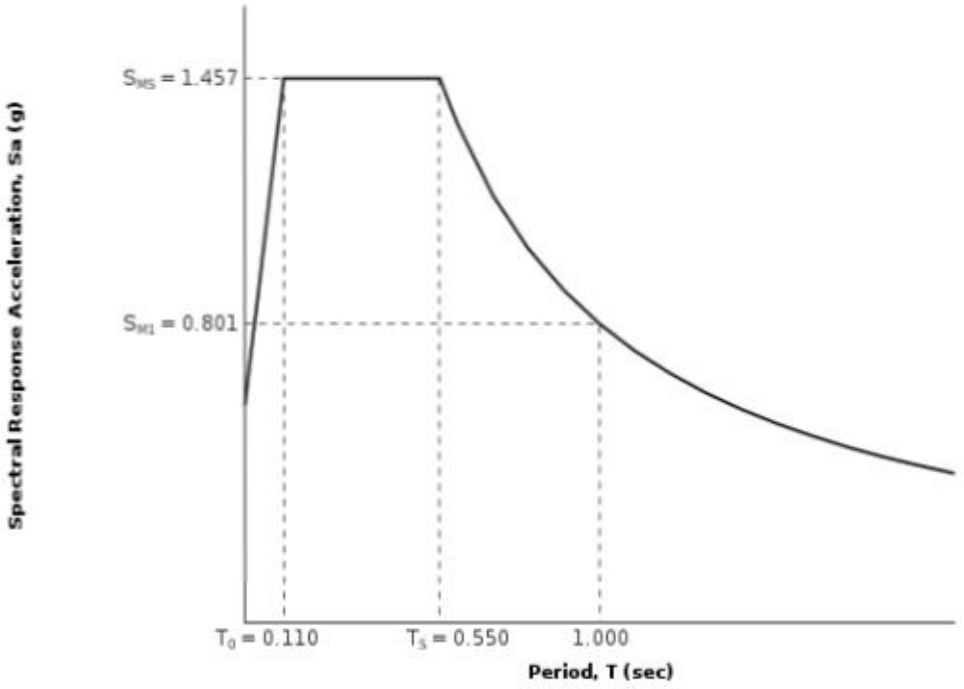
From Figure 22-12 [3] $T_L = 8$ seconds

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} = 1.063

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} = 0.971 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

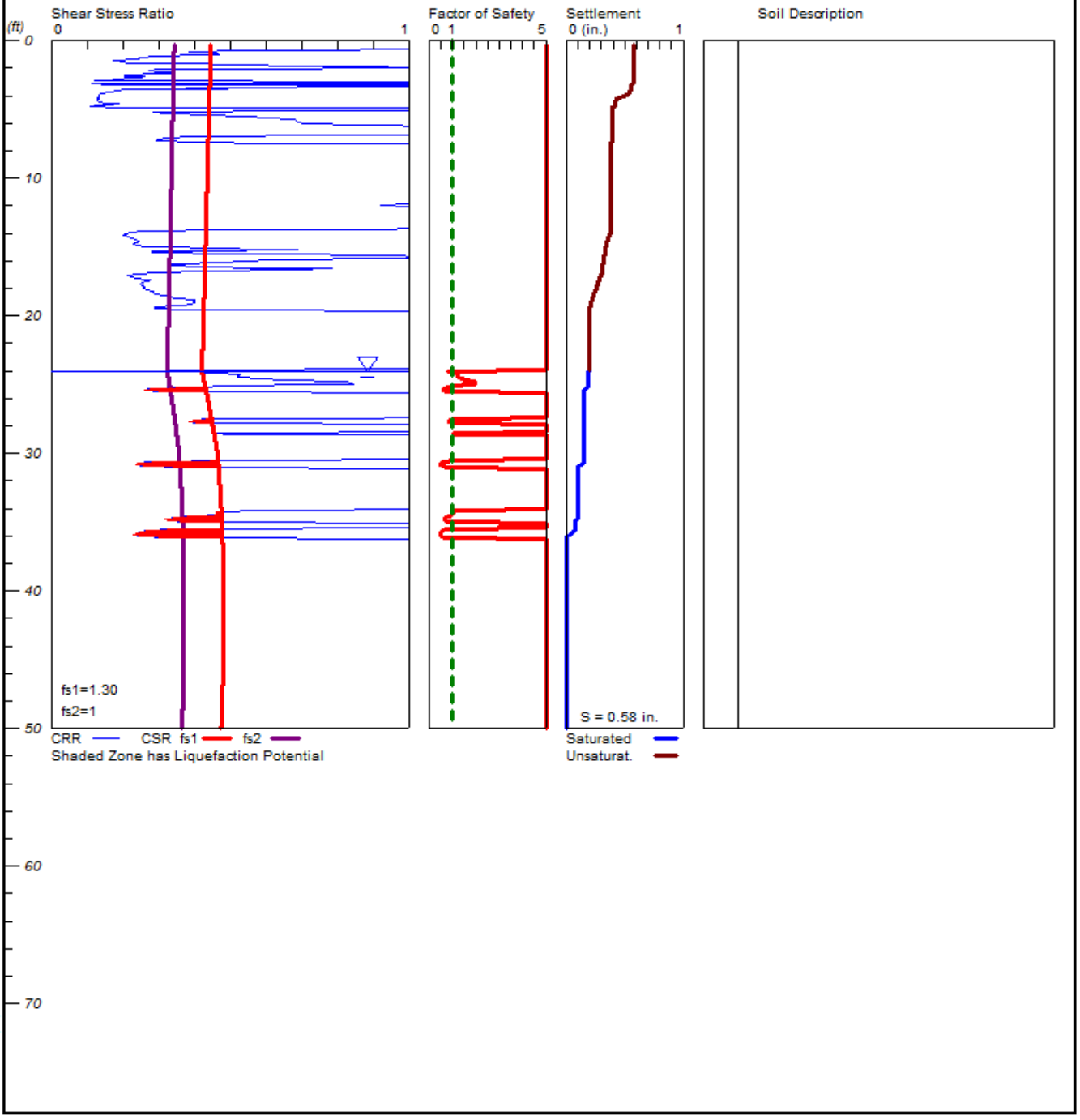
LIQUEFACTION ANALYSIS

LIQUEFACTION ANALYSIS

STEM Building

Hole No.=CS-1 Water Depth=24 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.=CS-1

Depth of Hole=50.00 ft

Water Table during Earthquake= 24.00 ft

Water Table during In-Situ Testing= 24.00 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= 1.3
   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	115.00	0.00	0.50
0.49	1.10	0.00	0.00	115.00	0.00	0.50
0.66	1.10	0.20	18.18	100.00	0.00	0.50
0.82	18.80	0.40	2.13	115.00	0.00	0.50
0.98	24.70	0.40	1.62	120.00	0.00	0.50
1.15	14.80	0.30	2.03	115.00	0.00	0.50
1.31	9.20	0.20	2.17	115.00	0.00	0.50
1.48	6.90	0.10	1.45	115.00	0.00	0.50
1.64	5.20	0.10	1.92	115.00	0.00	0.50
1.80	5.90	0.20	3.39	115.00	0.00	0.50
1.97	8.90	0.40	4.49	115.00	0.00	0.50
2.13	19.90	0.40	2.01	120.00	0.00	0.50
2.30	14.50	0.40	2.76	115.00	0.00	0.50
2.46	11.20	0.20	1.79	115.00	0.00	0.50
2.62	5.80	0.10	1.72	115.00	0.00	0.50
2.79	4.40	0.10	2.27	115.00	0.00	0.50
2.95	4.00	0.00	0.00	115.00	0.00	0.50
3.12	3.80	0.00	0.00	115.00	0.00	0.50
3.28	5.00	0.20	4.00	115.00	0.00	0.50
3.45	9.70	0.30	3.09	115.00	0.00	0.50
3.61	22.90	0.30	1.31	120.00	0.00	0.50
3.77	15.90	0.20	1.26	120.00	0.00	0.50
3.94	11.80	0.10	0.85	120.00	0.00	0.50
4.10	12.50	0.10	0.80	120.00	0.00	0.50

