APPENDIX E

Geotechnical Report

Geotechnical Engineering Report

Mission Bell Center Mixed Use Project
DE MBELL
1101 Mission Street
South Pasadena, California

July 2, 2018
Terracon Project No. 60185094

Prepared for:
CFT NV Developments LLC
Rosemead, California

Prepared by:
Terracon Consultants, Inc.
Tustin, California

July 2, 2018

CFT NV Developments LLC
1683 Walnut Grove Ave
Rosemead, California 91770

Attn: Mr. Charlie Shen
P: 626.799.9898
E: Charlie.shen@pandarg.com

Re: Geotechnical Engineering Report
Mission Bell Center Mixed Use Project (DE MBELL)
1101 Mission Street
South Pasadena, California
Terracon Project No. 60185094

Dear Mr. Shen:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with the signed task order dated, May 18, 2018.

This geotechnical engineering report presents the results of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of new foundations, floor slabs, infiltration systems and pavement 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.

PROFESSIONAL ENGINEER
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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

EXECUTIVE SUMMARY

A geotechnical exploration has been performed for the proposed mixed-use building to be located at 1101 Mission Street, South Pasadena, California. Terracon's geotechnical scope of work included the advancement of five (5) test borings to approximate depths of 21½ and 92 feet below existing site grades (bgs).

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

- Based on the results of the borings, subsurface conditions encountered on the project site generally consist of predominantly medium dense to very dense sand with variable amounts of silt and clay to the maximum depth explored at 92 feet bgs. Intermittent clay layers with varying amounts of sand were encountered within borings B-1, B-3, P-1, and P-2.
- Groundwater was not encountered in the test borings at the time of field exploration.
- Seismically-induced settlement of dry sands is expected to be on the order of one inch and differential settlement is between ½ and ¾ inch below the basement level.
- Basement levels are proposed to be at an approximate depth of 20 feet bgs within the majority of the project site. Based on this, the soils beneath the foundations and floor slabs at the basement level should be scarified, moisture conditioned and compacted to a minimum depth of 10 inches.
- Light (automobile) parking areas – 3" AC over 4" Class II AB or 5" PCC; On-site driveways and delivery areas – 3" AC over 7" Class II AB or 6" PCC. All pavements should be supported on a minimum of 10 inches of scarified, moisture conditioned, and compacted materials.
- The 2016 California Building Code (CBC) seismic site classification for this site is C.
- 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
MISSION BELL CENTER MIXED USE PROJECT
1101 MISSION STREET
SOUTH PASADENA, CALIFORNIA
Terracon Project No. 60185094
June 4, 2018

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the proposed new three-story mixed-use building with two basement level to be located at 1101 Mission Street, South Pasadena, 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 systems

Our geotechnical engineering scope of work for this project included the advancement of three (5) test borings to approximate depths of 21½ and 92 feet bgs. Two (2) of the borings were utilized for percolation testing.

Logs of the borings along with a Boring Location Diagram (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 Diagram (Exhibit A-2 in Appendix A).
Proposed Project and Structures	The project will include the construction of a mixed-use building comprised of two basement levels and three levels above ground. The total area of the project site is about 31,113 SF. The gross commercial and residential areas of each levels are presented below: ■ Level 1: 14,904 SF (Excluding the historic building) ■ Level 2: 16,017 SF ■ Level 3: 13,576 SF Both basement levels will be developed with parking stalls.
Finished Floor Elevation	The finish floor of the basement is anticipated to be at an approximate depth of 20 feet bgs.
Maximum Loads (assumed)	Columns: 200 to 350 kips Walls: 3 to 4 klf Slabs: 150 psf max
Grading	Grading will include excavations below existing grade to accommodate two basement levels. The excavation height is anticipated to be between 20 and 25 feet bgs.
Traffic Loading	Assumed Design Traffic Index (TI's): Automobile Parking Areas: 4.5 On-site Driveways and Delivery Areas: 6.0

2.2 Site Location and Description

Item	Description
Location	This project site is located at the 1101 Mission Street, South Pasadena, California
Existing improvements	The project site is occupied by multiple buildings with associated pavements. A historic building is located at the northeast corner of the project site. This historic building will be kept in place and will not be modified.
Surrounding developments	North: Mission Street South: Commercial buildings with parking and El Centro Street East: Commercial buildings with parking and Fremont Avenue West: Fairview Avenue
Current ground cover	Asphalt pavements and concrete hardscape
Existing topography	Relatively level project site

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The site is situated within the eastern Transverse Range Geomorphic Province in Southern California. Geologic structures within the Transverse Ranges Province trend mostly east west, in contrast to the prevailing northwest trend elsewhere in the state. The Transverse Range Province contains the highest peaks composed of pre-Phanerozoic rocks south of the Sierra Nevada, four of the eight islands off the southern California coast, and is both bounded and transected by several major fault zones. [1, 2] Surficial geologic units mapped at the site consists of Quaternary recent alluvium deposits. [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. Based on the results of the borings, subsurface conditions encountered on the project site generally consist of predominantly medium dense to very dense sand with variable amounts of silt and clay to the maximum depth explored at 92 feet bgs. Intermittent clay layers with varying amounts of sand were encountered within borings B-1, B-3, P-1, and P-2.

Laboratory tests were conducted on selected soil samples and the test results are presented in Appendix B and on the boring logs. Atterberg limit test results indicate that the near surface materials exhibit non to low plasticity. A Direct shear test was performed on materials encountered at the approximate depth of 10 feet and indicated an ultimate friction angles of 32 degrees with a corresponding cohesion of 204 psf.

3.3 Groundwater

Groundwater was not encountered in the test borings 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.

Based on the County of Los Angeles, Department of Publics Works groundwater data, the groundwater level in the project vicinity ranges between 94.3 and 123.8 feet bgs between 1980 and 2007.[4]

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[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] State of California – Division of Mines and Geology*, Geologic Map of California, Olaf P. Jenkins Edition, Los Angeles Sheet,* Compilation by Charles W. Jennings in 1962.

[4] County of Los Angeles, Department of Publics Works, groundwater monitoring well No. 4067FF. The well is located about 6,940 feet northwest of the project site.

3.4 Seismic Considerations

3.4.1 Seismic Site Classification

DESCRIPTION	VALUE
2016 California Building Code Site Classification (CBC)	C
Site Latitude	34.1157°
Site Longitude	-118.1548°
S_s Spectral Acceleration for a Short Period	2.814g
S_1 Spectral Acceleration for a 1-Second Period	0.984g
F_a Site Coefficient for a Short Period	1.000
F_v Site Coefficient for a 1-Second Period	1.300

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. As calculated using the USGS Unified Hazard Tool, the Elysian Park Fault is considered to have the most significant effect at the site from a design standpoint. This fault is located approximately 6.5 kilometers from the site and has a maximum credible earthquake magnitude of 6.5.

