ALBUS & ASSOCIATES

formerly Albus-Keefe & Associates, Inc.

June 6, 2023
J.N.: 3157.00

Mr. Brian Geis
The Olson Company
3010 Old Ranch Parkway, Suite 100
Seal Beach, California 90740

Subject: **Geotechnical Due-Diligence Investigation, Proposed Multi-Family Residential Development, 12828 Newhope Street, Garden Grove, California**

Dear Mr. Geis,

Albus & Associates, Inc. is pleased to present to you our geotechnical due-diligence report for the proposed multi-family residential development at the subject site. This report presents a summary of our literature review, subsurface exploration, laboratory testing, and engineering analyses. Conclusions relevant to the feasibility of the proposed site development are also presented herein based on the findings of our work.

We appreciate this opportunity to be of service to you. If you should have any questions regarding the contents of this report, please do not hesitate to call our office.

Sincerely,

ALBUS & ASSOCIATES, INC.

Paul Kim
Associate Engineer

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of our work is to evaluate the feasibility of the proposed site development in order to assist you in your land acquisition evaluation and due-diligence review. The scope of our work for this investigation was focused primarily on the geotechnical issues that we expect could have significant fiscal impacts on future site development. While this report is comprehensive for feasibility purposes, it is not intended for final design purposes. As such, additional geotechnical studies may be warranted based on our review of future rough grading plans and foundation plans. The scope of our work for this investigation included the following:

- Review of published geologic and seismic data for the site and surrounding area
- Exploratory drilling and soil sampling
- Laboratory testing of select soil samples
- Engineering analyses of data obtained from our review, exploration, and laboratory testing
- Evaluate site seismicity, liquefaction potential, and settlement potential
- Preparation of this report

1.2 SITE LOCATION AND DESCRIPTION

The site is located at the address of 12828 Newhope Street within the city of Garden Grove, California. The site is bordered by Newhope Street to the west, Zeta Street to the north, residential properties to the east, and Dunklee Lane to the south. The location of the site and its relationship to the surrounding areas are shown in Figure 1, Site Location Map.

The site consists of 0.9 acres of land and is presently developed with a single-family residence. The building pad is situated approximately 2 feet above the grade of the street. The remaining portions of the site are covered in asphalt associated with the interior driveway and vegetation. Vegetation onsite consists of medium to large-sized trees and grass.

Drainage on site appears to be primarily sheet flow and directed south and west towards the roadways.

Walls are present along all sides of the property lines. Except for the eastern perimeter wall, other walls are retaining walls. The retaining walls are about 6 feet high, retaining up to approximately 2 feet. The elevation of the project site is typically higher than the northern, western, and southern roads but similar to eastern neighborhood houses.

FIGURE 1-SITE LOCATION MAP

Proposed Multi-Family Residential Development
12828 Newhope Street, Garden Grove, California

NOT TO SCALE

1.3 PROPOSED DEVELOPMENT

We understand that the site will be redeveloped for residential use. We anticipate the proposed site development will consist of attached three-story townhomes and associated interior driveways, perimeter/retaining walls, underground utilities, and a stormwater infiltration system.

No grading or structural plans were available in preparing this report. However, we anticipate some minor to moderate cut and filling of the site will be required to achieve future surface configuration and we expect future foundation loads will be relatively light.

2.0 INVESTIGATION

2.1 RESEARCH

We have reviewed the referenced geologic publications, maps, and historical aerial photos of the vicinity. Data from these sources were utilized to the development of some of our findings and conclusions presented in this report.

Research of aerial photographs indicates that in 1953, the site appeared to be entirely used for citrus groves, and the east adjacent properties were developed with houses. At this time, a single-family residence was constructed. By 1967, the single family residence was expanded to the north while the remaining portions of the site were still used for citrus groves. The residence is roughly in the same location as the existing residence. By 1972, the area was cleared of citrus groves and additional trees were planted on the site. By 1987, the surrounding areas also had been developed. The site appears to have remained relatively unchanged since.

2.2 SUBSURFACE EXPLORATION

Subsurface exploration for this investigation was conducted on May 23, 2023 and consisted of drilling three (3) soil borings to a maximum depth of approximately 51.5 feet below the existing ground surface (bgs). The borings were drilled using a truck-mounted, continuous-flight, hollow-stem-auger drill rig. Representatives of *Albus & Associates, Inc*. logged the exploratory borings. Visual and tactile identifications were made of the materials encountered, and their descriptions are presented on the Exploration Logs in Appendix A. The approximate locations of the borings are shown on the enclosed Geotechnical Map, Plate 1.

Bulk, relatively undisturbed and Standard Penetration Test (SPT) samples were obtained at selected depths for subsequent laboratory testing. Relatively undisturbed samples were obtained using a 3-inch O.D., 2.5-inch I.D., California split-spoon soil sampler lined with brass rings. SPT samples were obtained using a standard SPT soil sampler. During each sampling interval, the samplers were driven 18 inches with successive drops of a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler was recorded for each six inches of advancement. The total blow count for the lower 12 inches of advancement per soil sample is recorded on the exploration log. Samples were placed in sealed containers or plastic bags and transported to our laboratory for analyses and testing. The borings were backfilled with soil cuttings upon completion of drilling.

Two percolation test wells (P-1 and P-2) were drilled adjacent to exploratory boring B-1 for subsequent percolation testing.

2.3 LABORATORY TESTING

Selected samples of representative earth materials from the borings were tested in our laboratory. Tests consisted of in-situ moisture and dry density, maximum dry density and optimum moisture content, soluble sulfate content, grain size analysis, percent passing No. 200 sieve, consolidation/collapse potential, Atterberg limits, direct shear, and corrosivity. Descriptions of laboratory testing and a summary of the test results are presented in Appendix B and on the exploration log in Appendix A.

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Artificial fill material was observed in our soil borings and are anticipated to be generally 2 feet deep. Deeper portions of artificial fill may be encountered in localized areas. A retaining wall exists along all sides of the property lines and retains approximately 2 feet at the northwest and southwest corners before tapering off heading south and east. The artificial fill materials observed onsite are typically silty sands that are damp to very moist, loose to medium dense, and gray.

Young alluvial fan deposits (Qyfa) were encountered below the fill materials to the maximum depths explored of 51.5 feet. The materials were typically interbedded with a predominance of coarse-grained materials. Deeper portions of the alluvial fan deposits were observed to be cohesive. The materials consisted of sands with variable amounts of silt and clay, and sandy clay, which were very moist and loose to dense and very stiff to hard.

A more detailed description of the interpreted soil profile at each of the boring locations, based upon the borehole cuttings and soil samples, are presented in Appendix A. The stratigraphic descriptions in the logs represent the predominant materials encountered and relatively thin, often discontinuous layers of different material may occur within the major divisions.

3.2 GROUNDWATER

Groundwater was encountered at 37 feet below the existing grade during this firm's subsurface exploration to a depth of 51.5 feet. The CDMG Special Report 003 suggests that historic high groundwater for the subject site is about 10 feet below the ground surface. We researched online groundwater well data in the California Department of Water Resources database and found three wells located around the site (north, east, and west). The locations of the three wells are depicted in Figure 2. Data from these wells spans from 1970 to 2023. The recorded depths to groundwater from these wells are plotted in Figure 3.

As indicated by Figure 3, all three wells indicate that groundwater has remained below a depth of 45 feet since 1970, except for one measurement on May 1, 1979. This measurement may be an error considering other data. Except for this measurement, all measured groundwater depths are deeper than 45 feet. Based on the data from these wells, the water encountered in our borings is likely a shallower perched condition that is hydraulically separate from a deeper aquifer being measured by the local wells. A zone of finer-grained interlayers are present below a depth of 35 feet which may be impeding flow of water downward to a deeper aquifer.

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FIGURE 2 - Groundwater Well Location Map

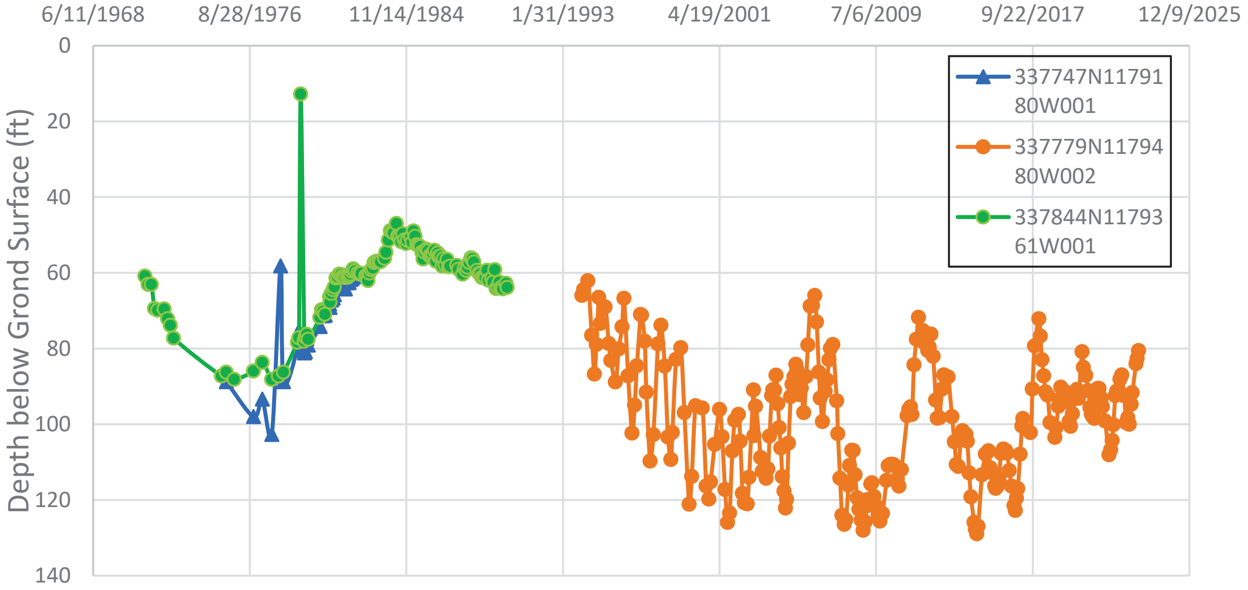

FIGURE 3 - Ground Water Data

3.3 ACTIVE FAULTS

Based on our review of the referenced publications and seismic data, no active faults are known to project through or immediately adjacent the subject sites and the sites do not lie within an "Earthquake Fault Zone" as defined by the State of California in Earthquake Fault Zoning Act. Table 3.1 presents a summary of known seismically active faults within 10 miles of the sites based on the 2008 USGS National Seismic Hazard Maps.

