UPDATE TO GEOTECHNICAL ENGINEERING INVESTIGATION AND GEOLOGIC SEISMIC HAZARDS EVALUATION

NEW ELEMENTARY SCHOOL - LEMOORE
NW OF CINNAMON DRIVE AND N. 19TH AVENUE
LEMOORE, CALIFORNIA

BSK PROJECT G18-324-11F

PREPARED FOR:

LEMOORE UNION ELEMENTARY SCHOOL DISTRICT
1200 W. CINNAMON DRIVE
LEMOORE, CALIFORNIA 93245

JANUARY 9, 2019

UPDATE TO GEOTECHNICAL ENGINEERING INVESTIGATION AND GEOLOGIC SEISMIC HAZARDS EVALUATION
NEW ELEMENTARY SCHOOL - LEMOORE
NW OF CINNAMON DRIVE AND N. 19TH AVENUE
LEMOORE, CALIFORNIA

Prepared for:

Lemoore Union Elementary School District
1200 W. Cinnamon Drive
Lemoore, California 93245

BSK Project: G18-324-11F

January 10, 2019

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1 INTRODUCTION

1.1 General

This report presents the results of the updated geotechnical engineering investigation and geologic/seismic hazards evaluation for the new elementary school in Lemoore as shown on the Boring Location Map, Figure 2. BSK prepared a Geotechnical Investigation and Geologic/Seismic Hazards Study Report (BSK Job 03230063, dated October 2 and 19, 2002, respectively). Due to a lapse in time since the preparation of the report and the adoption of the 2016 California Building Code (CBC), it will be necessary to update the referenced reports. This report provides revised/updated recommendations, as necessary, for the proposed new elementary school.

The geotechnical engineering investigation was conducted in general accordance with the scope of services outlined in BSK Proposal GF18-17618, dated December 4, 2018.

In the event that significant changes occur in the design or location of the proposed improvements, the conclusions and recommendations presented in the report will not be considered valid unless the changes are reviewed by BSK and the conclusions and recommendations are modified or verified in writing as necessary.

1.2 Project Description

We understand that this project consists of the design and construction of a new elementary school campus. We assume the new campus will include single-story wood or steel framed buildings. The following table provides a summary of the proposed buildings and associated square footage.

PROPOSED BUILDINGS

Building	Area (sf.)
Multi-Use/Cafeteria	8,431
Library/Administration	6,902
Kindergarten	6,008
Classroom Wings	9,121

We assume the new buildings will be supported on conventional reinforced concrete foundations and slab-on-grade floors. Building design loads were not provided at the time this report was prepared, as such, we assume maximum wall and column loads to be less than 10 kips/ft and 30 kips, respectively. Other improvements are anticipated to include underground utilities, hardscaping, and landscaping. Fill elevations are anticipated to be less than 2 foot above natural grade, to achieve level building pad and positive site drainage.

1.3 Purpose and Scope of Services

The purpose of the geotechnical investigation is to assess soil conditions at the project site and provide updated geotechnical engineering recommendations and geologic/seismic hazards evaluations for use by the project designers during preparation of the project plans and specifications. The scope of the investigation included a field exploration, laboratory testing, engineering analysis, and geologic seismic hazards evaluations.

The investigation was performed in conformance with Chapter 18 “Soils and Foundations,” Section 1803A of the 2016 California Building Code and Title 24, California Code of Regulations, for submission to Division of the State Architect.

2 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Field Investigation

The field exploration, conducted on December 21, 2018 consisted of a site reconnaissance and hand auguring four (4) exploratory test borings. The test borings were excavated, within the area of the proposed improvements with a manually operated hand auger to depths of approximately 4 to 10 feet below ground surface (bgs). The approximate boring locations are presented on Figure 2, Boring Location Map. Details of the field exploration and the boring logs are provided in Appendix A.

2.2 Laboratory Testing

Laboratory testing of selected samples were performed to evaluate their physical and engineering characteristics and properties. The testing program included in-situ moisture and dry density, gradation, direct shear, R-value, and corrosion potential.

The in-situ moisture and dry density test results are presented on the boring logs in Appendix A. Descriptions of the laboratory test methods and test results are provided in Appendix B.

3 SITE CONDITIONS

3.1 Site Description

At the time of the field investigation the southern portion of the project site was occupied by an existing asphalt paved parking lot, ball court, solar panels, and hardscaping. The remaining portion of the project site was undeveloped and appeared to be in similar condition as described in the referenced reports. The general site coordinates are approximately 36.307273° North Latitude and 119.799985° West Longitude. The project site was bounded to the north and west by residential buildings to the east by N. 19th Avenue and to the south by the district office and parking lot and Cinnamon Drive beyond.

3.2 Subsurface Description

The near surface soils encountered within the test borings consisted of fine to medium-grained silty sand in the upper 2.5 to 8 feet bgs underlain by sandy clay, sandy silt, poorly graded sand with silt, and silty sand to the maximum depth of exploration, 10 feet bgs. The boring logs in Appendix A provide a more detailed description of the soils encountered in each boring, including the applicable Unified Soil Classification System symbols.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 General

Based upon the data collected during this investigation and from a geotechnical engineering standpoint, it is our opinion that there are no soil conditions that would preclude the construction of the proposed improvements. The referenced reports may be utilized for the design and construction of the proposed elementary school provided the following recommendations are incorporated in the appropriate sections of the referenced report. The planned improvements may be supported on shallow reinforced concrete spread and/or continuous footings.

4.2 Soil Corrosivity

Based on test results, on-site, near-surface soils have low soluble sulfate and chloride contents, a moderate minimum resistivity, and are alkaline. Thus, on-site soils are considered to have a low corrosion potential with respect to buried concrete and a moderate corrosive potential for unprotected metal conduits.

We recommend that Type I/Type II cement be used in the formulation of concrete, and that buried reinforcing steel protection be provided with a minimum concrete cover required by the American Concrete Institute (ACI) Building Code for Structural Concrete, ACI 318, Chapter 7.7. Buried metal conduits must have protective coatings in accordance with the manufacturer’s specifications. If detailed recommendations for corrosion protection are desired, a corrosion specialist must be consulted.

4.3 Site Preparation and Earthwork Construction

The following procedures must be implemented during site preparation for the proposed building addition. It should be noted that references to maximum dry density, optimum moisture content, and relative compaction are based on ASTM D1557 (or latest test revision) laboratory test procedures.

1. Within the area of the planned improvements, remove existing underground utilities and debris to expose a clean soil surface free of deleterious material.