Based on the USGS Design Maps Summary Report, using the American Society of Civil Engineers (ASCE 7-10) standard, the peak ground acceleration (PGA_M) at the project site is expected to be 1.076. Based on the USGS Unified Hazard Tool, the project site has a mode magnitude of 6.9. Furthermore, the site is not located within an Alquist-Priolo Earthquake Fault Zone based on our review of the State Fault Hazard Maps.[5]

3.4.3 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 Geological Survey (CGS) has designated certain areas as potential liquefaction hazard zones. These are areas considered at a risk of liquefaction-related ground failure during a seismic event, based upon mapped surficial deposits and the presence of a relatively shallow water table.

[5] 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.

The project site is not located within a liquefaction potential zones as indicated by the CGS. However, in order to evaluate the dry sand settlements, liquefaction analyses were performed below the basement level. Seismically-induced settlement of dry sands is expected to be on the order of one inch and differential settlement is between ½ and ¾ inch below the basement level.

3.5 Percolation Test Results

Two (2) in-situ percolation tests (falling head borehole permeability) were performed to approximate depths of 15 and 30 feet 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 the entire amount of water added to the borings had infiltrated into the ground. At the beginning of each test, the pipes were refilled with water and readings were taken at standardized time intervals. Percolation rates are provided in the following table:

TEST RESULTS			
Test Location (depth, feet bgs)	**Slowest Measured Percolation Rate (in/hr)**	**Correlated Infiltration Rate* (in/hr)**	**Water Head (in)**
P-1 (10 to 15 ft)**	43	3.3	51
P-2 (25 to 30 ft)	112	11.3	44

*If the proposed infiltration systems will mainly rely on vertical downward seepage, the correlated infiltration rates should be used. The correlated infiltration rates were calculated using the Los Angeles County Reduction Factor method.
** Boring was drilled to 20 feet and due to the caving, the testing was done between 10 and 15 feet bgs.

Based on our test results, the correlated infiltration rates were found to be greater than 0.3 in/hr between depths of 10 to 15 feet and 25 to 30 feet bgs. Since the project site is not located within the liquefaction potential hazard zone, infiltration onsite may be considered feasible from geotechnical standpoint.

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. The designer should take into consideration the variability of the native soils when selecting appropriate design rates. 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 at least 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 exposure class S0 in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 19.

Laboratory test results indicate the on-site soils have pH of 8.42, minimum resistivity of 3,104 ohm-centimeters, a water soluble sulfates contents of 0.01%, Red-Ox potential of +661 mV, chloride content of 27 ppm, and negligible sulfides as shown on the attached Results of Corrosivity Analysis sheet. These values should be used to evaluate corrosive potential of the on-site soils to underground ferrous metals.

Refer to the Results of Corrosivity Analysis sheet 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 the recommendations provided in this report are implemented during design and construction. Based on the geotechnical engineering analyses, subsurface exploration, and laboratory test results, the proposed new building may be supported on a shallow foundation system.

Basement levels are proposed to be at an approximate depth of 20 feet bgs within the majority of the project site. Based on this, the soils beneath the foundations and floor slabs at the basement levels should be scarified, moisture conditioned and compacted to a minimum depth of 10 inches.

Based on the findings summarized in this report, it is our professional opinion that the proposed construction will not be subject to a hazard from settlement, slippage, or landslide, provided the recommendations of our report are incorporated into the proposed construction. It is also our opinion that the proposed construction will not adversely affect the geologic stability of the site or adjacent properties provided the recommendations contained in our report are incorporated into the proposed construction.

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 and pavements are contingent upon following the recommendations outlined in this section. All grading for the proposed building should incorporate the limits of the building plus a lateral distance of 3 feet.

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 pavements, demolition debris, and other deleterious materials from proposed building area. 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 remaining underground utilities 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 and pavements should be removed from the site and not be allowed for use as on-site fill. However, if the contractor desires to crush on-site pavements and concrete and use it as engineered fill, the crushed materials should be evaluated in accordance to Section 4.2.3 of the report.

Although fill materials and underground facilities such as septic tanks, cesspools, basements, other utility lines were not observed during the site reconnaissance, such features could be encountered during construction. If underground facilities or unanticipated fill materials are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

4.2.2 Subgrade Preparation

The soils beneath the foundations and floor slabs at the basement level should be scarified, moisture conditioned and compacted to a minimum depth of 10 inches.

Other over-excavation bottoms, 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.

Subsequent to clearing, grubbing, and removal of topsoil and existing pavements, subgrade soils beneath exterior slabs and pavements should be scarified, moisture conditioned, and compacted to a minimum depth of 10 inches per Section 4.2.4 requirements. The moisture content and compaction of subgrade soils should be maintained until slab or pavement 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 soils are considered suitable to be used as engineered fill onsite. On-site soils or imported materials may be used as engineered fill materials in the following areas:

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

Imported soils should conform to low volume change materials as indicated in the following specifications:

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

- 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 eight 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**
Imported low volume change or onsite materials:			
Beneath shallow foundations:	90%	-1%	+4%
Beneath slabs:	90%	-1%	+4%
Utility trenches*:	90%	-1%	+4%
Beneath pavements:	95%	-1%	+4%
Bottom of excavation to receive fill:	90%	-1%	+4%
Miscellaneous backfill:	90%	-1%	+4%
Aggregate base (beneath pavements):	95%	-2%	+2%

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

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 pavements should be sealed or eliminated. In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately 5 percent for at least 10 feet from perimeter walls.

Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration. We recommend a minimum horizontal setback distance of 15 feet from the perimeter of the building and the high-water elevation of the nearest water source.

It is our understanding that deep infiltration will be utilized onsite through dry wells. Deep infiltration should be located at a minimum lateral distance of 15 feet from any proposed or deep foundations or basement wall. The location of infiltration systems should not cause potential pressures on basement walls. Terracon should review the design of the proposed infiltration systems and their proximity to the existing and proposed structures.

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

4.2.6 Exterior Slab Design and Construction

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

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

4.2.7 Utility Trenches

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

On-site materials are considered suitable for backfill of utility and pipe trenches from one foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances. Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

4.2.8 Construction Considerations

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable. However, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Some additional effort may be necessary to excavate into dense materials, particularly in deep narrow excavations such as utility trenches. Consideration should be given to obtaining a unit price for difficult excavation in the contract documents for the project.

