# Appendix D: Geotechnical Evaluation

# GEOTECHNICAL EVALUATION
# FOR
# PROPOSED MULTI-FAMILY RESIDENTIAL DEVELOPMENT
# APNS 099-031-01, -02, -08, -09, -10, AND -11
# CITY OF GARDEN GROVE, ORANGE COUNTY, CALIFORNIA

**PREPARED FOR**

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**PROJECT NO. 3291-CR** **AUGUST 29, 2022**

GEOTEK

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August 29, 2022
Project No. 3291-CR

**Melia Homes**
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Irvine, California 92618

Attention: Mr. Chad Brown

Subject: Geotechnical Evaluation
Proposed Multi-Family Residential Development
APNs 099-031-01, -02, -08, -09, -10, and -11
City of Garden Grove, Orange County, California

Dear Mr. Brown:

We are pleased to provide herein the results of our geotechnical evaluation for the subject property located in the city of Garden Grove, Orange County, California. This report presents a discussion of our evaluation and provides preliminary geotechnical recommendations for earthwork, foundation design, and construction. In our opinion, site development is feasible from a geotechnical viewpoint provided that the recommendations included herein are incorporated into the design and construction phases of site development.

The opportunity to be of service is sincerely appreciated. If you should have any questions, please do not hesitate to call our office.

Respectfully submitted,
**GeoTek, Inc.**

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ENCLOSURES

# 1. PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to complete an evaluation of the existing geotechnical conditions of the project site with respect to currently anticipated site development. Services provided for this study included the following:

- Research and review of available geologic and geotechnical data, and general information pertinent to the site,
- Site reconnaissance,
- Site exploration consisting of drilling four exploratory hollow-stem auger borings and pushing three Cone Penetration Test (CPT) soundings within the most accessible portions of the property,
- Collection of relatively undisturbed and bulk soil samples of the onsite materials from the borings,
- Laboratory testing of the soil samples obtained from the site,
- Review and evaluation of site seismicity,
- Engineering analyses, and
- Compilation of this geotechnical report which presents our findings, conclusions, and recommendations for site development.

The intent of this report is to aid in the assessment of the site for future proposed development from a geotechnical perspective. The professional opinions and geotechnical information contained in this report may need to be updated based upon our review of the final site development plans. These plans should be provided to GeoTek, Inc. (GeoTek) for review when available.

# 2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

## 2.1 SITE DESCRIPTION

The subject site is situated at 13252 and 13292 Brookhurst Street and 10052 Central Avenue in the city of Garden Grove, Orange County, California. The site is also identified by Orange County Assessor's Parcel Numbers (APNs) 099-031-01, -02, -08, -09, -10 and -11. The irregular-

shaped property consists of approximately 1.6-acres and is currently occupied by two single-story buildings (13252 and 13292 Brookhurst Street) in the northwest and southwest corners of the site and associated parking areas. The northeastern portion of the site (10052 Central Avenue) contains a driveway and is currently a vacant lot. This area was occupied by a structure between 1994 and 2017 which was later demolished. Overall site topography is relatively flat and slopes downward to the north-northwest with elevations ranging from about 77 to 72 feet above mean sea level (amsl).

The site is bounded by Central Avenue on the north, Brookhurst Street on the west, and Imperial Avenue on the south with either commercial or residential buildings beyond. The site is bounded by residential properties on the east. The general location of the site is shown in Figure 1. The current site conditions are shown on Figure 2a.

### 2.2 PROPOSED DEVELOPMENT

According to the *Site Plan* prepared by Summa Architecture, Inc. and dated August 17, 2022, the project will consist of razing the existing buildings and improvements for the construction of 35 townhomes, a recreation area, parking and drive areas, underground utilities, and other improvements. The structures are anticipated to be up to two to three stories in height, of wood-framed construction, and will utilize post-tensioned foundation systems. Minor cuts and fills less than five feet are anticipated to be required to reach design grades.

If site development differs from the assumptions made herein, the recommendations included in this report should be subject to further review and evaluation. Final site development plans should be reviewed by GeoTek when they become available. Additional geotechnical field exploration, analyses and recommendations may be necessary upon review of site development plans.

## 3. FIELD EXPLORATION AND LABORATORY TESTING

### 3.1 FIELD EXPLORATION

The soils underlying the site were explored on August 8 and August 15, 2022 by means of excavating four exploratory borings and three CPT soundings to depths between 19 and 51.5 feet. The borings were drilled with a truck-mounted hollow-stem auger drill rig and the soundings with a 30-ton CPT truck. An engineer from our firm kept detailed logs of the borings and collected relatively undisturbed and disturbed soil samples at selected boring depths. The approximate locations of the site explorations are shown on the Exploration Location Maps, Figures 2a-b. Logs of the explorations are provided in Appendix A.

### 3.2 LABORATORY TESTING

Laboratory testing was performed on selected relatively undisturbed and bulk soil samples collected during the field exploration. The purpose of the laboratory testing was to confirm the field classification of the soil materials encountered and to evaluate the soils physical properties for use in the engineering design and analysis. Results of the laboratory testing program along with a brief description and relevant information regarding testing procedures are included in Appendix B.

## 4. GEOLOGIC AND SOILS CONDITIONS

### 4.1 REGIONAL SETTING

The subject property is situated in the Peninsular Ranges geomorphic province. The Peninsular Ranges province is one of the largest geomorphic units in western North America. Basically, it extends roughly 975 miles from the north and extends from the Transverse Ranges geomorphic province to the tip of Baja California, from north to south. This province varies in width from about 30 to 100 miles. It is bounded on the west by the Pacific Ocean, on the south by the Gulf of California and on the east by the Colorado Desert Province.

The Peninsular Ranges are essentially a series of northwest-southeast oriented fault blocks. Several major fault zones are found in this province. The Elsinore Fault zone and the San Jacinto Fault zone trend northwest-southeast and are found in the near the middle of the province. The San Andreas Fault zone borders the northeasterly margin of the province.

More specific to the subject property, Morton, D.M. and Miller, F.K., (2006) map the site to be underlain by Quaternary age Young Alluvial-Fan Deposits. Additionally, the nearest known active fault to the site is the Newport-Inglewood Rose Canyon fault zone located approximately 6.6 miles to the southwest of the site.

### 4.2 GENERAL SOIL/GEOLOGIC CONDITIONS

A brief description of the earth materials encountered in the explorations is presented in the following sections.

#### 4.2.1 Undocumented Fill

Our borings found that the site is covered by moderate amounts of fill associated with the current and past use of the site. The fill is generally composed of loose to medium dense, slightly moist to moist, silty sand, poorly graded sand, and clayey silt. The fill observed extended to about four

to seven feet below the existing ground surface at the explored locations. However, we anticipate that the fill could extend to greater depths in the vicinity of the current buildings and improvements as well as within the emptied lot within the eastern portion the site.

### 4.2.2 Young Alluvial Fan Deposits

Young alluvial fan deposits were encountered in our borings below the fill and extended to the maximum depth explored of about 51.5 feet. The alluvial fan deposits consisted of interbedded silty sand, clayey silt, poorly graded sand, and clay. The alluvium was grey to brown in color, moist to wet, and loose/soft to dense/stiff to the total depth explored, based on our field observations, blow counts, and in-place density determinations. Tests conducted on the most unfavorable units of the alluvium (selected based on blow counts) indicated negligible potential for collapse upon the application of water. The near surface site soils were found to have "very low" expansion potential when tested and classified in accordance with ASTM D 4829.

## 4.3 SURFACE WATER AND GROUNDWATER

### 4.3.1 Surface Water

If encountered during the earthwork construction, surface water on this site is the result of precipitation or surface run-off from surrounding sites. Overall drainage in the area is variable, and most commonly directed toward the north-northwest. Provisions for surface drainage will need to be accounted for by the project civil engineer.

### 4.3.2 Groundwater

Groundwater was encountered in Borings B-1, B-3, and B-4 at approximately 21, 17, and 17 feet below existing ground surface, respectively. A pore pressure dissipation test performed in CPT-3 also suggests that depth to groundwater is about 14 feet.

The GeoTracker database shows several groundwater wells situated about 300 feet north of the site, with groundwater elevations ranging from about 63 to 65 feet amsl. Using an average site elevation of 75 feet amsl, groundwater level under the site would be on the order of 10 to 12 feet in the site region. This is consistent with the Historically Highest Ground Water Map included in the *Seismic Hazard Zone Report for the Anaheim and Newport Beach Quadrangles* (California Department of Conservation, 1997) which indicates that historic high groundwater in the project area is about 10 to 20 feet deep.

Perched groundwater or localized seepage can occur due to variations in rainfall, irrigation practices, and other factors not evident at the time of this investigation.

## 4.4 FAULTING AND SEISMICITY

The geologic structure of the entire southern California area is dominated mainly by northwest-trending faults associated with the San Andreas system. The site is in a seismically active region. No active or potentially active fault is known to exist at this site nor is the site situated within an *"Alquist-Priolo"* Earthquake Fault Zone (Bryant and Hart, 2007; CGS, 1986). The subject property is not located within a State of California Seismic Hazard Zone for earthquake induced liquefaction (CGS, 1997). The subject property is not located within a State of California Seismic Hazard Zone for earthquake induced landsliding. Additionally, the nearest known active fault to the site is the Newport-Inglewood Rose Canyon fault zone located approximately 6.6 miles to the southwest of the site.

### 4.4.1 Seismic Design Parameters

The site is located at approximately 33.7703º Latitude and -117.9543º Longitude. Based on the conditions observed in the site excavations and review of regional geologic maps, a Site Class "D" appears to be the appropriate category for the property. Site spectral accelerations (Sa and S1), for 0.2 and 1.0 second periods for a Class "D" site, were determined from the SEAOC/OSHPD web interface that utilizes the USGS web services and retrieves the seismic design data and presents that information in a report format. As noted using the ASCE 7-16 option on the SEAOC/OSHPD website, the values for SM1 and SD1 are reported as "null-See Section 11.4.8 (of ASCE 7-16)". As noted in ASCE 7-16, Section 11.4.8, a site-specific ground motion procedure is recommended for Site Class D when the value S1 exceeds 0.2. The value S1 for the subject site exceeds 0.2.

For a Site Class D, an exception to performing a site-specific ground motion analysis is allowed in ASCE 7-16 where S1 exceeds 0.2 provided the value of the seismic response coefficient, Cs, is conservatively calculated by Eq 12.8-2 of ASCE 7-16 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. 12.8-3 for $T_L \geq T > 1.5T_s$ or Eq. 12.8-4 for $T > T_L$.

Assuming that the Cs value calculated by and used by the structural engineer allows for the exclusion per ASCE 7-16, noted above, then a site-specific ground motion analysis is not required. For this assumption and condition, the following seismic design parameters, based on the 2015 National Earthquake Hazards Reduction Program (NEHRP)/ASCE 7-16, are presented on the following table:

| SITE SEISMIC PARAMETERS | |
|---|---|
| Mapped 0.2 sec Period Spectral Acceleration, $S_S$ | 1.371g |
| Mapped 1.0 sec Period Spectral Acceleration, $S_1$ | 0.487g |
| Site Coefficient for Site Class "D," $F_a$ | 1.0 |
| Site Coefficient for Site Class "D," $F_v$ | 1.813 |
| Maximum Considered Earthquake Spectral Response Acceleration for 0.2 Second, $S_{MS}$ | 1.374g |
| Maximum Considered Earthquake Spectral Response Acceleration for 1.0 Second, $S_{M1}$ | 0.883g |
| 5% Damped Design Spectral Response Acceleration Parameter at 0.2 Second, $S_{DS}$ | 0.916g |
| 5% Damped Design Spectral Response Acceleration Parameter at 1 second, $S_{D1}$ | 0.589g |
| Site Modified Peak Ground Acceleration, $PGA_M$ | 0.586g |
| Seismic Design Category | D |

Final selection of the appropriate seismic design coefficients should be made by the project structural engineer based upon the local practices and ordinances, expected building response and desired level of conservatism.

## 4.5 LIQUEFACTION AND SEISMICALLY INDUCED SETTLEMENT

Liquefaction describes a phenomenon in which cyclic stresses, produced by earthquake-induced ground motion, create excess pore pressures in relatively cohesionless and low plastic soils. These soils may thereby acquire a high degree of mobility, which can lead to lateral movement, sliding, consolidation and settlement of loose sediments, sand boils and other damaging deformations. This phenomenon occurs only below the water table, but, after liquefaction has developed, the effects can propagate upward into overlying non-saturated soil as excess pore water dissipates.

The factors known to influence liquefaction potential include soil type and grain size, relative density, groundwater level, confining pressures, and both intensity and duration of ground shaking. In general, materials that are susceptible to liquefaction are loose, saturated granular soils having low fines content under low confining pressures and some low plastic silts and clays.

Based on the review of available groundwater data, a historic high groundwater depth of 10 feet was used in our liquefaction analysis. The analysis was performed with the aid of the computer program Cliq version 3.4.1.4 (Geologismiki, 2006) in conjunction with the soil profiles identified within all CPT soundings performed at the property. A magnitude weighted (Mw) seismic event

of 7.3 obtained with the USGS deaggregation web application (based on a 2 percent exceedance in 50 years) and a $PGA_M$ value of 0.65g were used in the assessment.

The results of the analyses indicated the presence of a few layers of loose sands and silty sands that would be prone to settlement during the design-level earthquake. The following table summarizes the amount of total settlement (liquefaction settlement plus "dry sand" settlement) estimated at each CPT location:

| ESTIMATED SEISMICALLY INDUCED TOTAL SETTLEMENT | |
|---|---|
| CPT Sounding | Total Settlement (in) |
| 1 | 0.8 |
| 2 | 0.9 |
| 3 | 0.6 |

As noted above, the seismically induced total settlements at the property could be up to one inch total and up to 0.5 inches differential settlement over a 30-foot span. The results of the liquefaction and settlement analysis are presented within Appendix C.

### 4.6 OTHER SEISMIC HAZARDS

Evidence of ancient landslides or slope instabilities at this site was not observed during our investigation. Thus, the potential for landslides is considered negligible.

The potential for secondary seismic hazards such as a seiche or tsunami is considered negligible due to site elevation and distance to an open body of water.

## 5. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 GENERAL

Development of the site appears feasible from a geotechnical viewpoint. The following recommendations should be incorporated into the design and construction phases of development.

### 5.2 EARTHWORK CONSIDERATIONS

Earthwork and grading should be performed in accordance with the applicable grading ordinances of the City of Garden Grove, the 2019 California Building Code (CBC), and recommendations contained in this report. Site grading plans should be reviewed by this office

when they become available. Additional recommendations will likely be offered subsequent to review of these plans.

### 5.2.1 Site Clearing and Preparation

Site preparation should start with demolition/razing of existing site structures/improvements and removal of deleterious materials and vegetation. Demolition should include removal of all pavements, floor slabs, foundations, and any other below-grade construction. These materials should be properly disposed of off-site. Voids resulting from site clearing (such as removals of underground utilities, foundations, etc.) should be replaced with engineered fill materials.

### 5.2.2 Removals

Based on our data and field observations, the upper five to ten feet from existing grade or three feet below footing base, whichever is deeper, should be removed to provide a homogeneous, dense fill mat for structural support. Deeper removals may be required in some areas to eliminate all previously existing undocumented fill and unsuitable alluvium. The bottom of removals should expose competent native alluvial soils which are defined as relatively homogeneous, no visibly porous materials with an in-place density of at least 85 percent of the soil's maximum dry density as determined per ASTM D 1557. As a minimum, removals should extend down and away from foundation elements at a 1:1 (h:v) projection to the recommended removal depth, or a minimum of five feet laterally.

The upper two feet of soil or one foot below pavement subgrade, whichever is deeper, should be removed below asphaltic concrete pavement and Portland cement concrete hardscape areas. The horizontal extent of removals should extend at least two feet beyond the edge of the improvements.

The bottom of all removals should be scarified to a minimum depth of 12 inches, brought to slightly above the optimum moisture content, and then recompacted to at least 90 percent of the soil's maximum dry density (ASTM D 1557). The bottom of removals should be observed by a GeoTek representative prior to scarification.

The bottom of removals may encounter very moist/soft soils that may require stabilization. If necessary, removal bottoms may be stabilized with a layer of gravel or geogrid supplemented with gravel, prior to placing engineered compacted fill. A 12-inch thick layer of gravel has been successfully used on similar project sites that GeoTek has provided services in the past. Specific stabilization recommendations should be provided by GeoTek based on the soil conditions encountered at the time of site grading.

### 5.2.3 Engineered Fill

The onsite soils are considered suitable for reuse as engineered fill provided they are free from vegetation, roots, and rock/concrete or hard lumps greater than six inches in maximum dimension.

At the time of our field investigation, some of the on-site soils were very moist (four to ten percent above optimum water content). To be suitable for placement as engineered fill, these materials should be dried to approximately optimum moisture content

Concrete generated from the demolition of existing site improvements may be incorporated into site fills provided the following guidelines are implemented: 1) concrete should be free of rebar or other deleterious materials and should be broken down to a maximum dimension of six inches; 2) concrete should not be placed within three feet of finish grade in the building pad areas or within one foot of subgrade elevations in the street/drive areas; 3) concrete should be distributed in the fill and should not be "nested" or placed in concentrated pockets.

The undercut areas should be brought to final pad elevations with fill materials that are placed and compacted in general accordance with minimum project standards. Fill materials should be placed at or slightly above optimum moisture content and should be compacted to a minimum relative compaction of 90 percent as determined by ASTM Test Method D 1557.

### 5.2.4 Excavation Characteristics

Excavation in the onsite soil materials is expected to be easy using heavy-duty grading equipment in good operating conditions.

All temporary excavations for grading purposes and installation of underground utilities should be constructed in accordance with local and Cal-OSHA guidelines. Temporary excavations within the onsite materials should be stable at 1:1 (h:v) inclinations for cuts less than ten feet in height.

### 5.2.5 Shrinkage and Subsidence

Several factors will impact earthwork balancing on the site, including shrinkage, subsidence, trench spoil from utilities and footing excavations, as well as the accuracy of topography.

Shrinkage and subsidence are primarily dependent upon the degree of compactive effort achieved during construction. For planning purposes, a shrinkage factor of 10 to 20 percent for both the existing fills and upper alluvium may be considered. Site balance areas should be available to

adjust project grades, depending on actual field conditions at the conclusion of site earthwork construction. Subsidence on the order of up to 0.2-feet could occur.

### 5.2.6 Trench Excavations and Backfill

Temporary excavations within the onsite materials should be stable at 1:1 (h:v) inclinations for short durations during construction, and where cuts do not exceed ten feet in height. Temporary cuts to a maximum height of four feet can be excavated vertically, but local sloughing and/or failure could occur due to the granular nature of some of the onsite units. Increased caution should be applied when working near or within any excavations at this site.

Trench excavations should conform to Cal-OSHA regulations. The contractor should have a competent person, per OSHA requirements, on site during construction to observe conditions and to make the appropriate recommendations.

Utility trench backfill should be compacted to at least 90 percent relative compaction (as determined per ASTM D 1557). Under-slab trenches should also be compacted to project specifications. Where applicable, based on jurisdictional requirements, the top 12 inches of backfill below subgrade for road pavements should be compacted to at least 95 percent relative compaction. Much of the onsite materials may not be suitable for use as bedding material but should be suitable as backfill provided particles larger than six ± inches are removed.

Compaction should be achieved with a mechanical compaction device. Ponding or jetting of trench backfill is not recommended. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

## 5.3 DESIGN RECOMMENDATIONS

### 5.3.1 Foundation Design Criteria

The site soils were found to generally have "very low" expansion potential in accordance with ASTM D 4829. Additional testing of the soils should be performed during construction to evaluate the as-graded conditions. Additional recommendations may be necessary based on the as-graded soils conditions.

The foundation elements for the proposed structures should bear entirely in engineered fill soils and should be designed in accordance with the 2019 CBC.

It is our understanding that Melia prefers post-tensioned foundation systems for the future residential buildings. For foundations designed in accordance with the recommendations presented in this report, we anticipate a total static settlement of up to one-inch and a differential

static settlement of up to 0.5-inch in a 30-foot span. As noted previously, seismically induced total and differential settlements are estimated to be similar to the cited static settlements.

The slab designer may choose the post-tension design methodology. Since the CBC indicated Post Tensioning Institute (PTI) design methodology is intended for expansive soils conditions which do not apply, no $e_m$ or $y_m$ parameters as used in the PTI methodology are provided. However, the slab design should consider the estimated static and seismically induced settlement as noted above.

| **MINIMUM DESIGN REQUIREMENTS FOR POST-TENSIONED FOUNDATIONS** | |
|---|---|
| Design Parameter | "Very Low" Expansion Potential |
| Foundation Depth or Minimum Perimeter Beam Depth (inches below lowest adjacent grade) | Up to three stories – 12 |
| Minimum Foundation Width | Up to three stories – 12 |
| Minimum Slab Thickness (actual) | 4 inches |
| Presaturation of Subgrade Soil (Percent of Optimum) | Minimum 100% of the optimum moisture content to a depth of at least 12 inches prior to placing concrete |

It should be noted that the above recommendations are based on soil support characteristics only. The structural engineer should design the slab and beam reinforcement based on actual loading conditions.

An allowable bearing capacity of 1,500 pounds per square foot (psf) may be used for design of post-tensioned slab foundations. An increase of one third may be applied when considering short-term live loads (e.g. seismic and wind loads)

The passive earth pressure may be computed as an equivalent fluid having a density of 225 psf per foot of depth, to a maximum earth pressure of 2,000 psf for footings founded on engineered fill. A coefficient of friction between soil and concrete of 0.35 may be used with dead load forces. The upper one foot of soil below the adjacent grade should not be used in calculating passive pressure unless the ground is covered by concrete or pavement. Passive pressure and frictional resistance could be combined without reduction.

A moisture and vapor retarding system should be placed below slabs-on-grade where moisture migration through the slab is undesirable. Guidelines for these systems are provided in the 2019 California Green Building Standards Code (CALGreen) Section 4.505.2, the 2019 CBC Section 1907.1, ACI 360R-10, and ACI 302.2R-06.

It should be realized that the effectiveness of the vapor retarding membrane can be adversely impacted as the result of construction related punctures (e.g. stake penetrations, tears, punctures from walking on the aggregate layer, etc.). These occurrences should be limited as much as possible during construction. Thicker membranes are generally more resistant to accidental puncture than thinner ones. Products specifically designed for use as moisture/vapor retarders may also be more puncture resistant. It is GeoTek's opinion that a minimum ten mil thick membrane with joints properly overlapped and sealed should be considered, unless otherwise specified by the slab design professional. Moisture and vapor retarding systems are intended to provide a certain level of resistance to vapor and moisture transmission through the concrete, but do not eliminate it. The acceptable level of moisture transmission through the slab is to a large extent based on the type of flooring used and atmospheric conditions.

Ultimately, the vapor retarding system should be comprised of suitable elements to limit migration of water and reduce transmission of water vapor through the slab to acceptable levels. The selected elements should have suitable properties (i.e. thickness, composition, strength, and permeance) to achieve the desired performance level. Consideration should be given to consulting with an individual possessing specific expertise in this area for additional evaluation.

### 5.3.2 Miscellaneous Foundation Recommendations

- To minimize moisture penetration beneath the slab on grade areas, utility trenches should be backfilled with engineered fill, lean concrete, or concrete slurry where they intercept the perimeter footing or thickened slab edge.
- Soils from the footing excavations should not be placed in the slab-on-grade areas unless properly compacted and tested. The excavations should be free of loose/sloughed materials and be neatly trimmed at the time of concrete placement.
- Under-slab utility trenches should be compacted to project specifications. Compaction should be achieved with a mechanical compaction device. If backfill soils have dried out, they should be thoroughly moisture conditioned prior to placement in trenches.

### 5.3.3 Foundation Set Backs

Foundations should comply with the following setbacks. Improvements not conforming to these setbacks are subject to the increased likelihood of excessive lateral movements and/or differential settlements. If large enough, these movements can compromise the integrity of the improvements. The following recommendations are presented:

- The outside bottom edge of all footings should be set back a minimum of H/2 (where H is the slope height) from the face of any ascending slope. The setback should be at least five feet and need not to exceed 15 feet. Where a retaining wall is constructed at the

toe of the slope, the height of the slope should be measured from top of the wall to the top of the slope.

- The outside bottom edge of all footings should be set back a minimum of H/3 from the face of any descending slope. The setback should be at least seven feet and need not exceed 40 feet.
- The bottom of all footings for structures near retaining walls should be deepened so as to extend below a 1:1 (h:v) projection upward from the bottom inside edge of the wall foundation.
- The bottom of any future foundations for structures should be deepened so as to extend below a 1:1 (h:v) projection upward from the bottom of the nearest excavation.

### 5.3.4 Retaining Wall Design and Construction

#### 5.3.4.1 General Design Criteria

Recommendations presented in this report apply to typical masonry or concrete walls retaining up to six feet of soils. Additional review and recommendations should be requested for higher walls. These are typical design criteria and are not intended to supersede the design by the structural engineer.

Wall foundations should be embedded a minimum of 12 inches below the lowest adjacent grade and should rest entirely on at least 36 inches of compacted fill placed on competent native soil. Wall footings should be designed using an allowable bearing capacity of 2,000 psf. An increase of one-third may be applied when considering short-term live loads (e.g. seismic and wind loads). The passive earth pressure may be computed as an equivalent fluid having a density of 225 psf per foot of depth, to a maximum earth pressure of 2,000 psf. Unless the ground is covered by asphalt or concrete, the passive pressure should be neglected in the upper one foot. A coefficient of friction between soil and concrete of 0.35 may be used with dead load forces. The passive pressure and frictional resistance can be combined without reduction. For wall footings entirely placed on engineered fill, a minimum footing reinforcement of about two No. 4 rebars (one placed near the top and one near the bottom of footing) should be provided. These are tentative recommendations. Final reinforcement recommendations should be provided by the project structural/wall engineer.

All earth retention structure plans, as applicable, should be reviewed by this office prior to finalization. The seismic design parameters as discussed in this report remain applicable to all proposed earth retention structures at this site and should be properly incorporated into the design and construction of the structures.

Earthwork considerations, site clearing and remedial earthwork for all earth retention structures should meet the requirements of this report, unless specifically provided otherwise, or more stringent requirements or recommendations are made by the designer. The backfill material placement for all earth retention structures should meet the requirement of Section 5.3.4.4 in this report.

In general, cantilever earth retention structures, which are designed to yield at least 0.001H, where H is equal to the height of the earth retention structure to the base of its footing, may be designed using the active condition. Rigid earth retention structures (including but not limited to rigid walls, and walls braced at top, such as typical basement walls) should be designed using the at-rest condition.

In addition to the design lateral forces due to retained earth, surcharges due to improvements, such as an adjacent building or traffic loading, should be considered in the design of the earth retention structures. Loads applied within a 1:1 (h:v) projection from the surcharge on the stem and footing of the earth retention structure should be considered in the design.

Final selection of the appropriate design parameters should be made by the designer of the earth retention structures.

### 5.3.4.2 Cantilevered Walls

The recommendations presented below are for cantilevered walls retaining up to six feet of soils. Active earth pressure may be used for retaining wall design, provided the top of the wall is not restrained from minor deflections. An equivalent fluid pressure approach may be used to compute the horizontal pressure against the wall. Appropriate fluid unit weights are given below for specific slope gradients of the retained material. These do not include other superimposed loading conditions such as traffic, structures, or adverse geologic conditions.

| ACTIVE EARTH PRESSURES | | |
|---|---|---|
| Surface Slope of Retained Materials (h:v) | Equivalent Fluid Pressure (pcf) Native Backfill* | Equivalent Fluid Pressure (pcf) Import Granular Backfill** |
| Level | 44 | 36 |
| 2:1 | 79 | 53 |

*The design pressures assume the native backfill material has an expansion index less than or equal to 20 and a friction angle of at least 28 degrees. Backfill zone includes area between the back of the wall and footing to a plane (1:1 h:v) up from the bottom of the wall foundation to the ground surface.
**The design pressures assume that import granular backfill material has an expansion index less than or equal to 20 and a friction angle of at least 34 degrees. Backfill zone includes area between the back

of the wall and footing to a plane (1:1 h:v) up from the bottom of the wall foundation to the ground surface.

#### 5.3.4.3 Restrained Retaining Walls

Retaining walls that will be restrained prior to placing and compacting backfill material, or that have reentrant or male corners, should be designed for an at-rest equivalent fluid pressure of 65 pcf, plus any applicable surcharge loading, for native backfill and level back slope condition. For imported granular backfill, an at-rest equivalent fluid pressure of 57 pcf should be utilized. For areas of male or reentrant corners, the restrained wall design should extend a minimum distance of twice the height of the wall laterally from the corner, or a distance otherwise determined by the project structural engineer.

#### 5.3.4.4 Retaining Wall Backfill and Drainage

Retaining wall backfill should be free of deleterious and/or oversized materials and should have properties indicated in Section 5.3.4.2. Retaining walls should be provided with an adequate pipe and gravel back drain system to help prevent buildup of hydrostatic pressures. Backdrains should consist of a four-inch diameter perforated collector pipe (Schedule 40, SDR 35, or approved equivalent) embedded in a minimum of one-cubic foot per linear foot of ¾- to 1-inch clean crushed rock or an approved equivalent, wrapped in filter fabric (Mirafi 140N or an approved equivalent). The drain system should be connected to a suitable outlet. Waterproofing of site walls should be performed where moisture migration through the wall is undesirable.

Retaining wall backfill should be placed in lifts no greater than eight inches in thickness and compacted to a minimum of 90 percent relative compaction in accordance with ASTM Test Method D 1557. The wall backfill should also include a minimum one-foot wide section of ¾- to 1-inch clean crushed rock (or an approved equivalent). The rock should be placed immediately adjacent to the back of the wall and extend up from a back drain to within approximately 24 inches of the finish grade. The rock should be separated from the earth with filter fabric. The upper 24 inches should consist of compacted on-site soil.

As an alternative to the drain rock and fabric, Miradrain 2000, or approved equivalent, may be used behind the retaining wall. The Miradrain 2000 should extend from the base of the wall to within two feet of the ground surface. The subdrain should be placed at the base of the wall in direct contact with the Miradrain 2000.

The presence of other materials might necessitate revision to the parameters provided and modification of the wall designs. Proper surface drainage needs to be provided and maintained.

#### 5.3.4.5 Other Design Considerations

- Wall design should consider the additional surcharge loads from superjacent slopes and/or footings, where appropriate.
- No backfill should be placed against concrete until minimum design strengths are evident by compression tests of cylinders.
- The retaining wall footing excavations, backcuts, and backfill materials should be approved the project geotechnical engineer or their authorized representative.

### 5.3.5 Pool Construction

The proposed swimming pool should derive support entirely from engineered fill. A minimum 12 inches of fill compacted to at least 90 percent of the soil's maximum dry density per ASTM D 1557 should be provided below the pool shell.

The pool walls be designed for at-rest soil conditions using an equivalent fluid pressure of 65 pcf. Pool walls surcharged by adjacent structures should be designed for additional pressures. Alternatively, the pool walls may be designed as freestanding walls using the active soil state conditions provided that some lateral movement of the pool walls would be acceptable. If the active state is to be used, an equivalent fluid pressure of 44 pcf is considered suitable. These recommended pressures assume that native soil is used as wall backfill with a level backslope and the backfill is in a drained condition. If a drain system adjacent/beneath the pool is not provided, the pool walls should then be designed for an equivalent fluid pressure of 98 pcf for the at-rest condition and 87 pcf for the active condition.

As noted above, the use of the lower (drained condition) at-rest or active soil pressures will require a subdrain system beneath/adjacent to the pool. A typical subdrain system includes a series of four-inch diameter perforated drain pipes encapsulated with at least one cubic foot of free-draining material per linear foot of pipe. The free-draining material should be encapsulated within a geotextile to prevent migration of fines into the drainage medium. The drain pipes should be routed to an acceptable discharge location, as determined by the civil engineer/pool designed. If desired, GeoTek can review the subdrain system once designed to determine if additional measures are warranted.

Pool decking supported on grade should be separated from the pool bond beam by a full-depth, mastic construction joint. If it is desired to extend the pool deck over the bond beam, consideration should be given to designing the deck as a structural slab supported by the pool shell. This will reduce the possibility of deck cracking occurring along the outer edge of the bond beam. We also recommend that the pool decking subgrade be "pre-saturated" prior to concrete

placement. The subgrade soils should be moisture conditioned to at least 100 percent of the soil's optimum moisture content to a depth of 12 inches, prior to concrete placement. Testing by the geotechnical engineer is recommended to confirm that the soils have been adequately moisture treated.

Pool decking may consist of five-inch-thick concrete and the use of reinforcement is suggested. A minimum of No. 4 rebars spaced 24 inches each way or equivalent should be placed at mid-height of the concrete slab. Control joints should be placed in two directions and located a distance apart approximately equal to 24 to 36 times the slab thickness. The pool designer should provide final design recommendations.

While the site soils are anticipated to have a negligible sulfate content (see Section 5.3.9), it is our recommendation that Type V cement be used for the pool construction due to the chemicals associated with the pool water.

### 5.3.6 Underground Utility Construction

Due to the relatively high groundwater table under the site and in the vicinity, underground utilities deeper than 10-15 feet should consider buoyancy in their design. The dewatering systems will likely be necessary for utility installation at 10 feet or deeper.

### 5.3.7 Pavement Design Considerations

Pavement design for proposed on-site parking and drive areas was conducted per Caltrans *Highway Design Manual* guidelines for flexible pavements and the Portland Cement Association for rigid pavements. Based on an assumed design R-value of 30 and for Traffic Indexes (TIs) of 5.0 for car parking areas and 6.0 for drive areas for light traffic with occasional truck traffic, the following preliminary sections were calculated:

| GEOTECHNICAL RECOMMENDATION FOR MINIMUM PAVEMENT SECTION | | |
|---|---|---|
| Traffic Index | Thickness of Flexible Pavement Section | Thickness of Rigid Pavement Section |
| 5.0 | 3" AC/6" AB/Compacted Subgrade or 6" AC/Compacted Subgrade | -- |
| 6.0 | 4" AC/7" AB/compacted Subgrade or 7.5" AC/Compacted Subgrade | 6.5" PCC/4" AB/Compacted Subgrade |

*AC = Asphalt Concrete, AB = Aggregate Base, PCC = Portland Cement Concrete with a f'c > 3,500 psi.

The TIs used in our pavement design are considered reasonable values for the proposed pavement areas and should provide a pavement life of approximately 20 years with a normal amount of flexible pavement maintenance. Irrigation adjacent to pavements, without a deep curb or other cutoff to separate landscaping from the paving may result in premature pavement failure.

Traffic parameters used for design were selected based upon engineering judgment and not upon information furnished to us such as an equivalent wheel load analysis or a traffic study.

No structural reinforcement of the concrete pavements is required. However, temperature and shrinkage control reinforcement should be provided. This reinforcement should consist of No. 4 rebars on 24-inch centers, each way, or equivalent. The reinforcement should be placed at mid-height to the concrete pavement. Also, the concrete pavement should be provided with proper joints to help control cracking. All materials and methods of construction should also conform to the requirements of the City of Garden Grove. These pavement sections should be considered preliminary until reviewed and approved by the City.

The recommended pavement sections provided are intended as a minimum guideline and final selection of pavement cross section parameters should be made by the project civil engineer, based upon the local laws and ordinates, expected subgrade and pavement response, and desired level of conservatism. If thinner or highly variable pavement sections are constructed, increased maintenance and repair could be expected. Final pavement design should be checked by testing of soils exposed at subgrade (the upper one foot) after final grading has been completed.

Asphalt concrete and aggregate base should conform to current Caltrans Standard Specifications Section 39 and 26-1.02, respectively. As an alternative, asphalt concrete can conform to Section 203-6 of the current Standard Specifications for Public Work (Green Book). Crushed aggregate base or crushed miscellaneous base can conform to Section 200-2.2 and 200-2.4 of the Green Book, respectively. Pavement base should be compacted to at least 95 percent of the ASTM D1557 laboratory maximum dry density (modified proctor).

All pavement installation, including preparation and compaction of subgrade, compaction of base material, placement and rolling of asphaltic concrete, should be done in accordance with the City of Garden Grove specifications, and under the observation and testing of GeoTek and a City Inspector where required. Jurisdictional minimum compaction requirements in excess of the aforementioned minimums may govern.

Deleterious material, excessive wet or dry pockets, oversized rock fragments, and other unsuitable yielding materials encountered during grading should be removed. Once existing compacted fill are brought to the proposed pavement subgrade elevations, the subgrade should be proof-rolled in order to check for a uniform and unyielding surface. The upper 12 inches of pavement subgrade soils should be scarified, moisture conditioned at or near optimum moisture content, and recompacted to at least 95 percent of the laboratory maximum dry density (ASTM D1557). If loose or yielding materials are encountered during construction, additional evaluation of these areas should be carried out by GeoTek. All pavement section changes should be properly transitioned.

### 5.3.8 Soil Corrosivity

The soil resistivity was tested in the laboratory on two samples collected during our field exploration. The results of the testing (3,417 and 4,288 ohm-cm) indicate that the soil samples are "corrosive" to buried ferrous metals, based on the guidelines provided in *Corrosion Basics: An Introduction* (Roberge, 2005). Consideration should be given to consulting with a corrosion engineer.

### 5.3.9 Soil Sulfate Content

The sulfate content was determined in the laboratory for two soil samples obtained during our field exploration. The results (0.004 and 0.027 percent) indicate that the water-soluble sulfate range is less than 0.1 percent by weight which is considered "not applicable" (i.e. negligible) as per Table 4.2.1 of ACI 318. Based upon the test results, no special concrete mix design is required by Code for sulfate attack resistance. Additional testing of soils collected near finish grade should be performed after site grading.

### 5.3.10 Import Soils

Import soils should have an expansion index similar to the on-site soils. GeoTek also recommends that, as a minimum, proposed import soils be tested for soluble sulfate content and expansion index. GeoTek should be notified a minimum of 72 hours of potential import sources so that appropriate sampling and laboratory testing can be performed.

### 5.3.11 Concrete Flatwork

#### *5.3.11.1 Exterior Concrete Slabs, Sidewalks, and Driveways*

Exterior concrete slabs, sidewalks, and driveways should be designed using a four-inch minimum thickness. No specific reinforcement is required due to the non-structural nature. However, the use of some reinforcement should be considered. Some shrinkage and cracking of the concrete should be anticipated as a result of typical mix designs and curing practices commonly utilized in residential construction.

Sidewalks and driveways may be under the jurisdiction of the governing agency. If so, jurisdictional design and construction criteria would apply, if more restrictive than the recommendations presented herein.

Subgrade soils, classified as having "very low" expansion potential, should be pre-moistened prior to placing concrete. The subgrade soils below exterior concrete flatwork should be pre-saturated to a minimum of 100 percent of optimum moisture content to a depth of 12 inches.

All concrete installation, including preparation and compaction of subgrade, should be done in accordance with the City of Garden Grove specifications, and under the observation and testing of GeoTek and a City Inspector, if necessary.

*5.3.11.2 Concrete Performance*

Concrete cracks should be expected. These cracks can vary from sizes that are essentially unnoticeable to more than 1/8 inch in width. Most cracks in concrete, while unsightly, do not significantly impact long-term performance. While it is possible to take measures (proper concrete mix, placement, curing, control joints, etc.) to reduce the extent and size of cracks that occur, some cracking will occur despite the best efforts to minimize it. Concrete can also undergo chemical processes that are dependent on a wide range of variables, which are difficult, at best, to control. Concrete, while seemingly a stable material, is also subject to internal expansion and contraction due to external changes over time.

One of the simplest means to control cracking is to provide weakened control joints for cracking to occur along. These do not prevent cracks from developing; they simply provide a relief point for the stresses that develop. These joints are a widely accepted means to control cracks but are not always effective. Control joints are more effective the more closely spaced they are. GeoTek suggests that control joints be placed in two directions and located a distance apart roughly equal to 24 to 36 times the slab thickness.

Exterior concrete flatwork (patios, walkways, driveways, etc.) is often some of the most visible aspects of site development. They are typically given the least level of quality control, being considered "non-structural" components. We suggest that the same standards of care be applied to these features as to the structure itself.

## 5.4 POST CONSTRUCTION CONSIDERATIONS

### 5.4.1 Landscape Maintenance and Planting

Water has been shown to weaken the inherent strength of soil, and slope stability is significantly reduced by overly wet conditions. Positive surface drainage away from graded slopes should be maintained and only the amount of irrigation necessary to sustain plant life should be provided for planted slopes. Controlling surface drainage and runoff and maintaining a suitable vegetation cover can minimize erosion. Plants selected for landscaping should be lightweight, deep-rooted types that require little water and are capable of surviving the prevailing climate.

Overwatering should be avoided. The soils should be maintained in a solid to semi-solid state as defined by the materials Atterberg Limits. Care should be taken when adding soil amendments to avoid excessive watering. Leaching as a method of soil preparation prior to planting is not recommended. An abatement program to control ground-burrowing rodents should be implemented and maintained. This is critical as burrowing rodents can decreased the long-term performance of slopes.

It is common for planting to be placed adjacent to structures in planter or lawn areas. This will result in the introduction of water into the ground adjacent to the foundation. This type of landscaping should be avoided. If used, then extreme care should be exercised about the irrigation and drainage in these areas.

### 5.4.2 Drainage

The need to maintain proper surface drainage and subsurface systems cannot be overly emphasized. Positive site drainage should be maintained at all times. Drainage should not flow uncontrolled down any descending slope. Water should be directed away from foundations and not allowed to pond or seep into the ground. Pad drainage should be directed toward approved area(s) and not be blocked by other improvements.

It is the owner's responsibility to maintain and clean drainage devices on or contiguous to their lot. In order to be effective, maintenance should be conducted on a regular and routine schedule and necessary corrections made prior to each rainy season.

## 5.5 PLAN REVIEW AND CONSTRUCTION OBSERVATIONS

We recommend that site grading plans, pool plans, retaining wall plans, foundation plans, and relevant project specifications be reviewed by this office prior to construction to check for conformance with the recommendations of this report. We also recommend that GeoTek representatives be present during site grading and foundation construction to check for proper implementation of the geotechnical recommendations. The owner/developer should verify that GeoTek representatives perform at least the following duties:

- Observe site clearing and grubbing operations for proper removal of unsuitable materials.
- Observe and test bottom of removals prior to fill placement.
- Evaluate the suitability of onsite and import materials for fill placement and collect soil samples for laboratory testing where necessary.
- Observe the fill for uniformity during placement, including utility trenches.
- Perform field density testing of the fill materials.
- Observe and probe foundation excavations to confirm suitability of bearing materials.

If requested, a construction observation and compaction report can be provided by GeoTek, which can comply with the requirements of the governmental agencies having jurisdiction over the project. We recommend that these agencies be notified prior to commencement of construction so that necessary grading permits can be obtained.

## 6. INTENT

It is the intent of this report to aid in the design and construction of the proposed development. Implementation of the advice presented in this report is intended to reduce risk associated with construction projects. The professional opinions and geotechnical advice contained in this report are not intended to imply total performance of the project or guarantee that unusual or variable conditions will not be discovered during or after construction.

The scope of our evaluation is limited to the boundaries of the subject site. This review does not and should in no way be construed to encompass any areas beyond the specific area of the proposed construction as indicated to us by the client. Further, no evaluation of any existing site improvements is included. The scope is based on our understanding of the project and the client's needs, our fee estimate (P-0511022-CR) dated June 3, 2022 and geotechnical engineering standards normally used on similar projects in this region.

## 7. LIMITATIONS

The materials observed on the project site appear to be representative of the area; however, soil materials vary in character between excavations or conditions exposed during site construction. Site conditions may vary due to seasonal changes or other factors. GeoTek, Inc. assumes no responsibility or liability for work, testing or recommendations performed or provided by others.

Since our recommendations are based on the site conditions observed and encountered, and laboratory testing, our conclusion and recommendations are professional opinions that are limited to the extent of the available data. Observations during construction are important to allow for any change in recommendations found to be warranted. These opinions have been derived in accordance with current standards of practice and no warranty is expressed or implied. Standards of practice are subject to change with time.

# 8. SELECTED REFERENCES

ASCE, 2017, "Minimum Design Loads for Buildings and Other Structures, ASCE Standard ASCE/SEI 7-16".

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California Department of Conservation, 1997, "Seismic Hazard Zone Report for the Anaheim and Newport Beach 7.5 Quadrangles, Orange County, California."

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Seismic Design Values for Buildings (http://earthquake.usgs.gov/research/hazmaps/design).

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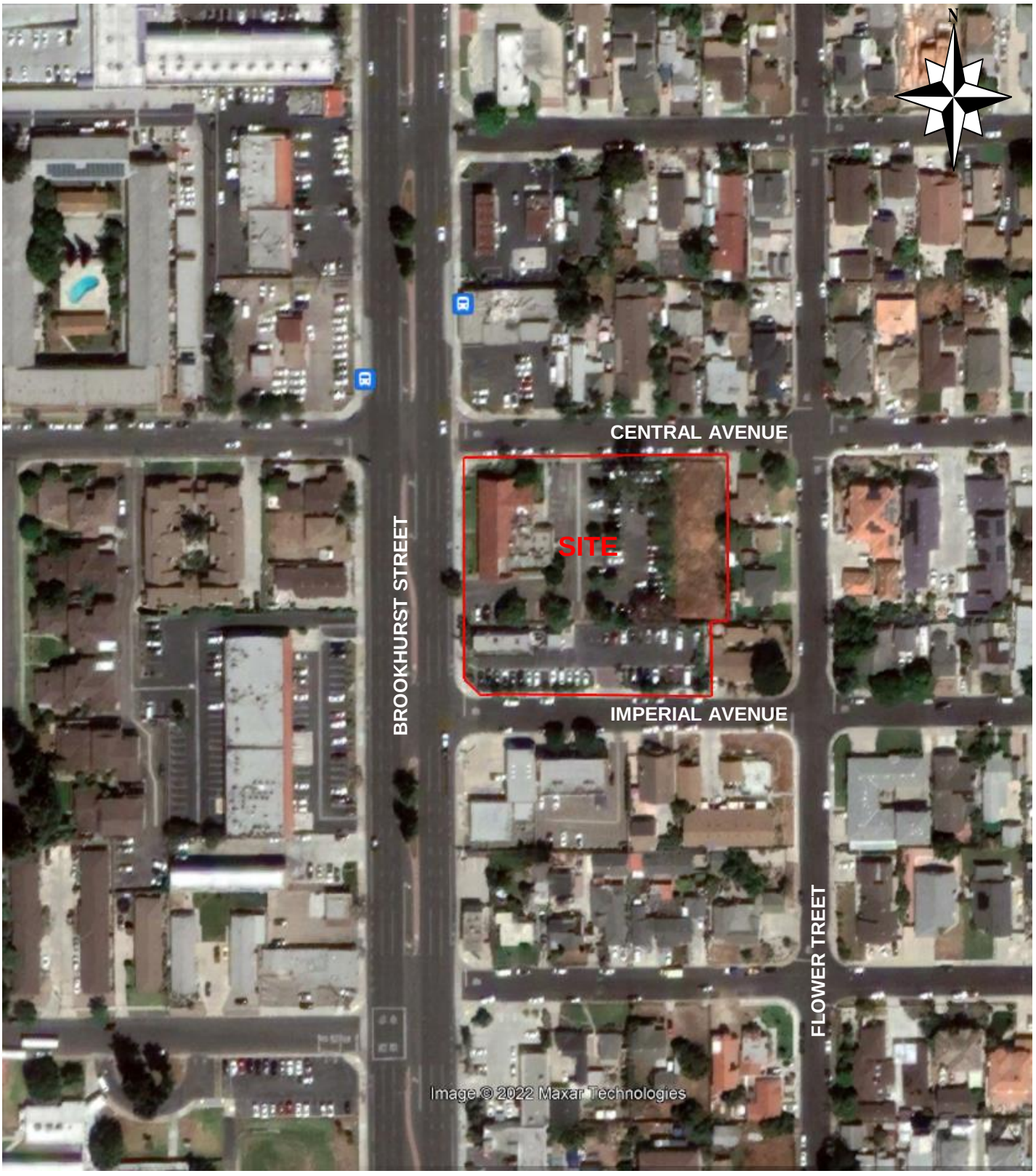


**Melia Homes**
Proposed Multi-Family Residential Development
APNs 099-031-01, -02, -08, -09, -10, and -11
Garden Grove, Orange County, California

Project No. 3291-CR

Scale:
As Shown

0 130 ft

**Figure 1**

**Site Location Map**

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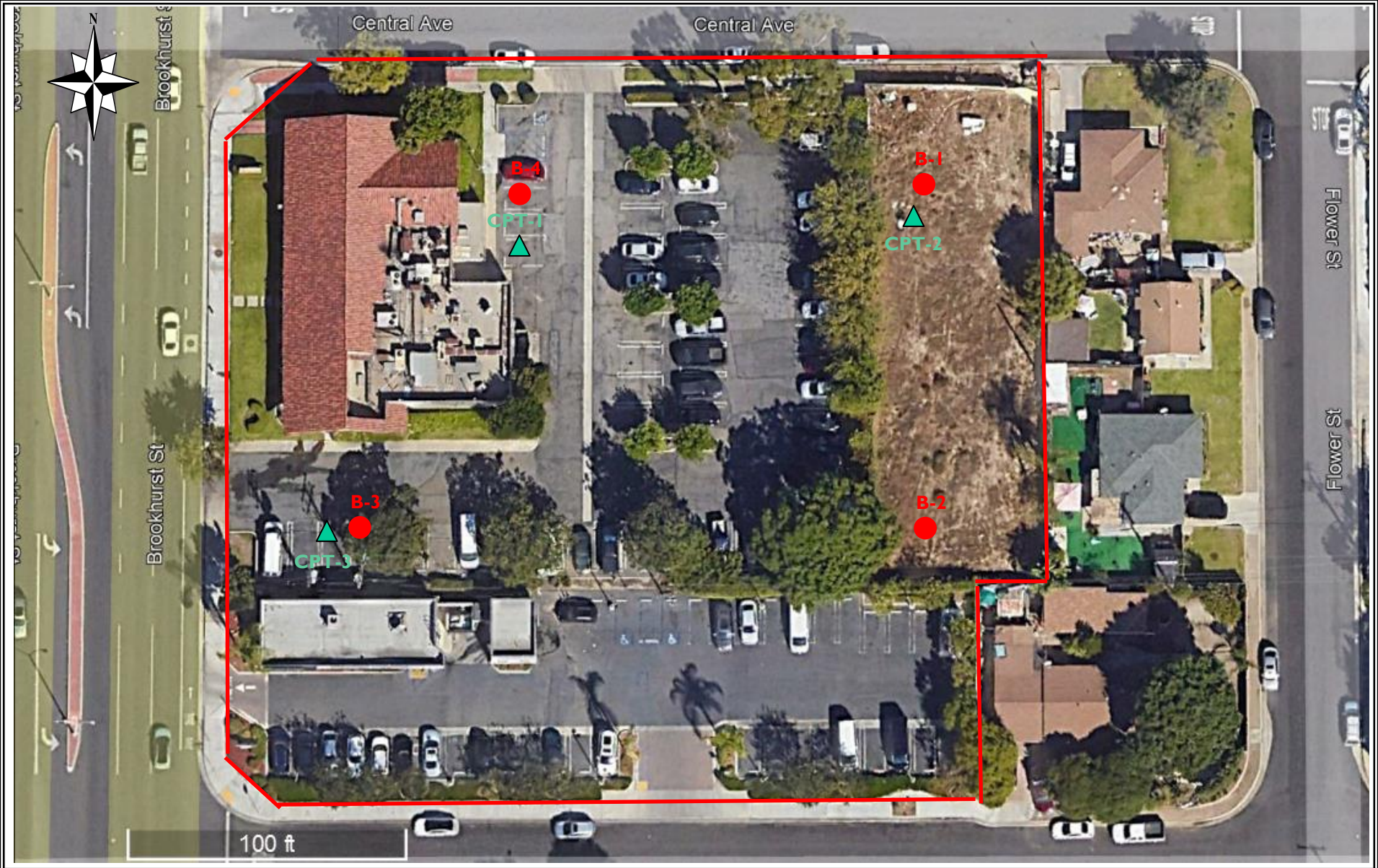


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Garden Grove, Orange County, California

Project No. 3291-CR

**Legend**
(Locations are Approximate)

B-4 ● Exploratory Boring

CPT-3 ▲ CPT Sounding

**Figures 2a**

**Exploration Location Maps**

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**Melia Homes**
Proposed Multi-Family Residential Development
APNs 099-031-01, -02, -08, -09, -10, and -11
Garden Grove, Orange County, California

Project No. 3291-CR

**Legend**
(Locations are Approximate)

B-4 Exploratory Boring

CPT-3 CPT Sounding

**Figures 2b**

**Exploration Location Maps**

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# APPENDIX A

**EXPLORATORY BORING AND CPT LOGS**

**Geotechnical Evaluation**
**APNs 099-031-01, -02, -08 through -11, Garden Grove, California**
**Project No. 3291-CR**

GEOTEK

## A - FIELD TESTING AND SAMPLING PROCEDURES

The Modified Split-Barrel Sampler (Ring)

The ring sampler is driven into the ground in accordance with ASTM Test Method D 3550. The sampler, with an external diameter of 3.0 inches, is lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sampler is typically driven into the ground 12 or 18 inches with a 140-pound hammer free falling from a height of 30 inches. Blow counts are recorded for every 6 inches of penetration as indicated on the logs of borings. The samples are removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

Bulk Samples (Large)

These samples are normally large bags of earth materials over 20 pounds in weight collected from the field by means of hand digging or exploratory cuttings.

