Cal Land Engineering, Inc.
dba Quartech Consultants
Geotechnical, Environmental, and Civil Engineering

April 23, 2015

El Monte Homes, LLC
1773 W. San Bernardino Road
West Covina, California 91790

Attention: Mr. Craig Cook

Subject: Report of Geotechnical Engineering Investigation, Proposed Residential development, 4422-4436 Bannister Avenue, APN: 8545-025-900, 901 and 017, El Monte, California; QCI Project No.: 15-010-003GE

Gentlemen:

In accordance with your request, Quartech Consultants (QCI) is pleased to submit this Geotechnical Engineering Report for the subject site. The purpose of this report was to evaluate the subsurface conditions and provide recommendations for foundation designs and other relevant parameters of the proposed construction.

Based on the findings and observations during our investigation, the proposed construction of the subject site for the intended use is considered feasible from the geotechnical engineering viewpoints, provided that specific recommendations set forth herein are followed.

This opportunity to be of service is sincerely appreciated. If you have any questions pertaining to this report, please call the undersigned.

Respectfully submitted,
Cal Land Engineering, Inc. (CLE)
dba Quartech Consultants (QCI)

Jack C. Lee, GE 2153
Principal

Abe Kazemzadeh
Project Engineer

Dist: (4) Addressee

REPORT OF GEOTECHNICAL ENGINEERING INVESTIGATION

Proposed Residential Development

At

APN: 8545-025-900, 901 & 017
4422-4436 Bannister Avenue
El Monte, California

Prepared by

QUARTECH CONSULTANTS (QCI)

Project No.: 15-010-003GE

April 23, 2015

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1.0 INTRODUCTION

1.1 Purpose

This report presents a summary of our preliminary geotechnical engineering investigation for the proposed construction at the subject site. The purposes of this investigation were to evaluate the subsurface conditions at the area of proposed construction and to provide recommendations foundation design and other relevant parameters of the development.

1.2 Scope of Services

Our scope of services included:

- Review of available soil engineering data of the area.
- Our subsurface investigation consisted of excavation of logging and sampling of four 8-inch diameter hollow stem auger borings to a maximum depth of 51.5 feet below the existing grade at the subject site. The exploration was logged by a QCI engineer. Boring logs are presented in Appendix A.
- Laboratory testing of representative samples to establish engineering characteristics of the on-site soil. The laboratory test results are presented in Appendices A and B.
- Engineering analyses of the geotechnical data obtained from our background studies, field investigation, and laboratory testing.
- Preparation of this report presenting our findings, conclusions, and recommendations.

1.3 Proposed Construction

The subject site would be used for a 22 single-family residences and associated improvements. The proposed buildings are anticipated to be one and/or two-story in height with concrete slab-on-grade. Column loads are unknown at this time, but are expected to be light to medium. Minor cut and fill grading operation is anticipated to reach the desired grades.

1.4 Site Location

The project site is located on east side of Bannister Avenue, relatively short distance north of Ramona Boulevard, in the City of El Monte, California. The approximate location of the site is presented in the attached Site Location Map (Figure 1). The lot size is approximately 3.3 acres. No major surface erosions were observed during our subsurface exploration.

2.0 SUBSURFACE EXPLORATION AND LABORATORY TESTING

2.1 Subsurface Exploration

Our subsurface investigation consisted of excavation of logging and sampling of four 8-inch diameter hollow stem auger borings to a maximum depth of 51.5 feet at the locations shown on the attached Site Plan, Figure 2. The drilling of the borings were supervised and logged by a QCI's engineer. Relatively undisturbed and bulk samples were collected for laboratory testing. In addition, Standard Penetration Tests (SPT) was also conducted during drilling of the boring. Boring logs are presented in Appendix A.

2.2 Laboratory Testing

Representative samples were tested for the following parameters: in-situ moisture content and density, consolidation, direct shear strength, percent of fines, expansion, and corrosion potential. Results of our laboratory testing along with a summary of the testing procedures are presented in Appendix B. In-situ moisture and density test results are presented on the boring logs in Appendix A.

3.0 SUMMARY OF GEOTECHNICAL CONDITIONS

3.1 Soil Conditions

The onsite near surface soils consist predominantly of silty sand (SM) and sand mixtures (SP-SM). In general, these soils exist in medium dense condition. Underlying the surface soils, poorly graded sand, (SP) and silty sand mixtures (SP-SM) were disclosed in the borings to the depths explored (51.5 feet). These soils exist in the dense to very dense, and slightly moist conditions. The soils become denser as depth increases.

3.2 Groundwater

No groundwater was encountered in the borings to the depths explored. Based on our review of the "Historically Highest Ground Water Contours and Borehole Log Data Locations, El Monte Quadrangle", by CGS (previously CDMG), it is estimated that the highest historical ground water level is approximately 15 to 20 feet below the existing grade. It should be noted that the CDMG ground water map is obtained by evaluating technical publications, geotechnical borehole data, water-well logs dating back to the "turn-of-the-century". This report also indicated that ground water levels in the areas from 1960-1997 data are generally 5 to 50 feet deeper than the earlier measured data. No specific date was provided pertaining to the high ground water level.

4.0 SEISMICITY

4.1 Faulting

Based on our study, there are no known active faults crossing the property. The nearest known active regional fault is the Raymond Fault zones located at 5.1 miles from the site.

4.2 Seismicity

The subject site is located in southern California, which is a tectonically active area. The type and magnitude of seismic hazards affecting the site depend on the distance to causative faults, the intensity, and the magnitude of the seismic event. Table 1 indicates the distance of the fault zones and the associated maximum magnitude earthquake that can be produced by nearby seismic events. As indicated in Table 1, the Raymond fault zones are considered to have the most significant effect to the site from a design standpoint.

TABLE 1

Characteristics and Estimated Earthquakes for Regional Faults

Fault Name	Approximate Distance to the Site (mile)	Maximum Magnitude Earthquake (Mmax)
Raymond	5.1	6.8
Sierra Madre	5.7	7.2
Upper Elysian Park	5.8	6.7
Elsinore; W	6.4	7.0
Clamshell-Sawpit	6.8	6.7
San Jose	7.5	6.7
Verdugo	9.5	6.9
Puente Hills (Santa Fe Springs)	10.3	6.7
Puente Hills (LA)	10.5	7.0
Puente Hills (Coyote Hills)	13.1	6.9
Hollywood	13.5	6.7
Chino	15.0	6.8
Cucamonga	15.9	6.7
Santa Monica Connected alt 2	16.4	7.4

Reference: 2008 National Seismic Hazard Maps-Source Parameters

4.3 Estimated Earthquake Ground Motions

In order to estimate the seismic ground motions at the subject site, QCI has utilized the seismic hazard map published by California Geological Survey. According to this report, the peak ground alluvium acceleration at the subject site for a 2% and 10% probability of exceedance in 50 years is about 0.826.g and 0.502g, respectively (2008 NSHMP PSHA Interactive Deaggregation).

5.0 SEISMIC HAZARDS

5.1 Liquefaction

Liquefaction is the transformation of a granular material from a solid to a liquid state as a result of increasing pore-water pressure. The material will then loses strength and can flow if unrestrained, thus leading to ground failure. Liquefaction can be triggered in saturated cohesionless material by short-term cyclic loading, such as shaking due to an earthquake. Ground failure that results from liquefaction can be manifested as flow landsliding, lateral spread, loss of bearing capacity, or settlement.

The potential for liquefaction at the site's sandy soil was evaluated using the computer program "LIQUEFY2" by Thomas Blake, the subsurface data from Boring B-1 and B-3, the design earthquake (M =7.0), and ground acceleration of 0.826g (2% probability of exceedance in 50 years). The total unit weight used for the onsite soils is 120 pcf. The calculated ground water level is raised to the depth of 5 feet below the existing ground surface. Based on the analyses presented on the enclosed Appendix C indicated that the factor of safety for B-3 is less than 1.30 for the onsite soils at the depth of 32 to 37 feet.

5.2 Earthquake Induced Settlement

The sandy soils tend to settle and densify when they are subjected to earthquake shaking. Should the sand be saturated and there is no possibility for drainage so that constant volume conditions are maintained, the primary effect of the shaking is the generation of excess pore water pressures. Settlement then occurs as the excess pore pressures dissipate. The primary factors controlling seismic induced settlement are the cyclic stress ratio, maximum shear strain induced by earthquake, the strength and density of the sand, and the magnitude of the earthquake. Based on the procedures developed by Tokimatsu and Seed on 1987, it is our opinion that liquefaction induced total settlement and deferential settlement of saturated sand is 0.45 inch and 0.30 inch respectively.

5.3 Landsliding

A potential for landsliding is often suggested in areas of moderate to steep terrain that is underlain by weak or un-favorably oriented geological conditions. Neither of these conditions exists at the site. Due to the relatively flat nature of the site, it is our opinion that the potential for landslide is remote.

5.4 Lurching

Soil lurching refers to the rolling motion on the surface due to the passage of seismic surface waves. Effects of this nature are not considered significant on the subject site where the thickness of alluvium does not vary appreciably under structures.

5.5 Surface Rupture

Surface rupture is a break in the ground surface during or as a consequence of seismic activity. The potential for surface rupture on the subject site is considered low due to the absence of known active faults at the site.

5.6 Ground Shaking

Throughout southern California, ground shaking, as a result of earthquakes, is a constant potential hazard. The relative potential for damage from this hazard is a function of the type and magnitude of earthquake events and the distance of the subject site from the event. Accordingly, proposed structures should be designed and constructed in accordance with applicable portions of the building code.

6.0 CONCLUSIONS

Based on the results of our subsurface investigation, it is our opinion that the proposed improvements is feasible from a geotechnical standpoint, provided the recommendations contained herein are incorporated in the design and construction. The following is a summary of the geotechnical design and construction factors that may affect the development of the site:

6.1 Seismicity

Based on our studies on seismicity, there are no known active faults crossing the property. However, the site is located in a seismically active region and is subject to seismically induced ground shaking from nearby and distant faults, which is a characteristic of all Southern California.

6.2 Liquefaction Potential

Based on our liquefaction evaluation, it is estimated that potential seismic induced settlement of the underlying sandy soils for B-3 is about 0.45 inch for the onsite sandy soils.

6.3 Excavatability

Based on our subsurface investigation, excavation of the subsurface materials should be able to be accomplished with conventional earthwork equipment.

6.4 Surficial Soil Removal

The near surface soils are relatively dry and vary in density. In order to provide a uniform support for the foundation, it is recommended the existing soil be removed and backfilled with compacted fill to a minimum depth of 4 feet below the existing grade to provide a uniform support of the structures.

6.5 Groundwater

No groundwater was encountered in the borings to the depths explored. In our opinion, groundwater will not be a problem during the near surface construction.

7.0 RECOMMENDATIONS

The following recommendations should be incorporated into the design or construction phases.

7.1 Grading

7.1.1 Site Preparation

Prior to initiating grading operations, any existing vegetation, organic soil, trash, debris, over-sized materials (greater than 8 inches), and other deleterious materials within fill areas should be removed from the site.

7.1.2 Surficial Soil Removals

Based on our field exploration and laboratory data obtained to date, it is recommended that the surficial soils be removed to a depth of 4 feet below existing grade or 2 feet below the bottom of the footing, whichever is deeper. The recommended removal should be extended at least 4 feet beyond building lines or to the limits of the existing building. The existing near surface soils should also be removed at least one foot within the proposed driveway areas.

Locally deeper removals may be necessary to expose competent natural ground. The actual removal depths should be determined in the field as conditions are exposed. Visual inspection and/or testing may be used to define removal requirements.