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

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

The exposed subgrade and each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the geotechnical engineer's representative prior to placement of additional lifts. We recommend that each lift of fill be tested for density and moisture content at a frequency of one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. We recommend one density and moisture content test for every 50 linear feet of compacted utility trench backfill.

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 mitigation 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

Based on the geotechnical engineering analyses, subsurface exploration, and laboratory test results, the proposed new building may be supported on spread foundation system. Due to the close proximity to the adjacent existing buildings, the existing adjacent buildings will impose a surcharge load on to the proposed spread footings.

For design purposes, a 45-degree angle line may be superimposed downward from the edge of the base of the existing building footings to simulate the stress bulb distribution of the existing footings. If this line intersects the new footings and below-grade walls, the new footings and walls should be designed for the surcharge load.

If new foundations are constructed adjacent to the existing foundations at neighboring properties, there is a risk that the bearing material could become undermined and/or overstressed due to overlapping stresses. Provisions should be made during construction to prevent undermining or disturbing the soils supporting existing foundations. If excavations extend below an imaginary 1H:1V inclined plane projecting below the bottom edge of any adjacent existing foundations, they should be shored as recommended in this report.

Maintaining a sufficient clear distance between new and existing foundations will reduce the potential for increased bearing stresses and additional foundation settlement. Connections between the existing building and the new addition should allow for some differential movement.

Design recommendations for the proposed foundation system are as follows:

DESCRIPTION	RECOMMENDATION
Foundation Type	Conventional Shallow Spread Footings
Bearing Material	Minimum 10 inches of scarified, moisture conditioned and compacted subgrade
Allowable Bearing Pressure	5,000 psf
Depth to the Basement Level	About 20 feet below the existing ground
Minimum Dimensions	Walls: 18 inches; Columns: 24 inches
Minimum Embedment Depth Below Finished Grade	18 inches
Total Estimated Settlement	1 inch
Estimated Differential Settlement	½ inch across 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.

Foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of control joints at openings or other discontinuities in masonry walls is recommended.

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

4.4 Floor Slab

DESCRIPTION	RECOMMENDATION
Interior floor system	Slab-on-grade concrete
Floor slab support	Minimum 10 inches of scarified, moisture conditioned and compacted subgrade
Subbase	Minimum 4-inches of Aggregate Base
Modulus of subgrade reaction	200 pounds per square inch per inch (psi/in) (The modulus was obtained based on estimates obtained from NAVFAC 7.1 design charts). This value is for a small loaded area (1 Sq. ft or less) such as for forklift wheel loads or point loads and should be adjusted for larger loaded areas.

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 wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer 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

The lateral earth pressure recommendations herein are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever or gravity type concrete walls. These lateral earth pressure recommendations are also applicable for the design of lateral loading against foundation walls.
These recommendations are not applicable to the design of geogrid-reinforced-backfill walls. Recommendations covering these types of wall systems are beyond the scope of services for this project; however, we are available to develop recommendations for the design of such wall systems upon request.

For on-site materials above any free water surface, recommended equivalent fluid pressures for unrestrained foundation elements are:

ITEM	ENGINEERED FILL COMPRISED OF ONSITE SOILS
Active Case	37 psf/ft
Passive Case	390 psf/ft
At-Rest Case	56 psf/ft
Surcharge Loads	0.33*(Surcharge)
Coefficient of Friction	0.4*
* Use 0.3 if used in conjunction with passive lateral earth pressure	

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.

Total lateral earth pressures acting on the basement walls during a seismic event will likely include the active or at-rest static forces and a dynamic increment. The active dynamic increment should be applied to unrestrained walls as resultant force acting at 0.6H height from the base of the wall. Such increment should be added to the static earth pressures. The dynamic lateral earth resultant force (for a 1.076g peak ground acceleration) is $24H^2$ (in units of pounds per linear foot (plf), where H (in units of feet) is the height of the soil behind the wall. The at-rest dynamic increment should be applied to restrained walls as resultant force acting at 0.45H height from the base of the wall. Such increment should be added to the static earth pressures. The dynamic lateral earth resultant force (for a 1.076g peak ground acceleration) is $39H^2$ (in units of plf), where H (in units of feet) is the height of the soil behind the wall.

The design of retaining structures and shoring systems should consider surcharge loads imposed on the foundations. In addition, the design should take into consideration new footing loads and anticipated vehicular loads in the vicinity of the proposed basement walls. In general, surcharge loads should be considered where they are located within a horizontal distance behind the wall equal to the height of the wall.

Surcharge loads acting at the top of the wall should be applied to the wall over the backfill as a uniform pressure over the entire wall height, and should be added to the static earth pressures. Surcharge stresses due to point loads, line loads, and those of limited extent, such as compaction equipment, should be evaluated using elastic theory.

Adequate drainage should be provided behind the retaining walls to collect water from irrigation, landscaping, surface runoff, or other sources, to achieve a free-draining backfill condition. The wall back drain should consist of Class 2 permeable materials[6] that are placed behind the entire wall height to within 18 inches of ground surface at the top of the wall. As a minimum, the width of Class 2 permeable materials behind the wall should be two feet. As an alternative, drainage panels/mats may be used in lieu of the Class 2 permeable materials. Water collected by the back drain should be directed to an appropriate outlet, such as perforated pipes, for disposal.

For the design of braced shoring, we recommend such shoring be designed using a rectangular-shaped distribution of lateral earth pressure of 24H psf, where H (in units of feet) is the height of the braced shoring. Surcharge loads from the nearby buildings should be also considered in the design of the shoring.

Fill against foundation and retaining walls should be compacted to densities specified in Earthwork section of this report. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Over-compaction may cause excessive lateral earth pressures which could result in wall movement.

The design of the shored excavation should be performed by an engineer knowledgeable and experienced with the on-site soil conditions. The contractor should be aware that slope height, slope inclination or excavation depths should in no case exceed those specified in local, state or federal safety regulations, e.g. OSHA Health and Safety Standards for Excavation, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if not followed, the owner or the contractor could be liable for substantial penalties.

4.6 Below Grade Structures Considerations

Based on our understanding of the project, we anticipate that excavations up to 25 feet below existing grade are planned for this project. The sides of below grade structure excavations may either be sloped or formed with vertical cuts. For vertical sided excavations greater than 5 feet in depth, the excavations will require the use of shoring, bracing or some form of retention to prevent sloughing and caving of the soil into the excavation.

[6] In accordance with the requirements and specifications of the State of California Department of Transportation.

