John R. Byerly
INCORPORATED

GEOTECHNICAL INVESTIGATION

MAY 16, 2024

TERRACE VIEW ELEMENTARY SCHOOL

PROPOSED MODULAR CLASSROOM BUILDING

22731 GRAND TERRACE ROAD

GRAND TERRACE, CALIFORNIA

CLIENT:

COLTON JOINT UNIFIED SCHOOL DISTRICT

1212 NORTH VALENCIA DRIVE

COLTON, CALIFORNIA 92324

ATTENTION: OWEN CHANG, DIECTOR OF FACILITIES, PLANNING, AND CONSTRUCTION

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RPT. NO.: 8301
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INTRODUCTION

During April and May of 2024, an investigation of the soil conditions underlying the proposed modular classroom building area at the existing Terrace View Elementary School was conducted by this firm. The purpose of our investigation was to evaluate the surface and subsurface conditions at the site with respect to safe and economical foundation types, vertical and lateral bearing values, liquefaction and seismic settlement potential, and site preparation. Included in the recommendations are the seismic design parameters as required by the 2022 California Building Code and the ASCE Standard 7-16. Recommendations are also provided for the design of portland cement concrete pavement to receive only pedestrian traffic. We have reviewed the requirements of the Division of the State Architect (DSA) regarding the evaluation of geologic conditions associated with this site. We understand that the proposed modular classroom building will be a single-story, wood or light gauge frame structure, and will have a footprint area of less than 4,000 square feet, therefore; in accordance with DSA IR A-4, a geologic hazards report will not be required for this project. Our geotechnical investigation, together with our conclusions and recommendations, is discussed in detail in the following report.

This report has been prepared for the exclusive use of the Colton Joint Unified School District and their design consultants for specific application to the project described herein. Should the project be modified, the conclusions and recommendations presented in this report should be reviewed by the geotechnical engineer. Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, express or implied.

PROJECT DESCRIPTION

For the preparation of this report, we reviewed the project site plan prepared by SGH Architects. We understand that planned improvements to the existing Terrace View Elementary School will consist of a single-story modular classroom building with a footprint area of about 2,880 square feet. The modular classroom building will be supported by cast-in-place concrete footings. Relatively light foundation loads are expected. A crawl space 18 inches in maximum height will be situated below the new modular classroom building. The site for the proposed modular classroom building appears to be at the approximate desired grade, and no significant additional cuts and fills seem likely. The site configuration and proposed development are illustrated on Enclosure 1.

SITE CONDITIONS

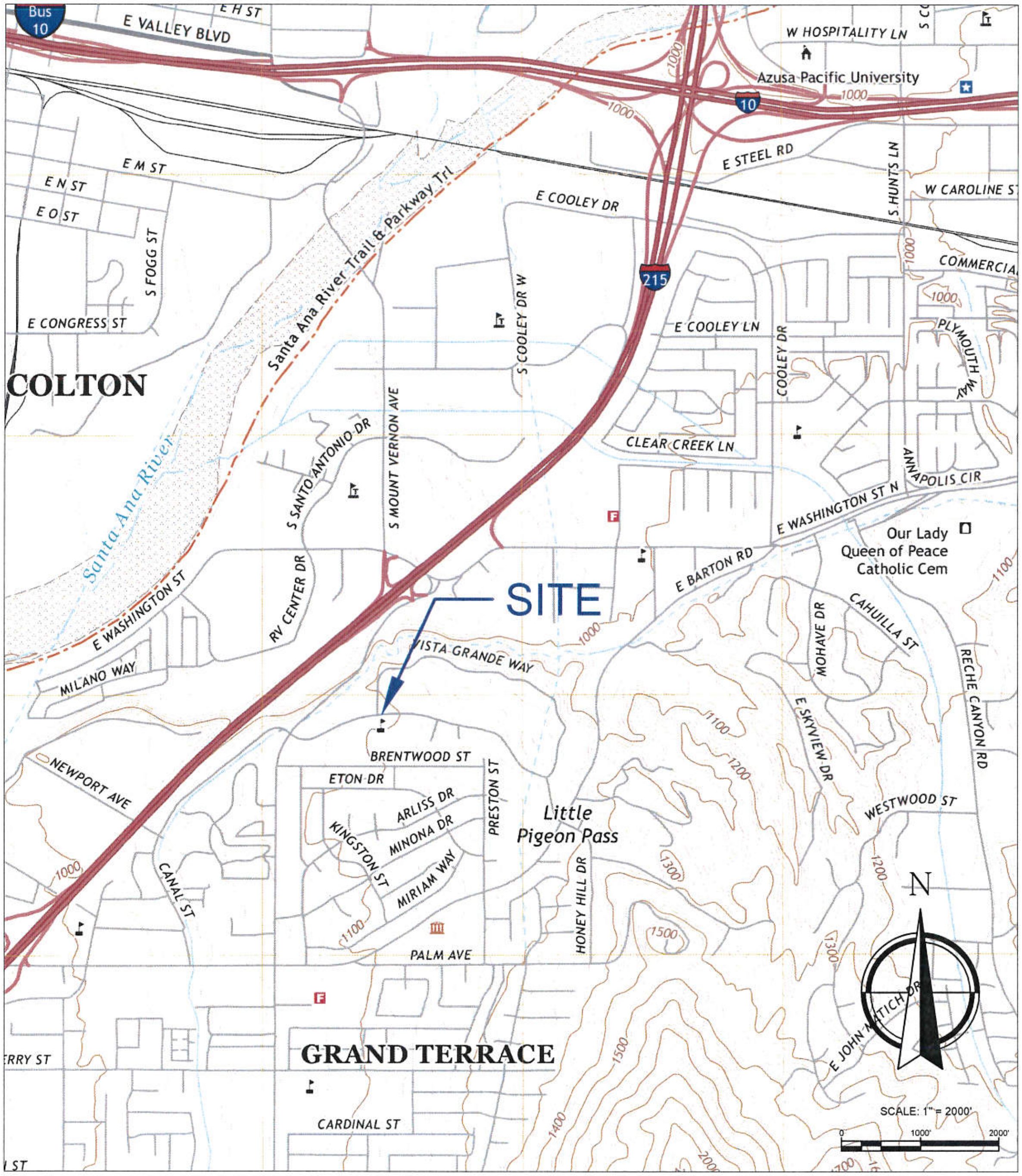
The existing Terrace View Elementary School is located on the south side of Grand Terrace Road, east of Mount Vernon Avenue in the city of Grand Terrace. An Index Map showing the general vicinity of the site is presented on the following page. The coordinates of the site are latitude 34.0421° N and longitude -117.3079° W (World Geodetic System of 1984). The current elementary school campus is active and is occupied by existing buildings, and associated parking, driveway, ball field, hardscape, and landscape areas. The area to be developed for the modular classroom building is currently occupied by existing playground equipment which will be removed/demolished prior to construction. The project site plan shows that a maximum 20-inch-high retaining wall extends in an east-west direction and is situated to the north of the proposed modular building. This existing retaining wall supports an ascending slope up to 3 feet in height with a gradient of 3:1 (H:V). The properties to the north across Grand Terrace Road are vacant. Single-family residences are situated to the east of the school property and to the south across Brentwood Street. The adjacent properties to the west are occupied by senior housing and single-family residences. The area topography is generally flat, sloping downward to the northwest at an average gradient of less than 4 percent.

FIELD AND LABORATORY INVESTIGATION

The soils in the area of the proposed modular classroom building were explored by two test borings drilled with a limited-access track-mounted flight-auger to depths of up to 51.5 feet below the existing ground surface. The approximate locations of the test borings are indicated on Enclosure 1. The soils encountered were examined and visually classified by one of our field engineers. A summary of the soil classifications appears as Enclosure 2. The exploration logs show subsurface conditions at the dates and locations indicated, and may not be representative of other locations and times. The stratification lines presented on the logs represent the approximate boundaries between soil types, and the transitions may be gradual. A hollow-stem auger with an outside diameter of 7.9 inches was utilized. The inside diameter of the auger was 4.3 inches.

Bulk and relatively undisturbed samples were obtained at selected levels within the explorations and delivered to our laboratory for testing and evaluation. The driving energy or blow counts required to

INDEX MAP



SOURCE DOCUMENTS: USGS SAN BERNARDINO SOUTH QUADRANGLE, CALIFORNIA, 7.5 MINUTE SERIES, 2021

TOWNSHIP AND RANGE: SECTION 33, T1S, R4W

LATITUDE: 34.0421° N

LONGITUDE: 117.3079° W

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File No.: S-14681

advance the sampler at each sample interval were also noted. Relatively undisturbed soil samples were recovered at various intervals in the borings with a California sampler. The California sampler was a 2.9-inch outside diameter, 2.5-inch inside diameter, split-barrel sampler lined with brass tubes. The sampler was 18 inches long. The sampler conformed to the requirements of ASTM D 3550. A 140-pound automatic trip hammer was lifted hydraulically and was dropped 30 inches for each blow. Standard penetration tests were performed as Boring 1 was advanced. The standard penetration test blow counts are shown on the log for Boring 1. Standard penetration testing was performed with a 2.0-inch outside diameter, 1.5-inch inside diameter, split-barrel sampler. The sampler was 18 inches long and was unlined. The sampler conformed to the requirements of ASTM D 1586. A 140-pound automatic trip hammer was lifted hydraulically and was dropped 30 inches for each blow. An efficiency value of 1.0 was assumed for the automatic trip hammer.

Included in our laboratory testing were moisture/density determinations on all undisturbed samples. Optimum moisture content/maximum dry density relationships were established for typical soil types so that the relative compaction of the subsoils could be determined. Consolidation testing was conducted on a selected sample to evaluate the compressibility characteristics of the soil. The moisture/density data are presented on the boring logs presented in Enclosure 2. The maximum density and consolidation test results appear on Enclosures 3 and 4, respectively. Chemical testing, comprised of pH, soluble sulfate, chloride, redox potential, and resistivity testing, was also performed. These test results are presented in the "Chemical Test Results" section of this report.

SOIL CONDITIONS

The upper soils encountered in our test borings consisted of loose to dense silty sands, sands with silt; and stiff sandy silts. A 1-foot-thick layer of loose soil was encountered at a depth of 3 feet in Boring 1. The deeper soils consisted of medium dense to very dense silty sands, and silty sands with traces of gravel. The consolidation test indicates a potential for 4.7 percent hydroconsolidation in the upper soils. Based on published geologic reports for this area, dense alluvial soil is considered to extend to a depth of at least 100 feet beneath the site. Neither bedrock nor ground water was encountered in these borings. The near-surface soils encountered in our test borings are granular, non-plastic materials and are considered to have a very low expansion potential in accordance with ASTM D4829.

LIQUEFACTION AND DYNAMIC SETTLEMENT

Liquefaction is a phenomenon that occurs when a soil undergoes a transformation from a solid state to a liquefied condition due to the effects of increased pore-water pressure. Loose saturated soils with particle sizes in the medium sand to silt range are particularly susceptible to liquefaction when subjected to seismic ground shaking. Affected soils lose all strength during liquefaction, and foundation failure can occur.

Free ground water was not encountered in our test boring locations. Based on ground water data, our consulting engineering geologist estimates that the shallowest historic depth to ground water is expected to have been deeper than 75 feet below existing grade. Based on the great depth to ground water, we conclude that the potential for seismically induced liquefaction is low.

It is anticipated that major earthquake ground shaking will occur during the lifetime of the proposed development from the seismically active San Jacinto fault located approximately 1.4 miles northeast of the site. This fault would create the most significant earthshaking event. Based on an earthquake magnitude of 7.8, a peak horizontal ground acceleration of 0.904g is assigned to the site. To evaluate the potential for seismically induced settlement of the subsoils, the soils were analyzed for relative density. The most effective measurement of relative density of sands with respect to seismic settlement potential is standard penetration resistance. Standard penetration tests were performed as Boring 1 was advanced to a depth of 51.5 feet. The standard penetration test "N" values are presented on the boring log for Boring 1.