7.1.3 Treatment of Removal Bottoms

Soils exposed within areas approved for fill placement should be scarified to a depth of 6 inches, conditioned to near optimum moisture content, then compacted in-place to minimum project standards.

7.1.4 Structural Backfill

The onsite soils may be used as compacted fill provided they are free of organic materials and debris. Fills should be placed in relatively thin lifts; brought to near optimum moisture content, then compacted to obtain at least 90 percent relative compaction based on laboratory standard ASTM D-1557-09.

7.2 Foundation Design

7.2.1 Bearing Value

An allowable bearing value of 1500 pounds per square foot may be used for evaluation of existing shallow continuous footings 12 inches wide and 18 inches deep, and shallow pad footings at least 24 square inches wide and 18 inches deep. This value may be increased by one-third when considering short duration seismic or wind loads.

7.2.2 Settlement

Settlement of the footings placed as recommended, and subject to no more than allowable loads is not expected to exceed 3/4 inch. Differential settlement between adjacent columns is not anticipated to exceed 1/4 inch for the adjacent column spaced at a distance of about 30 feet.

Additionally, the foundation should also be designed to resist the potential liquefaction induced total settlement and differential settlement of about 0.45 inch and 0.30 inch, respectively.

7.2.3 Lateral Resistance

Passive earth pressure may be computed as an equivalent fluid pressure of 300 pounds per cubic foot, with a maximum earth pressure of 1500 pounds per square foot. An allowable coefficient of friction between soil and concrete of 0.30 may be used with the dead load forces. When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third.

7.2.4 Foundation Construction

It is anticipated that the entire structure will be underlain by onsite soils of very low expansion potential. All footings should be founded at a minimum depth of 18 inches below the lowest adjacent ground surface. All continuous footings should have at least two No. 4 reinforcing bars placed both at the top and two No. 4 reinforcing bars placed at the bottom of the footings.

7.2.5 Concrete Slab

Concrete slabs should be a minimum of 4 inches thick and reinforced with a minimum of No. 3 reinforcing bar spaced 18-inch each way or its equivalent. All slab reinforcement should be supported to ensure proper positioning during placement of concrete.

In order to comply with the requirements of the 2013 CalGreen Section 4.505.2.1, a minimum of 4-inch thick base of ½ inch or larger clean aggregate should be provided with a vapor barrier in direct contact with concrete. A 10-mil Polyethylene vapor retarder, with joints lapped not less than 6 inches, should be placed above the aggregate and in direct contact with the concrete slab.

7.3 Temporary Trench Excavation and Backfill

All trench excavations should conform to CAL-OSHA and local safety codes. All utility trenches backfill should be brought to near optimum moisture content and then compacted to obtain a minimum relative compaction of 90 percent of ASTM D-1557-09.

8.0 INSPECTION

As a necessary requisite to the use of this report, the following inspection is recommended:

- Temporary excavations.
- Removal of surficial and unsuitable soils.
- Backfill placement and compaction.
- Utility trench backfill.

The geotechnical engineer should be notified at least 1 day in advance of the start of construction. A joint meeting between the client, the contractor, and the geotechnical engineer is recommended prior to the start of construction to discuss specific procedures and scheduling.

9.0 SEISMIC DESIGN

Based on our studies on seismicity, there are no known active faults crossing the property. However, the subject site is located in southern California, which is a tectonically active area. Based on ASCE 7-10 Standard, CBC 2013, the following seismic related values may be used:

Seismic Parameters (Latitude: 34.079196, Longitude: -118.001716)	Site Class" D"
Mapped 0.2 Sec Period Spectral Acceleration **Ss**	2.253g
Mapped 1.0 Sec Period Spectral Acceleration **S1**	0.784g
Site Coefficient for Site Class "D", **Fa**	1.0
Site Coefficient for Site Class "D", **Fv**	1.5
Maximum Considered Earthquake Spectral Response Acceleration Parameter at 0.2 Second, **SMS**	2.253g
Maximum Considered Earthquake Spectral Response Acceleration Parameter at 1.0 Second, **SM1**	1.176g
Design Spectral Response Acceleration Parameters for 0.2 sec, **SDS**	1.502g
Design Spectral Response Acceleration Parameters for 1.0 Sec, **SD1**	0.784g

The Project Structural Engineer should be aware of the information provided above to determine if any additional structural strengthening is warranted.

10.0 CORROSION POTENTIAL

Chemical laboratory tests were conducted on the existing onsite near surface materials sampled during QCI's field investigation to aid in evaluation of soil corrosion potential and the attack on concrete by sulfate soils. The testing results are presented in Appendix B.

According to 2013 CBC and ACI 318-11, a "negligible" exposure to sulfate can be expected for concrete placed in contact with the onsite soils. Therefore, Type II cement or its equivalent may be used for this project. Based on the resistivity test results, it is estimated that the subsurface soils are moderately corrosive to buried metal pipe. It is recommended that any underground steel utilities be blasted and given protective coating. Should additional protective measures be warranted, a corrosion specialist should be consulted.

11.0 REMARKS

The conclusions and recommendations contained herein are based on the findings and observations at the exploratory locations. However, soil materials may vary in characteristics between locations of the exploratory locations. If conditions are encountered during construction,

which appear to be different from those disclosed by the exploratory work, this office should be notified so as to recommend the need for modifications.

This report has been prepared in accordance with generally accepted professional engineering principles and practice. No warranty is expressed or implied. This report is subject to review by controlling public agencies having jurisdiction.

12.0 REFERENCES

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www.conservation.ca.gov/cgs/rghm/psha/fault_parameters/pdf/Documents/B_flt.pdf
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"Earthquake Hazards Program, Seismic Design Maps and tools", ASCE 7-10 Standards

APPENDIX A
FIELD INVESTIGATION

Our subsurface investigation consisted of excavation of logging and sampling of four 8-inch diameter hollow stem auger boring to a maximum depth of 51.5 feet below the existing grade at the subject site at approximate locations shown on the enclosed Site Plan, Figure 2.

The drilling of the boring was supervised by a QCI's engineer, who continuously logged the borings and visually classified the soils in accordance with the Unified Soil Classification System. Ring and SPT samples were taken at frequent intervals. These samples were obtained by driving a sampler with successive blows of 140-pound hammer dropping from a height of 30 inches.

Representative undisturbed samples of the subsurface soils were retained in a series of brass rings, each having an inside diameter of 2.42 inches and a height of 1.00 inch. All ring samples +were transported to our laboratory. Bulk surface soil samples were also collected for additional classification and testing.

APPENDIX B

LABORATORY TESTING

During the subsurface exploration, QCI personnel collected relatively undisturbed ring samples and bulk samples. The following tests were performed on selected soil samples:

Moisture-Density

The moisture content and dry unit weight were determined for each relatively undisturbed soil sample obtained in the test borings in accordance with ASTM D2937 standard. The results of these tests are shown on the boring logs in Appendix A.

Shear Tests

Shear tests were performed in a direct shear machine of strain-control type in accordance with ASTM D3080 standard. The rate of deformation was 0.010 inch per minute. Selected samples were sheared under varying confining loads in order to determine the Coulomb shear strength parameters: internal friction angle and cohesion. The shear test results are presented in the attached plates.

Consolidation Tests

Consolidation tests were performed on selected undisturbed soil samples in accordance with ASTM D2435 standard. The consolidation apparatus is designed for a one-inch high soil filled brass ring. Loads are applied in several increments in a geometric progression and the resulting deformations are recorded at selected time intervals. Porous stones are placed in contact with the top and bottom of each specimen to permit addition and release of pore fluid. The samples were inundated with water at a load of two kilo-pounds (kips) per square foot, and the test results are shown on the attached Figures.

Expansion Index

Laboratory Expansion Index test was conducted on the existing onsite near surface materials sampled during QCI's field investigation to aid in evaluation of soil expansion potential. The test is performed in accordance with ASTM D-4829. The testing result is presented below:

Sample Location	Expansion Index	Expansion Potential
B-1 @ 0-3'	1	Very Low

Corrosion Potential

Chemical laboratory tests were conducted on the existing onsite near surface materials sampled during QCI's field investigation to aid in evaluation of soil corrosion potential and the attack on

concrete by sulfate soils. These tests are performed in accordance with California Test Method 417, 422, 532, and 643. The testing results are presented below:

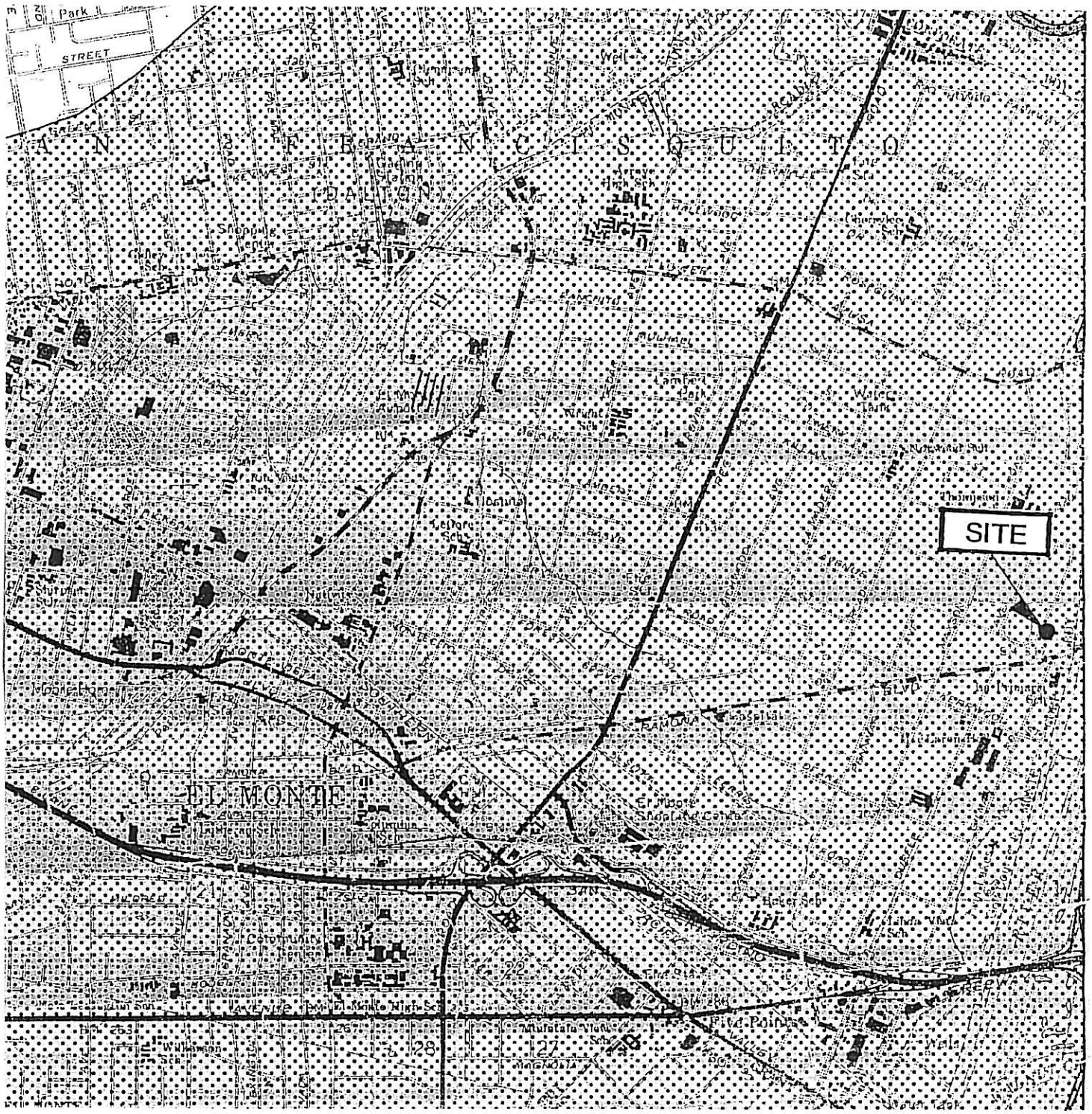
Sample Location	pH	Chloride (ppm)	Sulfate (% by weight)	Min. Resistivity (ohm-cm)
B-1 @ 0'-3'	7.32	160	0.0010	4,500