As a safety measure, no equipment should be operated within 5 feet of the edge of the excavation and no materials should be stockpiled within 10 feet of the excavation. Excavations should not approach closer than a distance equal to the depth of excavation from existing structures/facilities without some form of protection for the facilities. Proper berming or ditching should be performed to divert any surface runoff away from the excavation.

4.7 Pavements

4.7.1 Design Recommendations

An estimated design R-Value 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)*	
	Automobile Parking Areas Assumed Traffic Index (TI) = 4.5	**On-Site Driveways and Delivery Areas Assumed TI = 6.0**
Section I Portland Cement Concrete (600 psi Flexural Strength)	5.0-inches PCC	6.0-inches PCC
Section II Asphaltic Concrete	3-inches AC over 4-inches Class II Aggregate Base	3-inches AC over 7-inches Class II Aggregate Base

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

All pavements should be supported on a minimum of 10 inches of scarified, moisture conditioned, and compacted materials. 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.

Subsequent to clearing, grubbing, and removal of topsoil, subgrade soils beneath all pavements should be scarified, moisture conditioned, and compacted to a minimum depth of 10 inches. All materials should meet the CALTRANS Standard Specifications for Highway Construction. Aggregate base materials should meet the gradation and quality requirement of Class 2 Aggregate Base (¾ inch maximum) in Caltrans Standard Specifications, latest edition, Sections 25 through 29.

All concrete for rigid pavements should have a minimum flexural strength of 600 psi (4,250 psi Compressive Strength), 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.

4.7.2 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.

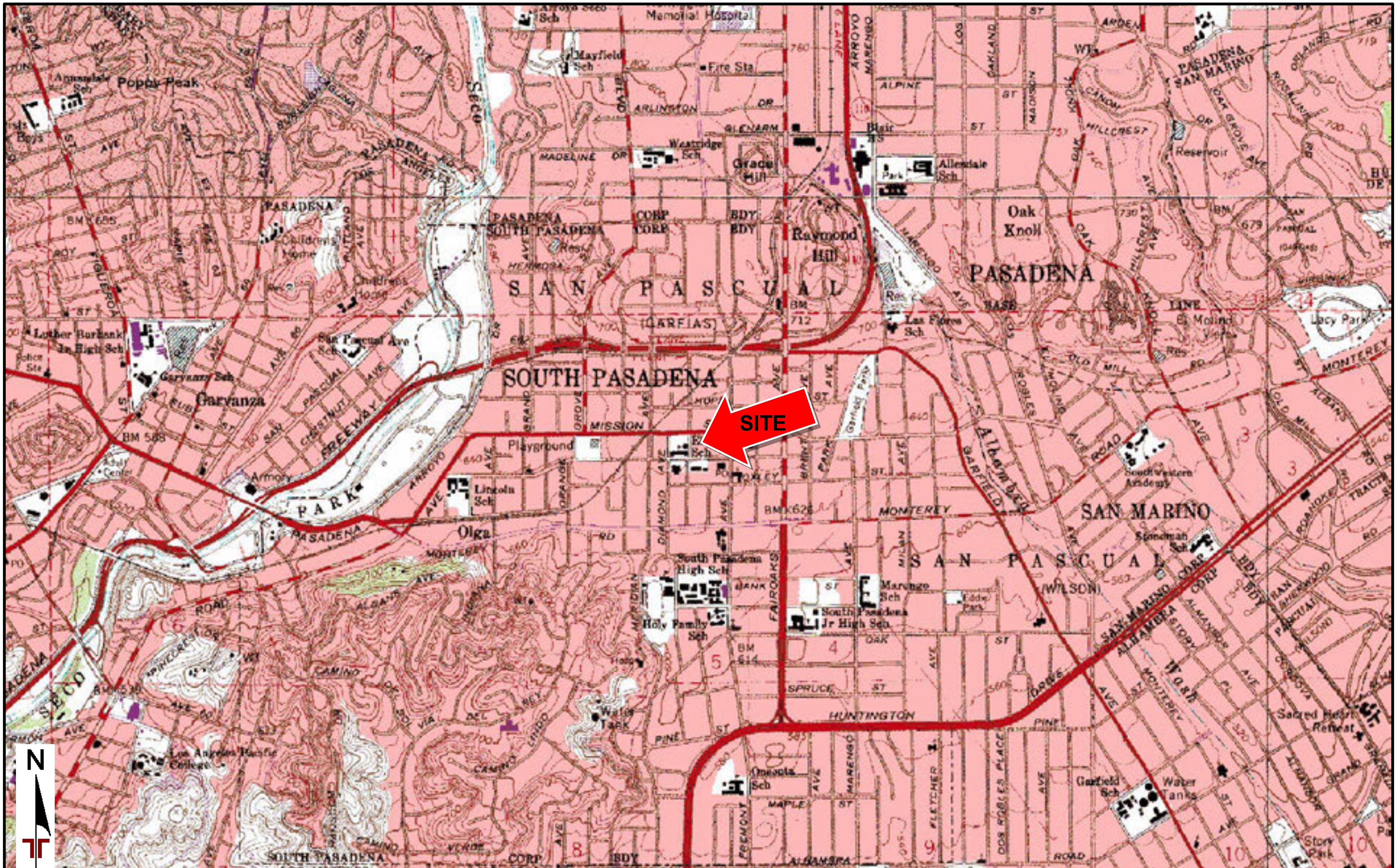
The analysis and recommendations presented in this report are based upon the data obtained from the borings and test performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due 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: PASADENA, CA (1/1/1995), MOUNT WILSON, CA (1/1/1995), LOS ANGELES, CA (1/1/1994) and EL MONTE, CA (1/1/1994).
DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: SP	Project No. 60185094
Drawn by: SP	Scale: 1"=2,000'
Checked by: FFB	File Name: A-1 & A-2
Approved by: FFB	Date: June 2018

Terracon
1421 Edinger Ave, Ste C
Tustin, CA 92780-6287

SITE LOCATION

Mission Bell Center Mixed Use Project
1101 Mission Street
South Pasadena, CA

Exhibit
A-1

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

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

Project Manager:	SP
Drawn by:	SP
Checked by:	FFB
Approved by:	FFB

Project No.	60185094
Scale:	AS SHOWN
File Name:	A-1 & A-2
Date:	June 2018

Terracon

1421 Edinger Ave, Ste C
Tustin, CA 92780-6287

EXPLORATION PLAN

Mission Bell Center Mixed Use Project
1101 Mission Street
South Pasadena, CA

Exhibit

A-2

Field Exploration Description

A total of five (5) test borings were performed at the site on June 1 and 4, 2018. The borings were drilled to approximate depths of 21½ and 92 feet bgs. The approximate locations of the borings are shown on the attached Boring Location Diagram, Exhibit A-2. Test borings were advanced with a truck-mounted CME-75 drill rig utilizing 8-inch diameter hollow-stem augers. Two of the borings were utilized for percolation testing.