4.27	16.60	0.10	0.60	120.00	0.00	0.50
4.43	12.00	0.10	0.83	120.00	0.00	0.50
4.59	8.30	0.10	1.20	115.00	0.00	0.50
4.76	6.60	0.00	0.00	115.00	0.00	0.50
4.92	6.50	0.20	3.08	115.00	0.00	0.50
5.09	11.50	0.50	4.35	115.00	0.00	0.50
5.25	36.90	0.70	1.90	120.00	0.00	0.50
5.41	58.30	0.90	1.54	120.00	0.00	0.50
5.58	76.00	0.90	1.18	125.00	0.00	0.50
5.74	79.30	1.10	1.39	125.00	0.00	0.50
5.91	70.90	1.40	1.97	120.00	0.00	0.50
6.07	54.00	1.80	3.33	120.00	0.00	0.50
6.23	37.90	2.00	5.28	115.00	0.00	0.50
6.40	31.80	2.00	6.29	115.00	0.00	0.50
6.56	29.90	1.80	6.02	115.00	0.00	0.50
6.73	27.90	1.50	5.38	115.00	0.00	0.50
6.89	31.30	1.10	3.51	115.00	0.00	0.50
7.05	41.10	0.90	2.19	120.00	0.00	0.50
7.22	42.80	0.80	1.87	120.00	0.00	0.50
7.38	36.80	1.10	2.99	115.00	0.00	0.50
7.55	26.80	1.20	4.48	115.00	0.00	0.50
7.71	20.90	1.10	5.26	115.00	0.00	0.50
7.87	18.00	1.00	5.56	115.00	0.00	0.50
8.04	16.70	0.80	4.79	115.00	0.00	0.50
8.20	15.50	0.80	5.16	115.00	0.00	0.50
8.37	14.40	0.70	4.86	115.00	0.00	0.50
8.53	14.20	0.70	4.93	115.00	0.00	0.50
8.69	15.10	0.70	4.64	115.00	0.00	0.50
8.86	16.00	0.80	5.00	115.00	0.00	0.50
9.02	15.70	0.80	5.10	115.00	0.00	0.50
9.19	15.30	0.70	4.58	115.00	0.00	0.50
9.35	15.70	0.70	4.46	115.00	0.00	0.50
9.51	16.50	0.80	4.85	115.00	0.00	0.50
9.68	17.00	0.90	5.29	115.00	0.00	0.50
9.84	17.60	0.90	5.11	115.00	0.00	0.50
10.01	19.40	1.00	5.15	115.00	0.00	0.50
10.17	20.10	1.10	5.47	115.00	0.00	0.50
10.34	22.50	1.20	5.33	115.00	0.00	0.50
10.50	24.50	1.30	5.31	115.00	0.00	0.50
10.66	27.10	1.40	5.17	115.00	0.00	0.50
10.83	27.30	1.50	5.49	115.00	0.00	0.50
10.99	27.30	1.50	5.49	115.00	0.00	0.50
11.16	29.10	1.60	5.50	115.00	0.00	0.50
11.32	32.00	1.60	5.00	115.00	0.00	0.50
11.48	35.30	1.60	4.53	115.00	0.00	0.50
11.65	35.30	1.50	4.25	115.00	0.00	0.50
11.81	36.50	1.40	3.84	115.00	0.00	0.50
11.98	35.30	1.30	3.68	115.00	0.00	0.50
12.14	31.70	1.30	4.10	115.00	0.00	0.50
12.30	23.60	1.20	5.08	115.00	0.00	0.50
12.47	20.50	1.10	5.37	115.00	0.00	0.50
12.63	20.40	1.10	5.39	115.00	0.00	0.50
12.80	20.40	1.10	5.39	115.00	0.00	0.50

12.96	18.70	1.10	5.88	115.00	0.00	0.50
13.12	20.10	1.10	5.47	115.00	0.00	0.50
13.29	23.90	1.10	4.60	115.00	0.00	0.50
13.45	29.50	1.20	4.07	115.00	0.00	0.50
13.62	33.00	1.30	3.94	115.00	0.00	0.50
13.78	37.20	1.10	2.96	115.00	0.00	0.50
13.94	52.60	0.80	1.52	120.00	0.00	0.50
14.11	56.40	0.60	1.06	120.00	0.00	0.50
14.27	57.50	0.70	1.22	120.00	0.00	0.50
14.44	61.30	0.80	1.31	120.00	0.00	0.50
14.60	59.30	0.90	1.52	120.00	0.00	0.50
14.76	58.60	0.80	1.37	120.00	0.00	0.50
14.93	51.90	1.00	1.93	120.00	0.00	0.50
15.09	42.90	1.30	3.03	115.00	0.00	0.50
15.26	33.40	1.10	3.29	115.00	0.00	0.50
15.42	77.10	1.10	1.43	120.00	0.00	0.50
15.58	151.70	2.00	1.32	125.00	0.00	0.50
15.75	179.80	2.00	1.11	125.00	0.00	0.50
15.91	146.00	1.00	0.68	125.00	0.00	0.50
16.08	128.10	1.00	0.78	125.00	0.00	0.50
16.24	90.70	1.20	1.32	120.00	0.00	0.50
16.40	57.80	1.50	2.60	120.00	0.00	0.50
16.57	42.00	1.50	3.57	115.00	0.00	0.50
16.73	41.70	1.30	3.12	115.00	0.00	0.50
16.90	45.60	1.00	2.19	120.00	0.00	0.50
17.06	47.40	0.80	1.69	120.00	0.00	0.50
17.23	46.90	0.90	1.92	120.00	0.00	0.50
17.39	43.50	1.00	2.30	120.00	0.00	0.50
17.55	46.70	1.00	2.14	120.00	0.00	0.50
17.72	50.20	1.00	1.99	120.00	0.00	0.50
17.88	58.40	1.10	1.88	120.00	0.00	0.50
18.05	65.50	1.10	1.68	120.00	0.00	0.50
18.21	73.40	1.20	1.63	120.00	0.00	0.50
18.37	76.00	1.20	1.58	120.00	0.00	0.50
18.54	77.70	1.40	1.80	120.00	0.00	0.50
18.70	82.80	1.50	1.81	120.00	0.00	0.50
18.87	75.10	1.80	2.40	120.00	0.00	0.50
19.03	84.90	1.80	2.12	120.00	0.00	0.50
19.19	90.90	1.70	1.87	120.00	0.00	0.50
19.36	73.20	1.30	1.78	120.00	0.00	0.50
19.52	49.70	1.30	2.62	115.00	0.00	0.50
19.69	29.10	1.30	4.47	115.00	0.00	0.50
19.85	22.40	1.00	4.46	115.00	0.00	0.50
20.01	18.60	0.70	3.76	115.00	0.00	0.50
20.18	17.40	0.60	3.45	115.00	0.00	0.50
20.34	17.30	0.60	3.47	115.00	0.00	0.50
20.51	17.10	0.60	3.51	115.00	0.00	0.50
20.67	17.00	0.60	3.53	115.00	0.00	0.50
20.83	17.70	0.60	3.39	115.00	0.00	0.50
21.00	19.10	0.70	3.66	115.00	0.00	0.50
21.16	19.30	0.70	3.63	115.00	0.00	0.50
21.33	19.50	0.80	4.10	115.00	0.00	0.50
21.49	20.10	0.70	3.48	115.00	0.00	0.50