Using the information presented in Table 3 of Page 73 of the publication by Idriss and Boulanger (Soil Liquefaction During Earthquakes, Idriss and Boulanger, MNO-12, 2008) an analysis was conducted to determine the sampler correction factor Cs. The SPT sampler is machined to fit liners, therefore a correction factor of 1.0 may not be appropriate. Throughout the test boring, a calculation was performed to determine the average $(N_1)_{60}$ value from which Cs was subsequently determined. An average Cs value of 1.3 was calculated and used in the analysis.

The standard penetration data provided input for the LiquefyPro Version 4.3 program for liquefaction and seismically induced settlement. As indicated in Special Publication 117A (Revised) Release, "Guidelines for Evaluating and Mitigating Seismic Hazards in California, March 2009," a safety factor of 1.3 was used in this analysis. We have assumed that the upper 3 feet of soil will be overexcavated and replaced as engineered fill, and that the bottom of overexcavation would be scarified and recompacted to a depth of 12 inches. The engineered fill was assumed to have an "N" value of 30. The results of this evaluation are shown on Enclosure 5. This analysis reveals a total potential dynamic settlement of 2.21 inches in Boring 1. The differential settlement is expected to be no more than ½ the total, or 1.11 inches. This value is less than ¼ 0.010L, or 1.20 inches for a minimum building width of 40 feet, conforming to the requirements of ASCE 7-16, Section 12.13.9. It is our judgment that neither liquefaction nor seismically induced dry settlement need be a consideration in the design of the single-story modular classroom building.

CONCLUSIONS

It appears that the upper soils are non-uniform, varying from loose to medium dense. In order to provide uniform soil conditions for foundation support, overexcavation and replacement of the loose soil is recommended below the modular classroom building where existing improvements will allow. Complete stabilization of the existing soil under pavement areas would require removal and recompaction of the existing loose soil. The cost of complete removal and recompaction of the existing loose soil within pavement areas does not appear to be warranted. Substantial stabilization can be obtained by removal and recompaction of the upper 3 feet of soil within pavement areas. Recommendations for foundation design are provided below for a very low expansion potential. Subsequent to site preparation, the new modular classroom building may be safely founded on shallow cast-in-place concrete footings. Detailed recommendations are provided below.

RECOMMENDATIONS

FOUNDATION DESIGN

Where the site is prepared as recommended, the proposed single-story modular building may be founded on conventional shallow continuous and spread footings. The footings should be at least 12 inches wide, should be placed at least 12 inches below the lowest final adjacent grade, and should be designed for a maximum safe soil bearing pressure of 1,500 pounds per square foot for dead plus live loads. Increasing the footing embedment depth to 18 inches would allow the utilization of a maximum soil bearing pressure of 2,000 pounds per square foot. These values may be increased by one-third for wind and seismic loading.

Continuous footings should be reinforced with at least two No. 4 bars, one placed near the top and one near the bottom of the footings. This recommendation for foundation reinforcement is based on geotechnical considerations. Structural design may require additional foundation reinforcement.

SEISMIC DESIGN PARAMETERS

The seismic design coefficients and factors as required by the 2022 California Building Code and ASCE Standard 7-16 are provided in the following table:

Factor or Coefficient	***Value***
Latitude	34.0421° N
Longitude	-117.3079° W
S_S	2.142g
S_1	0.853g
F_a	1.2
F_v	1.7
S_{DS}	1.714g
S_{D1}	0.967g
S_{MS}	2.571g
S_{M1}	1.450g
T_L	8 seconds
PGA	0.904g
Site Class	D

LATERAL LOADING

Resistance to lateral loads will be provided by passive earth pressure and basal friction. For footings bearing against compacted fill, passive earth pressure may be considered to develop at a rate of 350 pounds per square foot per foot of depth. Basal friction may be computed at 0.35 times the normal dead load. The resistance from basal friction and passive earth pressure may be combined directly without reduction. The allowable lateral resistance may be increased by one-third for wind and seismic loading.

SITE PREPARATION

We assume that the site will be prepared in accordance with the California Building Code and the current City of Grand Terrace Grading Ordinance. The recommendations presented below are to establish additional grading criteria. These recommendations should be considered preliminary and are subject to modification or expansion based on a geotechnical review of the project foundation and precise grading plans.

- All areas to be graded should be stripped of organic matter, man-made obstructions, and other deleterious materials. Underground utilities should be removed and relocated or abandoned. All cavities created during site clearing should be cleaned of loose and disturbed soil, shaped to provide access for construction equipment, and backfilled with fill placed and compacted as described below.

- Any existing artificial fill should be removed from the proposed improvement areas, including the modular building and hardscape areas. The removals should extend beyond the building area a horizontal distance at least equal to the depth of removal or 5 feet, whichever distance is greater. Organic matter and other unsuitable debris should be separated from the removed fill and hauled from the site. The removed artificial fill should be stockpiled pending replacement or be placed in areas previously prepared.

- Overexcavation

    - Modular building area – Subsequent to removal of any existing artificial fill, the upper soil underlying the modular building area, should be overexcavated to a depth of at least 3 feet below the presently existing ground surface or final ground surface. The soil exposed in the bottom of the overexcavation should be evaluated by a representative of the geotechnical engineer. Natural soil exhibiting a relative compaction of less than 85 percent (ASTM D1557) should be further overexcavated until undisturbed soil exhibiting a relative compaction of at least 85 percent is encountered. The overexcavation should extend beyond the building area a horizontal distance at least equal to the depth of overexcavation below the existing ground surface. The representative of the geotechnical engineer should evaluate the soil conditions encountered and determine where the overexcavation can be terminated.

- Due to the presence of the small retaining wall to the north, there would be horizontal limitations to the overexcavation requirements on the north side of the modular building. Slot cutting should be performed in alternate segments with a maximum width of 10 feet as measured parallel to the existing retaining wall. The recommended limits of overexcavation and recompaction should be followed for the initial segments. Subsequent to completion of the initial segments, the intermediate 10-foot segments should be prepared. The use of a sheepsfoot roller on the end of a backhoe boom would be acceptable within 6 feet of the existing retaining wall.

- <u>Hardscape areas</u> – Loose soil underlying hardscape areas should be removed to a maximum depth of 3 feet below the existing ground surface or the finish subgrade, whichever is deeper. Should competent natural soil (undisturbed soil exhibiting a relative compaction of at least 85 percent) be encountered at a depth of less than 3 feet below hardscape areas, the overexcavation can be terminated at that depth. The soils exposed in the subexcavated surfaces should be scarified to a depth of at least 12 inches. The scarified soil should be moisture conditioned to near the optimum moisture content, and densified to a relative compaction of at least 90 percent (ASTM D1557).

- Approved subexcavated surfaces and all other surfaces to receive fill should be scarified to a minimum depth of 12 inches, moisture conditioned to near the optimum moisture content, and densified to a minimum relative compaction of 90 percent (ASTM D1557).

- The on-site soils should provide adequate quality fill material provided they are free from significant organic matter and other deleterious materials, and are at acceptable moisture contents. Any asphalt and portland cement concrete removed during site clearing may be pulverized into fragments not exceeding 3 inches in greatest dimension and incorporated into the fill at all levels in the structure area. Import fill should be inorganic, granular, non-expansive soil free from rocks or lumps greater than 8 inches in maximum dimension, and should exhibit a very low expansion potential (expansion index less than 21), negligible sulfate content (less than 1,000 ppm soluble sulfate by dry weight of soil), and low corrosion potential. Prior to bringing import fill to the site, the contractor should obtain certification to verify that the proposed import meets the State of California Department of Toxic Substance Control (DTSC) environmental standards. Proposed import should be sampled at the source and tested by this firm for expansion index, soluble sulfate content, and corrosion potential.

- All fill should be placed in 8-inch or less lifts. Each lift of fill should be moisture conditioned to near the optimum moisture content. Engineered fill should be densified to a minimum relative compaction of 90 percent (ASTM D1557). Where the horizontal limits of overexcavation cannot be achieved, the engineered fill should be densified to a relative compaction of at least 95 percent.

- The surface of the site should be graded to provide positive drainage away from the structure. Drainage should be directed to established swales and then to appropriate drainage structures to minimize the possibility of erosion. Water should not be allowed to pond adjacent to footings.

SHRINKAGE AND SUBSIDENCE

Volume change in going from cut to fill conditions is anticipated where near-surface grading will occur. Assuming the fill will be compacted to an average relative compaction of 93 percent, an average cut-fill shrinkage of 10 percent is estimated. Further volume loss will occur through subsidence during preparation of the natural ground surface. Although the contractor's methods and equipment utilized in preparing the natural ground will have a significant effect on the amount of natural ground subsidence that will occur, our experience indicates as much as 0.10 foot of subsidence in areas prepared to receive fill should be anticipated. These values are exclusive of losses due to stripping or removal of subsurface obstructions.

PORTLAND CEMENT CONCRETE PAVEMENT

For hardscape areas to receive only pedestrian traffic, we recommend the PCC pavement be at least 3.5 inches in thickness and placed directly on the compacted subgrade soil. There are no geotechnical conditions indicating the need for reinforcement of the concrete pavement. The design engineer may wish to provide some level of reinforcement to minimize the width of shrinkage cracks.

Prior to the placement of concrete, we recommend that the final subgrade surface be scarified to a depth of at least 12 inches, moisture conditioned to near the optimum moisture content, and densified to a relative compaction of at least 90 percent (ASTM D1557). Concrete should be proportioned for a maximum slump of 4 inches and to achieve a minimum compressive strength of at least 2,500 psi at 28 days. If additional workability is desired, a plasticizing or water-reducing admixture should be utilized in lieu of increasing the water content. Control joints for the 3.5-inch-thick pavement should be spaced no more than 10.5 feet on-center each way. Control joints should be established either by hand groovers, plastic inserts, or saw-cutting as soon as the concrete can be cut without dislodging aggregate. Cutting the control joints the day after the concrete pour will likely result in uncontrolled shrinkage cracks. Concrete should not be placed in hot and windy weather. Water curing should commence immediately after the final finishing and should continue for at least 7 days.

CHEMICAL TEST RESULTS

The chemical test results from a sample taken from Boring 2 between the ground surface and a depth of 5 feet are shown on the following table:

Analysis	Result	Units
Saturated Resistivity	5500	ohm-cm
Chloride	ND (Not Detected)	ppm
Sulfate	140	ppm
pH	8.5	pH units
Redox Potential	170	mV

The soil tested in Boring 1 exhibited negligible soluble sulfate content; therefore, sulfate-resistant concrete will not be required for this project. In addition, the results of the corrosivity testing indicate that the soil tested is not detrimentally corrosive to ferrous-metal pipes.

FOUNDATION AND PRECISE GRADING PLAN REVIEW

The project foundation and precise grading plans should be reviewed by the geotechnical engineer. Additional recommendations may be required at that time.

CONSTRUCTION OBSERVATIONS

All grading operations, including the preparation of the existing ground surface, should be observed and compaction tests performed by this firm. No fill should be placed on any prepared surface until that surface has been evaluated by the representative of the geotechnical engineer. All footing excavations should be observed by the representative of the geotechnical engineer prior to placement of forms or reinforcing steel.

The conclusions and recommendations presented in this report are based upon the field and laboratory investigation described herein, and represent our best engineering judgment. Should conditions be encountered in the field that appear different from those described in this report, we should be contacted immediately in order that appropriate recommendations might be prepared.