The borings were located in the field by using the proposed site plan, an aerial photograph of the site, GPS handheld device and measuring from reference features. 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: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1156° Longitude: -118.1548°

DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.9	**ASPHALT**, 11-inch thickness											
1.6	**AGGREGATE BASE COURSE**, 8-inch thickness											
5.0	**SANDY LEAN CLAY (CL)**, trace gravel, mottled light brown and brown											
	SILTY CLAYEY SAND (SC-SM), medium dense	5			4-4-9 N=13						23-19-4	
10.0												
	SILTY SAND (SM), trace gravel, brown, medium dense	10			6-15-30				13	118	NP	36
15.0												
	POORLY GRADED SAND WITH SILT (SP-SM), trace gravel, brown very dense	15			15-24-27 N=51							10
	trace clay				50/6"				8	122		
		20			27-50/6"				4	108		
		25										

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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
Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-01-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-4

BORING LOG NO. B-1

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1156° Longitude: -118.1548°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), trace gravel, brown *(continued)*				25-33-32 N=65							
		30			27-50/4.5"				5	112		
		35										
		40			18-50/6"							
		45										
		50										

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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
Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-01-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-4

BORING LOG NO. B-1

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC Rosemead, CA

SITE: 1101 Mission Street South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1156° Longitude: -118.1548°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), trace gravel, brown *(continued)*			X	25-34-50 N=84							
		55										
		60		X	25-45-40 N=85							
		65										
	dense	70		X	14-22-16 N=38							
		75										

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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

Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-01-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-4

BORING LOG NO. B-1

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1156° Longitude: -118.1548°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), trace gravel, brown *(continued)*											
	80.0	80										
	POORLY GRADED SAND (SP), trace clay and gravel, brown, very dense			X	17-29-50 N=79							
		85										
		90		X	19-31-38 N=69							
	92.0											
	Auger Refusal at 92 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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
Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-01-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-4

BORING LOG NO. B-2

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1154° Longitude: -118.155°

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**ASPHALT**, 6-inch thickness											
0.8	**AGGREGATE BASE COURSE**, 4-inch thickness											
5.0	**POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC)**, brown											
	SILT WITH SAND (ML), light brown, stiff	5			6-6-6 N=12						NP	75
10.0												
	SILTY SAND (SM), trace gravel, light brown dense	10			12-19-27 N=46							14
	very dense	15			15-28-50/5"							
	trace clay				50/6"				7	122		
	dense	20			34-29-36				4	120		
		25										

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

Hammer Type: Automatic

Advancement Method: Hollow Stem Auger Abandonment Method: Boring backfilled with Auger Cuttings; Surface capped with asphalt	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

Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC Rosemead, CA

SITE: 1101 Mission Street South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1154° Longitude: -118.155°

DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), trace gravel, light brown *(continued)* very dense, trace clay				50/6"				6	117		
	30			29-31-31 N=62							
	35			15-28-32 N=60							
	40			42-42-27 N=69							
	45			28-50/6"							
	50										

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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

Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 34.1154° Longitude: -118.155° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	50.5				50/6"							
	Boring Terminated at 50.5 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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

Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-5

BORING LOG NO. B-3

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1554° Longitude: -118.1545°

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.6	**ASPHALT**, 7-inch thickness											
1.0	**AGGREGATE BASE COURSE**, 5-inch thickness											
	SANDY SILTY CLAY (CL-ML), with gravel, brown											
	hard	5			7-13-22 N=35				7	119	23-19-4	
7.5	**POORLY GRADED SAND (SP)**, trace clay and gravel, light brown											
	medium dense	10			12-13-14 N=27							
		15			7-12-16 N=28							
19.0	**SILTY CLAYEY SAND (SC-SM)**, brown											
	dense	20			14-10-24 N=34						27-20-7	47
	very dense				40-50/4"				6	109		
25.0		25										

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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
Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-6

BORING LOG NO. B-3

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1554° Longitude: -118.1545°

DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
POORLY GRADED SAND WITH SILT (SP-SM), trace gravel, light brown, very dense				50/6"				3	119		12
trace clay	30			34-50/5"				3	107		
trace gravel	35			21-31-34 N=65							
	40			21-35-40 N=75							
	45			3.5-50/6"							
50.0	50										

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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
Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-6

BORING LOG NO. B-3

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC Rosemead, CA

SITE: 1101 Mission Street South Pasadena, CA

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 34.1554° Longitude: -118.1545° DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDY LEAN CLAY (CL), brown, hard 51.5			X	20-12-20 N=32							
	Boring Terminated at 51.5 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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

Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 06-04-2018	Boring Completed: 06-04-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-6

BORING LOG NO. P-1

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC
Rosemead, CA

SITE: 1101 Mission Street
South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1153° Longitude: -118.155°

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.4	**ASPHALT**, 5-inch thickness											
0.7	**AGGREGATE BASE COURSE**, 3-inch thickness											
3.0	**SANDY LEAN CLAY (CL)**, with gravel, brown											
	SILTY SAND (SM), trace gravel, light brown											
	medium dense	5			4-6-9 N=15						23-20-3	41
		15			4-5-12 N=17							
20.0												
21.5	**SANDY LEAN CLAY (CL)**, mottled tan and brown, very stiff	20			5-8-13 N=21							58
	Boring Terminated at 21.5 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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
Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 05-31-2018	Boring Completed: 05-31-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-7

BORING LOG NO. P-2

PROJECT: Mission Bell Center Mixed Use Project

CLIENT: CFT NV Developments LLC Rosemead, CA

SITE: 1101 Mission Street South Pasadena, CA

LOCATION See Exhibit A-2

Latitude: 34.1153° Longitude: -118.1544°

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**ASPHALT**, 6-inch thickness											
0.9	**AGGREGATE BASE COURSE**, 5-inch thickness											
	CLAYEY SAND (SC), trace gravel, brown											
	medium dense	5			8-7-7 N=14							46
10.0	**POORLY GRADED SAND (SP)**, trace silt and gravel, light brown, dense	10			11-14-16 N=30							
		15										
20.0	**SANDY LEAN CLAY (CL)**, light brown, hard	20			9-20-26 N=46							51
25.0		25										

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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

Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 05-31-2018	Boring Completed: 05-31-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-8

BORING LOG NO. P-2

PROJECT: Mission Bell Center Mixed Use Project

**CLIENT: CFT NV Developments LLC
Rosemead, CA**

**SITE: 1101 Mission Street
South Pasadena, CA**

LOCATION See Exhibit A-2

Latitude: 34.1153° Longitude: -118.1544°

GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND (SP), trace clay and gravel, light brown, very dense				28-38-32 N=70							
		30			21-25-27 N=52							
	31.5											
	Boring Terminated at 31.5 Feet											

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with Auger Cuttings
Surface capped with asphalt

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

Not encountered

Terracon
1421 Edinger Ave, Ste C
Tustin, CA

Boring Started: 05-31-2018	Boring Completed: 05-31-2018
Drill Rig: CME 75	Driller: 2R Drilling
Project No.: 60185094	Exhibit: A-8

APPENDIX B

LABORATORY TESTING

Laboratory Testing

Samples retrieved during the field exploration were taken to the 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.