Existing utilities or irrigation pipes must be removed to a point at least 5-feet horizontally outside the proposed building area. Resultant cavities must be backfilled with engineered fill. Abandoned pipelines to remain that are less than 2 inches in diameter should be capped at the cutoff point, while pipelines greater than 2 inches in diameter should be filled with a 1-sack sand-cement slurry.

2. Soil disturbed as a result of demolition, undocumented shallow fill, debris, and/or abandoned underground structures must be excavated to expose undisturbed native soil.

3. The exposed subgrade must be proof-rolled under the observation of a BSK field representative to detect soft or pliant areas. The exposed surface must be scarified a minimum of 8 inches, uniformly moisture conditioned to at or above optimum moisture, and compacted to 90 percent relative compaction.

4. Excavated soils, free of deleterious substances (organic matter, demolition debris, etc.) and with less than 3 percent organic content by weight, may be returned to the excavations as engineered fill. Engineered fill must be placed in uniform layers not exceeding 8-inches in loose thickness, moisture-conditioned to within 2 percent of optimum moisture content and compacted to at least 90 percent of the maximum dry density. The upper 12 inches of engineered fill placed as backfill under pavement sections must be compacted to at least 95 percent of the maximum dry density. Acceptance of engineered fill placement must be based on moisture content at time of compaction and relative compaction. Consideration can be made to reuse of excavated asphalt and hardscape as base material for pavement areas, provided it is pulverized and sufficiently blended to meet Caltrans Class 2 aggregate-base standards.

5. Imported fill materials must be free of deleterious substances and have less than 3 percent organic content by weight. The project specifications must require the contractor to contact BSK for review of the proposed import fill materials for conformance with these recommendations at least two weeks prior to importing to the site, whether from on-site or off-site borrow areas. Imported fill soils must be non-hazardous and be derived from a single, consistent soil type source conforming to the following criteria:

   Maximum Particle Size: 3-inches
   Percent Passing #4 Sieve: 65 – 100
   Percent Passing #200 Sieve: 20 – 45
   Plasticity Index: less than 12
   Expansion Index: < 20
   Low Corrosion Potential:
      Soluble Sulfates: < 1,500 mg/kg
      Soluble Chlorides: < 300 mg/kg
      Soil Resistivity: > 3,000 ohm-cm

The Department of Toxic Substance Control (DTSC) has detailed guidelines for the testing of import soils to school sites. These guidelines take into account the past and present land usage at a borrow pit, the acreage of the borrow pit and the volume of import soil to establish the amount of chemical testing of import fill recommended. BSK must be contacted for review and analytical testing of proposed import fill materials for conformance with these recommendations at least 15 days prior to transporting fill to the site.

Grading operations must be scheduled as to avoid working during periods of inclement weather. Should these operations be performed during or shortly following periods of inclement weather, unstable soil conditions may result in the soils exhibiting a "pumping" condition. This condition is caused by excess moisture, in combination with compaction, resulting in saturation and near zero air voids in the soils. If this condition occurs, the affected soils must be over-excavated to the depth at which stable soils are encountered and replaced with suitable soils compacted as engineered fill. Alternatively, the Contractor may proceed with grading operations after utilizing a method to stabilize the soil subgrade, which must be subject to review by BSK prior to implementation.

4.4 Concrete Slabs-on-Grade

Non-structural concrete slab-on-grade must be a minimum of 4-inches thick and must be supported on a compacted subgrade prepared in accordance with the “Site Preparation and Earthwork Construction” section of this report. Existing onsite surface soils are considered to have a very low expansion potential. For design purposes, in order to regulate cracking of the slabs, construction joints and/or saw-cut control joints must be provided in each direction at a maximum spacing of 10 feet on centers along with steel reinforcement as recommended by the project’s Structural Engineer. Control joints must have a minimum depth of one-quarter of the slab thickness. It is recommended that steel reinforcement used in concrete slabs-on-grade consist of steel rebar. Structural concrete slabs-on-grade may be designed using an unadjusted long-term Modulus of Subgrade Reaction (Ks) of 155 pounds per cubic inch (pci) constructed on a properly compacted subgrade or engineered fill. This value is based on the correlations to soil strength using one foot by one foot plate-load tests and should therefore be scaled (adjusted) to the actual slab width. Field and laboratory tests were not performed to establish the Ks value provided herein. For sand soils, such as those found at this site, the adjusted Ks value can be obtained by multiplying the value provided above by $[(B+B_1)/(2B)]^2$, where B is the slab width in feet and B_1 is 1 foot (width of a one foot by one foot plate-load test apparatus).

Interior concrete slabs must be successively underlain by: 1-½ inches of washed concrete sand; a durable vapor barrier; and a smooth, compacted subgrade surface. The vapor barrier must meet the requirements of ASTM: E1745 Class A and have a water vapor transmission rate (WVTR) of less than or equal to 0.012 Perms as tested by ASTM: E96. Examples of acceptable vapor barrier products include: Stego Wrap (15-mil) Vapor Barrier by STEGO INDUSTRIES LLC; W.R. Meadows Premoulded Membrane with Plasmatic Core; and Zero-Perm by Alumiseal. Because of the importance of the vapor barrier, joints must be carefully spliced and taped.

If migration of subgrade moisture through the slab is not a concern, then the vapor barrier and overlying sand may be omitted. The slab subgrade must be kept in a moist condition until the vapor barrier or concrete slab is placed. BSK's representative must be called to the site to review soil and moisture conditions immediately prior to placing the vapor barrier or concrete slab.

As indicated in the PCA Engineering Bulletin 119, Concrete Floors and Moisture, and applicable ACI Committee reports (see ACI 360R-06, Design of Slabs-on-Ground, dated October 2006 and ACI 302.1R-04, Guide for Concrete Floor and Slab Construction, dated June 2004), the sand layer between the vapor barrier and concrete floor slab may be omitted. The advantage of this option is that it can reduce the amount of moisture that can be transmitted through the slab (especially if the sand layer becomes moist or wet prior to placing the concrete); however, the risk of slab "curling" is much greater. The "curling" may result from a sharp contrast in moisture-drying conditions between the exposed slab surface and the surface in contact with the membrane. As recommended in the referenced ACI Committee reports, measures must be taken to reduce the risk of "curling" such as reducing the joint spacing, using a low shrinkage mix design, and reinforcing the concrete slab. In order to regulate cracking of the slab, we recommend that full depth construction joints and control joints be provided in each direction with slab thickness and steel reinforcing recommended by the structural engineer.