Bulk Samples (Small)

These are plastic bag samples which are normally airtight and contain less than five pounds in weight of earth materials collected from the field by means of hand digging or exploratory cuttings. These samples are primarily used for determining natural moisture content and classification indices.

## B – BORING LOG LEGEND

The following abbreviations and symbols often appear in the classification and description of soil and rock on the logs of borings:

*SOILS*

| | |
|---|---|
| USCS | Unified Soil Classification System |
| f-c | Fine to coarse |
| f-m | Fine to medium |

*GEOLOGIC*

| | |
|---|---|
| B: Attitudes | Bedding: strike/dip |
| J: Attitudes | Joint: strike/dip |
| C: Contact line | |
| …….. | Dashed line denotes USCS material change |
| ——— | Solid Line denotes unit / formational change |
| ——— | Thick solid line denotes end of boring |

(Additional denotations and symbols are provided on the logs of borings)

**GeoTek, Inc.**

# LOG OF EXPLORATORY BORING

| | | | | | |
|---|---|---|---|---|---|
| **CLIENT:** | Melia Homes | **DRILLER:** | 2R Drilling | **LOGGED BY:** | C. Diaz |
| **PROJECT NAME:** | 10052 Central Ave | **DRILL METHOD:** | Hollow Stem | **OPERATOR:** | Cody |
| **PROJECT NO.:** | 3291-CR | **HAMMER:** | 140#/30" | **RIG TYPE:** | CME 75 |
| **LOCATION:** | Graden Grove, CA | | | **DATE:** | 8/2/2022 |

**Boring No.: B-1**

| Depth (ft) | SAMPLES: Sample Type | SAMPLES: Blows/ 6 in | SAMPLES: Sample Number | USCS Symbol | MATERIAL DESCRIPTION AND COMMENTS | Laboratory Testing: Water Content (%) | Laboratory Testing: Dry Density (pcf) | Laboratory Testing: Others |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Fill:** | | | |
| 5 | | 7<br>8<br>8 | R1 | SM/SP | Silty f-m SAND to f-m SAND, grey, moist, loose to medium dense | 10.6 | 99.4 | MD, EI, SA, SR |
| | | | | | **Alluvium:** | | | |
| | | 5<br>6<br>11 | R2 | ML | Clayey SILT, grey, moist to very moist, stiff, trace very fine grained sand | 17.5 | 107.8 | SA |
| 10 | | 7<br>11<br>13 | R3 | | Same as above | 14.0 | 107.7 | |
| | | 7<br>8<br>13 | R4 | SM | Silty vf-f SAND, grey, moist to very moist, medium dense, trace clay | 19.7 | 106.9 | |
| 15 | | | | | | | | |
| | | 8<br>7<br>5 | R5 | | Same as above | 23.0 | 102.7 | |
| 20 | | | | ▽ | | | | |
| | | 21<br>34<br>36 | R6 | | No recovery. Groundwater at 21 feet | | | |
| 25 | | 2<br>3<br>3 | S1 | SP/CL | F-m SAND, grey, moist to very moist, loose to CLAY, grey, moist to very moist, medium stiff | | | |
| 30 | | 5<br>9<br>13 | S2 | SM | Silty F-m SAND, grey, moist to very moist, medium dense | | | |

LEGEND

**Sample type**: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

**Lab testing:** AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

**GeoTek, Inc.**

# LOG OF EXPLORATORY BORING

| | | | | | |
|---|---|---|---|---|---|
| **CLIENT:** | Melia Homes | **DRILLER:** | 2R Drilling | **LOGGED BY:** | C. Diaz |
| **PROJECT NAME:** | 10052 Central Ave | **DRILL METHOD:** | Hollow Stem | **OPERATOR:** | Cody |
| **PROJECT NO.:** | 3291-CR | **HAMMER:** | 140#/30" | **RIG TYPE:** | CME 75 |
| **LOCATION:** | Graden Grove, CA | | | **DATE:** | 8/2/2022 |

**Boring No.: B-1 (continued)**

| Depth (ft) | SAMPLES: Sample Type | SAMPLES: Blows/ 6 in | SAMPLES: Sample Number | USCS Symbol | MATERIAL DESCRIPTION AND COMMENTS | Laboratory Testing: Water Content (%) | Laboratory Testing: Dry Density (pcf) | Laboratory Testing: Others |
|---|---|---|---|---|---|---|---|---|
| 35 | | 4<br>5<br>6 | S3 | SP | Vf-f SAND, grey, very moist to wet, medium dense | | | |
| 40 | | 3<br>4<br>5 | S4 | SP/CL | F SAND, grey, wet, loose to CLAY, grey, moist to very moist, stiff | | | |
| 45 | | 7<br>9<br>7 | S4 | SC/CL | Clayey f SAND, gey, very moist, medium dense to Sandy CLAY, grey , vey moist, very stiff | | | |
| 50 | | 4<br>10<br>13 | S5 | SC | Clayey f SAND, grey, very moist, medium dense | | | |
| 55 | | | | | **BORING TERMINATED AT 51.5 FEET**<br><br>Groundwater encountered at 21 feet 2 inches<br>Boring backfilled with bentonite | | | |
| 60 | | | | | | | | |

LEGEND

**Sample type**: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

**Lab testing:** AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

**GeoTek, Inc.**

# LOG OF EXPLORATORY BORING

| | | | | | |
|---|---|---|---|---|---|
| **CLIENT:** | Melia Homes | **DRILLER:** | 2R Drilling | **LOGGED BY:** | C. Diaz |
| **PROJECT NAME:** | 10052 Central Ave | **DRILL METHOD:** | Hollow Stem | **OPERATOR:** | Cody |
| **PROJECT NO.:** | 3291-CR | **HAMMER:** | 140#/30" | **RIG TYPE:** | CME 75 |
| **LOCATION:** | Graden Grove, CA | | | **DATE:** | 8/2/2022 |

| Depth (ft) | SAMPLES: Sample Type | SAMPLES: Blows/ 6 in | SAMPLES: Sample Number | USCS Symbol | **Boring No.: B-2** / MATERIAL DESCRIPTION AND COMMENTS | Laboratory Testing: Water Content (%) | Laboratory Testing: Dry Density (pcf) | Laboratory Testing: Others |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Fill:** | | | |
| | ■ | 9<br>19<br>18 | R1 | SM | Silty f SAND, light grey-brown, slightly moist, medium dense | 1.7 | 101.2 | |
| 5 | ■ | 7<br>10<br>12 | R2 | ML | Clayey SILT, light grey, slightly moist, stiff | 1.4 | 99.2 | |
| | | | | | **Alluvium:** | | | |
| | ■ | 4<br>5<br>7 | R3 | SM | Silty f SAND, orange brown to brown, moist to very moist, loose | 23.0 | 98.5 | HC |
| 10 | ■ | 5<br>8<br>10 | R4 | ML | Clayey SILT, dark gray, moist to very moist, stiff, trace fine grained sand | 19.6 | 109.3 | |
| 15 | ■ | 4<br>5<br>7 | R5 | SM | Silty f SAND, grayish brown, moist to very moist, trace clay | 20.2 | 108.4 | |
| 20 | | 4<br>6<br>7 | R6 | | No Recovery | | | |
| | | | | | **BORING TERMINATED AT 21.5 FEET** | | | |
| | | | | | No groundwater encountered<br>Boring backfilled with bentonite | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |

LEGEND

**Sample type**: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

**Lab testing:** AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

**GeoTek, Inc.**

# LOG OF EXPLORATORY BORING

| | | | | | |
|---|---|---|---|---|---|
| **CLIENT:** | Melia Homes | **DRILLER:** | 2R Drilling | **LOGGED BY:** | C. Diaz |
| **PROJECT NAME:** | 10052 Central Ave | **DRILL METHOD:** | Hollow Stem | **OPERATOR:** | Cody |
| **PROJECT NO.:** | 3291-CR | **HAMMER:** | 140#/30" | **RIG TYPE:** | CME 75 |
| **LOCATION:** | Graden Grove, CA | | | **DATE:** | 8/2/2022 |

**Boring No.: B-3**

| Depth (ft) | SAMPLES: Sample Type | SAMPLES: Blows/ 6 in | SAMPLES: Sample Number | USCS Symbol | MATERIAL DESCRIPTION AND COMMENTS | Laboratory Testing: Water Content (%) | Laboratory Testing: Dry Density (pcf) | Laboratory Testing: Others |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Fill:** 3" Concrete, no base | | | |
| 5 | ■ | 7<br>10<br>12 | R1 | SP/SM | **Alluvium:**<br>Silty f-m SAND to f-m SAND, light grey, slightly moist, medium dense | 1.7 | 92.2 | |
| | ■ | 3<br>4<br>6 | R2 | CL | Sandy CLAY, grey, moist to very moist, medium stiff | 24.3 | 90.5 | SA, AL |
| 10 | ■ | 5<br>6<br>7 | R3 | SM/ML | Silty vf SAND to vf sandy SILT, grey, very moist, stiff | 25.9 | 98.6 | |
| 15 | ■ | 6<br>9<br>9 | R4 | SM | Silty f SAND, grey, moist to very moist, medium dense | 17.9 | 108.3 | SA |
| | | | ▽ | | Groundwater at 17 feet | | | |
| | ■ | 8<br>15<br>18 | R5 | SM/SP | Silty f-m SAND to f-m SAND, grey, wet, medium dense | 15.2 | 111.9 | |
| 20 | | | | | **BORING TERMINATED AT 19.5 FEET**<br><br>Groundwater encountered at 17 feet<br>Boring backfilled with bentonite | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |

LEGEND

**Sample type**: ■ ---Ring ■ ---SPT ▨ ---Small Bulk ▩ ---Large Bulk □ ---No Recovery ▽ ---Water Table

**Lab testing:** AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

**GeoTek, Inc.**

# LOG OF EXPLORATORY BORING

| | | | | | |
|---|---|---|---|---|---|
| **CLIENT:** | Melia Homes | **DRILLER:** | 2R Drilling | **LOGGED BY:** | C. Diaz |
| **PROJECT NAME:** | 10052 Central Ave | **DRILL METHOD:** | Hollow Stem | **OPERATOR:** | Cody |
| **PROJECT NO.:** | 3291-CR | **HAMMER:** | 140#/30" | **RIG TYPE:** | CME 75 |
| **LOCATION:** | Graden Grove, CA | | | **DATE:** | 8/2/2022 |

**Boring No.: B-4**

| Depth (ft) | Sample Type | Blows/ 6 in | Sample Number | USCS Symbol | MATERIAL DESCRIPTION AND COMMENTS | Water Content (%) | Dry Density (pcf) | Others |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Fill:** 3.5" Concrete, no base | | | |
| | | 7<br>7 | R1 | SP | F SAND, light grey, white, slightly moist, medium dense | 2.6 | 100.3 | EI, SA, SR |
| | | 10 | | | **Alluvium:** | | | |
| 5 | | 5<br>3<br>2 | R2 | CL | Silty CLAY, grey to olive gray, moist to very moist, soft | 19.9 | 99.4 | HC, SA |
| | | 3<br>4<br>6 | R3 | | becomes medium stiff | 20.7 | 101.4 | |
| 10 | | 3<br>4<br>5 | R4 | | Same as above | 25.7 | 93.8 | HC, SA, AL |
| 15 | | 7<br>7<br>7 | R5 | SM/ML | Silty vf SAND to vf sandy SILT, gray, very moist, stiff | 21.5 | 104.2 | SA |
| | | | ▽ | | Groundwater at 16.5 feet | | | |
| 20 | | 4<br>3<br>4 | R6 | | No Recovery | | | |
| | | | | | **BORING TERMINATED AT 21.5 FEET** | | | |
| | | | | | Groundwater encountered at 16 feet 8 inches<br>Boring backfilled with bentonite | | | |
| 25 | | | | | | | | |
| 30 | | | | | | | | |

LEGEND

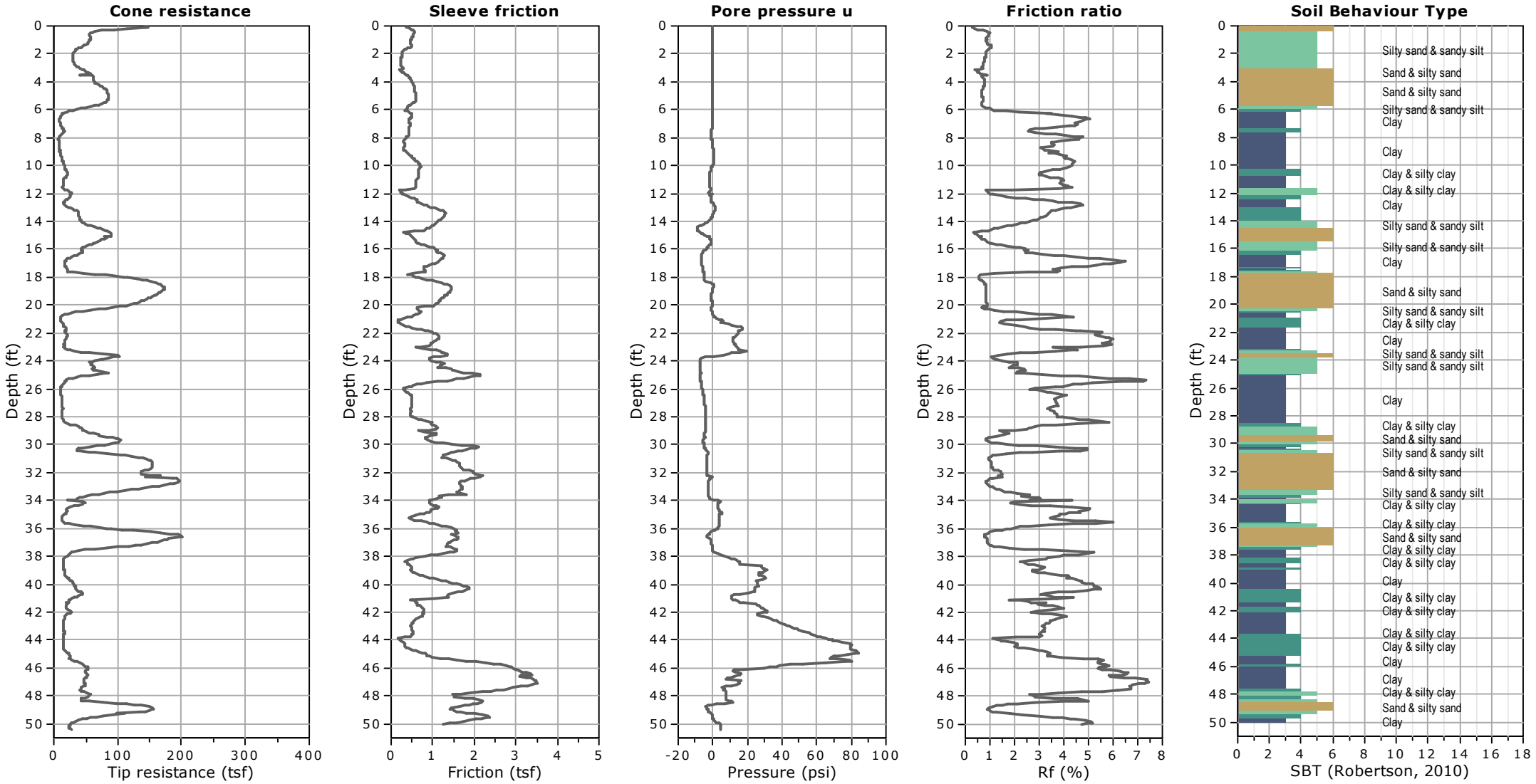
**Sample type**: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

**Lab testing:** AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

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

**Project:** GeoTek
**Location:** 13252 Brookhurst St, Garden Grove, CA

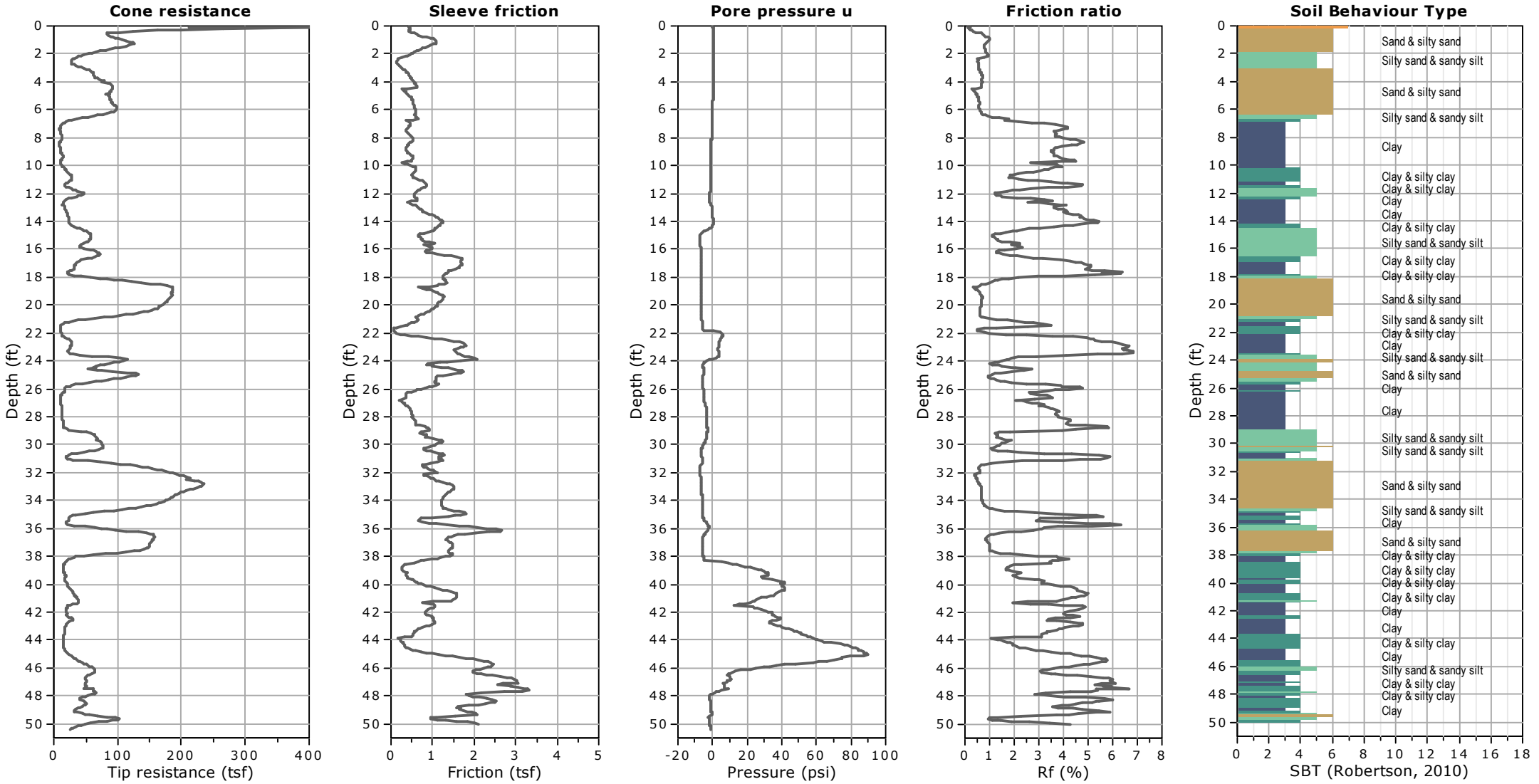
**CPT-1**
Total depth: 50.42 ft, Date: 8/15/2022



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

**Project:** GeoTek
**Location:** 13252 Brookhurst St, Garden Grove, CA

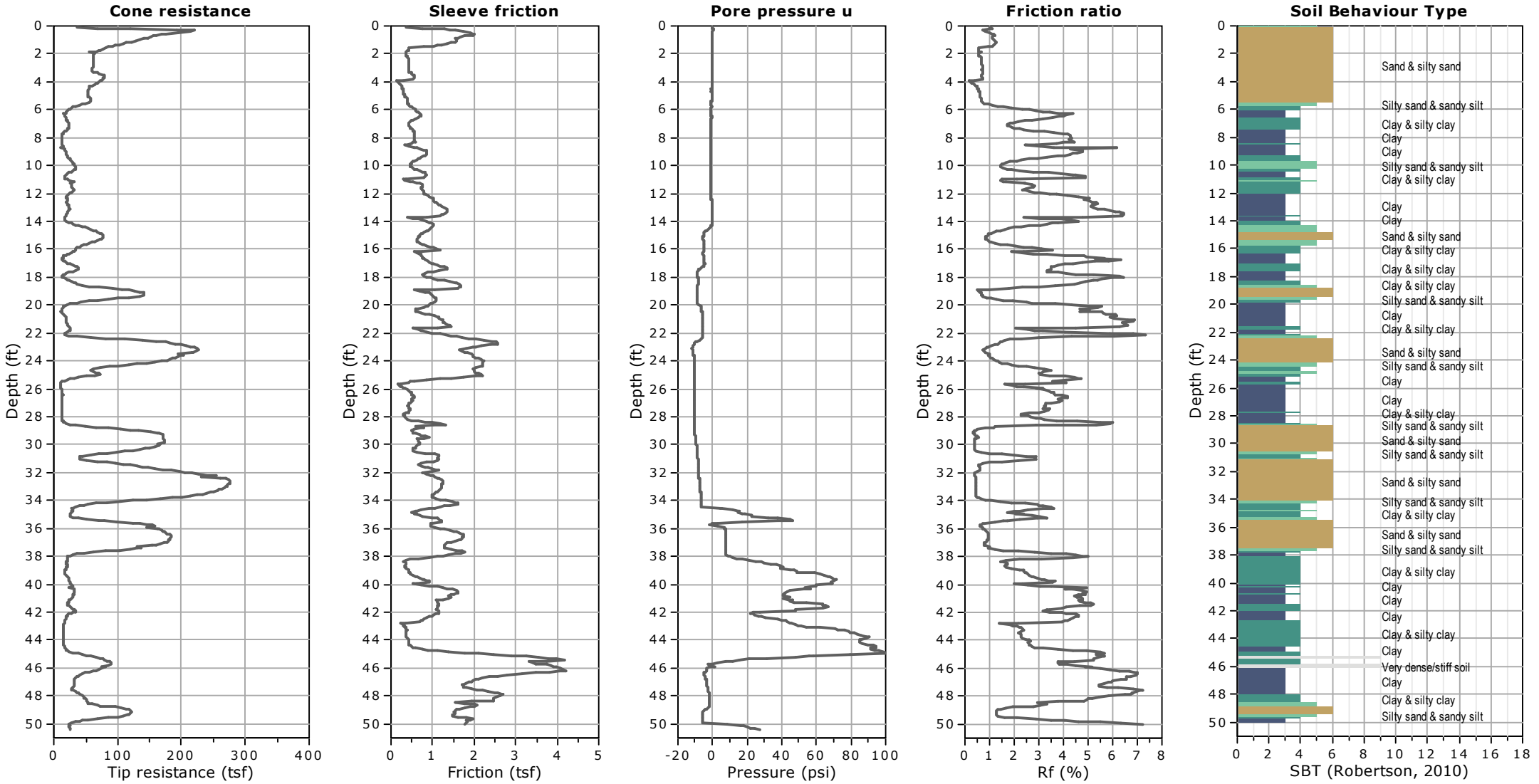
**CPT-2**
Total depth: 50.40 ft, Date: 8/15/2022



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

**Project:** GeoTek
**Location:** 13252 Brookhurst St, Garden Grove, CA

**SCPT-3**
Total depth: 50.40 ft, Date: 8/15/2022



# APPENDIX B

**LABORATORY TEST RESULTS**

**Geotechnical Evaluation**
**APNs 099-031-01, -02, -08 through -11, Garden Grove, California**
**Project No. 3291-CR**

GEOTEK

## SUMMARY OF LABORATORY TESTING

### Atterberg Limits
Selected fine-grained soil samples were tested for Atterberg Limits in general accordance with ASTM D 4318. Test results are included herein.

### Classification
Soils were classified visually in general accordance with the Unified Soil Classification System (ASTM Test Method D 2487). The soil classifications are shown on the logs of exploratory borings in Appendix A.

### Collapse
Several collapse tests were conducted in accordance with ASTM D4546. The results of these tests are presented herein.

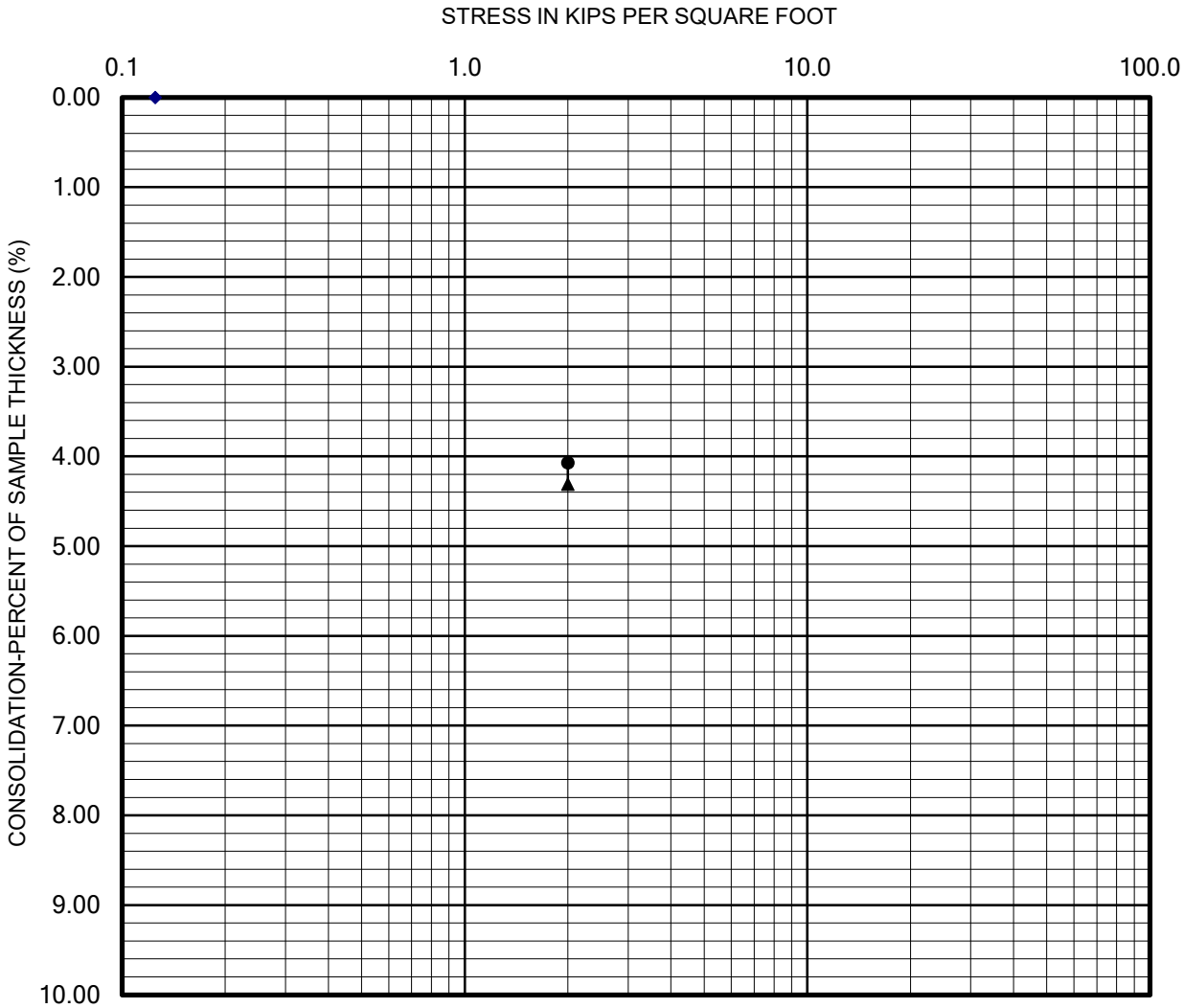
### Expansion Index
The expansion potential of the soils was determined by performing expansion index tests on two representative soil samples from the site in general accordance with ASTM D 4829. The results of these tests are presented herein.

### In Situ Moisture Content and Unit Weight
The field moisture content was measured in the laboratory on selected samples collected during the field investigation. The field moisture content is determined as a percentage of the dry unit weight. The dry density was measured in the laboratory on selected ring samples. The results are shown on the logs of exploratory borings in Appendix A.

### Moisture-Density Relationship
Laboratory testing was performed on a representative soil sample collected during the subsurface exploration. The laboratory maximum dry density and optimum moisture content for the soil type was determined in general accordance with test method ASTM Test Procedure D 1557. The results are presented herein.

### Percent Passing No. 200 Sieve
Several samples were tested to estimate the amount of soil finer than No. 200 sieve. Tests were conducted in general accordance with ASTM D 1140. The results are presented herein.

### Sulfate Content, Resistivity and Chloride Content
Testing to determine the water-soluble sulfate content, minimum resistivity, and chloride concentration in selected soil samples was performed by others. The results are included herein.




Seating Cycle
Loading Prior to Inundation
Loading After Inundation
Rebound Cycle

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

GEOTEK

# COLLAPSE REPORT

## Sample: B-2 @ 7 feet

| | |
|---|---|
| CHECKED BY: DA | Lab: Corona |
| PROJECT NO.: 3291-CR | Date: 8/8/2022 |

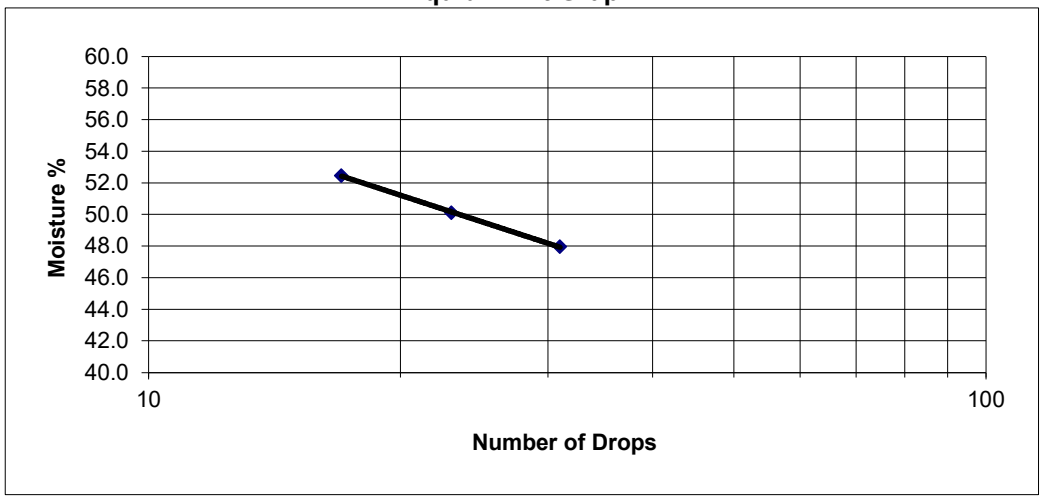
GEOTEK

# ATTERBERG LIMITS DATA

| | | | |
|---|---|---|---|
| Field Classification | | Job No. | 3291-CR |
| Sample Number | | Client | Melia Homes |
| Sample Type | | Project | 13252 Brookhurts Street & 10052 |
| Location | B-4 @ 10 feet | | |
| Tested by: | RL | | |

| | Plastic Limit | | | Liquid Limit | | |
|---|---|---|---|---|---|---|
| **Number of Blows** | | | | 31 | 23 | 17 |
| **Wt. of Dish + Wet Soil** | 36.45 | 37.05 | | 17.89 | 19.82 | 20.48 |
| **Wt. of Dish + Dry Soil** | 34.98 | 35.55 | | 14.14 | 15.29 | 15.58 |
| **Wt. of Moisture** | 1.47 | 1.50 | | 3.75 | 4.53 | 4.90 |
| **Wt. of Dish** | 30.25 | 30.71 | | 6.32 | 6.25 | 6.24 |
| **Wt. of Dry Soil** | 4.73 | 4.84 | | 7.82 | 9.04 | 9.34 |
| **Moisture Content %** | 31.1 | 31.0 | | 48.0 | 50.1 | 52.5 |

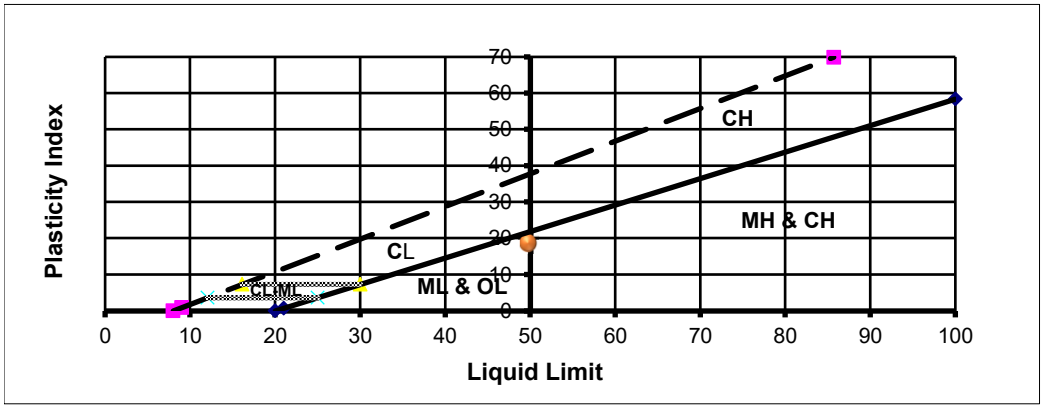
**Liquid Limit Graph**




Liquid Limit
50

Plastic Limit
31

Plasticity Index
19



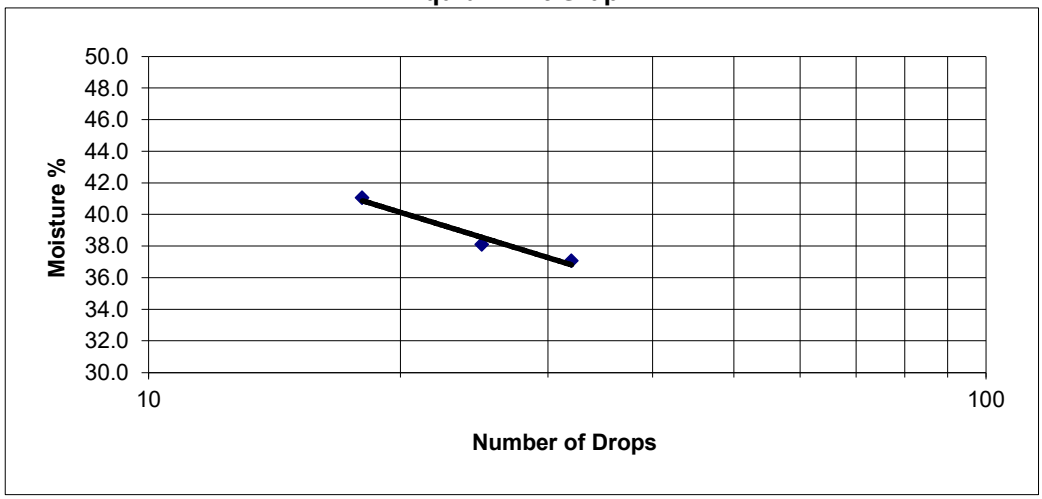
GEOTEK

# ATTERBERG LIMITS DATA

| | | | |
|---|---|---|---|
| Field Classification | | Job No. | 3291-CR |
| Sample Number | | Client | Melia Homes |
| Sample Type | | Project | 13252 Brookhurts Street & 10052 |
| Location | B-3 @ 7 feet | | |
| Tested by: | RL | | |

| | Plastic Limit | | | Liquid Limit | | |
|---|---|---|---|---|---|---|
| **Number of Blows** | | | | 32 | 25 | 18 |
| **Wt. of Dish + Wet Soil** | 36.75 | 36.72 | | 22.08 | 21.37 | 19.71 |
| **Wt. of Dish + Dry Soil** | 35.65 | 35.56 | | 17.81 | 17.22 | 15.78 |
| **Wt. of Moisture** | 1.10 | 1.16 | | 4.27 | 4.15 | 3.93 |
| **Wt. of Dish** | 30.60 | 30.33 | | 6.22 | 6.33 | 6.26 |
| **Wt. of Dry Soil** | 5.05 | 5.23 | | 11.52 | 10.89 | 9.57 |
| **Moisture Content %** | 21.8 | 22.2 | | 37.1 | 38.1 | 41.1 |

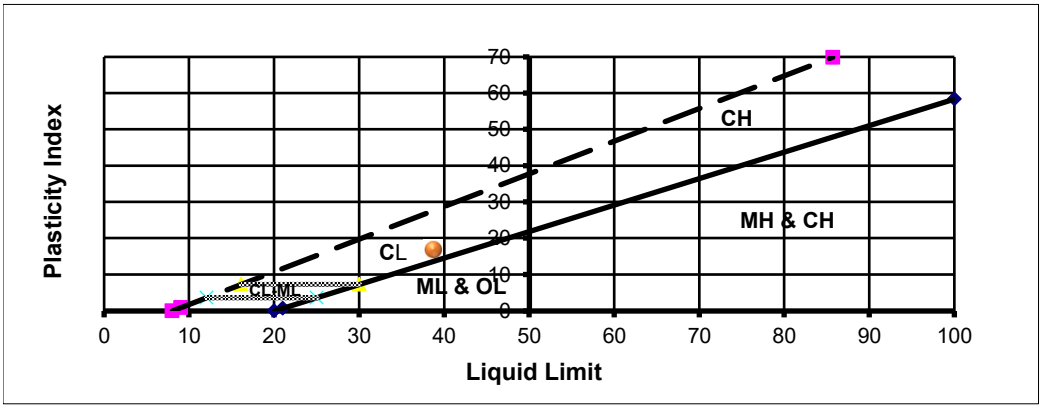
**Liquid Limit Graph**

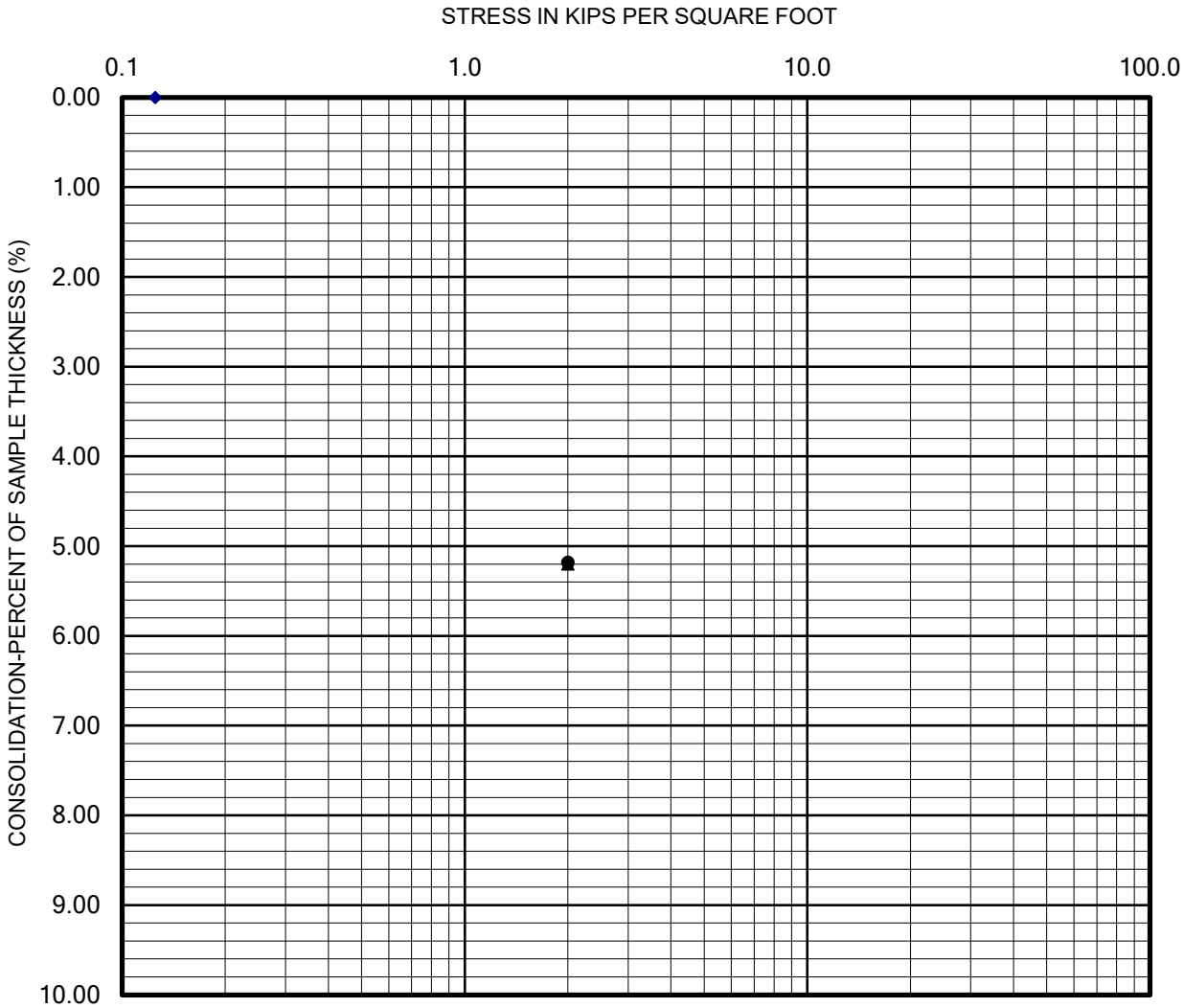



Liquid Limit
39

Plastic Limit
22

Plasticity Index
17






Seating Cycle
Loading Prior to Inundation
Loading After Inundation
Rebound Cycle

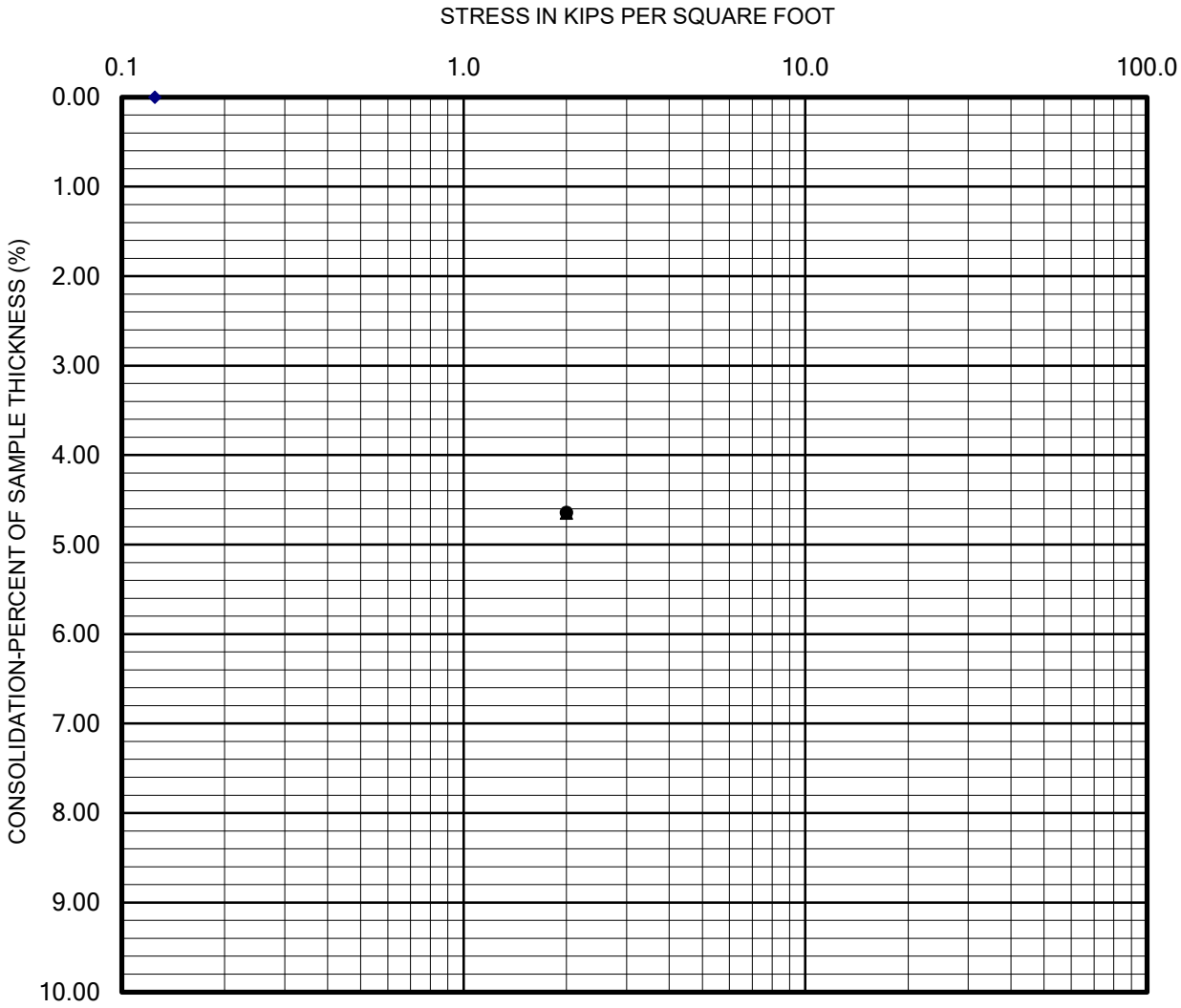
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

GEOTEK

# COLLAPSE REPORT

## Sample: B-4 @ 5 feet

| | |
|---|---|
| CHECKED BY: DA | Lab: Corona |
| PROJECT NO.: 3291-CR | Date: 8/8/2022 |




Seating Cycle
Loading Prior to Inundation
Loading After Inundation
Rebound Cycle

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

GEOTEK

# COLLAPSE REPORT

## Sample: B-4 @ 10 feet

| | |
|---|---|
| CHECKED BY: DA | Lab: Corona |
| PROJECT NO.: 3291-CR | Date: 8/8/2022 |

GEOTEK

# EXPANSION INDEX TEST

**(ASTM D4829)**

| | | | |
|---|---|---|---|
| ***Client:*** | Melia Homes | ***Tested/ Checked By:*** | KG Lab No Corona |
| ***Project Number:*** | 3291-CR | ***Date Tested:*** | 8/15/2022 |
| ***Project Location:*** | 13252 Brookhurts St & 10052 Central Ave | ***Sample Source:*** | B-1 @ 3-8 feet |
| | | ***Sample Description:*** | |

Ring #: _____ Ring Dia. : 4.01" Ring Ht. 1"

**DENSITY DETERMINATION**

| | |
|---|---|
| Weight of compacted sample & ring (gm) | 782.4 |
| Weight of ring (gm) | 369.7 |
| Net weight of sample (gm) | **412.7** |
| Wet Density, lb / ft3 (C*0.3016) | **124.5** |
| Dry Density, lb / ft3 (D/1.F) | **114.7** |

**SATURATION DETERMINATION**

| | |
|---|---|
| Moisture Content, % | 8.5 |
| Specific Gravity, assumed | **2.70** |
| Unit Wt. of Water @ 20 °C, (pcf) | **62.4** |
| % Saturation | **49.0** |

**READINGS**

| DATE | TIME | READING | |
|---|---|---|---|
| 8/15/2022 | | 0.1000 | Initial |
| 8/15/2022 | | 0.0970 | 10 min/Dry |
| | | | |
| | | | |
| | | | |
| 8/16/2022 | | 0.0970 | Final |

**FINAL MOISTURE**

| Final Weight of wet sample & tare | % Moisture |
|---|---|
| 806.5 | **14.3** |

**EXPANSION INDEX = 0**

GEOTEK

# EXPANSION INDEX TEST

**(ASTM D4829)**

| | | | |
|---|---|---|---|
| ***Client:*** | Melia Homes | ***Tested/ Checked By:*** | KG Lab No Corona |
| ***Project Number:*** | 3291-CR | ***Date Tested:*** | 8/12/2022 |
| ***Project Location:*** | 13252 Brookhurts St & 10052 Central Ave | ***Sample Source:*** | B-4 @ 3-8 feet |
| | | ***Sample Description:*** | |

Ring #: _____ Ring Dia. : 4.01" Ring Ht. 1"

**DENSITY DETERMINATION**

| | |
|---|---|
| Weight of compacted sample & ring (gm) | 769.1 |
| Weight of ring (gm) | 362.6 |
| Net weight of sample (gm) | **406.5** |
| Wet Density, lb / ft3 (C*0.3016) | **122.6** |
| Dry Density, lb / ft3 (D/1.F) | **112.5** |

**SATURATION DETERMINATION**

| | |
|---|---|
| Moisture Content, % | 9.0 |
| Specific Gravity, assumed | **2.70** |
| Unit Wt. of Water @ 20 °C, (pcf) | **62.4** |
| % Saturation | **48.8** |

**READINGS**

| DATE | TIME | READING | |
|---|---|---|---|
| 8/12/2022 | | 0.2790 | Initial |
| 8/12/2022 | | 0.2770 | 10 min/Dry |
| | | | |
| | | | |
| | | | |
| 8/13/2022 | | 0.2840 | Final |

**FINAL MOISTURE**

| Final Weight of wet sample & tare | % Moisture |
|---|---|
| 790.5 | **14.3** |

**EXPANSION INDEX = 7**

**GeoTek - Corona**
1548 N. Maple St.
Corona, CA 92880
Phone: (951) 710-1160
Fax: (951) 710-1167

# Proctor Report

**Report No: PTR:22-00003-S01**

**Client:** Melia Homes
8951 Research Drive
Irvine CA 92618

**CC:**

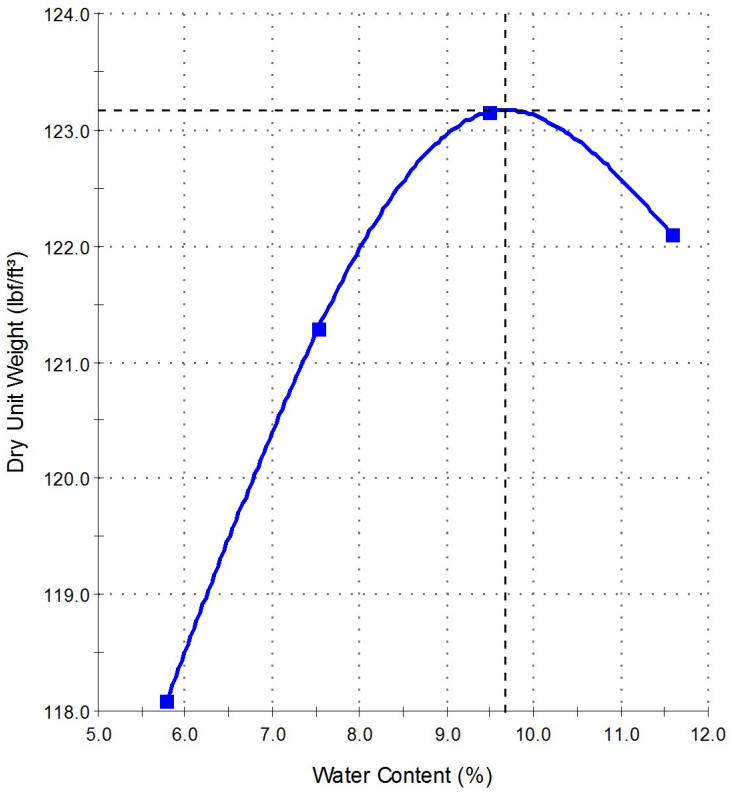
**Project:** 3291-CR
13252 Brookhurst & 1005 Central Avenue,
Garden Grove



## Sample Details

**Sample ID:** 22-00003-S01
**Sampled By:**
**Date Sampled:** 8/2/2022
**Tested By:** Diego Alvarez-Victorica

## Dry Unit Weight - Water Content Relationship




## Test Results

ASTM D 1557

| | |
|---|---|
| **Maximum Dry Unit Weight (lbf/ft³):** | **123.2** |
| **Optimum Water Content (%):** | **9.7** |
| Method: | A |
| Preparation Method: | |
| Retained Sieve No 4 (4.75mm) (%): | 6 |
| Passing Sieve No 4 (4.75mm) (%): | 94 |
| Tested By: | |
| Date Tested: | |