21.65	19.10	0.80	4.19	115.00	0.00	0.50
21.82	18.80	0.80	4.26	115.00	0.00	0.50
21.98	19.50	1.00	5.13	115.00	0.00	0.50
22.15	27.70	1.20	4.33	115.00	0.00	0.50
22.31	29.60	1.30	4.39	115.00	0.00	0.50
22.47	29.80	1.30	4.36	115.00	0.00	0.50
22.64	28.00	1.20	4.29	115.00	0.00	0.50
22.80	23.80	1.10	4.62	115.00	0.00	0.50
22.97	21.40	0.90	4.21	115.00	0.00	0.50
23.13	18.30	0.90	4.92	115.00	0.00	0.50
23.30	18.80	0.80	4.26	115.00	0.00	0.50
23.46	33.40	0.90	2.69	115.00	0.00	0.50
23.62	38.30	1.40	3.66	115.00	0.00	0.50
23.79	34.80	1.40	4.02	115.00	0.00	0.50
23.95	54.30	1.50	2.76	115.00	0.00	0.50
24.12	125.60	1.90	1.51	120.00	0.00	0.50
24.28	135.80	2.10	1.55	125.00	0.00	0.50
24.44	137.90	2.00	1.45	125.00	0.00	0.50
24.61	159.00	2.00	1.26	125.00	0.00	0.50
24.77	190.60	2.10	1.10	125.00	0.00	0.50
24.94	198.70	1.90	0.96	125.00	0.00	0.50
25.10	165.20	1.40	0.85	125.00	0.00	0.50
25.26	112.20	1.20	1.07	125.00	0.00	0.50
25.43	66.80	1.30	1.95	120.00	0.00	0.50
25.59	41.10	1.60	3.89	115.00	0.00	0.50
25.76	28.10	1.30	4.63	115.00	0.00	0.50
25.92	22.50	0.90	4.00	115.00	0.00	0.50
26.08	19.70	0.70	3.55	115.00	0.00	0.50
26.25	19.10	0.70	3.66	115.00	0.00	0.50
26.41	19.80	0.70	3.54	115.00	0.00	0.50
26.58	18.90	0.60	3.17	115.00	0.00	0.50
26.74	18.60	0.60	3.23	115.00	0.00	0.50
26.90	18.60	0.60	3.23	115.00	0.00	0.50
27.07	19.50	1.00	5.13	115.00	0.00	0.50
27.23	39.90	1.70	4.26	115.00	0.00	0.50
27.40	52.80	2.20	4.17	115.00	0.00	0.50
27.56	81.90	2.10	2.56	120.00	0.00	0.50
27.72	81.40	2.00	2.46	120.00	0.00	0.50
27.89	44.30	1.70	3.84	115.00	0.00	0.50
28.05	26.40	1.30	4.92	115.00	0.00	0.50
28.22	24.10	1.20	4.98	115.00	0.00	0.50
28.38	44.30	1.80	4.06	115.00	0.00	0.50
28.54	60.80	1.80	2.96	115.00	0.00	0.50
28.71	43.30	1.60	3.70	115.00	0.00	0.50
28.87	24.90	1.20	4.82	115.00	0.00	0.50
29.04	17.70	0.90	5.08	115.00	0.00	0.50
29.20	15.80	0.70	4.43	115.00	0.00	0.50
29.36	17.20	0.60	3.49	115.00	0.00	0.50
29.53	20.80	1.00	4.81	115.00	0.00	0.50
29.69	28.20	1.40	4.96	115.00	0.00	0.50
29.86	35.40	2.00	5.65	115.00	0.00	0.50
30.02	41.10	2.30	5.60	115.00	0.00	0.50
30.19	48.10	2.50	5.20	115.00	0.00	0.50

30.35	52.30	2.30	4.40	115.00	0.00	0.50
30.51	57.70	1.80	3.12	115.00	0.00	0.50
30.68	64.10	1.20	1.87	120.00	0.00	0.50
30.84	65.70	1.20	1.83	120.00	0.00	0.50
31.01	58.10	1.60	2.75	115.00	0.00	0.50
31.17	46.60	2.00	4.29	115.00	0.00	0.50
31.33	39.70	2.10	5.29	115.00	0.00	0.50
31.50	38.50	2.00	5.19	115.00	0.00	0.50
31.66	31.80	2.00	6.29	115.00	0.00	0.50
31.83	30.10	1.70	5.65	115.00	0.00	0.50
31.99	27.80	1.50	5.40	115.00	0.00	0.50
32.15	27.40	1.50	5.47	115.00	0.00	0.50
32.32	32.90	1.60	4.86	115.00	0.00	0.50
32.48	29.90	1.90	6.35	115.00	0.00	0.50
32.65	32.40	1.80	5.56	115.00	0.00	0.50
32.81	29.10	1.70	5.84	115.00	0.00	0.50
32.97	31.50	1.80	5.71	115.00	0.00	0.50
33.14	31.90	2.00	6.27	115.00	0.00	0.50
33.30	36.20	2.20	6.08	115.00	0.00	0.50
33.47	41.60	2.40	5.77	115.00	0.00	0.50
33.63	41.80	2.60	6.22	115.00	0.00	0.50
33.79	46.80	2.50	5.34	115.00	0.00	0.50
33.96	51.80	2.40	4.63	115.00	0.00	0.50
34.12	66.30	2.40	3.62	115.00	0.00	0.50
34.29	87.00	2.40	2.76	120.00	0.00	0.50
34.45	96.30	2.60	2.70	120.00	0.00	0.50
34.61	94.90	2.00	2.11	120.00	0.00	0.50
34.78	99.20	1.70	1.71	120.00	0.00	0.50
34.94	82.30	2.00	2.43	120.00	0.00	0.50
35.11	50.60	2.00	3.95	115.00	0.00	0.50
35.27	36.70	2.00	5.45	115.00	0.00	0.50
35.43	54.00	1.70	3.15	115.00	0.00	0.50
35.60	65.90	1.40	2.12	120.00	0.00	0.50
35.76	74.10	1.30	1.75	120.00	0.00	0.50
35.93	70.60	1.20	1.70	120.00	0.00	0.50
36.09	61.70	1.50	2.43	115.00	0.00	0.50
36.26	40.50	1.60	3.95	115.00	0.00	0.50
36.42	29.70	1.50	5.05	115.00	0.00	0.50
36.58	29.10	1.40	4.81	115.00	0.00	0.50
36.75	35.00	1.40	4.00	115.00	0.00	0.50
36.91	31.50	1.20	3.81	115.00	0.00	0.50
37.08	25.60	0.90	3.52	115.00	0.00	0.50
37.24	22.60	0.70	3.10	115.00	0.00	0.50
37.40	20.10	0.70	3.48	115.00	0.00	0.50
37.57	18.10	0.70	3.87	115.00	0.00	0.50
37.73	18.80	0.80	4.26	115.00	0.00	0.50
37.90	20.00	0.80	4.00	115.00	0.00	0.50
38.06	19.60	0.80	4.08	115.00	0.00	0.50
38.22	19.00	0.70	3.68	115.00	0.00	0.50
38.39	17.70	0.60	3.39	115.00	0.00	0.50
38.55	16.60	0.60	3.61	115.00	0.00	0.50
38.72	16.70	0.60	3.59	115.00	0.00	0.50
38.88	17.30	0.60	3.47	115.00	0.00	0.50