Excessive landscape water or leaking utility lines could create elevated moisture conditions under concrete slabs, which could result in adverse moisture or mildew conditions in floor slabs or walls. Accordingly, care must be taken to avoid excess irrigation around the structures, as well as to periodically monitor for leaking utility lines. Likewise, positive surface drainage must be provided around the perimeter of the structures as discussed in the "Surface Drainage Control" section 4.11.

The adverse effects of moisture vapor transmission on flooring materials can be substantially reduced by the use of a low porosity concrete. This can be achieved by specifying a low water-cement ratio (0.45 or less by weight) a minimum compressive strength of 4,000 psi at 28 days, and a minimum of 7 days wet-curing.

4.5 Excavation Stability

Soils encountered within the upper 10-feet are generally Type C soil in accordance with OSHA (Occupational Safety and Health Administration). The slopes surrounding or along temporary excavations should be no steeper than 1.5H:1V for excavations that are less than 5-feet deep and exhibit no indication of instability, but must be no steeper than 2H:1V (horizontal to vertical) for excavations that are deeper than 5-feet, to a maximum depth of 10-feet. The presence of sand layers with minimal to low fine contents was observed in boring B-4 of the current investigation and borings throughout the site in the referenced report. If sand layers are encountered, slopes should be laid back. Temporary excavations for the project construction must be left open for as short a time as possible and must be protected from water runoff. In addition, equipment and/or soil stockpiles must be maintained at least 5 feet or a distance equal to the depth of excavation, whichever distance is greater, away from the top of the excavations. Slope height, slope inclination, and excavation depths (including utility trench excavations) must in no case exceed those specified in local, state, or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations 29 CFR Part 1926, or successor regulations). These excavation recommendations are based on soil characteristics derived from the test boring. Variations in soil conditions will likely be encountered during excavation. At the time of construction, BSK must be afforded the opportunity to observe and document sloping and shoring conditions, and the opportunity to provide review of actual field conditions to account for condition variations not otherwise anticipated in the preparation of these recommendations.

4.6 Utility Trench Excavation and Backfill

Pipes and conduits must be bedded and shaded in accordance with the requirements of the pipe manufacturer. Where no specific requirements exist, we recommend a minimum of 6-inches of sand bedding material for pipe installations greater than 12-inches in diameter. For pipe diameters smaller than 12-inches, the bedding thickness may be reduced to 4-inches. The bedding material and envelope (up to 6-inches above the pipe) must consist of sand (Sand Equivalent greater than 30), be placed in loose lifts not exceeding 8-inches in thickness, compacted to at least 90 percent of the maximum dry density, and moisture conditioned to within 2 percent of optimum moisture content. Water jetting to attain compaction must not be allowed.

Adequate excavation width must be provided to permit uniform compaction on both sides of utility lines installed within the trench. The trench backfill material may consist of engineered fill. Trench backfill outside the building footprint must be placed in loose lifts not to exceed 8-inches in loose thickness, compacted to at least 90 percent of the maximum dry density, and moisture conditioned to within 2 percent of optimum moisture content. The upper 12-inches of trench backfill below pavement sections must be compacted to at least 95 percent of the maximum dry density. Conduits extending through or below footings must be “sleeved” as determined by the Project Structural Engineer. Utility trench backfill beneath the building areas must be backfilled in accordance with Section 4.3 (Site Preparation and Earthwork Construction).

4.7 Surface Drainage Control

Final grading around site improvements must provide for positive and enduring drainage away from the building foundations. Ponding of water must not be allowed on or near the building or paved surfaces. Saturation of the soils immediately adjacent to or below the building area must not be allowed. Irrigation water must be applied in amounts not exceeding those required to offset evaporation, sustain plant life, and maintain a relatively uniform moisture profile around and below, site improvements.

5 PLANS AND SPECIFICATIONS REVIEW

BSK recommends that it be retained to review the draft plans and specifications for the project, with regard to foundations and earthwork, prior to their being finalized and issued for construction bidding.

6 CONSTRUCTION TESTING AND OBSERVATIONS

Geotechnical testing and observation during construction is a vital extension of this geotechnical investigation. BSK recommends that it be retained for those services. Field review during site preparation and grading allows for evaluation of the exposed soil conditions and confirmation or revision of the assumptions and extrapolations made in formulating the design parameters and recommendations. BSK's observations must be supplemented with periodic compaction tests to establish substantial conformance with these recommendations. BSK must also be called to the site to observe foundation excavations, prior to placement of reinforcing steel or concrete, in order to assess whether the actual bearing conditions are compatible with the conditions anticipated during the preparation of this report. BSK must also be called to the site to observe placement of foundation and slab concrete.

If a firm other than BSK is retained for these services during construction, that firm must notify the owner, project designers, governmental building officials, and BSK that the firm has assumed the responsibility for all phases (i.e., both design and construction) of the project within the purview of the geotechnical engineer. Notification must indicate that the firm has reviewed this report and any subsequent addenda, and that it either agrees with BSK's conclusions and recommendations, or that it will provide independent recommendations

7 LIMITATIONS

The analyses and recommendations submitted in this report are based upon the data obtained from the current investigation at locations shown on figure 2 and data presented in the referenced reports. The report does not reflect variations which may occur between or beyond the borings. The nature and extent of such variations may not become evident until additional exploration and testing is performed or construction is initiated. If variations then appear, a re-evaluation of the recommendations of this report will be necessary after performing on-site observations during the excavation period and noting the characteristics of the variations.