Percent Passing #200 Sieve

Percent of soil passing #200 sieve was determined for selected soil samples in accordance with ASTM D1140 standard. The test results are presented in the following table:

Sample Location	% Passing #200
B-1 @ 5'	2.5
B-1 @ 10'	3.5
B-1 @ 15'	3.8
B-1 @ 20'	4.7
B-1 @ 25'	3.0
B-1 @ 30'	24.9
B-1 @ 35'	4.8
B-1 @ 40'	9.1
B-1 @ 45'	10.8
B-1 @ 50'	3.7

Sample Location	% Passing #200
B-3 @ 5'	2.5
B-3 @ 10'	6.4
B-3 @ 15'	3.5
B-3 @ 20'	5.2
B-3 @ 25'	3.9
B-3 @ 30'	5.1
B-3 @ 35'	3.3
B-3@ 40'	9.5
B-3 @ 45'	7.3
B-3 @ 50'	8.6



N

Scale 1" = 2000'

LEGEND:

Map modified from "Seismic Hazard Zones, El Monte Quadrangle" by CDMG

Area Subjected to Liquefaction Induced Settlement

Cal Land Engineering, Inc.
dba Quartech Consultants
Geotechnical, Environmental and Civil Engineering Services

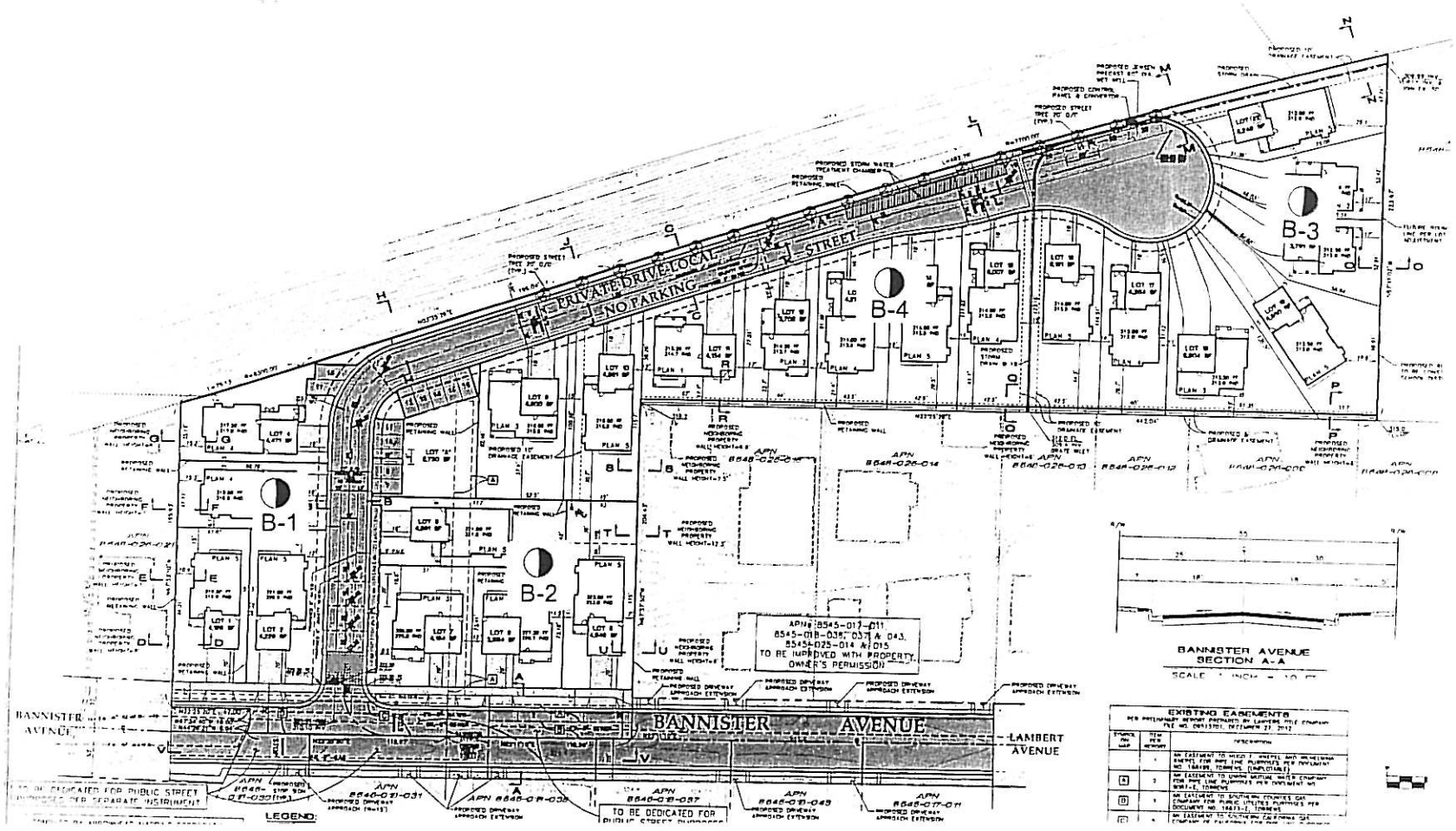
Project Address:

APN: 8545-025-900. 901 & 017
4422-4436 Bannister Avenue
El Monte, California

SITE LOCATION MAP

4/15

FIGURE 1



Scale : As Shown

LEGEND

◑ Approximate Location of Boring
B-1

Cal Land Engineering, Inc. dba Quartech Consultants Geotechnical, Environmental & Civil Engineering Services	Project Address: APN: 8545-025-900. 901 & 017 4422-4436 Bannister Avenue El Monte, California

SITE PLAN

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FIGURE 2

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BORING LOG B-1

PROJECT LOCATION: 4422-4436 Bannister Avenue, El Monte, California

PROJECT NO: 15-010-003

DATE DRILLIED: 3-13-15

SAMPLE METHOD: Hollow Stem

ELEVATION: N/A

LOGGED BY: KA

S: Standard Penetration Test

R: Ring Sample

Depth (ft)	Sample: Bulk	Sample: Undisturbed	Sample: Blows/6"	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
	Bag			SP/SM		4.9	Sand and silty sand, medium grained, light to tan brown, slightly moist, loose
		R	13 22 28	SP/SM	111.4	3.0	Sand and silty sand,medium grained, tan brown, slightly moist, medium dense percent fines= 5.4%
5		S	14 17 19				
		R	28 33	SP	95.8	1.0	Sand, fine grained, tan brown, slightly moist, dense, with fine gravel percent fines= 2.5%
10		S	28 29 30	SP		1.3	Sand, fine grained, light brown, slightly moist, very dense, gravel up to 1/2" in size percent fines= 3.5%
15		S	35 40 50	SP		2.3	Sand, fine grained, light brown, slightly moist, very dense percent fines= 3.8%
20		S	25 28 28	SP		1.4	Sand, medium grained, light brown, slightly moist, very dense, gravel up to 1/2" in size percent fines= 4.7%
25		S	49 50/5"	SP		1.9	Sand, medium grained, light tbrown, slightly moist, very dense, gravelly percent fines= 3.0%
30		S	20 25 28	SM		11.6	Silty sand, fine grained, light brown, moist, very dense percent fines= 24.9%
35		S	17 20 25	SP		2.8	Sand and silty sand, medium grained, light brown, slightly moist, dense with fine gravel percent fines= 4.8%

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dba Quartech Consultants

BORING LOG B-1

PROJECT LOCATION: 4422-4436 Bannister Avenue, El Monte, California

PROJECT NO: 15-010-003

DATE DRILLIED: 3-13-15

SAMPLE METHOD: Hollow Stem

ELEVATION: N/A

LOGGED BY: KA

S: Standard Penetration Test

R: Ring Sample

Depth (ft)	Sample: Bulk	Sample: Undisturbed	Sample: Blows/6"	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
		S	21 47 50/5"	SP/ SM		3.3	Sand and silty sand, medium grained, light brown, slightly moist, very dense percent fines= 9.1%
45		S	23 50 50/5"	SP/ SM		4.1	Sand and silty sand, medium grained, light brown, slightly moist, very dense percent fines= 10.8%
50		S	34 41 50/5"	SP		2.7	Sand, coarse grained, light tbrown, slightly moist, very dense, gravel up to 3/4" in size percent fines= 3.7%
55							
60							Total Depth 51.5 ft. No groundwater. Hole Backfilled — Hammer Driving Weight: 140 lbs Hammer Driving Height: 30 inches
65							
70							
75							

Cal Land Engineering, Inc.
dba Quartech Consultants

BORING LOG B-2

PROJECT LOCATION: 4422-4436 Bannister Avenue, El Monte, California

PROJECT NO: 15-010-003

DATE DRILLIED: 3-13-15

SAMPLE METHOD: Hollow Stem

ELEVATION: N/A

LOGGED BY: KA

S: Standard Penetration Test

R: Ring Sample

Depth (ft)	Sample: Bulk	Sample: Undisturbed	Sample: Blows/6"	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
		R	9 14 20	SM	108.2	4.3	Silty sand, medium grained, medium brown, slightly moist, medium dense to dense
5		S	14 26 29	SP/ SM		2.3	Sand and silty sand, medium grained, grayish brown, slightly moist, very dense
10		S	24 50 50/5"	SP		1.7	Sand, coarse grained, light brown, slightly moist, very dense, gravel up to 3/8" in size
15		S	28 30 34	SP/ SM		1.4	Sand, fine grained, light brown, slightly moist, very dense
20		S	30 41 50	SP		1.8	Sand, medium grained, tan brown, slightly moist, very dense, gravel up to 1" in size
25							Total Depth 21.5 ft. No groundwater. Hole Backfilled — Hammer Driving Weight: 140 lbs Hammer Driving Height: 30 inches
30							
35							

Cal Land Engineering, Inc.
dba Quartech Consultants

BORING LOG B-3

PROJECT LOCATION: 4422-4436 Bannister Avenue, El Monte, California

PROJECT NO: 15-010-003

DATE DRILLIED: 3-13-15

SAMPLE METHOD: Hollow Stem

ELEVATION: N/A

LOGGED BY: KA

S: Standard Penetration Test

R: Ring Sample

Depth (ft)	Sample: Bulk	Sample: Undisturbed	Sample: Blows/6"	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
	Bag			SP/SM		2.7	Sand and silty sand, medium grained, light to tan brown, slightly moist, loose
		R	12 14 21	SP	109.0.4	4.4	Sand, medium grained, tan brown, slightly moist, medium dense percent fines= 4.1%
5		S	10 12 16				
		R	20 23	SP	96.7	3.1	Sand, medium grained, tan brown, slightly moist, medium dense, with fine gravel percent fines= 2.5%
10		S	12 18 20	SP/SM		1.7	Sand and silty sand, coarse grained, light brown, slightly moist, dense, gravelly percent fines= 6.4%
15		S	14 20 22				
		R	28 30	SP	119.2	1.8	Sand, medium to coarse grained, light brown, slightly moist, dense percent fines= 3.5%
20		S	10 18 19	SP/SM		1.9	Sand and silty sand, medium grained, light brown, slightly moist, dense, with fine gravel percent fines= 5.2%
25		S	28 30 40				
		R	50 50/3"	SP	121.4	3.0	Sand, medium grained, light tbrown, slightly moist, very dense, gravel up to 1" in size percent fines= 3.9%
30		S	20 23 25	SP/SM		2.0	Sand and silty sand, medium to coarse grained, tan brown, slightly moist, dense, gravelly percent fines= 5.1%
35		S	16 19 22	SP		2.5	Sand, medium grained, light brown, slightly moist, dense, gravel up to 1/2" in size percent fines= 3.3%