39.04	16.60	0.50	3.01	115.00	0.00	0.50
39.21	15.80	0.50	3.16	115.00	0.00	0.50
39.37	16.30	0.50	3.07	115.00	0.00	0.50
39.54	16.20	0.50	3.09	115.00	0.00	0.50
39.70	14.90	0.40	2.68	115.00	0.00	0.50
39.86	14.60	0.50	3.42	115.00	0.00	0.50
40.03	16.70	0.60	3.59	115.00	0.00	0.50
40.19	18.70	0.70	3.74	115.00	0.00	0.50
40.36	18.80	0.90	4.79	115.00	0.00	0.50
40.52	25.30	1.10	4.35	115.00	0.00	0.50
40.68	27.70	1.00	3.61	115.00	0.00	0.50
40.85	22.80	0.90	3.95	115.00	0.00	0.50
41.01	18.00	0.70	3.89	115.00	0.00	0.50
41.18	15.70	0.60	3.82	115.00	0.00	0.50
41.34	15.10	0.50	3.31	115.00	0.00	0.50
41.50	14.80	0.60	4.05	115.00	0.00	0.50
41.67	16.50	0.70	4.24	115.00	0.00	0.50
41.83	16.20	0.70	4.32	115.00	0.00	0.50
42.00	16.60	0.70	4.22	115.00	0.00	0.50
42.16	16.40	0.70	4.27	115.00	0.00	0.50
42.32	17.80	0.70	3.93	115.00	0.00	0.50
42.49	17.60	0.70	3.98	115.00	0.00	0.50
42.65	17.00	0.90	5.29	115.00	0.00	0.50
42.82	20.60	1.20	5.83	115.00	0.00	0.50
42.98	25.30	1.40	5.53	115.00	0.00	0.50
43.15	23.40	1.30	5.56	115.00	0.00	0.50
43.31	21.80	1.10	5.05	115.00	0.00	0.50
43.47	20.50	0.90	4.39	115.00	0.00	0.50
43.64	18.70	1.00	5.35	115.00	0.00	0.50
43.80	21.30	1.20	5.63	115.00	0.00	0.50
43.97	29.50	1.70	5.76	115.00	0.00	0.50
44.13	23.70	1.20	5.06	115.00	0.00	0.50
44.29	18.60	0.70	3.76	115.00	0.00	0.50
44.46	16.20	0.60	3.70	115.00	0.00	0.50
44.62	14.90	0.50	3.36	115.00	0.00	0.50
44.79	14.60	0.50	3.42	115.00	0.00	0.50
44.95	15.30	0.60	3.92	115.00	0.00	0.50
45.11	17.10	0.60	3.51	115.00	0.00	0.50
45.28	17.10	0.60	3.51	115.00	0.00	0.50
45.44	17.20	0.60	3.49	115.00	0.00	0.50
45.61	16.70	0.60	3.59	115.00	0.00	0.50
45.77	17.20	0.70	4.07	115.00	0.00	0.50
45.93	18.20	0.70	3.85	115.00	0.00	0.50
46.10	20.10	0.90	4.48	115.00	0.00	0.50
46.26	23.40	0.90	3.85	115.00	0.00	0.50
46.43	24.40	0.90	3.69	115.00	0.00	0.50
46.59	22.60	0.90	3.98	115.00	0.00	0.50
46.75	22.40	1.10	4.91	115.00	0.00	0.50
46.92	33.10	1.60	4.83	115.00	0.00	0.50
47.08	40.80	1.90	4.66	115.00	0.00	0.50
47.25	53.30	1.90	3.56	115.00	0.00	0.50
47.41	59.20	1.80	3.04	115.00	0.00	0.50
47.57	58.20	1.90	3.26	115.00	0.00	0.50

47.74	51.70	2.00	3.87	115.00	0.00	0.50
47.90	42.40	2.00	4.72	115.00	0.00	0.50
48.07	35.90	2.10	5.85	115.00	0.00	0.50
48.23	32.50	1.40	4.31	115.00	0.00	0.50
48.39	23.40	0.90	3.85	115.00	0.00	0.50
48.56	22.20	0.90	4.05	115.00	0.00	0.50
48.72	24.90	1.40	5.62	115.00	0.00	0.50
48.89	35.00	2.10	6.00	115.00	0.00	0.50
49.05	41.50	2.60	6.27	115.00	0.00	0.50
49.22	46.40	2.80	6.03	115.00	0.00	0.50
49.38	47.00	2.40	5.11	115.00	0.00	0.50
49.54	41.20	1.50	3.64	115.00	0.00	0.50
49.71	26.60	0.70	2.63	115.00	0.00	0.50
49.87	18.20	0.60	3.30	115.00	0.00	0.50

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

Output Results:

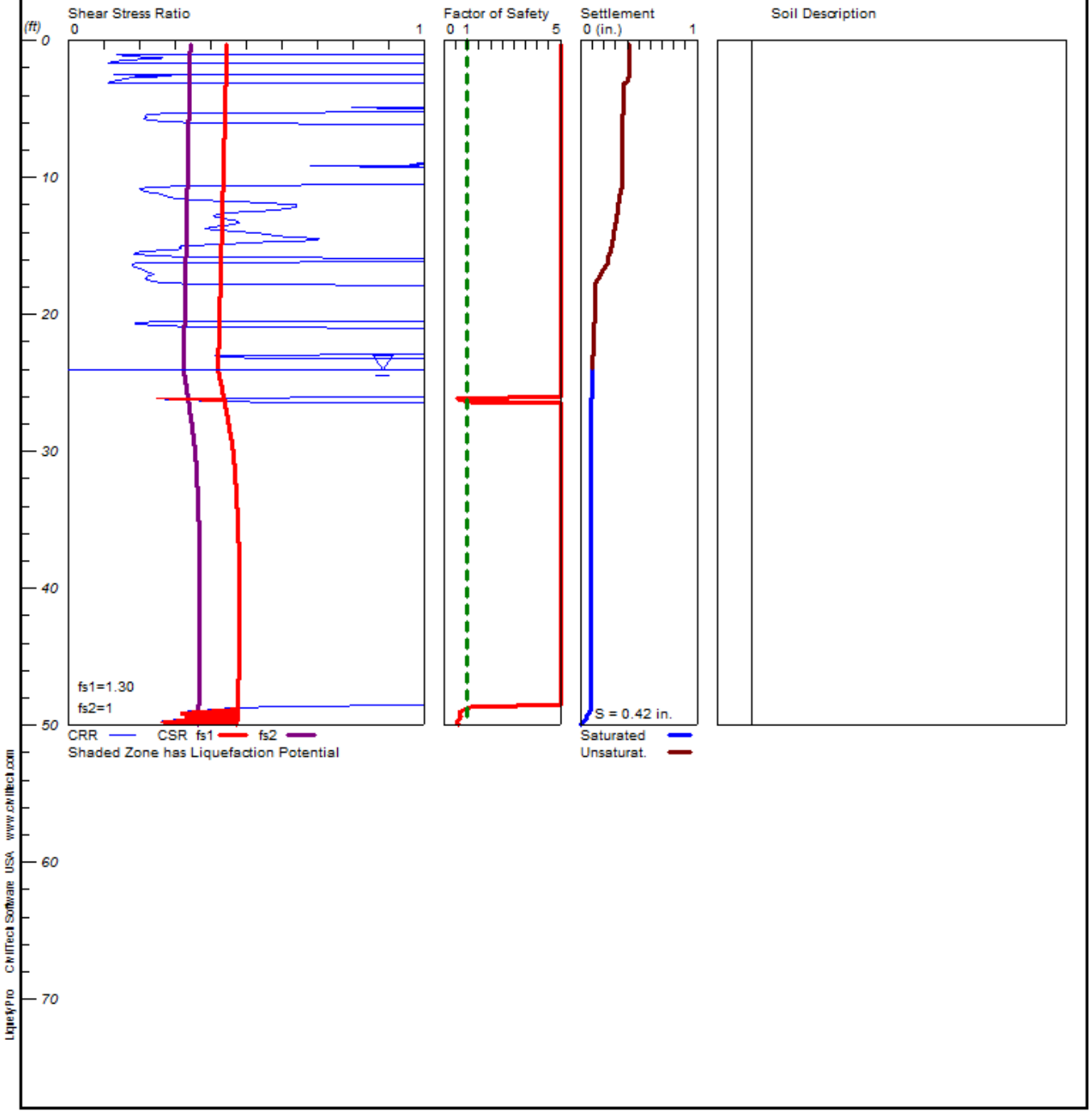
Settlement of Saturated Sands=0.19 in.
Settlement of Unsaturated Sands=0.39 in.
Total Settlement of Saturated and Unsaturated Sands=0.58 in.
Differential Settlement=0.291 to 0.384 in.