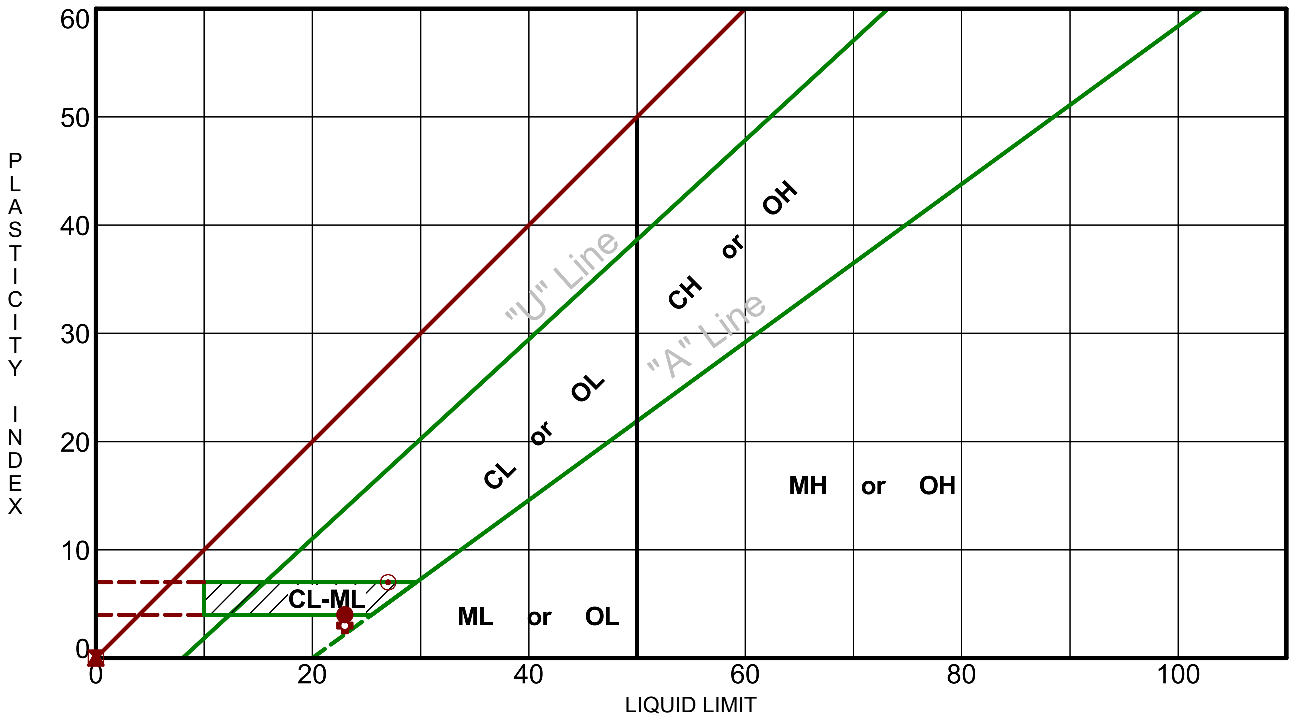
Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation and earthwork recommendations. Laboratory tests were performed in general accordance 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
- ASTM D 512 Chloride Content
- AWWA 4500 H pH
- ASTM C136 Sieve Analysis
- ASTM D4318 Atterberg Limits
- ASTM D2216 Moisture Content
- AWWA 4500 E Soluble Sulfates
- ASTM G57 Minimum Resistivity
- ASTM D3080 Direct Shear

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	**B-1**	**5 - 6.5**	**23**	**19**	**4**		**SC-SM**	**SILTY CLAYEY SAND**
⊠	**B-1**	**10 - 11.5**	**NP**	**NP**	**NP**	**36**	**SM**	**SILTY SAND**
▲	**B-2**	**5 - 6.5**	**NP**	**NP**	**NP**	**75**	**ML**	**SILT with SAND**
★	**B-3**	**5 - 6.5**	**23**	**19**	**4**		**CL-ML**	**SANDY SILTY CLAY**
⊙	**B-3**	**20 - 21.5**	**27**	**20**	**7**	**47**	**SC-SM**	**SILTY, CLAYEY SAND**
✿	**P-1**	**5 - 6.5**	**23**	**20**	**3**	**41**	**SM**	**SILTY SAND**