TABLE 3.1
Summary of Active Faults

Name	Distance (miles)	Slip Rate (mm/yr.)	Preferred Dip (degrees)	Slip Sense	Rupture Top (km)	Fault Length (km)
San Joaquin Hills	5.64	0.5	23	thrust	2	27
Puente Hills (Coyote Hills)	6.53	0.7	26	thrust	2.8	17
Newport Inglewood Connected alt 2	7.84	1.3	90	strike slip	0	208
Newport Inglewood Connected alt 1	7.94	1	88	strike slip	0	65
Newport-Inglewood, alt 1	7.94	1.3	89	strike slip	0	208

4.0 ANALYSES

4.1 SEISMICITY

Following ASCE7-16, Section 21.5.3, the mapped Maximum Considered Earthquake Geometric Mean (MCE_G) peak ground acceleration is $PGA_M = 0.639g$. Additional evaluation will be necessary to determine the site-specific value to be used for evaluation of liquefaction, lateral spreading, seismic settlements, and other soil-related issues. Based on the results of deaggregation analysis performed using USGS Unified Hazard Tool, the mean event associated with a probability of exceedance equal to 2% over 50 years has a moment magnitude of 6.68 and the mean distance to the seismic source is 8.1 miles.

4.2 STATIC SETTLEMENT

Analyses were performed to estimate settlement of footings for the anticipated loading conditions and configurations. Loading conditions for the proposed foundations are not known at this time. Based on previous experience, we have assumed the maximum load will not exceed 3 kips/ft. for continuous footing loads and 75 kips per column loads.

Based on the anticipated foundation loads and provided the existing surficial materials are removed and recompacted to provide a uniform layer of engineered compacted fill, the total and differential static settlements are not anticipated to exceed 1 inch and ½-inch over 30 feet, respectively, for the proposed residential structures.

4.3 LIQUEFACTION

Engineering research of soil liquefaction potential (Youd, et al., 2001) indicates that generally three basic factors must exist concurrently in order for liquefaction to occur. These factors include:

- A source of ground shaking, such as an earthquake, capable of generating soil mass distortions.
- A relatively loose silty and/or sandy soil.
- A relative shallow groundwater table (within approximately 50 feet below ground surface) or completely saturated soil conditions that will allow positive pore pressure generation.

The site is located within a State-designated zone of potentially liquefiable soils. Additionally, historic groundwater is about 10 feet below ground surface. The site is also predominately underlain by coarse grained materials which are susceptible to liquefaction. Groundwater was encountered at 37 feet below the existing grade during this firm's subsurface exploration although review of groundwater data from three nearby wells suggests that groundwater has not risen above 45 feet since 1979 and has predominantly been below a depth of 60 feet.

Our analysis indicates that liquefaction may occur below the site during periods of strong ground motion. Our analyses indicate liquefaction could lead to a total seismic settlement (saturated and dry) of the ground surface of up to approximately 3.7 inches due to seismic consolidation during liquefaction. Given this condition, differential settlement due to seismic settlement would likely be on the order of ½ of the total seismic settlement or approximately 1.9 inches over 30 feet.

If hazards from liquefaction were likely, these hazards can be mitigated to the extent required to reduce seismic risk to "acceptable levels." The use of well-reinforced foundations, such as post-tensioned slabs, grade beams with structural slabs, or mat foundations, has been proven to adequately provide basal support for similar structures during comparable liquefaction events.

5.0 CONCLUSIONS

5.1 FEASIBILITY OF PROPOSED DEVELOPMENT

From a geotechnical point of view, the proposed site development is considered feasible. Furthermore, it is also our opinion that the proposed development will not adversely impact the stability of adjoining properties. The adequacy and sufficiency of the preliminary findings and conclusions provided herein should be assessed based upon the final grading and structural plans. A supplemental geotechnical investigation report will be required for design, permitting and construction.

5.2 GEOLOGIC HAZARDS

5.2.1 Ground Rupture

From a geotechnical point of view, the proposed site development is considered feasible. Furthermore, it is also our opinion that the proposed development will not adversely impact the stability of adjoining properties. The adequacy and sufficiency of the preliminary findings and conclusions provided herein should be assessed based upon the final grading and structural plans. A supplemental geotechnical investigation report will be required for design, permitting and construction.

5.2.2 Ground Shaking

The site is situated in a seismically active area that has historically been affected by generally moderate to occasionally high levels of ground motion. The site lies in relatively close proximity to several seismically active faults; therefore, during the life of the proposed structures, the property will probably experience similar moderate to occasionally high ground shaking from these fault zones, as well as some background shaking from other seismically active areas of the Southern California region. Potential ground accelerations have been estimated for the site and are presented in Section 4.1 of this report. Design and construction in accordance with the current California Building Code (CBC 2022) requirements is anticipated to adequately address potential ground shaking.

5.2.3 Liquefaction

The site is mapped with a historical high groundwater level of approximately 10 feet. We have performed an evaluation of liquefaction potential. Based on our analyses, liquefaction may occur below the site during periods of strong ground motion using historic high groundwater. Our analyses indicate liquefaction could lead to a total seismic settlement (saturated and dry) of the ground surface of up to approximately 3.7 inches due to seismic consolidation during liquefaction. Given this condition, differential settlement due to seismic settlement would likely be on the order of ½ of the total seismic settlement or approximately 1.9 inches over 30 feet.

5.3 STATIC SETTLEMENT

Our exploration and laboratory testing indicated that portions of the underlying soils are relatively loose. However, provided the existing artificial fill soils are removed and recompacted, total and differential static settlement can likely be limited to a maximum of 1 inch and ½-inch over 30 feet, respectively. These estimated magnitudes of static settlements are considered within tolerable limits for the proposed residential structures.

5.4 EARTHWORK AND MATERIAL CHARACTERISTICS

In general, the existing fill materials are considered unsuitable in their existing condition to support proposed structural fills and site development. This condition can be mitigated by removal and recompaction of unsuitable soils. The anticipated depth of removal to mitigate structural load-induced settlement below the proposed residential buildings, retaining walls, and pavement is on the order of 2 feet below the existing ground surface. As mentioned previously, some localized areas of deeper artificial fills may be present onsite. A minimum of 2 feet of engineered fill should be placed to support the proposed buildings and retaining walls.

Temporary construction slopes and trench excavations can likely be cut vertically up to a height of 3 feet within the onsite materials provided that no surcharging of the excavations is present. Temporary excavations greater than 3 feet in height will likely require side laybacks to 1:1 (H:V) or flatter to mitigate the potential for sloughing. Vertical excavations exposing sandy materials will likely have no tolerance for a vertical cut and require laybacks at a 1.5:1 gradient (H:V). Site materials may be prone to sloughing and possible caving if allowed to dry. The sandy materials will limit vertical excavations along the property line.

Demolition of the existing site improvements will generate a concrete debris. Significant portions of concrete debris can likely be reduced in size to less than 4 inches and incorporated within fill soils during earthwork operations.

Onsite disposal systems, clarifiers and other underground improvements may be present beneath the site. If encountered during future rough grading, these improvements will require proper abandonment or removal.

Existing walls are present along all sides of the property lines. These walls are estimated to be retaining up to 2 feet within the northwest and southwest corner. If the proposed buildings are close to the existing walls, special considerations may be required in order to excavate along this wall. Additionally, any structures proposed near the wall will need to be supported such that surcharge loads are not applied to the existing wall.

Off-site improvements exist near the property lines. The presence of the existing off-site improvements may limit removals of unsuitable materials adjacent to the property lines. Therefore, construction of perimeter site walls may require deepened footings and/or additional reinforcement and additional control joints, where removals are restricted by property boundaries. The proposed perimeter walls may require A-B-C slot construction, in areas of sandy materials or where wall heights exceed 4 feet.

Subsurface soils are anticipated to be relatively easy to excavate with conventional heavy earthmoving equipment. Removal and recompaction of the site materials will result in some minor shrinkage and subsidence. Design of site grading will require consideration of this loss when evaluating earthwork balance issues.

The site soils encountered during our investigation were generally below or near optimum moisture content and will require the addition of water to achieve proper compaction.

5.5 SHRINKAGE AND BULKAGE

Volumetric changes in earth quantities will occur when excavated onsite soil materials are replaced as properly compacted fill. We estimate the existing upper earth materials will shrink approximately 10 to 15 percent due to the varying densities throughout the site. Subsidence of removal bottoms is estimated to be on the order of 0.15 feet. The estimates of shrinkage are intended as an aid for project engineers in determining earthwork quantities. However, these estimates should be used with some caution since they are not absolute values. Contingencies should be made for balancing earthwork quantities based on actual swelling and bulkage that occurs during the grading process.

5.6 SOIL EXPANSION

Based on USCS visual manual classification, the near-surface sandy soils within the site are generally anticipated to possess a **Very Low** expansion potential. Additional testing for soil expansion will be required subsequent to rough grading and prior to construction of foundations and other concrete work to confirm these conditions.

5.7 FOUNDATIONS

Conventional shallow spread and continuous footings may be utilized to support the proposed residential buildings and wall structures at the site. However, if liquefaction potential is considered to be a hazard, post-tensioned foundations may be used. Considering the **Very Low** expansion potential, the foundations for the proposed structures and other site improvements, such as retaining walls, screen walls, and flatwork, will likely require only nominal reinforcement and depths.