Cal Land Engineering, Inc.
dba Quartech Consultants

BORING LOG B-3

PROJECT LOCATION: 4422-4436 Bannister Avenue, El Monte, California

PROJECT NO: 15-010-003

DATE DRILLIED: 3-13-15

SAMPLE METHOD: Hollow Stem

ELEVATION: N/A

LOGGED BY: KA

S: Standard Penetration Test

R: Ring Sample

Depth (ft)	Sample: Bulk	Sample: Undisturbed	Sample: Blows/6"	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
		S	25 44 50/5"	SP/ SM		3.6	Sand and silty sand, coarse grained, light brown, slightly moist, very dense, gravelly percent fines= 9.5%
45		S	22 50 50/5"	SP/ SM		3.8	Sand and silty sand, medium grained, light brown, slightly moist, very dense percent fines= 7.3%
50		S	30 33 45	SP/ SM		3.2	Sand and silty sand, medium grained, light tbrown, slightly moist, very dense, gravel up to 1" in size, percent fines= 8.6%
55							
60							Total Depth 51.5 ft. No groundwater. Hole Backfilled Hammer Driving Weight: 140 lbs Hammer Driving Height: 30 inches
65							
70							
75							

Cal Land Engineering, Inc.
dba Quartech Consultants

BORING LOG B-4

PROJECT LOCATION: 4422-4436 Bannister Avenue, El Monte, California

PROJECT NO: 15-010-003

DATE DRILLIED: 3-13-15

SAMPLE METHOD: Hollow Stem

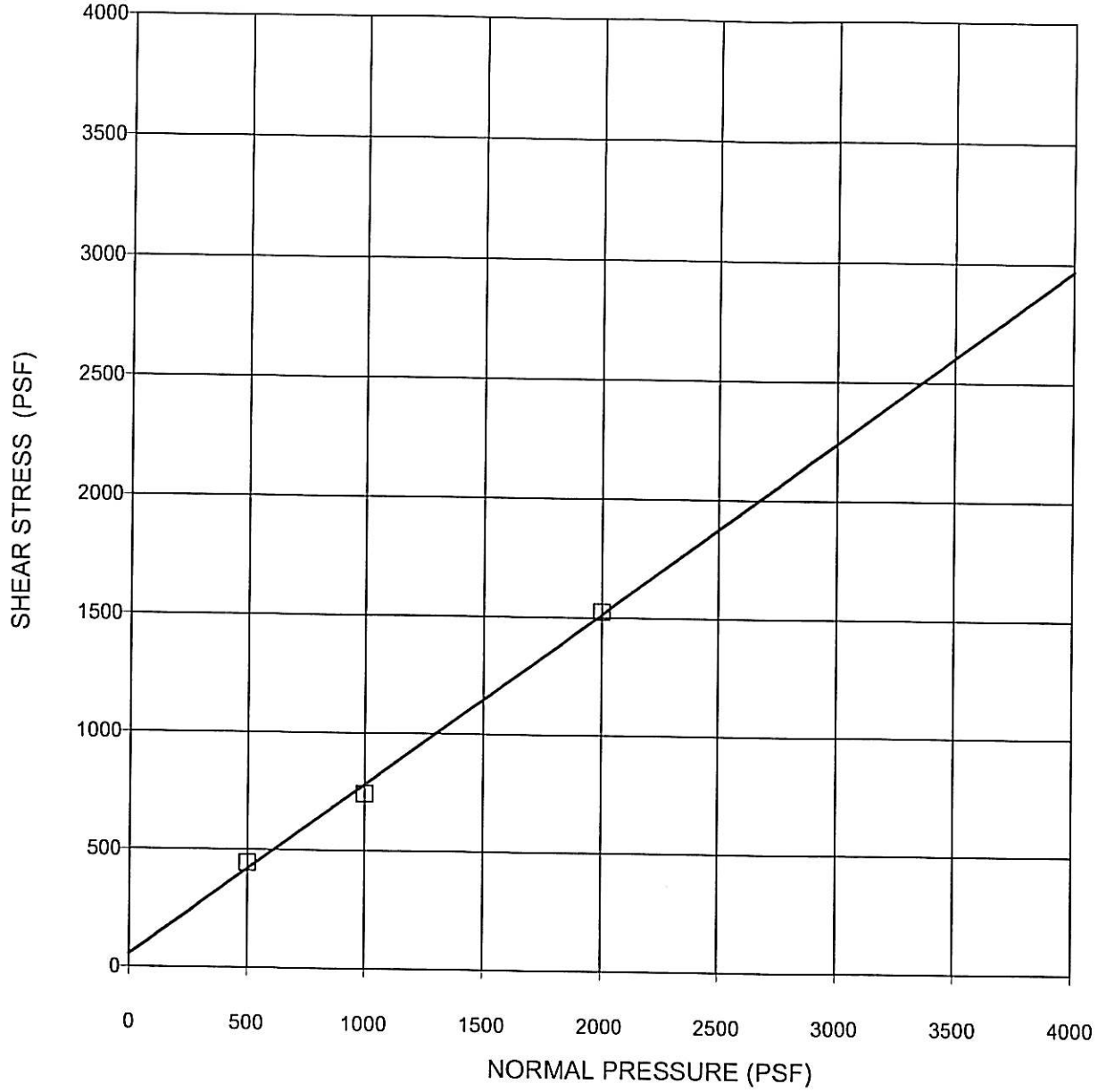
ELEVATION: N/A

LOGGED BY: KA

S: Standard Penetration Test

R: Ring Sample

Depth (ft)	Sample: Bulk	Sample: Undisturbed	Sample: Blows/6"	USCS Symbol	Dry Unit Wt. (pcf)	Moisture (%)	Description of Material
		R	50/5"	SP	126.1	2.5	Gravelly coarse grained sand, medium brown, slightly moist, very dense
5		R	50/2"	SP	111.5	3.4	Gravelly coarse grained sand, grayish brown, slightly moist, very dense
10		R	50/4"	SP	110.3	3.5	Sand, coarse grained, light brown, slightly moist, very dense, gravel up to 1/2" in size
15		S	50/5"	SP/ SM		2.1	Sand and silty sand, coarse grained, light brown, slightly moist, very dense
20		S	50/4"	SP/ SM		2.6	Sand and silty sand, medium grained, tan brown, slightly moist, very dense, gravel up to 1/2" in size
25							Total Depth 21.5 ft. No groundwater. Hole Backfilled Hammer Driving Weight: 140 lbs Hammer Driving Height: 30 inches
30							
35							



SYMBOL	BOREHOLE NUMBER	SAMPLE NUMBER	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	COHESION (PSF)	FRICTION ANGLE (DEG)
□	B-1	N/A	2.0	RING	SP-SM	50	36

Vertical Loads (PSF)	Moisture Content Before Test(%)	Moisture Content After test (%)
500	3.0	19.0
1000	3.0	18.6
2000	3.0	18.0

Cal Land Engineering, Inc.
dba Quartech Consultants
Geotechnical, Environmental & Civil Engineering Services

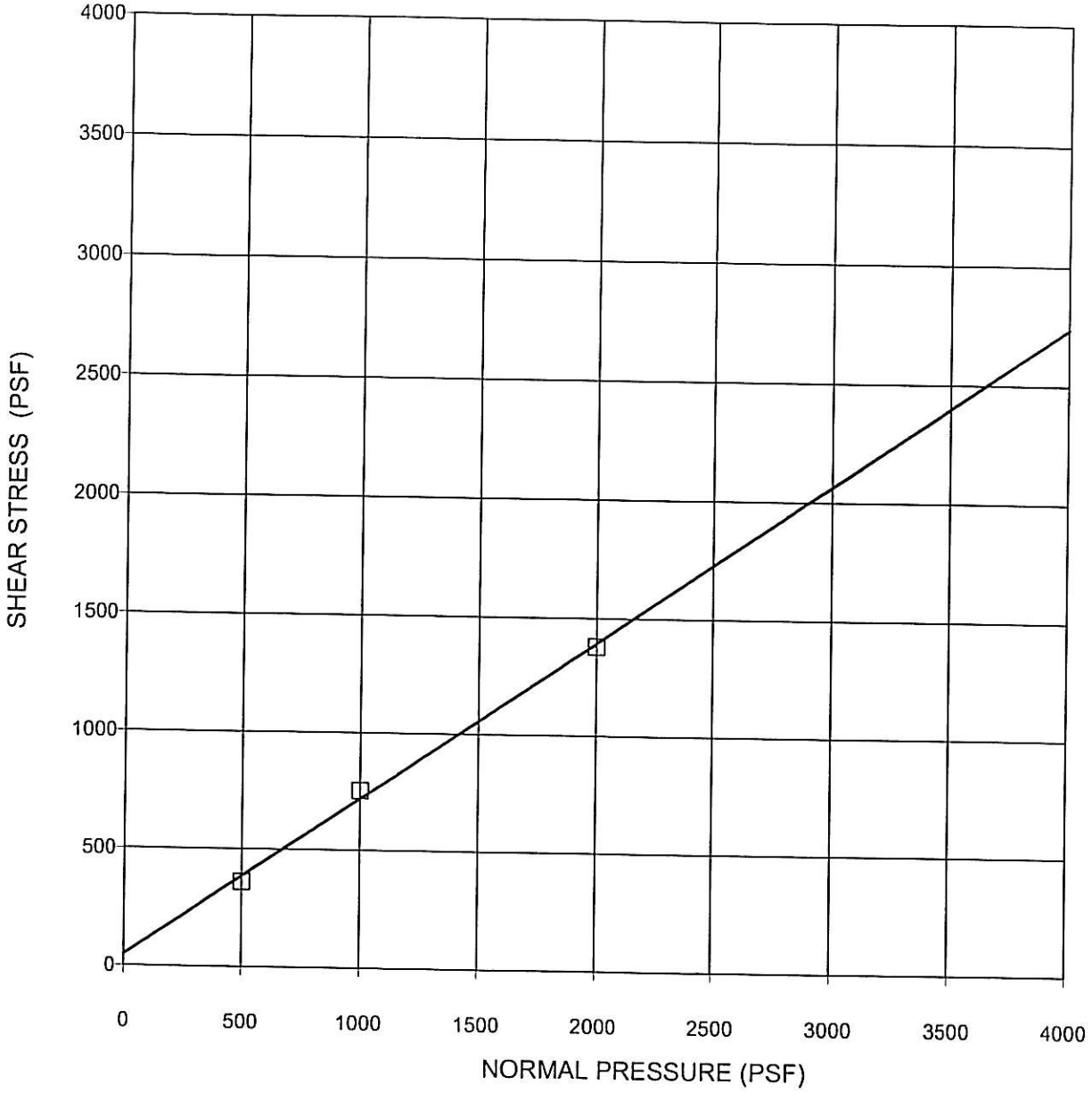
Project Address:

APN: 8545-025-900. 901 & 017
4422-4436 Bannister Avenue
El Monte, California

DIRECT SHEAR
(ASTM D3080)

4/15

FIGURE



SYMBOL	BOREHOLE NUMBER	SAMPLE NUMBER	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	COHESION (PSF)	FRICTION ANGLE (DEG)
□	B-1	N/A	5.0	RING	SP	40	34