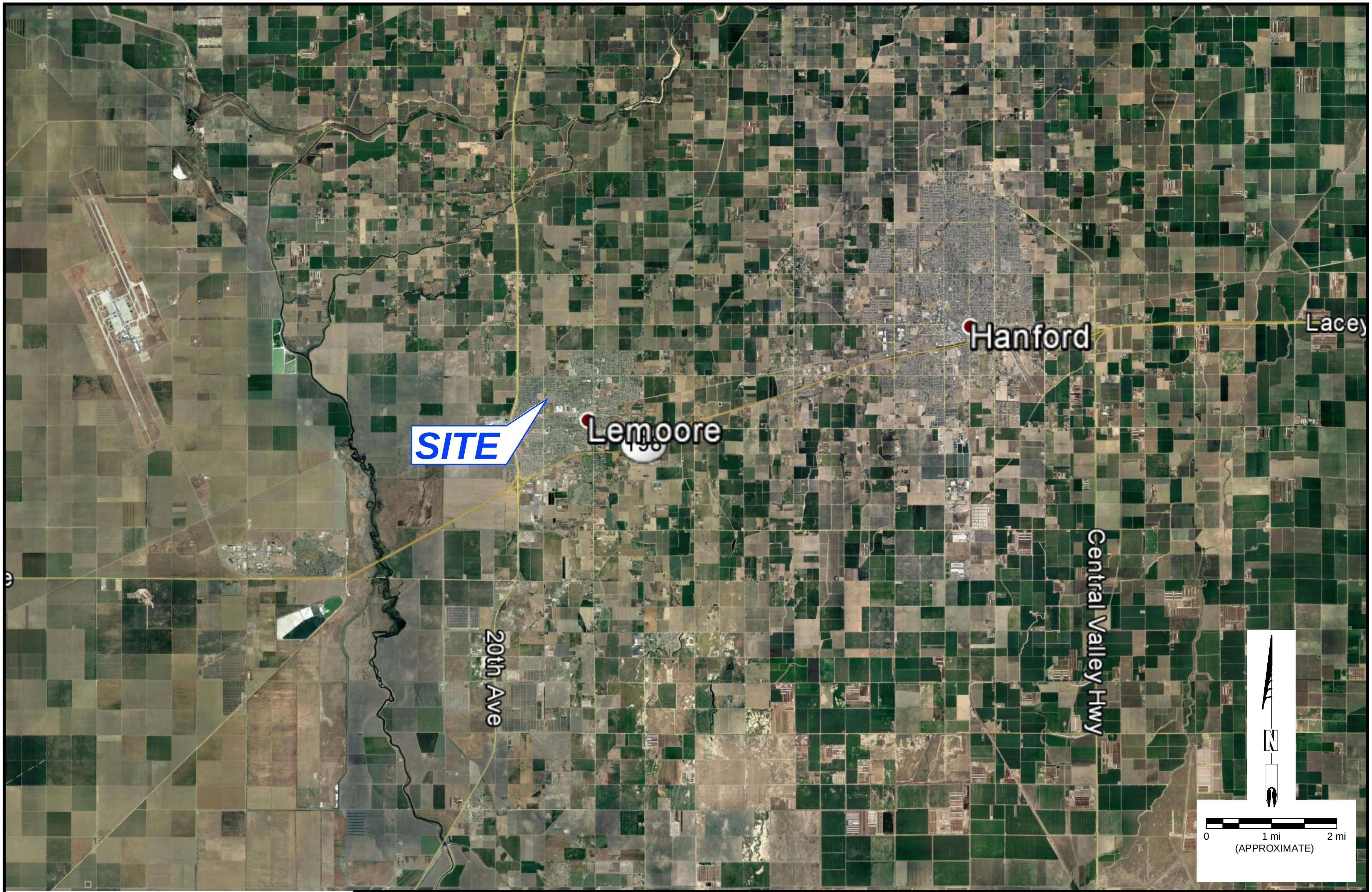
The validity of the recommendations contained in this report is also dependent upon an adequate testing and observation program during the construction phase. BSK assumes no responsibility for construction compliance with the design concepts or recommendations unless it has been retained to perform the testing and observation services during construction as described above.

The findings of this report are valid as of the present. However, changes in the conditions of the site can occur with the passage of time, whether caused by natural processes or the work of man, on this property or adjacent property. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation, governmental policy or the broadening of knowledge.

The report has been prepared in accordance with generally accepted geotechnical engineering practices which existed in Kings County at the time the report was written. No other warranties either express or implied are made as to the professional advice provided under the terms of BSK's agreement with Client and included in this report.

FIGURES

P:\FRS\Active\G1832411F – New Elementary School – Lemoore\Graphics\G18–324–11F.dwg User:jschallberger Plotted:Jan 02, 2019 – 4:02pm Last Save:Dec 26, 2018 – 9:21am



REFERENCE IMAGE: Google Earth

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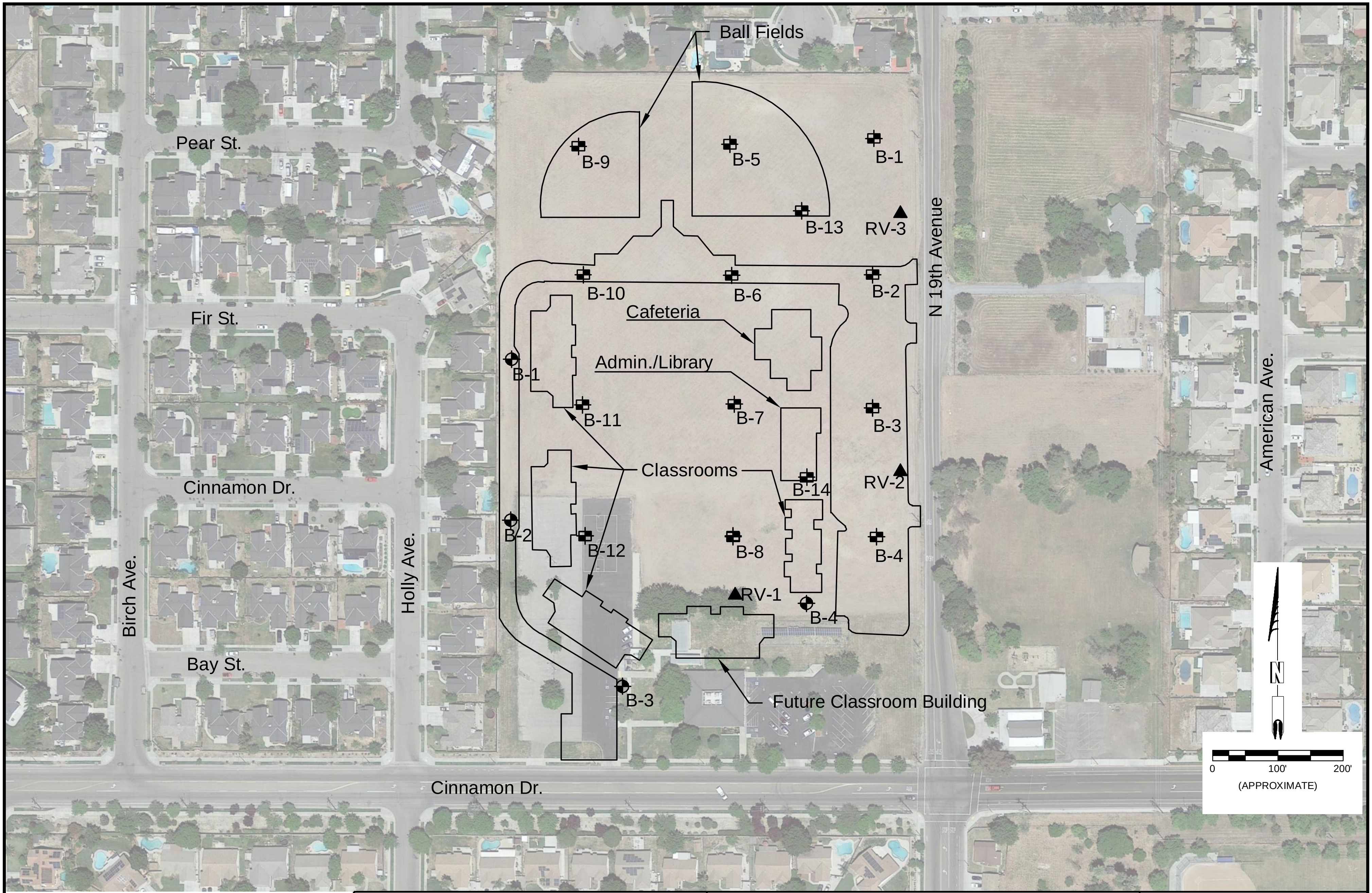
SITE VICINITY MAP