LIQUEFACTION ANALYSIS

STEM Building

Hole No.=CS-2 Water Depth=24 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.=CS-2

Depth of Hole=50.00 ft

Water Table during Earthquake= 24.00 ft

Water Table during In-Situ Testing= 24.00 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= 1.3
   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	115.00	0.00	0.50
0.49	1.10	0.00	0.00	115.00	0.00	0.50
0.66	9.40	0.00	0.00	120.00	0.00	0.50
0.82	7.90	0.00	0.00	120.00	0.00	0.50
0.98	8.20	0.00	0.00	120.00	0.00	0.50
1.15	11.80	0.20	1.69	115.00	0.00	0.50
1.31	21.70	0.30	1.38	120.00	0.00	0.50
1.48	13.60	0.10	0.74	120.00	0.00	0.50
1.64	8.40	0.00	0.00	120.00	0.00	0.50
1.80	5.60	0.00	0.00	115.00	0.00	0.50
1.97	3.60	0.00	0.00	115.00	0.00	0.50
2.13	2.10	0.00	0.00	115.00	0.00	0.50
2.30	1.90	0.00	0.00	115.00	0.00	0.50
2.46	2.50	0.00	0.00	115.00	0.00	0.50
2.62	5.30	0.10	1.89	115.00	0.00	0.50
2.79	14.20	0.20	1.41	115.00	0.00	0.50
2.95	12.50	0.10	0.80	120.00	0.00	0.50
3.12	8.30	0.00	0.00	120.00	0.00	0.50
3.28	5.80	0.00	0.00	115.00	0.00	0.50
3.45	4.10	0.00	0.00	115.00	0.00	0.50
3.61	2.90	0.00	0.00	115.00	0.00	0.50
3.77	2.60	0.00	0.00	115.00	0.00	0.50
3.94	2.30	0.00	0.00	115.00	0.00	0.50
4.10	2.50	0.00	0.00	115.00	0.00	0.50

4.27	3.00	0.00	0.00	115.00	0.00	0.50
4.43	3.10	0.00	0.00	115.00	0.00	0.50
4.59	3.40	0.00	0.00	115.00	0.00	0.50
4.76	5.20	0.20	3.85	115.00	0.00	0.50
4.92	16.80	0.60	3.57	115.00	0.00	0.50
5.09	20.20	1.00	4.95	115.00	0.00	0.50
5.25	20.60	0.70	3.40	115.00	0.00	0.50
5.41	30.70	0.50	1.63	120.00	0.00	0.50
5.58	41.10	0.40	0.97	125.00	0.00	0.50
5.74	39.40	0.40	1.02	120.00	0.00	0.50
5.91	32.70	0.70	2.14	120.00	0.00	0.50
6.07	22.30	0.80	3.59	115.00	0.00	0.50
6.23	16.00	0.80	5.00	115.00	0.00	0.50
6.40	12.70	0.50	3.94	115.00	0.00	0.50
6.56	12.10	0.40	3.31	115.00	0.00	0.50
6.73	11.30	0.50	4.42	115.00	0.00	0.50
6.89	10.80	0.40	3.70	115.00	0.00	0.50
7.05	9.80	0.30	3.06	115.00	0.00	0.50
7.22	9.40	0.30	3.19	115.00	0.00	0.50
7.38	9.40	0.30	3.19	115.00	0.00	0.50
7.55	10.30	0.30	2.91	115.00	0.00	0.50
7.71	10.90	0.40	3.67	115.00	0.00	0.50
7.87	11.70	0.40	3.42	115.00	0.00	0.50
8.04	12.10	0.50	4.13	115.00	0.00	0.50
8.20	13.10	0.60	4.58	115.00	0.00	0.50
8.37	14.20	0.70	4.93	115.00	0.00	0.50
8.53	14.60	0.70	4.79	115.00	0.00	0.50
8.69	14.70	0.70	4.76	115.00	0.00	0.50
8.86	15.60	0.60	3.85	115.00	0.00	0.50
9.02	22.50	0.90	4.00	115.00	0.00	0.50
9.19	30.00	1.00	3.33	115.00	0.00	0.50
9.35	19.70	1.10	5.58	115.00	0.00	0.50
9.51	18.70	0.90	4.81	115.00	0.00	0.50
9.68	17.80	0.90	5.06	115.00	0.00	0.50
9.84	20.00	0.90	4.50	115.00	0.00	0.50
10.01	19.10	0.90	4.71	115.00	0.00	0.50
10.17	18.10	0.90	4.97	115.00	0.00	0.50
10.34	19.90	0.90	4.52	115.00	0.00	0.50
10.50	22.40	0.80	3.57	115.00	0.00	0.50
10.66	30.40	0.70	2.30	115.00	0.00	0.50
10.83	39.80	0.60	1.51	120.00	0.00	0.50
10.99	51.10	0.60	1.17	120.00	0.00	0.50
11.16	68.90	0.60	0.87	125.00	0.00	0.50
11.32	77.00	0.50	0.65	125.00	0.00	0.50
11.48	77.60	0.60	0.77	125.00	0.00	0.50
11.65	90.30	0.70	0.78	125.00	0.00	0.50
11.81	113.10	0.90	0.80	125.00	0.00	0.50
11.98	126.40	1.00	0.79	125.00	0.00	0.50
12.14	127.50	1.00	0.78	125.00	0.00	0.50
12.30	123.90	1.00	0.81	125.00	0.00	0.50
12.47	117.90	0.90	0.76	125.00	0.00	0.50
12.63	108.90	0.80	0.73	125.00	0.00	0.50
12.80	103.10	0.80	0.78	125.00	0.00	0.50