Respectfully submitted,

JOHN R. BYERLY, INC.

LICENSED PROFESSIONAL ENGINEER
JOHN R. BYERLY
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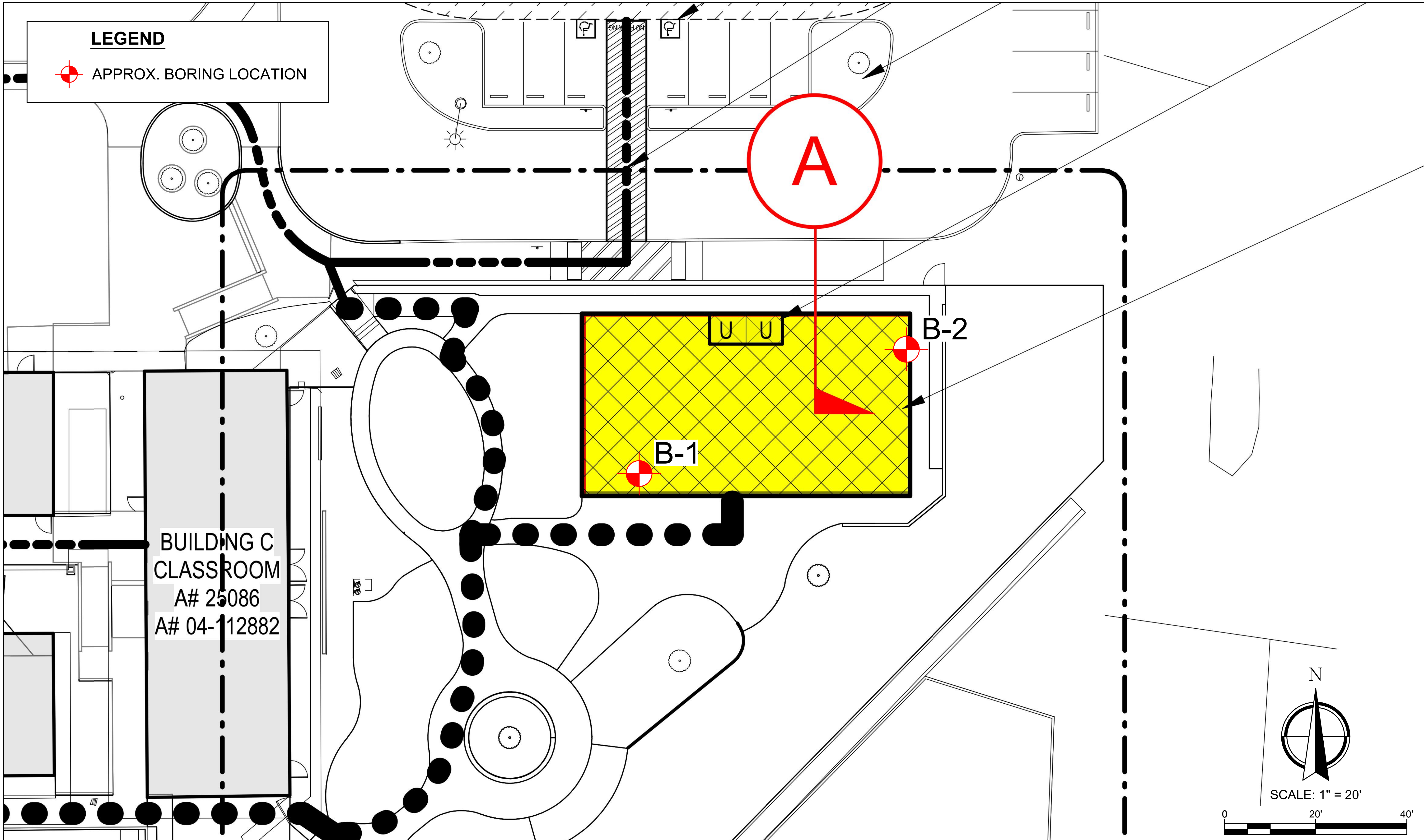
EXP. 06/30/25
GEOTECHNICAL
STATE OF CALIFORNIA

John R. Byerly, Geotechnical Engineer
President

JRB:MLL:st

Enclosures:
(1) Plot Plan
(2) Test Boring Logs
(3) Maximum Density Determinations
(4) Consolidation Test Results
(5) Liquefaction and Dynamic Settlement Analysis



SOURCE DOCUMENT: SHEET A1.01, SGH ARCHITECTS, 16 JULY 2022

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GEOTECHNICAL INVESTIGATION

TERRACE VIEW ELEMENTARY SCHOOL
22731 GRAND TERRACE ROAD
GRAND TERRACE, CALIFORNIA

Enclosure 1
Rpt. No.: 8301
File No.: S-14681

B-1

Boring Date: 3/27/24
Surface Elevation:
Drilling Method: Limited-Access Track Rig

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table	USCS	Description
0						GWT not encountered	SM	Red-brown silty fine to medium sand, moist, and medium dense
		21	112	11.6	87			
		11	106	7.4	82			-becoming loose at 3.0 feet
5							SP	Gray-brown fine to medium sand with silt, damp, and medium dense
	23	29	114	4.6	86			
10	26	22	114	10.1	88		SM	Brown silty fine to medium sand, moist, and medium dense
15	54	50/10"	121	9.2	91		SM	Red-brown silty fine to coarse sand, moist, and dense
20	31	28	118	8.7	89		SM	Light brown silty fine to coarse sand, moist, and medium dense
25	100	50/7"	126	10.4	95		SM	Brown silty fine to coarse sand with a trace of gravel, moist, and very dense
30	85	50/6"	128	9.6	96			
35								

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LOG OF BORING

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Terrace View Elementary School
Grand Terrace, California

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B-1

Boring Date: 3/27/24
Surface Elevation:
Drilling Method: Limited-Access Track Rig

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table	USCS	Description
35	79						SM	Brown silty fine to coarse sand with a trace of gravel, moist, and very dense
40	82						SM	Red-brown silty fine to medium sand with a trace of gravel, moist, and very dense
45	77							
50	100							
55								Total Depth at 51.5 Feet No Free Ground Water Encountered
60								
65								
70								

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LOG OF BORING

John R. Byerly, Inc.

Terrace View Elementary School
Grand Terrace, California

Enclosure 2, Page 2
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B-2

Boring Date: 3/27/24
Surface Elevation:
Drilling Method: Limited-Access Track Rig

Depth	Std. Pen. "N" Value	Blows/Ft.	Dry Density (PCF)	Moisture Content (%)	Rel. Compaction (%)	Water Table	Class	Description
0						GWT not encountered	ML	Gray-brown sandy silt, very moist, and stiff
		18	103	21.9	86			
							SM	Gray-brown silty fine to medium sand, moist, and medium dense
		27	115	11.2	89			
5		35	119	3.1	90		SP	Gray-brown fine to medium sand with silt, damp, and dense
		42	120	3.8	91			
10		50	120	7.4	93		SM	Gray-brown silty fine to medium sand, moist, and dense
15		50/11"	119	8.2	92			
							SM	Red-brown silty fine to coarse sand, moist, and dense
20		50/9"	125	9.3	94			
25		50/10"	124	8.3	93		SM	Brown silty fine to coarse sand with a trace of gravel, moist, and dense
30		50/3"	129	7.7	97			-becoming very dense at 30.0 feet
								Total Depth at 31.0 Feet No Free Ground Water Encountered
35								

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LOG OF BORING

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Terrace View Elementary School
Grand Terrace, California