Proposed New Elementary School - Lemoore
NW of Cinnamon Drive and N. 19th Avenue
Lemoore, California

FIGURE 1

JOB NO. G18–324–11F
DATE January 2, 2019
DR. BY JS
CH. BY HN
SCALE AS SHOWN
SHEET NO. 1
OF 1 SHEETS



LEGEND:

⊕ B-4 APPROXIMATE BORING LOCATIONS (2018)

⊞ B-14 PREVIOUS BORING LOCATIONS (BSK JOB 0.03230063, OCTOBER 2, 2002)

▲ RV-3 PREVIOUS R-VALUE LOCATIONS (BSK JOB 0.03230063, OCTOBER 2, 2002)

REFERENCE IMAGE: Google Earth

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BORING LOCATION MAP

Proposed New Elementary School - Lemoore
NW of Cinnamon Drive and N. 19th Avenue
Lemoore, California

FIGURE 2

JOB NO. G18-324-11F
DATE January 8, 2019
DR. BY JS
CH. BY HN
SCALE AS SHOWN
SHEET NO. 1
OF 1 SHEETS

APPENDIX A
FIELD EXPLORATION

APPENDIX A
Field Exploration

The field exploration was conducted on December 21, 2018, under the oversight of a BSK staff engineer. Four (4) test borings were excavated to a depth of between 4 and 10 feet below existing ground surface (bgs) within the proposed building area. The borings were excavated with a manually operated hand auger. The approximate location of the test borings are presented on Figure 2, Boring Location Map.

The soil materials encountered in the test boring were visually classified in the field and a log was recorded during the excavation and sampling operations. Visual classification of the materials encountered in the test boring was made in general accordance with the Unified Soil Classification System (ASTM D2487). A soil classification chart is presented herein. Boring logs are presented herein and should be consulted for more details concerning subsurface conditions. Stratification lines were approximated by the field staff on the basis of observations made at the time of excavation while the actual boundaries between different soil types may be gradual and soil conditions may vary at other locations.

Subsurface samples were obtained at the successive depths shown on the boring logs by driving a sampler which consisted of a 2.5-inch inside diameter (I.D.) with a slide hammer. The relatively undisturbed soil samples were capped at both ends to preserve the samples at their natural moisture content. At the completion of the field exploration, the test borings were backfilled with the soil cuttings, as set forth in BSK's proposal.

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	●	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	○	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	▥	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	▨	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	⁘	WELL GRADED SANDS, GRAVELLY SANDS
			SP	⁘	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	▥	SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC	▨	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	▥	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	▨	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	☰	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	▥	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	≋	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	⁂	PEAT AND OTHER HIGHLY ORGANIC SOILS

■	Modified California	RV	R-Value
⧓	Standard Penetration Test (SPT)	SA	Sieve Analysis
⊠	Split Spoon	SW	Swell Test
◪	Pushed Shelby Tube	TC	Cyclic Triaxial
◫	Auger Cuttings	TX	Unconsolidated Undrained Triaxial
✋	Grab Sample	TV	Torvane Shear
⧄	Sample Attempt with No Recovery	UC	Unconfined Compression
CA	Chemical Analysis	(1.2)	(Shear Strength, ksf)
CN	Consolidation	WA	Wash Analysis
CP	Compaction	(20)	(with % Passing No. 200 Sieve)
DS	Direct Shear	∇	Water Level at Time of Drilling
PM	Permeability	▼	Water Level after Drilling(with date measured)
PP	Pocket Penetrometer		

SOIL CLASSIFICATION CHART AND LOG KEY

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Project: New Elementary School-Lemoore

Location: NW of Cinnamon Drive and N. 19th Avenue

Project No.: G18-324-11F

Logged By: J. Schallberger

Checked By: H. Ngo

Boring: **B-1**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
								SM	**Silty SAND** - dark brown, moist, fine to medium grained, rootlets	
1										
2	■	✋								
	■			105.4	11.2			CL	**Sandy CLAY** - dark brown, moist, fine grained sand	No sample due to concrete/cemented material.
3										
									... cemented	
4										
									Boring terminated at approximately 4 feet bgs due to auger refusal. Borehole backfilled with soil cuttings. No groundwater encountered.	
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 12/21/18
Date Completed: 12/21/18

Surface Elevation:
Sample Method: 2.5" I.D. Drive Tube
Groundwater Depth: Not Encountered
Completion Depth: 4 Feet
Borehole Diameter: 4 inch

* See key sheet for symbols and abbreviations used above.

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Project: New Elementary School-Lemoore

Location: NW of Cinnamon Drive and N. 19th Avenue

Project No.: G18-324-11F

Logged By: J. Schallberger

Checked By: H. Ngo

Page 1 of 1

Boring: **B-2**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
							░	SM	**Silty SAND** - dark brown, very moist, fine to medium grained, rootlets	
1	■			96.2	10.0	45	░		... fine grained	
2		✋					░			
3							░			
4	■			107.0	11.6		░		... fine to medium grained	
5									Boring terminated at approximately 5 feet bgs. Borehole backfilled with soil cuttings. No groundwater encountered.	
6										
7										
8										
9										
10										
11										
12										
13										
14										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 12/21/18
Date Completed: 12/21/18

Surface Elevation:
Sample Method: 2.5" I.D. Drive Tube
Groundwater Depth: Not Encountered
Completion Depth: 5 Feet
Borehole Diameter: 4 inch

* See key sheet for symbols and abbreviations used above.