Vertical Loads (PSF)	Moisture Content Before Test(%)	Moisture Content After test (%)
500	1.0	26.6
1000	1.0	26.1
2000	1.0	25.2

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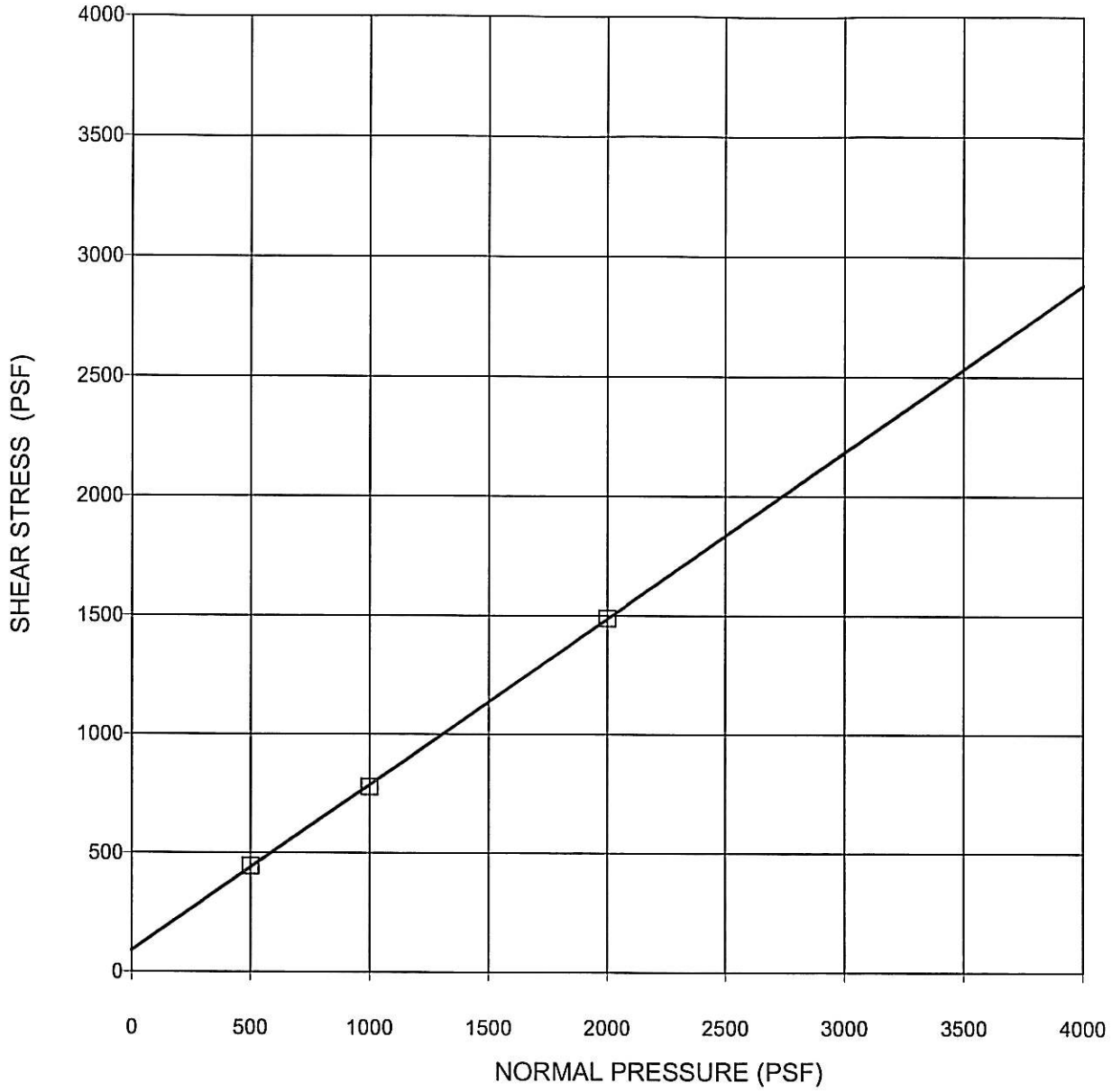
dba Quartech Consultants
Geotechnical, Environmental & Civil Engineering Services

Project Address:
APN: 8545-025-900. 901 & 017
4422-4436 Bannister Avenue
El Monte, California

DIRECT SHEAR
(ASTM D3080)

4/15

FIGURE



SYMBOL	BOREHOLE NUMBER	SAMPLE NUMBER	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	COHESION (PSF)	FRICTION ANGLE (DEG)
□	B-2	N/A	2.0	RING	SM	90	35

Vertical Loads (PSF)	Moisture Content Before Test(%)	Moisture Content After test (%)
500	4.3	20.4
1000	4.3	20.0
2000	4.3	19.3

Cal Land Engineering, Inc.
dba Quartech Consultants
Geotechnical, Environmental & Civil Engineering Services

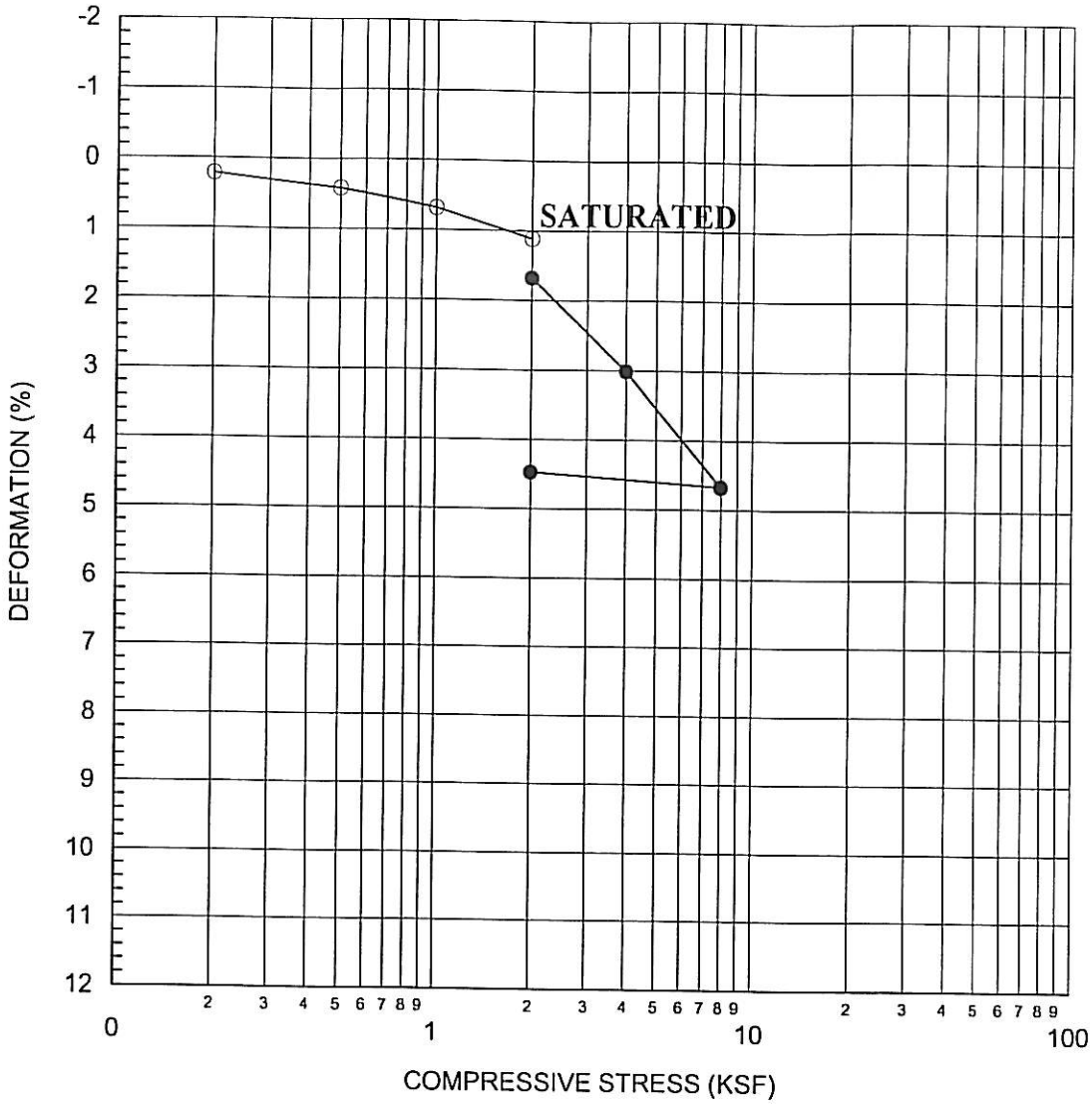
Project Address:

APN: 8545-025-900. 901 & 017
4422-4436 Bannister Avenue
El Monte, California

DIRECT SHEAR
(ASTM D3080)

4/15

FIGURE



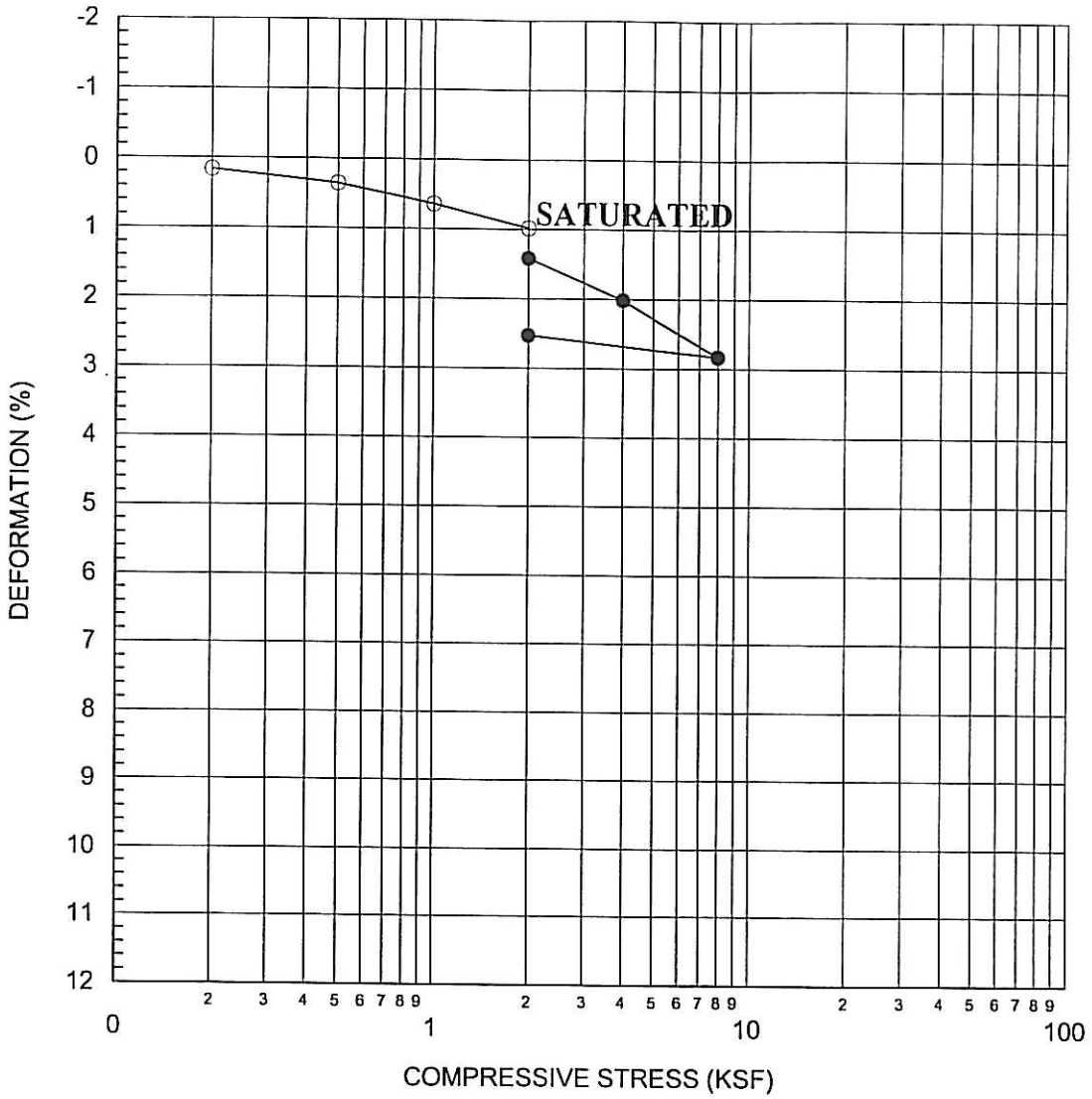
SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SOIL TYPE	INIT. MOISTURE CONTENT (%)	INIT. DRY DENSITY (PCF)	INIT. VOID RATIO
○	B-1	N/A	6.0	SP	1.0	98.5	0.759