Enclosure 2, Page 3
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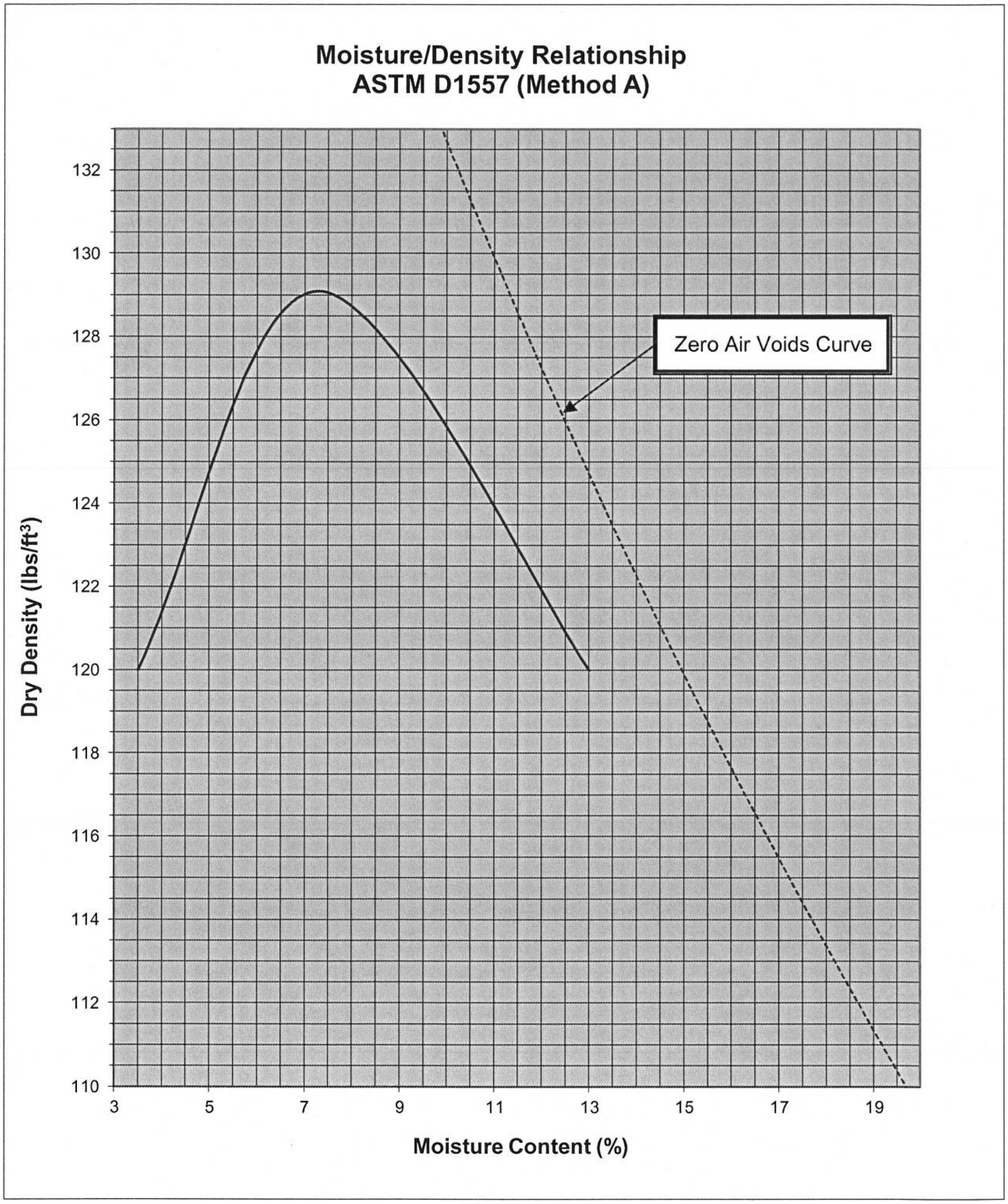
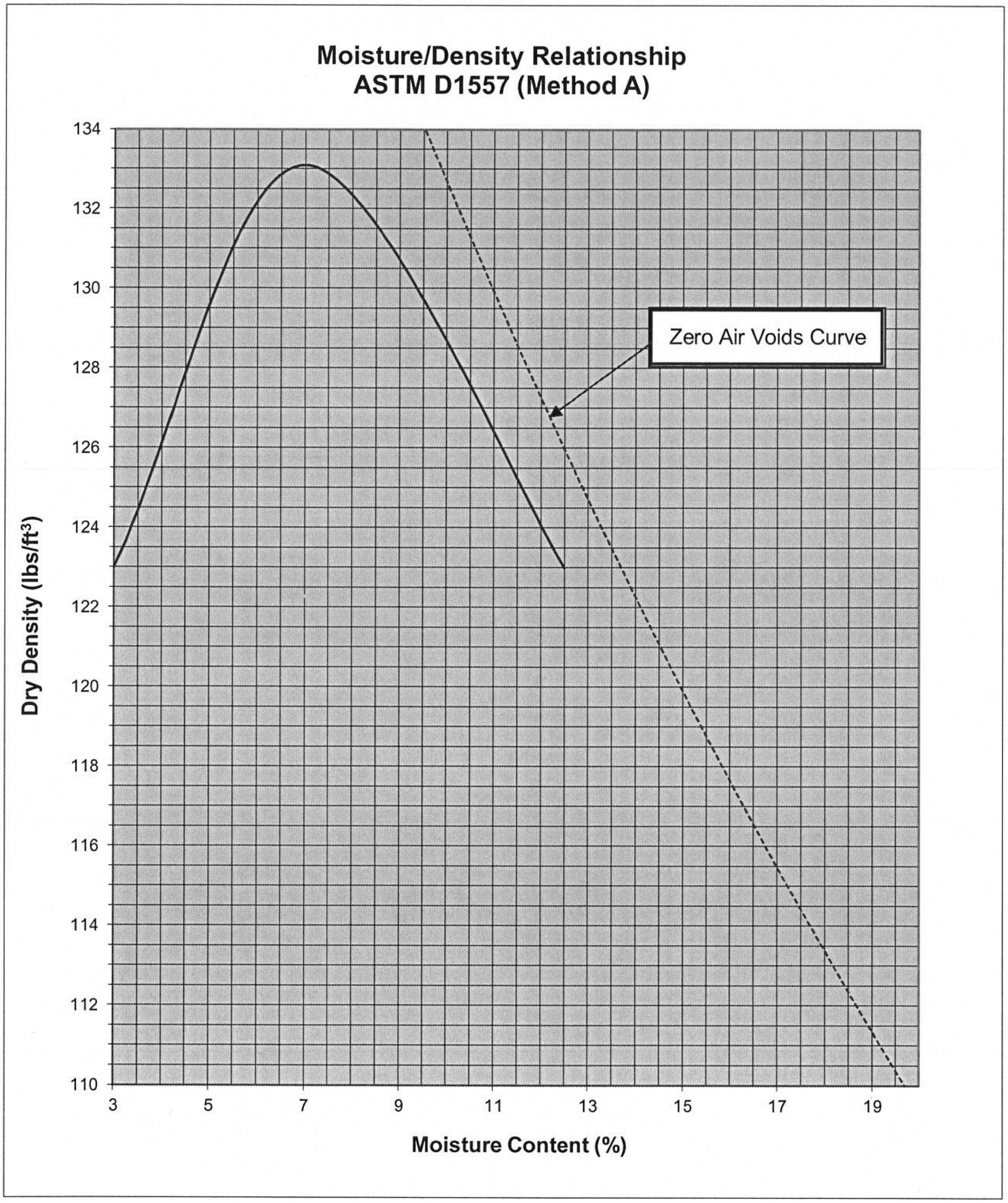
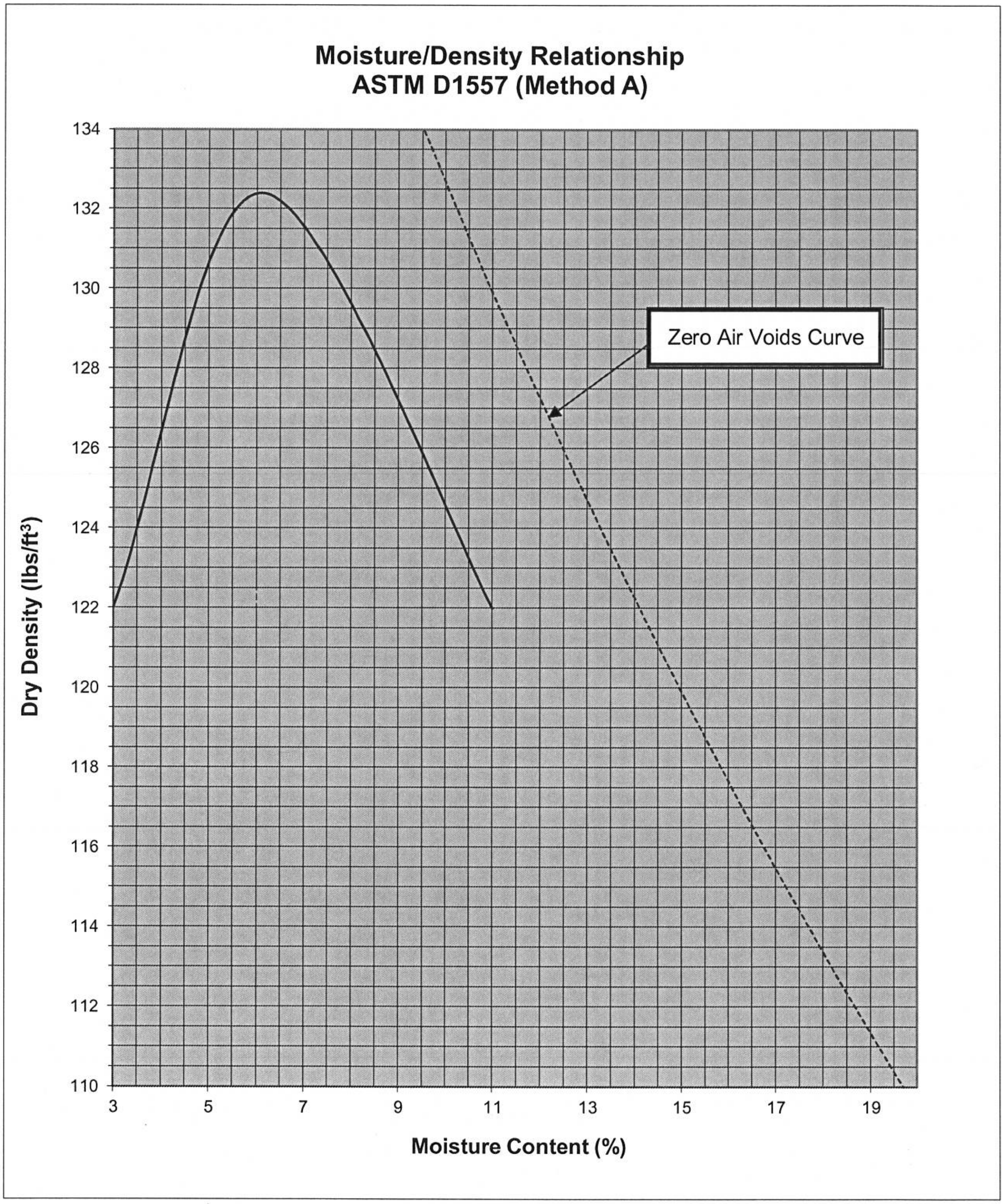


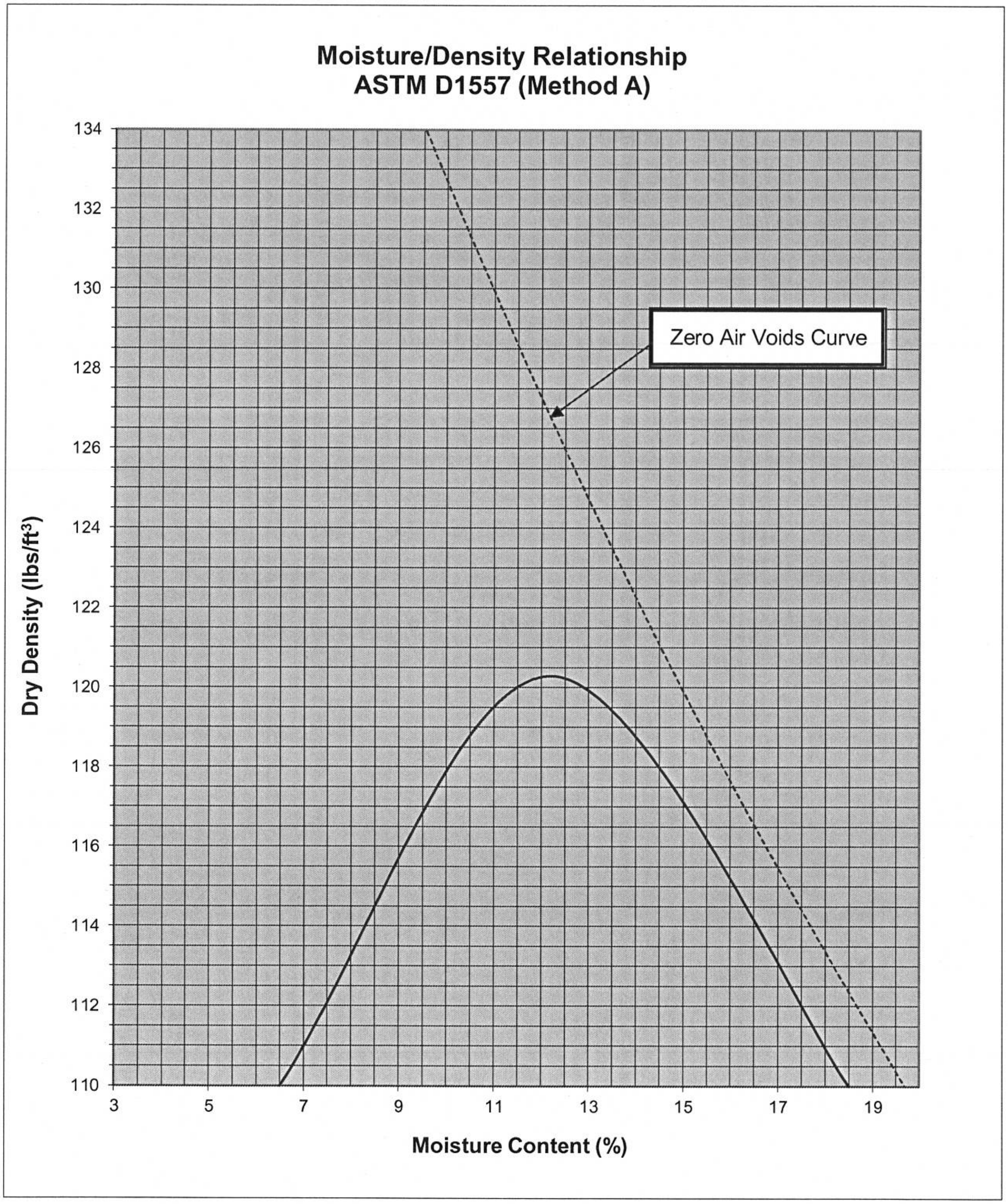
Boring No.	B-1
Depth (ft.)	10.0
Optimum Moisture (%)	7.3
Maximum Dry Density (pcf)	129.1
Soil Classification	Brown silty fine to medium sand (SM)



Boring No.	B-2
Depth (ft.)	20.0
Optimum Moisture (%)	7.0
Maximum Dry Density (pcf)	133.1
Soil Classification	Red-brown silty fine to coarse sand (SM)



Boring No.	B-2
Depth (ft.)	5.0
Optimum Moisture (%)	6.1
Maximum Dry Density (pcf)	132.4
Soil Classification	Gray-brown fine to medium sand with silt (SP)