PROJECT: Mission Bell Center Mixed Use Project

SITE: 1101 Mission Street
South Pasadena, CA

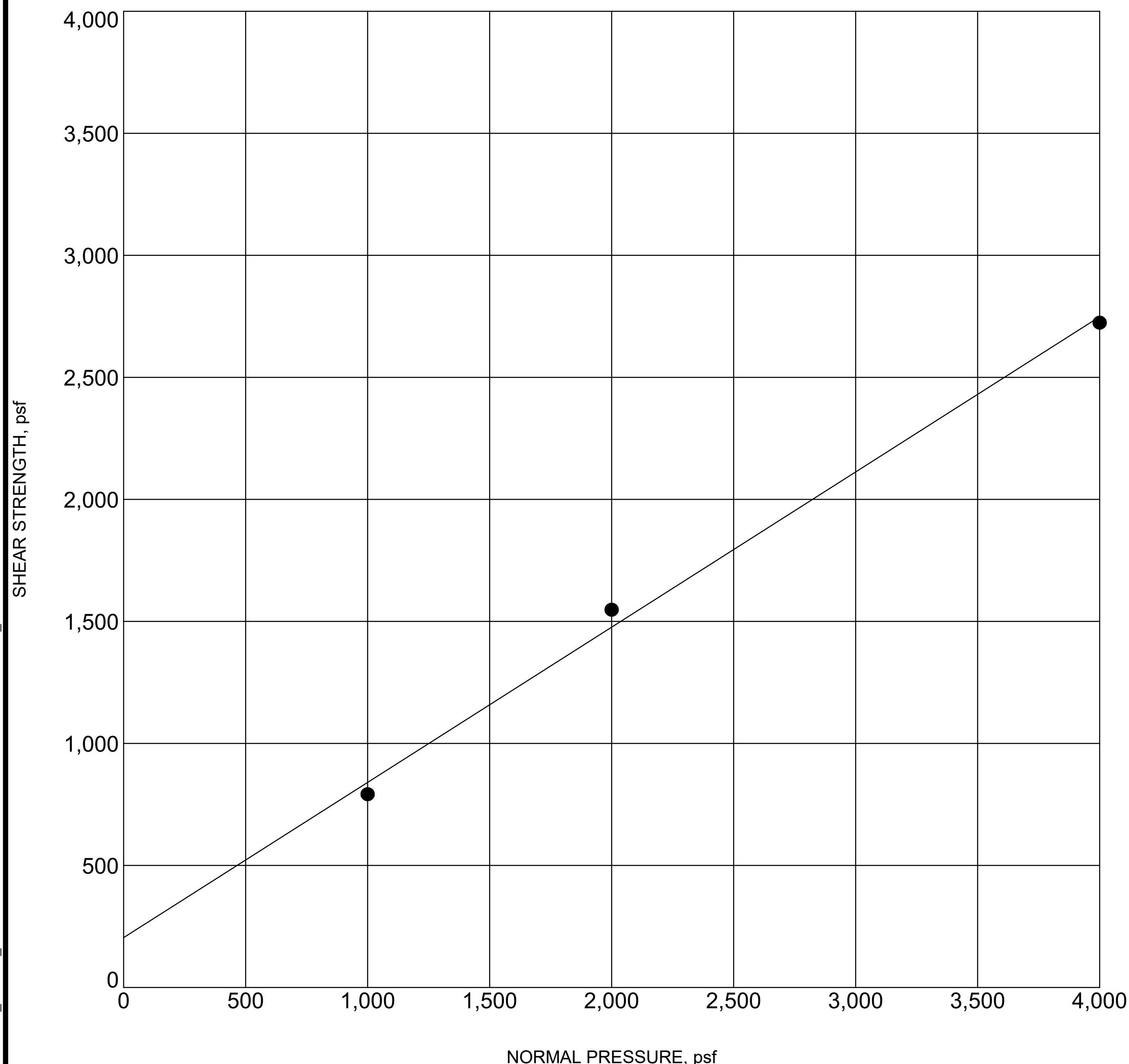
1421 Edinger Ave, Ste C
Tustin, CA

PROJECT NUMBER: 60185094

CLIENT: CFT NV Developments LLC
Rosemead, CA

EXHIBIT: B-2

DIRECT SHEAR TEST ASTM D3080



	Specimen Identification		Classification	γ_d, pcf	WC,%	c, psf	ϕ°
●	**B-1**	**10.0ft**	**SILTY SAND (SM)**	**118**	**13**	**204**	**32**

PROJECT: Mission Bell Center Mixed Use Project

SITE: 1101 Mission Street
South Pasadena, CA

1421 Edinger Ave, Ste C
Tustin, CA

PROJECT NUMBER: 60185094

CLIENT: CFT NV Developments LLC
Rosemead, CA

EXHIBIT: B-3

CHEMICAL LABORATORY TEST REPORT

Project Number: 60185094
Service Date: 06/11/18
Report Date: 06/18/18
Task:

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

Client
CFT NV Developments LLC

Project
CFT: Mission Bell Center

Sample Submitted By: Terracon (60) **Date Received:** 6/8/2018 **Lab No.: 18-0708**

Results of Corrosion Analysis

Sample Number	
Sample Location	B-1
Sample Depth (ft.)	5.0
pH Analysis, AWWA 4500 H	8.42
Water Soluble Sulfate (SO4), AWWA 4500 E (percent %)	0.01
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Chlorides, ASTM D 512, (mg/kg)	27
Red-Ox, AWWA 2580, (mV)	+661
Total Salts, AWWA 2540, (mg/kg)	664
Resistivity, ASTM G 57, (ohm-cm)	3104

Analyzed By: Trisha Campo

Trisha Campo
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 Hammer

DESCRIPTIVE SOIL CLASSIFICATION

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

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels and sands.			**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 Includes silts and clays.			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

GRAIN SIZE TERMINOLOGY

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

RELATIVE PROPORTIONS OF FINES

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

PLASTICITY DESCRIPTION

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

Terracon

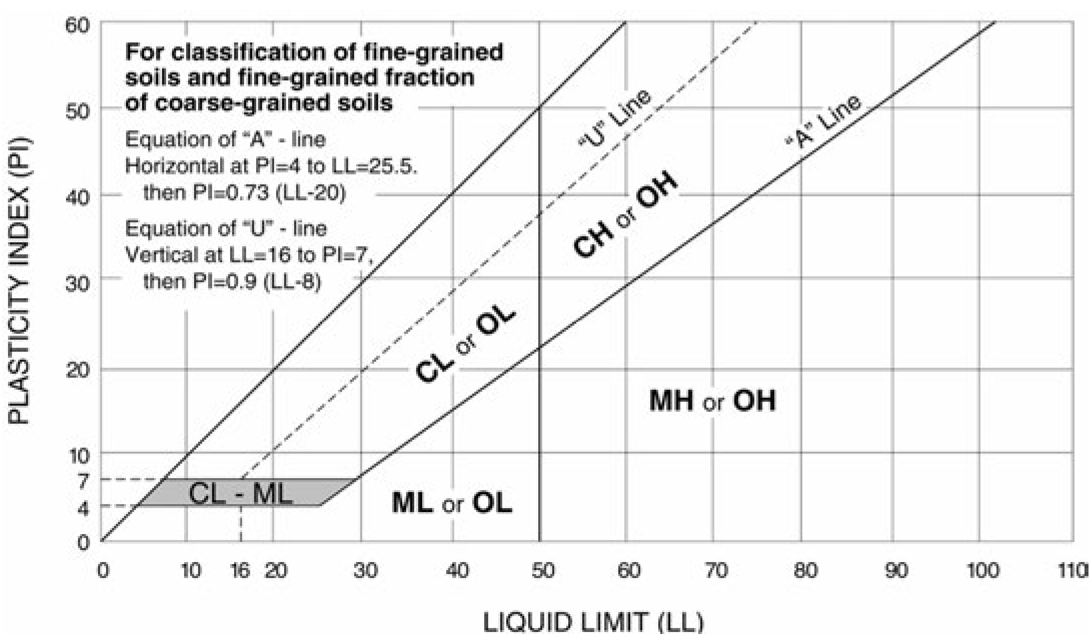
UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: 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 ≥ 4 and 1 ≤ Cc ≤ 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 ≥ 6 and 1 ≤ Cc ≤ 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