Cal Land Engineering, Inc. dba Quartech Consultants Geotechnical, Environmental & Civil Engineering Services	Project Address: APN: 8545-025-900. 901 & 017 4422-4436 Bannister Avenue El Monte, California

CONSOLIDATION
(ASTM D2435)

4/15

FIGURE



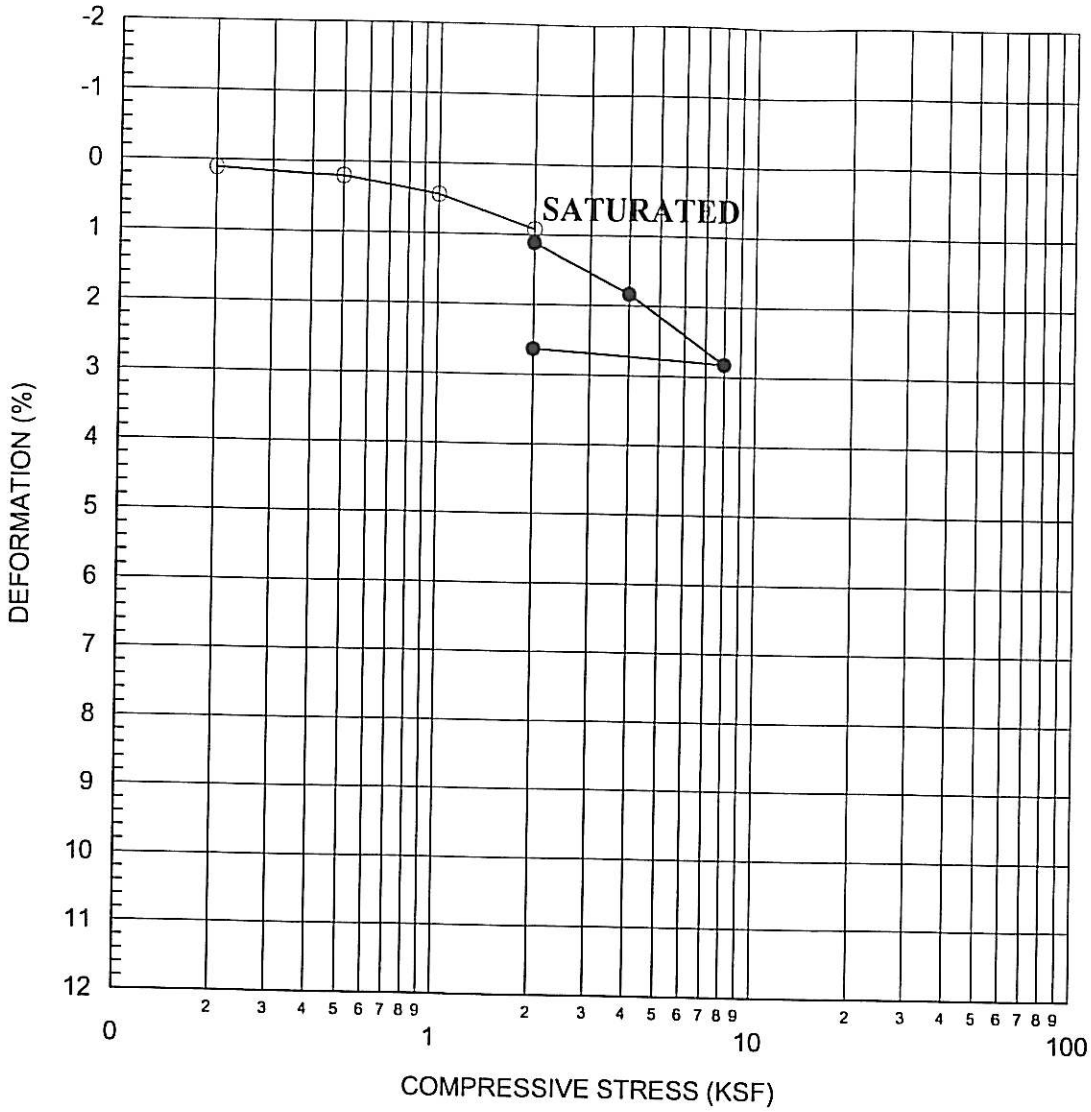
SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SOIL TYPE	INIT. MOISTURE CONTENT (%)	INIT. DRY DENSITY (PCF)	INIT. VOID RATIO
○	B-3	N/A	16.0	SP	1.8	119.2	0.413

Cal Land Engineering, Inc. dba Quartech Consultants Geotechnical, Environmental & Civil Engineering Services	Project Address: APN: 8545-025-900. 901 & 017 4422-4436 Bannister Avenue El Monte, California

CONSOLIDATION
(ASTM D2435)

4/15

FIGURE



SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SOIL TYPE	INIT. MOISTURE CONTENT (%)	INIT. DRY DENSITY (PCF)	INIT. VOID RATIO
○	B-4	N/A	10.0	SP	3.5	110.3	0.527

Cal Land Engineering, Inc. dba Quartech Consultants Geotechnical, Environmental & Civil Engineering Services	Project Address: APN: 8545-025-900. 901 & 017 4422-4436 Bannister Avenue El Monte, California

CONSOLIDATION
(ASTM D2435)

4/15

FIGURE

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*      L I Q U E F Y 2     *
*                          *
*       Version 1.50       *
*                          *
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EMPIRICAL PREDICTION OF
EARTHQUAKE-INDUCED LIQUEFACTION POTENTIAL

B-1
JOB NUMBER: 15-010-003 DATE: 04-22-2015

JOB NAME: 4422 BANNISTER

SOIL-PROFILE NAME: BANNISTER.LDW

BORING GROUNDWATER DEPTH: 50.00 ft

CALCULATION GROUNDWATER DEPTH: 5.00 ft

DESIGN EARTHQUAKE MAGNITUDE: 7.00 Mw

SITE PEAK GROUND ACCELERATION: 0.826 g

BOREHOLE DIAMETER CORRECTION FACTOR: 1.00

SAMPLER SIZE CORRECTION FACTOR: 1.00

N60 HAMMER CORRECTION FACTOR: 1.00

MAGNITUDE SCALING FACTOR METHOD: Idriss (1997, in press)

Magnitude Scaling Factor: 1.193

rd-CORRECTION METHOD: Seed (1985)

FIELD SPT N-VALUES ARE CORRECTED FOR THE LENGTH OF THE DRIVE RODS.

Rod Stick-Up Above Ground: 3.0 ft

CN NORMALIZATION FACTOR: 1.044 tsf

MINIMUM CN VALUE: 0.6

B-1

NCEER [1997] Method

LIQUEFACTION ANALYSIS SUMMARY

File Name: BANNISTER.OUT

SOIL NO.	CALC. DEPTH (ft)	TOTAL STRESS (tsf)	EFF. STRESS (tsf)	FIELD N (B/ft)	FC DELTA N1_60	C N	CORR. (N1)60 (B/ft)	LIQUE. RESIST RATIO	r d	INDUC. STRESS RATIO	LIQUE. SAFETY FACTOR
1	0.25	0.015	0.015	36	0.06	*	*	*	*	*	**
1	0.75	0.045	0.045	36	0.06	*	*	*	*	*	**
1	1.25	0.075	0.075	36	0.06	*	*	*	*	*	**
1	1.75	0.105	0.105	36	0.06	*	*	*	*	*	**
1	2.25	0.135	0.135	36	0.06	*	*	*	*	*	**
1	2.75	0.165	0.165	36	0.06	*	*	*	*	*	**
1	3.25	0.195	0.195	36	0.06	*	*	*	*	*	**
1	3.75	0.225	0.225	36	0.06	*	*	*	*	*	**
1	4.25	0.255	0.255	36	0.06	*	*	*	*	*	**
1	4.75	0.285	0.285	36	0.06	*	*	*	*	*	**
1	5.25	0.315	0.307	36	0.06	1.865	50.4	Infin	0.990	0.545	NonLiq
1	5.75	0.345	0.322	36	0.06	1.865	50.4	Infin	0.989	0.569	NonLiq
1	6.25	0.375	0.336	36	0.06	1.865	50.4	Infin	0.987	0.592	NonLiq
1	6.75	0.405	0.350	36	0.06	1.865	50.4	Infin	0.986	0.612	NonLiq
2	7.25	0.435	0.365	59	0.07	1.319	58.4	Infin	0.985	0.631	NonLiq
2	7.75	0.465	0.379	59	0.07	1.319	58.4	Infin	0.984	0.648	NonLiq
2	8.25	0.495	0.394	59	0.07	1.319	58.4	Infin	0.983	0.664	NonLiq
2	8.75	0.525	0.408	59	0.07	1.319	58.4	Infin	0.982	0.678	NonLiq
2	9.25	0.555	0.422	59	0.07	1.319	58.4	Infin	0.981	0.692	NonLiq
2	9.75	0.585	0.437	59	0.07	1.319	58.4	Infin	0.980	0.704	NonLiq
2	10.25	0.615	0.451	59	0.07	1.319	58.4	Infin	0.979	0.716	NonLiq
2	10.75	0.645	0.466	59	0.07	1.319	58.4	Infin	0.978	0.727	NonLiq
2	11.25	0.675	0.480	59	0.07	1.319	58.4	Infin	0.977	0.737	NonLiq
2	11.75	0.705	0.494	59	0.07	1.319	58.4	Infin	0.976	0.747	NonLiq
3	12.25	0.735	0.509	90	0.10	1.077	83.9	Infin	0.974	0.756	NonLiq
3	12.75	0.765	0.523	90	0.10	1.077	83.9	Infin	0.973	0.764	NonLiq
3	13.25	0.795	0.538	90	0.10	1.077	83.9	Infin	0.972	0.772	NonLiq
3	13.75	0.825	0.552	90	0.10	1.077	83.9	Infin	0.971	0.779	NonLiq
3	14.25	0.855	0.566	90	0.10	1.077	83.9	Infin	0.970	0.786	NonLiq
3	14.75	0.885	0.581	90	0.10	1.077	83.9	Infin	0.969	0.793	NonLiq
3	15.25	0.915	0.595	90	0.10	1.077	83.9	Infin	0.968	0.799	NonLiq
3	15.75	0.945	0.610	90	0.10	1.077	83.9	Infin	0.967	0.805	NonLiq
3	16.25	0.975	0.624	90	0.10	1.077	83.9	Infin	0.966	0.810	NonLiq
3	16.75	1.005	0.638	90	0.10	1.077	83.9	Infin	0.965	0.815	NonLiq
4	17.25	1.035	0.653	56	0.06	0.933	48.8	Infin	0.964	0.820	NonLiq
4	17.75	1.065	0.667	56	0.06	0.933	48.8	Infin	0.963	0.825	NonLiq
4	18.25	1.095	0.682	56	0.06	0.933	48.8	Infin	0.961	0.829	NonLiq
4	18.75	1.125	0.696	56	0.06	0.933	48.8	Infin	0.960	0.833	NonLiq
4	19.25	1.155	0.710	56	0.06	0.933	48.8	Infin	0.959	0.837	NonLiq
4	19.75	1.185	0.725	56	0.06	0.933	48.8	Infin	0.958	0.841	NonLiq
4	20.25	1.215	0.739	56	0.06	0.933	48.8	Infin	0.956	0.844	NonLiq
4	20.75	1.245	0.754	56	0.06	0.933	48.8	Infin	0.955	0.847	NonLiq
4	21.25	1.275	0.768	56	0.06	0.933	48.8	Infin	0.954	0.850	NonLiq