5.8 CONCRETE MIX DESIGN

Laboratory testing of onsite soil indicates negligible soluble sulfate content. Concrete designed to follow the procedures provided in ACI 318, Section 4.3, Table 4.3.1 for **negligible** sulfate exposure are anticipated to be adequate for mitigation of sulfate attack on concrete. Upon completion of rough grading, an evaluation of as-graded conditions and further laboratory testing will be required for the site to confirm or modify the conclusions provided in this section.

5.9 CORROSION POTENTIAL

Laboratory testing of onsite soil indicates indicate a minimum resistivity of 10,000 ohm-cm, chloride content of 65 ppm, and a pH of 7. Based on laboratory test results, site soils are **Slightly Corrosive** to metals. Structures fabricated from metals should have appropriate corrosion protection if they will be in direct contact with site soils. Under such conditions, a corrosion specialist should provide specific recommendations.

5.10 PAVEMENT SECTIONS

Existing near-surface sandy soils are anticipated to have a moderate R-value. Based on the assumed R-value of 35 and a traffic index of 5, a preliminary pavement structural section of 3 inches asphaltic concrete over 5 inches of aggregate base, may be used for planning and estimating purpose. R-value testing will be required subsequent to rough grading and prior to construction of interior driveways to confirm these conditions.

5.11 PERCOLATION CHARACTERISTICS

Groundwater was encountered at 37 feet below the ground surface at the time of our investigation although literature indicates historical levels as shallow as 10 feet. As with most areas in southern California, ground water levels have generally been dropping due to water extraction and historical shallow levels are unlikely to occur in the future. Given the unusually high rainfall this past season, the current groundwater levels likely represent a relatively shallow condition over the last few decades. We estimate that future groundwater levels during the life of the project are unlikely to be shallower than 35 feet.

Soils located within the upper 35 feet are primarily sandy in nature with relatively high infiltration rates. Below a depth of 35 feet, materials encountered were predominately interbedded coarse-grained and fine grained soils that will tend to impede groundwater infiltration. Based on this condition, dry wells are feasible for use in infiltrating storm water. However, wells will need to be limited to a depth of 25 feet.

Preliminary analyses indicate that a dry well could likely provide a peak measured infiltration flow of approximately 0.038 cfs and the chamber empties within approximately 2.5 hours. The typical dry well is estimated to be 25 feet deep. We estimate the Design Capture Volume (DCV) will be about 2,500 ft^3. Assuming a factor of safety of 3.0 applied to our estimated flow rate of the dry well, we estimate the DCV can be treated within the required 72 hours using one dry well. We also estimate the system will require an additional retention storage of about 2,200 cubic feet placed upstream of the dry well. This retention storage can be accommodated by pipe or vault systems. Further percolation testing and/or evaluation may be necessary based on review of preliminary WQMP design plans.

6.0 LIMITATIONS

This report is based on the proposed development and geotechnical data as described herein. The materials described herein and in other literature are believed representative of the total project area, and the conclusions contained in this report are presented on that basis. However, soil materials can vary in characteristics between points of exploration, both laterally and vertically, and those variations could affect the conclusions and recommendations contained herein. As such, observation and testing by a geotechnical consultant prior to and during the grading and construction phases of the project are essential to confirming the basis of this report.

This report summarizes several geotechnical topics that should be beneficial for project planning and budgetary evaluations. *The information presented herein is intended only for a preliminary feasibility evaluation and* ***is not*** *intended to satisfy the requirements of a site specific and detailed geotechnical investigation required for further planning and permitting.*

This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty.

This report should be reviewed and updated after a period of one year or if the site ownership or project concept changes from that described herein.

This report has been prepared for the exclusive use of **The Olson Company** to assist the project consultants in determining the feasibility of the proposed development. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

Respectfully submitted,

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EXPLANATION
(Locations Approximate)

⊕ - Exploratory Boring

▲ - Percolation Test Boring

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ALBUS & ASSOCIATES

GEOTECHNICAL MAP

Job No.: 3157.00	Date: 12/06/2022	Plate: 1

APPENDIX A

EXPLORATION LOGS

Field Identification Sheet

- Light gray
- Gray
- Dark gray
- Gray Brown
- Light brown
- Brown
- Dark Brown
- Olive brown
- Olive
- Yellow
- Yellowish brown
- Yellowish red
- Red
- Reddish Brown
- Tan

Description Order:

Description, Color, Moisture, Density, Grain Size, Additional Description

Description	%	Example
	0-5	Sand
trace	5-15	Sand trace Silt
with	15-30	Sand with Silt
	30+	Silty Sand

More Examples

Sand with Silt trace Clay
Sand trace Silt and Clay
Sand with Silt and Clay
Gravelly Sand with Silt trace Clay
Silty Clay with Sand trace Gravel

Moisture

Dry	absence of water
Damp	below optimum
Moist	near optimum
Very Moist	above optimum
Wet	free water visible

Density (Navfac)

Coarse grained soils	SPT	CA
Very Loose	0-3	0-5
Loose	3-8	5-13
Medium Dense	8-14	13-22
Dense	14-25	22-40
Very Dense	25>	40>

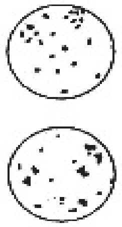
Fine grained soils		
Very Soft	2<	0-3
Soft	2-4	3-6
Medium Stiff	4-8	6-13
Stiff	8-15	13-24
Very Stiff	15-30	24-48
Hard	30>	48>

Grain Size

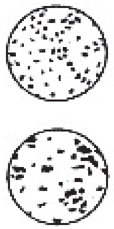
Description		Sieve Size	Approx. Size
Boulders		>12"	Larger than basketball
Cobbles		3-12"	Fist to basketball
Gravel	coarse	3/4-3"	Thumb to Fist
	fine	#4-3/4"	Pea to Thumb
Sand	coarse	#10-4	Rock Salt to Pea
	medium	#40-10	Sugar to Rock Salt
	fine	#200-40	Flour to Sugar
Fines		Pass #200	Smaller than Flour

Additional Description (ie. roots, pinhole pores, debris, etc.)

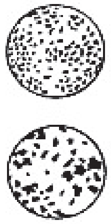
Trace 5%



Moderate 15%



Abundant 30%



EXPLORATION LOG

Project:
Location:
Address:
Elevation:
Job Number:
Client:
Date:
Drill Method:
Driving Weight:
Logged By:

Depth (feet)	Lithology	Material Description	Water	Samples			Laboratory Tests		
				Blows Per Foot	Core	Bulk	Moisture Content (%)	Dry Density (pcf)	Other Lab Tests
		EXPLANATION							
		Solid lines separate geologic units and/or material types.							
5		Dashed lines indicate unknown depth of geologic unit change or material type change.							
		Solid black rectangle in Core column represents California Split Spoon sampler (2.5in ID, 3in OD).			■				
		Double triangle in core column represents SPT sampler.			⧗				
10		**Vertical Lines** in core column represents Shelby sampler.			▥				
		Solid black rectangle in Bulk column respresents large bag sample.				■			
		Other Laboratory Tests:							
15		Max = Maximum Dry Density/Optimum Moisture Content							
		EI = Expansion Index							
		SO4 = Soluble Sulfate Content							
		DSR = Direct Shear, Remolded							
		DS = Direct Shear, Undisturbed							
		SA = Sieve Analysis (1" through #200 sieve)							
		Hydro = Particle Size Analysis (SA with Hydrometer)							
20		200 = Percent Passing #200 Sieve							
		Consol = Consolidation							
		SE = Sand Equivalent							
		Rval = R-Value							
		ATT = Atterberg Limits							

Albus & Associates, Inc.

Plate A-1

EXPLORATION LOG B-1

JOB NO. 3157.00	CLIENT/PROJECT The Olson Company	DAY Tuesday	DATE 2023-05-23
LOCATION 12828 Newhope Street, Garden Grove	LATITUDE 33.77704	LONGITUDE -117.92861	ELEVATION 94.7
LOGGED BY ddalbus	DRILLER 2R Drilling	DRILL METHOD Hollow-Stem Auger	DRIVING WEIGHT 140 lbs / 30 in

DEPTH	LITHO	DESCRIPTION	H2O	COR	BAG	BLOW COUNT	MC (%)	DD (pcf)	LAB
1	▬	Asphalt							
2		**Artificial Fill (Af)** Sand trace Silt (SP): gray, moist, loose, fine to medium grained		▨		13	19.5	99.7	
3									
4		**Alluvial Fan Deposits (Qyfa)** Sand trace Silt (SP): gray, moist, loose, fine to medium grained, trace pinhole pores		▨		12	8.8	103.3	consol
5									
6		@ 4 ft, trace pinhole pores		▨		14	11.2	103	
7		@ 6 ft, medium dense, trace pinhole pores							
8									
9									
10		Sand (SP): light gray, dry, medium dense, fine to coarse grained sand		▨		27	2	101.4	
11									
12									
13									
14									
15		Silty Sand (SM): gray, moist, medium dense, fine grained sand		⧗		12			200
16									
17									
18									
19									
20		Sand (SP): light gray, dry to damp, dense, fine to coarse grained		⧗		27			200
21									
22									
23									
24									
25		Silty Sand (SM): gray, moist, dense, fine grained		⧗		18			
26									
27									
28									
29									

EXPLORATION LOG B-1

JOB NO.	CLIENT/PROJECT	DAY	DATE
3157.00	The Olson Company	Tuesday	2023-05-23

LOCATION	LATITUDE	LONGITUDE	ELEVATION
12828 Newhope Street, Garden Grove	33.77704	-117.92861	94.7

LOGGED BY	DRILLER	DRILL METHOD	DRIVING WEIGHT
ddalbus	2R Drilling	Hollow-Stem Auger	140 lbs / 30 in