ASTM D 4718

| | |
|---|---|
| **Corrected Maximum Dry Unit Weight (lbf/ft³):** | **123.2** |
| **Corrected Optimum Water Content (%):** | **9.7** |
| **Sieve Size (Oversize):** | No 4 |
| **Oversize Particles (%):** | 6 |

## Comments

B-1 @ 3-8 feet

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-1
Client: Melia Homes depth 3-8 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 248.7 | 48.2 | 16.2% | |

Dry Weight 296.9

Soak Time 1440 Minutes

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-1
Client: Melia Homes depth 7 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 93.1 | 240.6 | 72.1% | |

Dry Weight 333.7

Soak Time 1440 Minutes

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-3
Client: Melia Homes depth 7 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 70.7 | 178.5 | 71.6% | |

Dry Weight 249.2

Soak Time 1440 Minutes

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-3
Client: Melia Homes depth 13.5 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 137.7 | 115.2 | 45.6% | |

Dry Weight 252.9

Soak Time 1440 Minutes

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-4
Client: Melia Homes depth 3-8 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 165.5 | 104.5 | 38.7% | |

Dry Weight 270

Soak Time 1440 Minutes

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-4
Client: Melia Homes depth 3 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 340.3 | 7 | 2.0% | |

Dry Weight 347.3

Soak Time 1440 Minutes

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-4
Client: Melia Homes depth 10 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 13 | 196.3 | 93.8% | |

Dry Weight 209.3

Soak Time 1440 Minutes

GEOTEK

# -200 WASH

Date:
W.O.: 3291-CR sample ID B-4
Client: Melia Homes depth 15 feet
Project: 13252-CR Melia Homes

| Sieve Size | Particle Diameter | | Wt. Retained | Wt. Passing | % Passing | Specs |
|---|---|---|---|---|---|---|
| | in. | mm. | | | | |
| #200 | 0.0029 | 0.074 | 121.1 | 118.4 | 49.4% | |

Dry Weight 239.5

Soak Time 1440 Minutes

# Soil Analysis Lab Results

Client: GeoTek, Inc.
Job Name: 13252 Brookwurst St & 10052 Central Ave
Client Job Number: 3291-CR Melia Homes
Project X Job Number: S220804K
August 7, 2022

| | Method | ASTM D4327 | | ASTM D4327 | | ASTM G187 | | ASTM G51 | ASTM G200 | SM 4500-D | ASTM D4327 | ASTM D6919 | ASTM D6919 | ASTM D6919 | ASTM D6919 | ASTM D6919 | ASTM D4327 | ASTM D4327 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Bore# / Description** | **Depth** | **Sulfates** $SO_4^{2-}$ | | **Chlorides** $Cl^-$ | | **Resistivity** As Rec'd \| Minimum | | **pH** | **Redox** | **Sulfide** $S^{2-}$ | **Nitrate** $NO_3^-$ | **Ammonium** $NH_4^+$ | **Lithium** $Li^+$ | **Sodium** $Na^+$ | **Potassium** $K^+$ | **Magnesium** $Mg^{2+}$ | **Calcium** $Ca^{2+}$ | **Fluoride** $F_2^{--}$ | **Phosphate** $PO_4^{3-}$ |
| | (ft) | (mg/kg) | (wt%) | (mg/kg) | (wt%) | (Ohm-cm) | (Ohm-cm) | | (mV) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) |
| B1 | 3-8 | 275.1 | 0.0275 | 51.1 | 0.0051 | 113,900 | 3,417 | 7.8 | 125 | 0.69 | 3.4 | 9.0 | 0.01 | 94.7 | 10.0 | 34.8 | 146.8 | 3.3 | 0.9 |
| B4 | 3-8 | 43.3 | 0.0043 | 17.1 | 0.0017 | 14,070 | 4,288 | 8.0 | 123 | 0.21 | 1.3 | 4.7 | ND | 37.8 | 12.7 | 29.0 | 150.4 | 8.7 | 1.5 |

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract
PPM = mg/kg (soil) = mg/L (Liquid)

# APPENDIX C

**RESULTS OF LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSIS**

**Geotechnical Evaluation**
**APNs 099-031-01, -02, -08 through -11, Garden Grove, California**
**Project No. 3291-CR**

GEOTEK

GeoTek, Inc.
1548 North Maple Street, Corona, California 92878
(951) 710-1160 Office (951) 710-1667 fax www.geotekusa.com

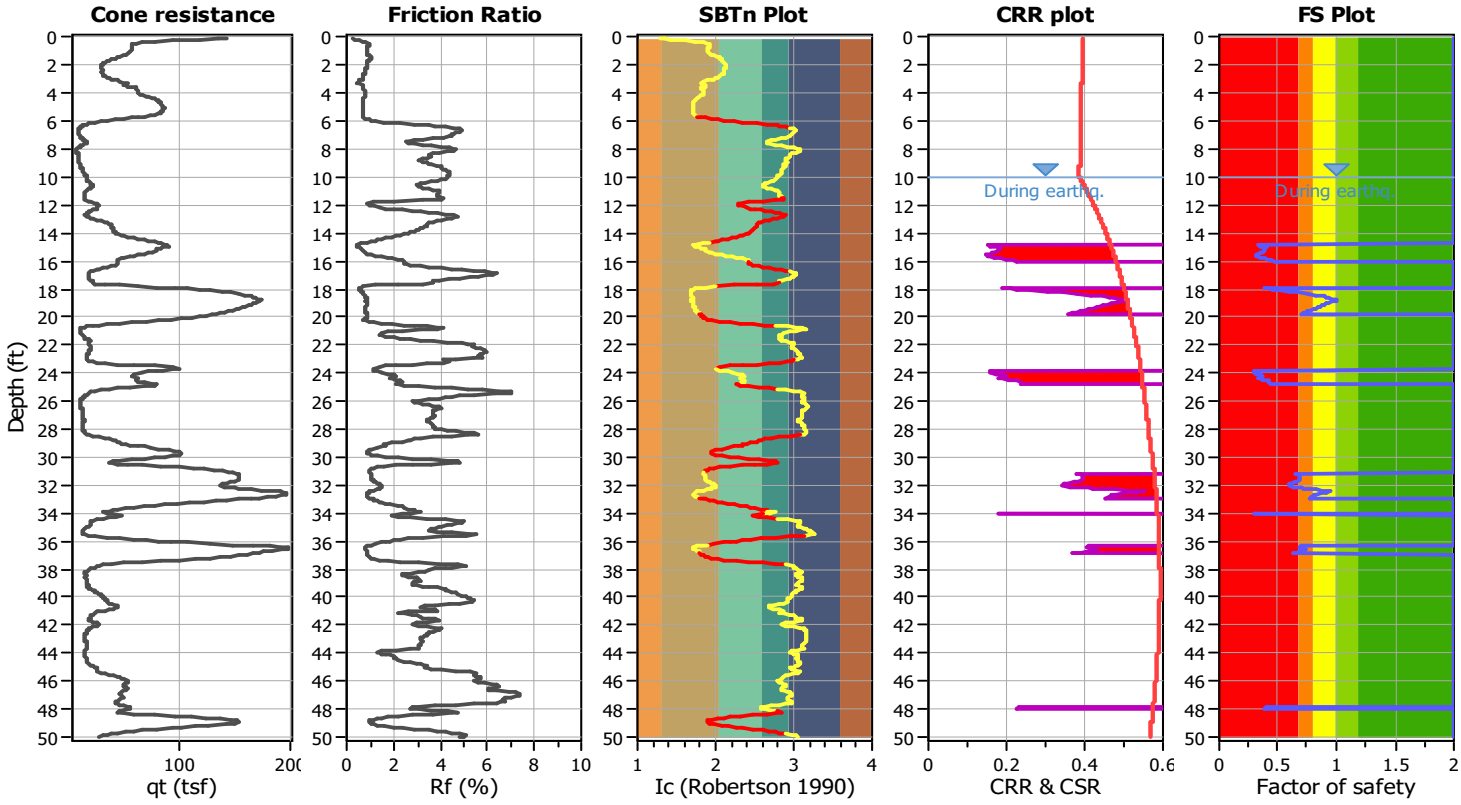
# LIQUEFACTION ANALYSIS REPORT

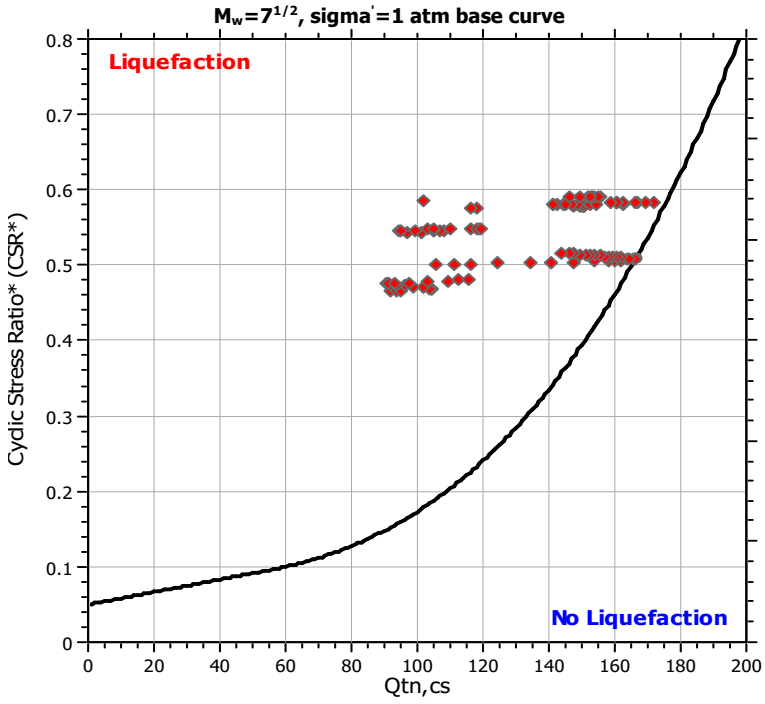
**Project title : Multi-Family Residential Project** **Location : Garden Grove, CA**

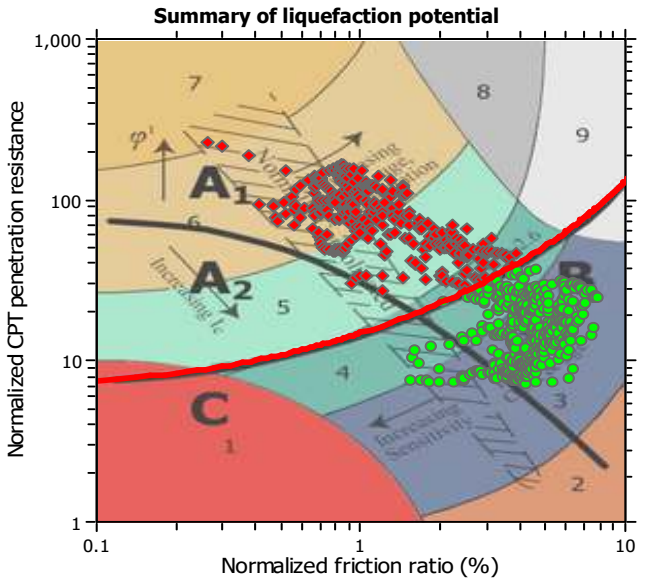
**CPT file : CPT-1**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 17.00 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 10.00 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 60.00 ft |
| Earthquake magnitude $M_w$: | 7.30 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.65 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

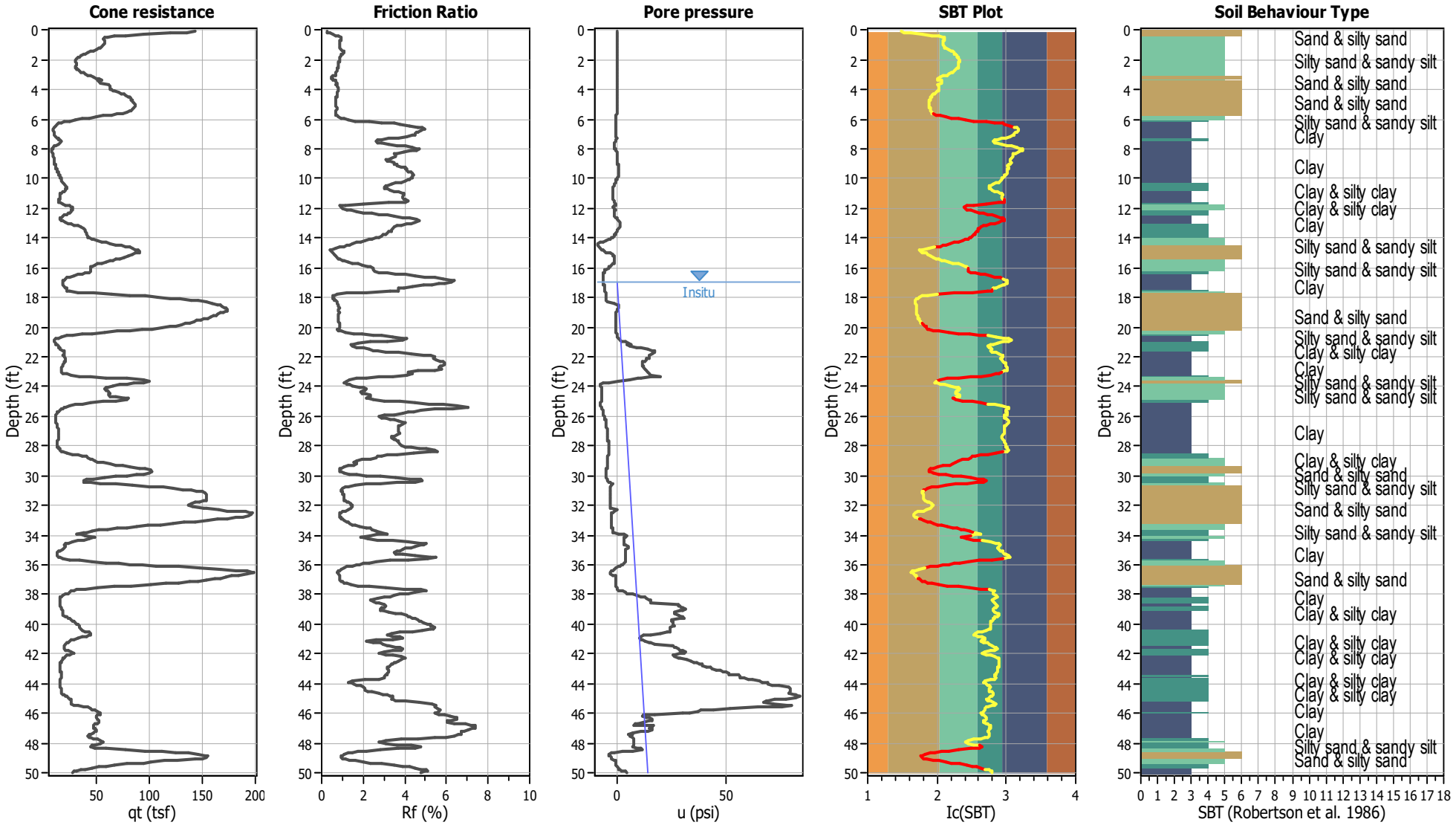



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots



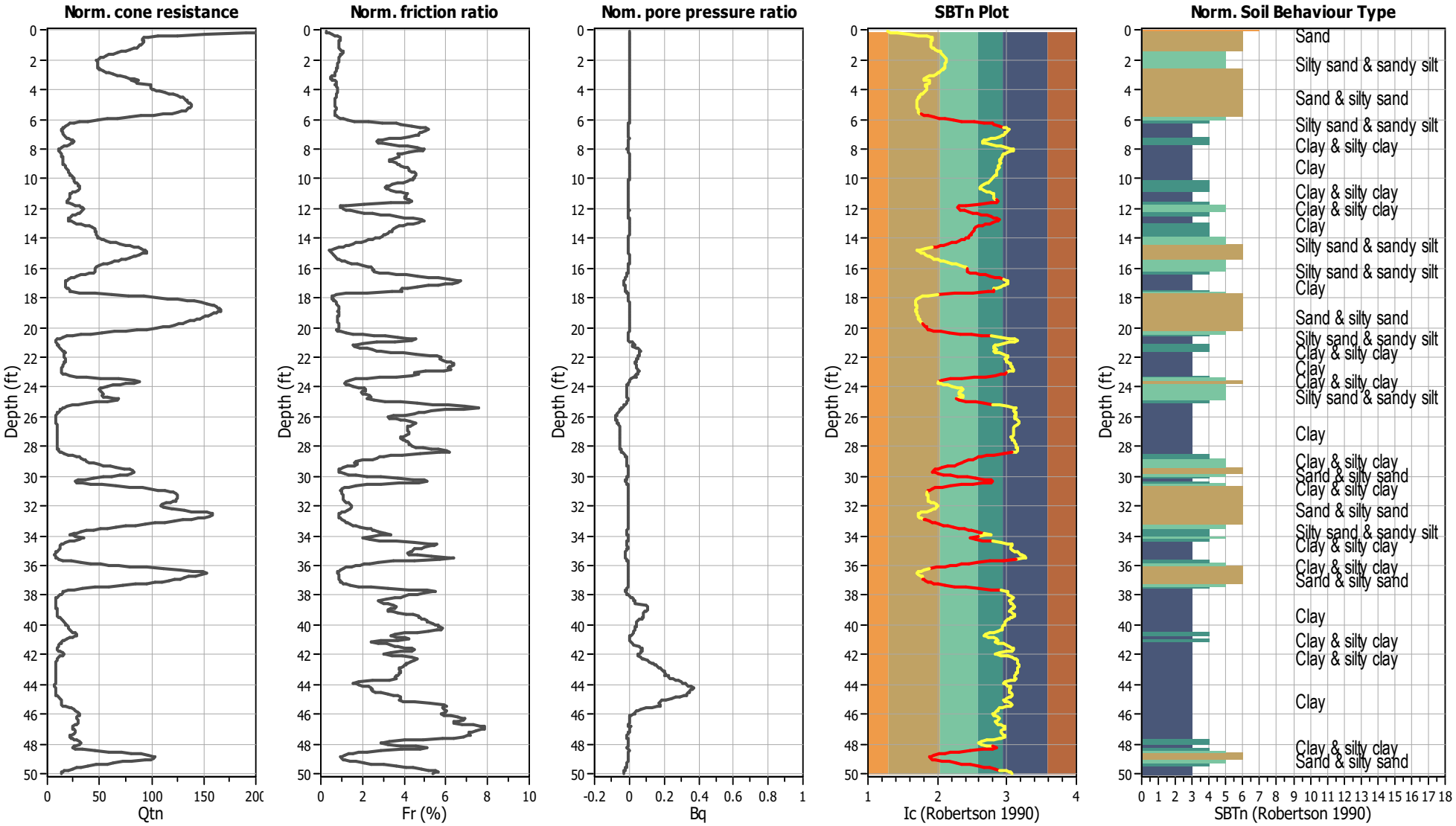

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



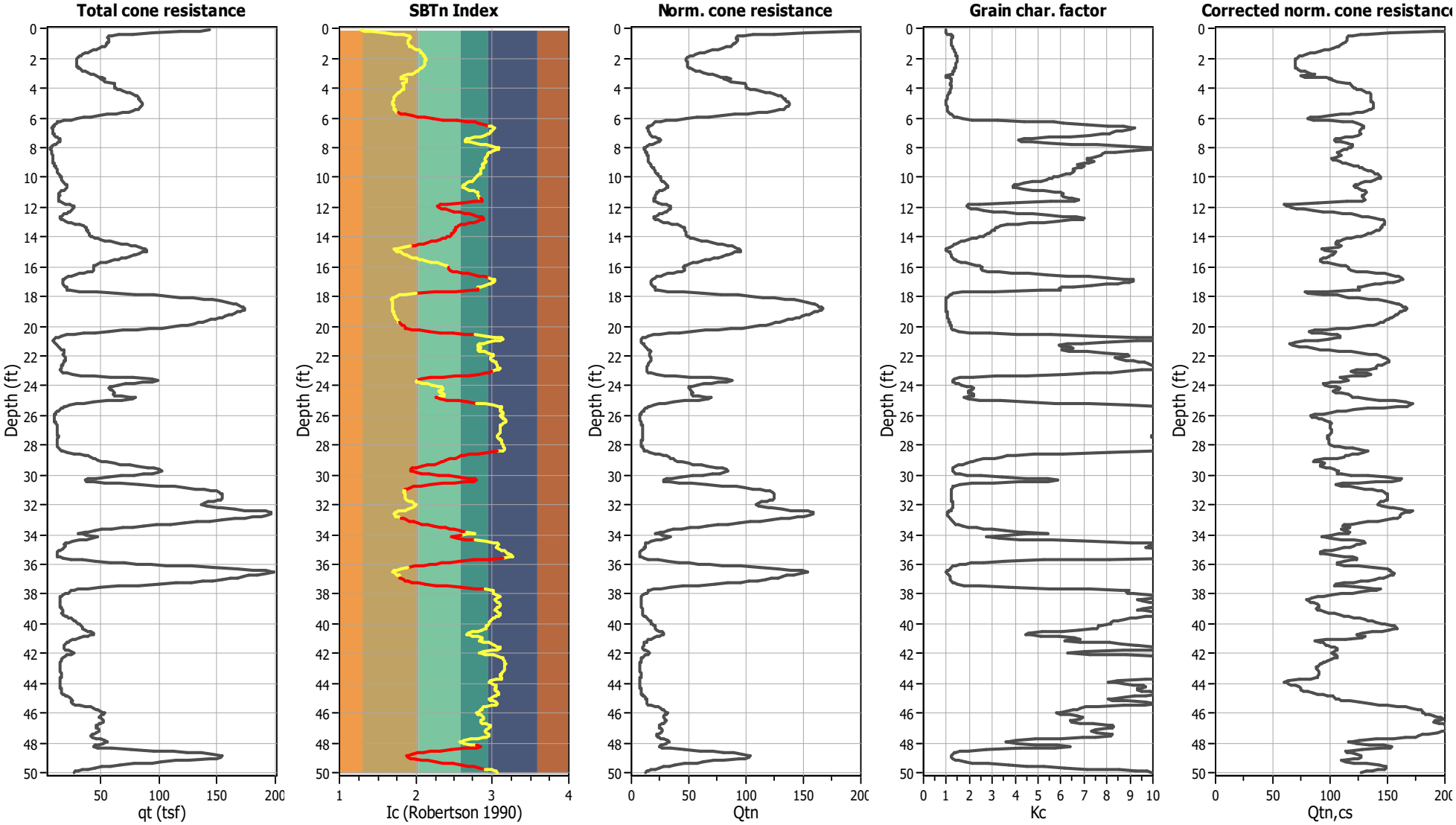

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

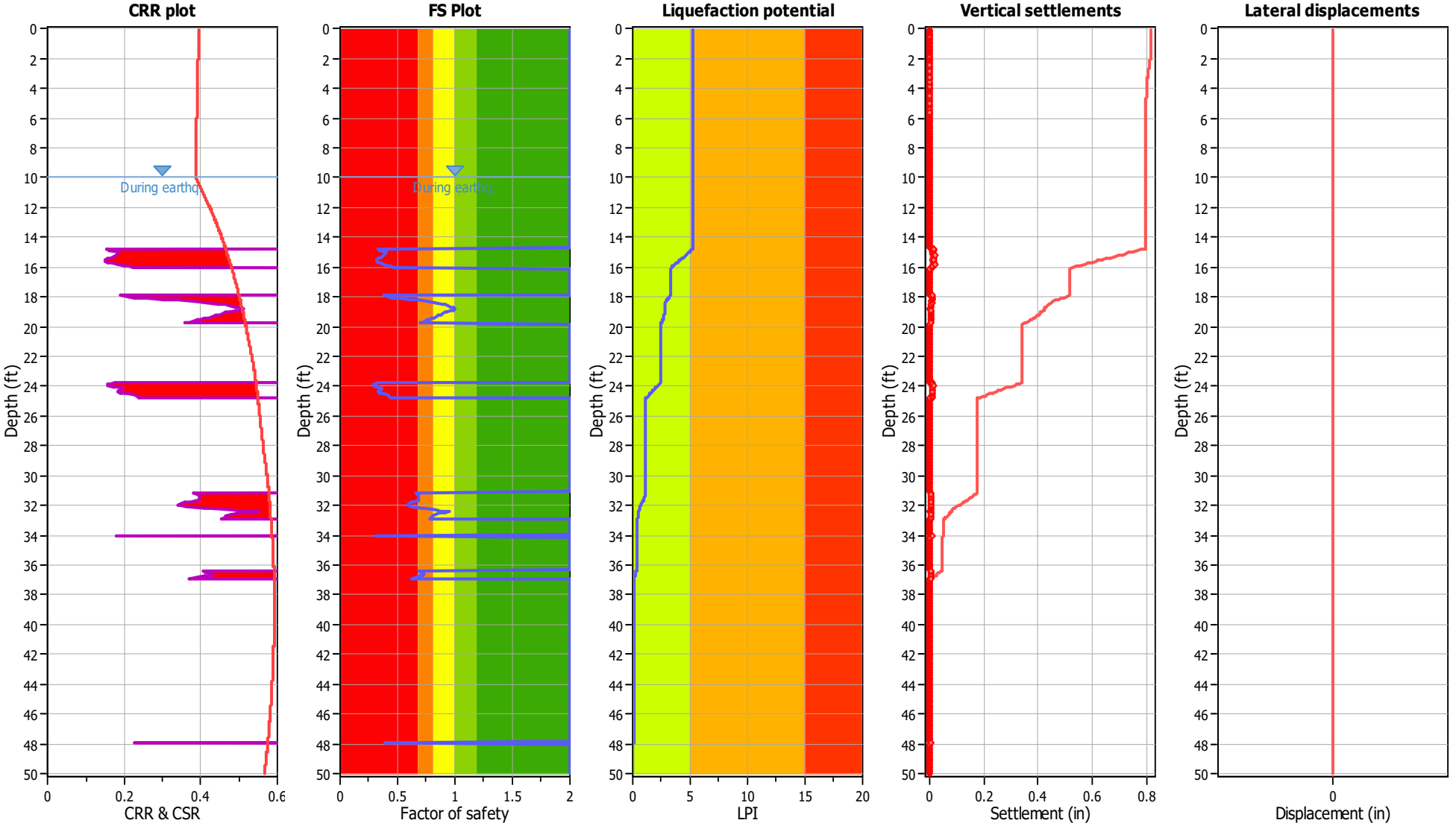
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

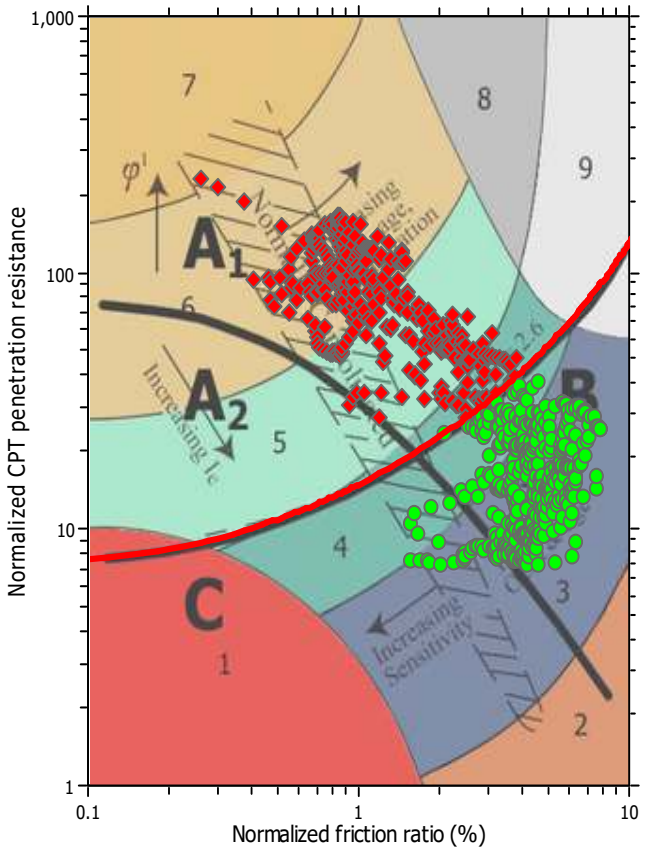
**F.S. color scheme**

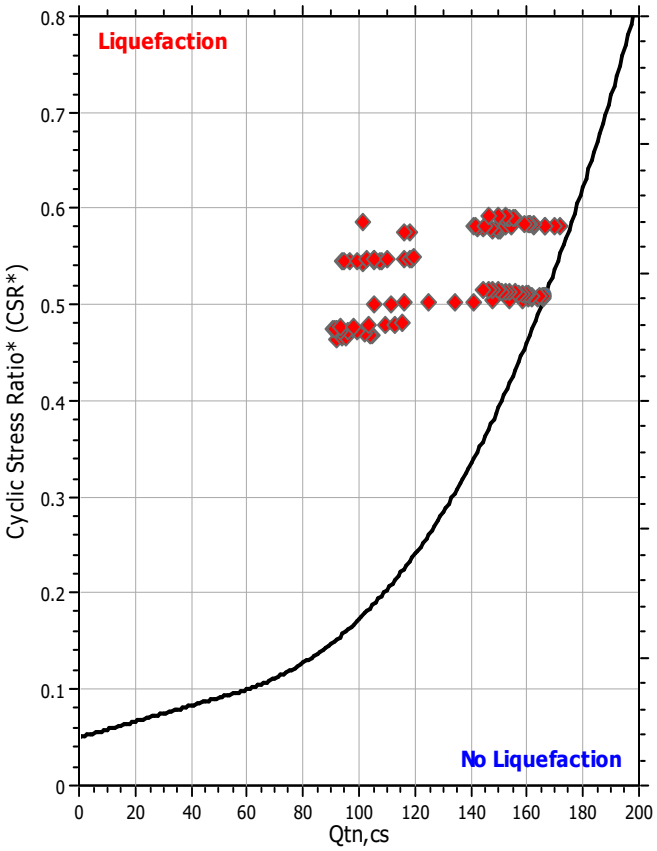
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

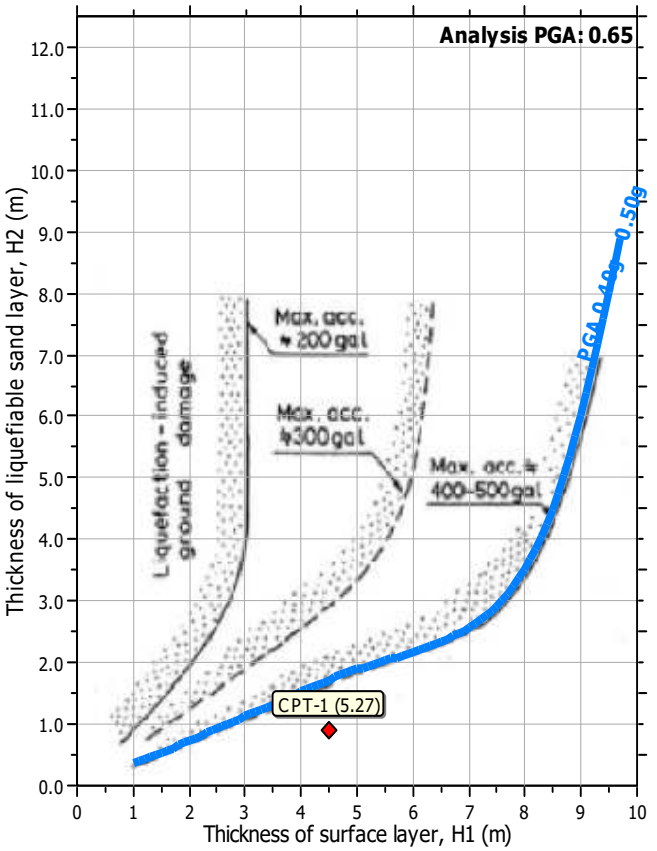
**LPI color scheme**

- Very high risk
- High risk
- Low risk

# Liquefaction analysis summary plots



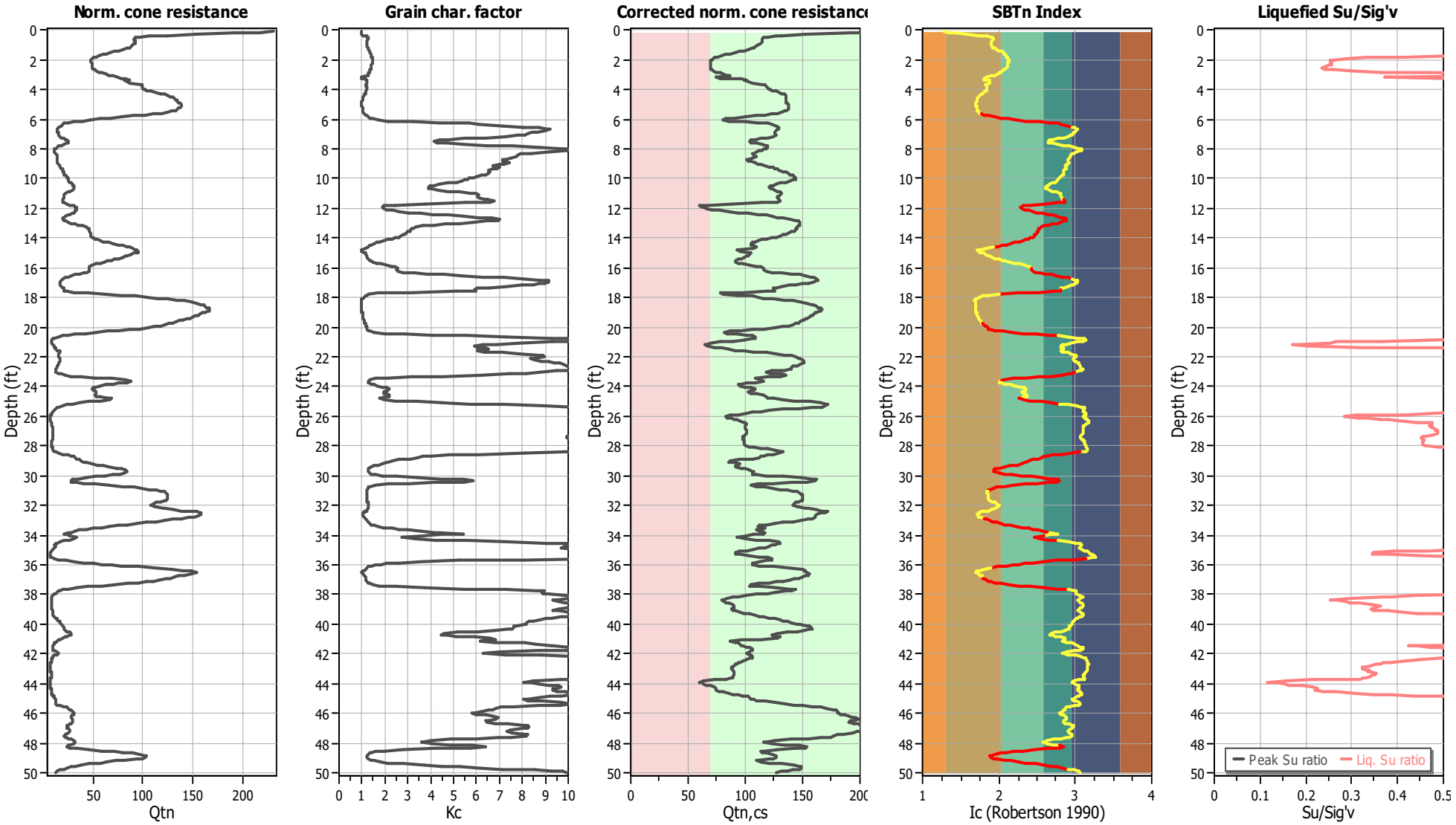




**Input parameters and analysis data**

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**:: Post-earthquake settlement of dry sands ::**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.07 | 1.28 | 230.50 | 1.00 | 230.50 | 38 | 651 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.13 | 1.33 | 216.49 | 1.00 | 216.49 | 36 | 655 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.21 | 1.43 | 191.05 | 1.00 | 191.05 | 33 | 654 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.27 | 1.59 | 151.96 | 1.00 | 151.96 | 27 | 639 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.34 | 1.73 | 124.49 | 1.05 | 131.10 | 25 | 625 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.40 | 1.84 | 106.06 | 1.19 | 126.47 | 25 | 611 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.46 | 1.90 | 97.06 | 1.24 | 120.05 | 24 | 603 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.53 | 1.92 | 92.79 | 1.25 | 116.03 | 23 | 592 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.61 | 1.93 | 90.96 | 1.25 | 114.14 | 23 | 585 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.68 | 1.92 | 91.51 | 1.25 | 114.17 | 23 | 580 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.74 | 1.91 | 92.26 | 1.24 | 114.65 | 23 | 579 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.80 | 1.90 | 93.02 | 1.24 | 114.98 | 23 | 577 | 0.39 | 0.005 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.86 | 1.90 | 91.90 | 1.24 | 113.69 | 23 | 571 | 0.39 | 0.005 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.94 | 1.90 | 91.34 | 1.24 | 112.89 | 23 | 566 | 0.39 | 0.006 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.99 | 1.90 | 90.01 | 1.24 | 111.46 | 22 | 561 | 0.39 | 0.006 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.05 | 1.90 | 89.25 | 1.24 | 110.58 | 22 | 557 | 0.39 | 0.007 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.12 | 1.91 | 87.51 | 1.25 | 108.99 | 22 | 553 | 0.39 | 0.007 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.19 | 1.92 | 86.18 | 1.25 | 107.91 | 22 | 551 | 0.39 | 0.008 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.25 | 1.94 | 83.48 | 1.27 | 105.74 | 22 | 549 | 0.39 | 0.009 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.33 | 1.98 | 79.72 | 1.29 | 102.70 | 21 | 545 | 0.39 | 0.009 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.39 | 2.01 | 75.20 | 1.32 | 99.15 | 21 | 539 | 0.39 | 0.010 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.45 | 2.04 | 71.09 | 1.35 | 95.64 | 20 | 528 | 0.39 | 0.011 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.52 | 2.06 | 67.27 | 1.36 | 91.65 | 20 | 510 | 0.39 | 0.013 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.58 | 2.07 | 63.26 | 1.37 | 86.97 | 19 | 486 | 0.39 | 0.015 | 0.02 | 13.34 | 0.02 | 0.000 |
| 1.64 | 2.08 | 59.55 | 1.39 | 82.54 | 18 | 462 | 0.39 | 0.018 | 0.02 | 13.34 | 0.02 | 0.000 |
| 1.71 | 2.09 | 56.24 | 1.40 | 78.88 | 17 | 444 | 0.39 | 0.021 | 0.03 | 13.34 | 0.02 | 0.000 |
| 1.77 | 2.10 | 53.49 | 1.42 | 75.79 | 16 | 427 | 0.39 | 0.024 | 0.03 | 13.34 | 0.03 | 0.000 |
| 1.84 | 2.11 | 51.10 | 1.43 | 73.22 | 16 | 414 | 0.39 | 0.028 | 0.04 | 13.34 | 0.03 | 0.000 |
| 1.92 | 2.12 | 49.31 | 1.45 | 71.44 | 16 | 404 | 0.39 | 0.033 | 0.04 | 13.34 | 0.04 | 0.000 |
| 1.99 | 2.13 | 48.09 | 1.46 | 70.39 | 15 | 399 | 0.39 | 0.036 | 0.05 | 13.34 | 0.04 | 0.000 |
| 2.05 | 2.13 | 47.63 | 1.47 | 69.96 | 15 | 396 | 0.39 | 0.039 | 0.05 | 13.34 | 0.05 | 0.000 |
| 2.11 | 2.13 | 47.68 | 1.47 | 69.89 | 15 | 396 | 0.39 | 0.041 | 0.06 | 13.34 | 0.05 | 0.000 |
| 2.17 | 2.12 | 48.13 | 1.45 | 70.02 | 15 | 396 | 0.39 | 0.043 | 0.06 | 13.34 | 0.05 | 0.000 |
| 2.24 | 2.11 | 48.68 | 1.44 | 70.11 | 15 | 397 | 0.39 | 0.045 | 0.06 | 13.34 | 0.06 | 0.000 |
| 2.30 | 2.11 | 48.93 | 1.43 | 70.03 | 15 | 396 | 0.39 | 0.048 | 0.07 | 13.34 | 0.06 | 0.000 |
| 2.36 | 2.11 | 48.82 | 1.43 | 69.77 | 15 | 394 | 0.39 | 0.051 | 0.07 | 13.34 | 0.06 | 0.001 |
| 2.45 | 2.11 | 48.56 | 1.43 | 69.41 | 15 | 392 | 0.39 | 0.055 | 0.08 | 13.34 | 0.07 | 0.001 |
| 2.51 | 2.10 | 48.51 | 1.42 | 69.05 | 15 | 390 | 0.39 | 0.060 | 0.08 | 13.34 | 0.08 | 0.001 |
| 2.58 | 2.09 | 49.01 | 1.41 | 69.01 | 15 | 389 | 0.39 | 0.063 | 0.09 | 13.34 | 0.08 | 0.001 |
| 2.64 | 2.08 | 49.87 | 1.39 | 69.32 | 15 | 389 | 0.39 | 0.066 | 0.09 | 13.34 | 0.09 | 0.001 |
| 2.70 | 2.06 | 51.23 | 1.37 | 70.20 | 15 | 391 | 0.39 | 0.067 | 0.10 | 13.34 | 0.09 | 0.001 |
| 2.76 | 2.05 | 53.21 | 1.35 | 71.87 | 15 | 398 | 0.39 | 0.067 | 0.09 | 13.34 | 0.08 | 0.001 |
| 2.84 | 2.02 | 55.94 | 1.33 | 74.36 | 16 | 407 | 0.39 | 0.065 | 0.09 | 13.34 | 0.08 | 0.001 |
| 2.90 | 2.00 | 59.18 | 1.31 | 77.49 | 16 | 419 | 0.39 | 0.061 | 0.08 | 13.34 | 0.07 | 0.001 |
| 2.96 | 1.98 | 62.68 | 1.29 | 81.04 | 17 | 432 | 0.39 | 0.057 | 0.07 | 13.34 | 0.06 | 0.000 |
| 3.03 | 1.95 | 66.48 | 1.27 | 84.24 | 17 | 438 | 0.39 | 0.057 | 0.07 | 13.34 | 0.06 | 0.000 |
| 3.09 | 1.89 | 70.39 | 1.23 | 86.48 | 17 | 431 | 0.39 | 0.063 | 0.08 | 13.34 | 0.07 | 0.001 |
| 3.15 | 1.84 | 74.59 | 1.00 | 74.59 | 15 | 428 | 0.39 | 0.067 | 0.10 | 13.34 | 0.09 | 0.001 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.23 | 1.81 | 78.64 | 1.00 | 78.64 | 15 | 436 | 0.39 | 0.066 | 0.09 | 13.34 | 0.08 | 0.001 |
| 3.29 | 1.81 | 82.65 | 1.17 | 96.54 | 19 | 460 | 0.39 | 0.057 | 0.06 | 13.34 | 0.05 | 0.000 |
| 3.35 | 1.81 | 86.76 | 1.17 | 101.16 | 20 | 482 | 0.39 | 0.051 | 0.05 | 13.34 | 0.05 | 0.000 |
| 3.42 | 1.88 | 80.76 | 1.22 | 98.82 | 20 | 489 | 0.39 | 0.050 | 0.05 | 13.34 | 0.05 | 0.000 |
| 3.48 | 1.88 | 84.00 | 1.22 | 102.68 | 20 | 508 | 0.39 | 0.046 | 0.05 | 13.34 | 0.04 | 0.000 |
| 3.56 | 1.88 | 86.38 | 1.22 | 105.64 | 21 | 523 | 0.39 | 0.044 | 0.04 | 13.34 | 0.04 | 0.000 |
| 3.63 | 1.82 | 97.89 | 1.17 | 114.81 | 22 | 549 | 0.39 | 0.040 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.68 | 1.82 | 99.06 | 1.18 | 116.72 | 23 | 559 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.75 | 1.83 | 99.40 | 1.19 | 117.86 | 23 | 567 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.81 | 1.84 | 99.60 | 1.19 | 118.76 | 23 | 573 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.89 | 1.84 | 99.85 | 1.20 | 119.47 | 23 | 578 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.94 | 1.85 | 100.40 | 1.20 | 120.29 | 24 | 583 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.01 | 1.84 | 101.67 | 1.20 | 121.54 | 24 | 588 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.07 | 1.83 | 104.10 | 1.19 | 123.61 | 24 | 595 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.14 | 1.82 | 107.70 | 1.17 | 126.39 | 25 | 604 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.20 | 1.80 | 112.16 | 1.15 | 129.47 | 25 | 615 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.27 | 1.78 | 116.82 | 1.13 | 132.22 | 25 | 625 | 0.39 | 0.037 | 0.03 | 13.34 | 0.02 | 0.000 |
| 4.33 | 1.77 | 121.03 | 1.11 | 134.11 | 26 | 634 | 0.39 | 0.037 | 0.03 | 13.34 | 0.02 | 0.000 |
| 4.40 | 1.75 | 124.52 | 1.09 | 135.17 | 26 | 640 | 0.39 | 0.037 | 0.03 | 13.34 | 0.02 | 0.000 |
| 4.46 | 1.74 | 127.61 | 1.06 | 135.52 | 26 | 645 | 0.39 | 0.037 | 0.03 | 13.34 | 0.02 | 0.000 |
| 4.55 | 1.73 | 130.04 | 1.04 | 135.48 | 26 | 648 | 0.39 | 0.038 | 0.03 | 13.34 | 0.02 | 0.000 |
| 4.61 | 1.72 | 131.92 | 1.02 | 135.13 | 25 | 650 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.67 | 1.71 | 132.93 | 1.01 | 134.85 | 25 | 652 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.74 | 1.71 | 133.88 | 1.01 | 134.80 | 25 | 653 | 0.39 | 0.040 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.80 | 1.71 | 134.74 | 1.00 | 134.84 | 25 | 655 | 0.39 | 0.040 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.86 | 1.70 | 135.70 | 1.00 | 135.70 | 25 | 657 | 0.39 | 0.041 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.92 | 1.70 | 136.81 | 1.00 | 136.81 | 26 | 660 | 0.39 | 0.041 | 0.03 | 13.34 | 0.03 | 0.000 |
| 5.00 | 1.70 | 137.81 | 1.00 | 137.81 | 26 | 663 | 0.39 | 0.042 | 0.03 | 13.34 | 0.03 | 0.000 |
| 5.07 | 1.70 | 138.36 | 1.00 | 138.36 | 26 | 667 | 0.39 | 0.042 | 0.03 | 13.34 | 0.03 | 0.000 |
| 5.13 | 1.70 | 137.95 | 1.00 | 137.95 | 26 | 669 | 0.39 | 0.043 | 0.03 | 13.34 | 0.03 | 0.000 |
| 5.19 | 1.71 | 137.09 | 1.01 | 138.06 | 26 | 669 | 0.39 | 0.044 | 0.03 | 13.34 | 0.03 | 0.000 |
| 5.25 | 1.71 | 135.91 | 1.01 | 137.84 | 26 | 666 | 0.39 | 0.045 | 0.03 | 13.34 | 0.03 | 0.000 |
| 5.32 | 1.72 | 134.58 | 1.02 | 137.22 | 26 | 662 | 0.39 | 0.047 | 0.03 | 13.34 | 0.03 | 0.000 |
| 5.38 | 1.72 | 132.40 | 1.03 | 135.90 | 26 | 654 | 0.39 | 0.050 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.46 | 1.72 | 129.30 | 1.04 | 133.92 | 25 | 642 | 0.39 | 0.053 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.53 | 1.73 | 124.88 | 1.05 | 131.21 | 25 | 626 | 0.39 | 0.059 | 0.05 | 13.34 | 0.04 | 0.000 |
| 5.59 | 1.74 | 118.88 | 1.08 | 127.88 | 24 | 607 | 0.39 | 0.066 | 0.05 | 13.34 | 0.04 | 0.000 |
| 5.65 | 1.77 | 110.95 | 1.11 | 123.50 | 24 | 584 | 0.39 | 0.076 | 0.06 | 13.34 | 0.05 | 0.000 |
| 5.71 | 1.81 | 101.45 | 1.16 | 117.61 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.78 | 1.86 | 90.38 | 1.21 | 109.53 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.84 | 1.94 | 78.85 | 1.27 | 99.80 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.91 | 2.03 | 67.52 | 1.33 | 90.13 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.97 | 2.12 | 57.26 | 1.44 | 82.73 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.04 | 2.22 | 47.76 | 1.68 | 80.17 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.11 | 2.36 | 39.43 | 2.15 | 84.92 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.17 | 2.54 | 30.54 | 3.25 | 99.25 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.24 | 2.67 | 25.36 | 4.38 | 110.98 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.30 | 2.78 | 21.29 | 5.64 | 120.10 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.38 | 2.82 | 20.12 | 6.10 | 122.76 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.45 | 2.89 | 17.78 | 7.13 | 126.76 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.52 | 2.95 | 16.09 | 8.03 | 129.20 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.57 | 2.99 | 14.92 | 8.69 | 129.71 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.64 | 3.02 | 14.16 | 9.11 | 129.01 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.69 | 3.03 | 13.85 | 9.22 | 127.64 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.79 | 3.01 | 14.04 | 9.01 | 126.48 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.85 | 2.99 | 14.49 | 8.66 | 125.51 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.91 | 2.98 | 14.89 | 8.42 | 125.40 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.97 | 2.97 | 15.25 | 8.25 | 125.78 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.04 | 2.96 | 15.60 | 8.11 | 126.57 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.11 | 2.94 | 16.15 | 7.82 | 126.36 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.17 | 2.90 | 17.16 | 7.23 | 124.00 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.23 | 2.84 | 18.67 | 6.38 | 119.15 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.30 | 2.77 | 20.65 | 5.48 | 113.19 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.36 | 2.71 | 22.67 | 4.77 | 108.10 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.43 | 2.67 | 24.13 | 4.36 | 105.25 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.50 | 2.64 | 25.03 | 4.16 | 104.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.55 | 2.66 | 24.77 | 4.26 | 105.44 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.62 | 2.70 | 23.39 | 4.67 | 109.19 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.69 | 2.77 | 21.00 | 5.44 | 114.16 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.75 | 2.85 | 18.36 | 6.44 | 118.21 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.82 | 2.92 | 15.92 | 7.53 | 119.88 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.89 | 3.00 | 13.68 | 8.77 | 119.95 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.96 | 3.05 | 12.15 | 9.74 | 118.33 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.02 | 3.09 | 11.24 | 10.36 | 116.41 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.09 | 3.09 | 10.98 | 10.42 | 114.34 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.15 | 3.07 | 11.23 | 9.96 | 111.85 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.22 | 3.02 | 11.94 | 9.15 | 109.25 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.28 | 2.97 | 12.80 | 8.36 | 107.00 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.35 | 2.95 | 13.41 | 7.94 | 106.49 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.42 | 2.94 | 13.76 | 7.81 | 107.51 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.49 | 2.94 | 14.01 | 7.76 | 108.63 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.55 | 2.94 | 14.10 | 7.74 | 109.16 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.62 | 2.92 | 14.15 | 7.49 | 106.03 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.68 | 2.91 | 14.15 | 7.28 | 102.99 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.75 | 2.89 | 14.19 | 7.13 | 101.11 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.81 | 2.90 | 14.29 | 7.16 | 102.28 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.88 | 2.90 | 14.53 | 7.21 | 104.85 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.94 | 2.92 | 14.53 | 7.45 | 108.17 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.00 | 2.90 | 15.43 | 7.19 | 111.03 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.07 | 2.89 | 16.25 | 7.01 | 113.92 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.13 | 2.87 | 17.31 | 6.73 | 116.52 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.19 | 2.88 | 17.40 | 6.93 | 120.58 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.26 | 2.89 | 17.65 | 7.02 | 123.89 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.32 | 2.88 | 18.25 | 6.91 | 126.19 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.39 | 2.86 | 19.12 | 6.70 | 128.00 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.45 | 2.85 | 19.88 | 6.53 | 129.80 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.52 | 2.85 | 20.28 | 6.53 | 132.45 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.59 | 2.86 | 20.57 | 6.57 | 135.20 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.66 | 2.85 | 21.02 | 6.55 | 137.76 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.72 | 2.84 | 21.73 | 6.43 | 139.60 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.79 | 2.83 | 22.63 | 6.23 | 140.92 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.85 | 2.81 | 23.59 | 6.02 | 142.12 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.92 | 2.80 | 24.49 | 5.85 | 143.20 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.98 | 2.79 | 25.24 | 5.70 | 143.79 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |

**Total estimated settlement: 0.02**

**Abbreviations**

$Q_{tn}$: Equivalent clean sand normalized cone resistance
$K_c$: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
$G_{max}$: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
$N_c$: Equivalent number of cycles
$e_v$: Volumetric strain
Settle.: Calculated settlement

**:: Post-earthquake settlement due to soil liquefaction ::**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.04 | 143.59 | 2.00 | 0.00 | 0.83 | 0.00 | 10.11 | 141.98 | 2.00 | 0.00 | 0.83 | 0.00 |
| 10.18 | 139.20 | 2.00 | 0.00 | 0.83 | 0.00 | 10.24 | 135.30 | 2.00 | 0.00 | 0.83 | 0.00 |
| 10.31 | 130.79 | 2.00 | 0.00 | 0.83 | 0.00 | 10.38 | 126.75 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.44 | 123.92 | 2.00 | 0.00 | 0.82 | 0.00 | 10.51 | 121.94 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.57 | 121.14 | 2.00 | 0.00 | 0.82 | 0.00 | 10.64 | 121.42 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.70 | 123.14 | 2.00 | 0.00 | 0.82 | 0.00 | 10.77 | 125.48 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.83 | 128.19 | 2.00 | 0.00 | 0.82 | 0.00 | 10.90 | 130.65 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.96 | 132.01 | 2.00 | 0.00 | 0.81 | 0.00 | 11.03 | 131.48 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.10 | 130.21 | 2.00 | 0.00 | 0.81 | 0.00 | 11.16 | 129.17 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.23 | 128.42 | 2.00 | 0.00 | 0.81 | 0.00 | 11.30 | 128.30 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.37 | 128.89 | 2.00 | 0.00 | 0.81 | 0.00 | 11.43 | 129.49 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.50 | 130.49 | 2.00 | 0.00 | 0.81 | 0.00 | 11.57 | 128.55 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.63 | 114.25 | 2.00 | 0.00 | 0.80 | 0.00 | 11.70 | 88.68 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.77 | 66.67 | 2.00 | 0.00 | 0.80 | 0.00 | 11.83 | 60.01 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.90 | 62.22 | 2.00 | 0.00 | 0.80 | 0.00 | 11.96 | 64.02 | 2.00 | 0.00 | 0.80 | 0.00 |
| 12.03 | 65.91 | 2.00 | 0.00 | 0.80 | 0.00 | 12.08 | 70.13 | 2.00 | 0.00 | 0.80 | 0.00 |
| 12.16 | 76.26 | 2.00 | 0.00 | 0.79 | 0.00 | 12.23 | 84.93 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.29 | 93.80 | 2.00 | 0.00 | 0.79 | 0.00 | 12.35 | 103.00 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.42 | 111.13 | 2.00 | 0.00 | 0.79 | 0.00 | 12.48 | 117.81 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.54 | 123.05 | 2.00 | 0.00 | 0.79 | 0.00 | 12.61 | 128.06 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.67 | 133.30 | 2.00 | 0.00 | 0.79 | 0.00 | 12.74 | 139.10 | 2.00 | 0.00 | 0.78 | 0.00 |
| 12.80 | 143.79 | 2.00 | 0.00 | 0.78 | 0.00 | 12.87 | 146.64 | 2.00 | 0.00 | 0.78 | 0.00 |
| 12.93 | 147.94 | 2.00 | 0.00 | 0.78 | 0.00 | 13.00 | 148.12 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.06 | 147.93 | 2.00 | 0.00 | 0.78 | 0.00 | 13.13 | 147.33 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.19 | 146.23 | 2.00 | 0.00 | 0.78 | 0.00 | 13.26 | 145.35 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.32 | 144.78 | 2.00 | 0.00 | 0.77 | 0.00 | 13.39 | 144.44 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.46 | 143.77 | 2.00 | 0.00 | 0.77 | 0.00 | 13.52 | 142.62 | 2.00 | 0.00 | 0.77 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.58 | 140.45 | 2.00 | 0.00 | 0.77 | 0.00 | 13.68 | 137.85 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.74 | 135.07 | 2.00 | 0.00 | 0.77 | 0.00 | 13.81 | 132.71 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.87 | 129.88 | 2.00 | 0.00 | 0.76 | 0.00 | 13.94 | 126.50 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.00 | 122.64 | 2.00 | 0.00 | 0.76 | 0.00 | 14.06 | 118.76 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.12 | 115.02 | 2.00 | 0.00 | 0.76 | 0.00 | 14.19 | 111.44 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.25 | 108.22 | 2.00 | 0.00 | 0.76 | 0.00 | 14.31 | 105.85 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.38 | 104.88 | 2.00 | 0.00 | 0.76 | 0.00 | 14.44 | 105.35 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.51 | 106.84 | 2.00 | 0.00 | 0.75 | 0.00 | 14.57 | 108.94 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.64 | 109.55 | 2.00 | 0.00 | 0.75 | 0.00 | 14.71 | 107.01 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.78 | 92.18 | 0.33 | 1.87 | 0.75 | 0.02 | 14.84 | 93.96 | 0.34 | 1.84 | 0.75 | 0.01 |
| 14.91 | 95.09 | 0.34 | 1.82 | 0.75 | 0.02 | 14.97 | 104.25 | 0.40 | 1.69 | 0.75 | 0.01 |
| 15.04 | 104.57 | 0.40 | 1.68 | 0.75 | 0.01 | 15.09 | 104.05 | 0.39 | 1.68 | 0.74 | 0.01 |
| 15.16 | 102.08 | 0.38 | 1.71 | 0.74 | 0.01 | 15.25 | 101.80 | 0.38 | 1.71 | 0.74 | 0.02 |
| 15.31 | 99.04 | 0.36 | 1.74 | 0.74 | 0.01 | 15.38 | 96.23 | 0.34 | 1.78 | 0.74 | 0.01 |
| 15.45 | 93.49 | 0.33 | 1.82 | 0.74 | 0.01 | 15.52 | 91.63 | 0.32 | 1.85 | 0.74 | 0.02 |
| 15.55 | 90.87 | 0.32 | 1.86 | 0.74 | 0.01 | 15.62 | 91.27 | 0.32 | 1.85 | 0.74 | 0.01 |
| 15.68 | 93.36 | 0.33 | 1.81 | 0.73 | 0.01 | 15.75 | 97.69 | 0.35 | 1.75 | 0.73 | 0.01 |
| 15.85 | 103.19 | 0.38 | 1.67 | 0.73 | 0.02 | 15.91 | 109.29 | 0.42 | 1.59 | 0.73 | 0.01 |
| 15.97 | 112.81 | 0.45 | 1.54 | 0.73 | 0.01 | 16.03 | 115.62 | 0.47 | 1.51 | 0.73 | 0.01 |
| 16.10 | 115.82 | 2.00 | 0.00 | 0.73 | 0.00 | 16.16 | 116.23 | 2.00 | 0.00 | 0.73 | 0.00 |
| 16.23 | 117.90 | 2.00 | 0.00 | 0.72 | 0.00 | 16.30 | 123.31 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.36 | 131.67 | 2.00 | 0.00 | 0.72 | 0.00 | 16.43 | 139.99 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.49 | 147.25 | 2.00 | 0.00 | 0.72 | 0.00 | 16.55 | 152.72 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.62 | 156.85 | 2.00 | 0.00 | 0.72 | 0.00 | 16.68 | 159.61 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.75 | 162.01 | 2.00 | 0.00 | 0.72 | 0.00 | 16.82 | 163.02 | 2.00 | 0.00 | 0.71 | 0.00 |
| 16.88 | 162.30 | 2.00 | 0.00 | 0.71 | 0.00 | 16.95 | 159.16 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.02 | 154.50 | 2.00 | 0.00 | 0.71 | 0.00 | 17.08 | 149.40 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.15 | 144.48 | 2.00 | 0.00 | 0.71 | 0.00 | 17.21 | 138.44 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.28 | 131.86 | 2.00 | 0.00 | 0.71 | 0.00 | 17.34 | 126.54 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.40 | 123.85 | 2.00 | 0.00 | 0.71 | 0.00 | 17.46 | 124.06 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.53 | 125.16 | 2.00 | 0.00 | 0.70 | 0.00 | 17.59 | 119.76 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.66 | 98.16 | 2.00 | 0.00 | 0.70 | 0.00 | 17.73 | 77.78 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.79 | 80.85 | 2.00 | 0.00 | 0.70 | 0.00 | 17.86 | 94.47 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.93 | 105.55 | 0.38 | 1.56 | 0.70 | 0.01 | 17.99 | 111.51 | 0.42 | 1.49 | 0.70 | 0.01 |
| 18.05 | 116.36 | 0.45 | 1.43 | 0.69 | 0.01 | 18.11 | 124.52 | 0.52 | 1.35 | 0.69 | 0.01 |
| 18.18 | 134.09 | 0.60 | 1.27 | 0.69 | 0.01 | 18.24 | 140.86 | 0.68 | 1.04 | 0.69 | 0.01 |
| 18.31 | 147.80 | 0.75 | 0.79 | 0.69 | 0.01 | 18.41 | 153.56 | 0.83 | 0.75 | 0.69 | 0.01 |
| 18.47 | 158.17 | 0.89 | 0.55 | 0.69 | 0.00 | 18.53 | 160.29 | 0.91 | 0.53 | 0.69 | 0.00 |
| 18.60 | 162.02 | 0.94 | 0.53 | 0.68 | 0.00 | 18.66 | 163.92 | 0.97 | 0.38 | 0.68 | 0.00 |
| 18.73 | 165.61 | 0.99 | 0.38 | 0.68 | 0.00 | 18.77 | 166.67 | 1.00 | 0.37 | 0.68 | 0.00 |
| 18.86 | 166.01 | 0.99 | 0.38 | 0.68 | 0.00 | 18.93 | 164.40 | 0.97 | 0.38 | 0.68 | 0.00 |
| 18.99 | 162.03 | 0.93 | 0.52 | 0.68 | 0.00 | 19.05 | 160.72 | 0.91 | 0.53 | 0.68 | 0.00 |
| 19.12 | 159.55 | 0.90 | 0.53 | 0.68 | 0.00 | 19.18 | 158.32 | 0.88 | 0.54 | 0.67 | 0.00 |
| 19.25 | 156.93 | 0.86 | 0.54 | 0.67 | 0.00 | 19.32 | 155.53 | 0.84 | 0.72 | 0.67 | 0.01 |
| 19.38 | 154.00 | 0.82 | 0.73 | 0.67 | 0.01 | 19.45 | 152.55 | 0.80 | 0.74 | 0.67 | 0.01 |
| 19.52 | 151.06 | 0.78 | 0.74 | 0.67 | 0.01 | 19.58 | 149.41 | 0.76 | 0.76 | 0.67 | 0.01 |
| 19.64 | 147.78 | 0.74 | 0.94 | 0.67 | 0.01 | 19.71 | 146.07 | 0.72 | 0.96 | 0.67 | 0.01 |
| 19.78 | 144.03 | 0.69 | 0.97 | 0.66 | 0.01 | 19.84 | 141.41 | 2.00 | 0.00 | 0.66 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.91 | 137.92 | 2.00 | 0.00 | 0.66 | 0.00 | 19.97 | 133.39 | 2.00 | 0.00 | 0.66 | 0.00 |
| 20.04 | 125.82 | 2.00 | 0.00 | 0.66 | 0.00 | 20.11 | 116.22 | 2.00 | 0.00 | 0.66 | 0.00 |
| 20.17 | 105.72 | 2.00 | 0.00 | 0.66 | 0.00 | 20.23 | 95.80 | 2.00 | 0.00 | 0.66 | 0.00 |
| 20.30 | 87.13 | 2.00 | 0.00 | 0.66 | 0.00 | 20.37 | 82.21 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.43 | 84.68 | 2.00 | 0.00 | 0.65 | 0.00 | 20.48 | 92.84 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.55 | 101.47 | 2.00 | 0.00 | 0.65 | 0.00 | 20.61 | 106.62 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.68 | 109.12 | 2.00 | 0.00 | 0.65 | 0.00 | 20.75 | 109.02 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.81 | 105.89 | 2.00 | 0.00 | 0.65 | 0.00 | 20.88 | 99.09 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.93 | 88.82 | 2.00 | 0.00 | 0.65 | 0.00 | 21.00 | 78.11 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.06 | 69.91 | 2.00 | 0.00 | 0.64 | 0.00 | 21.16 | 65.81 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.22 | 65.11 | 2.00 | 0.00 | 0.64 | 0.00 | 21.29 | 67.32 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.35 | 72.88 | 2.00 | 0.00 | 0.64 | 0.00 | 21.42 | 79.68 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.49 | 85.93 | 2.00 | 0.00 | 0.64 | 0.00 | 21.55 | 91.46 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.62 | 98.51 | 2.00 | 0.00 | 0.63 | 0.00 | 21.68 | 107.61 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.74 | 117.80 | 2.00 | 0.00 | 0.63 | 0.00 | 21.80 | 126.49 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.87 | 134.34 | 2.00 | 0.00 | 0.63 | 0.00 | 21.94 | 139.72 | 2.00 | 0.00 | 0.63 | 0.00 |
| 22.00 | 143.81 | 2.00 | 0.00 | 0.63 | 0.00 | 22.07 | 145.76 | 2.00 | 0.00 | 0.63 | 0.00 |
| 22.14 | 147.81 | 2.00 | 0.00 | 0.62 | 0.00 | 22.20 | 149.69 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.27 | 151.12 | 2.00 | 0.00 | 0.62 | 0.00 | 22.34 | 151.73 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.40 | 151.26 | 2.00 | 0.00 | 0.62 | 0.00 | 22.46 | 149.84 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.53 | 147.53 | 2.00 | 0.00 | 0.62 | 0.00 | 22.60 | 144.59 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.66 | 141.82 | 2.00 | 0.00 | 0.62 | 0.00 | 22.73 | 140.04 | 2.00 | 0.00 | 0.61 | 0.00 |
| 22.79 | 139.81 | 2.00 | 0.00 | 0.61 | 0.00 | 22.85 | 139.35 | 2.00 | 0.00 | 0.61 | 0.00 |
| 22.92 | 133.69 | 2.00 | 0.00 | 0.61 | 0.00 | 22.98 | 123.29 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.05 | 118.02 | 2.00 | 0.00 | 0.61 | 0.00 | 23.11 | 122.11 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.18 | 131.82 | 2.00 | 0.00 | 0.61 | 0.00 | 23.24 | 135.31 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.31 | 130.11 | 2.00 | 0.00 | 0.60 | 0.00 | 23.37 | 120.04 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.43 | 110.12 | 2.00 | 0.00 | 0.60 | 0.00 | 23.49 | 108.59 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.56 | 114.01 | 2.00 | 0.00 | 0.60 | 0.00 | 23.65 | 115.28 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.72 | 109.05 | 2.00 | 0.00 | 0.60 | 0.00 | 23.79 | 101.45 | 0.33 | 1.38 | 0.60 | 0.01 |
| 23.85 | 96.82 | 0.30 | 1.43 | 0.60 | 0.01 | 23.89 | 94.17 | 0.29 | 1.46 | 0.60 | 0.01 |
| 23.98 | 94.73 | 0.29 | 1.45 | 0.59 | 0.02 | 24.04 | 99.46 | 0.31 | 1.39 | 0.59 | 0.01 |
| 24.11 | 105.31 | 0.35 | 1.32 | 0.59 | 0.01 | 24.17 | 108.15 | 0.36 | 1.29 | 0.59 | 0.01 |
| 24.24 | 107.14 | 0.36 | 1.30 | 0.59 | 0.01 | 24.30 | 105.13 | 0.34 | 1.32 | 0.59 | 0.01 |
| 24.37 | 102.97 | 0.33 | 1.34 | 0.59 | 0.01 | 24.43 | 105.29 | 0.34 | 1.31 | 0.59 | 0.01 |
| 24.50 | 109.81 | 0.37 | 1.27 | 0.58 | 0.01 | 24.57 | 116.24 | 0.41 | 1.21 | 0.58 | 0.01 |
| 24.63 | 118.59 | 0.43 | 1.18 | 0.58 | 0.01 | 24.70 | 118.42 | 0.43 | 1.18 | 0.58 | 0.01 |
| 24.76 | 119.44 | 0.43 | 1.17 | 0.58 | 0.01 | 24.83 | 123.97 | 2.00 | 0.00 | 0.58 | 0.00 |
| 24.89 | 131.46 | 2.00 | 0.00 | 0.58 | 0.00 | 24.96 | 142.87 | 2.00 | 0.00 | 0.58 | 0.00 |
| 25.02 | 156.34 | 2.00 | 0.00 | 0.58 | 0.00 | 25.09 | 166.09 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.16 | 170.53 | 2.00 | 0.00 | 0.57 | 0.00 | 25.23 | 171.52 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.29 | 169.81 | 2.00 | 0.00 | 0.57 | 0.00 | 25.36 | 166.49 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.43 | 158.88 | 2.00 | 0.00 | 0.57 | 0.00 | 25.49 | 146.36 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.55 | 132.48 | 2.00 | 0.00 | 0.57 | 0.00 | 25.62 | 120.79 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.68 | 113.06 | 2.00 | 0.00 | 0.56 | 0.00 | 25.75 | 106.69 | 2.00 | 0.00 | 0.56 | 0.00 |
| 25.81 | 100.89 | 2.00 | 0.00 | 0.56 | 0.00 | 25.88 | 93.57 | 2.00 | 0.00 | 0.56 | 0.00 |
| 25.94 | 86.76 | 2.00 | 0.00 | 0.56 | 0.00 | 26.01 | 82.91 | 2.00 | 0.00 | 0.56 | 0.00 |
| 26.08 | 84.15 | 2.00 | 0.00 | 0.56 | 0.00 | 26.15 | 87.22 | 2.00 | 0.00 | 0.56 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26.21 | 89.65 | 2.00 | 0.00 | 0.56 | 0.00 | 26.25 | 92.30 | 2.00 | 0.00 | 0.56 | 0.00 |
| 26.32 | 95.10 | 2.00 | 0.00 | 0.55 | 0.00 | 26.40 | 98.25 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.47 | 100.18 | 2.00 | 0.00 | 0.55 | 0.00 | 26.53 | 100.65 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.60 | 100.23 | 2.00 | 0.00 | 0.55 | 0.00 | 26.66 | 99.81 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.72 | 100.03 | 2.00 | 0.00 | 0.55 | 0.00 | 26.79 | 100.16 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.86 | 100.40 | 2.00 | 0.00 | 0.54 | 0.00 | 26.92 | 100.62 | 2.00 | 0.00 | 0.54 | 0.00 |
| 26.99 | 100.87 | 2.00 | 0.00 | 0.54 | 0.00 | 27.05 | 101.13 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.11 | 101.24 | 2.00 | 0.00 | 0.54 | 0.00 | 27.18 | 100.95 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.25 | 100.01 | 2.00 | 0.00 | 0.54 | 0.00 | 27.32 | 98.58 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.39 | 97.52 | 2.00 | 0.00 | 0.54 | 0.00 | 27.45 | 97.38 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.52 | 97.89 | 2.00 | 0.00 | 0.53 | 0.00 | 27.58 | 98.42 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.65 | 98.65 | 2.00 | 0.00 | 0.53 | 0.00 | 27.71 | 98.73 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.77 | 98.75 | 2.00 | 0.00 | 0.53 | 0.00 | 27.84 | 98.83 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.91 | 98.96 | 2.00 | 0.00 | 0.53 | 0.00 | 27.97 | 100.11 | 2.00 | 0.00 | 0.53 | 0.00 |
| 28.04 | 103.10 | 2.00 | 0.00 | 0.52 | 0.00 | 28.10 | 107.76 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.16 | 113.19 | 2.00 | 0.00 | 0.52 | 0.00 | 28.23 | 119.11 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.29 | 125.96 | 2.00 | 0.00 | 0.52 | 0.00 | 28.36 | 131.17 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.42 | 132.38 | 2.00 | 0.00 | 0.52 | 0.00 | 28.49 | 128.83 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.55 | 124.02 | 2.00 | 0.00 | 0.52 | 0.00 | 28.61 | 119.22 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.68 | 115.79 | 2.00 | 0.00 | 0.51 | 0.00 | 28.74 | 113.86 | 2.00 | 0.00 | 0.51 | 0.00 |
| 28.81 | 111.95 | 2.00 | 0.00 | 0.51 | 0.00 | 28.87 | 106.43 | 2.00 | 0.00 | 0.51 | 0.00 |
| 28.94 | 95.10 | 2.00 | 0.00 | 0.51 | 0.00 | 29.01 | 86.97 | 2.00 | 0.00 | 0.51 | 0.00 |
| 29.07 | 85.80 | 2.00 | 0.00 | 0.51 | 0.00 | 29.14 | 91.92 | 2.00 | 0.00 | 0.51 | 0.00 |
| 29.20 | 94.74 | 2.00 | 0.00 | 0.51 | 0.00 | 29.27 | 93.66 | 2.00 | 0.00 | 0.50 | 0.00 |
| 29.36 | 91.29 | 2.00 | 0.00 | 0.50 | 0.00 | 29.43 | 91.55 | 2.00 | 0.00 | 0.50 | 0.00 |
| 29.49 | 96.48 | 2.00 | 0.00 | 0.50 | 0.00 | 29.56 | 100.42 | 2.00 | 0.00 | 0.50 | 0.00 |
| 29.59 | 103.85 | 2.00 | 0.00 | 0.50 | 0.00 | 29.69 | 105.72 | 2.00 | 0.00 | 0.50 | 0.00 |
| 29.75 | 106.82 | 2.00 | 0.00 | 0.50 | 0.00 | 29.82 | 106.55 | 2.00 | 0.00 | 0.49 | 0.00 |
| 29.88 | 106.69 | 2.00 | 0.00 | 0.49 | 0.00 | 29.95 | 109.73 | 2.00 | 0.00 | 0.49 | 0.00 |
| 30.02 | 118.58 | 2.00 | 0.00 | 0.49 | 0.00 | 30.08 | 132.91 | 2.00 | 0.00 | 0.49 | 0.00 |
| 30.14 | 148.36 | 2.00 | 0.00 | 0.49 | 0.00 | 30.21 | 158.77 | 2.00 | 0.00 | 0.49 | 0.00 |
| 30.28 | 162.63 | 2.00 | 0.00 | 0.49 | 0.00 | 30.34 | 160.82 | 2.00 | 0.00 | 0.49 | 0.00 |
| 30.41 | 153.87 | 2.00 | 0.00 | 0.48 | 0.00 | 30.48 | 139.68 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.54 | 124.25 | 2.00 | 0.00 | 0.48 | 0.00 | 30.58 | 110.66 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.64 | 105.16 | 2.00 | 0.00 | 0.48 | 0.00 | 30.74 | 109.24 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.77 | 117.26 | 2.00 | 0.00 | 0.48 | 0.00 | 30.84 | 123.64 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.91 | 130.43 | 2.00 | 0.00 | 0.48 | 0.00 | 30.98 | 136.08 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.04 | 141.14 | 2.00 | 0.00 | 0.47 | 0.00 | 31.11 | 145.04 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.17 | 147.78 | 0.66 | 0.67 | 0.47 | 0.01 | 31.24 | 149.33 | 0.67 | 0.65 | 0.47 | 0.01 |
| 31.31 | 150.05 | 0.68 | 0.65 | 0.47 | 0.01 | 31.37 | 150.36 | 0.68 | 0.65 | 0.47 | 0.00 |
| 31.44 | 150.51 | 0.69 | 0.64 | 0.47 | 0.01 | 31.50 | 150.55 | 0.69 | 0.64 | 0.47 | 0.01 |
| 31.57 | 150.46 | 0.68 | 0.64 | 0.46 | 0.00 | 31.63 | 149.93 | 0.68 | 0.64 | 0.46 | 0.00 |
| 31.70 | 148.76 | 0.67 | 0.65 | 0.46 | 0.01 | 31.77 | 146.87 | 0.65 | 0.79 | 0.46 | 0.01 |
| 31.84 | 144.31 | 0.62 | 0.80 | 0.46 | 0.01 | 31.90 | 142.36 | 0.60 | 0.80 | 0.46 | 0.01 |
| 31.96 | 141.24 | 0.59 | 0.81 | 0.46 | 0.01 | 32.03 | 141.29 | 0.59 | 0.80 | 0.46 | 0.01 |
| 32.10 | 144.75 | 0.62 | 0.79 | 0.46 | 0.01 | 32.16 | 152.65 | 0.71 | 0.61 | 0.45 | 0.00 |
| 32.23 | 154.47 | 0.73 | 0.60 | 0.45 | 0.00 | 32.29 | 162.61 | 0.82 | 0.45 | 0.45 | 0.00 |
| 32.36 | 166.67 | 0.88 | 0.33 | 0.45 | 0.00 | 32.42 | 172.06 | 0.95 | 0.24 | 0.45 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 32.49 | 169.61 | 0.92 | 0.32 | 0.45 | 0.00 | 32.56 | 166.14 | 0.87 | 0.33 | 0.45 | 0.00 |
| 32.64 | 162.73 | 0.82 | 0.45 | 0.45 | 0.00 | 32.70 | 160.75 | 0.80 | 0.45 | 0.45 | 0.00 |
| 32.77 | 160.74 | 0.80 | 0.45 | 0.44 | 0.00 | 32.83 | 160.50 | 0.80 | 0.45 | 0.44 | 0.00 |
| 32.89 | 158.81 | 0.78 | 0.46 | 0.44 | 0.00 | 32.96 | 154.92 | 2.00 | 0.00 | 0.44 | 0.00 |
| 33.03 | 148.75 | 2.00 | 0.00 | 0.44 | 0.00 | 33.09 | 141.17 | 2.00 | 0.00 | 0.44 | 0.00 |
| 33.15 | 133.02 | 2.00 | 0.00 | 0.44 | 0.00 | 33.22 | 125.20 | 2.00 | 0.00 | 0.44 | 0.00 |
| 33.28 | 117.94 | 2.00 | 0.00 | 0.44 | 0.00 | 33.35 | 112.65 | 2.00 | 0.00 | 0.43 | 0.00 |
| 33.42 | 111.28 | 2.00 | 0.00 | 0.43 | 0.00 | 33.49 | 115.41 | 2.00 | 0.00 | 0.43 | 0.00 |
| 33.55 | 116.72 | 2.00 | 0.00 | 0.43 | 0.00 | 33.62 | 114.42 | 2.00 | 0.00 | 0.43 | 0.00 |
| 33.68 | 110.29 | 2.00 | 0.00 | 0.43 | 0.00 | 33.75 | 112.75 | 2.00 | 0.00 | 0.43 | 0.00 |
| 33.81 | 116.88 | 2.00 | 0.00 | 0.43 | 0.00 | 33.88 | 114.44 | 2.00 | 0.00 | 0.43 | 0.00 |
| 33.94 | 115.55 | 2.00 | 0.00 | 0.42 | 0.00 | 33.99 | 107.65 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.06 | 101.60 | 0.30 | 0.97 | 0.42 | 0.01 | 34.13 | 93.24 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.19 | 94.34 | 2.00 | 0.00 | 0.42 | 0.00 | 34.26 | 100.07 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.33 | 109.69 | 2.00 | 0.00 | 0.42 | 0.00 | 34.40 | 120.90 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.46 | 128.90 | 2.00 | 0.00 | 0.42 | 0.00 | 34.52 | 130.43 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.58 | 129.06 | 2.00 | 0.00 | 0.41 | 0.00 | 34.65 | 125.95 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.71 | 123.27 | 2.00 | 0.00 | 0.41 | 0.00 | 34.81 | 120.17 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.87 | 117.00 | 2.00 | 0.00 | 0.41 | 0.00 | 34.91 | 111.99 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.98 | 107.09 | 2.00 | 0.00 | 0.41 | 0.00 | 35.04 | 100.90 | 2.00 | 0.00 | 0.41 | 0.00 |
| 35.10 | 95.54 | 2.00 | 0.00 | 0.41 | 0.00 | 35.20 | 91.69 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.27 | 91.51 | 2.00 | 0.00 | 0.40 | 0.00 | 35.33 | 95.21 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.39 | 102.70 | 2.00 | 0.00 | 0.40 | 0.00 | 35.46 | 111.75 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.52 | 119.38 | 2.00 | 0.00 | 0.40 | 0.00 | 35.58 | 123.63 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.65 | 123.04 | 2.00 | 0.00 | 0.40 | 0.00 | 35.72 | 119.69 | 2.00 | 0.00 | 0.39 | 0.00 |
| 35.79 | 112.59 | 2.00 | 0.00 | 0.39 | 0.00 | 35.86 | 107.67 | 2.00 | 0.00 | 0.39 | 0.00 |
| 35.92 | 105.65 | 2.00 | 0.00 | 0.39 | 0.00 | 35.99 | 105.70 | 2.00 | 0.00 | 0.39 | 0.00 |
| 36.02 | 107.52 | 2.00 | 0.00 | 0.39 | 0.00 | 36.09 | 111.85 | 2.00 | 0.00 | 0.39 | 0.00 |
| 36.16 | 123.85 | 2.00 | 0.00 | 0.39 | 0.00 | 36.25 | 137.90 | 2.00 | 0.00 | 0.39 | 0.00 |
| 36.31 | 149.49 | 2.00 | 0.00 | 0.38 | 0.00 | 36.37 | 152.98 | 0.70 | 0.52 | 0.38 | 0.00 |
| 36.44 | 151.70 | 0.68 | 0.52 | 0.38 | 0.00 | 36.50 | 153.27 | 0.70 | 0.51 | 0.38 | 0.00 |
| 36.57 | 153.65 | 0.71 | 0.51 | 0.38 | 0.00 | 36.64 | 155.85 | 0.73 | 0.50 | 0.38 | 0.00 |
| 36.69 | 155.24 | 0.72 | 0.50 | 0.38 | 0.00 | 36.76 | 152.44 | 0.69 | 0.51 | 0.38 | 0.00 |
| 36.83 | 149.57 | 0.66 | 0.52 | 0.38 | 0.00 | 36.90 | 146.25 | 0.63 | 0.64 | 0.37 | 0.01 |
| 36.96 | 142.63 | 2.00 | 0.00 | 0.37 | 0.00 | 37.02 | 138.42 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.09 | 133.31 | 2.00 | 0.00 | 0.37 | 0.00 | 37.15 | 127.20 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.21 | 120.13 | 2.00 | 0.00 | 0.37 | 0.00 | 37.27 | 111.96 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.34 | 104.89 | 2.00 | 0.00 | 0.37 | 0.00 | 37.41 | 103.95 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.47 | 112.06 | 2.00 | 0.00 | 0.36 | 0.00 | 37.54 | 126.25 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.60 | 138.64 | 2.00 | 0.00 | 0.36 | 0.00 | 37.67 | 144.31 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.73 | 140.54 | 2.00 | 0.00 | 0.36 | 0.00 | 37.80 | 134.87 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.86 | 126.75 | 2.00 | 0.00 | 0.36 | 0.00 | 37.93 | 119.04 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.99 | 109.46 | 2.00 | 0.00 | 0.36 | 0.00 | 38.09 | 101.30 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.15 | 94.46 | 2.00 | 0.00 | 0.35 | 0.00 | 38.22 | 89.61 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.28 | 84.48 | 2.00 | 0.00 | 0.35 | 0.00 | 38.35 | 80.12 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.41 | 79.52 | 2.00 | 0.00 | 0.35 | 0.00 | 38.48 | 81.30 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.55 | 83.40 | 2.00 | 0.00 | 0.35 | 0.00 | 38.60 | 85.88 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.66 | 88.70 | 2.00 | 0.00 | 0.34 | 0.00 | 38.75 | 90.33 | 2.00 | 0.00 | 0.34 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38.81 | 90.66 | 2.00 | 0.00 | 0.34 | 0.00 | 38.85 | 90.05 | 2.00 | 0.00 | 0.34 | 0.00 |
| 38.91 | 88.99 | 2.00 | 0.00 | 0.34 | 0.00 | 39.00 | 88.33 | 2.00 | 0.00 | 0.34 | 0.00 |
| 39.07 | 89.00 | 2.00 | 0.00 | 0.34 | 0.00 | 39.13 | 91.65 | 2.00 | 0.00 | 0.34 | 0.00 |
| 39.20 | 95.22 | 2.00 | 0.00 | 0.34 | 0.00 | 39.26 | 99.34 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.33 | 103.64 | 2.00 | 0.00 | 0.33 | 0.00 | 39.39 | 108.37 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.45 | 112.26 | 2.00 | 0.00 | 0.33 | 0.00 | 39.52 | 116.35 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.59 | 120.75 | 2.00 | 0.00 | 0.33 | 0.00 | 39.65 | 125.72 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.72 | 130.05 | 2.00 | 0.00 | 0.33 | 0.00 | 39.78 | 133.48 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.84 | 136.83 | 2.00 | 0.00 | 0.32 | 0.00 | 39.90 | 140.81 | 2.00 | 0.00 | 0.32 | 0.00 |
| 39.97 | 144.78 | 2.00 | 0.00 | 0.32 | 0.00 | 40.04 | 147.99 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.11 | 153.20 | 2.00 | 0.00 | 0.32 | 0.00 | 40.17 | 155.84 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.24 | 157.91 | 2.00 | 0.00 | 0.32 | 0.00 | 40.30 | 157.96 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.37 | 155.88 | 2.00 | 0.00 | 0.32 | 0.00 | 40.44 | 151.49 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.50 | 145.02 | 2.00 | 0.00 | 0.31 | 0.00 | 40.56 | 136.39 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.63 | 127.98 | 2.00 | 0.00 | 0.31 | 0.00 | 40.70 | 123.58 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.76 | 123.46 | 2.00 | 0.00 | 0.31 | 0.00 | 40.82 | 125.98 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.89 | 130.00 | 2.00 | 0.00 | 0.31 | 0.00 | 40.95 | 127.98 | 2.00 | 0.00 | 0.31 | 0.00 |
| 41.01 | 113.77 | 2.00 | 0.00 | 0.30 | 0.00 | 41.08 | 96.66 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.14 | 86.12 | 2.00 | 0.00 | 0.30 | 0.00 | 41.21 | 91.18 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.27 | 93.48 | 2.00 | 0.00 | 0.30 | 0.00 | 41.34 | 94.78 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.42 | 96.37 | 2.00 | 0.00 | 0.30 | 0.00 | 41.48 | 97.90 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.55 | 100.87 | 2.00 | 0.00 | 0.30 | 0.00 | 41.62 | 103.58 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.68 | 105.66 | 2.00 | 0.00 | 0.29 | 0.00 | 41.75 | 106.24 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.81 | 104.73 | 2.00 | 0.00 | 0.29 | 0.00 | 41.87 | 103.26 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.96 | 101.13 | 2.00 | 0.00 | 0.29 | 0.00 | 42.00 | 101.52 | 2.00 | 0.00 | 0.29 | 0.00 |
| 42.06 | 103.57 | 2.00 | 0.00 | 0.29 | 0.00 | 42.13 | 104.37 | 2.00 | 0.00 | 0.29 | 0.00 |
| 42.19 | 105.78 | 2.00 | 0.00 | 0.28 | 0.00 | 42.26 | 105.93 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.33 | 104.11 | 2.00 | 0.00 | 0.28 | 0.00 | 42.39 | 101.06 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.49 | 97.65 | 2.00 | 0.00 | 0.28 | 0.00 | 42.54 | 95.00 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.61 | 93.47 | 2.00 | 0.00 | 0.28 | 0.00 | 42.68 | 92.42 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.74 | 91.42 | 2.00 | 0.00 | 0.28 | 0.00 | 42.80 | 90.16 | 2.00 | 0.00 | 0.27 | 0.00 |
| 42.87 | 88.97 | 2.00 | 0.00 | 0.27 | 0.00 | 42.93 | 88.26 | 2.00 | 0.00 | 0.27 | 0.00 |
| 42.99 | 88.31 | 2.00 | 0.00 | 0.27 | 0.00 | 43.06 | 88.90 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.13 | 89.43 | 2.00 | 0.00 | 0.27 | 0.00 | 43.19 | 89.69 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.26 | 90.10 | 2.00 | 0.00 | 0.27 | 0.00 | 43.32 | 90.38 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.38 | 90.37 | 2.00 | 0.00 | 0.26 | 0.00 | 43.45 | 89.82 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.52 | 89.21 | 2.00 | 0.00 | 0.26 | 0.00 | 43.59 | 88.71 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.65 | 87.99 | 2.00 | 0.00 | 0.26 | 0.00 | 43.71 | 83.22 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.77 | 73.45 | 2.00 | 0.00 | 0.26 | 0.00 | 43.84 | 63.97 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.90 | 60.24 | 2.00 | 0.00 | 0.26 | 0.00 | 43.97 | 62.41 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.04 | 63.94 | 2.00 | 0.00 | 0.25 | 0.00 | 44.10 | 66.40 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.16 | 70.00 | 2.00 | 0.00 | 0.25 | 0.00 | 44.25 | 73.03 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.32 | 74.16 | 2.00 | 0.00 | 0.25 | 0.00 | 44.39 | 74.08 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.42 | 74.67 | 2.00 | 0.00 | 0.25 | 0.00 | 44.52 | 76.69 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.58 | 80.63 | 2.00 | 0.00 | 0.24 | 0.00 | 44.65 | 85.14 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.71 | 89.59 | 2.00 | 0.00 | 0.24 | 0.00 | 44.78 | 93.94 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.84 | 98.12 | 2.00 | 0.00 | 0.24 | 0.00 | 44.91 | 101.88 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.97 | 104.21 | 2.00 | 0.00 | 0.24 | 0.00 | 45.04 | 105.48 | 2.00 | 0.00 | 0.24 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 45.08 | 106.87 | 2.00 | 0.00 | 0.24 | 0.00 | 45.15 | 109.92 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.21 | 116.78 | 2.00 | 0.00 | 0.23 | 0.00 | 45.31 | 125.78 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.37 | 135.42 | 2.00 | 0.00 | 0.23 | 0.00 | 45.43 | 143.18 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.50 | 149.84 | 2.00 | 0.00 | 0.23 | 0.00 | 45.56 | 159.05 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.62 | 165.31 | 2.00 | 0.00 | 0.23 | 0.00 | 45.69 | 171.07 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.76 | 176.24 | 2.00 | 0.00 | 0.22 | 0.00 | 45.82 | 179.66 | 2.00 | 0.00 | 0.22 | 0.00 |
| 45.89 | 180.99 | 2.00 | 0.00 | 0.22 | 0.00 | 45.95 | 180.90 | 2.00 | 0.00 | 0.22 | 0.00 |
| 46.02 | 181.30 | 2.00 | 0.00 | 0.22 | 0.00 | 46.08 | 183.51 | 2.00 | 0.00 | 0.22 | 0.00 |
| 46.14 | 187.02 | 2.00 | 0.00 | 0.22 | 0.00 | 46.21 | 190.64 | 2.00 | 0.00 | 0.22 | 0.00 |
| 46.27 | 194.00 | 2.00 | 0.00 | 0.22 | 0.00 | 46.34 | 196.69 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.41 | 198.20 | 2.00 | 0.00 | 0.21 | 0.00 | 46.47 | 195.32 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.54 | 191.45 | 2.00 | 0.00 | 0.21 | 0.00 | 46.60 | 190.55 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.67 | 194.91 | 2.00 | 0.00 | 0.21 | 0.00 | 46.74 | 200.82 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.80 | 199.45 | 2.00 | 0.00 | 0.21 | 0.00 | 46.86 | 201.19 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.93 | 201.73 | 2.00 | 0.00 | 0.20 | 0.00 | 47.00 | 201.91 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.07 | 201.30 | 2.00 | 0.00 | 0.20 | 0.00 | 47.12 | 203.94 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.20 | 200.76 | 2.00 | 0.00 | 0.20 | 0.00 | 47.26 | 197.06 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.31 | 193.35 | 2.00 | 0.00 | 0.20 | 0.00 | 47.40 | 185.31 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.46 | 180.81 | 2.00 | 0.00 | 0.20 | 0.00 | 47.53 | 176.38 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.59 | 174.33 | 2.00 | 0.00 | 0.19 | 0.00 | 47.65 | 166.45 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.72 | 154.56 | 2.00 | 0.00 | 0.19 | 0.00 | 47.78 | 139.93 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.84 | 125.49 | 2.00 | 0.00 | 0.19 | 0.00 | 47.90 | 118.29 | 0.41 | 0.38 | 0.19 | 0.00 |
| 47.99 | 116.07 | 0.39 | 0.39 | 0.19 | 0.00 | 48.06 | 123.34 | 2.00 | 0.00 | 0.19 | 0.00 |
| 48.12 | 133.89 | 2.00 | 0.00 | 0.18 | 0.00 | 48.19 | 145.97 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.26 | 153.68 | 2.00 | 0.00 | 0.18 | 0.00 | 48.32 | 153.01 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.39 | 143.54 | 2.00 | 0.00 | 0.18 | 0.00 | 48.45 | 127.60 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.52 | 116.29 | 2.00 | 0.00 | 0.18 | 0.00 | 48.58 | 112.81 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.64 | 114.33 | 2.00 | 0.00 | 0.18 | 0.00 | 48.69 | 118.71 | 2.00 | 0.00 | 0.17 | 0.00 |
| 48.78 | 123.19 | 2.00 | 0.00 | 0.17 | 0.00 | 48.84 | 126.25 | 2.00 | 0.00 | 0.17 | 0.00 |
| 48.91 | 126.81 | 2.00 | 0.00 | 0.17 | 0.00 | 48.97 | 126.33 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.04 | 124.27 | 2.00 | 0.00 | 0.17 | 0.00 | 49.11 | 120.53 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.17 | 111.47 | 2.00 | 0.00 | 0.17 | 0.00 | 49.22 | 109.97 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.28 | 113.30 | 2.00 | 0.00 | 0.16 | 0.00 | 49.36 | 120.38 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.43 | 131.91 | 2.00 | 0.00 | 0.16 | 0.00 | 49.48 | 142.19 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.54 | 147.24 | 2.00 | 0.00 | 0.16 | 0.00 | 49.61 | 149.04 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.67 | 149.06 | 2.00 | 0.00 | 0.16 | 0.00 | 49.76 | 147.64 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.81 | 141.62 | 2.00 | 0.00 | 0.16 | 0.00 | 49.88 | 137.15 | 2.00 | 0.00 | 0.15 | 0.00 |
| 49.95 | 131.35 | 2.00 | 0.00 | 0.15 | 0.00 | 50.01 | 126.98 | 2.00 | 0.00 | 0.15 | 0.00 |

**Total estimated settlement: 0.79**

**Abbreviations**

| | |
|---|---|
| $Q_{tn,cs}$: | Equivalent clean sand normalized cone resistance |
| FS: | Factor of safety against liquefaction |
| $e_v$ (%): | Post-liquefaction volumentric strain |
| DF: | $e_v$ depth weighting factor |
| Settlement: | Calculated settlement |

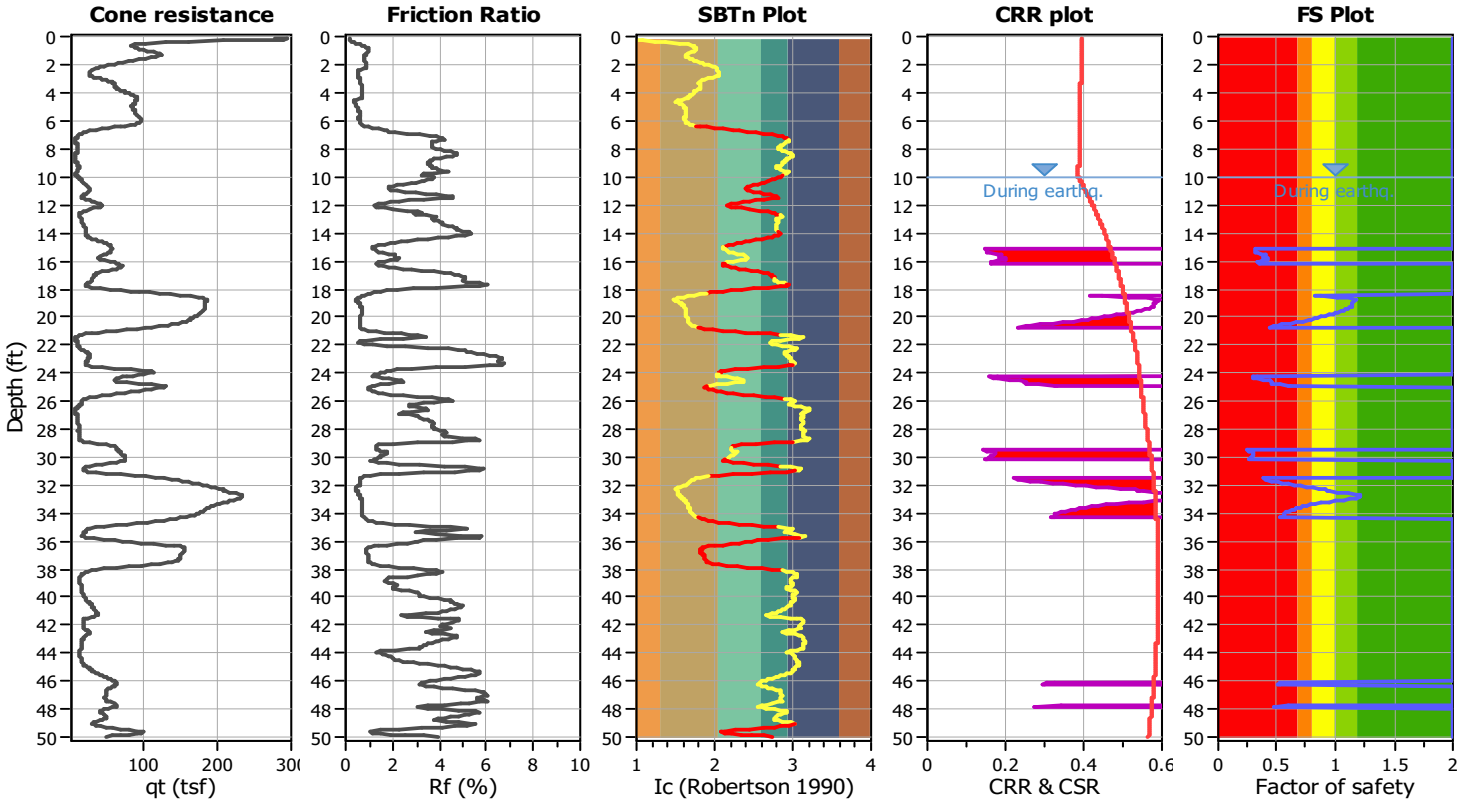
# LIQUEFACTION ANALYSIS REPORT

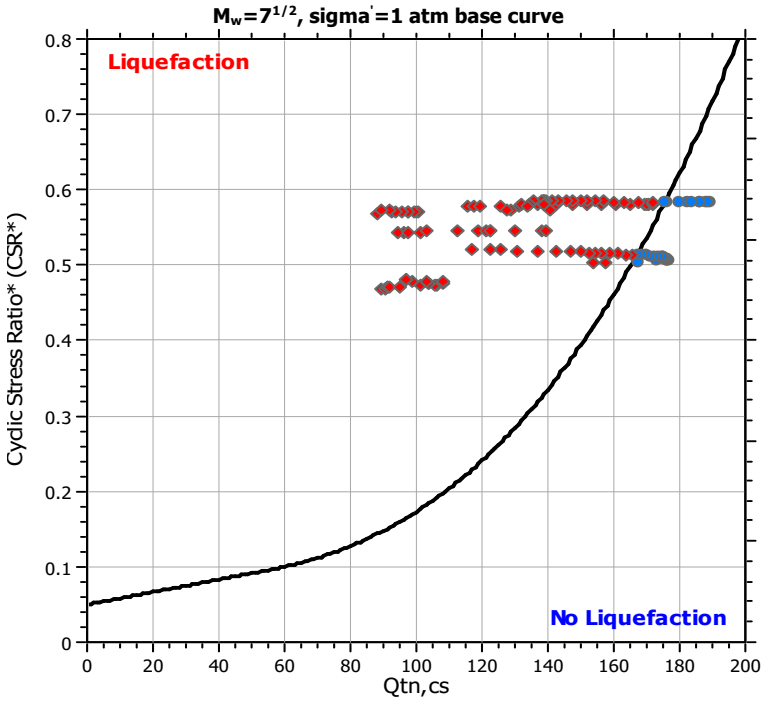
**Project title : Multi-Family Residential Project** **Location : Garden Grove, CA**

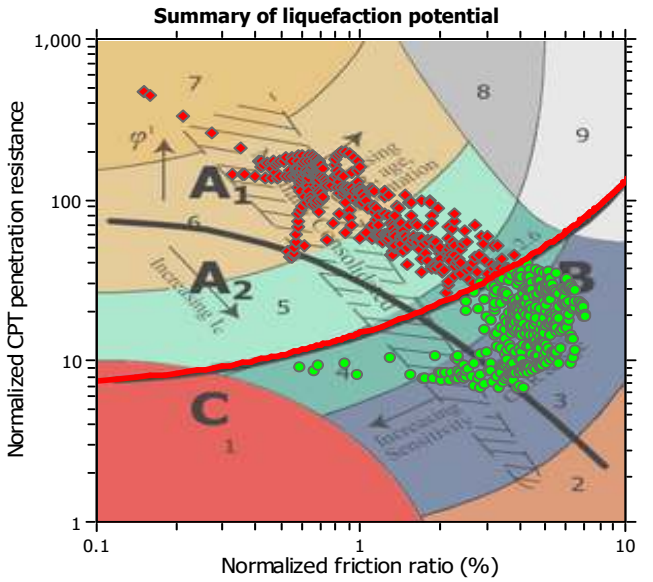
**CPT file : CPT-2**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 17.00 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 10.00 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 60.00 ft |
| Earthquake magnitude $M_w$: | 7.30 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.65 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