B-1

NCEER [1997] Method

LIQUEFACTION ANALYSIS SUMMARY

File Name: BANNISTER.OUT

SOIL NO.	CALC. DEPTH (ft)	TOTAL STRESS (tsf)	EFF. STRESS (tsf)	FIELD N (B/ft)	FC DELTA N1_60	C N	CORR. (N1)60 (B/ft)	LIQUE. RESIST RATIO	r d	INDUC. STRESS RATIO	LIQUE. SAFETY FACTOR
4	21.75	1.305	0.782	56	0.06	0.933	48.8	Infin	0.952	0.853	NonLiq
5	22.25	1.335	0.797	99	0.10	0.834	81.3	Infin	0.951	0.855	NonLiq
5	22.75	1.365	0.811	99	0.10	0.834	81.3	Infin	0.949	0.858	NonLiq
5	23.25	1.395	0.826	99	0.10	0.834	81.3	Infin	0.948	0.860	NonLiq
5	23.75	1.425	0.840	99	0.10	0.834	81.3	Infin	0.946	0.862	NonLiq
5	24.25	1.455	0.854	99	0.10	0.834	81.3	Infin	0.945	0.864	NonLiq
5	24.75	1.485	0.869	99	0.10	0.834	81.3	Infin	0.943	0.865	NonLiq
5	25.25	1.515	0.883	99	0.10	0.834	81.3	Infin	0.941	0.867	NonLiq
5	25.75	1.545	0.898	99	0.10	0.834	81.3	Infin	0.939	0.868	NonLiq
5	26.25	1.575	0.912	99	0.10	0.834	81.3	Infin	0.938	0.869	NonLiq
5	26.75	1.605	0.926	99	0.10	0.834	81.3	Infin	0.936	0.870	NonLiq
6	27.25	1.635	0.941	53	8.93	0.762	49.3	Infin	0.934	0.871	NonLiq
6	27.75	1.665	0.955	53	8.93	0.762	49.3	Infin	0.931	0.872	NonLiq
6	28.25	1.695	0.970	53	8.93	0.762	49.3	Infin	0.929	0.872	NonLiq
6	28.75	1.725	0.984	53	8.93	0.762	49.3	Infin	0.927	0.872	NonLiq
6	29.25	1.755	0.998	53	8.93	0.762	49.3	Infin	0.925	0.873	NonLiq
6	29.75	1.785	1.013	53	8.93	0.762	49.3	Infin	0.922	0.873	NonLiq
6	30.25	1.815	1.027	53	8.93	0.762	49.3	Infin	0.920	0.872	NonLiq
6	30.75	1.845	1.042	53	8.93	0.762	49.3	Infin	0.917	0.872	NonLiq
6	31.25	1.875	1.056	53	8.93	0.762	49.3	Infin	0.914	0.872	NonLiq
6	31.75	1.905	1.070	53	8.93	0.762	49.3	Infin	0.912	0.871	NonLiq
7	32.25	1.935	1.085	45	0.04	0.705	31.8	Infin	0.909	0.870	NonLiq
7	32.75	1.965	1.099	45	0.04	0.705	31.8	Infin	0.906	0.869	NonLiq
7	33.25	1.995	1.114	45	0.04	0.705	31.8	Infin	0.903	0.868	NonLiq
7	33.75	2.025	1.128	45	0.04	0.705	31.8	Infin	0.899	0.867	NonLiq
7	34.25	2.055	1.142	45	0.04	0.705	31.8	Infin	0.896	0.866	NonLiq
7	34.75	2.085	1.157	45	0.04	0.705	31.8	Infin	0.893	0.864	NonLiq
7	35.25	2.115	1.171	45	0.04	0.705	31.8	Infin	0.889	0.862	NonLiq
7	35.75	2.145	1.186	45	0.04	0.705	31.8	Infin	0.886	0.860	NonLiq
7	36.25	2.175	1.200	45	0.04	0.705	31.8	Infin	0.882	0.858	NonLiq
7	36.75	2.205	1.214	45	0.04	0.705	31.8	Infin	0.878	0.856	NonLiq
8	37.25	2.235	1.229	97	1.64	0.660	65.6	Infin	0.874	0.854	NonLiq
8	37.75	2.265	1.243	97	1.64	0.660	65.6	Infin	0.871	0.852	NonLiq
8	38.25	2.295	1.258	97	1.64	0.660	65.6	Infin	0.866	0.849	NonLiq
8	38.75	2.325	1.272	97	1.64	0.660	65.6	Infin	0.862	0.846	NonLiq
8	39.25	2.355	1.286	97	1.64	0.660	65.6	Infin	0.858	0.843	NonLiq
8	39.75	2.385	1.301	97	1.64	0.660	65.6	Infin	0.854	0.840	NonLiq
8	40.25	2.415	1.315	97	1.64	0.660	65.6	Infin	0.849	0.837	NonLiq
8	40.75	2.445	1.330	97	1.64	0.660	65.6	Infin	0.845	0.834	NonLiq
8	41.25	2.475	1.344	97	1.64	0.660	65.6	Infin	0.840	0.831	NonLiq
8	41.75	2.505	1.358	97	1.64	0.660	65.6	Infin	0.836	0.827	NonLiq
9	42.25	2.535	1.373	99	2.84	0.622	64.4	Infin	0.831	0.824	NonLiq
9	42.75	2.565	1.387	99	2.84	0.622	64.4	Infin	0.826	0.820	NonLiq
9	43.25	2.595	1.402	99	2.84	0.622	64.4	Infin	0.822	0.817	NonLiq

B-1

NCEER [1997] Method

LIQUEFACTION ANALYSIS SUMMARY

File Name: BANNISTER.OUT

SOIL NO.	CALC. DEPTH (ft)	TOTAL STRESS (tsf)	EFF. STRESS (tsf)	FIELD N (B/ft)	FC DELTA N1_60	C N	CORR. (N1)60 (B/ft)	LIQUE. RESIST RATIO	r d	INDUC. STRESS RATIO	LIQUE. SAFETY FACTOR
9	43.75	2.625	1.416	99	2.84	0.622	64.4	Infin	0.817	0.813	NonLiq
9	44.25	2.655	1.430	99	2.84	0.622	64.4	Infin	0.812	0.809	NonLiq
9	44.75	2.685	1.445	99	2.84	0.622	64.4	Infin	0.807	0.805	NonLiq
9	45.25	2.715	1.459	99	2.84	0.622	64.4	Infin	0.802	0.801	NonLiq
9	45.75	2.745	1.474	99	2.84	0.622	64.4	Infin	0.797	0.797	NonLiq
9	46.25	2.775	1.488	99	2.84	0.622	64.4	Infin	0.792	0.793	NonLiq
9	46.75	2.805	1.502	99	2.84	0.622	64.4	Infin	0.787	0.788	NonLiq
10	47.25	2.835	1.517	91	0.07	0.608	55.4	Infin	0.782	0.784	NonLiq
10	47.75	2.865	1.531	91	0.07	0.608	55.4	Infin	0.776	0.780	NonLiq
10	48.25	2.895	1.546	91	0.07	0.608	55.4	Infin	0.771	0.776	NonLiq
10	48.75	2.925	1.560	91	0.07	0.608	55.4	Infin	0.766	0.771	NonLiq
10	49.25	2.955	1.574	91	0.07	0.608	55.4	Infin	0.761	0.767	NonLiq
10	49.75	2.985	1.589	91	0.07	0.608	55.4	Infin	0.756	0.763	NonLiq

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*                           *
*      L I Q U E F Y 2      *
*                           *
*       Version 1.50        *
*                           *
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EMPIRICAL PREDICTION OF
EARTHQUAKE-INDUCED LIQUEFACTION POTENTIAL

B-3
JOB NUMBER: 15-010-003 DATE: 04-22-2015

JOB NAME: 4422 BANNISTER

SOIL-PROFILE NAME: BANB2.LDW

BORING GROUNDWATER DEPTH: 50.00 ft

CALCULATION GROUNDWATER DEPTH: 5.00 ft

DESIGN EARTHQUAKE MAGNITUDE: 7.00 Mw

SITE PEAK GROUND ACCELERATION: 0.826 g

BOREHOLE DIAMETER CORRECTION FACTOR: 1.00

SAMPLER SIZE CORRECTION FACTOR: 1.00

N60 HAMMER CORRECTION FACTOR: 1.00

MAGNITUDE SCALING FACTOR METHOD: Idriss (1997, in press)

Magnitude Scaling Factor: 1.193

rd-CORRECTION METHOD: Seed (1985)

FIELD SPT N-VALUES ARE CORRECTED FOR THE LENGTH OF THE DRIVE RODS.