DEPTH	LITHO	DESCRIPTION	H2O	COR	BAG	BLOW COUNT	MC (%)	DD (pcf)	LAB
	⁙	Sand (SP): light gray, dry to damp, dense, fine grained		⧗		20			
31									
32									
33									
34									
35	▨	Sandy Clay (CL): gray, moist to very moist, loose, fine grained		⧗		4	23.7		200 att
36									
37									
38									
39									
40	⁞	Sand trace Silt (SP): gray, wet, medium dense, fine to medium grained		⧗		10			
41	▨	Sandy Clay (CL): gray, very moist, very stiff, fine grained							
42									
43									
44									
45	⁙	Sand (SP): gray, wet, medium dense, fine to coarse grained		⧗		10			
46	▨	Sandy Clay (CL): gray, very moist, very stiff, fine grained							
47									
48									
49									
50	▨	Sandy Clay (CL): gray, very moist to wet, hard, fine grained		⧗		23			
51									
52		Total Depth 51.5 feet Groundwater 37 feet Boring backfilled with soil cuttings							
53									
54									
55									
56									
57									
58									
59									

EXPLORATION LOG B-2

JOB NO. 3157.00	CLIENT/PROJECT The Olson Company	DAY Tuesday	DATE 2023-05-23
LOCATION 12828 Newhope Street, Garden Grove	LATITUDE 33.77701	LONGITUDE -117.92846	ELEVATION 95.2
LOGGED BY ddalbus	DRILLER 2R Drilling	DRILL METHOD Hollow-Stem Auger	DRIVING WEIGHT 140 lbs / 30 in

DEPTH	LITHO	DESCRIPTION	H2O	COR	BAG	BLOW COUNT	MC (%)	DD (pcf)	LAB
		Asphalt			▨				max so4 ph resist ch
1		**Artificial Fill (Af)** Sand trace Silt (SP): gray, moist, loose, fine grained			▨				
2		**Alluvial Fan Deposits (Qyfa)** Sand trace Silt (SP): gray, moist, loose, fine grained, trace pinhole pores and roots		▨	▨	13	7.2	94.7	
3				▨	▨				
4		@ 4 ft, medium dense, trace pinhole pores		▨	▨	14	8.2	101	
5				▨					
6		Sand with Silt (SP): gray, moist, loose, fine grained, trace pinhole pores		▨		12	8	95.8	consol
7				▨					
8									
9									
10		Sand trace Silt (SP): gray, very moist, medium dense, fine grained, trace pinhole pores and roots		▨		20	4.3	103.3	
11				▨					
12		Total Depth 11.5 feet No Groundwater Boring backfilled with soil cuttings							
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

EXPLORATION LOG B-3

JOB NO. 3157.00	CLIENT/PROJECT The Olson Company	DAY Tuesday	DATE 2023-05-23
LOCATION 12828 Newhope Street, Garden Grove	LATITUDE 33.77701	LONGITUDE -117.92808	ELEVATION 93.9
LOGGED BY ddalbus	DRILLER 2R Drilling	DRILL METHOD Hollow-Stem Auger	DRIVING WEIGHT 140 lbs / 30 in

DEPTH	LITHO	DESCRIPTION	H2O	COR	BAG	BLOW COUNT	MC (%)	DD (pcf)	LAB
		Asphalt							
1		**Artificial Fill (Af)** Silty Sand trace Clay (SM): gray, very moist, medium dense, fine grained							
2				▨		19	16.7	107.4	
3		**Alluvial Fan Deposits (Qyfa)** Silty Sand trace Clay (SM): gray, very moist, medium dense, fine grained, trace pinhole pores and roots							
4				▨		12	5.7	99.7	consol
5		Sand (SP): gray, moist, loose, fine to medium grained							
6		@ 6 ft, medium dense, fine to coarse grained		▨		18	4.5	100.6	
7									
8									
9									
10		@ 10 ft, more coarse grained sand		▨		21	2.2	99.3	
11									
12		Total Depth 11.5 feet No Groundwater Boring backfilled with soil cuttings							
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									

APPENDIX B

LABORATORY TEST PROGRAM

LABORATORY TESTING PROGRAM

Soil Classification

Soils encountered within the exploratory borings were initially classified in the field in general accordance with the visual-manual procedures of the Unified Soil Classification System (ASTM D 2487). The samples were re-examined in the laboratory and classifications reviewed and then revised where appropriate. The assigned group symbols are presented on the Exploration Logs provided in Appendix A.

In Situ Moisture and Density

Moisture content and unit dry density of in-place soil materials were determined in representative strata. Test data are summarized in the Boring Logs, Appendix A.

Maximum Dry Density and Optimum Moisture Content

Maximum dry density and optimum moisture content were performed on representative samples of the site materials obtained from our field explorations. The test was performed in accordance with ASTM D 1557. Pertinent test values are given in Table B.

Soluble Sulfate Content

Chemical analysis is being performed on selected samples to determine soluble sulfate content. The test was performed in accordance with California Test Method No. 417. The test result is still pending.

Atterberg Limits

Atterberg Limits (Liquid Limit, Plastic Limit, and Plasticity Index) were performed in accordance with Test Method ASTM D4318. Pertinent test values are presented in Table B-1.

Consolidation

Consolidation tests were performed for selected soil samples in general conformance with ASTM D 2435. Axial loads were applied in several increments to a laterally restrained 1-inch-high sample. Loads were applied in geometric progression by doubling the previous load, and the resulting deformations were recorded at selected time intervals. Results of the tests are graphically presented on Plates B-1 thru B-3.

Percent Passing the No. 200 Sieve

Percent of material passing the No. 200 sieve was determined on selected samples to verify visual classifications performed in the field. These tests were performed in accordance with ASTM D1140-00. Test results are presented in Table B.

Direct Shear

Direct shear testing was performed for a selected soil sample remolded to 90 percent of the maximum dry density. This test was performed in general accordance with ASTM D3080-04. Three specimens were prepared for the test. The test specimens were artificially saturated, and then sheared under varied normal loads at a constant rate. The results are graphically presented on Plate B-4.

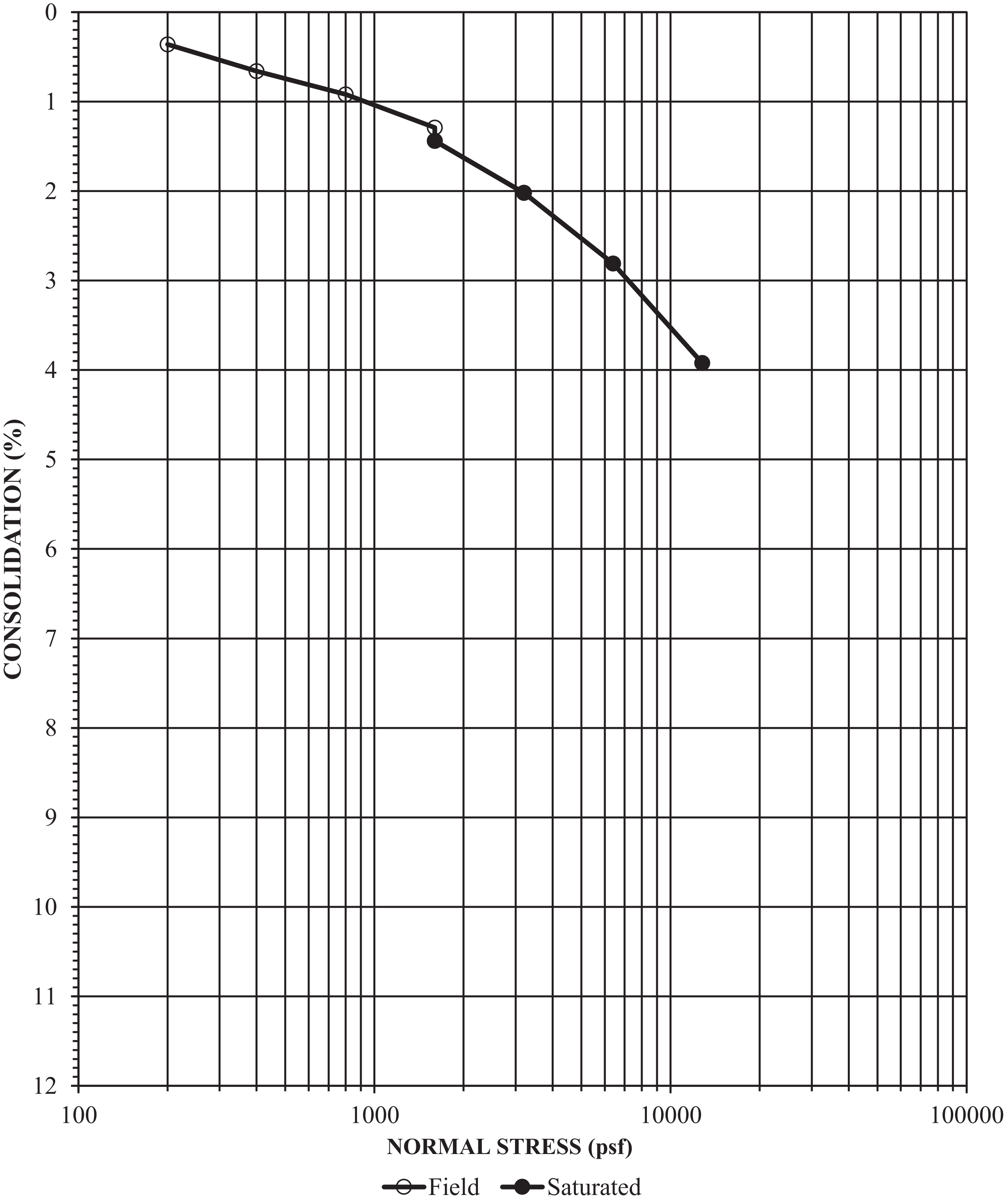
Corrosion

Select samples is being tested for minimum resistivity and pH in accordance with California Test Method 643. Results of these tests are still pending.