12.96	107.60	0.80	0.74	125.00	0.00	0.50
13.12	115.30	0.80	0.69	125.00	0.00	0.50
13.29	119.20	0.80	0.67	125.00	0.00	0.50
13.45	115.70	0.80	0.69	125.00	0.00	0.50
13.62	106.80	0.80	0.75	125.00	0.00	0.50
13.78	104.30	0.80	0.77	125.00	0.00	0.50
13.94	100.40	1.40	1.39	125.00	0.00	0.50
14.11	118.70	1.30	1.10	125.00	0.00	0.50
14.27	131.70	1.10	0.84	125.00	0.00	0.50
14.44	149.80	0.80	0.53	125.00	0.00	0.50
14.60	149.20	0.40	0.27	125.00	0.00	0.50
14.76	126.90	1.00	0.79	125.00	0.00	0.50
14.93	98.40	1.00	1.02	125.00	0.00	0.50
15.09	63.20	1.30	2.06	120.00	0.00	0.50
15.26	48.40	1.20	2.48	120.00	0.00	0.50
15.42	41.00	0.70	1.71	120.00	0.00	0.50
15.58	39.20	0.60	1.53	120.00	0.00	0.50
15.75	34.70	0.80	2.31	115.00	0.00	0.50
15.91	26.70	0.80	3.00	115.00	0.00	0.50
16.08	21.30	0.70	3.29	115.00	0.00	0.50
16.24	33.10	0.60	1.81	120.00	0.00	0.50
16.40	43.20	0.60	1.39	120.00	0.00	0.50
16.57	55.90	0.60	1.07	120.00	0.00	0.50
16.73	65.50	0.70	1.07	120.00	0.00	0.50
16.90	73.10	0.70	0.96	125.00	0.00	0.50
17.06	70.80	0.90	1.27	120.00	0.00	0.50
17.23	66.20	0.80	1.21	120.00	0.00	0.50
17.39	65.30	0.80	1.23	120.00	0.00	0.50
17.55	65.20	0.90	1.38	120.00	0.00	0.50
17.72	46.50	1.10	2.37	120.00	0.00	0.50
17.88	28.80	0.90	3.13	115.00	0.00	0.50
18.05	19.20	0.70	3.65	115.00	0.00	0.50
18.21	16.40	0.40	2.44	115.00	0.00	0.50
18.37	14.90	0.40	2.68	115.00	0.00	0.50
18.54	14.90	0.50	3.36	115.00	0.00	0.50
18.70	14.80	0.50	3.38	115.00	0.00	0.50
18.87	14.40	0.40	2.78	115.00	0.00	0.50
19.03	13.80	0.40	2.90	115.00	0.00	0.50
19.19	15.30	0.50	3.27	115.00	0.00	0.50
19.36	16.40	0.60	3.66	115.00	0.00	0.50
19.52	17.30	0.60	3.47	115.00	0.00	0.50
19.69	18.00	0.60	3.33	115.00	0.00	0.50
19.85	17.50	0.60	3.43	115.00	0.00	0.50
20.01	16.40	0.60	3.66	115.00	0.00	0.50
20.18	17.60	0.70	3.98	115.00	0.00	0.50
20.34	20.40	0.80	3.92	115.00	0.00	0.50
20.51	31.40	0.70	2.23	115.00	0.00	0.50
20.67	49.80	0.70	1.41	120.00	0.00	0.50
20.83	48.20	1.10	2.28	120.00	0.00	0.50
21.00	38.30	1.30	3.39	115.00	0.00	0.50
21.16	28.50	1.20	4.21	115.00	0.00	0.50
21.33	26.50	1.10	4.15	115.00	0.00	0.50
21.49	27.90	0.90	3.23	115.00	0.00	0.50

21.65	21.90	0.90	4.11	115.00	0.00	0.50
21.82	17.90	0.80	4.47	115.00	0.00	0.50
21.98	18.60	0.70	3.76	115.00	0.00	0.50
22.15	18.20	0.60	3.30	115.00	0.00	0.50
22.31	20.50	0.70	3.41	115.00	0.00	0.50
22.47	20.00	0.80	4.00	115.00	0.00	0.50
22.64	23.60	0.80	3.39	115.00	0.00	0.50
22.80	21.60	1.00	4.63	115.00	0.00	0.50
22.97	40.90	1.10	2.69	115.00	0.00	0.50
23.13	48.30	1.40	2.90	115.00	0.00	0.50
23.30	31.80	1.10	3.46	115.00	0.00	0.50
23.46	23.40	1.20	5.13	115.00	0.00	0.50
23.62	32.20	1.30	4.04	115.00	0.00	0.50
23.79	37.60	1.40	3.72	115.00	0.00	0.50
23.95	35.10	1.50	4.27	115.00	0.00	0.50
24.12	29.70	1.30	4.38	115.00	0.00	0.50
24.28	24.30	1.10	4.53	115.00	0.00	0.50
24.44	20.40	0.80	3.92	115.00	0.00	0.50
24.61	17.50	0.60	3.43	115.00	0.00	0.50
24.77	17.00	0.50	2.94	115.00	0.00	0.50
24.94	15.60	0.60	3.85	115.00	0.00	0.50
25.10	16.10	0.70	4.35	115.00	0.00	0.50
25.26	16.70	0.60	3.59	115.00	0.00	0.50
25.43	16.40	0.60	3.66	115.00	0.00	0.50
25.59	16.00	0.50	3.13	115.00	0.00	0.50
25.76	14.90	0.40	2.68	115.00	0.00	0.50
25.92	15.50	0.70	4.52	115.00	0.00	0.50
26.08	47.40	1.00	2.11	120.00	0.00	0.50
26.25	96.20	1.80	1.87	120.00	0.00	0.50
26.41	65.70	2.10	3.20	115.00	0.00	0.50
26.58	37.40	2.00	5.35	115.00	0.00	0.50
26.74	31.50	1.30	4.13	115.00	0.00	0.50
26.90	20.20	1.00	4.95	115.00	0.00	0.50
27.07	22.60	1.30	5.75	115.00	0.00	0.50
27.23	32.00	1.70	5.31	115.00	0.00	0.50
27.40	41.00	1.70	4.15	115.00	0.00	0.50
27.56	46.70	1.80	3.85	115.00	0.00	0.50
27.72	27.40	1.40	5.11	115.00	0.00	0.50
27.89	18.40	0.90	4.89	115.00	0.00	0.50
28.05	15.70	0.50	3.18	115.00	0.00	0.50
28.22	14.60	0.50	3.42	115.00	0.00	0.50
28.38	14.30	0.40	2.80	115.00	0.00	0.50
28.54	13.90	0.40	2.88	115.00	0.00	0.50
28.71	14.40	0.50	3.47	115.00	0.00	0.50
28.87	16.40	0.70	4.27	115.00	0.00	0.50
29.04	20.20	1.00	4.95	115.00	0.00	0.50
29.20	23.80	1.20	5.04	115.00	0.00	0.50
29.36	26.40	1.40	5.30	115.00	0.00	0.50
29.53	28.20	1.50	5.32	115.00	0.00	0.50
29.69	26.50	1.50	5.66	115.00	0.00	0.50
29.86	29.20	1.50	5.14	115.00	0.00	0.50
30.02	35.10	1.60	4.56	115.00	0.00	0.50
30.19	34.80	1.60	4.60	115.00	0.00	0.50