Rod Stick-Up Above Ground: 3.0 ft

CN NORMALIZATION FACTOR: 1.044 tsf

MINIMUM CN VALUE: 0.6

B-3

NCEER [1997] Method

LIQUEFACTION ANALYSIS SUMMARY

File Name: BANB2.OUT

SOIL NO.	CALC. DEPTH (ft)	TOTAL STRESS (tsf)	EFF. STRESS (tsf)	FIELD N (B/ft)	FC DELTA N1_60	C N	CORR. (N1)60 (B/ft)	LIQUE. RESIST RATIO	r d	INDUC. STRESS RATIO	LIQUE. SAFETY FACTOR
1	0.25	0.015	0.015	28	0.05	*	*	*	*	*	**
1	0.75	0.045	0.045	28	0.05	*	*	*	*	*	**
1	1.25	0.075	0.075	28	0.05	*	*	*	*	*	**
1	1.75	0.105	0.105	28	0.05	*	*	*	*	*	**
1	2.25	0.135	0.135	28	0.05	*	*	*	*	*	**
1	2.75	0.165	0.165	28	0.05	*	*	*	*	*	**
1	3.25	0.195	0.195	28	0.05	*	*	*	*	*	**
1	3.75	0.225	0.225	28	0.05	*	*	*	*	*	**
1	4.25	0.255	0.255	28	0.05	*	*	*	*	*	**
1	4.75	0.285	0.285	28	0.05	*	*	*	*	*	**
1	5.25	0.315	0.307	28	0.05	1.865	39.2	Infin	0.990	0.545	NonLiq
1	5.75	0.345	0.322	28	0.05	1.865	39.2	Infin	0.989	0.569	NonLiq
1	6.25	0.375	0.336	28	0.05	1.865	39.2	Infin	0.987	0.592	NonLiq
1	6.75	0.405	0.350	28	0.05	1.865	39.2	Infin	0.986	0.612	NonLiq
2	7.25	0.435	0.365	38	0.21	1.319	37.8	Infin	0.985	0.631	NonLiq
2	7.75	0.465	0.379	38	0.21	1.319	37.8	Infin	0.984	0.648	NonLiq
2	8.25	0.495	0.394	38	0.21	1.319	37.8	Infin	0.983	0.664	NonLiq
2	8.75	0.525	0.408	38	0.21	1.319	37.8	Infin	0.982	0.678	NonLiq
2	9.25	0.555	0.422	38	0.21	1.319	37.8	Infin	0.981	0.692	NonLiq
2	9.75	0.585	0.437	38	0.21	1.319	37.8	Infin	0.980	0.704	NonLiq
2	10.25	0.615	0.451	38	0.21	1.319	37.8	Infin	0.979	0.716	NonLiq
2	10.75	0.645	0.466	38	0.21	1.319	37.8	Infin	0.978	0.727	NonLiq
2	11.25	0.675	0.480	38	0.21	1.319	37.8	Infin	0.977	0.737	NonLiq
2	11.75	0.705	0.494	38	0.21	1.319	37.8	Infin	0.976	0.747	NonLiq
3	12.25	0.735	0.509	42	0.05	1.077	39.1	Infin	0.974	0.756	NonLiq
3	12.75	0.765	0.523	42	0.05	1.077	39.1	Infin	0.973	0.764	NonLiq
3	13.25	0.795	0.538	42	0.05	1.077	39.1	Infin	0.972	0.772	NonLiq
3	13.75	0.825	0.552	42	0.05	1.077	39.1	Infin	0.971	0.779	NonLiq
3	14.25	0.855	0.566	42	0.05	1.077	39.1	Infin	0.970	0.786	NonLiq
3	14.75	0.885	0.581	42	0.05	1.077	39.1	Infin	0.969	0.793	NonLiq
3	15.25	0.915	0.595	42	0.05	1.077	39.1	Infin	0.968	0.799	NonLiq
3	15.75	0.945	0.610	42	0.05	1.077	39.1	Infin	0.967	0.805	NonLiq
3	16.25	0.975	0.624	42	0.05	1.077	39.1	Infin	0.966	0.810	NonLiq
3	16.75	1.005	0.638	42	0.05	1.077	39.1	Infin	0.965	0.815	NonLiq
4	17.25	1.035	0.653	37	0.04	0.933	32.3	Infin	0.964	0.820	NonLiq
4	17.75	1.065	0.667	37	0.04	0.933	32.3	Infin	0.963	0.825	NonLiq
4	18.25	1.095	0.682	37	0.04	0.933	32.3	Infin	0.961	0.829	NonLiq
4	18.75	1.125	0.696	37	0.04	0.933	32.3	Infin	0.960	0.833	NonLiq
4	19.25	1.155	0.710	37	0.04	0.933	32.3	Infin	0.959	0.837	NonLiq
4	19.75	1.185	0.725	37	0.04	0.933	32.3	Infin	0.958	0.841	NonLiq
4	20.25	1.215	0.739	37	0.04	0.933	32.3	Infin	0.956	0.844	NonLiq
4	20.75	1.245	0.754	37	0.04	0.933	32.3	Infin	0.955	0.847	NonLiq
4	21.25	1.275	0.768	37	0.04	0.933	32.3	Infin	0.954	0.850	NonLiq

B-3

NCEER [1997] Method

LIQUEFACTION ANALYSIS SUMMARY

File Name: BANB2.OUT

SOIL NO.	CALC. DEPTH (ft)	TOTAL STRESS (tsf)	EFF. STRESS (tsf)	FIELD N (B/ft)	FC DELTA N1_60	C N	CORR. (N1)60 (B/ft)	LIQUE. RESIST RATIO	r d	INDUC. STRESS RATIO	LIQUE. SAFETY FACTOR
4	21.75	1.305	0.782	37	0.04	0.933	32.3	Infin	0.952	0.853	NonLiq
5	22.25	1.335	0.797	99	0.10	0.834	81.3	Infin	0.951	0.855	NonLiq
5	22.75	1.365	0.811	99	0.10	0.834	81.3	Infin	0.949	0.858	NonLiq
5	23.25	1.395	0.826	99	0.10	0.834	81.3	Infin	0.948	0.860	NonLiq
5	23.75	1.425	0.840	99	0.10	0.834	81.3	Infin	0.946	0.862	NonLiq
5	24.25	1.455	0.854	99	0.10	0.834	81.3	Infin	0.945	0.864	NonLiq
5	24.75	1.485	0.869	99	0.10	0.834	81.3	Infin	0.943	0.865	NonLiq
5	25.25	1.515	0.883	99	0.10	0.834	81.3	Infin	0.941	0.867	NonLiq
5	25.75	1.545	0.898	99	0.10	0.834	81.3	Infin	0.939	0.868	NonLiq
5	26.25	1.575	0.912	99	0.10	0.834	81.3	Infin	0.938	0.869	NonLiq
5	26.75	1.605	0.926	99	0.10	0.834	81.3	Infin	0.936	0.870	NonLiq
6	27.25	1.635	0.941	48	0.05	0.762	36.6	Infin	0.934	0.871	NonLiq
6	27.75	1.665	0.955	48	0.05	0.762	36.6	Infin	0.931	0.872	NonLiq
6	28.25	1.695	0.970	48	0.05	0.762	36.6	Infin	0.929	0.872	NonLiq
6	28.75	1.725	0.984	48	0.05	0.762	36.6	Infin	0.927	0.872	NonLiq
6	29.25	1.755	0.998	48	0.05	0.762	36.6	Infin	0.925	0.873	NonLiq
6	29.75	1.785	1.013	48	0.05	0.762	36.6	Infin	0.922	0.873	NonLiq
6	30.25	1.815	1.027	48	0.05	0.762	36.6	Infin	0.920	0.872	NonLiq
6	30.75	1.845	1.042	48	0.05	0.762	36.6	Infin	0.917	0.872	NonLiq
6	31.25	1.875	1.056	48	0.05	0.762	36.6	Infin	0.914	0.872	NonLiq
6	31.75	1.905	1.070	48	0.05	0.762	36.6	Infin	0.912	0.871	NonLiq
7	32.25	1.935	1.085	41	0.04	0.705	28.9	0.376	0.909	0.870	0.51
7	32.75	1.965	1.099	41	0.04	0.705	28.9	0.376	0.906	0.869	0.52
7	33.25	1.995	1.114	41	0.04	0.705	28.9	0.376	0.903	0.868	0.52
7	33.75	2.025	1.128	41	0.04	0.705	28.9	0.376	0.899	0.867	0.52
7	34.25	2.055	1.142	41	0.04	0.705	28.9	0.376	0.896	0.866	0.52
7	34.75	2.085	1.157	41	0.04	0.705	28.9	0.376	0.893	0.864	0.52
7	35.25	2.115	1.171	41	0.04	0.705	28.9	0.376	0.889	0.862	0.52
7	35.75	2.145	1.186	41	0.04	0.705	28.9	0.376	0.886	0.860	0.52
7	36.25	2.175	1.200	41	0.04	0.705	28.9	0.376	0.882	0.858	0.52
7	36.75	2.205	1.214	41	0.04	0.705	28.9	0.376	0.878	0.856	0.52
8	37.25	2.235	1.229	94	2.21	0.660	64.2	Infin	0.874	0.854	NonLiq
8	37.75	2.265	1.243	94	2.21	0.660	64.2	Infin	0.871	0.852	NonLiq
8	38.25	2.295	1.258	94	2.21	0.660	64.2	Infin	0.866	0.849	NonLiq
8	38.75	2.325	1.272	94	2.21	0.660	64.2	Infin	0.862	0.846	NonLiq
8	39.25	2.355	1.286	94	2.21	0.660	64.2	Infin	0.858	0.843	NonLiq
8	39.75	2.385	1.301	94	2.21	0.660	64.2	Infin	0.854	0.840	NonLiq
8	40.25	2.415	1.315	94	2.21	0.660	64.2	Infin	0.849	0.837	NonLiq
8	40.75	2.445	1.330	94	2.21	0.660	64.2	Infin	0.845	0.834	NonLiq
8	41.25	2.475	1.344	94	2.21	0.660	64.2	Infin	0.840	0.831	NonLiq
8	41.75	2.505	1.358	94	2.21	0.660	64.2	Infin	0.836	0.827	NonLiq
9	42.25	2.535	1.373	99	0.64	0.622	62.2	Infin	0.831	0.824	NonLiq
9	42.75	2.565	1.387	99	0.64	0.622	62.2	Infin	0.826	0.820	NonLiq
9	43.25	2.595	1.402	99	0.64	0.622	62.2	Infin	0.822	0.817	NonLiq

B-3

NCEER [1997] Method

LIQUEFACTION ANALYSIS SUMMARY

File Name: BANB2.OUT

SOIL NO.	CALC. DEPTH (ft)	TOTAL STRESS (tsf)	EFF. STRESS (tsf)	FIELD N (B/ft)	FC DELTA N1_60	C N	CORR. (N1)60 (B/ft)	LIQUE. RESIST RATIO	r d	INDUC. STRESS RATIO	LIQUE. SAFETY FACTOR
9	43.75	2.625	1.416	99	0.64	0.622	62.2	Infin	0.817	0.813	NonLiq
9	44.25	2.655	1.430	99	0.64	0.622	62.2	Infin	0.812	0.809	NonLiq
9	44.75	2.685	1.445	99	0.64	0.622	62.2	Infin	0.807	0.805	NonLiq
9	45.25	2.715	1.459	99	0.64	0.622	62.2	Infin	0.802	0.801	NonLiq
9	45.75	2.745	1.474	99	0.64	0.622	62.2	Infin	0.797	0.797	NonLiq
9	46.25	2.775	1.488	99	0.64	0.622	62.2	Infin	0.792	0.793	NonLiq
9	46.75	2.805	1.502	99	0.64	0.622	62.2	Infin	0.787	0.788	NonLiq
10	47.25	2.835	1.517	78	1.36	0.608	48.8	Infin	0.782	0.784	NonLiq
10	47.75	2.865	1.531	78	1.36	0.608	48.8	Infin	0.776	0.780	NonLiq
10	48.25	2.895	1.546	78	1.36	0.608	48.8	Infin	0.771	0.776	NonLiq
10	48.75	2.925	1.560	78	1.36	0.608	48.8	Infin	0.766	0.771	NonLiq
10	49.25	2.955	1.574	78	1.36	0.608	48.8	Infin	0.761	0.767	NonLiq
10	49.75	2.985	1.589	78	1.36	0.608	48.8	Infin	0.756	0.763	NonLiq

LIQUEFACTION INDUCED SETTLEMENT

References:

1. "Evaluation of Settlement in Sands Due to Earthquake Shaking", Seed, et. al., ASCE Journal of Geotechnical Engineering, Page 861 – 878, Vol. 113, No. 8, August 1987

2. "Manual for Evaluation and Mitigation of Liquefaction Hazard for Foundation Design", Workshop on Seismic Hazards Mapping Act, Los Angeles, January 1998

Recommended Fine Correction (Ref 2)

Percent of Fine	N_{corr}(Blow/ft)
10	1
25	2
50	4
75	5

Job # 15-010-003 Address: 4422 Bannister Ave, El Monte, California
April-22-2015

From Liquefaction Study: **B-3**

Soil Layer with FS < 1.30

From Reference 1: Earthquake Magnitude Correction
$r_m = 0.65/(0.1(M-1)) = 0.65/(0.1(7.0-1)) = 1.08$

Layer	Depth (feet)	τ/δ	Percent of Fine	(N1)	$(N1)_{60, corr}$	Volumetric Strain ε	Settlement (inch)
1	32-37	0.866	9.1	40	28.9	0.75 %	0.45

Total Settlement: 0.45 inches

Differential Settlement
67% x total settlement = 0.67 x 0.45 = 0.30 Inch