TABLE B
SUMMARY OF LABORATORY TEST RESULTS

Boring No.	Sample Depth (ft)	Soil Description	Test Results	
B-1	15	Silty Sand (SM)	Passing #200 Sieve (%):	23
B-1	20	Sand trace Silt (SP)	Passing #200 Sieve (%):	6
B-1	35	Sandy Clay (CL)	Passing #200 Sieve (%): Liquid Limit: Plastic Index:	66.3 33 14
B-2	0-5	Sand with Silt (SP)	Max. Dry Density (pcf): Opt. Moisture Content (%): Soluble Sulfate Content: Sulfate Exposure: Resistivity (ohm-cm): pH: Chloride content (ppm):	123.5 11 0.000 % Negligible 10,000 7 65

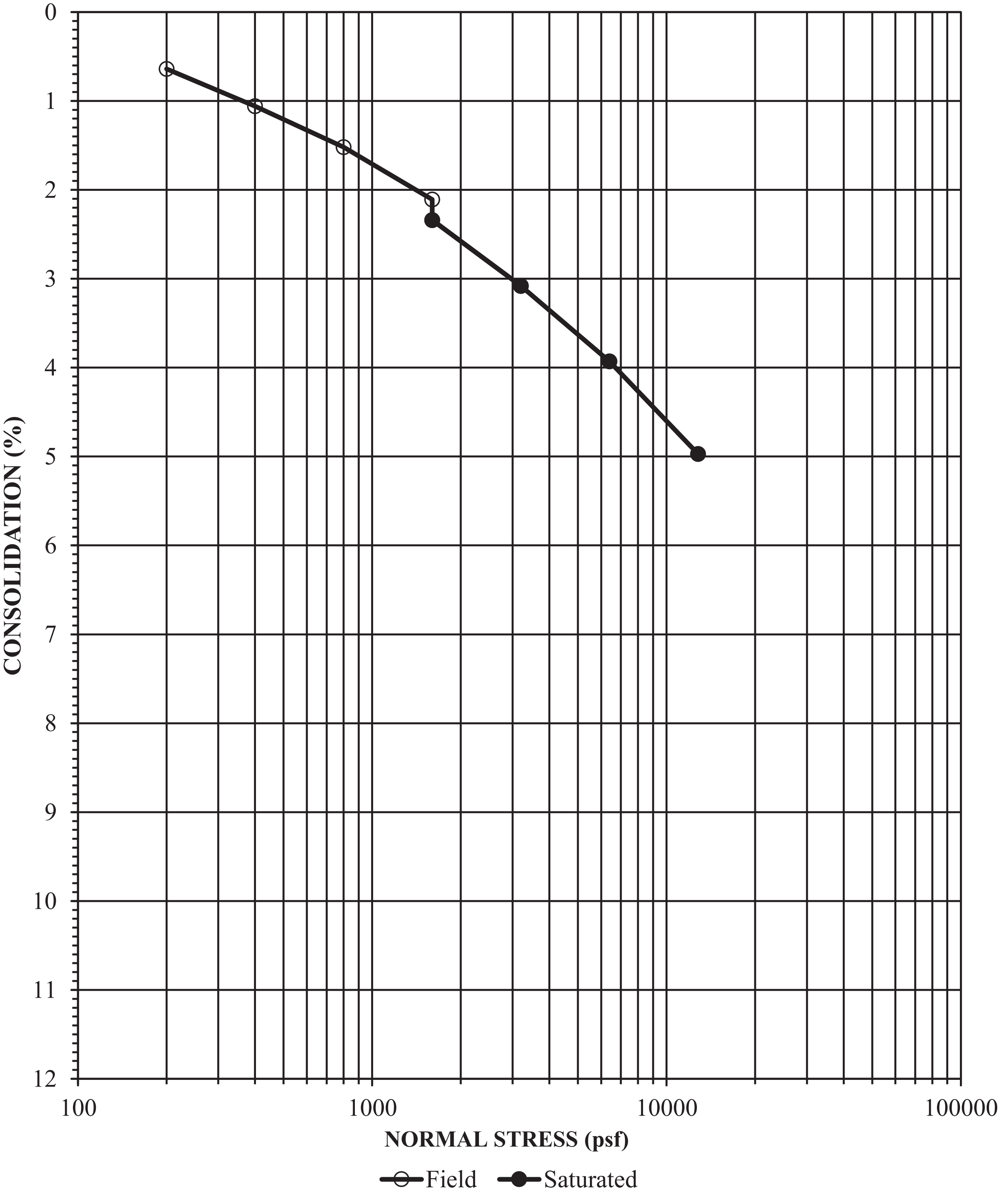
CONSOLIDATION



Job Number	Location	Depth	Description
3157.00	B-1	4	Sand trace Silt (SP)

Initial Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Concent (%)

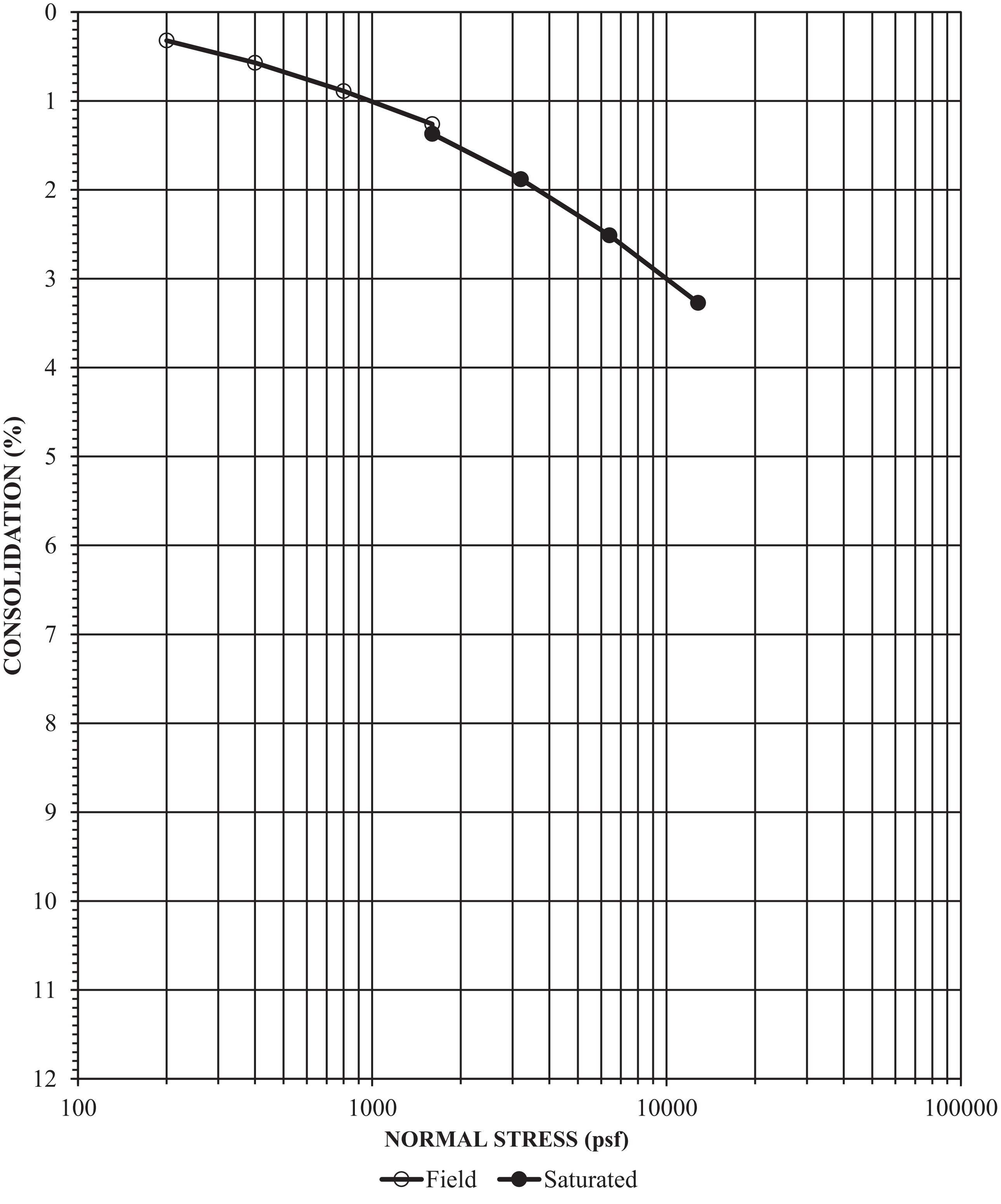
CONSOLIDATION



Job Number	Location	Depth	Description
3157.00	B-2	6	Sand (SP)

Initial Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Concent (%)