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Location: NW of Cinnamon Drive and N. 19th Avenue

Project No.: G18-324-11F

Logged By: J. Schallberger

Checked By: H. Ngo

Page 1 of 1

Boring: **B-3**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
0								SM	**Silty SAND** - brown, moist, fine to medium grained, rootlets	
1	■	✋		104.0	6.2					ø = 32°, c = 100 psf
2										
3									... gray/black ... brown, fine grained	
4										
5	■			98.1	10.4				... fine to medium grained, pinholes	
6										
7									... increase fines	
8		✋						ML	**Sandy SILT** - brown, moist, fine grained sand	
9	■								... pinholes	
10									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings. No groundwater encountered.	
11										
12										
13										
14										

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 12/21/18
Date Completed: 12/21/18

Surface Elevation:
Sample Method: 2.5" I.D. Drive Tube
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4 inch

* See key sheet for symbols and abbreviations used above.

BSK Associates
550 W Locust
93650
Telephone: 559-497-2880
Fax: 559-497-2886

Project: New Elementary School-Lemoore

Location: NW of Cinnamon Drive and N. 19th Avenue

Project No.: G18-324-11F

Logged By: J. Schallberger

Checked By: H. Ngo

Boring: **B-4**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
0								SM	**Silty SAND** - dark brown, moist, fine to medium grained, rootlets	
1.5		✋								
2	■			93.8	16.3				... pinholes	
5	■			86.2	27.9					
5.5								SP-SM	**Poorly Graded SAND with Silt** - brown, moist, fine to medium grained	
7								SM	**Silty SAND** - brown, moist, fine to medium grained	
8		✋						ML	**Sandy SILT** - brown, moist, fine grained sand, red striations	
9		✋						SM	**Silty SAND** - light brown, moist, fine to medium grained	
10									Boring terminated at approximately 10 feet bgs. Borehole backfilled with soil cuttings. No groundwater encountered.	

Drilling Contractor: BSK Associates
Drilling Method: Hand Auger
Drilling Equipment: N/A
Date Started: 12/21/18
Date Completed: 12/21/18

Surface Elevation:
Sample Method: 2.5" I.D. Drive Tube
Groundwater Depth: Not Encountered
Completion Depth: 10 Feet
Borehole Diameter: 4 inch

* See key sheet for symbols and abbreviations used above.

APPENDIX B
LABORATORY TESTING

APPENDIX B
Laboratory Testing

The results of laboratory testing performed in conjunction with this project are contained in this Appendix. The following laboratory tests were performed on soil samples in general conformance with applicable standards.

In-Situ Moisture and Density

The field moisture content and in-place dry density determinations were performed on a relatively undisturbed samples obtained from the test borings. The field moisture content, as a percentage of dry weight of the soils, was determined by weighing the samples before and after oven drying in accordance with ASTM D2216 test procedures. Dry densities, in pounds per cubic foot, were also determined for undisturbed core samples in accordance with ASTM D2937 test procedures. Test results are presented on the boring logs in Appendix A.

Sieve Analysis Test

One (1) Sieve Analysis Test was performed on two combined bulk soil samples in the area of planned construction. The test was performed in general accordance with Test Method ASTM D422. The result of the test is presented on Figure B-1.

Direct Shear Test

One (1) direct shear test was performed on a remolded test specimen. The three-point shear test was performed in general accordance with ASTM D3080, Direct Shear Test for Soil under Consolidated Drained Conditions. The test specimens, each 2.42 inches in diameter and 1 inch in height, were subjected to shear along a plane at mid-height after allowing for pore pressure dissipation. The results of this test are presented on Figure B-2.

R-Value Test

One (1) R-value test was performed on a selected soil sample in the area of the proposed roadway. The tests were performed in general conformance with California Department of Transportation's Test Method (CT) 301. The results of the test are presented on Figure B-3.

Soil Corrosivity

The results of chemical analyses performed on a bulk soil sample using CT 643 (for minimum resistivity and PH) and CT 417 and 422 (for soluble sulfate and chlorides, respectively).

SUMMARY OF CHEMICAL TEST RESULTS

Sample Location	pH	Sulfate (mg/kg)	Chloride (mg/kg)	Minimum Resistivity (ohms-cm)
B-3 @ 0 – 4’	9.9	17	110	1220

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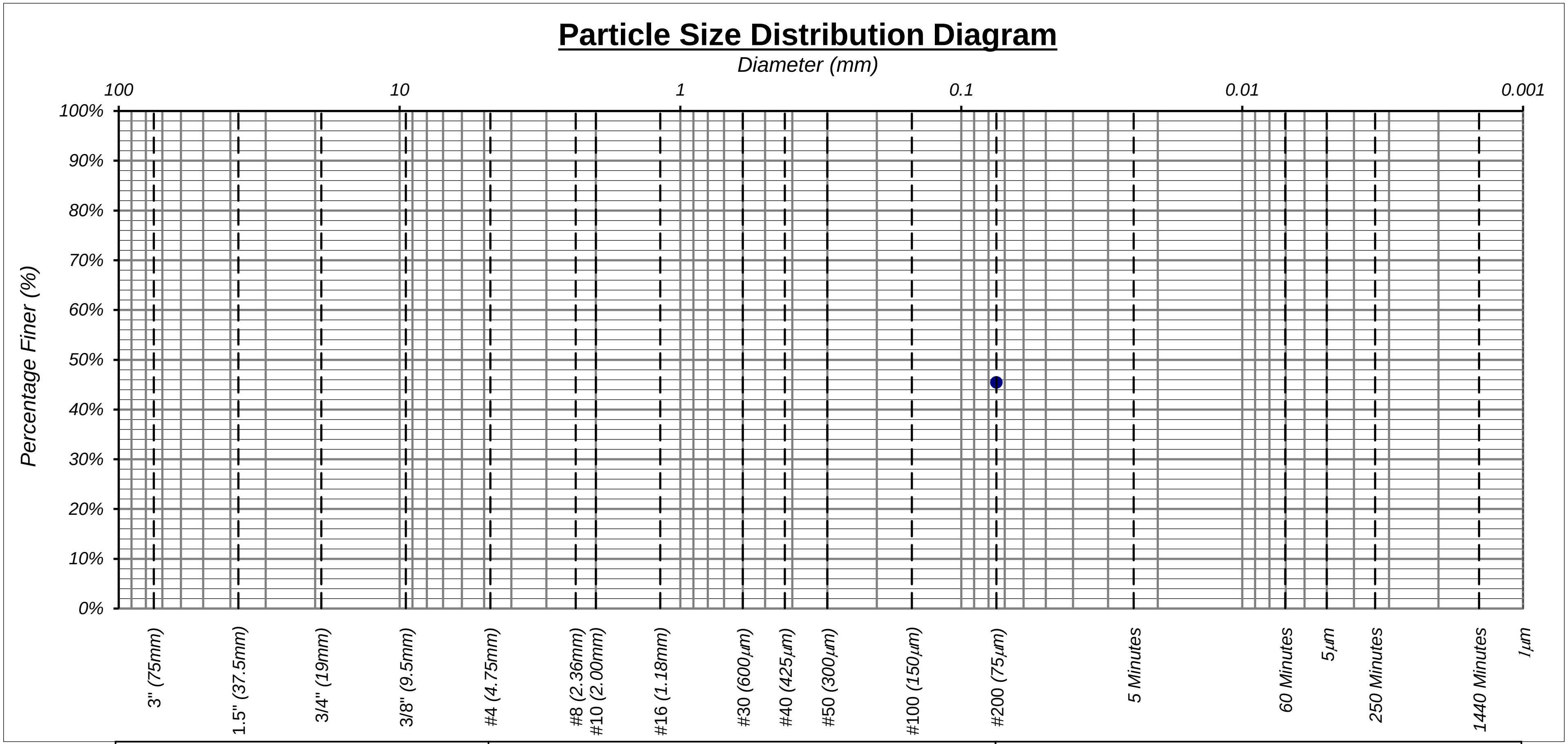
FIGURE -B-1
550 W. Locust Ave.
Fresno, CA 93650
Ph: (559) 497-2868
Fax: (559) 497-2886