Boring No.	B-2
Depth (ft.)	1.0
Optimum Moisture (%)	12.2
Maximum Dry Density (pcf)	120.3
Soil Classification	Gray-brown sandy silt (ML)

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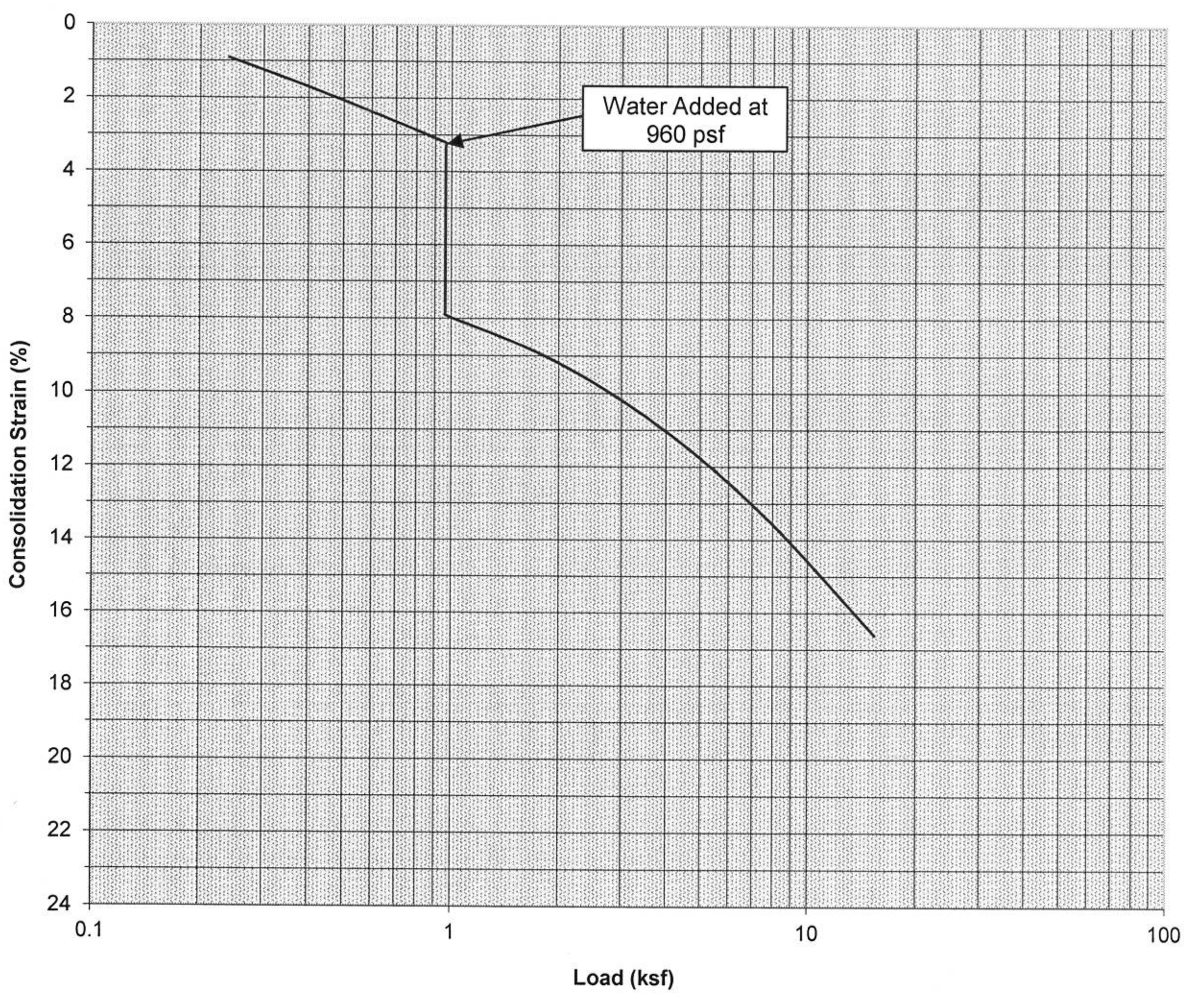
Consolidation Test Results



Classification: SM

Boring Number:	B-1	Initial Moisture Content (%)	7.4
Depth (ft)	3.0	Final Moisture Content (%)	15.4
Specimen Diameter (in)	2.4	Initial Dry Density (pcf)	106
Specimen Thickness (in)	1.0		

Enclosure 4
Rpt. No.: 8301
File No.: S-14681

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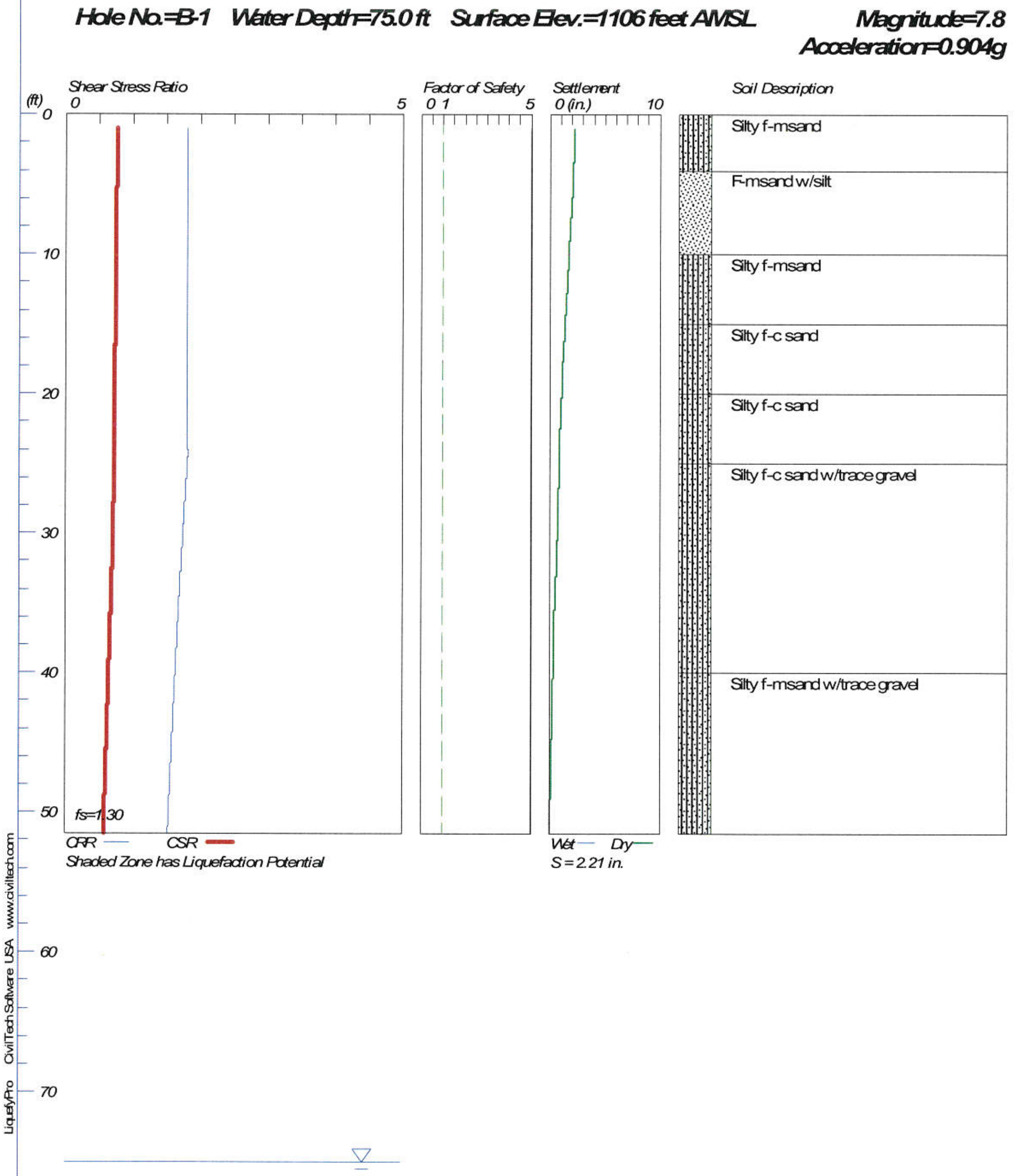
LIQUEFACTION ANALYSIS

TERRACE VIEW E.S. - PROPOSED MODULAR CLASSROOM BUILDING



John R. Byerly, Inc. S-14681

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LIQUEFACTION ANALYSIS CALCULATION SHEET

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Input File Name: P:\WORD PROCESSING\TerraServer\Liquefy4\S-14681.1.liq
Title: TERRACE VIEW E..S. - PROPOSED MODULAR CLASSROOM BUILDING
Subtitle: S-14681

Surface Elev.=1106 feet AMSL
Hole No.=B-1
Depth of Hole= 51.5 ft
Water Table during Earthquake= 75.0 ft
Water Table during In-Situ Testing= 75.0 ft
Max. Acceleration= 0.9 g
Earthquake Magnitude= 7.8
User defined factor of safty (applied to CSR) User fs=1.3
fs=user, Plot one CSR (fs=user)

Hammer Energy Ratio, Ce=1
Borehole Diameter, Cb=1.15
Sampeling Method, Cs=1.3
SPT Fines Correction Method: Stark/Olson et al.*
Settlement Analysis Method: Ishihara / Yoshimine*
Fines Correction for Liquefaction: Stark/Olson et al.*
Fine Correction for Settlement: Post-Liq. Correction *
Average Input Data: Smooth*
* Recommended Options

Input Data:

Depth ft	SPT	Gamma pcf	Fines %
1.0	30.0	130.0	30.0
3.0	30.0	130.0	30.0
4.0	30.0	130.0	30.0
6.0	23.0	119.2	1.0
11.0	26.0	125.5	30.0
16.0	54.0	132.1	25.0
21.0	31.0	128.3	25.0
26.0	100.0	139.1	25.0
31.0	85.0	140.3	25.0
35.0	79.0	140.0	25.0
40.0	82.0	140.0	25.0
45.0	77.0	140.0	25.0
50.0	100.0	140.0	25.0

Output Results:
Settlement of saturated sands=0.00 in.
Settlement of dry sands=2.21 in.
Total settlement of saturated and dry sands=2.21 in.
Differential Settlement=1.103 to 1.457 in.