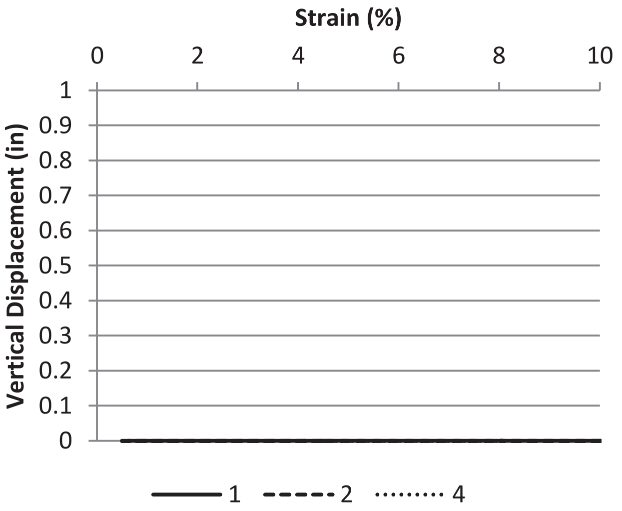
CONSOLIDATION

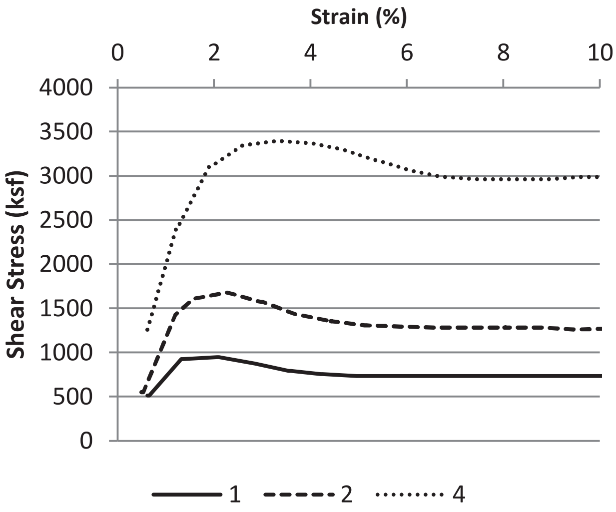


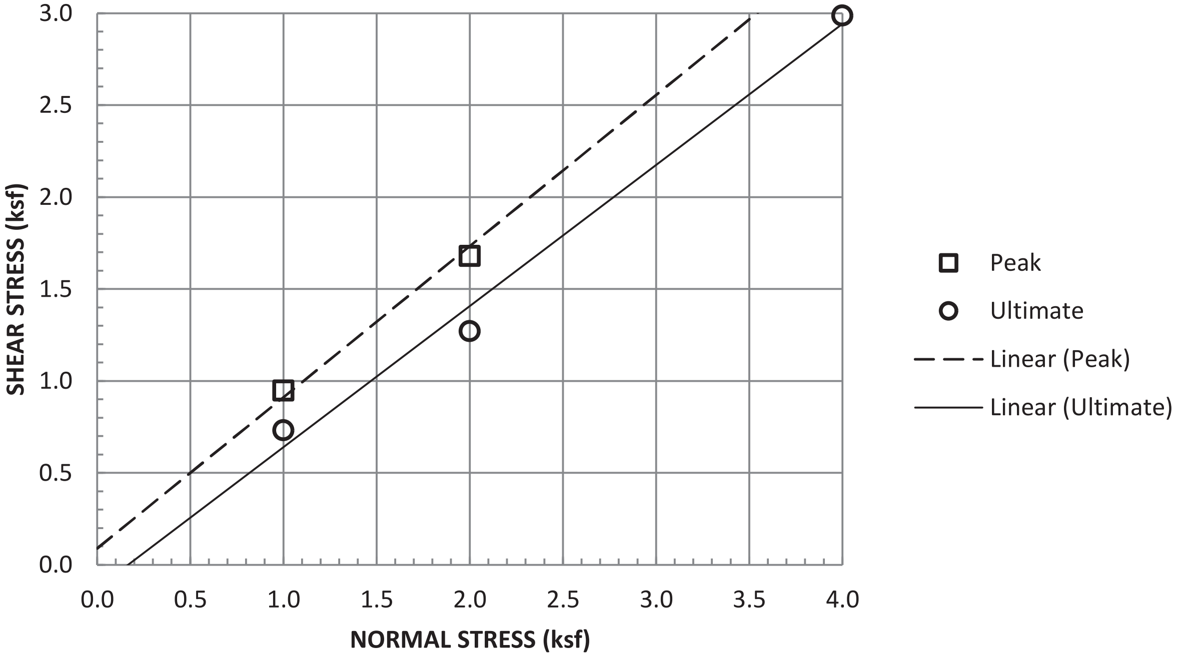
Job Number	Location	Depth	Description
3157.00	B-3	4	Sand (SP)

Initial Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Concent (%)

DIRECT SHEAR







Sample Type:	Remolded, Saturated		
Normal Stress (ksf)	1	2	4
Peak Shear Stress (ksf)	0.948	1.68	3.396
Peak Displacement (in)	0	0	0
Ultimate Shear Stress (ksf)	0.732	1.272	2.988
Ultimate Displacement (in)	948	1680	3396
Initial Dry Density (pcf)	111.2	111.3	111.3
Initial Moisture Content (%)	11	11	11
Final Moisture Content (%)	17	16.8	16.9
Strain Rate (in/min)	.035		

Job Number	Location	Depth	Description
3157.00	B-2	0-5	Sand with Silt (SP)

APPENDIX C

LIQUEFACTION ANALYSES

TABLE C-1

ANALYSIS OF LIQUEFACTION POTENTIAL
BORING: B-1 (2%PE in 50 yrs; FS=1.3)

Client:
J.N.
Site:

Hammer Type (D,S,A)	**A**	[Ce= D 0.75, S 0.95, A Hammer Efficiency]		
Boring Diameter, ID (in)	**4**			
Site Acceleration (g)	**0.683**	PGAm w/o MSF		
for a Magnitude (Mw) of	**6.68**	Corresponding to 2%PE in 50 yrs		
and MSF of	**1.41**		Analysis Type:	General
Depth to High GW	**10.0**	ft.	FS for Liquefaction:	**1.3**
Depth to GW during invest.	**37.0**	ft.	FS for Liqu. Settlement:	**1.3**
Hammer Efficiency	**90.1**	%	PI Threshold for Liquefaction:	**12**
Sublayer Thickness	**1.0**	ft.	Min. Moisture Cnt for Liqu. (%LL)	**85**
Depth of Analysis	**50.0**	ft.	Max FS for Plotting:	**5.0**

Layer Label (Auto)	**Depth Interval (ft)**		**Layer Mid-Depth (ft)**	**Soil Type (USCS)**	**Fines <#200 Sieve (%)**	**LL (%)**	**PI**	**M (%)**	**Field Nf (bls/ft)**	**Sample Type SPT/CA**	**Soil Wet Density (pcf)**
	Top	**Bottom**									
1	0.0	5.0	2.5	SP	15				12	CA	115
2	5.0	10.0	7.5	SP	15				14	CA	115
3	10.0	15.0	12.5	SP	5				27	CA	105
4	15.0	20.0	17.5	SM	23				12	SPT	105
5	20.0	25.0	22.5	SP	6				27	SPT	105
6	25.0	30.0	27.5	SM	23				18	SPT	105
7	30.0	35.0	32.5	SP	5				20	SPT	105
8	35.0	40.0	37.5	CL	66	33	14	23.7	4	SPT	105
9	40.0	41.0	40.5	SP	5				10	SPT	105
10	41.0	45.0	43.0	CL	60	33	14	24	10	SPT	120
11	45.0	46.0	45.5	SP	5				10	SPT	105
12	46.0	50.0	48.0	CL	60	33	14	24	10	SPT	120
13	50.0	51.5	50.8	CL	60	33	14	24	23	SPT	120
14	51.5										
15	51.6										

TABLE C-2
ANALYSIS OF LIQUEFACTION POTENTIAL
BORING: B-1 (2%PE in 50 yrs; FS=1.3)

SP

Client:	0	
J.N.	0	
Site:	0	
Hammer Type (D,S,A)	A	
Boring Diameter, ID (in)	4	
Site Acceleration (g)	0.683	
for a Magnitude (Mw) of	6.68	
and MSF of	1.41	
Depth to High GW	10	ft.
Depth to GW during invest.	37	ft.
Hammer Efficiency	90.1	%
Sublayer Thickness	1	ft.
Depth of Boring	50	ft.

FS for Liquefaction:	1.3
FS for Liqu. Settlement:	1.3
PI Threshold for Liquefaction:	12
Moisture Cnt Threshold for Liqu. (%LL)	85

Notes: Underlined numbersare estimated values.
(1) Based on current groundwater conditions at the time of investigation.
(2) Based on assumed/proposed high groundwater conditions.
(3) Kα=1.0

(4)
A Layer is located above historically high groundwater
B Factor of Saftey is greater than the specified value of FS=1.3
C The $(N_1)_{60\text{-cs}}$ is greater than 30 blows per foot
D PI > 12 or the in situ moisture content (M%) < 85% LL

Reference: Youd, T.L., et.al., (2001), "Liquefaction Resistance of Soils: Summary Report From The 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils", ASCE Journal of Geotechnical and Geoenvironmental Engineering, Vol.127, No.10, pp.817-833, October, 2001.