30.35	33.50	1.60	4.78	115.00	0.00	0.50
30.51	29.90	1.40	4.68	115.00	0.00	0.50
30.68	22.50	1.10	4.89	115.00	0.00	0.50
30.84	18.90	1.10	5.82	115.00	0.00	0.50
31.01	22.30	1.30	5.83	115.00	0.00	0.50
31.17	38.50	1.90	4.94	115.00	0.00	0.50
31.33	41.60	2.20	5.29	115.00	0.00	0.50
31.50	23.40	1.10	4.70	115.00	0.00	0.50
31.66	16.10	0.50	3.11	115.00	0.00	0.50
31.83	13.50	0.50	3.70	115.00	0.00	0.50
31.99	14.10	0.40	2.84	115.00	0.00	0.50
32.15	12.80	0.50	3.91	115.00	0.00	0.50
32.32	13.80	0.40	2.90	115.00	0.00	0.50
32.48	15.00	0.50	3.33	115.00	0.00	0.50
32.65	15.70	0.60	3.82	115.00	0.00	0.50
32.81	15.30	0.60	3.92	115.00	0.00	0.50
32.97	16.10	0.60	3.73	115.00	0.00	0.50
33.14	17.80	0.60	3.37	115.00	0.00	0.50
33.30	20.00	0.90	4.50	115.00	0.00	0.50
33.47	21.30	1.00	4.69	115.00	0.00	0.50
33.63	21.50	1.10	5.12	115.00	0.00	0.50
33.79	21.60	1.20	5.56	115.00	0.00	0.50
33.96	23.90	1.30	5.44	115.00	0.00	0.50
34.12	26.80	1.50	5.60	115.00	0.00	0.50
34.29	27.00	1.50	5.56	115.00	0.00	0.50
34.45	27.30	1.60	5.86	115.00	0.00	0.50
34.61	29.20	1.70	5.82	115.00	0.00	0.50
34.78	28.10	1.50	5.34	115.00	0.00	0.50
34.94	29.20	1.80	6.16	115.00	0.00	0.50
35.11	36.10	1.90	5.26	115.00	0.00	0.50
35.27	34.60	1.90	5.49	115.00	0.00	0.50
35.43	33.90	1.70	5.01	115.00	0.00	0.50
35.60	27.50	1.70	6.18	115.00	0.00	0.50
35.76	25.80	1.50	5.81	115.00	0.00	0.50
35.93	24.20	1.40	5.79	115.00	0.00	0.50
36.09	24.40	1.20	4.92	115.00	0.00	0.50
36.26	23.60	1.10	4.66	115.00	0.00	0.50
36.42	23.00	0.90	3.91	115.00	0.00	0.50
36.58	20.40	0.90	4.41	115.00	0.00	0.50
36.75	19.40	0.90	4.64	115.00	0.00	0.50
36.91	18.80	0.90	4.79	115.00	0.00	0.50
37.08	18.00	0.80	4.44	115.00	0.00	0.50
37.24	17.30	0.70	4.05	115.00	0.00	0.50
37.40	16.60	0.60	3.61	115.00	0.00	0.50
37.57	15.70	0.60	3.82	115.00	0.00	0.50
37.73	16.10	0.40	2.48	115.00	0.00	0.50
37.90	14.00	0.50	3.57	115.00	0.00	0.50
38.06	15.00	0.50	3.33	115.00	0.00	0.50
38.22	13.90	0.50	3.60	115.00	0.00	0.50
38.39	13.80	0.40	2.90	115.00	0.00	0.50
38.55	13.80	0.40	2.90	115.00	0.00	0.50
38.72	14.00	0.40	2.86	115.00	0.00	0.50
38.88	15.10	0.60	3.97	115.00	0.00	0.50

39.04	17.60	0.70	3.98	115.00	0.00	0.50
39.21	22.00	0.70	3.18	115.00	0.00	0.50
39.37	17.80	0.70	3.93	115.00	0.00	0.50
39.54	17.10	1.00	5.85	115.00	0.00	0.50
39.70	25.60	1.50	5.86	115.00	0.00	0.50
39.86	30.50	1.60	5.25	115.00	0.00	0.50
40.03	29.40	1.50	5.10	115.00	0.00	0.50
40.19	23.70	1.30	5.49	115.00	0.00	0.50
40.36	18.70	0.90	4.81	115.00	0.00	0.50
40.52	19.30	0.50	2.59	115.00	0.00	0.50
40.68	14.30	0.40	2.80	115.00	0.00	0.50
40.85	11.60	0.30	2.59	115.00	0.00	0.50
41.01	11.00	0.20	1.82	115.00	0.00	0.50
41.18	11.40	0.20	1.75	115.00	0.00	0.50
41.34	11.60	0.20	1.72	115.00	0.00	0.50
41.50	11.20	0.30	2.68	115.00	0.00	0.50
41.67	11.80	0.30	2.54	115.00	0.00	0.50
41.83	11.80	0.30	2.54	115.00	0.00	0.50
42.00	12.10	0.30	2.48	115.00	0.00	0.50
42.16	12.30	0.30	2.44	115.00	0.00	0.50
42.32	12.10	0.40	3.31	115.00	0.00	0.50
42.49	12.40	0.40	3.23	115.00	0.00	0.50
42.65	13.00	0.40	3.08	115.00	0.00	0.50
42.82	13.00	0.30	2.31	115.00	0.00	0.50
42.98	13.10	0.30	2.29	115.00	0.00	0.50
43.15	13.40	0.40	2.99	115.00	0.00	0.50
43.31	13.80	0.40	2.90	115.00	0.00	0.50
43.47	14.00	0.40	2.86	115.00	0.00	0.50
43.64	14.10	0.40	2.84	115.00	0.00	0.50
43.80	14.20	0.40	2.82	115.00	0.00	0.50
43.97	14.70	0.40	2.72	115.00	0.00	0.50
44.13	14.70	0.40	2.72	115.00	0.00	0.50
44.29	15.60	0.50	3.21	115.00	0.00	0.50
44.46	17.00	0.60	3.53	115.00	0.00	0.50
44.62	17.30	0.80	4.62	115.00	0.00	0.50
44.79	18.60	0.80	4.30	115.00	0.00	0.50
44.95	18.60	0.80	4.30	115.00	0.00	0.50
45.11	18.60	0.80	4.30	115.00	0.00	0.50
45.28	18.40	0.70	3.80	115.00	0.00	0.50
45.44	19.20	0.80	4.17	115.00	0.00	0.50
45.61	21.50	1.10	5.12	115.00	0.00	0.50
45.77	29.50	1.20	4.07	115.00	0.00	0.50
45.93	27.80	1.50	5.40	115.00	0.00	0.50
46.10	32.70	1.50	4.59	115.00	0.00	0.50
46.26	31.80	1.40	4.40	115.00	0.00	0.50
46.43	30.20	1.20	3.97	115.00	0.00	0.50
46.59	27.60	1.00	3.62	115.00	0.00	0.50
46.75	22.90	1.20	5.24	115.00	0.00	0.50
46.92	28.00	1.40	5.00	115.00	0.00	0.50
47.08	38.40	1.90	4.95	115.00	0.00	0.50
47.25	54.80	1.90	3.47	115.00	0.00	0.50
47.41	40.60	1.60	3.94	115.00	0.00	0.50
47.57	27.20	1.40	5.15	115.00	0.00	0.50

47.74	24.20	1.40	5.79	115.00	0.00	0.50
47.90	26.00	1.20	4.62	115.00	0.00	0.50
48.07	26.30	1.40	5.32	115.00	0.00	0.50
48.23	33.60	1.70	5.06	115.00	0.00	0.50
48.39	62.90	2.30	3.66	115.00	0.00	0.50
48.56	76.60	2.60	3.39	115.00	0.00	0.50
48.72	86.70	2.70	3.11	115.00	0.00	0.50
48.89	99.40	2.50	2.52	120.00	0.00	0.50
49.05	101.70	2.00	1.97	120.00	0.00	0.50
49.22	96.80	2.00	2.07	120.00	0.00	0.50
49.38	88.90	2.10	2.36	120.00	0.00	0.50
49.54	84.40	2.00	2.37	120.00	0.00	0.50
49.71	94.50	1.60	1.69	120.00	0.00	0.50
49.87	78.50	1.70	2.17	120.00	0.00	0.50