Design Maps Detailed Report

ASCE 7-10 Standard (34.1157°N, 118.1548°W)

Site Class C – "Very Dense Soil and Soft Rock", 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] $S_S = 2.814$ g

From Figure 22-2 [2] $S_1 = 0.984$ 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 C, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
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 $\bar{s}_u$ < 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 = C and S_S = 2.814 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 = C and S_1 = 0.984 g, F_v = 1.300

Equation (11.4–1): $S_{MS} = F_aS_S = 1.000 \times 2.814 = 2.814$ g

Equation (11.4–2): $S_{M1} = F_vS_1 = 1.300 \times 0.984 = 1.280$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

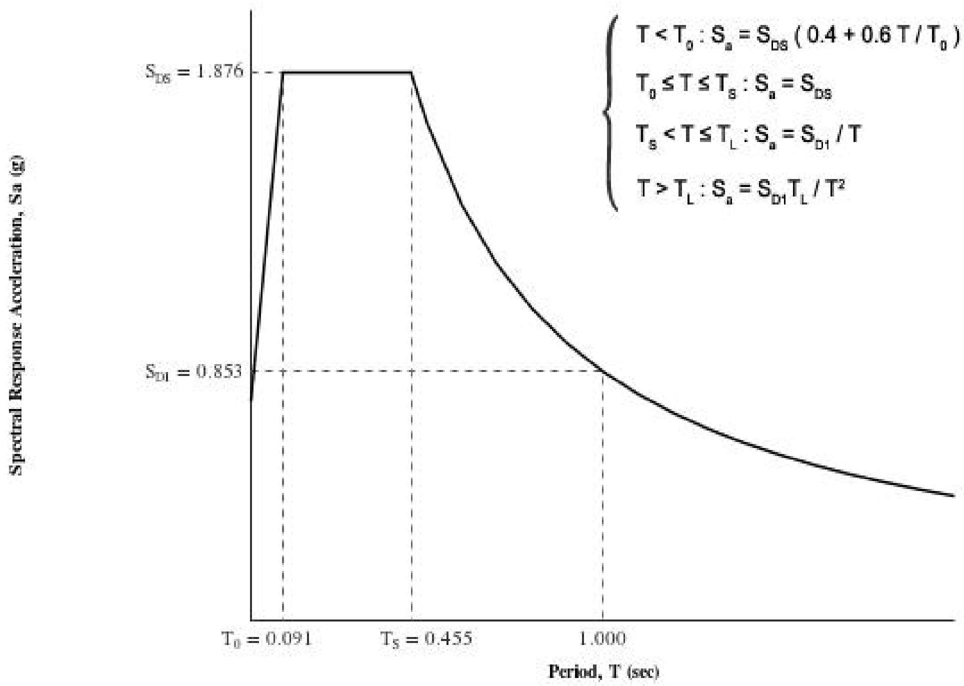
Equation (11.4–3): $S_{DS} = ⅔\ S_{MS} = ⅔ \times 2.814 = 1.876$ g

Equation (11.4–4): $S_{D1} = ⅔\ S_{M1} = ⅔ \times 1.280 = 0.853$ g

Section 11.4.5 — Design Response Spectrum

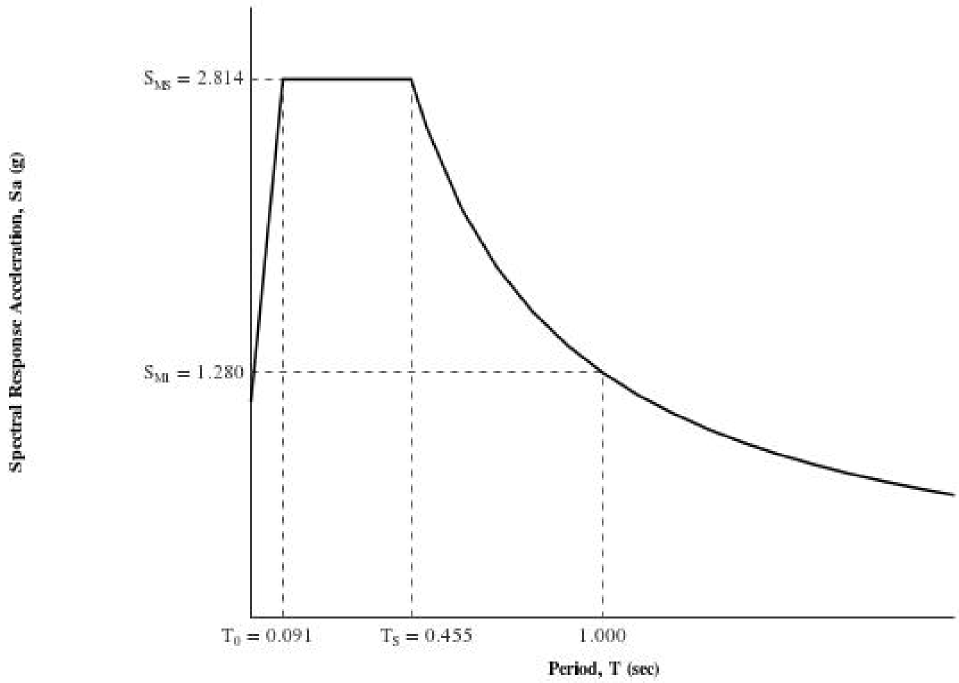
From Figure 22-12 [3] T_L = 8 seconds

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 = 1.076

Equation (11.8–1): $PGA_M = F_{PGA}PGA = 1.000 \times 1.076 = 1.076$ 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 = C and PGA = 1.076 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} = 0.941

From Figure 22-18 [6] C_{R1} = 0.946

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 ≤ S_{DS} < 0.33g	B	B	C
0.33g ≤ S_{DS} < 0.50g	C	C	D
0.50g ≤ S_{DS}	D	D	D

For Risk Category = I and S_{DS} = 1.876 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 ≤ S_{D1} < 0.133g	B	B	C
0.133g ≤ S_{D1} < 0.20g	C	C	D
0.20g ≤ S_{D1}	D	D	D

For Risk Category = I and S_{D1} = 0.853 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" = E

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

References

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