Gradation Analysis Report
ASTM D-422 / ASTM C-136

Project Name: New Elementary School - Lemoore
Project Number: G18-324-11F
Report Date: 01/02/19
Sample Location: B-2 @ 2'
Sample Lab ID: F18-741
Sample Date: 12/21/18
Sample Description: Silty SAND (SM), brown, moist, fine to medium grained
Test Date: 12/27/18

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 0 **% Sand =** 55 **% Fines =** 45

BSK ASSOCIATES

Direct Shear Test

ASTM D-3080

FIGURE B-2

550 W. Locust
Fresno, CA 93650
Ph: (559) 497-2880
Fax: (559) 497-2886

Project Name: New Elementary School - Lemoore

Project Number: G18-324-11F

Sample Location: B-3 @ 1'

Sampled By: J.S.

Tested By: D.M.

Lab Tracking ID: F18-741

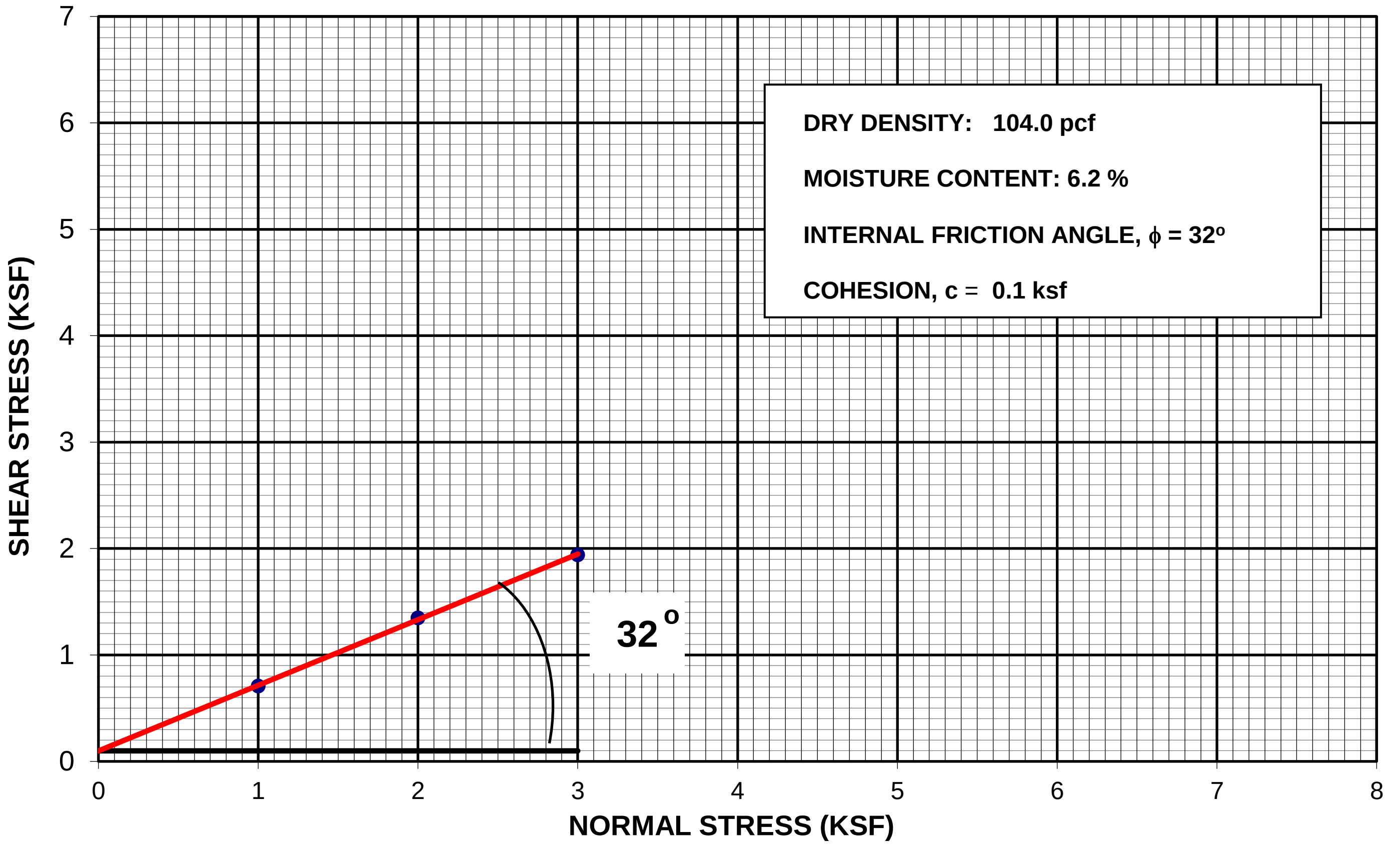
Sample Description: Silty SAND (SM) - brown, moist, fine to medium grained