Layer Label	Depth Interval (ft)		Layer Mid-Depth (ft)	Soil Type (USCS)	Fines <#200 Sieve (%)	LL (%)	PI	M (%)	Field Nf (bls/ft)	Sample Type SPT/CA	Soil Wet Density (pcf)	Total Stress (psf)$^{(1)}$	Effec. Stress (psf)$^{(1)}$	C_n	C_e	C_b	C_r	C_L	$(N_1)_{60}$ (lbs/ft)	α	β	$(N_1)_{60\text{-cs}}$ (lbs/ft)	Effec. Stress (psf)$^{(2)}$	R_d	CRR (M=7.5)	Kσ	CSR	FS $^{(3)}$	To Liquefy Y/N?	Reason$^{(4)}$ not Liquifiable
	Top	Bottom																												
																												1.30		
1	0.0	1.0	0.5	SP	15				12	CA	115	58	58	1.7	1.50	1.00	0.75	1.0	12.9	2.5	1.05	16.0	58	1.00	NA	1.00	0.44	NA	N	A
1	1.0	2.0	1.5	SP	15				12	CA	115	173	173	1.7	1.50	1.00	0.75	1.0	12.9	2.5	1.05	16.0	173	1.00	NA	1.00	0.44	NA	N	A
1	2.0	3.0	2.5	SP	15				12	CA	115	288	288	1.6	1.50	1.00	0.75	1.0	12.4	2.5	1.05	15.5	288	0.99	NA	1.00	0.44	NA	N	A
1	3.0	4.0	3.5	SP	15				12	CA	115	403	403	1.6	1.50	1.00	0.75	1.0	12.0	2.5	1.05	15.0	403	0.99	NA	1.00	0.44	NA	N	A
1	4.0	5.0	4.5	SP	15				12	CA	115	518	518	1.5	1.50	1.00	0.75	1.0	11.5	2.5	1.05	14.6	518	0.99	NA	1.00	0.44	NA	N	A
2	5.0	6.0	5.5	SP	15				14	CA	115	633	633	1.5	1.50	1.00	0.75	1.0	12.9	2.5	1.05	16.0	633	0.99	NA	1.00	0.44	NA	N	A
2	6.0	7.0	6.5	SP	15				14	CA	115	748	748	1.4	1.50	1.00	0.80	1.0	13.3	2.5	1.05	16.4	748	0.99	NA	1.00	0.44	NA	N	A
2	7.0	8.0	7.5	SP	15				14	CA	115	863	863	1.4	1.50	1.00	0.80	1.0	12.8	2.5	1.05	16.0	863	0.98	NA	1.00	0.44	NA	N	A
2	8.0	9.0	8.5	SP	15				14	CA	115	978	978	1.3	1.50	1.00	0.80	1.0	12.4	2.5	1.05	15.5	978	0.98	NA	1.00	0.44	NA	N	A
2	9.0	10.0	9.5	SP	15				14	CA	115	1093	1093	1.3	1.50	1.00	0.85	1.0	12.8	2.5	1.05	15.9	1093	0.98	NA	1.00	0.44	NA	N	A
3	10.0	11.0	10.5	SP	5				27	CA	105	1103	1103	1.3	1.50	1.00	0.85	1.0	24.6	0.0	1.00	24.6	1071	0.98	0.28	1.00	0.44	0.91	Y	
3	11.0	12.0	11.5	SP	5				27	CA	105	1208	1208	1.2	1.50	1.00	0.85	1.0	23.9	0.0	1.00	23.9	1114	0.97	0.27	1.00	0.46	0.83	Y	
3	12.0	13.0	12.5	SP	5				27	CA	105	1313	1313	1.2	1.50	1.00	0.85	1.0	23.2	0.0	1.00	23.2	1157	0.97	0.26	1.00	0.48	0.76	Y	
3	13.0	14.0	13.5	SP	5				27	CA	105	1418	1418	1.2	1.50	1.00	0.85	1.0	22.6	0.0	1.00	22.6	1199	0.97	0.25	1.00	0.50	0.71	Y	
3	14.0	15.0	14.5	SP	5				27	CA	105	1523	1523	1.1	1.50	1.00	0.85	1.0	22.0	0.0	1.00	22.0	1242	0.97	0.24	1.00	0.52	0.66	Y	
4	15.0	16.0	15.5	SM	23				12	SPT	105	1628	1628	1.1	1.50	1.00	0.85	1.2	20.4	4.1	1.10	26.5	1284	0.96	0.33	1.00	0.54	0.85	Y	
4	16.0	17.0	16.5	SM	23				12	SPT	105	1733	1733	1.1	1.50	1.00	0.90	1.2	21.1	4.1	1.10	27.3	1327	0.96	0.35	1.00	0.56	0.87	Y	
4	17.0	18.0	17.5	SM	23				12	SPT	105	1838	1838	1.1	1.50	1.00	0.90	1.2	20.6	4.1	1.10	26.7	1370	0.96	0.33	1.00	0.58	0.80	Y	
4	18.0	19.0	18.5	SM	23				12	SPT	105	1943	1943	1.0	1.50	1.00	0.90	1.2	20.1	4.1	1.10	26.2	1412	0.96	0.32	1.00	0.58	0.77	Y	
4	19.0	20.0	19.5	SM	23				12	SPT	105	2048	2048	1.0	1.50	1.00	0.90	1.2	19.6	4.1	1.10	25.7	1455	0.96	0.31	1.01	0.60	0.72	Y	
5	20.0	21.0	20.5	SP	6				27	SPT	105	2153	2153	1.0	1.50	1.00	0.90	1.2	43.2	0.0	1.00	43.4	1497	0.95	NA	1.00	0.60	NA	N	C
5	21.0	22.0	21.5	SP	6				27	SPT	105	2258	2258	1.0	1.50	1.00	0.90	1.2	42.2	0.0	1.00	42.5	1540	0.95	NA	0.99	0.62	NA	N	C
5	22.0	23.0	22.5	SP	6				27	SPT	105	2363	2363	0.9	1.50	1.00	0.95	1.2	43.6	0.0	1.00	43.9	1583	0.95	NA	0.99	0.62	NA	N	C
5	23.0	24.0	23.5	SP	6				27	SPT	105	2468	2468	0.9	1.50	1.00	0.95	1.2	42.7	0.0	1.00	42.9	1625	0.95	NA	0.98	0.64	NA	N	C
5	24.0	25.0	24.5	SP	6				27	SPT	105	2573	2573	0.9	1.50	1.00	0.95	1.2	41.8	0.0	1.00	42.0	1668	0.94	NA	0.97	0.64	NA	N	C
6	25.0	26.0	25.5	SM	23				18	SPT	105	2678	2678	0.9	1.50	1.00	0.95	1.2	27.3	4.1	1.10	34.1	1710	0.94	NA	0.96	0.66	NA	N	C
6	26.0	27.0	26.5	SM	23				18	SPT	105	2783	2783	0.9	1.50	1.00	0.95	1.2	26.8	4.1	1.10	33.5	1753	0.94	NA	0.96	0.66	NA	N	C
6	27.0	28.0	27.5	SM	23				18	SPT	105	2888	2888	0.9	1.50	1.00	0.95	1.2	26.2	4.1	1.10	32.9	1796	0.94	NA	0.95	0.66	NA	N	C
6	28.0	29.0	28.5	SM	23				18	SPT	105	2993	2993	0.8	1.50	1.00	0.95	1.2	25.7	4.1	1.10	32.4	1838	0.93	NA	0.94	0.68	NA	N	C
6	29.0	30.0	29.5	SM	23				18	SPT	105	3098	3098	0.8	1.50	1.00	1.00	1.2	26.6	4.1	1.10	33.3	1881	0.93	NA	0.94	0.68	NA	N	C
7	30.0	31.0	30.5	SP	5				20	SPT	105	3203	3203	0.8	1.50	1.00	1.00	1.2	29.0	0.0	1.00	29.0	1923	0.93	0.41	0.93	0.68	0.79	Y	
7	31.0	32.0	31.5	SP	5				20	SPT	105	3308	3308	0.8	1.50	1.00	1.00	1.2	28.5	0.0	1.00	28.5	1966	0.92	0.39	0.92	0.68	0.74	Y	
7	32.0	33.0	32.5	SP	5				20	SPT	105	3413	3413	0.8	1.50	1.00	1.00	1.2	28.0	0.0	1.00	28.0	2009	0.91	0.37	0.92	0.68	0.70	Y	
7	33.0	34.0	33.5	SP	5				20	SPT	105	3518	3518	0.8	1.50	1.00	1.00	1.2	27.5	0.0	1.00	27.5	2051	0.90	0.35	0.91	0.68	0.66	Y	
7	34.0	35.0	34.5	SP	5				20	SPT	105	3623	3623	0.7	1.50	1.00	1.00	1.2	27.0	0.0	1.00	27.0	2094	0.89	0.34	0.90	0.68	0.63	Y	
8	35.0	36.0	35.5	CL	66	33	14	23.7	4	SPT	105	3728	3728	0.7	1.50	1.00	1.00	1.2	5.3	5.0	1.20	11.4	2136	0.89	NA	0.90	0.68	NA	N	D
8	36.0	37.0	36.5	CL	66	33	14	23.7	4	SPT	105	3833	3833	0.7	1.50	1.00	1.00	1.2	5.2	5.0	1.20	11.3	2179	0.88	NA	0.89	0.68	NA	N	D
8	37.0	38.0	37.5	CL	66	33	14	23.7	4	SPT	105	3938	3906	0.7	1.50	1.00	1.00	1.2	5.2	5.0	1.20	11.2	2222	0.87	NA	0.89	0.68	NA	N	D
8	38.0	39.0	38.5	CL	66	33	14	23.7	4	SPT	105	4043	3949	0.7	1.50	1.00	1.00	1.2	5.1	5.0	1.20	11.2	2264	0.86	NA	0.89	0.68	NA	N	D
8	39.0	40.0	39.5	CL	66	33	14	23.7	4	SPT	105	4148	3992	0.7	1.50	1.00	1.00	1.2	5.1	5.0	1.20	11.1	2307	0.85	NA	0.88	0.68	NA	N	D
9	40.0	41.0	40.5	SP	5				10	SPT	105	4253	4034	0.7	1.50	1.00	1.00	1.2	12.7	0.0	1.00	12.7	2349	0.85	0.14	0.88	0.68	0.25	Y	
10	41.0	42.0	41.5	CL	60	33	14	24	10	SPT	120	4980	4699	0.6	1.50	1.00	1.00	1.2	11.5	5.0	1.20	18.8	3014	0.84	NA	0.85	0.62	NA	N	D
10	42.0	43.0	42.5	CL	60	33	14	24	10	SPT	120	5100	4757	0.6	1.50	1.00	1.00	1.2	11.4	5.0	1.20	18.7	3072	0.83	NA	0.84	0.62	NA	N	D
10	43.0	44.0	43.5	CL	60	33	14	24	10	SPT	120	5220	4814	0.6	1.50	1.00	1.00	1.2	11.3	5.0	1.20	18.6	3130	0.82	NA	0.84	0.60	NA	N	D
10	44.0	45.0	44.5	CL	60	33	14	24	10	SPT	120	5340	4872	0.6	1.50	1.00	1.00	1.2	11.2	5.0	1.20	18.5	3187	0.81	NA	0.84	0.60	NA	N	D
11	45.0	46.0	45.5	SP	5				10	SPT	105	4778	4247	0.7	1.50	1.00	1.00	1.2	12.3	0.0	1.00	12.3	2562	0.81	0.13	0.87	0.66	0.25	Y	
12	46.0	47.0	46.5	CL	60	33	14	24	10	SPT	120	5580	4987	0.6	1.50	1.00	1.00	1.2	11.0	5.0	1.20	18.3	3302	0.80	NA	0.83	0.60	NA	N	D
12	47.0	48.0	47.5	CL	60	33	14	24	10	SPT	120	5700	5045	0.6	1.50	1.00	1.00	1.2	11.0	5.0	1.20	18.2	3360	0.79	NA	0.83	0.60	NA	N	D
12	48.0	49.0	48.5	CL	60	33	14	24	10	SPT	120	5820	5102	0.6	1.50	1.00	1.00	1.2	10.9	5.0	1.20	18.1	3418	0.78	NA	0.83	0.60	NA	N	D
12	49.0	50.0	49.5	CL	60	33	14	24	10	SPT	120	5940	5160	0.6	1.50	1.00	1.00	1.2	10.8	5.0	1.20	18.0	3475	0.77	NA	0.83	0.58	NA	N	D

TABLE C-3
LIQUEFACTION INDUCED SETTLEMENT
BORING B-1 (2%PE in 50 yrs; FS=1.3)

Client: 0

J.N. 0

Site: 0

Notes:

(1) Effective ER=55% normalized standard penetration resistance for clean sands, $(N_1)_{60\text{-}cs}$*1.1 (Seed, 1994).