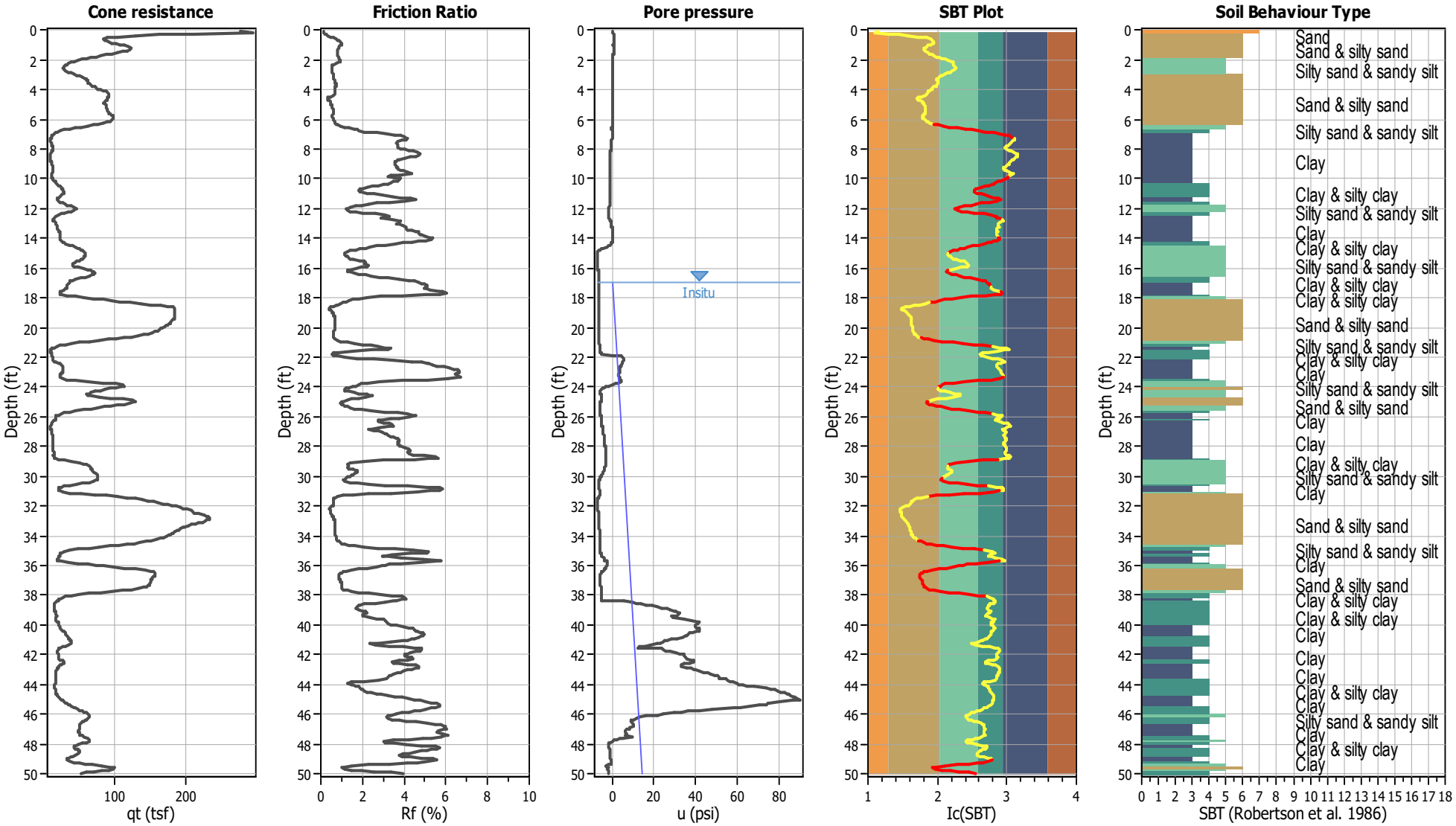



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots



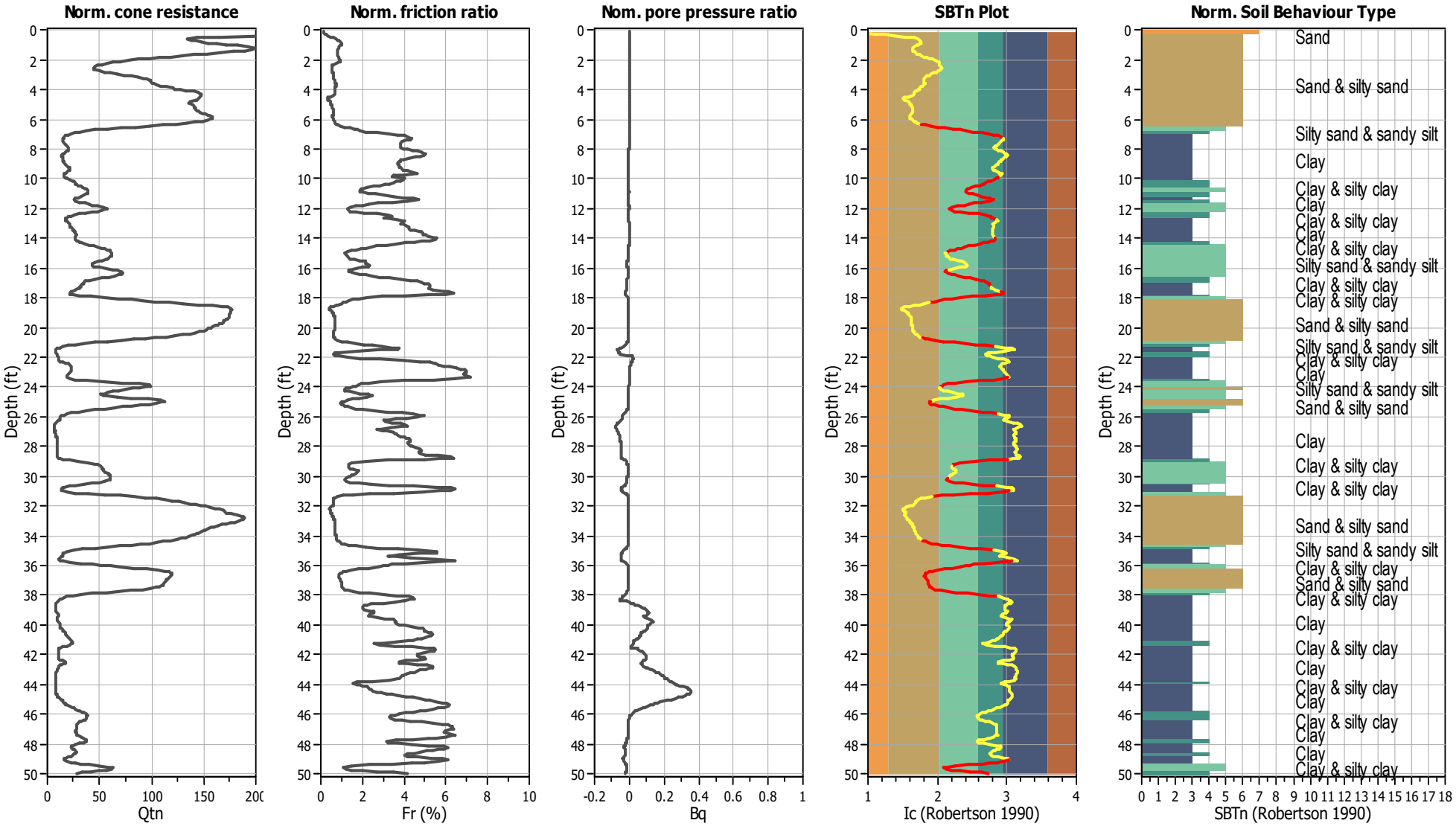

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



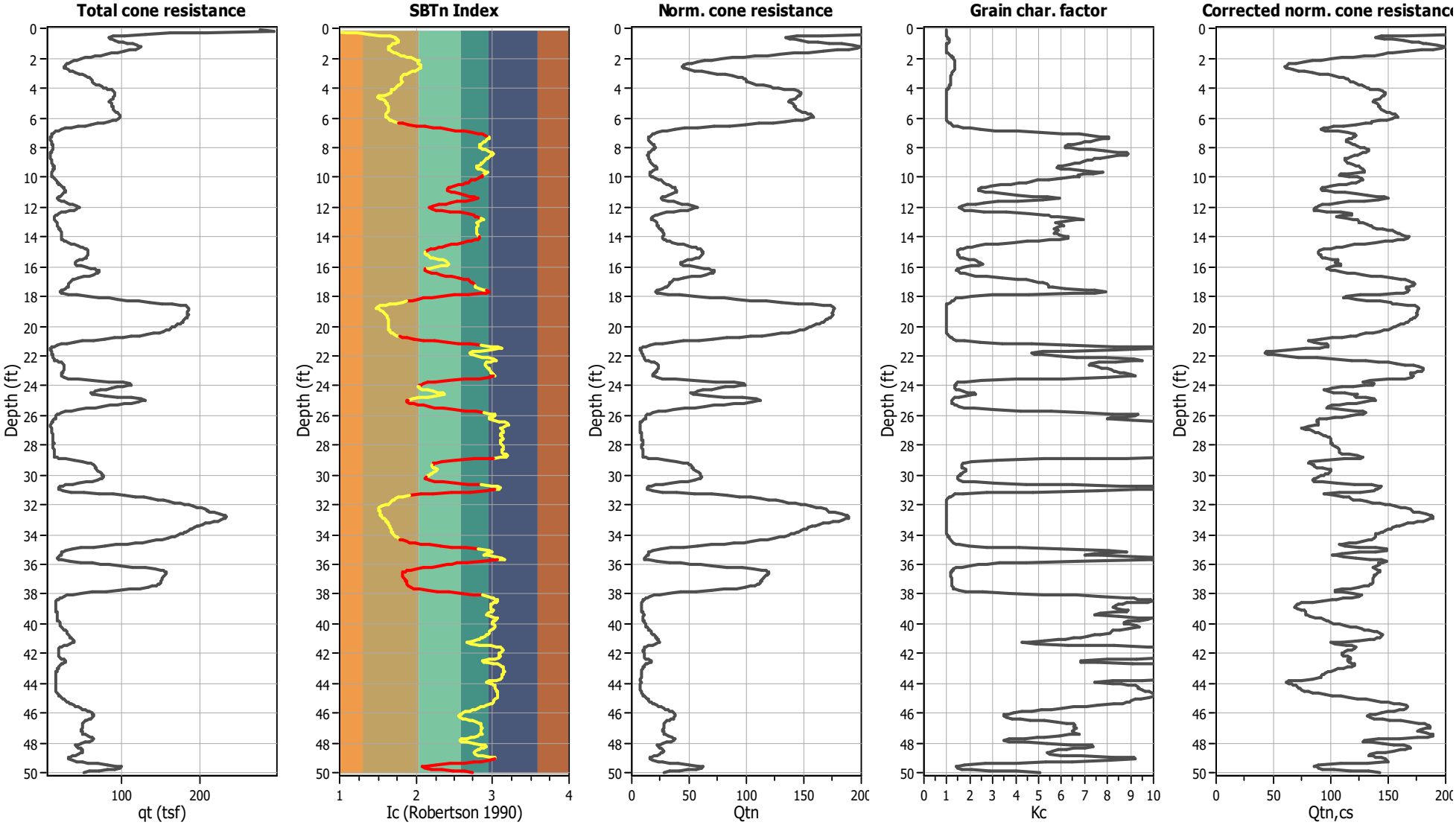

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

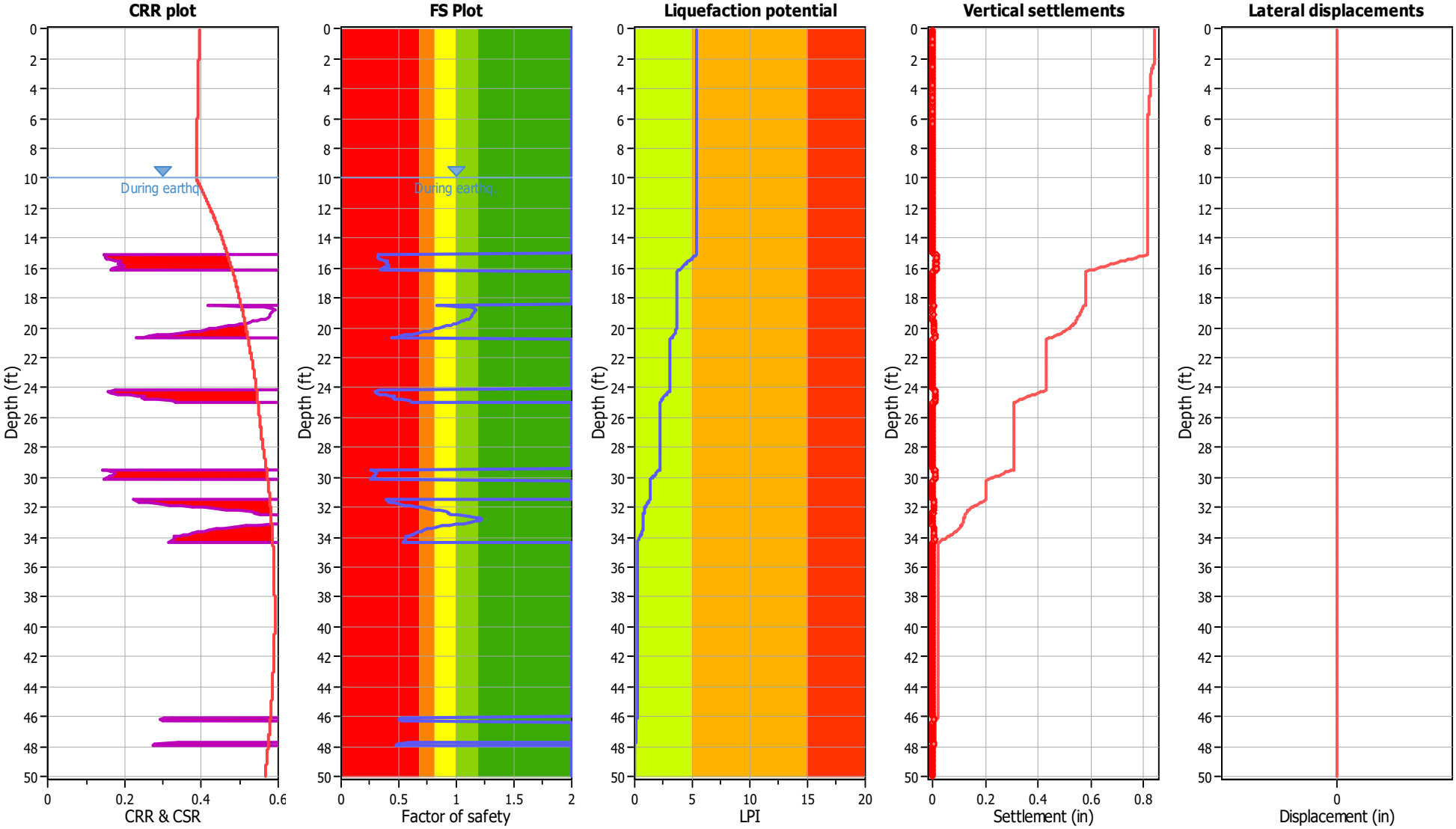
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

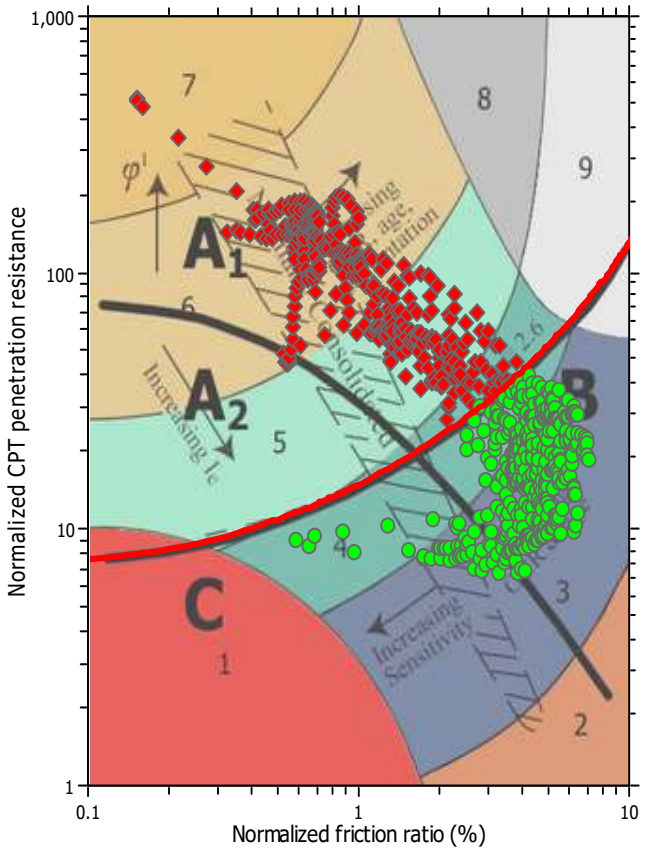
**F.S. color scheme**

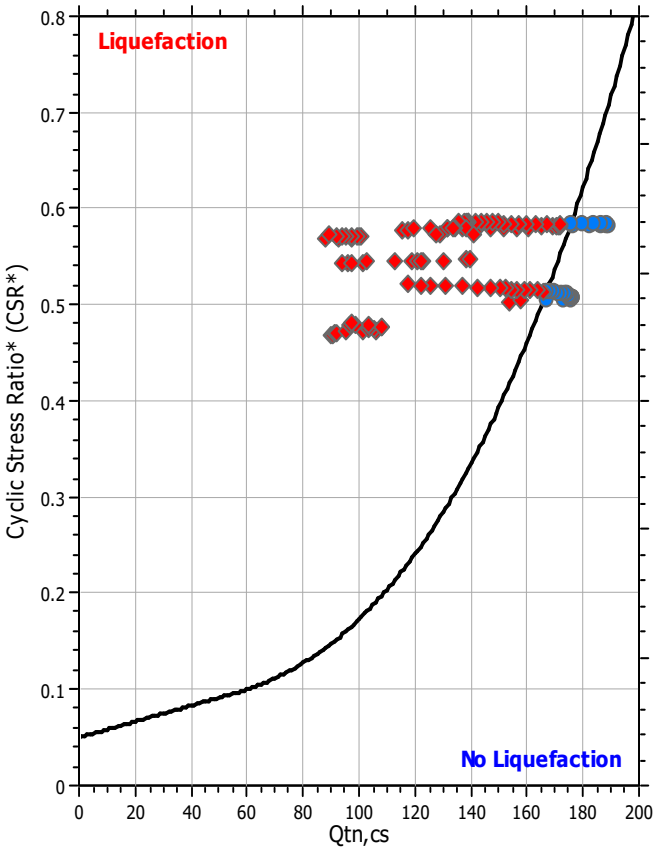
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

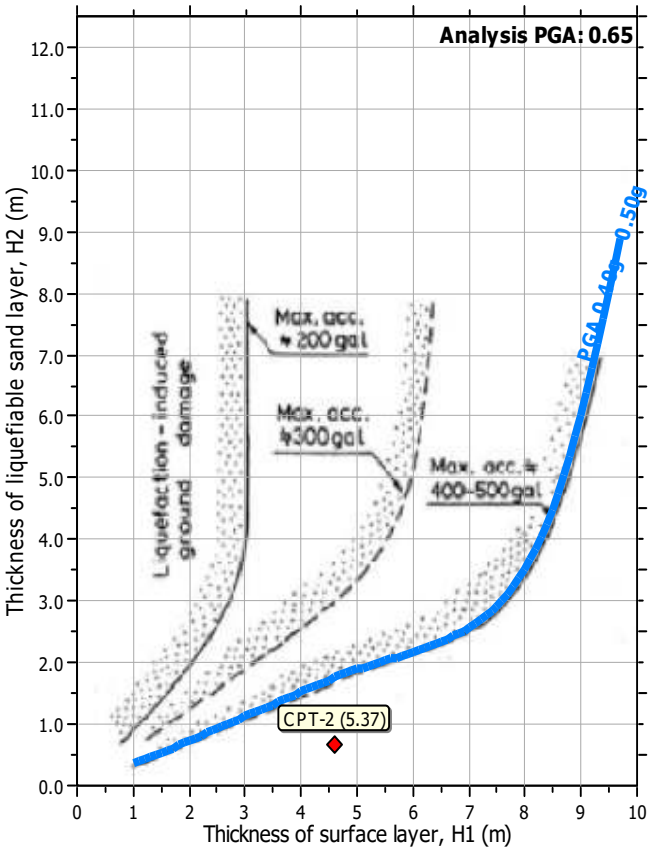
**LPI color scheme**

- Very high risk
- High risk
- Low risk

# Liquefaction analysis summary plots



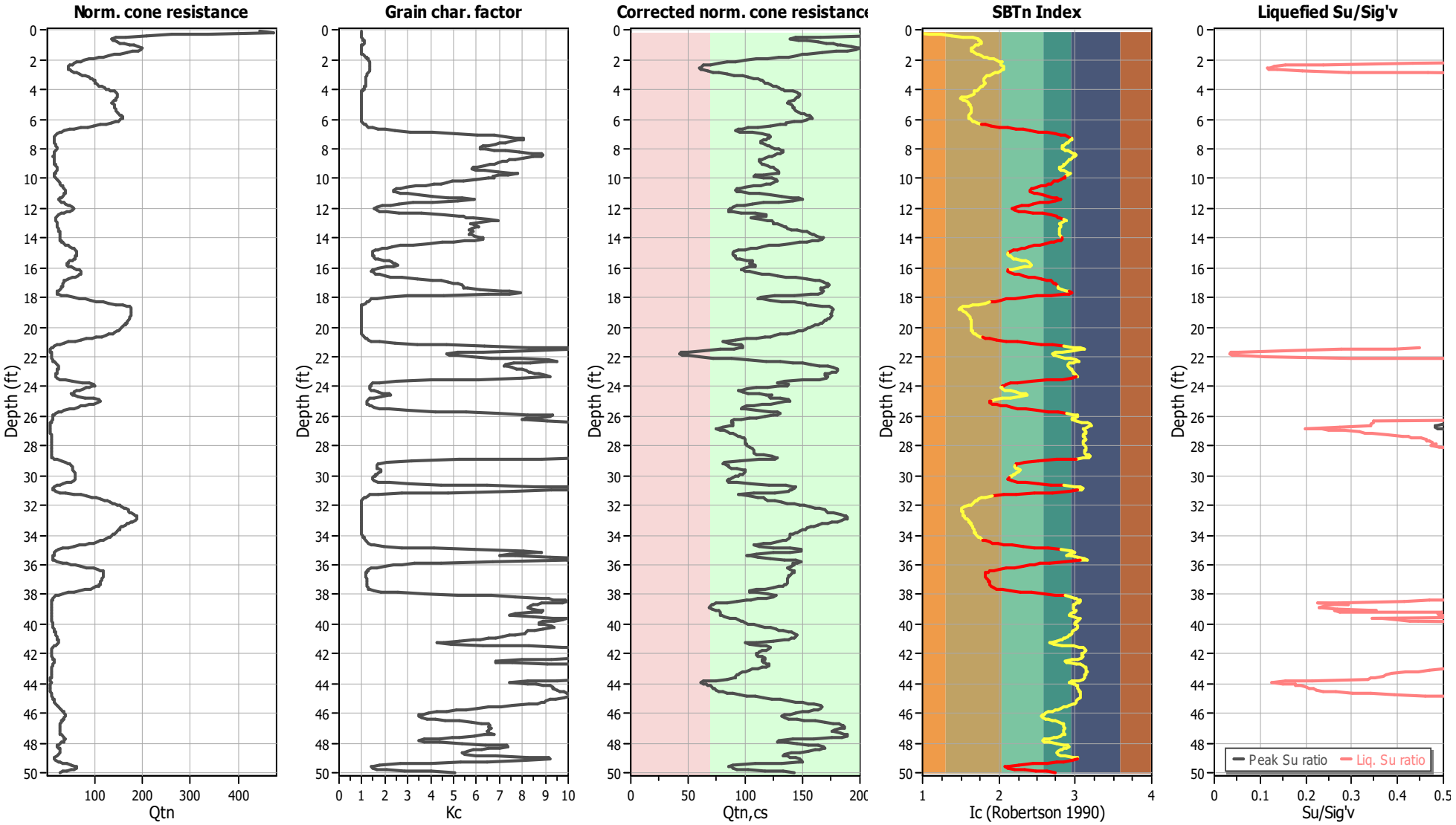




**Input parameters and analysis data**

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**:: Post-earthquake settlement of dry sands ::**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.07 | 0.92 | 445.51 | 1.00 | 445.51 | 66 | 804 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.13 | 0.89 | 474.17 | 1.00 | 474.17 | 69 | 818 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.20 | 0.90 | 467.16 | 1.00 | 467.16 | 68 | 813 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.27 | 1.09 | 336.69 | 1.00 | 336.69 | 52 | 752 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.33 | 1.24 | 260.81 | 1.00 | 260.81 | 42 | 703 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.40 | 1.38 | 209.06 | 1.00 | 209.06 | 35 | 673 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.46 | 1.54 | 165.64 | 1.00 | 165.64 | 29 | 652 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.53 | 1.66 | 143.62 | 1.00 | 143.62 | 26 | 656 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.59 | 1.72 | 134.23 | 1.04 | 139.09 | 26 | 667 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.66 | 1.74 | 137.62 | 1.06 | 145.93 | 28 | 695 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.74 | 1.75 | 142.02 | 1.08 | 153.96 | 29 | 729 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.80 | 1.76 | 148.00 | 1.10 | 163.04 | 31 | 771 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.86 | 1.76 | 154.24 | 1.11 | 170.69 | 33 | 807 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.93 | 1.75 | 162.75 | 1.09 | 176.80 | 34 | 837 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.99 | 1.73 | 172.17 | 1.05 | 180.33 | 34 | 861 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.05 | 1.70 | 182.82 | 1.00 | 182.82 | 34 | 880 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.13 | 1.67 | 192.15 | 1.00 | 192.15 | 35 | 893 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.19 | 1.65 | 198.44 | 1.00 | 198.44 | 36 | 898 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.26 | 1.64 | 199.96 | 1.00 | 199.96 | 37 | 893 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.32 | 1.64 | 196.55 | 1.00 | 196.55 | 36 | 875 | 0.39 | 0.005 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.38 | 1.64 | 189.49 | 1.00 | 189.49 | 35 | 849 | 0.39 | 0.005 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.45 | 1.66 | 178.93 | 1.00 | 178.93 | 33 | 817 | 0.39 | 0.006 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.53 | 1.68 | 166.75 | 1.00 | 166.75 | 31 | 784 | 0.39 | 0.007 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.59 | 1.71 | 153.60 | 1.00 | 154.25 | 29 | 748 | 0.39 | 0.007 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.66 | 1.74 | 141.37 | 1.06 | 150.49 | 28 | 716 | 0.39 | 0.008 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.72 | 1.77 | 129.65 | 1.12 | 144.75 | 28 | 684 | 0.39 | 0.009 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.78 | 1.81 | 118.54 | 1.16 | 137.35 | 27 | 653 | 0.39 | 0.011 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.85 | 1.84 | 107.88 | 1.19 | 128.79 | 25 | 623 | 0.39 | 0.012 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.91 | 1.88 | 97.78 | 1.22 | 119.68 | 24 | 593 | 0.39 | 0.014 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.97 | 1.93 | 87.37 | 1.25 | 109.63 | 22 | 562 | 0.39 | 0.016 | 0.01 | 13.34 | 0.01 | 0.000 |
| 2.04 | 1.97 | 77.98 | 1.28 | 100.13 | 21 | 529 | 0.39 | 0.019 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.11 | 2.01 | 69.55 | 1.32 | 91.69 | 19 | 498 | 0.39 | 0.023 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.17 | 2.04 | 62.96 | 1.34 | 84.32 | 18 | 464 | 0.39 | 0.029 | 0.03 | 13.34 | 0.03 | 0.000 |
| 2.24 | 2.03 | 57.11 | 1.34 | 76.37 | 16 | 420 | 0.39 | 0.041 | 0.05 | 13.34 | 0.05 | 0.000 |
| 2.30 | 2.02 | 52.14 | 1.33 | 69.14 | 15 | 378 | 0.39 | 0.061 | 0.09 | 13.34 | 0.08 | 0.001 |
| 2.37 | 2.02 | 48.27 | 1.33 | 63.97 | 13 | 349 | 0.39 | 0.087 | 0.14 | 13.34 | 0.13 | 0.001 |
| 2.43 | 2.05 | 45.53 | 1.36 | 61.82 | 13 | 343 | 0.39 | 0.098 | 0.16 | 13.34 | 0.15 | 0.001 |
| 2.49 | 2.06 | 44.76 | 1.36 | 61.04 | 13 | 340 | 0.39 | 0.108 | 0.18 | 13.34 | 0.17 | 0.001 |
| 2.57 | 2.06 | 43.94 | 1.37 | 60.20 | 13 | 336 | 0.39 | 0.121 | 0.21 | 13.34 | 0.19 | 0.002 |
| 2.63 | 2.05 | 44.60 | 1.36 | 60.65 | 13 | 337 | 0.39 | 0.125 | 0.21 | 13.34 | 0.19 | 0.001 |
| 2.69 | 2.05 | 46.27 | 1.35 | 62.54 | 13 | 346 | 0.39 | 0.117 | 0.19 | 13.34 | 0.17 | 0.001 |
| 2.77 | 2.02 | 50.42 | 1.32 | 66.60 | 14 | 363 | 0.39 | 0.102 | 0.16 | 13.34 | 0.14 | 0.001 |
| 2.83 | 1.98 | 55.44 | 1.29 | 71.70 | 15 | 382 | 0.39 | 0.087 | 0.12 | 13.34 | 0.11 | 0.001 |
| 2.89 | 1.95 | 60.96 | 1.27 | 77.33 | 16 | 402 | 0.39 | 0.074 | 0.10 | 13.34 | 0.09 | 0.001 |
| 2.96 | 1.91 | 67.30 | 1.24 | 83.78 | 17 | 425 | 0.39 | 0.064 | 0.08 | 13.34 | 0.07 | 0.001 |
| 3.02 | 1.88 | 74.09 | 1.22 | 90.50 | 18 | 447 | 0.39 | 0.056 | 0.06 | 13.34 | 0.06 | 0.000 |
| 3.08 | 1.85 | 81.19 | 1.20 | 97.20 | 19 | 471 | 0.39 | 0.049 | 0.05 | 13.34 | 0.05 | 0.000 |
| 3.16 | 1.82 | 87.42 | 1.18 | 102.80 | 20 | 492 | 0.39 | 0.045 | 0.04 | 13.34 | 0.04 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.22 | 1.81 | 92.53 | 1.16 | 107.35 | 21 | 511 | 0.39 | 0.042 | 0.04 | 13.34 | 0.04 | 0.000 |
| 3.29 | 1.80 | 95.83 | 1.15 | 110.66 | 21 | 526 | 0.39 | 0.040 | 0.04 | 13.34 | 0.03 | 0.000 |
| 3.35 | 1.80 | 97.90 | 1.16 | 113.20 | 22 | 538 | 0.39 | 0.039 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.42 | 1.81 | 99.01 | 1.16 | 114.94 | 22 | 547 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.48 | 1.81 | 99.61 | 1.17 | 116.09 | 23 | 553 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.55 | 1.81 | 100.42 | 1.17 | 117.33 | 23 | 560 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.61 | 1.82 | 101.79 | 1.17 | 119.04 | 23 | 568 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.67 | 1.81 | 104.72 | 1.16 | 121.42 | 24 | 577 | 0.39 | 0.037 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.76 | 1.79 | 108.92 | 1.14 | 124.19 | 24 | 588 | 0.39 | 0.037 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.83 | 1.77 | 114.54 | 1.11 | 126.91 | 24 | 600 | 0.39 | 0.036 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.89 | 1.74 | 120.42 | 1.07 | 129.29 | 24 | 614 | 0.39 | 0.035 | 0.03 | 13.34 | 0.02 | 0.000 |
| 3.95 | 1.74 | 122.80 | 1.07 | 131.26 | 25 | 624 | 0.39 | 0.034 | 0.03 | 13.34 | 0.02 | 0.000 |
| 4.00 | 1.72 | 128.17 | 1.04 | 133.05 | 25 | 637 | 0.39 | 0.033 | 0.03 | 13.34 | 0.02 | 0.000 |
| 4.07 | 1.71 | 133.24 | 1.01 | 134.20 | 25 | 650 | 0.39 | 0.033 | 0.02 | 13.34 | 0.02 | 0.000 |
| 4.14 | 1.68 | 141.04 | 1.00 | 141.04 | 26 | 665 | 0.39 | 0.032 | 0.02 | 13.34 | 0.02 | 0.000 |
| 4.20 | 1.67 | 144.64 | 1.00 | 144.64 | 27 | 674 | 0.39 | 0.031 | 0.02 | 13.34 | 0.02 | 0.000 |
| 4.29 | 1.67 | 146.71 | 1.00 | 146.71 | 27 | 681 | 0.39 | 0.032 | 0.02 | 13.34 | 0.02 | 0.000 |
| 4.33 | 1.67 | 147.67 | 1.00 | 147.67 | 27 | 685 | 0.39 | 0.032 | 0.02 | 13.34 | 0.02 | 0.000 |
| 4.40 | 1.64 | 147.46 | 1.00 | 147.46 | 27 | 658 | 0.39 | 0.036 | 0.02 | 13.34 | 0.02 | 0.000 |
| 4.48 | 1.58 | 146.74 | 1.00 | 146.74 | 26 | 608 | 0.39 | 0.045 | 0.03 | 13.34 | 0.03 | 0.000 |
| 4.54 | 1.52 | 145.67 | 1.00 | 145.67 | 26 | 557 | 0.39 | 0.060 | 0.04 | 13.34 | 0.04 | 0.000 |
| 4.61 | 1.50 | 144.40 | 1.00 | 144.40 | 25 | 541 | 0.39 | 0.067 | 0.05 | 13.34 | 0.04 | 0.000 |
| 4.67 | 1.53 | 143.17 | 1.00 | 143.17 | 25 | 556 | 0.39 | 0.064 | 0.05 | 13.34 | 0.04 | 0.000 |
| 4.74 | 1.55 | 142.16 | 1.00 | 142.16 | 25 | 568 | 0.39 | 0.061 | 0.05 | 13.34 | 0.04 | 0.000 |
| 4.80 | 1.59 | 137.58 | 1.00 | 137.58 | 25 | 574 | 0.39 | 0.060 | 0.05 | 13.34 | 0.04 | 0.000 |
| 4.87 | 1.60 | 137.25 | 1.00 | 137.25 | 25 | 582 | 0.39 | 0.059 | 0.05 | 13.34 | 0.04 | 0.000 |
| 4.92 | 1.61 | 136.12 | 1.00 | 136.12 | 25 | 588 | 0.39 | 0.059 | 0.05 | 13.34 | 0.04 | 0.000 |
| 4.99 | 1.61 | 139.87 | 1.00 | 139.87 | 25 | 601 | 0.39 | 0.057 | 0.04 | 13.34 | 0.04 | 0.000 |
| 5.07 | 1.62 | 139.94 | 1.00 | 139.94 | 25 | 611 | 0.39 | 0.055 | 0.04 | 13.34 | 0.04 | 0.000 |
| 5.13 | 1.63 | 141.10 | 1.00 | 141.10 | 26 | 622 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.19 | 1.64 | 141.61 | 1.00 | 141.61 | 26 | 629 | 0.39 | 0.053 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.26 | 1.64 | 142.11 | 1.00 | 142.11 | 26 | 634 | 0.39 | 0.053 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.32 | 1.64 | 142.71 | 1.00 | 142.71 | 26 | 638 | 0.39 | 0.053 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.38 | 1.64 | 143.36 | 1.00 | 143.36 | 26 | 643 | 0.39 | 0.053 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.45 | 1.64 | 144.47 | 1.00 | 144.47 | 26 | 647 | 0.39 | 0.053 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.53 | 1.64 | 146.24 | 1.00 | 146.24 | 27 | 652 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.59 | 1.63 | 148.57 | 1.00 | 148.57 | 27 | 656 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.65 | 1.62 | 151.15 | 1.00 | 151.15 | 27 | 661 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.72 | 1.61 | 153.83 | 1.00 | 153.83 | 28 | 664 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.78 | 1.60 | 156.25 | 1.00 | 156.25 | 28 | 668 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.85 | 1.60 | 157.82 | 1.00 | 157.82 | 28 | 673 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.91 | 1.61 | 158.07 | 1.00 | 158.07 | 29 | 679 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 5.98 | 1.62 | 156.70 | 1.00 | 156.70 | 28 | 684 | 0.39 | 0.054 | 0.04 | 13.34 | 0.03 | 0.000 |
| 6.06 | 1.64 | 153.80 | 1.00 | 153.80 | 28 | 685 | 0.39 | 0.055 | 0.04 | 13.34 | 0.03 | 0.000 |
| 6.12 | 1.66 | 149.08 | 1.00 | 149.08 | 27 | 681 | 0.39 | 0.057 | 0.04 | 13.34 | 0.03 | 0.000 |
| 6.18 | 1.68 | 142.73 | 1.00 | 142.73 | 26 | 671 | 0.39 | 0.060 | 0.04 | 13.34 | 0.04 | 0.000 |
| 6.25 | 1.71 | 134.15 | 1.01 | 135.90 | 25 | 657 | 0.39 | 0.065 | 0.05 | 13.34 | 0.04 | 0.000 |
| 6.32 | 1.76 | 123.29 | 1.10 | 135.89 | 26 | 642 | 0.39 | 0.071 | 0.05 | 13.34 | 0.04 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.38 | 1.83 | 110.85 | 1.18 | 130.80 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.45 | 1.90 | 98.32 | 1.24 | 121.78 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.51 | 2.00 | 84.97 | 1.30 | 110.89 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.58 | 2.11 | 71.52 | 1.44 | 102.87 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.64 | 2.23 | 57.82 | 1.70 | 98.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.71 | 2.32 | 46.24 | 2.02 | 93.47 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.78 | 2.41 | 37.21 | 2.45 | 91.29 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.84 | 2.52 | 30.81 | 3.10 | 95.52 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.91 | 2.63 | 26.29 | 4.06 | 106.66 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.98 | 2.73 | 22.53 | 5.08 | 114.48 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.04 | 2.82 | 19.69 | 6.05 | 119.17 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.10 | 2.87 | 17.91 | 6.77 | 121.19 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.16 | 2.90 | 16.74 | 7.27 | 121.66 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.23 | 2.93 | 15.82 | 7.66 | 121.10 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.30 | 2.95 | 14.95 | 8.03 | 120.00 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.36 | 2.96 | 14.64 | 8.05 | 117.80 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.43 | 2.94 | 14.74 | 7.82 | 115.26 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.50 | 2.92 | 15.13 | 7.49 | 113.26 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.56 | 2.90 | 15.63 | 7.23 | 113.06 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.63 | 2.89 | 16.34 | 7.02 | 114.69 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.70 | 2.87 | 17.14 | 6.83 | 117.09 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.76 | 2.85 | 18.20 | 6.54 | 119.00 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.83 | 2.83 | 19.21 | 6.28 | 120.65 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.89 | 2.82 | 20.01 | 6.13 | 122.70 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.96 | 2.83 | 20.31 | 6.18 | 125.60 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.02 | 2.84 | 20.10 | 6.41 | 128.91 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.08 | 2.87 | 19.48 | 6.76 | 131.66 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.15 | 2.90 | 18.36 | 7.25 | 133.07 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.21 | 2.94 | 16.88 | 7.86 | 132.76 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.28 | 2.98 | 15.50 | 8.44 | 130.84 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.35 | 3.00 | 14.53 | 8.82 | 128.16 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.41 | 3.01 | 14.06 | 8.93 | 125.62 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.48 | 3.00 | 13.96 | 8.83 | 123.27 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.54 | 2.98 | 14.16 | 8.50 | 120.33 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.61 | 2.96 | 14.51 | 8.06 | 116.93 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.68 | 2.93 | 14.81 | 7.70 | 114.09 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.74 | 2.92 | 15.10 | 7.46 | 112.74 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.81 | 2.91 | 15.40 | 7.31 | 112.58 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.87 | 2.89 | 15.85 | 7.11 | 112.66 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.94 | 2.88 | 16.35 | 6.92 | 113.16 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.01 | 2.87 | 16.91 | 6.77 | 114.37 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.07 | 2.86 | 17.66 | 6.59 | 116.43 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.13 | 2.84 | 18.72 | 6.36 | 119.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.20 | 2.82 | 20.08 | 6.05 | 121.55 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.26 | 2.80 | 21.19 | 5.85 | 123.91 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.33 | 2.80 | 21.70 | 5.80 | 125.92 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.39 | 2.81 | 21.39 | 5.96 | 127.50 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.46 | 2.84 | 20.22 | 6.36 | 128.60 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.55 | 2.88 | 18.63 | 6.95 | 129.48 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.61 | 2.92 | 17.20 | 7.54 | 129.70 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.65 | 2.94 | 16.18 | 7.82 | 126.53 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.71 | 2.91 | 15.67 | 7.37 | 115.49 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.78 | 2.88 | 15.51 | 6.97 | 108.14 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.85 | 2.87 | 16.02 | 6.71 | 107.49 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.91 | 2.87 | 17.13 | 6.79 | 116.36 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.98 | 2.85 | 18.79 | 6.55 | 123.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |

**Total estimated settlement: 0.03**

**Abbreviations**

$Q_{tn}$: Equivalent clean sand normalized cone resistance
$K_c$: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
$G_{max}$: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
$N_c$: Equivalent number of cycles
$e_v$: Volumetric strain
Settle.: Calculated settlement