Depth ft	CRRm	CSRfs w/fs	F.S.	S_sat. in.	S_dry in.	S_all in.
1.00	1.81	0.76	5.00	0.00	2.21	2.21
2.00	1.81	0.76	5.00	0.00	2.20	2.20
3.00	1.81	0.76	5.00	0.00	2.18	2.18
4.00	1.81	0.75	5.00	0.00	2.13	2.13
5.00	1.81	0.75	5.00	0.00	2.10	2.10
6.00	1.81	0.75	5.00	0.00	2.01	2.01
7.00	1.81	0.75	5.00	0.00	1.93	1.93
8.00	1.81	0.75	5.00	0.00	1.84	1.84
9.00	1.81	0.74	5.00	0.00	1.78	1.78
10.00	1.81	0.74	5.00	0.00	1.73	1.73
11.00	1.81	0.74	5.00	0.00	1.66	1.66
12.00	1.81	0.74	5.00	0.00	1.59	1.59
13.00	1.81	0.74	5.00	0.00	1.51	1.51
14.00	1.81	0.74	5.00	0.00	1.44	1.44
15.00	1.81	0.73	5.00	0.00	1.36	1.36
16.00	1.81	0.73	5.00	0.00	1.30	1.30
17.00	1.81	0.73	5.00	0.00	1.22	1.22
18.00	1.81	0.73	5.00	0.00	1.14	1.14
19.00	1.81	0.73	5.00	0.00	1.10	1.10
20.00	1.81	0.73	5.00	0.00	1.05	1.05
21.00	1.81	0.72	5.00	0.00	1.00	1.00
22.00	1.81	0.72	5.00	0.00	0.94	0.94
23.00	1.81	0.72	5.00	0.00	0.90	0.90
24.00	1.81	0.72	5.00	0.00	0.87	0.87
25.00	1.81	0.72	5.00	0.00	0.84	0.84
26.00	1.79	0.71	5.00	0.00	0.82	0.82
27.00	1.78	0.71	5.00	0.00	0.79	0.79
28.00	1.77	0.71	5.00	0.00	0.76	0.76
29.00	1.76	0.71	5.00	0.00	0.73	0.73
30.00	1.75	0.71	5.00	0.00	0.69	0.69
31.00	1.73	0.70	5.00	0.00	0.65	0.65
32.00	1.72	0.69	5.00	0.00	0.61	0.61
33.00	1.71	0.69	5.00	0.00	0.56	0.56
34.00	1.70	0.68	5.00	0.00	0.50	0.50
35.00	1.69	0.68	5.00	0.00	0.44	0.44
36.00	1.68	0.67	5.00	0.00	0.42	0.42
37.00	1.67	0.66	5.00	0.00	0.39	0.39
38.00	1.66	0.66	5.00	0.00	0.37	0.37
39.00	1.65	0.65	5.00	0.00	0.34	0.34
40.00	1.63	0.65	5.00	0.00	0.32	0.32
41.00	1.62	0.64	5.00	0.00	0.29	0.29
42.00	1.61	0.63	5.00	0.00	0.26	0.26
43.00	1.61	0.63	5.00	0.00	0.24	0.24
44.00	1.60	0.62	5.00	0.00	0.21	0.21
45.00	1.59	0.61	5.00	0.00	0.18	0.18
46.00	1.58	0.61	5.00	0.00	0.15	0.15
47.00	1.57	0.60	5.00	0.00	0.12	0.12
48.00	1.56	0.60	5.00	0.00	0.09	0.09
49.00	1.55	0.59	5.00	0.00	0.06	0.06
50.00	1.54	0.58	5.00	0.00	0.04	0.04
51.00	1.53	0.58	5.00	0.00	0.01	0.01

* F.S.<1, Liquefaction Potential Zone
(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

Units Depth = ft, Stress or Pressure = tsf (atm), Unit Weight = pcf, Settlement = in.

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        CRRm            Cyclic resistance ratio from soils
        CSRfs           Cyclic stress ratio induced by a given earthquake (with user
request factor of safety)
        F.S.            Factor of Safety against liquefaction, F.S.=CRRm/CSRfs
        S_sat           Settlement from saturated sands
        S_dry           Settlement from dry sands
        S_all           Total settlement from saturated and dry sands
        NoLiq           No-Liquefy Soils
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Hole No.=B-1
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SPT Fines Correction Method: Stark/Olson et al.*
Settlement Analysis Method: Ishihara / Yoshimine*
Fines Correction for Liquefaction: Stark/Olson et al.*
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Average Input Data: Smooth*
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Depth ft	SPT	Gamma pcf	Fines %
1.0	30.0	130.0	30.0
3.0	30.0	130.0	30.0
4.0	30.0	130.0	30.0
6.0	23.0	119.2	1.0
11.0	26.0	125.5	30.0
16.0	54.0	132.1	25.0
21.0	31.0	128.3	25.0
26.0	100.0	139.1	25.0
31.0	85.0	140.3	25.0
35.0	79.0	140.0	25.0
40.0	82.0	140.0	25.0
45.0	77.0	140.0	25.0
50.0	100.0	140.0	25.0

Output Results: (Interval = 1.00 ft)

CSR Calculation:

Depth ft	gamma pcf	sigma tsf	gamma' pcf	sigma' tsf	rd	CSR	fs (user)	CSRfs w/fs
1.00	130.0	0.065	130.0	0.065	1.00	0.58	1.3	0.76
2.00	130.0	0.130	130.0	0.130	1.00	0.58	1.3	0.76
3.00	130.0	0.195	130.0	0.195	0.99	0.58	1.3	0.76
4.00	130.0	0.260	130.0	0.260	0.99	0.58	1.3	0.75
5.00	124.6	0.324	124.6	0.324	0.99	0.58	1.3	0.75
6.00	119.2	0.385	119.2	0.385	0.99	0.58	1.3	0.75
7.00	120.5	0.445	120.5	0.445	0.98	0.58	1.3	0.75
8.00	121.7	0.505	121.7	0.505	0.98	0.57	1.3	0.75
9.00	123.0	0.566	123.0	0.566	0.98	0.57	1.3	0.74
10.00	124.2	0.628	124.2	0.628	0.98	0.57	1.3	0.74
11.00	125.5	0.691	125.5	0.691	0.97	0.57	1.3	0.74
12.00	126.8	0.754	126.8	0.754	0.97	0.57	1.3	0.74
13.00	128.1	0.817	128.1	0.817	0.97	0.57	1.3	0.74
14.00	129.5	0.882	129.5	0.882	0.97	0.57	1.3	0.74
15.00	130.8	0.947	130.8	0.947	0.97	0.56	1.3	0.73
16.00	132.1	1.012	132.1	1.012	0.96	0.56	1.3	0.73
17.00	131.3	1.078	131.3	1.078	0.96	0.56	1.3	0.73
18.00	130.6	1.144	130.6	1.144	0.96	0.56	1.3	0.73
19.00	129.8	1.209	129.8	1.209	0.96	0.56	1.3	0.73
20.00	129.1	1.274	129.1	1.274	0.95	0.56	1.3	0.73
21.00	128.3	1.338	128.3	1.338	0.95	0.56	1.3	0.72
22.00	130.5	1.403	130.5	1.403	0.95	0.55	1.3	0.72
23.00	132.6	1.468	132.6	1.468	0.95	0.55	1.3	0.72
24.00	134.8	1.535	134.8	1.535	0.94	0.55	1.3	0.72
25.00	136.9	1.603	136.9	1.603	0.94	0.55	1.3	0.72
26.00	139.1	1.672	139.1	1.672	0.94	0.55	1.3	0.71
27.00	139.3	1.742	139.3	1.742	0.94	0.55	1.3	0.71
28.00	139.6	1.811	139.6	1.811	0.93	0.55	1.3	0.71
29.00	139.8	1.881	139.8	1.881	0.93	0.55	1.3	0.71
30.00	140.1	1.951	140.1	1.951	0.93	0.54	1.3	0.71
31.00	140.3	2.021	140.3	2.021	0.92	0.54	1.3	0.70
32.00	140.2	2.091	140.2	2.091	0.91	0.53	1.3	0.69
33.00	140.2	2.162	140.2	2.162	0.91	0.53	1.3	0.69
34.00	140.1	2.232	140.1	2.232	0.90	0.52	1.3	0.68
35.00	140.0	2.302	140.0	2.302	0.89	0.52	1.3	0.68
36.00	140.0	2.372	140.0	2.372	0.88	0.52	1.3	0.67
37.00	140.0	2.442	140.0	2.442	0.87	0.51	1.3	0.66
38.00	140.0	2.512	140.0	2.512	0.86	0.51	1.3	0.66
39.00	140.0	2.582	140.0	2.582	0.86	0.50	1.3	0.65
40.00	140.0	2.652	140.0	2.652	0.85	0.50	1.3	0.65
41.00	140.0	2.722	140.0	2.722	0.84	0.49	1.3	0.64
42.00	140.0	2.792	140.0	2.792	0.83	0.49	1.3	0.63
43.00	140.0	2.862	140.0	2.862	0.82	0.48	1.3	0.63
44.00	140.0	2.932	140.0	2.932	0.82	0.48	1.3	0.62
45.00	140.0	3.002	140.0	3.002	0.81	0.47	1.3	0.61
46.00	140.0	3.072	140.0	3.072	0.80	0.47	1.3	0.61
47.00	140.0	3.142	140.0	3.142	0.79	0.46	1.3	0.60
48.00	140.0	3.212	140.0	3.212	0.78	0.46	1.3	0.60
49.00	140.0	3.282	140.0	3.282	0.78	0.45	1.3	0.59
50.00	140.0	3.352	140.0	3.352	0.77	0.45	1.3	0.58
51.00	140.0	3.422	140.0	3.422	0.76	0.44	1.3	0.58

CSR is based on water table at 75.0 during earthquake

CRR Calculation from SPT or BPT data:

Depth ft	SPT	Cebs	Cr	sigma'	Cn	(N1)60	Fines %	d(N1)60	(N1)60f	CRR7.5

–	1.00	30.00	1.49	0.75	0.065	1.70	57.18	30.0	6.00
63.18	2.00								
	2.00	30.00	1.49	0.75	0.130	1.70	57.18	30.0	6.00
63.18	2.00								
	3.00	30.00	1.49	0.75	0.195	1.70	57.18	30.0	6.00
63.18	2.00								
	4.00	30.00	1.49	0.75	0.260	1.70	57.18	30.0	6.00
63.18	2.00								
	5.00	26.50	1.49	0.75	0.324	1.70	50.51	15.5	2.52
53.03	2.00								
	6.00	23.00	1.49	0.75	0.385	1.61	41.58	1.0	0.00
41.58	2.00								
	7.00	23.60	1.49	0.75	0.445	1.50	39.68	6.8	0.43
40.12	2.00								
	8.00	24.20	1.49	0.75	0.505	1.41	38.18	12.6	1.82
40.00	2.00								
	9.00	24.80	1.49	0.85	0.566	1.33	41.88	18.4	3.22
45.09	2.00								
	10.00	25.40	1.49	0.85	0.628	1.26	40.73	24.2	4.61
45.33	2.00								
	11.00	26.00	1.49	0.85	0.691	1.20	39.76	30.0	6.00
45.76	2.00								
	12.00	31.60	1.49	0.85	0.754	1.15	46.26	29.0	5.76
52.02	2.00								
	13.00	37.20	1.49	0.85	0.817	1.11	52.29	28.0	5.52
57.81	2.00								
	14.00	42.80	1.49	0.85	0.882	1.06	57.92	27.0	5.28
63.20	2.00								
	15.00	48.40	1.49	0.95	0.947	1.03	70.65	26.0	5.04
75.69	2.00								
	16.00	54.00	1.49	0.95	1.012	0.99	76.22	25.0	4.80
81.02	2.00								
	17.00	49.40	1.49	0.95	1.078	0.96	67.56	25.0	4.80
72.36	2.00								
	18.00	44.80	1.49	0.95	1.144	0.94	59.49	25.0	4.80
64.29	2.00								
	19.00	40.20	1.49	0.95	1.209	0.91	51.93	25.0	4.80
56.73	2.00								
	20.00	35.60	1.49	0.95	1.274	0.89	44.80	25.0	4.80
49.60	2.00								
	21.00	31.00	1.49	0.95	1.338	0.86	38.06	25.0	4.80
42.86	2.00								
	22.00	44.80	1.49	0.95	1.403	0.84	53.72	25.0	4.80
58.52	2.00								
	23.00	58.60	1.49	0.95	1.468	0.83	68.68	25.0	4.80
73.48	2.00								
	24.00	72.40	1.49	0.95	1.535	0.81	82.99	25.0	4.80
87.79	2.00								
	25.00	86.20	1.49	0.95	1.603	0.79	96.69	25.0	4.80
101.49	2.00								
	26.00	100.00	1.49	0.95	1.672	0.77	109.83	25.0	4.80
114.63	2.00								
	27.00	97.00	1.49	0.95	1.742	0.76	104.39	25.0	4.80
109.19	2.00								
	28.00	94.00	1.49	1.00	1.811	0.74	104.41	25.0	4.80
109.21	2.00								
	29.00	91.00	1.49	1.00	1.881	0.73	99.19	25.0	4.80
103.99	2.00								
	30.00	88.00	1.49	1.00	1.951	0.72	94.18	25.0	4.80
98.98	2.00								
	31.00	85.00	1.49	1.00	2.021	0.70	89.38	25.0	4.80
94.18	2.00								