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

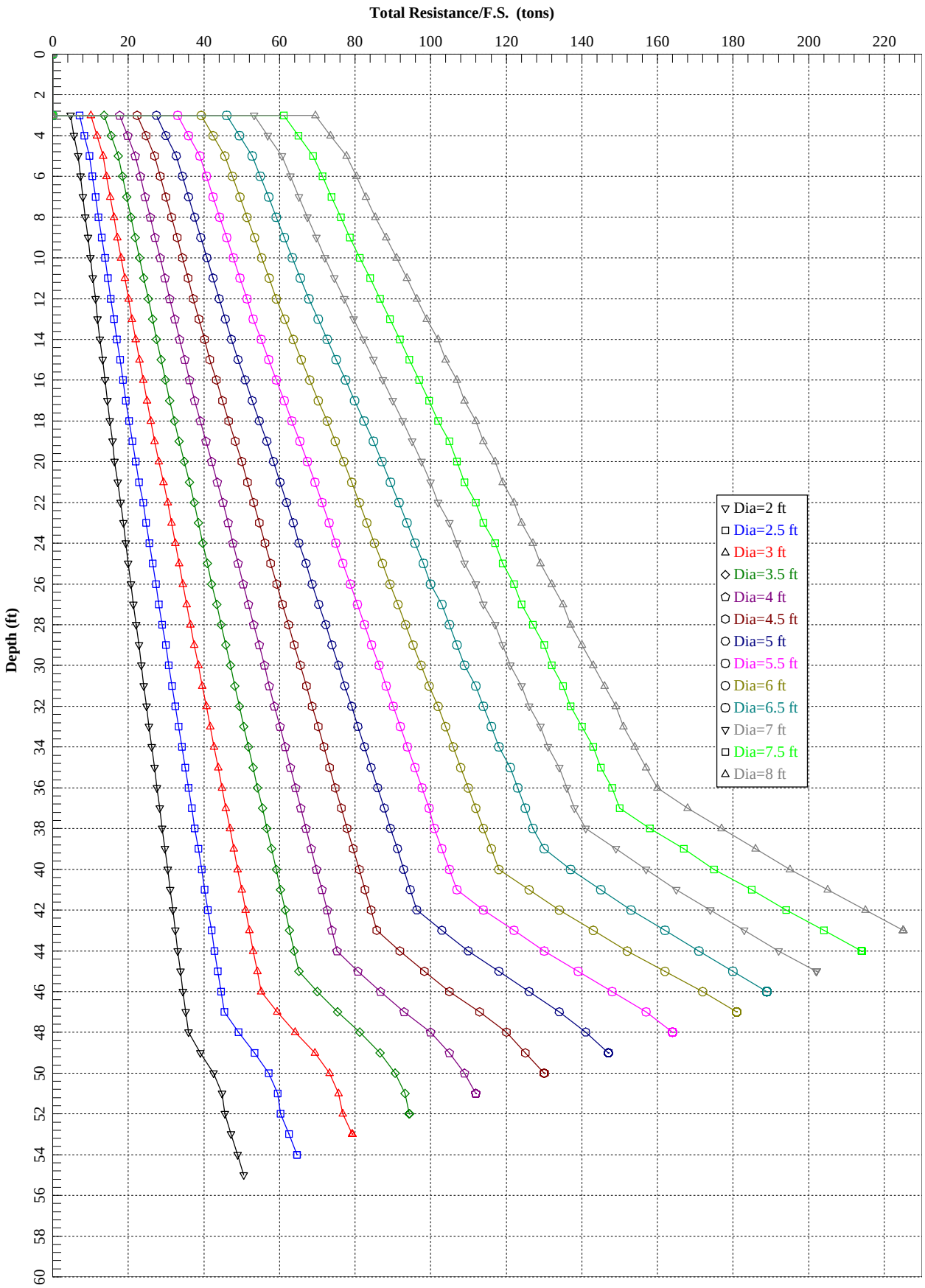
Output Results:

Settlement of Saturated Sands=0.10 in.
Settlement of Unsaturated Sands=0.32 in.
Total Settlement of Saturated and Unsaturated Sands=0.42 in.
Differential Settlement=0.209 to 0.276 in.

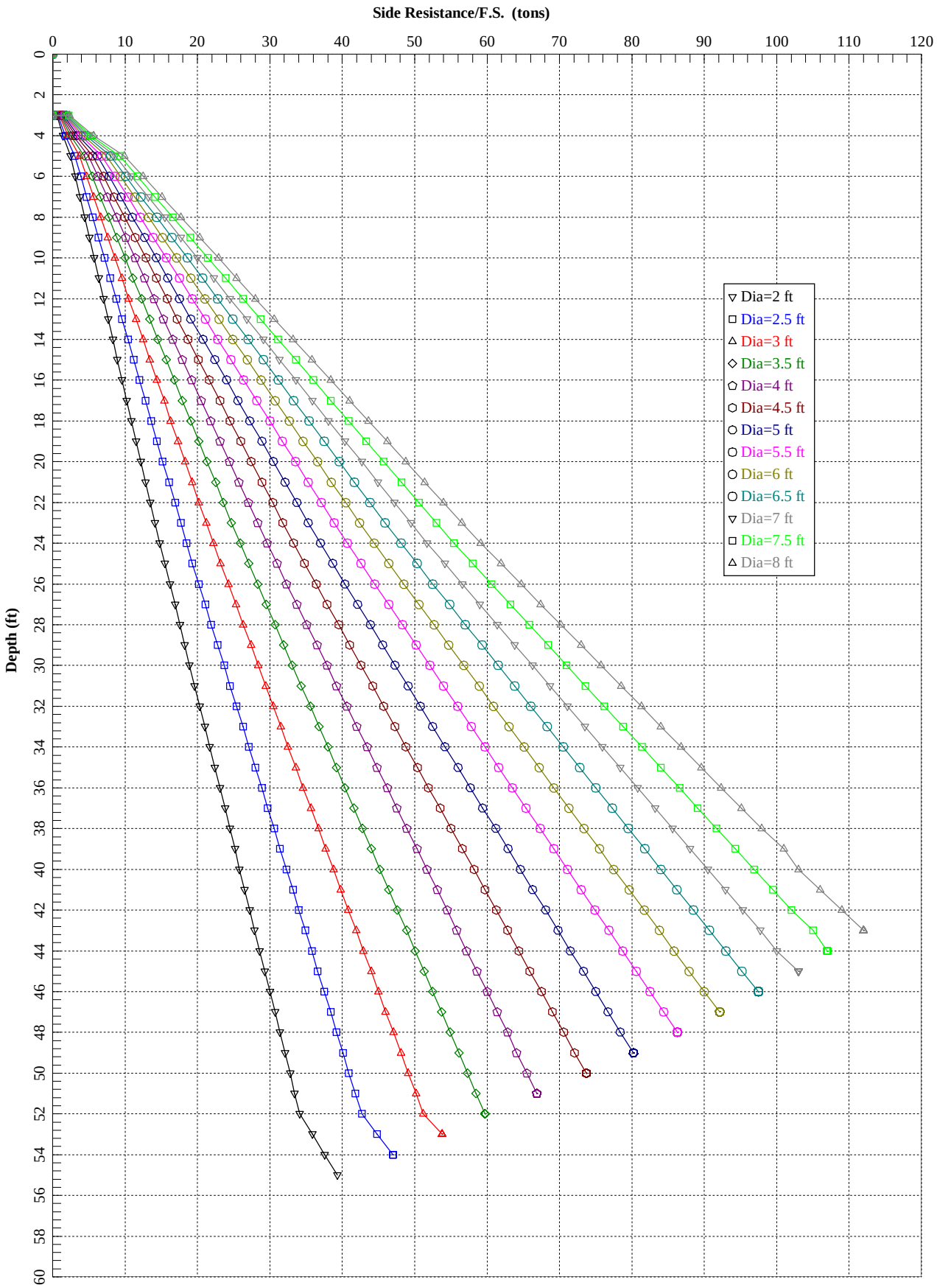
APPENDIX E

SHAFT CAPACITY GRAPHS

Allowable Axial Compression Capacity



Allowable Skin Friction Capacity



Axial Load versus Settlement