**:: Post-earthquake settlement due to soil liquefaction ::**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.05 | 126.74 | 2.00 | 0.00 | 0.83 | 0.00 | 10.12 | 128.15 | 2.00 | 0.00 | 0.83 | 0.00 |
| 10.19 | 127.02 | 2.00 | 0.00 | 0.83 | 0.00 | 10.25 | 124.92 | 2.00 | 0.00 | 0.83 | 0.00 |
| 10.32 | 122.18 | 2.00 | 0.00 | 0.83 | 0.00 | 10.38 | 118.43 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.45 | 113.41 | 2.00 | 0.00 | 0.82 | 0.00 | 10.51 | 107.07 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.58 | 100.32 | 2.00 | 0.00 | 0.82 | 0.00 | 10.64 | 95.31 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.71 | 92.69 | 2.00 | 0.00 | 0.82 | 0.00 | 10.77 | 91.73 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.84 | 93.05 | 2.00 | 0.00 | 0.82 | 0.00 | 10.90 | 96.67 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.96 | 103.72 | 2.00 | 0.00 | 0.81 | 0.00 | 11.03 | 112.30 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.09 | 122.29 | 2.00 | 0.00 | 0.81 | 0.00 | 11.19 | 131.88 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.25 | 139.71 | 2.00 | 0.00 | 0.81 | 0.00 | 11.29 | 146.30 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.38 | 149.75 | 2.00 | 0.00 | 0.81 | 0.00 | 11.45 | 149.35 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.51 | 141.45 | 2.00 | 0.00 | 0.80 | 0.00 | 11.57 | 128.90 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.64 | 116.15 | 2.00 | 0.00 | 0.80 | 0.00 | 11.71 | 106.00 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.77 | 98.99 | 2.00 | 0.00 | 0.80 | 0.00 | 11.84 | 92.70 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.91 | 89.34 | 2.00 | 0.00 | 0.80 | 0.00 | 11.97 | 88.01 | 2.00 | 0.00 | 0.80 | 0.00 |
| 12.03 | 86.67 | 2.00 | 0.00 | 0.80 | 0.00 | 12.10 | 85.69 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.17 | 85.76 | 2.00 | 0.00 | 0.79 | 0.00 | 12.21 | 89.40 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.30 | 96.74 | 2.00 | 0.00 | 0.79 | 0.00 | 12.37 | 108.97 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.43 | 117.99 | 2.00 | 0.00 | 0.79 | 0.00 | 12.50 | 117.92 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.56 | 110.92 | 2.00 | 0.00 | 0.79 | 0.00 | 12.60 | 104.33 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.66 | 105.42 | 2.00 | 0.00 | 0.79 | 0.00 | 12.73 | 113.26 | 2.00 | 0.00 | 0.78 | 0.00 |
| 12.80 | 119.84 | 2.00 | 0.00 | 0.78 | 0.00 | 12.87 | 123.24 | 2.00 | 0.00 | 0.78 | 0.00 |
| 12.95 | 124.09 | 2.00 | 0.00 | 0.78 | 0.00 | 13.01 | 124.84 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.08 | 127.82 | 2.00 | 0.00 | 0.78 | 0.00 | 13.14 | 131.36 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.21 | 134.07 | 2.00 | 0.00 | 0.78 | 0.00 | 13.28 | 135.38 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.35 | 136.88 | 2.00 | 0.00 | 0.77 | 0.00 | 13.41 | 139.99 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.48 | 144.89 | 2.00 | 0.00 | 0.77 | 0.00 | 13.54 | 150.21 | 2.00 | 0.00 | 0.77 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.61 | 153.94 | 2.00 | 0.00 | 0.77 | 0.00 | 13.67 | 156.40 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.73 | 157.95 | 2.00 | 0.00 | 0.77 | 0.00 | 13.80 | 160.02 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.87 | 162.73 | 2.00 | 0.00 | 0.76 | 0.00 | 13.93 | 165.96 | 2.00 | 0.00 | 0.76 | 0.00 |
| 13.99 | 167.81 | 2.00 | 0.00 | 0.76 | 0.00 | 14.06 | 167.39 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.13 | 163.67 | 2.00 | 0.00 | 0.76 | 0.00 | 14.20 | 158.76 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.26 | 153.27 | 2.00 | 0.00 | 0.76 | 0.00 | 14.32 | 147.15 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.39 | 139.15 | 2.00 | 0.00 | 0.76 | 0.00 | 14.45 | 129.70 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.52 | 121.12 | 2.00 | 0.00 | 0.75 | 0.00 | 14.59 | 114.58 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.65 | 109.67 | 2.00 | 0.00 | 0.75 | 0.00 | 14.71 | 104.80 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.78 | 99.55 | 2.00 | 0.00 | 0.75 | 0.00 | 14.84 | 94.44 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.91 | 90.71 | 2.00 | 0.00 | 0.75 | 0.00 | 14.98 | 88.96 | 2.00 | 0.00 | 0.75 | 0.00 |
| 15.04 | 88.85 | 2.00 | 0.00 | 0.75 | 0.00 | 15.11 | 89.60 | 0.31 | 1.90 | 0.74 | 0.02 |
| 15.17 | 90.53 | 0.32 | 1.88 | 0.74 | 0.01 | 15.23 | 91.16 | 0.32 | 1.87 | 0.74 | 0.01 |
| 15.30 | 91.40 | 0.32 | 1.86 | 0.74 | 0.02 | 15.36 | 92.15 | 0.32 | 1.85 | 0.74 | 0.01 |
| 15.43 | 95.09 | 0.34 | 1.80 | 0.74 | 0.01 | 15.50 | 101.34 | 0.37 | 1.70 | 0.74 | 0.01 |
| 15.56 | 106.36 | 0.41 | 1.64 | 0.74 | 0.01 | 15.63 | 105.69 | 0.40 | 1.64 | 0.74 | 0.01 |
| 15.70 | 103.56 | 0.39 | 1.67 | 0.73 | 0.01 | 15.75 | 103.96 | 0.39 | 1.66 | 0.73 | 0.01 |
| 15.82 | 108.16 | 0.41 | 1.60 | 0.73 | 0.01 | 15.88 | 108.07 | 0.41 | 1.60 | 0.73 | 0.01 |
| 15.95 | 103.28 | 0.38 | 1.66 | 0.73 | 0.01 | 16.02 | 98.60 | 0.35 | 1.72 | 0.73 | 0.02 |
| 16.09 | 96.60 | 0.34 | 1.75 | 0.73 | 0.01 | 16.16 | 97.05 | 0.34 | 1.74 | 0.73 | 0.01 |
| 16.22 | 99.54 | 2.00 | 0.00 | 0.73 | 0.00 | 16.28 | 103.63 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.34 | 108.82 | 2.00 | 0.00 | 0.72 | 0.00 | 16.41 | 114.52 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.48 | 121.12 | 2.00 | 0.00 | 0.72 | 0.00 | 16.54 | 128.18 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.60 | 135.59 | 2.00 | 0.00 | 0.72 | 0.00 | 16.67 | 144.47 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.76 | 153.59 | 2.00 | 0.00 | 0.72 | 0.00 | 16.83 | 161.38 | 2.00 | 0.00 | 0.71 | 0.00 |
| 16.89 | 165.13 | 2.00 | 0.00 | 0.71 | 0.00 | 16.96 | 167.86 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.02 | 170.42 | 2.00 | 0.00 | 0.71 | 0.00 | 17.09 | 172.26 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.15 | 172.81 | 2.00 | 0.00 | 0.71 | 0.00 | 17.22 | 172.11 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.28 | 170.65 | 2.00 | 0.00 | 0.71 | 0.00 | 17.34 | 168.37 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.41 | 166.26 | 2.00 | 0.00 | 0.70 | 0.00 | 17.48 | 165.64 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.54 | 167.70 | 2.00 | 0.00 | 0.70 | 0.00 | 17.61 | 167.52 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.67 | 167.59 | 2.00 | 0.00 | 0.70 | 0.00 | 17.74 | 163.40 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.80 | 156.99 | 2.00 | 0.00 | 0.70 | 0.00 | 17.87 | 142.82 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.93 | 125.87 | 2.00 | 0.00 | 0.70 | 0.00 | 18.00 | 113.87 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.07 | 110.88 | 2.00 | 0.00 | 0.69 | 0.00 | 18.13 | 114.51 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.19 | 121.92 | 2.00 | 0.00 | 0.69 | 0.00 | 18.25 | 131.84 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.32 | 143.15 | 2.00 | 0.00 | 0.69 | 0.00 | 18.39 | 152.66 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.45 | 153.78 | 0.83 | 0.74 | 0.69 | 0.01 | 18.52 | 157.77 | 0.88 | 0.55 | 0.69 | 0.00 |
| 18.58 | 167.41 | 1.02 | 0.37 | 0.69 | 0.00 | 18.65 | 173.30 | 1.12 | 0.26 | 0.68 | 0.00 |
| 18.71 | 175.95 | 1.16 | 0.19 | 0.68 | 0.00 | 18.78 | 176.59 | 1.17 | 0.19 | 0.68 | 0.00 |
| 18.85 | 176.35 | 1.16 | 0.19 | 0.68 | 0.00 | 18.91 | 175.97 | 1.16 | 0.19 | 0.68 | 0.00 |
| 18.98 | 175.49 | 1.15 | 0.26 | 0.68 | 0.00 | 19.04 | 175.19 | 1.14 | 0.26 | 0.68 | 0.00 |
| 19.13 | 174.87 | 1.13 | 0.26 | 0.68 | 0.00 | 19.19 | 175.14 | 1.14 | 0.26 | 0.67 | 0.00 |
| 19.26 | 175.13 | 1.14 | 0.26 | 0.67 | 0.00 | 19.32 | 174.71 | 1.13 | 0.26 | 0.67 | 0.00 |
| 19.39 | 173.67 | 1.11 | 0.26 | 0.67 | 0.00 | 19.43 | 172.35 | 1.09 | 0.26 | 0.67 | 0.00 |
| 19.49 | 170.98 | 1.06 | 0.26 | 0.67 | 0.00 | 19.55 | 169.77 | 1.04 | 0.36 | 0.67 | 0.00 |
| 19.62 | 168.58 | 1.02 | 0.36 | 0.67 | 0.00 | 19.69 | 167.22 | 1.00 | 0.36 | 0.67 | 0.00 |
| 19.76 | 165.50 | 0.98 | 0.37 | 0.67 | 0.00 | 19.82 | 163.48 | 0.95 | 0.50 | 0.66 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.88 | 161.32 | 0.91 | 0.51 | 0.66 | 0.00 | 19.95 | 158.82 | 0.88 | 0.52 | 0.66 | 0.00 |
| 20.02 | 156.42 | 0.84 | 0.70 | 0.66 | 0.01 | 20.09 | 154.30 | 0.82 | 0.71 | 0.66 | 0.01 |
| 20.16 | 152.47 | 0.79 | 0.72 | 0.66 | 0.01 | 20.23 | 150.18 | 0.76 | 0.74 | 0.66 | 0.01 |
| 20.29 | 146.81 | 0.72 | 0.94 | 0.66 | 0.01 | 20.36 | 142.41 | 0.67 | 0.97 | 0.65 | 0.01 |
| 20.42 | 136.99 | 0.61 | 1.18 | 0.65 | 0.01 | 20.49 | 130.54 | 0.55 | 1.23 | 0.65 | 0.01 |
| 20.55 | 125.55 | 0.51 | 1.26 | 0.65 | 0.01 | 20.62 | 122.30 | 0.48 | 1.29 | 0.65 | 0.01 |
| 20.68 | 117.14 | 0.44 | 1.33 | 0.65 | 0.01 | 20.75 | 110.16 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.82 | 101.79 | 2.00 | 0.00 | 0.65 | 0.00 | 20.89 | 91.14 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.95 | 82.00 | 2.00 | 0.00 | 0.64 | 0.00 | 21.02 | 79.94 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.08 | 85.12 | 2.00 | 0.00 | 0.64 | 0.00 | 21.14 | 91.79 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.21 | 96.10 | 2.00 | 0.00 | 0.64 | 0.00 | 21.27 | 97.86 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.34 | 97.67 | 2.00 | 0.00 | 0.64 | 0.00 | 21.40 | 95.73 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.47 | 89.70 | 2.00 | 0.00 | 0.64 | 0.00 | 21.54 | 78.18 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.60 | 63.71 | 2.00 | 0.00 | 0.63 | 0.00 | 21.67 | 50.55 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.74 | 44.34 | 2.00 | 0.00 | 0.63 | 0.00 | 21.80 | 42.73 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.86 | 45.39 | 2.00 | 0.00 | 0.63 | 0.00 | 21.93 | 50.12 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.98 | 59.64 | 2.00 | 0.00 | 0.63 | 0.00 | 22.08 | 71.92 | 2.00 | 0.00 | 0.63 | 0.00 |
| 22.14 | 87.57 | 2.00 | 0.00 | 0.62 | 0.00 | 22.21 | 102.61 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.26 | 117.71 | 2.00 | 0.00 | 0.62 | 0.00 | 22.33 | 130.72 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.40 | 141.60 | 2.00 | 0.00 | 0.62 | 0.00 | 22.46 | 150.28 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.52 | 157.72 | 2.00 | 0.00 | 0.62 | 0.00 | 22.59 | 165.00 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.66 | 171.63 | 2.00 | 0.00 | 0.62 | 0.00 | 22.72 | 176.63 | 2.00 | 0.00 | 0.61 | 0.00 |
| 22.79 | 179.91 | 2.00 | 0.00 | 0.61 | 0.00 | 22.86 | 180.87 | 2.00 | 0.00 | 0.61 | 0.00 |
| 22.92 | 180.83 | 2.00 | 0.00 | 0.61 | 0.00 | 22.98 | 179.09 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.05 | 176.07 | 2.00 | 0.00 | 0.61 | 0.00 | 23.12 | 172.71 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.18 | 170.12 | 2.00 | 0.00 | 0.61 | 0.00 | 23.24 | 169.80 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.31 | 171.04 | 2.00 | 0.00 | 0.60 | 0.00 | 23.38 | 172.08 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.45 | 170.51 | 2.00 | 0.00 | 0.60 | 0.00 | 23.51 | 164.61 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.58 | 150.16 | 2.00 | 0.00 | 0.60 | 0.00 | 23.65 | 133.75 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.72 | 128.24 | 2.00 | 0.00 | 0.60 | 0.00 | 23.78 | 133.13 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.84 | 137.68 | 2.00 | 0.00 | 0.60 | 0.00 | 23.91 | 136.19 | 2.00 | 0.00 | 0.59 | 0.00 |
| 23.98 | 129.18 | 2.00 | 0.00 | 0.59 | 0.00 | 24.04 | 119.76 | 2.00 | 0.00 | 0.59 | 0.00 |
| 24.11 | 109.67 | 2.00 | 0.00 | 0.59 | 0.00 | 24.17 | 101.45 | 0.33 | 1.36 | 0.59 | 0.01 |
| 24.24 | 95.94 | 0.30 | 1.42 | 0.59 | 0.01 | 24.30 | 94.10 | 0.29 | 1.44 | 0.59 | 0.01 |
| 24.36 | 97.46 | 0.31 | 1.40 | 0.59 | 0.01 | 24.43 | 102.94 | 0.33 | 1.34 | 0.59 | 0.01 |
| 24.50 | 112.67 | 0.39 | 1.24 | 0.58 | 0.01 | 24.56 | 118.56 | 0.43 | 1.19 | 0.58 | 0.01 |
| 24.63 | 122.57 | 0.46 | 1.15 | 0.58 | 0.01 | 24.69 | 121.00 | 0.45 | 1.16 | 0.58 | 0.01 |
| 24.76 | 122.47 | 0.46 | 1.15 | 0.58 | 0.01 | 24.82 | 130.19 | 0.52 | 1.09 | 0.58 | 0.01 |
| 24.89 | 138.13 | 0.59 | 1.04 | 0.58 | 0.01 | 24.95 | 139.53 | 0.61 | 1.03 | 0.58 | 0.01 |
| 25.02 | 135.24 | 2.00 | 0.00 | 0.58 | 0.00 | 25.08 | 128.81 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.14 | 121.55 | 2.00 | 0.00 | 0.57 | 0.00 | 25.21 | 114.35 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.28 | 107.39 | 2.00 | 0.00 | 0.57 | 0.00 | 25.34 | 101.66 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.41 | 97.72 | 2.00 | 0.00 | 0.57 | 0.00 | 25.48 | 96.46 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.54 | 100.44 | 2.00 | 0.00 | 0.57 | 0.00 | 25.61 | 110.23 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.68 | 122.21 | 2.00 | 0.00 | 0.56 | 0.00 | 25.74 | 128.37 | 2.00 | 0.00 | 0.56 | 0.00 |
| 25.80 | 130.04 | 2.00 | 0.00 | 0.56 | 0.00 | 25.87 | 127.60 | 2.00 | 0.00 | 0.56 | 0.00 |
| 25.93 | 123.92 | 2.00 | 0.00 | 0.56 | 0.00 | 26.00 | 117.13 | 2.00 | 0.00 | 0.56 | 0.00 |
| 26.07 | 110.09 | 2.00 | 0.00 | 0.56 | 0.00 | 26.14 | 103.38 | 2.00 | 0.00 | 0.56 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26.20 | 96.89 | 2.00 | 0.00 | 0.56 | 0.00 | 26.27 | 90.77 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.33 | 87.72 | 2.00 | 0.00 | 0.55 | 0.00 | 26.40 | 87.75 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.47 | 88.53 | 2.00 | 0.00 | 0.55 | 0.00 | 26.54 | 88.83 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.60 | 88.82 | 2.00 | 0.00 | 0.55 | 0.00 | 26.67 | 86.29 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.73 | 80.45 | 2.00 | 0.00 | 0.55 | 0.00 | 26.80 | 75.70 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.87 | 74.48 | 2.00 | 0.00 | 0.54 | 0.00 | 26.90 | 78.15 | 2.00 | 0.00 | 0.54 | 0.00 |
| 26.97 | 81.42 | 2.00 | 0.00 | 0.54 | 0.00 | 27.07 | 84.59 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.11 | 86.65 | 2.00 | 0.00 | 0.54 | 0.00 | 27.18 | 88.60 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.25 | 91.10 | 2.00 | 0.00 | 0.54 | 0.00 | 27.31 | 93.81 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.37 | 95.62 | 2.00 | 0.00 | 0.54 | 0.00 | 27.44 | 96.98 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.50 | 98.34 | 2.00 | 0.00 | 0.53 | 0.00 | 27.57 | 99.39 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.63 | 99.82 | 2.00 | 0.00 | 0.53 | 0.00 | 27.70 | 99.91 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.76 | 100.14 | 2.00 | 0.00 | 0.53 | 0.00 | 27.82 | 100.56 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.89 | 100.89 | 2.00 | 0.00 | 0.53 | 0.00 | 27.95 | 100.98 | 2.00 | 0.00 | 0.53 | 0.00 |
| 28.02 | 101.46 | 2.00 | 0.00 | 0.53 | 0.00 | 28.09 | 103.21 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.15 | 105.82 | 2.00 | 0.00 | 0.52 | 0.00 | 28.25 | 107.36 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.28 | 107.72 | 2.00 | 0.00 | 0.52 | 0.00 | 28.38 | 107.40 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.41 | 107.25 | 2.00 | 0.00 | 0.52 | 0.00 | 28.48 | 107.67 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.55 | 110.21 | 2.00 | 0.00 | 0.52 | 0.00 | 28.61 | 116.38 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.68 | 122.73 | 2.00 | 0.00 | 0.51 | 0.00 | 28.75 | 127.24 | 2.00 | 0.00 | 0.51 | 0.00 |
| 28.81 | 127.97 | 2.00 | 0.00 | 0.51 | 0.00 | 28.88 | 126.12 | 2.00 | 0.00 | 0.51 | 0.00 |
| 28.94 | 112.64 | 2.00 | 0.00 | 0.51 | 0.00 | 29.03 | 94.74 | 2.00 | 0.00 | 0.51 | 0.00 |
| 29.10 | 81.48 | 2.00 | 0.00 | 0.51 | 0.00 | 29.16 | 80.07 | 2.00 | 0.00 | 0.51 | 0.00 |
| 29.23 | 82.24 | 2.00 | 0.00 | 0.50 | 0.00 | 29.29 | 84.52 | 2.00 | 0.00 | 0.50 | 0.00 |
| 29.35 | 85.31 | 2.00 | 0.00 | 0.50 | 0.00 | 29.42 | 85.45 | 2.00 | 0.00 | 0.50 | 0.00 |
| 29.48 | 87.91 | 0.25 | 1.30 | 0.50 | 0.01 | 29.55 | 92.47 | 0.27 | 1.24 | 0.50 | 0.01 |
| 29.62 | 97.35 | 0.29 | 1.19 | 0.50 | 0.01 | 29.67 | 100.00 | 0.30 | 1.16 | 0.50 | 0.01 |
| 29.73 | 100.41 | 0.31 | 1.16 | 0.50 | 0.01 | 29.82 | 99.12 | 0.30 | 1.16 | 0.49 | 0.01 |
| 29.89 | 97.23 | 0.29 | 1.18 | 0.49 | 0.01 | 29.95 | 95.34 | 0.28 | 1.20 | 0.49 | 0.01 |
| 30.02 | 93.77 | 0.27 | 1.21 | 0.49 | 0.01 | 30.08 | 91.96 | 0.27 | 1.23 | 0.49 | 0.01 |
| 30.15 | 89.57 | 0.26 | 1.25 | 0.49 | 0.01 | 30.21 | 87.13 | 2.00 | 0.00 | 0.49 | 0.00 |
| 30.27 | 85.12 | 2.00 | 0.00 | 0.49 | 0.00 | 30.34 | 84.15 | 2.00 | 0.00 | 0.49 | 0.00 |
| 30.40 | 85.79 | 2.00 | 0.00 | 0.48 | 0.00 | 30.47 | 92.35 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.53 | 104.94 | 2.00 | 0.00 | 0.48 | 0.00 | 30.60 | 120.93 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.66 | 135.61 | 2.00 | 0.00 | 0.48 | 0.00 | 30.73 | 142.04 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.80 | 143.84 | 2.00 | 0.00 | 0.48 | 0.00 | 30.86 | 142.16 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.93 | 140.58 | 2.00 | 0.00 | 0.48 | 0.00 | 30.99 | 139.24 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.05 | 138.13 | 2.00 | 0.00 | 0.47 | 0.00 | 31.12 | 125.78 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.18 | 107.06 | 2.00 | 0.00 | 0.47 | 0.00 | 31.24 | 93.96 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.31 | 95.30 | 2.00 | 0.00 | 0.47 | 0.00 | 31.38 | 103.97 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.45 | 111.52 | 2.00 | 0.00 | 0.47 | 0.00 | 31.51 | 115.57 | 0.39 | 0.97 | 0.47 | 0.01 |
| 31.58 | 117.55 | 0.40 | 0.95 | 0.46 | 0.01 | 31.64 | 119.25 | 0.41 | 0.94 | 0.46 | 0.01 |
| 31.71 | 125.67 | 0.46 | 0.90 | 0.46 | 0.01 | 31.77 | 131.47 | 0.50 | 0.86 | 0.46 | 0.01 |
| 31.84 | 137.06 | 0.55 | 0.83 | 0.46 | 0.01 | 31.90 | 142.21 | 0.60 | 0.80 | 0.46 | 0.01 |
| 31.97 | 147.23 | 0.65 | 0.79 | 0.46 | 0.01 | 32.03 | 151.73 | 0.70 | 0.62 | 0.46 | 0.00 |
| 32.09 | 156.11 | 0.75 | 0.60 | 0.46 | 0.00 | 32.16 | 160.48 | 0.80 | 0.46 | 0.45 | 0.00 |
| 32.23 | 164.85 | 0.85 | 0.34 | 0.45 | 0.00 | 32.29 | 169.08 | 0.91 | 0.33 | 0.45 | 0.00 |
| 32.36 | 170.86 | 0.94 | 0.32 | 0.45 | 0.00 | 32.43 | 170.25 | 0.93 | 0.32 | 0.45 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 32.49 | 171.99 | 0.95 | 0.24 | 0.45 | 0.00 | 32.55 | 176.39 | 1.01 | 0.23 | 0.45 | 0.00 |
| 32.62 | 182.78 | 1.11 | 0.17 | 0.45 | 0.00 | 32.69 | 186.30 | 1.17 | 0.12 | 0.45 | 0.00 |
| 32.75 | 188.41 | 1.21 | 0.12 | 0.44 | 0.00 | 32.81 | 189.12 | 1.22 | 0.12 | 0.44 | 0.00 |
| 32.88 | 188.48 | 1.21 | 0.12 | 0.44 | 0.00 | 32.95 | 186.49 | 1.17 | 0.12 | 0.44 | 0.00 |
| 33.02 | 183.64 | 1.12 | 0.16 | 0.44 | 0.00 | 33.08 | 179.97 | 1.07 | 0.17 | 0.44 | 0.00 |
| 33.15 | 175.91 | 1.00 | 0.23 | 0.44 | 0.00 | 33.21 | 171.66 | 0.94 | 0.31 | 0.44 | 0.00 |
| 33.27 | 167.39 | 0.88 | 0.32 | 0.44 | 0.00 | 33.34 | 163.32 | 0.83 | 0.43 | 0.43 | 0.00 |
| 33.40 | 159.71 | 0.79 | 0.45 | 0.43 | 0.00 | 33.47 | 156.72 | 0.75 | 0.56 | 0.43 | 0.00 |
| 33.53 | 154.16 | 0.72 | 0.57 | 0.43 | 0.00 | 33.60 | 151.88 | 0.69 | 0.58 | 0.43 | 0.00 |
| 33.67 | 149.70 | 0.67 | 0.60 | 0.43 | 0.00 | 33.73 | 147.53 | 0.65 | 0.74 | 0.43 | 0.01 |
| 33.80 | 145.44 | 0.63 | 0.73 | 0.43 | 0.01 | 33.86 | 143.37 | 0.60 | 0.74 | 0.43 | 0.01 |
| 33.93 | 141.34 | 0.58 | 0.75 | 0.42 | 0.01 | 33.99 | 139.13 | 0.56 | 0.76 | 0.42 | 0.01 |
| 34.06 | 138.81 | 0.56 | 0.75 | 0.42 | 0.01 | 34.16 | 138.80 | 0.56 | 0.75 | 0.42 | 0.01 |
| 34.19 | 138.58 | 0.56 | 0.75 | 0.42 | 0.00 | 34.26 | 137.87 | 0.55 | 0.75 | 0.42 | 0.01 |
| 34.32 | 135.90 | 0.53 | 0.76 | 0.42 | 0.01 | 34.39 | 132.55 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.45 | 127.81 | 2.00 | 0.00 | 0.42 | 0.00 | 34.52 | 122.08 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.58 | 115.71 | 2.00 | 0.00 | 0.41 | 0.00 | 34.65 | 110.00 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.71 | 107.54 | 2.00 | 0.00 | 0.41 | 0.00 | 34.78 | 112.29 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.84 | 124.70 | 2.00 | 0.00 | 0.41 | 0.00 | 34.91 | 139.23 | 2.00 | 0.00 | 0.41 | 0.00 |
| 35.00 | 148.46 | 2.00 | 0.00 | 0.41 | 0.00 | 35.07 | 148.21 | 2.00 | 0.00 | 0.41 | 0.00 |
| 35.13 | 139.38 | 2.00 | 0.00 | 0.40 | 0.00 | 35.20 | 124.25 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.27 | 110.28 | 2.00 | 0.00 | 0.40 | 0.00 | 35.34 | 102.54 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.40 | 101.35 | 2.00 | 0.00 | 0.40 | 0.00 | 35.43 | 104.11 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.52 | 110.59 | 2.00 | 0.00 | 0.40 | 0.00 | 35.59 | 122.04 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.65 | 134.15 | 2.00 | 0.00 | 0.40 | 0.00 | 35.72 | 143.89 | 2.00 | 0.00 | 0.39 | 0.00 |
| 35.78 | 148.94 | 2.00 | 0.00 | 0.39 | 0.00 | 35.85 | 144.87 | 2.00 | 0.00 | 0.39 | 0.00 |
| 35.92 | 140.93 | 2.00 | 0.00 | 0.39 | 0.00 | 35.99 | 141.08 | 2.00 | 0.00 | 0.39 | 0.00 |
| 36.05 | 142.14 | 2.00 | 0.00 | 0.39 | 0.00 | 36.12 | 140.02 | 2.00 | 0.00 | 0.39 | 0.00 |
| 36.18 | 136.40 | 2.00 | 0.00 | 0.39 | 0.00 | 36.25 | 136.10 | 2.00 | 0.00 | 0.39 | 0.00 |
| 36.31 | 139.33 | 2.00 | 0.00 | 0.38 | 0.00 | 36.38 | 142.06 | 2.00 | 0.00 | 0.38 | 0.00 |
| 36.44 | 142.74 | 2.00 | 0.00 | 0.38 | 0.00 | 36.50 | 142.09 | 2.00 | 0.00 | 0.38 | 0.00 |
| 36.57 | 140.96 | 2.00 | 0.00 | 0.38 | 0.00 | 36.64 | 139.70 | 2.00 | 0.00 | 0.38 | 0.00 |
| 36.70 | 138.56 | 2.00 | 0.00 | 0.38 | 0.00 | 36.77 | 137.74 | 2.00 | 0.00 | 0.38 | 0.00 |
| 36.84 | 137.24 | 2.00 | 0.00 | 0.38 | 0.00 | 36.90 | 137.10 | 2.00 | 0.00 | 0.37 | 0.00 |
| 36.96 | 137.07 | 2.00 | 0.00 | 0.37 | 0.00 | 37.03 | 137.04 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.10 | 136.97 | 2.00 | 0.00 | 0.37 | 0.00 | 37.16 | 136.86 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.22 | 136.58 | 2.00 | 0.00 | 0.37 | 0.00 | 37.29 | 135.91 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.36 | 134.64 | 2.00 | 0.00 | 0.37 | 0.00 | 37.43 | 132.47 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.49 | 128.98 | 2.00 | 0.00 | 0.36 | 0.00 | 37.56 | 123.97 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.63 | 117.24 | 2.00 | 0.00 | 0.36 | 0.00 | 37.69 | 109.56 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.76 | 103.73 | 2.00 | 0.00 | 0.36 | 0.00 | 37.82 | 103.25 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.89 | 109.46 | 2.00 | 0.00 | 0.36 | 0.00 | 37.95 | 119.04 | 2.00 | 0.00 | 0.36 | 0.00 |
| 38.02 | 125.06 | 2.00 | 0.00 | 0.36 | 0.00 | 38.09 | 127.02 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.15 | 124.39 | 2.00 | 0.00 | 0.35 | 0.00 | 38.22 | 117.81 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.29 | 111.31 | 2.00 | 0.00 | 0.35 | 0.00 | 38.32 | 105.00 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.39 | 100.70 | 2.00 | 0.00 | 0.35 | 0.00 | 38.45 | 92.57 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.53 | 83.89 | 2.00 | 0.00 | 0.35 | 0.00 | 38.59 | 74.91 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.66 | 71.72 | 2.00 | 0.00 | 0.34 | 0.00 | 38.72 | 70.20 | 2.00 | 0.00 | 0.34 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38.79 | 69.26 | 2.00 | 0.00 | 0.34 | 0.00 | 38.86 | 68.71 | 2.00 | 0.00 | 0.34 | 0.00 |
| 38.93 | 68.89 | 2.00 | 0.00 | 0.34 | 0.00 | 38.99 | 70.59 | 2.00 | 0.00 | 0.34 | 0.00 |
| 39.05 | 73.95 | 2.00 | 0.00 | 0.34 | 0.00 | 39.12 | 77.17 | 2.00 | 0.00 | 0.34 | 0.00 |
| 39.18 | 78.60 | 2.00 | 0.00 | 0.34 | 0.00 | 39.25 | 78.03 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.31 | 77.87 | 2.00 | 0.00 | 0.33 | 0.00 | 39.38 | 77.89 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.44 | 79.02 | 2.00 | 0.00 | 0.33 | 0.00 | 39.51 | 82.13 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.60 | 86.57 | 2.00 | 0.00 | 0.33 | 0.00 | 39.63 | 91.24 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.70 | 93.75 | 2.00 | 0.00 | 0.33 | 0.00 | 39.80 | 95.85 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.86 | 97.33 | 2.00 | 0.00 | 0.32 | 0.00 | 39.92 | 99.54 | 2.00 | 0.00 | 0.32 | 0.00 |
| 39.98 | 102.68 | 2.00 | 0.00 | 0.32 | 0.00 | 40.05 | 106.96 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.11 | 112.10 | 2.00 | 0.00 | 0.32 | 0.00 | 40.18 | 117.42 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.25 | 122.44 | 2.00 | 0.00 | 0.32 | 0.00 | 40.31 | 126.36 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.38 | 129.74 | 2.00 | 0.00 | 0.32 | 0.00 | 40.45 | 133.37 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.51 | 137.43 | 2.00 | 0.00 | 0.31 | 0.00 | 40.58 | 140.78 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.64 | 142.63 | 2.00 | 0.00 | 0.31 | 0.00 | 40.71 | 145.41 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.77 | 144.97 | 2.00 | 0.00 | 0.31 | 0.00 | 40.84 | 143.79 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.90 | 142.18 | 2.00 | 0.00 | 0.31 | 0.00 | 40.96 | 140.16 | 2.00 | 0.00 | 0.31 | 0.00 |
| 41.03 | 137.47 | 2.00 | 0.00 | 0.30 | 0.00 | 41.10 | 134.53 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.16 | 123.78 | 2.00 | 0.00 | 0.30 | 0.00 | 41.23 | 109.30 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.29 | 99.55 | 2.00 | 0.00 | 0.30 | 0.00 | 41.36 | 103.16 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.43 | 113.72 | 2.00 | 0.00 | 0.30 | 0.00 | 41.49 | 118.54 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.55 | 121.62 | 2.00 | 0.00 | 0.30 | 0.00 | 41.61 | 122.18 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.67 | 120.55 | 2.00 | 0.00 | 0.29 | 0.00 | 41.73 | 117.71 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.80 | 114.64 | 2.00 | 0.00 | 0.29 | 0.00 | 41.90 | 111.99 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.96 | 110.68 | 2.00 | 0.00 | 0.29 | 0.00 | 42.02 | 110.10 | 2.00 | 0.00 | 0.29 | 0.00 |
| 42.09 | 110.17 | 2.00 | 0.00 | 0.29 | 0.00 | 42.15 | 111.57 | 2.00 | 0.00 | 0.29 | 0.00 |
| 42.22 | 114.52 | 2.00 | 0.00 | 0.28 | 0.00 | 42.28 | 116.93 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.35 | 116.96 | 2.00 | 0.00 | 0.28 | 0.00 | 42.42 | 114.92 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.48 | 115.04 | 2.00 | 0.00 | 0.28 | 0.00 | 42.54 | 115.38 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.61 | 117.55 | 2.00 | 0.00 | 0.28 | 0.00 | 42.67 | 118.82 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.73 | 120.87 | 2.00 | 0.00 | 0.28 | 0.00 | 42.80 | 120.66 | 2.00 | 0.00 | 0.27 | 0.00 |
| 42.87 | 118.38 | 2.00 | 0.00 | 0.27 | 0.00 | 42.93 | 114.88 | 2.00 | 0.00 | 0.27 | 0.00 |
| 42.99 | 110.55 | 2.00 | 0.00 | 0.27 | 0.00 | 43.05 | 106.54 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.12 | 103.06 | 2.00 | 0.00 | 0.27 | 0.00 | 43.19 | 100.61 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.26 | 97.93 | 2.00 | 0.00 | 0.27 | 0.00 | 43.32 | 95.46 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.38 | 93.81 | 2.00 | 0.00 | 0.26 | 0.00 | 43.45 | 93.04 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.51 | 92.07 | 2.00 | 0.00 | 0.26 | 0.00 | 43.57 | 90.88 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.66 | 89.74 | 2.00 | 0.00 | 0.26 | 0.00 | 43.72 | 84.33 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.79 | 73.97 | 2.00 | 0.00 | 0.26 | 0.00 | 43.85 | 63.96 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.92 | 61.37 | 2.00 | 0.00 | 0.26 | 0.00 | 43.98 | 63.57 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.05 | 65.50 | 2.00 | 0.00 | 0.25 | 0.00 | 44.11 | 67.46 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.17 | 69.64 | 2.00 | 0.00 | 0.25 | 0.00 | 44.25 | 71.17 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.31 | 72.41 | 2.00 | 0.00 | 0.25 | 0.00 | 44.38 | 73.39 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.44 | 74.84 | 2.00 | 0.00 | 0.25 | 0.00 | 44.50 | 77.12 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.57 | 80.39 | 2.00 | 0.00 | 0.24 | 0.00 | 44.63 | 84.49 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.70 | 89.14 | 2.00 | 0.00 | 0.24 | 0.00 | 44.76 | 94.63 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.83 | 101.18 | 2.00 | 0.00 | 0.24 | 0.00 | 44.89 | 108.54 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.96 | 115.86 | 2.00 | 0.00 | 0.24 | 0.00 | 45.02 | 123.23 | 2.00 | 0.00 | 0.24 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 45.10 | 130.33 | 2.00 | 0.00 | 0.24 | 0.00 | 45.16 | 137.43 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.23 | 144.06 | 2.00 | 0.00 | 0.23 | 0.00 | 45.29 | 150.04 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.35 | 155.22 | 2.00 | 0.00 | 0.23 | 0.00 | 45.42 | 159.33 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.48 | 165.73 | 2.00 | 0.00 | 0.23 | 0.00 | 45.55 | 167.30 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.62 | 167.29 | 2.00 | 0.00 | 0.23 | 0.00 | 45.67 | 165.99 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.74 | 163.53 | 2.00 | 0.00 | 0.22 | 0.00 | 45.80 | 159.93 | 2.00 | 0.00 | 0.22 | 0.00 |
| 45.87 | 155.36 | 2.00 | 0.00 | 0.22 | 0.00 | 45.93 | 149.84 | 2.00 | 0.00 | 0.22 | 0.00 |
| 46.00 | 144.08 | 2.00 | 0.00 | 0.22 | 0.00 | 46.07 | 138.56 | 0.56 | 0.39 | 0.22 | 0.00 |
| 46.13 | 134.09 | 0.52 | 0.40 | 0.22 | 0.00 | 46.22 | 131.82 | 0.51 | 0.40 | 0.22 | 0.00 |
| 46.29 | 133.57 | 0.52 | 0.40 | 0.22 | 0.00 | 46.36 | 137.78 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.39 | 144.57 | 2.00 | 0.00 | 0.21 | 0.00 | 46.46 | 151.82 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.53 | 160.96 | 2.00 | 0.00 | 0.21 | 0.00 | 46.60 | 169.64 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.66 | 176.84 | 2.00 | 0.00 | 0.21 | 0.00 | 46.73 | 181.78 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.79 | 184.42 | 2.00 | 0.00 | 0.21 | 0.00 | 46.86 | 185.55 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.93 | 186.03 | 2.00 | 0.00 | 0.20 | 0.00 | 46.99 | 186.70 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.06 | 183.31 | 2.00 | 0.00 | 0.20 | 0.00 | 47.12 | 177.73 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.19 | 175.97 | 2.00 | 0.00 | 0.20 | 0.00 | 47.26 | 177.24 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.33 | 182.96 | 2.00 | 0.00 | 0.20 | 0.00 | 47.39 | 186.96 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.45 | 189.04 | 2.00 | 0.00 | 0.20 | 0.00 | 47.52 | 188.78 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.59 | 183.84 | 2.00 | 0.00 | 0.19 | 0.00 | 47.65 | 176.10 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.72 | 159.80 | 2.00 | 0.00 | 0.19 | 0.00 | 47.78 | 140.89 | 0.59 | 0.34 | 0.19 | 0.00 |
| 47.85 | 128.68 | 0.48 | 0.36 | 0.19 | 0.00 | 47.91 | 127.60 | 0.48 | 0.36 | 0.19 | 0.00 |
| 47.98 | 134.47 | 2.00 | 0.00 | 0.19 | 0.00 | 48.05 | 144.55 | 2.00 | 0.00 | 0.19 | 0.00 |
| 48.11 | 154.90 | 2.00 | 0.00 | 0.18 | 0.00 | 48.17 | 163.60 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.23 | 168.09 | 2.00 | 0.00 | 0.18 | 0.00 | 48.32 | 169.25 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.39 | 167.87 | 2.00 | 0.00 | 0.18 | 0.00 | 48.43 | 165.13 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.50 | 160.64 | 2.00 | 0.00 | 0.18 | 0.00 | 48.56 | 154.72 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.63 | 147.95 | 2.00 | 0.00 | 0.18 | 0.00 | 48.69 | 139.70 | 2.00 | 0.00 | 0.17 | 0.00 |
| 48.76 | 133.88 | 2.00 | 0.00 | 0.17 | 0.00 | 48.83 | 133.38 | 2.00 | 0.00 | 0.17 | 0.00 |
| 48.89 | 137.01 | 2.00 | 0.00 | 0.17 | 0.00 | 48.95 | 138.94 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.02 | 143.45 | 2.00 | 0.00 | 0.17 | 0.00 | 49.11 | 147.33 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.17 | 148.18 | 2.00 | 0.00 | 0.17 | 0.00 | 49.24 | 149.96 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.30 | 145.91 | 2.00 | 0.00 | 0.16 | 0.00 | 49.37 | 131.21 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.43 | 108.12 | 2.00 | 0.00 | 0.16 | 0.00 | 49.50 | 88.89 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.57 | 84.99 | 2.00 | 0.00 | 0.16 | 0.00 | 49.63 | 87.39 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.70 | 89.17 | 2.00 | 0.00 | 0.16 | 0.00 | 49.75 | 93.10 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.81 | 102.43 | 2.00 | 0.00 | 0.16 | 0.00 | 49.87 | 116.96 | 2.00 | 0.00 | 0.15 | 0.00 |
| 49.94 | 133.11 | 2.00 | 0.00 | 0.15 | 0.00 | 50.01 | 143.27 | 2.00 | 0.00 | 0.15 | 0.00 |

**Total estimated settlement: 0.82**

**Abbreviations**

| | |
|---|---|
| $Q_{tn,cs}$: | Equivalent clean sand normalized cone resistance |
| FS: | Factor of safety against liquefaction |
| $e_v$ (%): | Post-liquefaction volumentric strain |
| DF: | $e_v$ depth weighting factor |
| Settlement: | Calculated settlement |

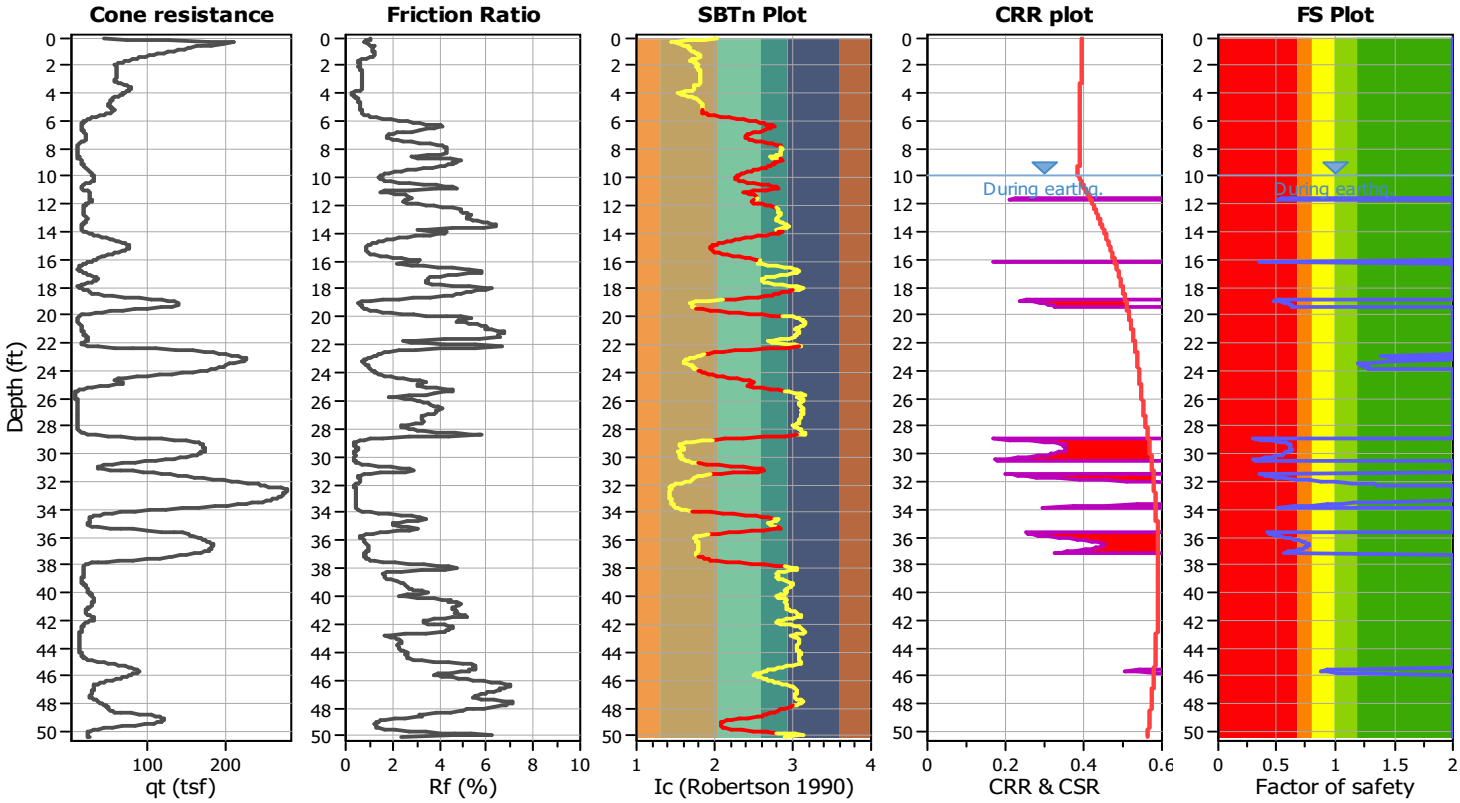
# LIQUEFACTION ANALYSIS REPORT

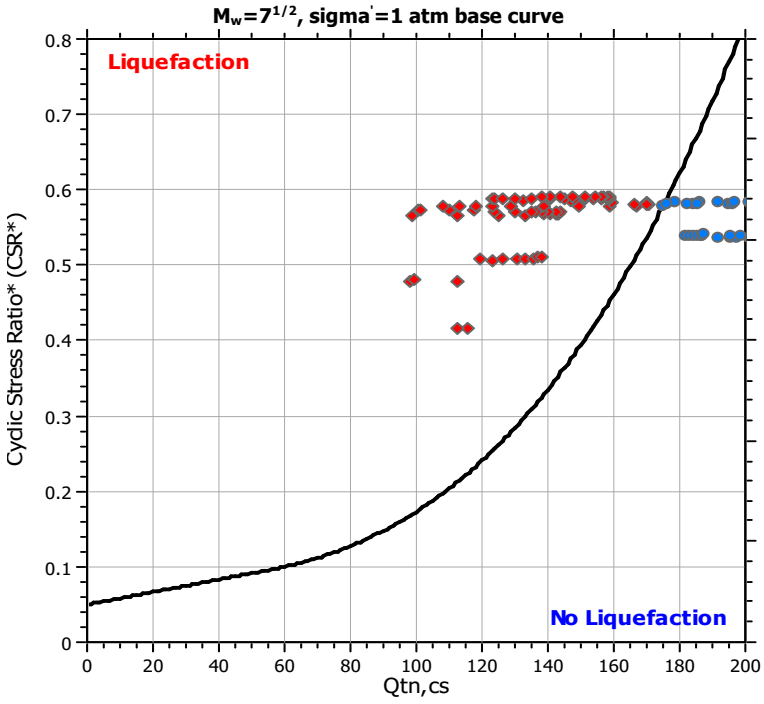
**Project title : Multi-Family Residential Project** **Location : Garden Grove, CA**

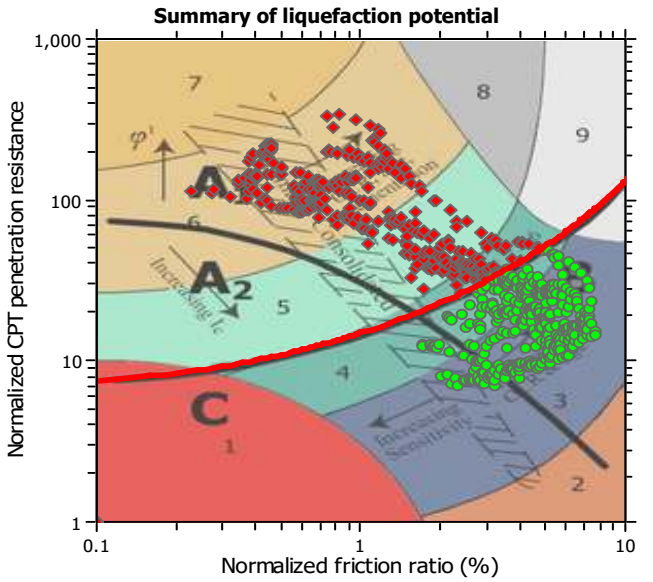
**CPT file : CPT-3**

**Input parameters and analysis data**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 17.00 ft | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 10.00 ft | Fill height: | N/A | Limit depth applied: | Yes |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | 60.00 ft |
| Earthquake magnitude $M_w$: | 7.30 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.65 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

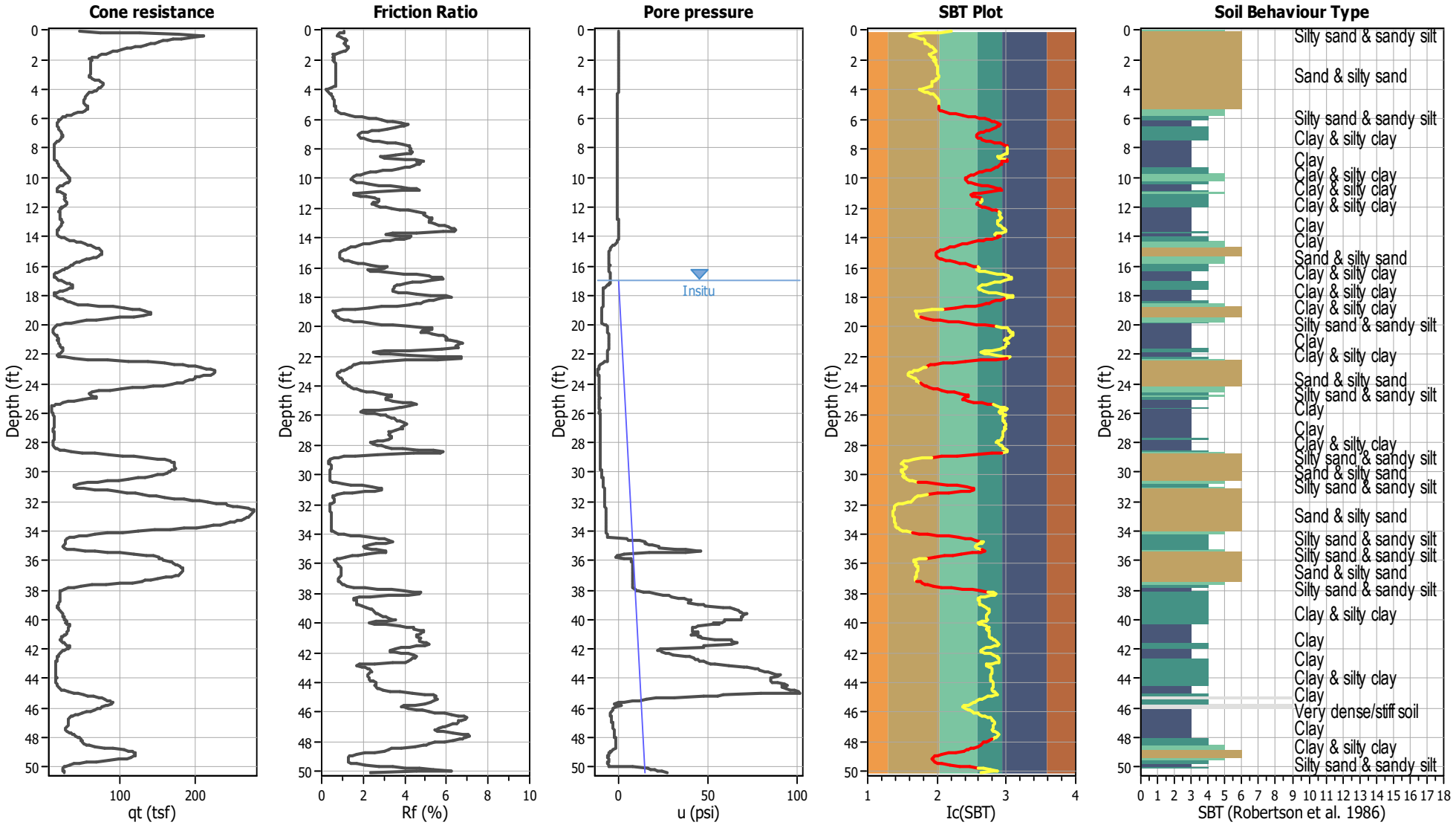



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots



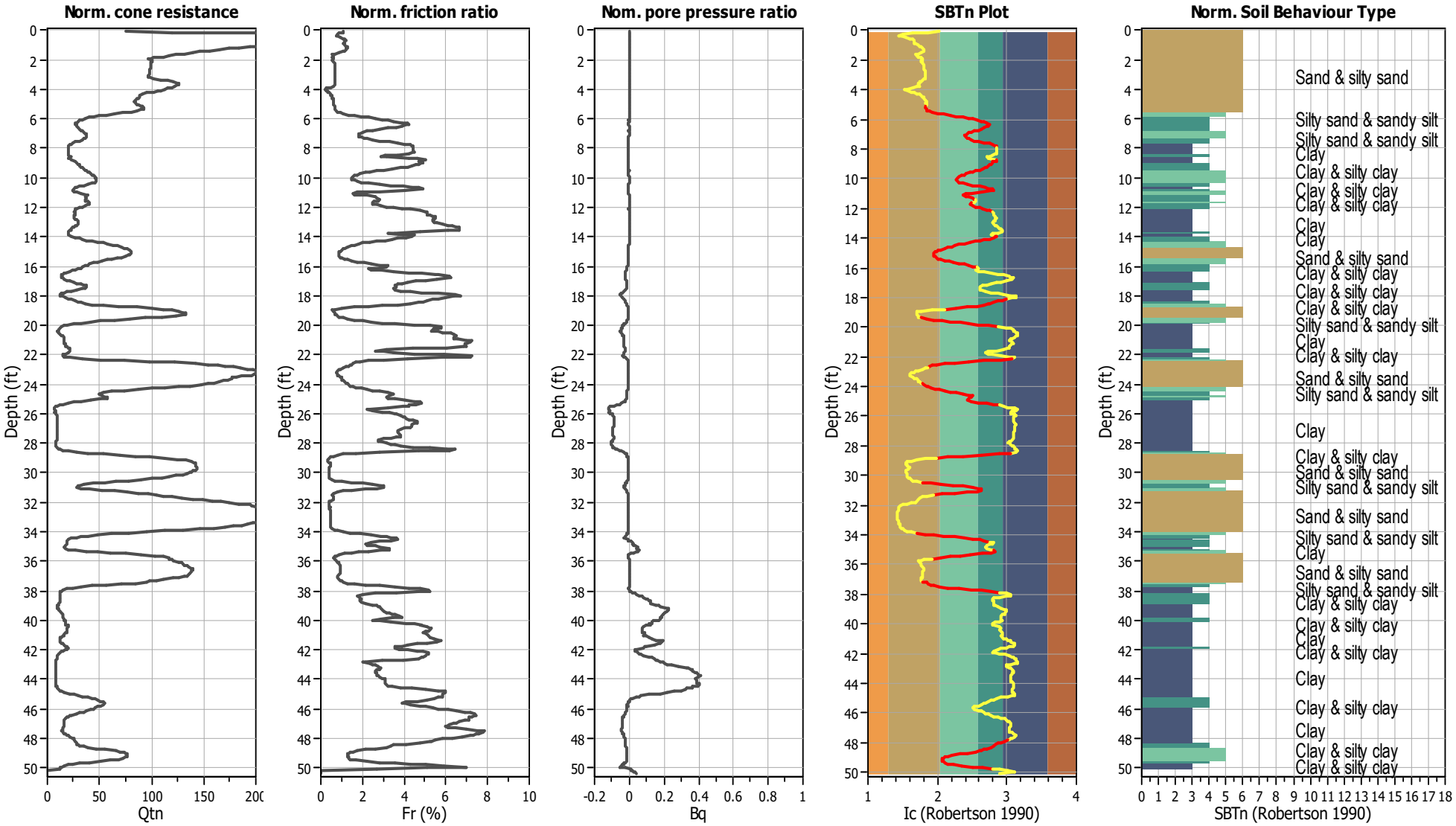

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**SBT legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## CPT basic interpretation plots (normalized)



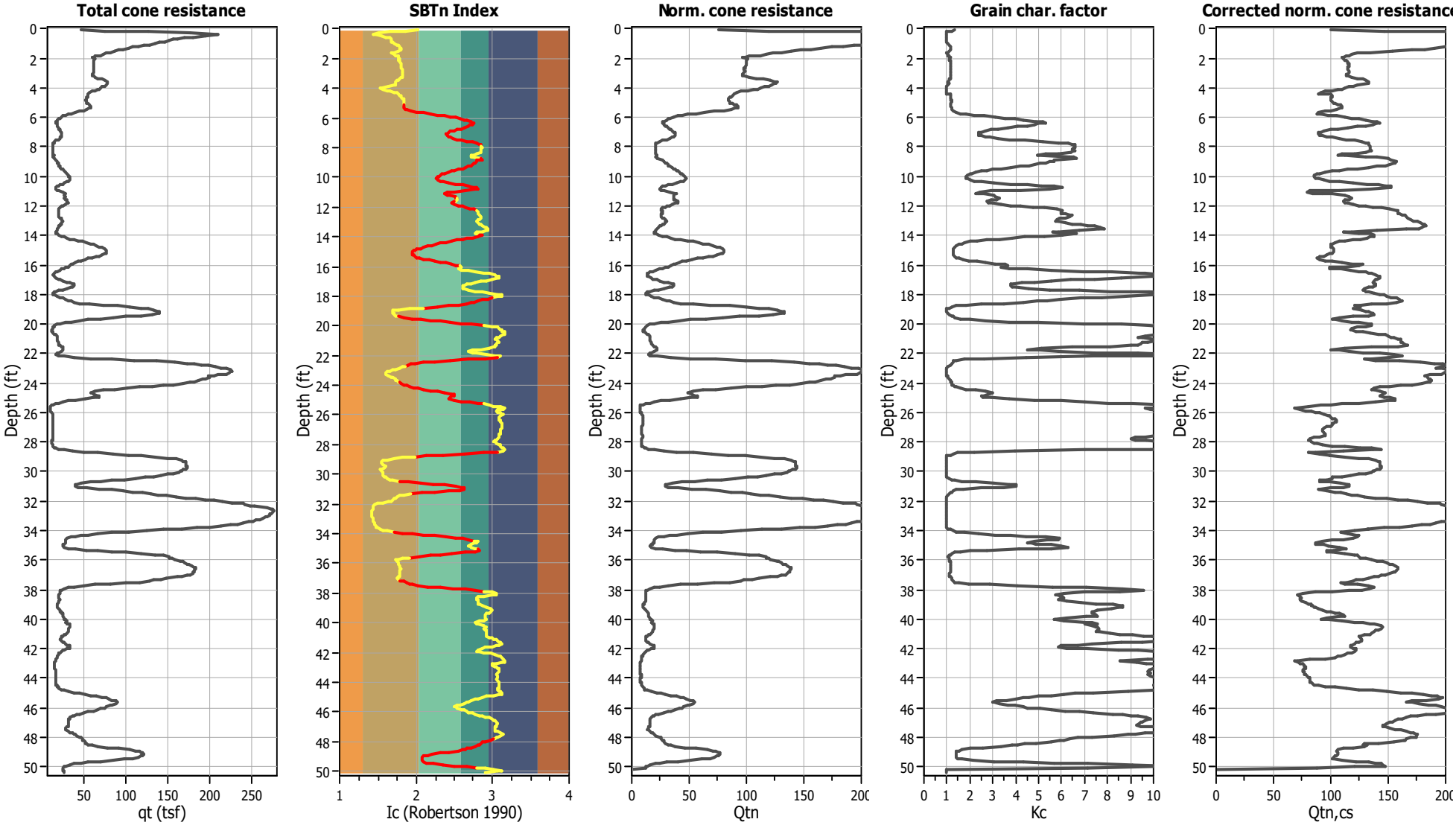

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

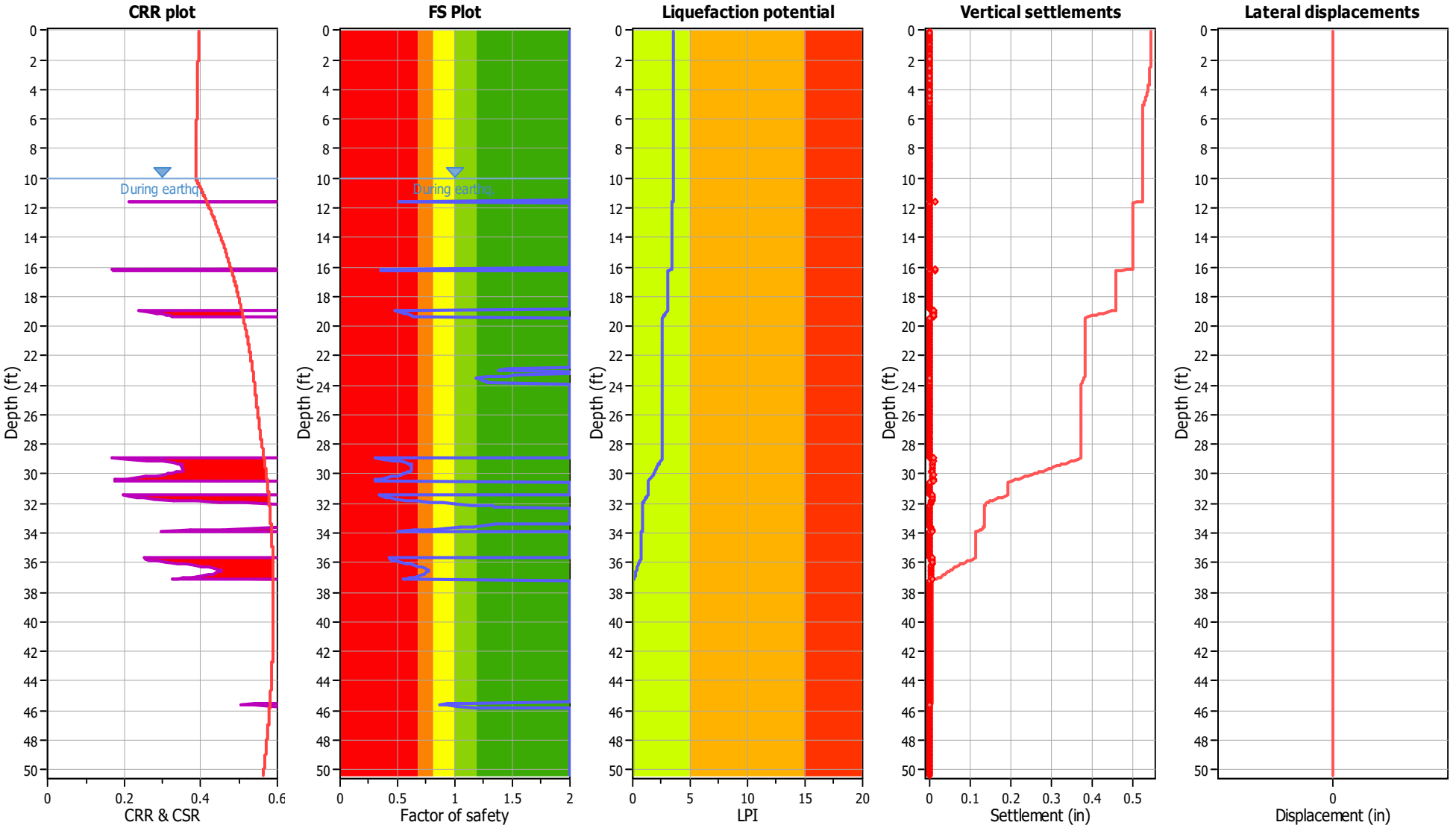
## Liquefaction analysis overall plots (intermediate results)




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

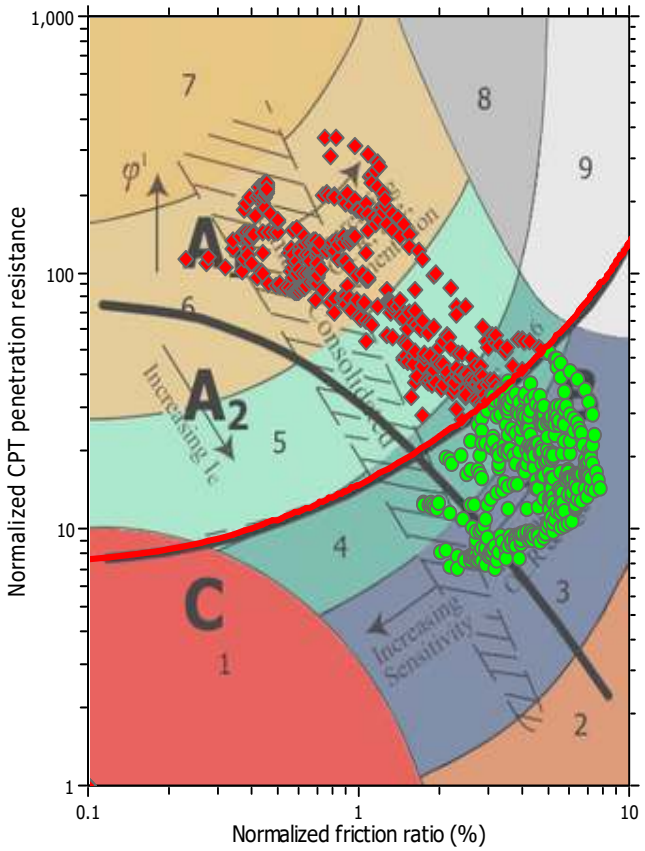
**F.S. color scheme**

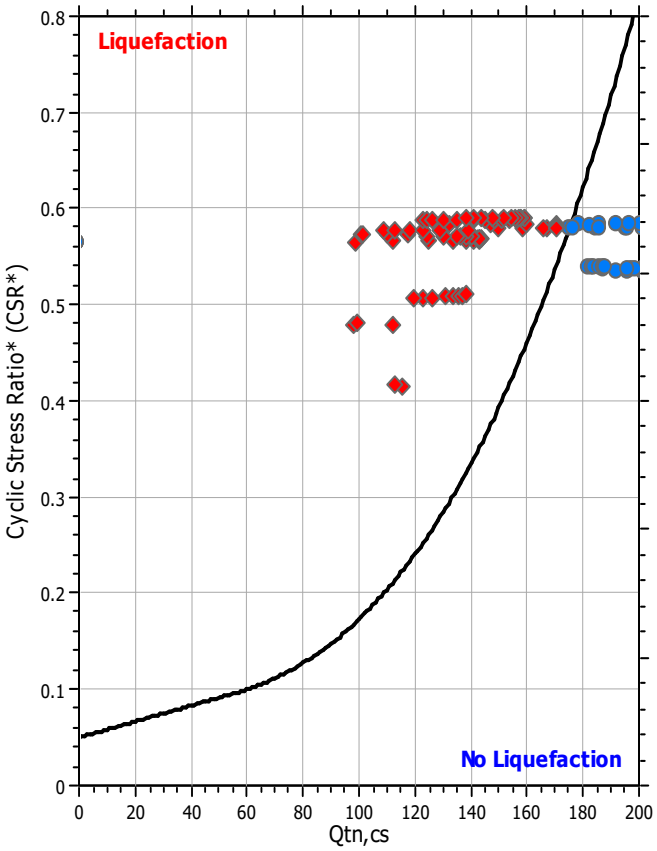
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