32.00	83.50	1.49	1.00	2.091	0.69	86.32	25.0	4.80	91.12	2.00
33.00	82.00	1.49	1.00	2.162	0.68	83.38	25.0	4.80	88.18	2.00
34.00	80.50	1.49	1.00	2.232	0.67	80.56	25.0	4.80	85.36	2.00
35.00	79.00	1.49	1.00	2.302	0.66	77.85	25.0	4.80	82.65	2.00
36.00	79.60	1.49	1.00	2.372	0.65	77.27	25.0	4.80	82.07	2.00
37.00	80.20	1.49	1.00	2.442	0.64	76.73	25.0	4.80	81.53	2.00
38.00	80.80	1.49	1.00	2.512	0.63	76.22	25.0	4.80	81.02	2.00
39.00	81.40	1.49	1.00	2.582	0.62	75.74	25.0	4.80	80.54	2.00
40.00	82.00	1.49	1.00	2.652	0.61	75.28	25.0	4.80	80.08	2.00
41.00	81.00	1.49	1.00	2.722	0.61	73.40	25.0	4.80	78.20	2.00
42.00	80.00	1.49	1.00	2.792	0.60	71.58	25.0	4.80	76.38	2.00
43.00	79.00	1.49	1.00	2.862	0.59	69.82	25.0	4.80	74.62	2.00
44.00	78.00	1.49	1.00	2.932	0.58	68.11	25.0	4.80	72.91	2.00
45.00	77.00	1.49	1.00	3.002	0.58	66.44	25.0	4.80	71.24	2.00
46.00	81.60	1.49	1.00	3.072	0.57	69.60	25.0	4.80	74.40	2.00
47.00	86.20	1.49	1.00	3.142	0.56	72.70	25.0	4.80	77.50	2.00
48.00	90.80	1.49	1.00	3.212	0.56	75.74	25.0	4.80	80.54	2.00
49.00	95.40	1.49	1.00	3.282	0.55	78.73	25.0	4.80	83.53	2.00
50.00	100.00	1.49	1.00	3.352	0.55	81.66	25.0	4.80	86.46	2.00
51.00	100.00	1.49	1.00	3.422	0.54	80.82	25.0	4.80	85.62	2.00

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CRR is based on water table at 75.0 during In-Situ Testing

Factor of Safety, - Earthquake Magnitude= 7.8:

Depth ft	sigC' tsf	CRR7.5 tsf	Ksigma	CRRv	MSF	CRRm	CSRfs w/fs	F.S. CRRm/CSRfs
1.00	0.04	2.00	1.00	2.00	0.90	1.81	0.76	5.00
2.00	0.08	2.00	1.00	2.00	0.90	1.81	0.76	5.00
3.00	0.13	2.00	1.00	2.00	0.90	1.81	0.76	5.00
4.00	0.17	2.00	1.00	2.00	0.90	1.81	0.75	5.00
5.00	0.21	2.00	1.00	2.00	0.90	1.81	0.75	5.00
6.00	0.25	2.00	1.00	2.00	0.90	1.81	0.75	5.00
7.00	0.29	2.00	1.00	2.00	0.90	1.81	0.75	5.00
8.00	0.33	2.00	1.00	2.00	0.90	1.81	0.75	5.00
9.00	0.37	2.00	1.00	2.00	0.90	1.81	0.74	5.00
10.00	0.41	2.00	1.00	2.00	0.90	1.81	0.74	5.00
11.00	0.45	2.00	1.00	2.00	0.90	1.81	0.74	5.00
12.00	0.49	2.00	1.00	2.00	0.90	1.81	0.74	5.00
13.00	0.53	2.00	1.00	2.00	0.90	1.81	0.74	5.00
14.00	0.57	2.00	1.00	2.00	0.90	1.81	0.74	5.00

15.00	0.62	2.00	1.00	2.00	0.90	1.81	0.73	5.00
16.00	0.66	2.00	1.00	2.00	0.90	1.81	0.73	5.00
17.00	0.70	2.00	1.00	2.00	0.90	1.81	0.73	5.00
18.00	0.74	2.00	1.00	2.00	0.90	1.81	0.73	5.00
19.00	0.79	2.00	1.00	2.00	0.90	1.81	0.73	5.00
20.00	0.83	2.00	1.00	2.00	0.90	1.81	0.73	5.00
21.00	0.87	2.00	1.00	2.00	0.90	1.81	0.72	5.00
22.00	0.91	2.00	1.00	2.00	0.90	1.81	0.72	5.00
23.00	0.95	2.00	1.00	2.00	0.90	1.81	0.72	5.00
24.00	1.00	2.00	1.00	2.00	0.90	1.81	0.72	5.00
25.00	1.04	2.00	1.00	2.00	0.90	1.81	0.72	5.00
26.00	1.09	2.00	0.99	1.99	0.90	1.79	0.71	5.00
27.00	1.13	2.00	0.99	1.97	0.90	1.78	0.71	5.00
28.00	1.18	2.00	0.98	1.96	0.90	1.77	0.71	5.00
29.00	1.22	2.00	0.97	1.94	0.90	1.76	0.71	5.00
30.00	1.27	2.00	0.97	1.93	0.90	1.75	0.71	5.00
31.00	1.31	2.00	0.96	1.92	0.90	1.73	0.70	5.00
32.00	1.36	2.00	0.95	1.90	0.90	1.72	0.69	5.00
33.00	1.41	2.00	0.95	1.89	0.90	1.71	0.69	5.00
34.00	1.45	2.00	0.94	1.88	0.90	1.70	0.68	5.00
35.00	1.50	2.00	0.93	1.87	0.90	1.69	0.68	5.00
36.00	1.54	2.00	0.93	1.85	0.90	1.68	0.67	5.00
37.00	1.59	2.00	0.92	1.84	0.90	1.67	0.66	5.00
38.00	1.63	2.00	0.92	1.83	0.90	1.66	0.66	5.00
39.00	1.68	2.00	0.91	1.82	0.90	1.65	0.65	5.00
40.00	1.72	2.00	0.90	1.81	0.90	1.63	0.65	5.00
41.00	1.77	2.00	0.90	1.80	0.90	1.62	0.64	5.00
42.00	1.81	2.00	0.89	1.79	0.90	1.61	0.63	5.00
43.00	1.86	2.00	0.89	1.78	0.90	1.61	0.63	5.00
44.00	1.91	2.00	0.88	1.76	0.90	1.60	0.62	5.00
45.00	1.95	2.00	0.88	1.75	0.90	1.59	0.61	5.00
46.00	2.00	2.00	0.87	1.74	0.90	1.58	0.61	5.00
47.00	2.04	2.00	0.87	1.73	0.90	1.57	0.60	5.00
48.00	2.09	2.00	0.86	1.72	0.90	1.56	0.60	5.00
49.00	2.13	2.00	0.86	1.71	0.90	1.55	0.59	5.00
50.00	2.18	2.00	0.85	1.71	0.90	1.54	0.58	5.00
51.00	2.22	2.00	0.85	1.70	0.90	1.53	0.58	5.00

* F.S.<1: Liquefaction Potential Zone. (If above water table: F.S.=5)
(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

CPT convert to SPT for Settlement Analysis:
Fines Correction for Settlement Analysis:

Depth ft	Ic	qc/N60	qc1 tsf	(N1)60	Fines %	d(N1)60	(N1)60s
1.00	-	-	-	57.18	30.0	2.56	59.75
2.00	-	-	-	57.18	30.0	2.56	59.75
3.00	-	-	-	57.18	30.0	2.56	59.75
4.00	-	-	-	57.18	30.0	2.56	59.75
5.00	-	-	-	50.51	15.5	1.41	51.93
6.00	-	-	-	41.58	1.0	0.10	41.67
7.00	-	-	-	39.68	6.8	0.64	40.33
8.00	-	-	-	38.18	12.6	1.16	39.34
9.00	-	-	-	41.88	18.4	1.66	43.53
10.00	-	-	-	40.73	24.2	2.12	42.85
11.00	-	-	-	39.76	30.0	2.56	42.32
12.00	-	-	-	46.26	29.0	2.49	48.75
13.00	-	-	-	52.29	28.0	2.41	54.70
14.00	-	-	-	57.92	27.0	2.34	60.26
15.00	-	-	-	70.65	26.0	2.26	72.91
16.00	-	-	-	76.22	25.0	2.19	78.41

17.00	-	-	-	67.56	25.0	2.19	69.75
18.00	-	-	-	59.49	25.0	2.19	61.68
19.00	-	-	-	51.93	25.0	2.19	54.11
20.00	-	-	-	44.80	25.0	2.19	46.99
21.00	-	-	-	38.06	25.0	2.19	40.25
22.00	-	-	-	53.72	25.0	2.19	55.91
23.00	-	-	-	68.68	25.0	2.19	70.87
24.00	-	-	-	82.99	25.0	2.19	85.17
25.00	-	-	-	96.69	25.0	2.19	98.88
26.00	-	-	-	100.00	25.0	2.19	102.19
27.00	-	-	-	100.00	25.0	2.19	102.19
28.00	-	-	-	100.00	25.0	2.19	102.19
29.00	-	-	-	99.19	25.0	2.19	101.37
30.00	-	-	-	94.18	25.0	2.19	96.37
31.00	-	-	-	89.38	25.0	2.19	91.57
32.00	-	-	-	86.32	25.0	2.19	88.50
33.00	-	-	-	83.38	25.0	2.19	85.57
34.00	-	-	-	80.56	25.0	2.19	82.75
35.00	-	-	-	77.85	25.0	2.19	80.03
36.00	-	-	-	77.27	25.0	2.19	79.46
37.00	-	-	-	76.73	25.0	2.19	78.92
38.00	-	-	-	76.22	25.0	2.19	78.41
39.00	-	-	-	75.74	25.0	2.19	77.92
40.00	-	-	-	75.28	25.0	2.19	77.47
41.00	-	-	-	73.40	25.0	2.19	75.59
42.00	-	-	-	71.58	25.0	2.19	73.77
43.00	-	-	-	69.82	25.0	2.19	72.00
44.00	-	-	-	68.11	25.0	2.19	70.29
45.00	-	-	-	66.44	25.0	2.19	68.63
46.00	-	-	-	69.60	25.0	2.19	71.79
47.00	-	-	-	72.70	25.0	2.19	74.89
48.00	-	-	-	75.74	25.0	2.19	77.93
49.00	-	-	-	78.73	25.0	2.19	80.91
50.00	-	-	-	81.66	25.0	2.19	83.84
51.00	-	-	-	80.82	25.0	2.19	83.01

Settlement of Saturated Sands:
Settlement Analysis Method: Ishihara / Yoshimine*

Depth	CSRfs	F.S.	Fines	(N1)60s	Dr	ec	dsz	dsv	S
ft	w/fs		%		%	%	in.	in.	in.