(2) Volumetric strain (Ishihara and Yoshimine, 1992) using $(N_1)_{55\text{-}cs}$.

(3) Volumetric strain (Tokimatsu and Seed, 1987) using $(N_1)_{60\text{-}cs}$.

								Total δ (in.)		2.34	3.09	2.71
Depth Interval (ft)		Soil layer thickness (ft)	Fines <#200 Sieve (%)	$(N_1)_{60\text{-}cs}$	$(N_1)_{55\text{-}cs}$ (1)	FS	IY Percent ε_v (2)	CSR*	TS Percent ε_v (3)	IY δ (in.)	TS δ (in.)	Ave δ (in.)
Top	Bottom											
0.00	1.00	1.00	15	16.0	17.6	NA	**0.00**	0.44	**NA**	NA	NA	0
1.00	2.00	1.00	15	16.0	17.6	NA	**0.00**	0.44	**NA**	NA	NA	0
2.00	3.00	1.00	15	15.5	17.1	NA	**0.00**	0.44	**NA**	NA	NA	0
3.00	4.00	1.00	15	15.0	16.5	NA	**0.00**	0.44	**NA**	NA	NA	0
4.00	5.00	1.00	15	14.6	16.0	NA	**0.00**	0.44	**NA**	NA	NA	0
5.00	6.00	1.00	15	16.0	17.7	NA	**0.00**	0.44	**NA**	NA	NA	0
6.00	7.00	1.00	15	16.4	18.1	NA	**0.00**	0.44	**NA**	NA	NA	0
7.00	8.00	1.00	15	16.0	17.6	NA	**0.00**	0.44	**NA**	NA	NA	0
8.00	9.00	1.00	15	15.5	17.1	NA	**0.00**	0.44	**NA**	NA	NA	0
9.00	10.00	1.00	15	15.9	17.5	NA	**0.00**	0.44	**NA**	NA	NA	0
10.00	11.00	1.00	5	24.6	27.0	0.9	**0.78**	0.44	**1.46**	0.09	0.18	0.13
11.00	12.00	1.00	5	23.9	26.3	0.8	**1.10**	0.46	**1.49**	0.13	0.18	0.16
12.00	13.00	1.00	5	23.2	25.5	0.8	**1.16**	0.48	**1.52**	0.14	0.18	0.16
13.00	14.00	1.00	5	22.6	24.9	0.7	**1.47**	0.50	**1.54**	0.18	0.18	0.18
14.00	15.00	1.00	5	22.0	24.2	0.7	**1.57**	0.52	**1.56**	0.19	0.19	0.19
15.00	16.00	1.00	23	26.5	29.2	0.8	**0.86**	0.54	**1.40**	0.10	0.17	0.14
16.00	17.00	1.00	23	27.3	30.0	0.9	**0.60**	0.56	**1.38**	0.07	0.17	0.12
17.00	18.00	1.00	23	26.7	29.4	0.8	**0.85**	0.58	**1.39**	0.10	0.17	0.13
18.00	19.00	1.00	23	26.2	28.8	0.8	**0.90**	0.58	**1.41**	0.11	0.17	0.14
19.00	20.00	1.00	23	25.7	28.2	0.7	**1.13**	0.60	**1.43**	0.14	0.17	0.15
20.00	21.00	1.00	6	43.4	47.8	NA	**0.00**	0.60	**NA**	NA	NA	0
21.00	22.00	1.00	6	42.5	46.7	NA	**0.00**	0.62	**NA**	NA	NA	0
22.00	23.00	1.00	6	43.9	48.2	NA	**0.00**	0.62	**NA**	NA	NA	0
23.00	24.00	1.00	6	42.9	47.2	NA	**0.00**	0.64	**NA**	NA	NA	0
24.00	25.00	1.00	6	42.0	46.2	NA	**0.00**	0.64	**NA**	NA	NA	0
25.00	26.00	1.00	23	34.1	37.5	NA	**0.00**	0.66	**NA**	NA	NA	0
26.00	27.00	1.00	23	33.5	36.9	NA	**0.00**	0.66	**NA**	NA	NA	0
27.00	28.00	1.00	23	32.9	36.2	NA	**0.00**	0.66	**NA**	NA	NA	0
28.00	29.00	1.00	23	32.4	35.6	NA	**0.00**	0.68	**NA**	NA	NA	0
29.00	30.00	1.00	23	33.3	36.7	NA	**0.00**	0.68	**NA**	NA	NA	0
30.00	31.00	1.00	5	29.0	31.9	0.8	**0.67**	0.68	**1.33**	0.08	0.16	0.12
31.00	32.00	1.00	5	28.5	31.3	0.7	**0.83**	0.68	**1.34**	0.10	0.16	0.13
32.00	33.00	1.00	5	28.0	30.8	0.7	**0.88**	0.68	**1.35**	0.11	0.16	0.13
33.00	34.00	1.00	5	27.5	30.2	0.7	**0.93**	0.68	**1.37**	0.11	0.16	0.14
34.00	35.00	1.00	5	27.0	29.7	0.6	**1.18**	0.68	**1.38**	0.14	0.17	0.15
35.00	36.00	1.00	66	11.4	12.5	NA	**0.00**	0.68	**NA**	NA	NA	0
36.00	37.00	1.00	66	11.3	12.4	NA	**0.00**	0.68	**NA**	NA	NA	0
37.00	38.00	1.00	66	11.2	12.3	NA	**0.00**	0.68	**NA**	NA	NA	0
38.00	39.00	1.00	66	11.2	12.3	NA	**0.00**	0.68	**NA**	NA	NA	0
39.00	40.00	1.00	66	11.1	12.2	NA	**0.00**	0.68	**NA**	NA	NA	0
40.00	41.00	1.00	5	12.7	13.9	0.3	**2.22**	0.68	**2.18**	0.27	0.26	0.26
41.00	42.00	1.00	60	18.8	20.7	NA	**0.00**	0.62	**NA**	NA	NA	0
42.00	43.00	1.00	60	18.7	20.5	NA	**0.00**	0.62	**NA**	NA	NA	0
43.00	44.00	1.00	60	18.6	20.4	NA	**0.00**	0.60	**NA**	NA	NA	0
44.00	45.00	1.00	60	18.5	20.3	NA	**0.00**	0.60	**NA**	NA	NA	0
45.00	46.00	1.00	5	12.3	13.5	0.2	**2.33**	0.66	**2.22**	0.28	0.27	0.27
46.00	47.00	1.00	60	18.3	20.1	NA	**0.00**	0.60	**NA**	NA	NA	0
47.00	48.00	1.00	60	18.2	20.0	NA	**0.00**	0.60	**NA**	NA	NA	0
48.00	49.00	1.00	60	18.1	19.9	NA	**0.00**	0.60	**NA**	NA	NA	0
49.00	50.00	1.00	60	18.0	19.8	NA	**0.00**	0.58	**NA**	NA	NA	0

TABLE C-4
ANALYSIS OF DRY SEISMIC SETTLEMENT POTENTIAL
BORING B-1 (2%PE in 50 yrs; FS=1.3)

Client: 0
J.N. 0
Site: 0

GW Depth: 10 feet
EQ Magnitude 6.68
MSF 1.41

Total Seismic Settlement of Unsaturated Soil w/ FS=2.0 (in): 0.96
Subtotal Seismic Settlement of Unsaturated Soil (in) 0.48
Total Thickness of Unsaturated Soil (ft) 10.0

Layer Mid-Depth (ft.)	**Soil Type**	**Eff. Stress σ'_{vo}(tsf)**	**Clean Sand $(N_1)_{60}$**	**CSR**	**(psf) τ_{avg} Avg. Shear Stress**	**(tsf) σ_m' Mean Bulk Stress**	**(tsf) G_{max} Max. Dyn.Shr. Mod.**	**γ_{eff} (G_{eff}/G_{max})**	**Eff. Cyclic Shr.Strain γ_{eff}**	**Eff. Cyclic Shr.Strain γ_{eff}** (%)	**Volume Strain (%)**	**EQ Mag. Factor**	**Layer Thickness (ft.)**	**Estimated Dry Sand Seismic Settlement (in.)**
									Fig.11		Fig.13			
0.5	SP	0.03	16.0	0.44	25.3	0.02	152.6	8.29E-05	1.66E-04	1.66E-02	2.20E-02	1.41	1.0	0.002
1.5	SP	0.09	16.0	0.44	75.9	0.06	264.3	1.44E-04	5.25E-04	5.25E-02	6.96E-02	1.41	1.0	0.006
2.5	SP	0.14	15.5	0.44	126.5	0.09	338.1	1.87E-04	2.07E-03	2.07E-01	2.84E-01	1.41	1.0	0.024
3.5	SP	0.20	15.0	0.44	177.1	0.13	395.6	2.24E-04	8.06E-03	8.06E-01	9.83E-01	1.41	1.0	0.084
4.5	SP	0.26	14.6	0.44	227.7	0.17	443.8	2.57E-04	6.16E-03	6.16E-01	8.44E-01	1.41	1.0	0.072
5.5	SP	0.32	16.0	0.44	278.3	0.21	506.7	2.75E-04	2.62E-03	2.62E-01	3.45E-01	1.41	1.0	0.029
6.5	SP	0.37	16.4	0.44	328.9	0.24	555.3	2.96E-04	4.02E-03	4.02E-01	5.13E-01	1.41	1.0	0.044
7.5	SP	0.43	16.0	0.44	379.5	0.28	590.7	3.21E-04	6.77E-03	6.77E-01	8.19E-01	1.41	1.0	0.070
8.5	SP	0.49	15.5	0.44	430.1	0.32	623.0	3.45E-04	7.38E-03	7.38E-01	8.97E-01	1.41	1.0	0.077
9.5	SP	0.55	15.9	0.44	480.7	0.36	663.8	3.62E-04	6.91E-03	6.91E-01	8.35E-01	1.41	1.0	0.071