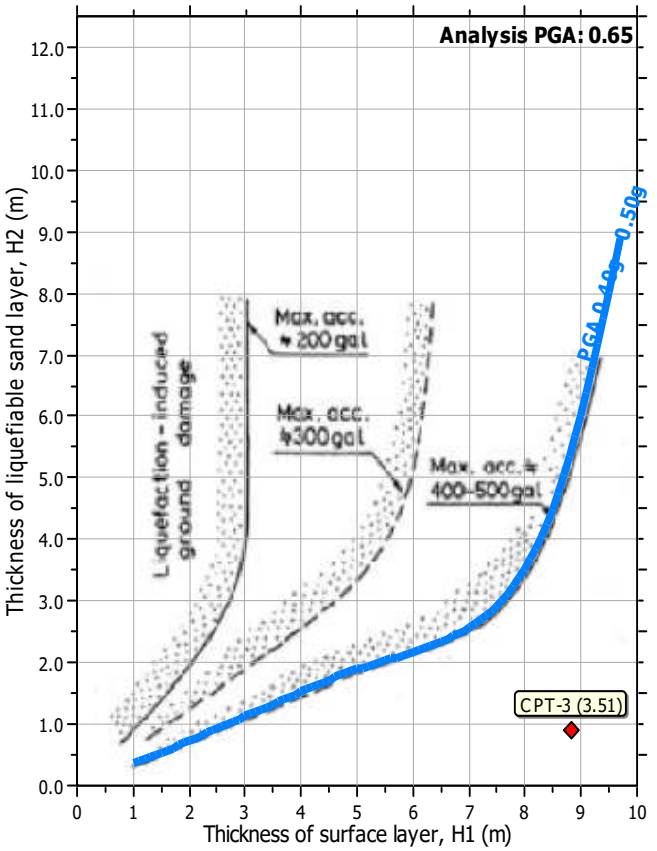
**LPI color scheme**

- Very high risk
- High risk
- Low risk

# Liquefaction analysis summary plots



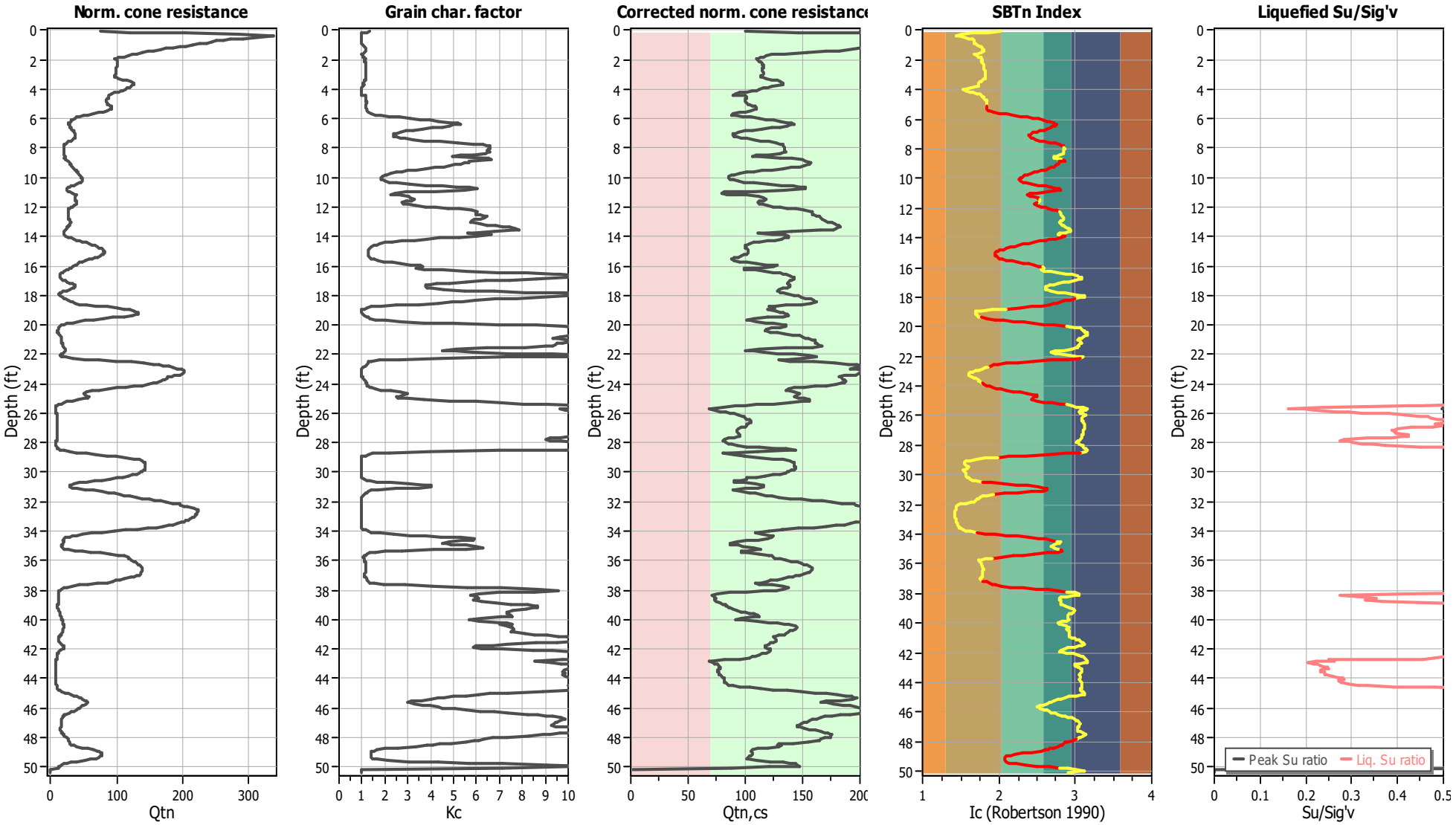




**Input parameters and analysis data**

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

## Check for strength loss plots (Robertson (2010))




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 10.00 ft | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 7.30 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.65 | Use fill: | No | Limit depth applied: | Yes |
| Depth to water table (insitu): | 17.00 ft | Fill height: | N/A | Limit depth: | 60.00 ft |

**:: Post-earthquake settlement of dry sands ::**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.07 | 2.02 | 75.22 | 1.33 | 99.67 | 21 | 544 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.15 | 1.87 | 120.01 | 1.22 | 145.83 | 29 | 717 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.21 | 1.65 | 203.44 | 1.00 | 203.44 | 37 | 925 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.27 | 1.51 | 284.70 | 1.00 | 284.70 | 50 | 1080 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.33 | 1.45 | 335.26 | 1.00 | 335.26 | 58 | 1172 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.40 | 1.48 | 337.08 | 1.00 | 337.08 | 58 | 1225 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.48 | 1.55 | 313.44 | 1.00 | 313.44 | 56 | 1247 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.54 | 1.61 | 289.69 | 1.00 | 289.69 | 52 | 1248 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.60 | 1.65 | 271.72 | 1.00 | 271.72 | 50 | 1236 | 0.39 | 0.001 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.67 | 1.67 | 260.46 | 1.00 | 260.46 | 48 | 1208 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.73 | 1.67 | 250.86 | 1.00 | 250.86 | 46 | 1168 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.79 | 1.67 | 243.20 | 1.00 | 243.20 | 45 | 1127 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.86 | 1.67 | 235.43 | 1.00 | 235.43 | 44 | 1096 | 0.39 | 0.002 | 0.00 | 13.34 | 0.00 | 0.000 |
| 0.92 | 1.69 | 225.99 | 1.00 | 225.99 | 42 | 1077 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.00 | 1.72 | 215.48 | 1.03 | 221.00 | 42 | 1063 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.06 | 1.75 | 204.97 | 1.08 | 221.51 | 42 | 1050 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.13 | 1.77 | 194.47 | 1.12 | 217.03 | 42 | 1026 | 0.39 | 0.003 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.19 | 1.79 | 184.22 | 1.14 | 209.31 | 40 | 990 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.26 | 1.80 | 174.32 | 1.15 | 200.04 | 39 | 948 | 0.39 | 0.004 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.32 | 1.80 | 164.87 | 1.16 | 190.64 | 37 | 906 | 0.39 | 0.005 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.39 | 1.81 | 155.74 | 1.16 | 181.43 | 35 | 864 | 0.39 | 0.005 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.45 | 1.81 | 146.96 | 1.16 | 170.56 | 33 | 811 | 0.39 | 0.006 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.51 | 1.76 | 139.04 | 1.11 | 153.78 | 29 | 727 | 0.39 | 0.008 | 0.00 | 13.34 | 0.00 | 0.000 |
| 1.58 | 1.72 | 131.02 | 1.02 | 133.86 | 25 | 645 | 0.39 | 0.010 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.66 | 1.68 | 123.61 | 1.00 | 123.61 | 23 | 584 | 0.39 | 0.012 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.72 | 1.71 | 116.96 | 1.01 | 117.72 | 22 | 571 | 0.39 | 0.013 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.79 | 1.72 | 112.03 | 1.04 | 116.16 | 22 | 557 | 0.39 | 0.015 | 0.01 | 13.34 | 0.01 | 0.000 |
| 1.85 | 1.77 | 102.64 | 1.11 | 113.77 | 22 | 538 | 0.39 | 0.017 | 0.02 | 13.34 | 0.01 | 0.000 |
| 1.91 | 1.78 | 99.18 | 1.12 | 111.45 | 21 | 527 | 0.39 | 0.018 | 0.02 | 13.34 | 0.02 | 0.000 |
| 1.99 | 1.78 | 96.74 | 1.13 | 109.77 | 21 | 519 | 0.39 | 0.020 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.05 | 1.76 | 100.64 | 1.10 | 110.81 | 21 | 524 | 0.39 | 0.020 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.11 | 1.77 | 100.18 | 1.12 | 111.80 | 21 | 528 | 0.39 | 0.021 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.17 | 1.78 | 99.97 | 1.13 | 113.23 | 22 | 536 | 0.39 | 0.021 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.24 | 1.79 | 99.86 | 1.15 | 114.35 | 22 | 542 | 0.39 | 0.021 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.30 | 1.80 | 99.80 | 1.15 | 115.08 | 22 | 546 | 0.39 | 0.022 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.36 | 1.81 | 99.65 | 1.16 | 115.46 | 22 | 549 | 0.39 | 0.023 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.43 | 1.81 | 99.44 | 1.16 | 115.57 | 22 | 550 | 0.39 | 0.023 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.51 | 1.81 | 99.08 | 1.16 | 115.34 | 22 | 549 | 0.39 | 0.025 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.58 | 1.81 | 98.67 | 1.17 | 115.00 | 22 | 548 | 0.39 | 0.026 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.64 | 1.81 | 98.31 | 1.17 | 114.76 | 22 | 547 | 0.39 | 0.027 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.70 | 1.82 | 98.05 | 1.17 | 114.73 | 22 | 548 | 0.39 | 0.028 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.76 | 1.82 | 98.14 | 1.17 | 115.06 | 22 | 550 | 0.39 | 0.028 | 0.02 | 13.34 | 0.02 | 0.000 |
| 2.83 | 1.82 | 98.39 | 1.17 | 115.51 | 22 | 552 | 0.39 | 0.029 | 0.03 | 13.34 | 0.02 | 0.000 |
| 2.89 | 1.82 | 98.54 | 1.17 | 115.75 | 23 | 554 | 0.39 | 0.030 | 0.03 | 13.34 | 0.02 | 0.000 |
| 2.96 | 1.82 | 98.02 | 1.18 | 115.41 | 22 | 553 | 0.39 | 0.031 | 0.03 | 13.34 | 0.02 | 0.000 |
| 3.04 | 1.83 | 96.90 | 1.18 | 114.49 | 22 | 549 | 0.39 | 0.033 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.10 | 1.83 | 96.38 | 1.18 | 113.84 | 22 | 546 | 0.39 | 0.034 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.16 | 1.83 | 96.28 | 1.18 | 113.66 | 22 | 545 | 0.39 | 0.036 | 0.03 | 13.34 | 0.03 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.22 | 1.82 | 98.04 | 1.17 | 115.12 | 22 | 551 | 0.39 | 0.036 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.29 | 1.81 | 102.30 | 1.16 | 118.77 | 23 | 565 | 0.39 | 0.035 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.37 | 1.79 | 108.13 | 1.14 | 123.30 | 24 | 584 | 0.39 | 0.033 | 0.03 | 13.34 | 0.02 | 0.000 |
| 3.43 | 1.77 | 115.22 | 1.11 | 127.77 | 24 | 604 | 0.39 | 0.031 | 0.02 | 13.34 | 0.02 | 0.000 |
| 3.49 | 1.75 | 120.54 | 1.08 | 130.64 | 25 | 619 | 0.39 | 0.030 | 0.02 | 13.34 | 0.02 | 0.000 |
| 3.55 | 1.74 | 124.80 | 1.06 | 132.32 | 25 | 630 | 0.39 | 0.030 | 0.02 | 13.34 | 0.02 | 0.000 |
| 3.62 | 1.73 | 126.26 | 1.05 | 133.14 | 25 | 635 | 0.39 | 0.030 | 0.02 | 13.34 | 0.02 | 0.000 |
| 3.68 | 1.73 | 126.11 | 1.06 | 133.26 | 25 | 635 | 0.39 | 0.031 | 0.02 | 13.34 | 0.02 | 0.000 |
| 3.75 | 1.74 | 124.58 | 1.07 | 132.94 | 25 | 632 | 0.39 | 0.032 | 0.02 | 13.34 | 0.02 | 0.000 |
| 3.81 | 1.71 | 121.99 | 1.01 | 123.14 | 23 | 596 | 0.39 | 0.038 | 0.03 | 13.34 | 0.03 | 0.000 |
| 3.89 | 1.64 | 118.93 | 1.00 | 118.93 | 22 | 532 | 0.39 | 0.054 | 0.05 | 13.34 | 0.04 | 0.000 |
| 3.96 | 1.55 | 115.78 | 1.00 | 115.78 | 21 | 464 | 0.39 | 0.088 | 0.09 | 13.34 | 0.08 | 0.001 |
| 4.02 | 1.53 | 112.68 | 1.00 | 112.68 | 20 | 439 | 0.39 | 0.113 | 0.11 | 13.34 | 0.10 | 0.001 |
| 4.08 | 1.57 | 109.38 | 1.00 | 109.38 | 20 | 450 | 0.39 | 0.106 | 0.11 | 13.34 | 0.10 | 0.001 |
| 4.15 | 1.62 | 105.98 | 1.00 | 105.98 | 19 | 460 | 0.39 | 0.100 | 0.11 | 13.34 | 0.09 | 0.001 |
| 4.21 | 1.66 | 101.58 | 1.00 | 101.58 | 19 | 466 | 0.39 | 0.098 | 0.11 | 13.34 | 0.09 | 0.001 |
| 4.27 | 1.71 | 95.49 | 1.00 | 95.49 | 18 | 468 | 0.39 | 0.099 | 0.11 | 13.34 | 0.10 | 0.001 |
| 4.33 | 1.75 | 91.17 | 1.00 | 91.17 | 17 | 468 | 0.39 | 0.102 | 0.12 | 13.34 | 0.11 | 0.001 |
| 4.40 | 1.77 | 88.65 | 1.00 | 88.65 | 17 | 470 | 0.39 | 0.104 | 0.13 | 13.34 | 0.11 | 0.001 |
| 4.48 | 1.78 | 88.79 | 1.13 | 100.29 | 19 | 474 | 0.39 | 0.104 | 0.11 | 13.34 | 0.10 | 0.001 |
| 4.54 | 1.80 | 87.92 | 1.15 | 100.94 | 19 | 479 | 0.39 | 0.103 | 0.11 | 13.34 | 0.09 | 0.001 |
| 4.60 | 1.81 | 86.85 | 1.16 | 101.13 | 20 | 482 | 0.39 | 0.104 | 0.11 | 13.34 | 0.09 | 0.001 |
| 4.67 | 1.82 | 85.42 | 1.18 | 100.61 | 20 | 482 | 0.39 | 0.107 | 0.11 | 13.34 | 0.10 | 0.001 |
| 4.74 | 1.83 | 84.35 | 1.19 | 100.03 | 20 | 481 | 0.39 | 0.111 | 0.11 | 13.34 | 0.10 | 0.001 |
| 4.81 | 1.84 | 83.84 | 1.19 | 99.73 | 20 | 481 | 0.39 | 0.114 | 0.12 | 13.34 | 0.10 | 0.001 |
| 4.87 | 1.84 | 84.34 | 1.19 | 100.21 | 20 | 483 | 0.39 | 0.115 | 0.12 | 13.34 | 0.10 | 0.001 |
| 4.94 | 1.84 | 84.80 | 1.19 | 100.83 | 20 | 486 | 0.39 | 0.116 | 0.12 | 13.34 | 0.10 | 0.001 |
| 5.01 | 1.84 | 85.86 | 1.19 | 102.04 | 20 | 492 | 0.39 | 0.114 | 0.11 | 13.34 | 0.10 | 0.001 |
| 5.07 | 1.83 | 87.37 | 1.19 | 103.78 | 20 | 500 | 0.39 | 0.110 | 0.11 | 13.34 | 0.09 | 0.001 |
| 5.13 | 1.83 | 89.54 | 1.19 | 106.21 | 21 | 511 | 0.39 | 0.104 | 0.10 | 13.34 | 0.09 | 0.001 |
| 5.20 | 1.83 | 91.57 | 1.19 | 108.59 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.26 | 1.83 | 92.68 | 1.19 | 110.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.33 | 1.84 | 92.32 | 1.19 | 110.03 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.40 | 1.85 | 90.39 | 1.20 | 108.62 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.47 | 1.88 | 86.02 | 1.22 | 105.34 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.54 | 1.93 | 79.97 | 1.26 | 100.57 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.61 | 2.00 | 72.20 | 1.31 | 94.56 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.67 | 2.09 | 63.78 | 1.40 | 89.58 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.74 | 2.18 | 55.91 | 1.57 | 88.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.79 | 2.28 | 49.26 | 1.85 | 90.91 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.86 | 2.37 | 44.28 | 2.21 | 97.84 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.93 | 2.45 | 39.91 | 2.64 | 105.32 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 5.99 | 2.52 | 36.20 | 3.12 | 112.79 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.06 | 2.58 | 33.31 | 3.55 | 118.23 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.13 | 2.62 | 31.38 | 3.96 | 124.20 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.19 | 2.66 | 30.00 | 4.33 | 130.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.25 | 2.72 | 27.96 | 4.89 | 136.78 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.31 | 2.75 | 27.04 | 5.20 | 140.67 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.37 | 2.76 | 26.73 | 5.32 | 142.18 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.43 | 2.73 | 27.84 | 5.03 | 139.99 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.50 | 2.71 | 28.50 | 4.80 | 136.74 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.56 | 2.68 | 29.20 | 4.48 | 130.95 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.63 | 2.64 | 30.11 | 4.07 | 122.65 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 6.72 | 2.59 | 31.22 | 3.65 | 114.03 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.79 | 2.54 | 32.63 | 3.24 | 105.87 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.85 | 2.49 | 34.09 | 2.92 | 99.60 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.92 | 2.45 | 35.51 | 2.66 | 94.48 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 6.98 | 2.42 | 36.67 | 2.48 | 91.05 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.05 | 2.40 | 37.52 | 2.38 | 89.32 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.12 | 2.40 | 37.97 | 2.35 | 89.22 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.18 | 2.40 | 37.97 | 2.38 | 90.49 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.25 | 2.42 | 37.46 | 2.48 | 92.94 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.31 | 2.45 | 36.39 | 2.65 | 96.52 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.38 | 2.48 | 35.16 | 2.87 | 100.98 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.45 | 2.53 | 33.13 | 3.22 | 106.73 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.51 | 2.60 | 30.54 | 3.71 | 113.36 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 7.57 | 2.67 | 27.28 | 4.42 | 120.59 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.64 | 2.74 | 24.43 | 5.19 | 126.70 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.71 | 2.80 | 22.45 | 5.82 | 130.72 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.76 | 2.83 | 21.18 | 6.27 | 132.86 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.83 | 2.85 | 20.61 | 6.47 | 133.37 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.89 | 2.86 | 20.30 | 6.57 | 133.47 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 7.96 | 2.86 | 20.20 | 6.61 | 133.60 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.02 | 2.86 | 20.29 | 6.59 | 133.76 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.09 | 2.85 | 20.49 | 6.53 | 133.89 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.15 | 2.85 | 20.69 | 6.49 | 134.31 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.22 | 2.86 | 20.63 | 6.57 | 135.57 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.29 | 2.85 | 20.58 | 6.52 | 134.24 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.35 | 2.84 | 20.37 | 6.40 | 130.30 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.42 | 2.80 | 20.47 | 5.87 | 120.16 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.49 | 2.75 | 20.71 | 5.28 | 109.39 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.55 | 2.72 | 21.52 | 4.91 | 105.64 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.62 | 2.73 | 22.52 | 4.99 | 112.50 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.68 | 2.84 | 20.49 | 6.35 | 130.12 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.73 | 2.85 | 21.50 | 6.53 | 140.50 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.79 | 2.86 | 22.56 | 6.64 | 149.81 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.88 | 2.79 | 26.71 | 5.69 | 151.92 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 8.94 | 2.78 | 27.67 | 5.67 | 156.80 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.00 | 2.77 | 28.63 | 5.51 | 157.61 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.07 | 2.75 | 29.64 | 5.28 | 156.50 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.14 | 2.73 | 30.64 | 5.04 | 154.33 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.20 | 2.71 | 31.44 | 4.82 | 151.55 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.27 | 2.69 | 32.20 | 4.58 | 147.45 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.33 | 2.65 | 33.30 | 4.23 | 140.72 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.40 | 2.60 | 34.92 | 3.79 | 132.49 | 0 | 0 | 0.39 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 9.46 | 2.55 | 36.42 | 3.38 | 123.16 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |

**:: Post-earthquake settlement of dry sands :: (continued)**

| Depth (ft) | Ic | $Q_{tn}$ | Kc | $Q_{tn,cs}$ | $N_{1,60}$ (blows) | $G_{max}$ (tsf) | CSR | Shear, γ (%) | $e_{vol(15)}$ (%) | $N_c$ | $e_v$ (%) | Settle. (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.53 | 2.50 | 38.13 | 3.01 | 114.85 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 9.60 | 2.46 | 39.45 | 2.73 | 107.62 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 9.66 | 2.42 | 40.80 | 2.47 | 100.93 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 9.72 | 2.38 | 41.97 | 2.27 | 95.19 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 9.79 | 2.34 | 43.16 | 2.10 | 90.63 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 9.85 | 2.32 | 44.17 | 1.98 | 87.60 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 9.92 | 2.29 | 45.11 | 1.90 | 85.93 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |
| 9.98 | 2.28 | 46.10 | 1.85 | 85.17 | 0 | 0 | 0.39 | 0.000 | 0.00 | 13.34 | 0.00 | 0.000 |

**Total estimated settlement: 0.02**

**Abbreviations**

$Q_{tn}$: Equivalent clean sand normalized cone resistance
$K_c$: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
$G_{max}$: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
$N_c$: Equivalent number of cycles
$e_v$: Volumetric strain
Settle.: Calculated settlement

**:: Post-earthquake settlement due to soil liquefaction ::**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.04 | 85.29 | 2.00 | 0.00 | 0.83 | 0.00 | 10.11 | 86.54 | 2.00 | 0.00 | 0.83 | 0.00 |
| 10.18 | 89.33 | 2.00 | 0.00 | 0.83 | 0.00 | 10.25 | 93.30 | 2.00 | 0.00 | 0.83 | 0.00 |
| 10.31 | 99.04 | 2.00 | 0.00 | 0.83 | 0.00 | 10.37 | 107.89 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.44 | 119.51 | 2.00 | 0.00 | 0.82 | 0.00 | 10.50 | 131.70 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.57 | 141.70 | 2.00 | 0.00 | 0.82 | 0.00 | 10.64 | 147.92 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.70 | 152.09 | 2.00 | 0.00 | 0.82 | 0.00 | 10.76 | 152.78 | 2.00 | 0.00 | 0.82 | 0.00 |
| 10.83 | 134.18 | 2.00 | 0.00 | 0.82 | 0.00 | 10.92 | 107.86 | 2.00 | 0.00 | 0.81 | 0.00 |
| 10.99 | 81.61 | 2.00 | 0.00 | 0.81 | 0.00 | 11.02 | 79.72 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.12 | 83.58 | 2.00 | 0.00 | 0.81 | 0.00 | 11.16 | 92.88 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.22 | 101.32 | 2.00 | 0.00 | 0.81 | 0.00 | 11.29 | 111.67 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.38 | 115.47 | 2.00 | 0.00 | 0.81 | 0.00 | 11.44 | 118.59 | 2.00 | 0.00 | 0.81 | 0.00 |
| 11.51 | 118.17 | 2.00 | 0.00 | 0.80 | 0.00 | 11.57 | 115.70 | 0.54 | 1.67 | 0.80 | 0.01 |
| 11.63 | 112.47 | 0.51 | 1.70 | 0.80 | 0.01 | 11.70 | 110.77 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.77 | 111.88 | 2.00 | 0.00 | 0.80 | 0.00 | 11.83 | 115.19 | 2.00 | 0.00 | 0.80 | 0.00 |
| 11.90 | 119.41 | 2.00 | 0.00 | 0.80 | 0.00 | 11.96 | 124.43 | 2.00 | 0.00 | 0.80 | 0.00 |
| 12.02 | 130.01 | 2.00 | 0.00 | 0.80 | 0.00 | 12.09 | 136.91 | 2.00 | 0.00 | 0.80 | 0.00 |
| 12.15 | 143.99 | 2.00 | 0.00 | 0.79 | 0.00 | 12.22 | 151.49 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.29 | 156.78 | 2.00 | 0.00 | 0.79 | 0.00 | 12.35 | 159.00 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.42 | 159.12 | 2.00 | 0.00 | 0.79 | 0.00 | 12.48 | 159.11 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.54 | 160.23 | 2.00 | 0.00 | 0.79 | 0.00 | 12.61 | 162.35 | 2.00 | 0.00 | 0.79 | 0.00 |
| 12.68 | 164.41 | 2.00 | 0.00 | 0.79 | 0.00 | 12.74 | 165.96 | 2.00 | 0.00 | 0.78 | 0.00 |
| 12.81 | 166.80 | 2.00 | 0.00 | 0.78 | 0.00 | 12.87 | 167.33 | 2.00 | 0.00 | 0.78 | 0.00 |
| 12.94 | 169.08 | 2.00 | 0.00 | 0.78 | 0.00 | 13.00 | 171.79 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.07 | 175.48 | 2.00 | 0.00 | 0.78 | 0.00 | 13.14 | 178.52 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.20 | 180.80 | 2.00 | 0.00 | 0.78 | 0.00 | 13.27 | 182.22 | 2.00 | 0.00 | 0.78 | 0.00 |
| 13.33 | 182.83 | 2.00 | 0.00 | 0.77 | 0.00 | 13.40 | 182.07 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.46 | 179.79 | 2.00 | 0.00 | 0.77 | 0.00 | 13.53 | 177.01 | 2.00 | 0.00 | 0.77 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.60 | 165.66 | 2.00 | 0.00 | 0.77 | 0.00 | 13.66 | 140.59 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.72 | 117.83 | 2.00 | 0.00 | 0.77 | 0.00 | 13.78 | 110.86 | 2.00 | 0.00 | 0.77 | 0.00 |
| 13.85 | 124.30 | 2.00 | 0.00 | 0.77 | 0.00 | 13.92 | 134.74 | 2.00 | 0.00 | 0.76 | 0.00 |
| 13.98 | 138.06 | 2.00 | 0.00 | 0.76 | 0.00 | 14.06 | 137.63 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.12 | 134.31 | 2.00 | 0.00 | 0.76 | 0.00 | 14.18 | 131.34 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.24 | 126.00 | 2.00 | 0.00 | 0.76 | 0.00 | 14.31 | 118.97 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.38 | 112.02 | 2.00 | 0.00 | 0.76 | 0.00 | 14.44 | 106.88 | 2.00 | 0.00 | 0.76 | 0.00 |
| 14.50 | 103.49 | 2.00 | 0.00 | 0.75 | 0.00 | 14.57 | 101.45 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.64 | 100.44 | 2.00 | 0.00 | 0.75 | 0.00 | 14.70 | 100.14 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.77 | 100.41 | 2.00 | 0.00 | 0.75 | 0.00 | 14.84 | 101.18 | 2.00 | 0.00 | 0.75 | 0.00 |
| 14.90 | 102.07 | 2.00 | 0.00 | 0.75 | 0.00 | 14.96 | 102.78 | 2.00 | 0.00 | 0.75 | 0.00 |
| 15.03 | 102.98 | 2.00 | 0.00 | 0.75 | 0.00 | 15.12 | 102.33 | 2.00 | 0.00 | 0.74 | 0.00 |
| 15.19 | 101.05 | 2.00 | 0.00 | 0.74 | 0.00 | 15.25 | 99.09 | 2.00 | 0.00 | 0.74 | 0.00 |
| 15.31 | 96.62 | 2.00 | 0.00 | 0.74 | 0.00 | 15.38 | 93.67 | 2.00 | 0.00 | 0.74 | 0.00 |
| 15.45 | 90.67 | 2.00 | 0.00 | 0.74 | 0.00 | 15.51 | 88.44 | 2.00 | 0.00 | 0.74 | 0.00 |
| 15.57 | 88.00 | 2.00 | 0.00 | 0.74 | 0.00 | 15.64 | 90.07 | 2.00 | 0.00 | 0.73 | 0.00 |
| 15.70 | 94.67 | 2.00 | 0.00 | 0.73 | 0.00 | 15.77 | 101.45 | 2.00 | 0.00 | 0.73 | 0.00 |
| 15.83 | 109.78 | 2.00 | 0.00 | 0.73 | 0.00 | 15.90 | 118.71 | 2.00 | 0.00 | 0.73 | 0.00 |
| 15.96 | 128.27 | 2.00 | 0.00 | 0.73 | 0.00 | 16.03 | 124.28 | 2.00 | 0.00 | 0.73 | 0.00 |
| 16.10 | 112.23 | 0.44 | 1.55 | 0.73 | 0.01 | 16.17 | 98.28 | 0.35 | 1.72 | 0.73 | 0.01 |
| 16.23 | 99.30 | 0.36 | 1.70 | 0.72 | 0.01 | 16.30 | 108.53 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.36 | 117.25 | 2.00 | 0.00 | 0.72 | 0.00 | 16.43 | 124.80 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.47 | 130.07 | 2.00 | 0.00 | 0.72 | 0.00 | 16.55 | 133.41 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.62 | 134.95 | 2.00 | 0.00 | 0.72 | 0.00 | 16.69 | 138.61 | 2.00 | 0.00 | 0.72 | 0.00 |
| 16.75 | 141.07 | 2.00 | 0.00 | 0.72 | 0.00 | 16.82 | 143.16 | 2.00 | 0.00 | 0.71 | 0.00 |
| 16.88 | 142.43 | 2.00 | 0.00 | 0.71 | 0.00 | 16.95 | 140.50 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.01 | 139.00 | 2.00 | 0.00 | 0.71 | 0.00 | 17.07 | 137.80 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.14 | 137.12 | 2.00 | 0.00 | 0.71 | 0.00 | 17.21 | 137.09 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.27 | 138.00 | 2.00 | 0.00 | 0.71 | 0.00 | 17.34 | 139.11 | 2.00 | 0.00 | 0.71 | 0.00 |
| 17.40 | 139.47 | 2.00 | 0.00 | 0.71 | 0.00 | 17.46 | 136.92 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.53 | 132.76 | 2.00 | 0.00 | 0.70 | 0.00 | 17.60 | 129.38 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.67 | 128.37 | 2.00 | 0.00 | 0.70 | 0.00 | 17.73 | 128.83 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.80 | 129.90 | 2.00 | 0.00 | 0.70 | 0.00 | 17.86 | 132.97 | 2.00 | 0.00 | 0.70 | 0.00 |
| 17.93 | 137.53 | 2.00 | 0.00 | 0.70 | 0.00 | 17.99 | 142.47 | 2.00 | 0.00 | 0.70 | 0.00 |
| 18.05 | 145.96 | 2.00 | 0.00 | 0.69 | 0.00 | 18.12 | 149.32 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.18 | 153.00 | 2.00 | 0.00 | 0.69 | 0.00 | 18.25 | 156.72 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.31 | 159.71 | 2.00 | 0.00 | 0.69 | 0.00 | 18.41 | 161.17 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.44 | 161.64 | 2.00 | 0.00 | 0.69 | 0.00 | 18.50 | 157.47 | 2.00 | 0.00 | 0.69 | 0.00 |
| 18.60 | 148.52 | 2.00 | 0.00 | 0.68 | 0.00 | 18.66 | 135.41 | 2.00 | 0.00 | 0.68 | 0.00 |
| 18.73 | 125.74 | 2.00 | 0.00 | 0.68 | 0.00 | 18.79 | 121.06 | 2.00 | 0.00 | 0.68 | 0.00 |
| 18.85 | 125.04 | 2.00 | 0.00 | 0.68 | 0.00 | 18.92 | 123.11 | 0.50 | 1.34 | 0.68 | 0.01 |
| 18.98 | 119.45 | 0.47 | 1.37 | 0.68 | 0.01 | 19.05 | 126.43 | 0.53 | 1.31 | 0.68 | 0.01 |
| 19.11 | 130.55 | 0.56 | 1.27 | 0.68 | 0.01 | 19.17 | 133.38 | 0.59 | 1.25 | 0.68 | 0.01 |
| 19.24 | 135.53 | 0.61 | 1.23 | 0.67 | 0.01 | 19.30 | 137.07 | 0.63 | 1.21 | 0.67 | 0.01 |
| 19.36 | 138.11 | 0.64 | 1.20 | 0.67 | 0.01 | 19.45 | 132.48 | 2.00 | 0.00 | 0.67 | 0.00 |
| 19.52 | 119.78 | 2.00 | 0.00 | 0.67 | 0.00 | 19.58 | 107.80 | 2.00 | 0.00 | 0.67 | 0.00 |
| 19.65 | 101.57 | 2.00 | 0.00 | 0.67 | 0.00 | 19.71 | 103.20 | 2.00 | 0.00 | 0.67 | 0.00 |
| 19.77 | 109.17 | 2.00 | 0.00 | 0.66 | 0.00 | 19.84 | 117.85 | 2.00 | 0.00 | 0.66 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.90 | 124.76 | 2.00 | 0.00 | 0.66 | 0.00 | 19.96 | 132.48 | 2.00 | 0.00 | 0.66 | 0.00 |
| 20.02 | 135.53 | 2.00 | 0.00 | 0.66 | 0.00 | 20.09 | 134.99 | 2.00 | 0.00 | 0.66 | 0.00 |
| 20.16 | 130.24 | 2.00 | 0.00 | 0.66 | 0.00 | 20.23 | 123.40 | 2.00 | 0.00 | 0.66 | 0.00 |
| 20.30 | 118.77 | 2.00 | 0.00 | 0.66 | 0.00 | 20.36 | 116.65 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.42 | 118.52 | 2.00 | 0.00 | 0.65 | 0.00 | 20.49 | 122.00 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.56 | 127.82 | 2.00 | 0.00 | 0.65 | 0.00 | 20.63 | 134.58 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.69 | 141.38 | 2.00 | 0.00 | 0.65 | 0.00 | 20.75 | 147.02 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.82 | 150.42 | 2.00 | 0.00 | 0.65 | 0.00 | 20.88 | 152.46 | 2.00 | 0.00 | 0.65 | 0.00 |
| 20.94 | 155.41 | 2.00 | 0.00 | 0.65 | 0.00 | 21.01 | 158.60 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.07 | 161.01 | 2.00 | 0.00 | 0.64 | 0.00 | 21.14 | 161.30 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.20 | 161.12 | 2.00 | 0.00 | 0.64 | 0.00 | 21.27 | 161.80 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.33 | 163.76 | 2.00 | 0.00 | 0.64 | 0.00 | 21.39 | 165.85 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.46 | 167.08 | 2.00 | 0.00 | 0.64 | 0.00 | 21.52 | 159.13 | 2.00 | 0.00 | 0.64 | 0.00 |
| 21.59 | 135.51 | 2.00 | 0.00 | 0.63 | 0.00 | 21.66 | 112.27 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.72 | 99.78 | 2.00 | 0.00 | 0.63 | 0.00 | 21.79 | 107.56 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.85 | 115.78 | 2.00 | 0.00 | 0.63 | 0.00 | 21.92 | 127.97 | 2.00 | 0.00 | 0.63 | 0.00 |
| 21.99 | 142.40 | 2.00 | 0.00 | 0.63 | 0.00 | 22.07 | 155.19 | 2.00 | 0.00 | 0.63 | 0.00 |
| 22.13 | 162.53 | 2.00 | 0.00 | 0.62 | 0.00 | 22.20 | 161.99 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.26 | 150.26 | 2.00 | 0.00 | 0.62 | 0.00 | 22.33 | 134.84 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.39 | 129.11 | 2.00 | 0.00 | 0.62 | 0.00 | 22.46 | 139.63 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.52 | 159.39 | 2.00 | 0.00 | 0.62 | 0.00 | 22.59 | 177.76 | 2.00 | 0.00 | 0.62 | 0.00 |
| 22.65 | 190.03 | 2.00 | 0.00 | 0.62 | 0.00 | 22.71 | 197.37 | 2.00 | 0.00 | 0.61 | 0.00 |
| 22.78 | 201.40 | 2.00 | 0.00 | 0.61 | 0.00 | 22.85 | 201.63 | 2.00 | 0.00 | 0.61 | 0.00 |
| 22.91 | 195.78 | 1.45 | 0.00 | 0.61 | 0.00 | 22.97 | 192.02 | 1.38 | 0.00 | 0.61 | 0.00 |
| 23.04 | 197.48 | 1.49 | 0.00 | 0.61 | 0.00 | 23.11 | 201.19 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.17 | 202.55 | 2.00 | 0.00 | 0.61 | 0.00 | 23.24 | 201.59 | 2.00 | 0.00 | 0.61 | 0.00 |
| 23.30 | 198.99 | 1.51 | 0.00 | 0.61 | 0.00 | 23.37 | 195.88 | 1.45 | 0.00 | 0.60 | 0.00 |
| 23.43 | 187.05 | 1.28 | 0.11 | 0.60 | 0.00 | 23.50 | 181.82 | 1.19 | 0.16 | 0.60 | 0.00 |
| 23.57 | 183.11 | 1.21 | 0.16 | 0.60 | 0.00 | 23.63 | 184.07 | 1.22 | 0.16 | 0.60 | 0.00 |
| 23.70 | 185.60 | 1.25 | 0.11 | 0.60 | 0.00 | 23.76 | 187.02 | 1.28 | 0.11 | 0.60 | 0.00 |
| 23.82 | 187.62 | 1.29 | 0.11 | 0.60 | 0.00 | 23.89 | 186.90 | 2.00 | 0.00 | 0.60 | 0.00 |
| 23.96 | 184.24 | 2.00 | 0.00 | 0.59 | 0.00 | 24.03 | 179.10 | 2.00 | 0.00 | 0.59 | 0.00 |
| 24.09 | 171.23 | 2.00 | 0.00 | 0.59 | 0.00 | 24.16 | 161.31 | 2.00 | 0.00 | 0.59 | 0.00 |
| 24.23 | 151.10 | 2.00 | 0.00 | 0.59 | 0.00 | 24.29 | 142.67 | 2.00 | 0.00 | 0.59 | 0.00 |
| 24.36 | 137.53 | 2.00 | 0.00 | 0.59 | 0.00 | 24.42 | 135.95 | 2.00 | 0.00 | 0.59 | 0.00 |
| 24.49 | 138.01 | 2.00 | 0.00 | 0.58 | 0.00 | 24.56 | 142.97 | 2.00 | 0.00 | 0.58 | 0.00 |
| 24.63 | 147.11 | 2.00 | 0.00 | 0.58 | 0.00 | 24.69 | 147.16 | 2.00 | 0.00 | 0.58 | 0.00 |
| 24.75 | 144.73 | 2.00 | 0.00 | 0.58 | 0.00 | 24.82 | 142.90 | 2.00 | 0.00 | 0.58 | 0.00 |
| 24.89 | 143.29 | 2.00 | 0.00 | 0.58 | 0.00 | 24.95 | 146.13 | 2.00 | 0.00 | 0.58 | 0.00 |
| 25.01 | 150.89 | 2.00 | 0.00 | 0.58 | 0.00 | 25.08 | 155.49 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.14 | 155.95 | 2.00 | 0.00 | 0.57 | 0.00 | 25.21 | 150.45 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.28 | 139.27 | 2.00 | 0.00 | 0.57 | 0.00 | 25.34 | 123.96 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.41 | 109.29 | 2.00 | 0.00 | 0.57 | 0.00 | 25.48 | 100.42 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.54 | 91.20 | 2.00 | 0.00 | 0.57 | 0.00 | 25.61 | 80.46 | 2.00 | 0.00 | 0.57 | 0.00 |
| 25.68 | 69.91 | 2.00 | 0.00 | 0.56 | 0.00 | 25.75 | 68.77 | 2.00 | 0.00 | 0.56 | 0.00 |
| 25.81 | 73.45 | 2.00 | 0.00 | 0.56 | 0.00 | 25.88 | 78.12 | 2.00 | 0.00 | 0.56 | 0.00 |
| 25.92 | 82.37 | 2.00 | 0.00 | 0.56 | 0.00 | 25.99 | 86.78 | 2.00 | 0.00 | 0.56 | 0.00 |
| 26.05 | 90.56 | 2.00 | 0.00 | 0.56 | 0.00 | 26.13 | 94.51 | 2.00 | 0.00 | 0.56 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26.19 | 97.17 | 2.00 | 0.00 | 0.56 | 0.00 | 26.25 | 98.82 | 2.00 | 0.00 | 0.56 | 0.00 |
| 26.34 | 100.03 | 2.00 | 0.00 | 0.55 | 0.00 | 26.40 | 101.61 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.47 | 103.77 | 2.00 | 0.00 | 0.55 | 0.00 | 26.53 | 105.44 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.60 | 105.24 | 2.00 | 0.00 | 0.55 | 0.00 | 26.66 | 103.50 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.73 | 101.95 | 2.00 | 0.00 | 0.55 | 0.00 | 26.79 | 101.78 | 2.00 | 0.00 | 0.55 | 0.00 |
| 26.85 | 101.72 | 2.00 | 0.00 | 0.54 | 0.00 | 26.91 | 99.98 | 2.00 | 0.00 | 0.54 | 0.00 |
| 26.98 | 96.79 | 2.00 | 0.00 | 0.54 | 0.00 | 27.04 | 94.01 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.11 | 92.59 | 2.00 | 0.00 | 0.54 | 0.00 | 27.18 | 92.48 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.24 | 92.41 | 2.00 | 0.00 | 0.54 | 0.00 | 27.31 | 92.61 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.37 | 93.57 | 2.00 | 0.00 | 0.54 | 0.00 | 27.43 | 94.63 | 2.00 | 0.00 | 0.54 | 0.00 |
| 27.53 | 95.04 | 2.00 | 0.00 | 0.53 | 0.00 | 27.59 | 93.55 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.65 | 90.20 | 2.00 | 0.00 | 0.53 | 0.00 | 27.72 | 85.45 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.79 | 81.21 | 2.00 | 0.00 | 0.53 | 0.00 | 27.85 | 79.93 | 2.00 | 0.00 | 0.53 | 0.00 |
| 27.92 | 81.13 | 2.00 | 0.00 | 0.53 | 0.00 | 27.98 | 83.41 | 2.00 | 0.00 | 0.53 | 0.00 |
| 28.05 | 85.56 | 2.00 | 0.00 | 0.52 | 0.00 | 28.11 | 88.30 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.18 | 92.83 | 2.00 | 0.00 | 0.52 | 0.00 | 28.25 | 101.10 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.31 | 112.75 | 2.00 | 0.00 | 0.52 | 0.00 | 28.37 | 125.01 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.42 | 135.84 | 2.00 | 0.00 | 0.52 | 0.00 | 28.49 | 143.31 | 2.00 | 0.00 | 0.52 | 0.00 |
| 28.55 | 137.05 | 2.00 | 0.00 | 0.52 | 0.00 | 28.62 | 110.56 | 2.00 | 0.00 | 0.51 | 0.00 |
| 28.69 | 86.09 | 2.00 | 0.00 | 0.51 | 0.00 | 28.76 | 80.18 | 2.00 | 0.00 | 0.51 | 0.00 |
| 28.82 | 89.97 | 2.00 | 0.00 | 0.51 | 0.00 | 28.88 | 100.23 | 2.00 | 0.00 | 0.51 | 0.00 |
| 28.95 | 98.61 | 0.30 | 1.20 | 0.51 | 0.01 | 29.01 | 112.41 | 0.37 | 1.08 | 0.51 | 0.01 |
| 29.08 | 124.75 | 0.46 | 0.99 | 0.51 | 0.01 | 29.14 | 133.34 | 0.53 | 0.93 | 0.51 | 0.01 |
| 29.21 | 138.58 | 0.58 | 0.90 | 0.50 | 0.01 | 29.28 | 140.87 | 0.60 | 0.89 | 0.50 | 0.01 |
| 29.34 | 142.87 | 0.62 | 0.88 | 0.50 | 0.01 | 29.41 | 142.71 | 0.62 | 0.88 | 0.50 | 0.01 |
| 29.49 | 142.54 | 0.61 | 0.87 | 0.50 | 0.01 | 29.54 | 142.77 | 0.62 | 0.87 | 0.50 | 0.01 |
| 29.61 | 143.08 | 0.62 | 0.87 | 0.50 | 0.01 | 29.66 | 143.43 | 0.62 | 0.86 | 0.50 | 0.01 |
| 29.74 | 143.57 | 0.62 | 0.86 | 0.50 | 0.01 | 29.81 | 142.79 | 0.62 | 0.86 | 0.49 | 0.01 |
| 29.86 | 139.94 | 0.59 | 0.88 | 0.49 | 0.01 | 29.93 | 138.09 | 0.57 | 0.88 | 0.49 | 0.01 |
| 29.99 | 136.31 | 0.55 | 0.89 | 0.49 | 0.01 | 30.08 | 134.83 | 0.54 | 0.90 | 0.49 | 0.01 |
| 30.15 | 130.02 | 0.50 | 0.92 | 0.49 | 0.01 | 30.21 | 123.92 | 0.45 | 0.96 | 0.49 | 0.01 |
| 30.28 | 117.20 | 0.40 | 1.00 | 0.49 | 0.01 | 30.34 | 109.87 | 0.36 | 1.05 | 0.49 | 0.01 |
| 30.41 | 100.69 | 0.31 | 1.13 | 0.48 | 0.01 | 30.47 | 101.42 | 0.31 | 1.12 | 0.48 | 0.01 |
| 30.54 | 96.61 | 2.00 | 0.00 | 0.48 | 0.00 | 30.60 | 90.05 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.67 | 90.77 | 2.00 | 0.00 | 0.48 | 0.00 | 30.73 | 98.76 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.80 | 108.18 | 2.00 | 0.00 | 0.48 | 0.00 | 30.86 | 114.03 | 2.00 | 0.00 | 0.48 | 0.00 |
| 30.93 | 115.98 | 2.00 | 0.00 | 0.48 | 0.00 | 30.99 | 115.92 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.06 | 110.81 | 2.00 | 0.00 | 0.47 | 0.00 | 31.12 | 100.21 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.18 | 89.94 | 2.00 | 0.00 | 0.47 | 0.00 | 31.25 | 89.60 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.32 | 96.49 | 2.00 | 0.00 | 0.47 | 0.00 | 31.39 | 103.48 | 2.00 | 0.00 | 0.47 | 0.00 |
| 31.45 | 108.40 | 0.34 | 1.02 | 0.47 | 0.01 | 31.52 | 112.91 | 0.37 | 0.99 | 0.47 | 0.01 |
| 31.59 | 118.07 | 0.40 | 0.95 | 0.46 | 0.01 | 31.65 | 122.82 | 0.44 | 0.92 | 0.46 | 0.01 |
| 31.72 | 128.98 | 0.48 | 0.88 | 0.46 | 0.01 | 31.78 | 138.96 | 0.57 | 0.82 | 0.46 | 0.01 |
| 31.85 | 149.34 | 0.67 | 0.64 | 0.46 | 0.01 | 31.91 | 158.50 | 0.78 | 0.48 | 0.46 | 0.00 |
| 31.98 | 166.87 | 0.88 | 0.34 | 0.46 | 0.00 | 32.04 | 175.13 | 1.00 | 0.24 | 0.46 | 0.00 |
| 32.11 | 184.54 | 1.15 | 0.17 | 0.46 | 0.00 | 32.18 | 195.15 | 1.33 | 0.08 | 0.45 | 0.00 |
| 32.24 | 196.04 | 1.35 | 0.08 | 0.45 | 0.00 | 32.30 | 201.65 | 2.00 | 0.00 | 0.45 | 0.00 |
| 32.36 | 205.69 | 2.00 | 0.00 | 0.45 | 0.00 | 32.44 | 217.39 | 2.00 | 0.00 | 0.45 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 32.50 | 221.28 | 2.00 | 0.00 | 0.45 | 0.00 | 32.57 | 222.89 | 2.00 | 0.00 | 0.45 | 0.00 |
| 32.63 | 223.44 | 2.00 | 0.00 | 0.45 | 0.00 | 32.70 | 222.99 | 2.00 | 0.00 | 0.45 | 0.00 |
| 32.77 | 221.89 | 2.00 | 0.00 | 0.44 | 0.00 | 32.84 | 220.54 | 2.00 | 0.00 | 0.44 | 0.00 |
| 32.88 | 219.32 | 2.00 | 0.00 | 0.44 | 0.00 | 32.94 | 218.11 | 2.00 | 0.00 | 0.44 | 0.00 |
| 33.03 | 216.33 | 2.00 | 0.00 | 0.44 | 0.00 | 33.10 | 214.15 | 2.00 | 0.00 | 0.44 | 0.00 |
| 33.16 | 211.16 | 2.00 | 0.00 | 0.44 | 0.00 | 33.23 | 208.08 | 2.00 | 0.00 | 0.44 | 0.00 |
| 33.29 | 204.56 | 2.00 | 0.00 | 0.44 | 0.00 | 33.36 | 200.95 | 2.00 | 0.00 | 0.43 | 0.00 |
| 33.42 | 196.71 | 1.35 | 0.00 | 0.43 | 0.00 | 33.49 | 191.89 | 1.26 | 0.08 | 0.43 | 0.00 |
| 33.55 | 185.98 | 1.16 | 0.11 | 0.43 | 0.00 | 33.62 | 178.84 | 1.05 | 0.22 | 0.43 | 0.00 |
| 33.68 | 170.27 | 0.92 | 0.31 | 0.43 | 0.00 | 33.74 | 159.63 | 0.78 | 0.44 | 0.43 | 0.00 |
| 33.81 | 146.85 | 0.64 | 0.73 | 0.43 | 0.01 | 33.88 | 132.22 | 0.50 | 0.79 | 0.43 | 0.01 |
| 33.95 | 132.77 | 2.00 | 0.00 | 0.42 | 0.00 | 34.01 | 121.13 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.07 | 109.76 | 2.00 | 0.00 | 0.42 | 0.00 | 34.14 | 108.02 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.20 | 114.84 | 2.00 | 0.00 | 0.42 | 0.00 | 34.26 | 121.62 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.33 | 124.33 | 2.00 | 0.00 | 0.42 | 0.00 | 34.40 | 123.54 | 2.00 | 0.00 | 0.42 | 0.00 |
| 34.46 | 122.95 | 2.00 | 0.00 | 0.42 | 0.00 | 34.53 | 119.48 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.58 | 111.44 | 2.00 | 0.00 | 0.41 | 0.00 | 34.65 | 101.57 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.72 | 92.89 | 2.00 | 0.00 | 0.41 | 0.00 | 34.78 | 86.19 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.84 | 87.00 | 2.00 | 0.00 | 0.41 | 0.00 | 34.91 | 86.92 | 2.00 | 0.00 | 0.41 | 0.00 |
| 34.98 | 93.67 | 2.00 | 0.00 | 0.41 | 0.00 | 35.07 | 97.65 | 2.00 | 0.00 | 0.41 | 0.00 |
| 35.11 | 107.66 | 2.00 | 0.00 | 0.40 | 0.00 | 35.20 | 112.83 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.26 | 111.26 | 2.00 | 0.00 | 0.40 | 0.00 | 35.33 | 102.60 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.40 | 96.78 | 2.00 | 0.00 | 0.40 | 0.00 | 35.43 | 96.30 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.50 | 101.13 | 2.00 | 0.00 | 0.40 | 0.00 | 35.59 | 112.08 | 2.00 | 0.00 | 0.40 | 0.00 |
| 35.65 | 120.13 | 2.00 | 0.00 | 0.40 | 0.00 | 35.71 | 122.96 | 0.43 | 0.78 | 0.39 | 0.01 |
| 35.78 | 124.04 | 0.44 | 0.77 | 0.39 | 0.01 | 35.84 | 125.96 | 0.45 | 0.76 | 0.39 | 0.01 |
| 35.90 | 130.14 | 0.48 | 0.74 | 0.39 | 0.00 | 35.98 | 134.87 | 0.52 | 0.71 | 0.39 | 0.01 |
| 36.05 | 140.77 | 0.58 | 0.69 | 0.39 | 0.01 | 36.12 | 144.84 | 0.62 | 0.67 | 0.39 | 0.01 |
| 36.19 | 148.27 | 0.65 | 0.54 | 0.39 | 0.00 | 36.25 | 151.28 | 0.68 | 0.53 | 0.39 | 0.00 |
| 36.32 | 153.89 | 0.71 | 0.51 | 0.38 | 0.00 | 36.38 | 156.29 | 0.74 | 0.50 | 0.38 | 0.00 |
| 36.45 | 157.98 | 0.76 | 0.40 | 0.38 | 0.00 | 36.51 | 158.82 | 0.77 | 0.39 | 0.38 | 0.00 |
| 36.58 | 158.74 | 0.77 | 0.39 | 0.38 | 0.00 | 36.64 | 158.04 | 0.76 | 0.39 | 0.38 | 0.00 |
| 36.70 | 157.11 | 0.75 | 0.49 | 0.38 | 0.00 | 36.77 | 155.99 | 0.73 | 0.49 | 0.38 | 0.00 |
| 36.84 | 154.30 | 0.72 | 0.50 | 0.38 | 0.00 | 36.90 | 151.42 | 0.68 | 0.51 | 0.37 | 0.00 |
| 36.97 | 147.53 | 0.64 | 0.65 | 0.37 | 0.00 | 37.03 | 143.78 | 0.60 | 0.65 | 0.37 | 0.01 |
| 37.10 | 140.89 | 0.58 | 0.65 | 0.37 | 0.01 | 37.16 | 138.30 | 0.55 | 0.66 | 0.37 | 0.01 |
| 37.23 | 132.48 | 2.00 | 0.00 | 0.37 | 0.00 | 37.27 | 127.72 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.36 | 122.28 | 2.00 | 0.00 | 0.37 | 0.00 | 37.42 | 119.99 | 2.00 | 0.00 | 0.37 | 0.00 |
| 37.49 | 113.34 | 2.00 | 0.00 | 0.36 | 0.00 | 37.55 | 108.46 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.62 | 111.67 | 2.00 | 0.00 | 0.36 | 0.00 | 37.69 | 122.63 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.76 | 132.80 | 2.00 | 0.00 | 0.36 | 0.00 | 37.82 | 137.64 | 2.00 | 0.00 | 0.36 | 0.00 |
| 37.88 | 137.59 | 2.00 | 0.00 | 0.36 | 0.00 | 37.94 | 132.80 | 2.00 | 0.00 | 0.36 | 0.00 |
| 38.01 | 126.68 | 2.00 | 0.00 | 0.36 | 0.00 | 38.07 | 115.63 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.13 | 100.72 | 2.00 | 0.00 | 0.35 | 0.00 | 38.20 | 86.95 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.26 | 76.00 | 2.00 | 0.00 | 0.35 | 0.00 | 38.33 | 71.00 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.39 | 70.87 | 2.00 | 0.00 | 0.35 | 0.00 | 38.46 | 72.83 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.52 | 73.99 | 2.00 | 0.00 | 0.35 | 0.00 | 38.59 | 73.66 | 2.00 | 0.00 | 0.35 | 0.00 |
| 38.65 | 73.36 | 2.00 | 0.00 | 0.34 | 0.00 | 38.72 | 73.14 | 2.00 | 0.00 | 0.34 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38.78 | 74.45 | 2.00 | 0.00 | 0.34 | 0.00 | 38.84 | 77.53 | 2.00 | 0.00 | 0.34 | 0.00 |
| 38.93 | 81.06 | 2.00 | 0.00 | 0.34 | 0.00 | 39.00 | 82.40 | 2.00 | 0.00 | 0.34 | 0.00 |
| 39.06 | 83.32 | 2.00 | 0.00 | 0.34 | 0.00 | 39.12 | 83.98 | 2.00 | 0.00 | 0.34 | 0.00 |
| 39.18 | 84.97 | 2.00 | 0.00 | 0.34 | 0.00 | 39.24 | 86.47 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.31 | 89.05 | 2.00 | 0.00 | 0.33 | 0.00 | 39.40 | 93.23 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.47 | 96.57 | 2.00 | 0.00 | 0.33 | 0.00 | 39.53 | 100.03 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.60 | 103.57 | 2.00 | 0.00 | 0.33 | 0.00 | 39.66 | 106.83 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.72 | 110.41 | 2.00 | 0.00 | 0.33 | 0.00 | 39.78 | 112.69 | 2.00 | 0.00 | 0.33 | 0.00 |
| 39.85 | 106.95 | 2.00 | 0.00 | 0.32 | 0.00 | 39.91 | 96.94 | 2.00 | 0.00 | 0.32 | 0.00 |
| 39.98 | 90.99 | 2.00 | 0.00 | 0.32 | 0.00 | 40.05 | 97.62 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.12 | 109.30 | 2.00 | 0.00 | 0.32 | 0.00 | 40.18 | 121.30 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.23 | 128.43 | 2.00 | 0.00 | 0.32 | 0.00 | 40.30 | 134.69 | 2.00 | 0.00 | 0.32 | 0.00 |
| 40.36 | 138.22 | 2.00 | 0.00 | 0.32 | 0.00 | 40.45 | 143.33 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.52 | 145.67 | 2.00 | 0.00 | 0.31 | 0.00 | 40.58 | 145.53 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.64 | 144.22 | 2.00 | 0.00 | 0.31 | 0.00 | 40.70 | 142.04 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.77 | 139.33 | 2.00 | 0.00 | 0.31 | 0.00 | 40.84 | 137.34 | 2.00 | 0.00 | 0.31 | 0.00 |
| 40.89 | 137.31 | 2.00 | 0.00 | 0.31 | 0.00 | 40.95 | 135.55 | 2.00 | 0.00 | 0.31 | 0.00 |
| 41.02 | 134.01 | 2.00 | 0.00 | 0.30 | 0.00 | 41.08 | 129.85 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.15 | 126.12 | 2.00 | 0.00 | 0.30 | 0.00 | 41.21 | 124.79 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.28 | 125.65 | 2.00 | 0.00 | 0.30 | 0.00 | 41.34 | 126.89 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.41 | 127.04 | 2.00 | 0.00 | 0.30 | 0.00 | 41.48 | 126.97 | 2.00 | 0.00 | 0.30 | 0.00 |
| 41.54 | 124.66 | 2.00 | 0.00 | 0.30 | 0.00 | 41.60 | 122.45 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.67 | 120.83 | 2.00 | 0.00 | 0.29 | 0.00 | 41.77 | 118.48 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.80 | 116.56 | 2.00 | 0.00 | 0.29 | 0.00 | 41.89 | 117.35 | 2.00 | 0.00 | 0.29 | 0.00 |
| 41.96 | 119.88 | 2.00 | 0.00 | 0.29 | 0.00 | 42.03 | 122.50 | 2.00 | 0.00 | 0.29 | 0.00 |
| 42.06 | 121.96 | 2.00 | 0.00 | 0.29 | 0.00 | 42.13 | 121.70 | 2.00 | 0.00 | 0.29 | 0.00 |
| 42.20 | 120.46 | 2.00 | 0.00 | 0.28 | 0.00 | 42.26 | 117.99 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.33 | 115.12 | 2.00 | 0.00 | 0.28 | 0.00 | 42.39 | 111.85 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.48 | 108.95 | 2.00 | 0.00 | 0.28 | 0.00 | 42.54 | 106.29 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.61 | 103.94 | 2.00 | 0.00 | 0.28 | 0.00 | 42.67 | 95.06 | 2.00 | 0.00 | 0.28 | 0.00 |
| 42.74 | 82.20 | 2.00 | 0.00 | 0.28 | 0.00 | 42.80 | 70.42 | 2.00 | 0.00 | 0.27 | 0.00 |
| 42.86 | 68.43 | 2.00 | 0.00 | 0.27 | 0.00 | 42.93 | 72.03 | 2.00 | 0.00 | 0.27 | 0.00 |
| 42.99 | 73.66 | 2.00 | 0.00 | 0.27 | 0.00 | 43.05 | 75.07 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.12 | 76.29 | 2.00 | 0.00 | 0.27 | 0.00 | 43.20 | 77.27 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.26 | 78.12 | 2.00 | 0.00 | 0.27 | 0.00 | 43.31 | 77.80 | 2.00 | 0.00 | 0.27 | 0.00 |
| 43.38 | 76.90 | 2.00 | 0.00 | 0.26 | 0.00 | 43.44 | 75.95 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.51 | 76.11 | 2.00 | 0.00 | 0.26 | 0.00 | 43.57 | 76.61 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.67 | 77.03 | 2.00 | 0.00 | 0.26 | 0.00 | 43.73 | 77.16 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.80 | 77.83 | 2.00 | 0.00 | 0.26 | 0.00 | 43.86 | 79.12 | 2.00 | 0.00 | 0.26 | 0.00 |
| 43.93 | 80.78 | 2.00 | 0.00 | 0.26 | 0.00 | 43.99 | 82.04 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.06 | 82.17 | 2.00 | 0.00 | 0.25 | 0.00 | 44.12 | 81.74 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.18 | 81.44 | 2.00 | 0.00 | 0.25 | 0.00 | 44.24 | 81.77 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.31 | 82.60 | 2.00 | 0.00 | 0.25 | 0.00 | 44.37 | 83.90 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.44 | 85.85 | 2.00 | 0.00 | 0.25 | 0.00 | 44.51 | 89.42 | 2.00 | 0.00 | 0.25 | 0.00 |
| 44.58 | 95.42 | 2.00 | 0.00 | 0.24 | 0.00 | 44.64 | 103.65 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.71 | 113.39 | 2.00 | 0.00 | 0.24 | 0.00 | 44.77 | 124.50 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.84 | 136.93 | 2.00 | 0.00 | 0.24 | 0.00 | 44.90 | 148.18 | 2.00 | 0.00 | 0.24 | 0.00 |
| 44.97 | 161.32 | 2.00 | 0.00 | 0.24 | 0.00 | 45.04 | 171.24 | 2.00 | 0.00 | 0.24 | 0.00 |