Settlement of Saturated Sands=0.000 in.
dsz is per each segment: dz=0.05 ft
dsv is per each print interval: dv=1 ft
S is cumulated settlement at this depth

Settlement of Dry Sands:

Depth	sigma'	sigC'	(N1)60s	CSRfs	Gmax	g*Ge/Gm	g_eff	ec7.5	Cec	ec	dsz	dsv	S
ft	tsf	tsf		w/fs	tsf			%		%	in.	in.	in.
51.45	3.45	2.24	82.64	0.57	2914.1	6.8E-4	0.2994	0.0947	1.12	0.1058	1.3E-3	0.001	0.001
51.00	3.42	2.22	83.01	0.58	2905.0	6.8E-4	0.2982	0.0943	1.12	0.1054	1.3E-3	0.011	0.013

	50.00	3.35	2.18	83.84	0.58	2884.8	6.8E-4	0.2954	0.0934	1.12
0.1045	1.3E-3	0.025	0.038							
	49.00	3.28	2.13	80.91	0.59	2820.9	6.9E-4	0.3065	0.0969	1.12
0.1084	1.3E-3	0.026	0.063							
	48.00	3.21	2.09	77.93	0.60	2756.0	6.9E-4	0.3185	0.1007	1.12
0.1126	1.4E-3	0.027	0.090							
	47.00	3.14	2.04	74.89	0.60	2689.9	7.0E-4	0.3315	0.1048	1.12
0.1172	1.4E-3	0.028	0.118							
	46.00	3.07	2.00	71.79	0.61	2622.6	7.1E-4	0.3456	0.1093	1.12
0.1222	1.5E-3	0.029	0.146							
	45.00	3.00	1.95	68.63	0.61	2553.9	7.2E-4	0.3612	0.1142	1.12
0.1277	1.5E-3	0.030	0.176							
	44.00	2.93	1.91	70.29	0.62	2544.2	7.2E-4	0.3499	0.1107	1.12
0.1237	1.5E-3	0.030	0.206							
	43.00	2.86	1.86	72.00	0.63	2533.8	7.1E-4	0.3387	0.1071	1.12
0.1197	1.4E-3	0.029	0.236							
	42.00	2.79	1.81	73.77	0.63	2522.9	7.0E-4	0.3274	0.1035	1.12
0.1157	1.4E-3	0.028	0.264							
	41.00	2.72	1.77	75.59	0.64	2511.4	6.9E-4	0.3161	0.0999	1.12
0.1117	1.3E-3	0.027	0.291							
	40.00	2.65	1.72	77.47	0.65	2499.2	6.8E-4	0.3048	0.0964	1.12
0.1078	1.3E-3	0.026	0.317							
	39.00	2.58	1.68	77.92	0.65	2470.8	6.8E-4	0.2994	0.0947	1.12
0.1058	1.3E-3	0.026	0.343							
	38.00	2.51	1.63	78.41	0.66	2442.1	6.8E-4	0.2935	0.0928	1.12
0.1038	1.2E-3	0.025	0.368							
	37.00	2.44	1.59	78.92	0.66	2413.1	6.7E-4	0.2873	0.0909	1.12
0.1016	1.2E-3	0.025	0.393							
	36.00	2.37	1.54	79.46	0.67	2383.7	6.7E-4	0.2808	0.0888	1.12
0.0993	1.2E-3	0.024	0.417							
	35.00	2.30	1.50	80.03	0.68	2353.9	6.6E-4	0.7392	0.2338	1.12
0.2614	3.1E-3	0.027	0.444							
	34.00	2.23	1.45	82.75	0.68	2343.7	6.5E-4	0.6724	0.2126	1.12
0.2377	2.9E-3	0.060	0.504							
	33.00	2.16	1.41	85.57	0.69	2332.5	6.4E-4	0.6115	0.1934	1.12
0.2162	2.6E-3	0.054	0.558							
	32.00	2.09	1.36	88.50	0.69	2320.3	6.3E-4	0.5560	0.1758	1.12
0.1966	2.4E-3	0.049	0.608							
	31.00	2.02	1.31	91.57	0.70	2307.0	6.1E-4	0.5053	0.1598	1.12
0.1787	2.1E-3	0.045	0.653							
	30.00	1.95	1.27	96.37	0.71	2305.6	6.0E-4	0.4479	0.1416	1.12
0.1584	1.9E-3	0.040	0.693							
	29.00	1.88	1.22	101.37	0.71	2302.4	5.8E-4	0.3873	0.1225	1.12
0.1369	1.6E-3	0.035	0.728							
	28.00	1.81	1.18	102.19	0.71	2265.2	5.7E-4	0.3570	0.1129	1.12
0.1262	1.5E-3	0.031	0.760							
	27.00	1.74	1.13	102.19	0.71	2221.2	5.6E-4	0.3326	0.1052	1.12
0.1176	1.4E-3	0.029	0.789							
	26.00	1.67	1.09	102.19	0.71	2176.4	5.5E-4	0.3095	0.0979	1.12
0.1094	1.3E-3	0.027	0.816							
	25.00	1.60	1.04	98.88	0.72	2107.8	5.4E-4	0.3003	0.0950	1.12
0.1062	1.3E-3	0.025	0.841							
	24.00	1.54	1.00	85.17	0.72	1962.7	5.6E-4	0.3394	0.1073	1.12
0.1200	1.4E-3	0.027	0.868							
	23.00	1.47	0.95	70.87	0.72	1805.5	5.9E-4	0.4050	0.1281	1.12
0.1432	1.7E-3	0.031	0.900							
	22.00	1.40	0.91	55.91	0.72	1630.6	6.2E-4	0.5316	0.1681	1.12
0.1879	2.3E-3	0.039	0.939							
	21.00	1.34	0.87	40.25	0.72	1427.5	6.8E-4	0.8513	0.2692	1.12
0.3010	3.6E-3	0.057	0.996							
	20.00	1.27	0.83	46.99	0.73	1466.4	6.3E-4	0.5714	0.1807	1.12
0.2020	2.4E-3	0.059	1.055							
	19.00	1.21	0.79	54.11	0.73	1497.5	5.9E-4	0.4093	0.1294	1.12

0.1447	1.7E-3	0.041	1.095							
	18.00	1.14	0.74	61.68	0.73	1521.5	5.5E-4	1.0000	0.3162	1.12
0.3536	4.2E-3	0.042	1.137							
	17.00	1.08	0.70	69.75	0.73	1539.0	5.1E-4	1.0000	0.3162	1.12
0.3536	4.2E-3	0.085	1.222							
	16.00	1.01	0.66	78.41	0.73	1550.5	4.8E-4	0.7723	0.2442	1.12
0.2730	3.3E-3	0.078	1.300							
	15.00	0.95	0.62	72.91	0.73	1463.5	4.7E-4	0.7390	0.2337	1.12
0.2613	3.1E-3	0.064	1.364							
	14.00	0.88	0.57	60.26	0.74	1325.5	4.9E-4	0.8987	0.2842	1.12
0.3177	3.8E-3	0.074	1.439							
	13.00	0.82	0.53	54.70	0.74	1235.7	4.9E-4	0.8795	0.2781	1.12
0.3109	3.7E-3	0.075	1.514							
	12.00	0.75	0.49	48.75	0.74	1141.9	4.9E-4	0.8807	0.2785	1.12
0.3114	3.7E-3	0.075	1.588							
	11.00	0.69	0.45	42.32	0.74	1042.8	4.9E-4	0.9147	0.2893	1.12
0.3234	3.9E-3	0.076	1.664							
	10.00	0.63	0.41	42.85	0.74	998.7	4.7E-4	0.6679	0.2112	1.12
0.2362	2.8E-3	0.066	1.730							
	9.00	0.57	0.37	43.53	0.74	953.3	4.4E-4	0.4821	0.1525	1.12
0.1705	2.0E-3	0.048	1.778							
	8.00	0.51	0.33	39.34	0.75	870.5	4.3E-4	1.0000	0.3306	1.12
0.3697	4.4E-3	0.065	1.843							
	7.00	0.44	0.29	40.33	0.75	823.5	4.0E-4	1.0000	0.3162	1.12
0.3536	4.2E-3	0.086	1.929							
	6.00	0.38	0.25	41.67	0.75	774.4	3.7E-4	1.0000	0.3162	1.12
0.3536	4.2E-3	0.085	2.014							
	5.00	0.32	0.21	51.93	0.75	764.3	3.2E-4	0.8222	0.2600	1.12
0.2907	3.5E-3	0.084	2.098							
	4.00	0.26	0.17	59.75	0.75	717.7	2.7E-4	0.1343	0.0425	1.12
0.0475	5.7E-4	0.028	2.126							
	3.00	0.20	0.13	59.75	0.76	621.6	2.4E-4	1.0000	0.3162	1.12
0.3536	4.2E-3	0.055	2.181							
	2.00	0.13	0.08	59.75	0.76	507.5	1.9E-4	0.0517	0.0163	1.12
0.0183	2.2E-4	0.023	2.204							
	1.00	0.07	0.04	59.75	0.76	358.9	1.4E-4	0.0257	0.0081	1.12
0.0091	1.1E-4	0.003	2.207							

Settlement of Dry Sands=2.207 in.
dsz is per each segment: dz=0.05 ft
dsv is per each print interval: dv=1 ft
S is cumulated settlement at this depth

Total Settlement of Saturated and Dry Sands=2.207 in.
Differential Settlement=1.103 to 1.457 in.

Units Depth = ft, Stress or Pressure = tsf (atm), Unit Weight = pcf, Settlement = in.

SPT	Field data from Standard Penetration Test (SPT)
BPT	Field data from Becker Penetration Test (BPT)
qc	Field data from Cone Penetration Test (CPT)
fc	Friction from CPT testing
Gamma	Total unit weight of soil
Gamma'	Effective unit weight of soil
Fines	Fines content [%]
D50	Mean grain size
Dr	Relative Density
sigma	Total vertical stress [tsf]

sigma'	Effective vertical stress [tsf]
sigC'	Effective confining pressure [tsf]
rd	Stress reduction coefficient
CSR	Cyclic stress ratio induced by earthquake
fs	User request factor of safety, apply to CSR
w/fs	With user request factor of safety inside
CSRfs	CSR with User request factor of safety
CRR7.5	Cyclic resistance ratio (M=7.5)
Ksigma	Overburden stress correction factor for CRR7.5
CRRv	CRR after overburden stress correction, CRRv=CRR7.5 * Ksigma
MSF	Magnitude scaling factor for CRR (M=7.5)
CRRm	After magnitude scaling correction CRRm=CRRv * MSF
F.S.	Factor of Safety against liquefaction F.S.=CRRm/CSRfs
Cebs	Energy Ratio, Borehole Dia., and Sample Method Corrections
Cr	Rod Length Corrections
Cn	Overburden Pressure Correction
(N1)60	SPT after corrections, (N1)60=SPT * Cr * Cn * Cebs
d(N1)60	Fines correction of SPT
(N1)60f	(N1)60 after fines corrections, (N1)60f=(N1)60 + d(N1)60
Cq	Overburden stress correction factor
qc1	CPT after Overburden stress correction
dqc1	Fines correction of CPT
qc1f	CPT after Fines and Overburden correction, qc1f=qc1 + dqc1
qc1n	CPT after normalization in Robertson's method
Kc	Fine correction factor in Robertson's Method
qc1f	CPT after Fines correction in Robertson's Method
Ic	Soil type index in Suzuki's and Robertson's Methods
(N1)60s	(N1)60 after seattlement fines corrections
ec	Volumetric strain for saturated sands
ds	Settlement in each Segment dz
dz	Segment for calculation, dz=0.050 ft
Gmax	Shear Modulus at low strain
g_eff	gamma_eff, Effective shear Strain
g*Ge/Gm	gamma_eff * G_eff/G_max, Strain-modulus ratio
ec7.5	Volumetric Strain for magnitude=7.5
Cec	Magnitude correction factor for any magnitude
ec	Volumetric strain for dry sands, ec=Cec * ec7.5
NoLiq	No-Liquefy Soils

References:

NCEER Workshop on Evaluation of Liquefaction Resistance of Soils. Youd, T.L., and Idriss, I.M., eds., Technical Report NCEER 97-0022.

SP117. Southern California Earthquake Center. Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California. University of Southern California. March 1999.