**:: Post-earthquake settlement due to soil liquefaction :: (continued)**

| Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) | Depth (ft) | $Q_{tn,cs}$ | FS | $e_v$ (%) | DF | Settlement (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 45.11 | 180.80 | 2.00 | 0.00 | 0.24 | 0.00 | 45.17 | 188.15 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.24 | 192.31 | 2.00 | 0.00 | 0.23 | 0.00 | 45.30 | 194.99 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.35 | 197.95 | 2.00 | 0.00 | 0.23 | 0.00 | 45.41 | 193.60 | 2.00 | 0.00 | 0.23 | 0.00 |
| 45.49 | 182.57 | 1.11 | 0.09 | 0.23 | 0.00 | 45.55 | 170.72 | 0.93 | 0.16 | 0.23 | 0.00 |
| 45.63 | 166.06 | 0.87 | 0.17 | 0.23 | 0.00 | 45.68 | 170.27 | 0.93 | 0.16 | 0.23 | 0.00 |
| 45.76 | 176.52 | 1.02 | 0.12 | 0.22 | 0.00 | 45.81 | 185.72 | 1.16 | 0.06 | 0.22 | 0.00 |
| 45.87 | 190.93 | 2.00 | 0.00 | 0.22 | 0.00 | 45.94 | 196.91 | 2.00 | 0.00 | 0.22 | 0.00 |
| 46.03 | 201.04 | 2.00 | 0.00 | 0.22 | 0.00 | 46.09 | 208.07 | 2.00 | 0.00 | 0.22 | 0.00 |
| 46.16 | 211.98 | 2.00 | 0.00 | 0.22 | 0.00 | 46.23 | 212.74 | 2.00 | 0.00 | 0.22 | 0.00 |
| 46.29 | 209.78 | 2.00 | 0.00 | 0.22 | 0.00 | 46.35 | 203.80 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.41 | 191.38 | 2.00 | 0.00 | 0.21 | 0.00 | 46.48 | 183.23 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.55 | 175.69 | 2.00 | 0.00 | 0.21 | 0.00 | 46.61 | 169.70 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.68 | 165.26 | 2.00 | 0.00 | 0.21 | 0.00 | 46.74 | 161.64 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.81 | 158.52 | 2.00 | 0.00 | 0.21 | 0.00 | 46.88 | 155.72 | 2.00 | 0.00 | 0.21 | 0.00 |
| 46.94 | 153.41 | 2.00 | 0.00 | 0.20 | 0.00 | 47.01 | 151.04 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.08 | 148.19 | 2.00 | 0.00 | 0.20 | 0.00 | 47.17 | 145.97 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.20 | 144.92 | 2.00 | 0.00 | 0.20 | 0.00 | 47.27 | 145.65 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.34 | 147.63 | 2.00 | 0.00 | 0.20 | 0.00 | 47.40 | 151.47 | 2.00 | 0.00 | 0.20 | 0.00 |
| 47.47 | 156.41 | 2.00 | 0.00 | 0.20 | 0.00 | 47.53 | 161.48 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.60 | 165.69 | 2.00 | 0.00 | 0.19 | 0.00 | 47.67 | 169.28 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.74 | 172.16 | 2.00 | 0.00 | 0.19 | 0.00 | 47.77 | 174.53 | 2.00 | 0.00 | 0.19 | 0.00 |
| 47.84 | 175.55 | 2.00 | 0.00 | 0.19 | 0.00 | 47.90 | 173.96 | 2.00 | 0.00 | 0.19 | 0.00 |
| 48.00 | 174.48 | 2.00 | 0.00 | 0.19 | 0.00 | 48.06 | 169.71 | 2.00 | 0.00 | 0.19 | 0.00 |
| 48.13 | 166.14 | 2.00 | 0.00 | 0.18 | 0.00 | 48.19 | 164.10 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.25 | 163.12 | 2.00 | 0.00 | 0.18 | 0.00 | 48.32 | 155.29 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.38 | 141.04 | 2.00 | 0.00 | 0.18 | 0.00 | 48.45 | 129.45 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.51 | 127.82 | 2.00 | 0.00 | 0.18 | 0.00 | 48.58 | 131.37 | 2.00 | 0.00 | 0.18 | 0.00 |
| 48.65 | 129.64 | 2.00 | 0.00 | 0.18 | 0.00 | 48.70 | 119.78 | 2.00 | 0.00 | 0.17 | 0.00 |
| 48.77 | 111.13 | 2.00 | 0.00 | 0.17 | 0.00 | 48.83 | 106.36 | 2.00 | 0.00 | 0.17 | 0.00 |
| 48.90 | 105.07 | 2.00 | 0.00 | 0.17 | 0.00 | 48.96 | 105.25 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.02 | 105.75 | 2.00 | 0.00 | 0.17 | 0.00 | 49.10 | 106.09 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.16 | 106.08 | 2.00 | 0.00 | 0.17 | 0.00 | 49.22 | 105.48 | 2.00 | 0.00 | 0.17 | 0.00 |
| 49.29 | 104.21 | 2.00 | 0.00 | 0.16 | 0.00 | 49.35 | 102.33 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.42 | 100.72 | 2.00 | 0.00 | 0.16 | 0.00 | 49.49 | 101.84 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.56 | 109.27 | 2.00 | 0.00 | 0.16 | 0.00 | 49.62 | 121.42 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.69 | 132.55 | 2.00 | 0.00 | 0.16 | 0.00 | 49.76 | 139.15 | 2.00 | 0.00 | 0.16 | 0.00 |
| 49.80 | 144.21 | 2.00 | 0.00 | 0.16 | 0.00 | 49.87 | 145.12 | 2.00 | 0.00 | 0.15 | 0.00 |
| 49.94 | 148.15 | 2.00 | 0.00 | 0.15 | 0.00 | 50.00 | 121.10 | 2.00 | 0.00 | 0.15 | 0.00 |
| 50.08 | 87.73 | 2.00 | 0.00 | 0.15 | 0.00 | 50.14 | -1.00 | 2.00 | 0.00 | 0.15 | 0.00 |
| 50.21 | -1.00 | 2.00 | 0.00 | 0.15 | 0.00 | 50.27 | -1.00 | 2.00 | 0.00 | 0.15 | 0.00 |
| 50.34 | -1.00 | 2.00 | 0.00 | 0.15 | 0.00 | 50.40 | -1.00 | 2.00 | 0.00 | 0.15 | 0.00 |

**Total estimated settlement: 0.52**

**Abbreviations**

| | |
|---|---|
| $Q_{tn,cs}$: | Equivalent clean sand normalized cone resistance |
| FS: | Factor of safety against liquefaction |
| $e_v$ (%): | Post-liquefaction volumentric strain |
| DF: | $e_v$ depth weighting factor |
| Settlement: | Calculated settlement |

# APPENDIX D

**GENERAL EARTHWORK AND GRADING GUIDELINES**

**Geotechnical Evaluation**
**APNs 099-031-01, -02, -08 through -11, Garden Grove, California**
**Project No. 3291-CR**

GEOTEK

# GENERAL GRADING GUIDELINES

Guidelines presented herein are intended to address general construction procedures for earthwork construction. Specific situations and conditions often arise which cannot reasonably be discussed in general guidelines, when anticipated these are discussed in the text of the report. Often unanticipated conditions are encountered which may necessitate modification or changes to these guidelines. It is our hope that these will assist the contractor to more efficiently complete the project by providing a reasonable understanding of the procedures that would be expected during earthwork and the testing and observation used to evaluate those procedures.

## General

Grading should be performed to at least the minimum requirements of governing agencies, Chapters 18 and 33 of the California Building Code, CBC (2019) and the guidelines presented below.

## Preconstruction Meeting

A preconstruction meeting should be held prior to site earthwork. Any questions the contractor has regarding our recommendations, general site conditions, apparent discrepancies between reported and actual conditions and/or differences in procedures the contractor intends to use should be brought up at that meeting. The contractor (including the main onsite representative) should review our report and these guidelines in advance of the meeting. Any comments the contractor may have regarding these guidelines should be brought up at that meeting.

## Grading Observation and Testing

1. Observation of the fill placement should be provided by our representative during grading. Verbal communication during the course of each day will be used to inform the contractor of test results. The contractor should receive a copy of the "Daily Field Report" indicating results of field density tests that day. If our representative does not provide the contractor with these reports, our office should be notified.
2. Testing and observation procedures are, by their nature, specific to the work or area observed and location of the tests taken, variability may occur in other locations. The contractor is responsible for the uniformity of the grading operations; our observations and test results are intended to evaluate the contractor's overall level of efforts during grading. The contractor's personnel are the only individuals participating in all aspect of site work. Compaction testing and observation should not be considered as relieving the contractor's responsibility to properly compact the fill.
3. Cleanouts, processed ground to receive fill, key excavations, and subdrains should be observed by our representative prior to placing any fill. It will be the contractor's responsibility to notify our representative or office when such areas are ready for observation.
4. Density tests may be made on the surface material to receive fill, as considered warranted by this firm.
5. In general, density tests would be made at maximum intervals of two feet of fill height or every 1,000 cubic yards of fill placed. Criteria will vary depending on soil conditions and size of the fill. More frequent testing may be performed. In any case, an adequate number of field density tests should be made to evaluate the required compaction and moisture content is generally being obtained.

6. Laboratory testing to support field test procedures will be performed, as considered warranted, based on conditions encountered (e.g. change of material sources, types, etc.) Every effort will be made to process samples in the laboratory as quickly as possible and in progress construction projects are our first priority. However, laboratory workloads may cause in delays and some soils may require a **minimum of 48 to 72 hours to complete test procedures**. Whenever possible, our representative(s) should be informed in advance of operational changes that might result in different source areas for materials.
7. Procedures for testing of fill slopes are as follows:
   a) Density tests should be taken periodically during grading on the flat surface of the fill, three to five feet horizontally from the face of the slope.
   b) If a method other than over building and cutting back to the compacted core is to be employed, slope compaction testing during construction should include testing the outer six inches to three feet in the slope face to determine if the required compaction is being achieved.
8. Finish grade testing of slopes and pad surfaces should be performed after construction is complete.

## Site Clearing

1. All vegetation, and other deleterious materials, should be removed from the site. If material is not immediately removed from the site it should be stockpiled in a designated area(s) well outside of all current work areas and delineated with flagging or other means. Site clearing should be performed in advance of any grading in a specific area.
2. Efforts should be made by the contractor to remove all organic or other deleterious material from the fill, as even the most diligent efforts may result in the incorporation of some materials. This is especially important when grading is occurring near the natural grade. All equipment operators should be aware of these efforts. Laborers may be required as root pickers.
3. Nonorganic debris or concrete may be placed in deeper fill areas provided the procedures used are observed and found acceptable by our representative.

## Treatment of Existing Ground

1. Following site clearing, all surficial deposits of alluvium and colluvium as well as weathered or creep effected bedrock, should be removed unless otherwise specifically indicated in the text of this report.
2. In some cases, removal may be recommended to a specified depth (e.g. flat sites where partial alluvial removals may be sufficient). The contractor should not exceed these depths unless directed otherwise by our representative.
3. Groundwater existing in alluvial areas may make excavation difficult. Deeper removals than indicated in the text of the report may be necessary due to saturation during winter months.
4. Subsequent to removals, the natural ground should be processed to a depth of six inches, moistened to near optimum moisture conditions and compacted to fill standards.
5. Exploratory back hoe or dozer trenches still remaining after site removal should be excavated and filled with compacted fill if they can be located.

## Fill Placement

1. Unless otherwise indicated, all site soil and bedrock may be reused for compacted fill; however, some special processing or handling may be required (see text of report).

2. Material used in the compacting process should be evenly spread, moisture conditioned, processed, and compacted in thin lifts six (6) to eight (8) inches in compacted thickness to obtain a uniformly dense layer. The fill should be placed and compacted on a nearly horizontal plane, unless otherwise found acceptable by our representative.
3. If the moisture content or relative density varies from that recommended by this firm, the contractor should rework the fill until it is in accordance with the following:
   a) Moisture content of the fill should be at or above optimum moisture. Moisture should be evenly distributed without wet and dry pockets. Pre-watering of cut or removal areas should be considered in addition to watering during fill placement, particularly in clay or dry surficial soils. The ability of the contractor to obtain the proper moisture content will control production rates.
   b) Each six-inch layer should be compacted to at least 90 percent of the maximum dry density in compliance with the testing method specified by the controlling governmental agency. In most cases, the testing method is ASTM Test Designation D 1557.
4. Rock fragments less than eight inches in diameter may be utilized in the fill, provided:
   a) They are not placed in concentrated pockets;
   b) There is a sufficient percentage of fine-grained material to surround the rocks;
   c) The distribution of the rocks is observed by, and acceptable to, our representative.
5. Rocks exceeding eight (8) inches in diameter should be taken off site, broken into smaller fragments, or placed in accordance with recommendations of this firm in areas designated suitable for rock disposal. On projects where significant large quantities of oversized materials are anticipated, alternate guidelines for placement may be included. If significant oversize materials are encountered during construction, these guidelines should be requested.
6. In clay soil, dry or large chunks or blocks are common. If in excess of eight (8) inches minimum dimension, then they are considered as oversized. Sheepsfoot compactors or other suitable methods should be used to break up blocks. When dry, they should be moisture conditioned to provide a uniform condition with the surrounding fill.

**Slope Construction**

1. The contractor should obtain a minimum relative compaction of 90 percent out to the finished slope face of fill slopes. This may be achieved by either overbuilding the slope and cutting back to the compacted core, or by direct compaction of the slope face with suitable equipment.
2. Slopes trimmed to the compacted core should be overbuilt by at least three (3) feet with compaction efforts out to the edge of the false slope. Failure to properly compact the outer edge results in trimming not exposing the compacted core and additional compaction after trimming may be necessary.
3. If fill slopes are built "at grade" using direct compaction methods, then the slope construction should be performed so that a constant gradient is maintained throughout construction. Soil should not be "spilled" over the slope face nor should slopes be "pushed out" to obtain grades. Compaction equipment should compact each lift along the immediate top of slope. Slopes should be back rolled or otherwise compacted at approximately every 4 feet vertically as the slope is built.
4. Corners and bends in slopes should have special attention during construction as these are the most difficult areas to obtain proper compaction.
5. Cut slopes should be cut to the finished surface. Excessive undercutting and smoothing of the face with fill may necessitate stabilization.

## UTILITY TRENCH CONSTRUCTION AND BACKFILL

Utility trench excavation and backfill is the contractors responsibility. The geotechnical consultant typically provides periodic observation and testing of these operations. While efforts are made to make sufficient observations and tests to verify that the contractors' methods and procedures are adequate to achieve proper compaction, it is typically impractical to observe all backfill procedures. As such, it is critical that the contractor use consistent backfill procedures.

Compaction methods vary for trench compaction and experience indicates many methods can be successful. However, procedures that "worked" on previous projects may or may not prove effective on a given site. The contractor(s) should outline the procedures proposed, so that we may discuss them **prior** to construction. We will offer comments based on our knowledge of site conditions and experience.

1. Utility trench backfill in slopes, structural areas, in streets and beneath flat work or hardscape should be brought to at least optimum moisture and compacted to at least 90 percent of the laboratory standard. Soil should be moisture conditioned prior to placing in the trench.
2. Flooding and jetting are not typically recommended or acceptable for native soils. Flooding or jetting may be used with select sand having a Sand Equivalent (SE) of 30 or higher. This is typically limited to the following uses:
   a) shallow (12 + inches) under slab interior trenches and,
   b) as bedding in pipe zone.

   The water should be allowed to dissipate prior to pouring slabs or completing trench compaction.
3. Care should be taken not to place soils at high moisture content within the upper three feet of the trench backfill in street areas, as overly wet soils may impact subgrade preparation. Moisture may be reduced to 2% below optimum moisture in areas to be paved within the upper three feet below sub grade.
4. Sand backfill should not be allowed in exterior trenches adjacent to and within an area extending below a 1:1 projection from the outside bottom edge of a footing, unless it is similar to the surrounding soil.
5. Trench compaction testing is generally at the discretion of the geotechnical consultant. Testing frequency will be based on trench depth and the contractors procedures. A probing rod would be used to assess the consistency of compaction between tested areas and untested areas. If zones are found that are considered less compact than other areas, this would be brought to the contractors attention.

## JOB SAFETY

### General

Personnel safety is a primary concern on all job sites. The following summaries are safety considerations for use by all our employees on multi-employer construction sites. On ground personnel are at highest risk of injury and possible fatality on grading construction projects. The company recognizes that construction activities will vary on each site and that job site safety is the contractor's responsibility. However, it is, imperative that all personnel be safety conscious to avoid accidents and potential injury.

In an effort to minimize risks associated with geotechnical testing and observation, the following precautions are to be implemented for the safety of our field personnel on grading and construction projects.

1. Safety Meetings: Our field personnel are directed to attend the contractor's regularly scheduled safety meetings.
2. Safety Vests: Safety vests are provided for and are to be worn by our personnel while on the job site.
3. Safety Flags: Safety flags are provided to our field technicians; one is to be affixed to the vehicle when on site, the other is to be placed atop the spoil pile on all test pits.

In the event that the contractor's representative observes any of our personnel not following the above, we request that it be brought to the attention of our office.

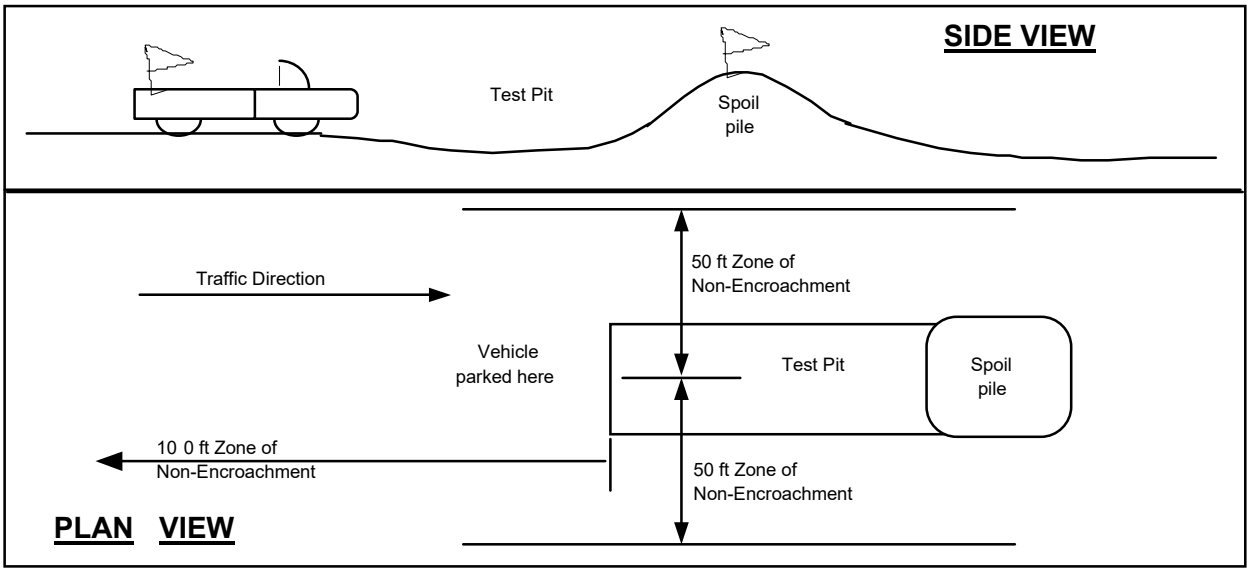
### Test Pits Location, Orientation and Clearance

The technician is responsible for selecting test pit locations. The primary concern is the technician's safety. However, it is necessary to take sufficient tests at various locations to obtain a representative sampling of the fill. As such, efforts will be made to coordinate locations with the grading contractors authorized representatives (e.g. dump man, operator, supervisor, grade checker, etc.), and to select locations following or behind the established traffic pattern, preferably outside of current traffic. The contractors authorized representative should direct excavation of the pit and safety during the test period. Again, safety is the paramount concern.

Test pits should be excavated so that the spoil pile is placed away from oncoming traffic. The technician's vehicle is to be placed next to the test pit, opposite the spoil pile. This necessitates that the fill be maintained in a drivable condition. Alternatively, the contractor may opt to park a piece of equipment in front of test pits, particularly in small fill areas or those with limited access.

A zone of non-encroachment should be established for all test pits (see diagram below). No grading equipment should enter this zone during the test procedure. The zone should extend outward to the sides approximately 50 feet from the center of the test pit and 100 feet in the direction of traffic flow. This zone is established both for safety and to avoid excessive ground vibration, which typically decreases test results.

## TEST PIT SAFETY PLAN




### Slope Tests

When taking slope tests, the technician should park their vehicle directly above or below the test location on the slope. The contractor's representative should effectively keep all equipment at a safe operation distance (e.g. 50 feet) away from the slope during testing.

The technician is directed to withdraw from the active portion of the fill as soon as possible following testing. The technician's vehicle should be parked at the perimeter of the fill in a highly visible location.

### Trench Safety

It is the contractor's responsibility to provide safe access into trenches where compaction testing is needed. Trenches for all utilities should be excavated in accordance with CAL-OSHA and any other applicable safety standards. Safe conditions will be required to enable compaction testing of the trench backfill.

All utility trench excavations in excess of 5 feet deep, which a person enters, are to be shored or laid back. Trench access should be provided in accordance with OSHA standards. Our personnel are directed not to enter any trench by being lowered or "riding down" on the equipment.

Our personnel are directed not to enter any excavation which;

1. is 5 feet or deeper unless shored or laid back,
2. exit points or ladders are not provided,
3. displays any evidence of instability, has any loose rock or other debris which could fall into the trench, or
4. displays any other evidence of any unsafe conditions regardless of depth.

If the contractor fails to provide safe access to trenches for compaction testing, our company policy requires that the soil technician withdraws and notifies their supervisor. The contractors representative will then be contacted in an effort to effect a solution. All backfill not tested due to safety concerns or other reasons is subject to reprocessing and/or removal.

**Procedures**

In the event that the technician's safety is jeopardized or compromised as a result of the contractor's failure to comply with any of the above, the technician is directed to inform both the developer's and contractor's representatives. If the condition is not rectified, the technician is required, by company policy, to immediately withdraw and notify their supervisor. The contractor's representative will then be contacted in an effort to effect a solution. No further testing will be performed until the situation is rectified. Any fill placed in the interim can be considered unacceptable and subject to reprocessing, recompaction or removal.

In the event that the soil technician does not comply with the above or other established safety guidelines, we request that the contractor bring this to technicians attention and notify our project manager or office. Effective communication and coordination between the contractors' representative and the field technician(s) is strongly encouraged in order to implement the above safety program and safety in general.

The safety procedures outlined above should be discussed at the contractor's safety meetings. This will serve to inform and remind equipment operators of these safety procedures particularly the zone of non-encroachment.

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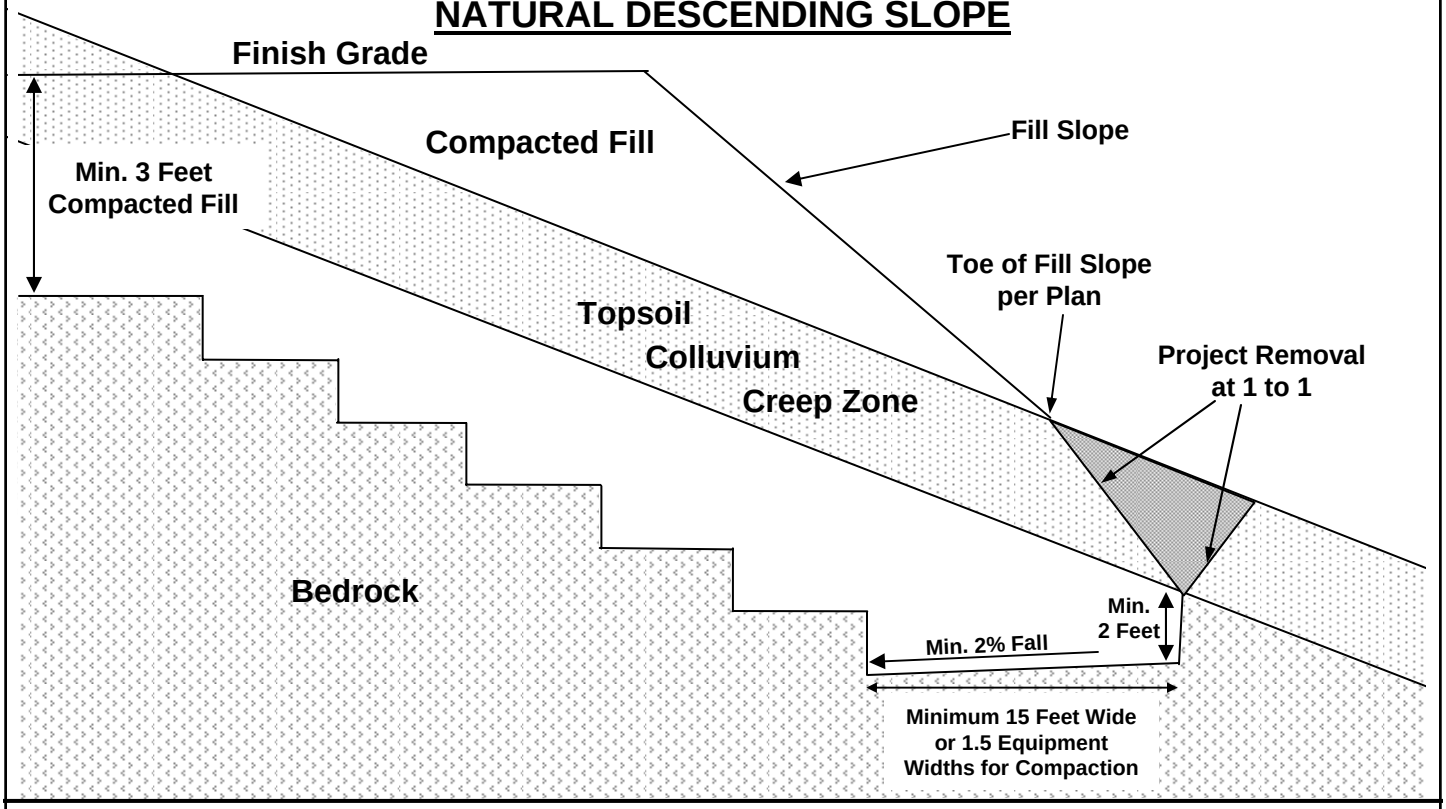
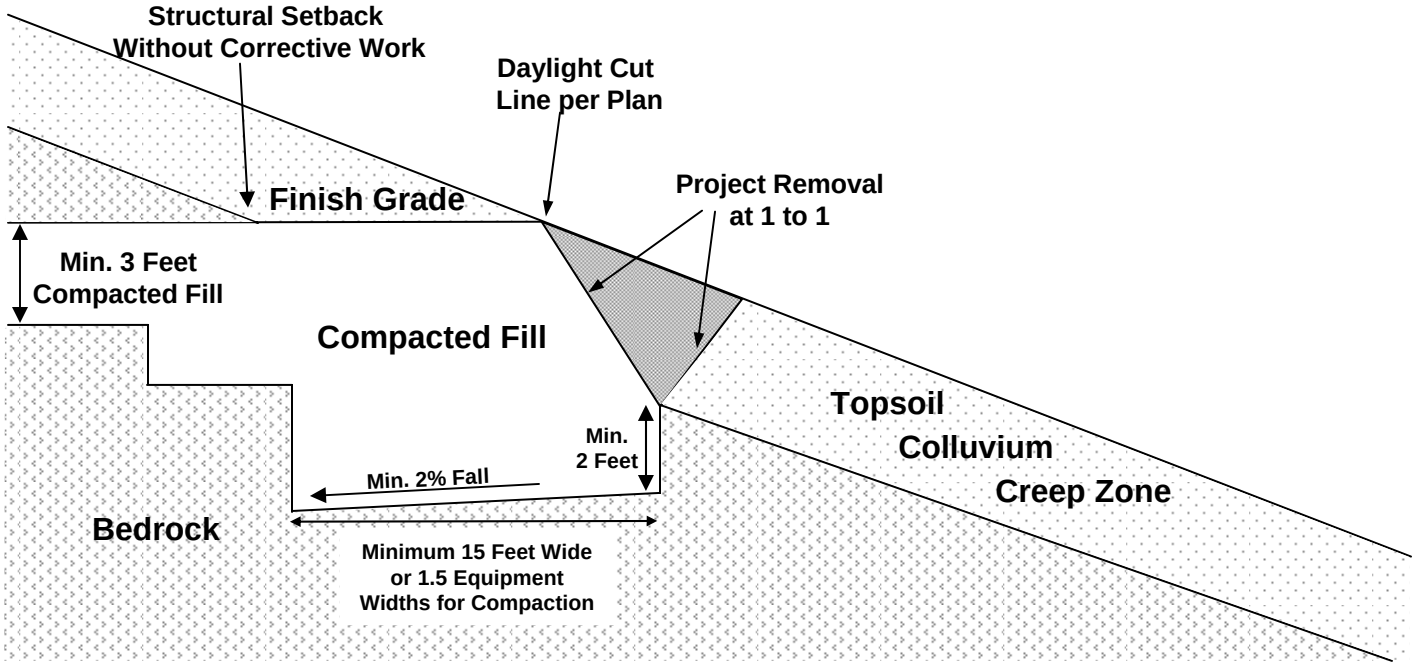
## TYPICAL FILL SLOPE OVER NATURAL DESCENDING SLOPE




## DAYLIGHT CUT AREA OVER NATURAL DESCENDING SLOPE

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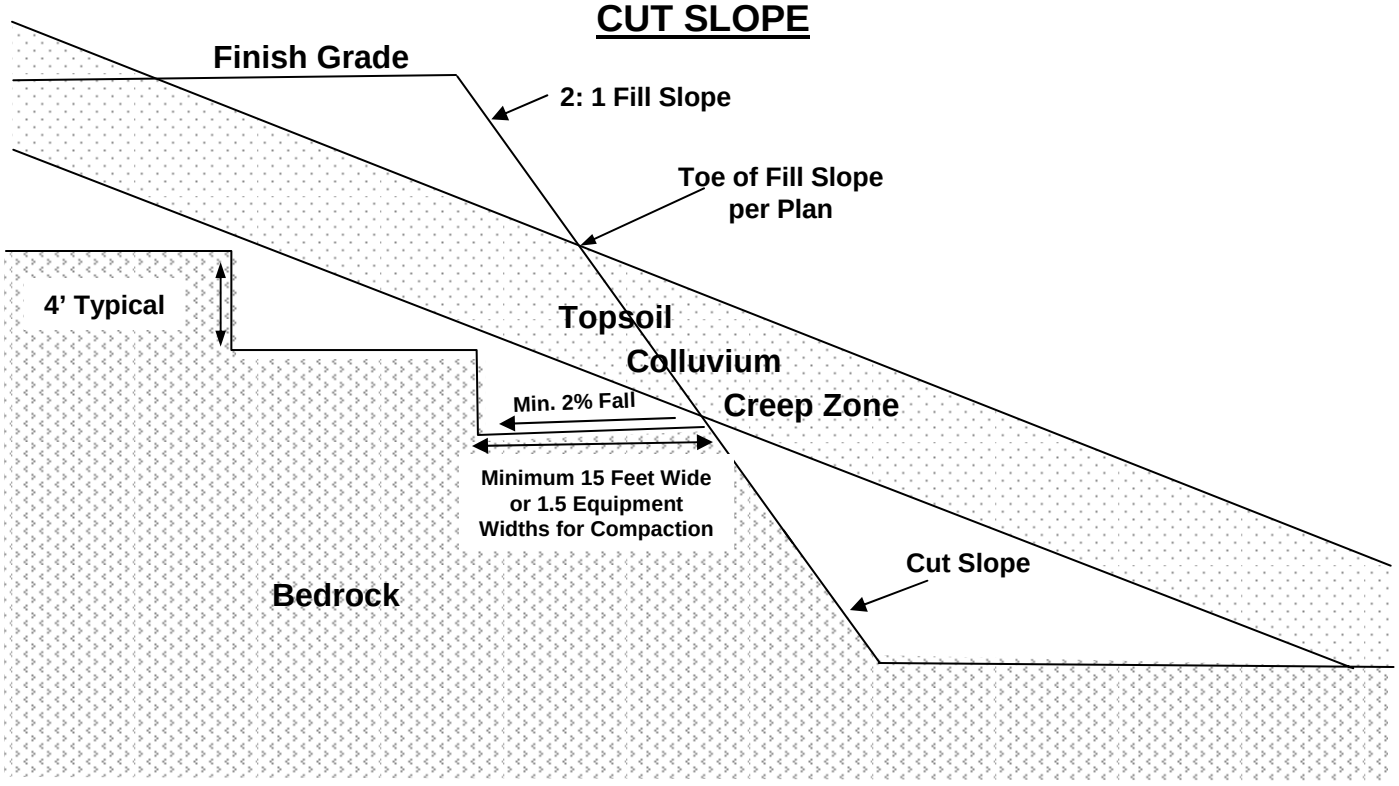
TREATMENT ABOVE NATURAL SLOPES

STANDARD GRADING GUIDELINES

PLATE D-1

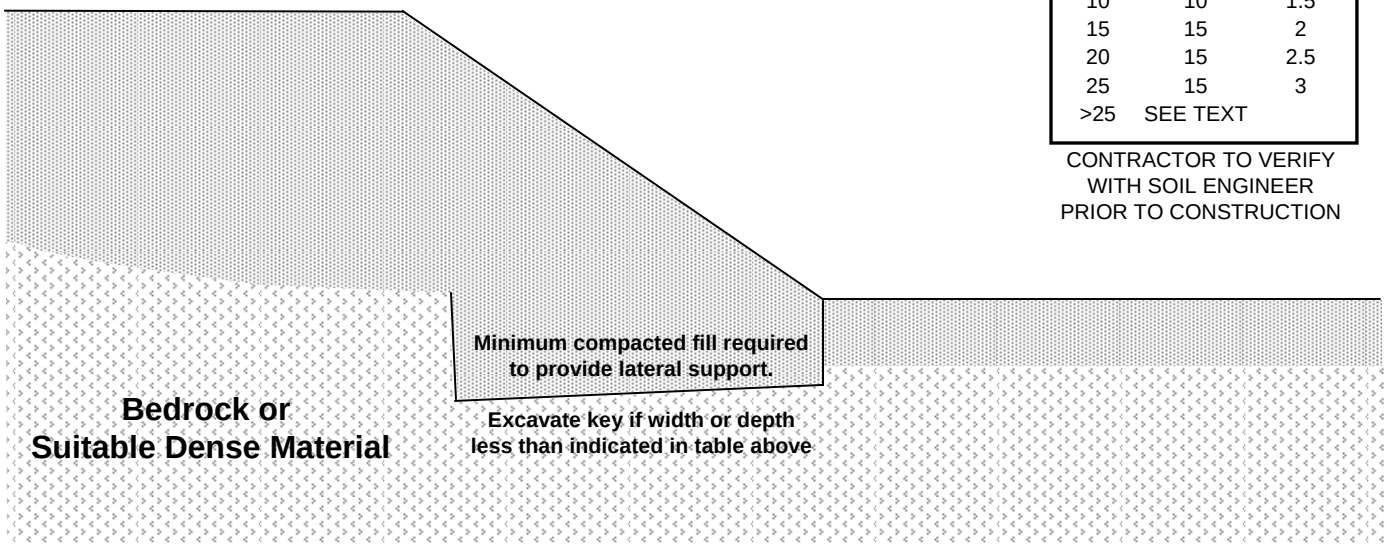
# TYPICAL FILL SLOPE OVER CUT SLOPE




# TYPICAL FILL SLOPE

| SLOPE HEIGHT | MIN. KEY WIDTH | MIN. KEY DEPTH |
|---|---|---|
| 5 | 7 | 1 |
| 10 | 10 | 1.5 |
| 15 | 15 | 2 |
| 20 | 15 | 2.5 |
| 25 | 15 | 3 |
| >25 | SEE TEXT | |

CONTRACTOR TO VERIFY WITH SOIL ENGINEER PRIOR TO CONSTRUCTION

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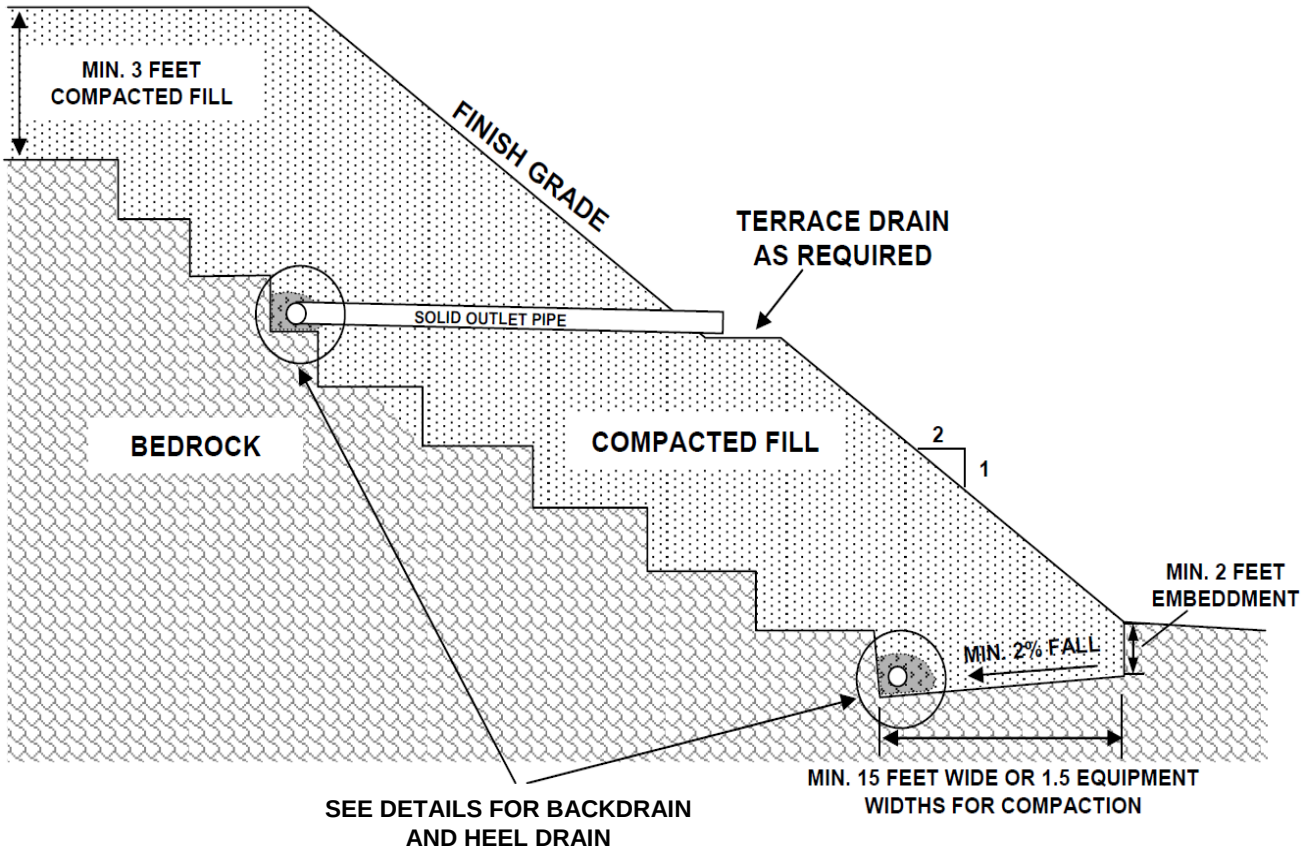
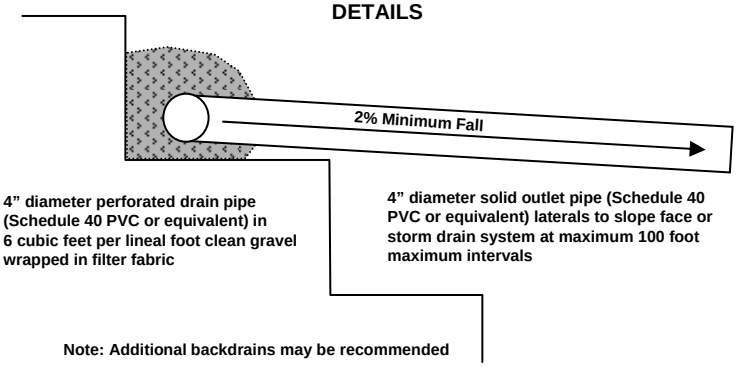
COMMON FILL
SLOPE KEYS

STANDARD GRADING GUIDELINES

PLATE D-2




**BACKDRAIN DETAILS**




4" diameter perforated drain pipe (Schedule 40 PVC or equivalent) in 6 cubic feet per lineal foot clean gravel wrapped in filter fabric

4" diameter solid outlet pipe (Schedule 40 PVC or equivalent) laterals to slope face or storm drain system at maximum 100 foot maximum intervals

Note: Additional backdrains may be recommended

**HEEL DRAIN DETAILS**

6" diameter perforated drain pipe in 6 cubic feet per lineal foot clean gravel wrapped in filter fabric, outlet pipe to gravity flow with 2% minimum fall

| | | | |
|---|---|---|---|
| GEOTEK | 1548 North Maple Street<br>Corona, California 92878 | TYPICAL BUTTRESS AND STABILIZATION FILL | STANDARD GRADING GUIDELINES<br><br>PLATE D-3 |