Sample Date: 12/21/2018

Test Date: 12/28/2018

Report Date: 1/2/2019

SHEAR STRENGTH DIAGRAM



DRY DENSITY: 104.0 pcf

MOISTURE CONTENT: 6.2 %

INTERNAL FRICTION ANGLE, ϕ = 32º

COHESION, c = 0.1 ksf

APPENDIX C

Update to Geologic/Seismic Hazard Evaluation
New Elementary School – Lemoore
Lemoore Union Elementary School District
NW of Cinnamon Drive and N. 19th Avenue
Lemoore, California

BSK G18-324-11F

January 10, 201

Table of Contents

Figures

C1.0 INTRODUCTION

BSK prepared a Geologic/Seismic Hazards Evaluation Report (G03-23-0063, dated October 19, 2002). The building code has changed to the 2016 California Building Code (CBC) since the completion of the Report, which includes new seismic design parameters for use in structure design. This report presents the updated geologic and seismic hazards evaluation prepared in accordance with 2016 California Building Code (CBC), CCR Title 24, Chapters 16 and 18 requirements for a Geotechnical/Engineering Geologic Report. The evaluation was performed in conformance with California Geologic Survey Note 48 (October 2013). The referenced Geologic/Seismic Hazards Evaluation Report is considered applicable to the proposed new elementary school, however, the appropriate sections of the referenced report (2002) must be replaced with the following sections provided below.

C2.0 SEISMIC HAZARDS ASSESSMENT

C2.1 Site Class

Based on Section 1613A.3.2 of the 2016 California Building Code (CBC), the Site shall be classified as Site Class A, B, C, D, E or F based on the Site soil properties and in accordance with Chapter 20 of ASCE 7-10. Based on data from the soil borings, as per Table 20.3-1 of ASCE 7-10, the Site is Class D ($15 \leq N \leq 50$).

C2.2 Seismic Design Criteria

The 2016 California Building Code (CBC) utilizes ground motion based on the Risk-Targeted Maximum Considered Earthquake (MCE_R) that is define in the 2016 CBC as the most severe earthquake effects considered by this code, determined for the orientation that results in the largest maximum response to horizontal ground motions and with adjustment for targeted risk. Ground motion parameters in the 2016 CBC are based on ASCE 7-10, Chapter 11.

The United States Geologic Survey (USGS) has prepared maps presenting the Risk-Targeted MCE spectral acceleration (5% damping) for periods of 0.2 seconds (S_S) and 1.0 seconds (S_1). The values of S_S and S_1 can be obtained from the OSHPD Seismic Design Maps Application available at: https://seismicmaps.org/

Table 1 below presents the spectral acceleration parameters produced for Site Class D by OSHPD Seismic Design Maps Application and Chapter 16 of the 2016 CBC based on ASCE 7-10.

TABLE 1
SPECTRAL ACCELERATION PARAMETERS
RISK TARGETED MAXIMUM CONSIDERED EARTHQUAKE

Criteria	Value		Reference
MCE Mapped Spectral Acceleration (g)	S_S = 0.917	S_1 = 0.333	USGS Mapped Value
Site Coefficients (Site Class D)	F_a = 1.133	F_v = 1.734	ASCE Table 11.4
Site Adjusted MCE Spectral Acceleration (g)	S_{MS} = 1.039	S_{M1} = 0.578	ASCE Equations 11.4.1-2
Design Spectral Acceleration (g)	S_{DS} = 0.693	S_{D1} = 0.385	ASCE Equations 11.4.3-4

C2.3 Geometric Mean Peak Ground Acceleration

As per Section 1803A.5.12 of the CBC, peak ground acceleration (PGA) utilized for dynamic lateral earth pressures and liquefaction, shall be based on a site specific study (ASCE 7-10, Section 21.5) or ASCE 7-10, Section 11.8.3. The OSHPD Seismic Design Maps Application based on ASCE 7-10, Section 11.8.3 produced the values shown in Table 2 based on Site Class D.

TABLE 2
GEOMETRIC MEAN PEAK GROUND ACCELERATION
MAXIMUM CONSIDERED EARTHQUAKE

Criteria	Value	Reference
Mapped Peak Ground Acceleration (g)	PGA = 0.350	USGS Mapped Value
Site Coefficients (Site Class D)	F_{PGA} = 1.150	ASCE Table 11.8-1
Geometric Mean PGA (g)	PGA_M = 0.403	ASCE Equations 11.8-1

C2.4 Seismic Source Deaggregation

Seismically induced ground motion at a site can be caused by earthquakes on any of the sources surrounding the site. Deaggregation of the seismic hazard was performed by using the USGS Interactive Deaggregation website. The deaggregation determination, at the maximum considered earthquake (MCE) hazard level, results in distance, magnitude and epsilon (ground-motion uncertainty) for each source that contributes to the hazard. Each source has a corresponding epsilon, which is the probabilistic value relative to the mean value of ground motion for that source.

Deaggregation based on a probabilistic model developed by the USGS indicates that the extreme seismic source with the highest magnitude that contributes to the peak ground acceleration (PGA) is a magnitude 7.9 earthquake from the San Andreas Fault. For liquefaction and seismic settlement, the modal magnitude (Mw) of 5.1 would be appropriate for probabilistic input parameter that is consistent with the design earthquake ground motion.

C2.5 Liquefaction

Settlement of the ground surface with consequential differential movement of structures is a major cause of seismic damage for buildings founded on alluvial deposits. Vibration settlement of relatively dry and loose granular deposits beneath structures can be readily induced by the horizontal components of ground shaking associated with even moderate intensity earthquakes. Silver and Seed (1971) have demonstrated that settlement of dry sands due to cyclic loading is a function of 1) the relative density of the soil; 2) the magnitude of the cyclic shear stress; and 3) the number of strain cycles. As indicated above, seismically-induced ground settlement can also occur due to the liquefaction of relatively loose, saturated granular deposits.

In order for liquefaction triggering to occur due to ground shaking, it is generally accepted that four conditions will exist:

- The subsurface soils are in a relatively loose state
- The soils are saturated
- The soils have low plasticity
- Ground shaking is of sufficient intensity to act as a triggering mechanism

Groundwater is shallow and sandy loose units are present, therefore a liquefaction/seismic settlement analysis was performed using the program Liquefy Pro version 5.8k using boring data from the 2002 BSK borings B-13 and B-14.

Input parameters for the liquefaction and settlement analysis were based upon:

- PGA based upon the geometric mean peak ground acceleration or 0.403g.
- Magnitude 5.1 of controlling earthquake from Deaggregation of the seismic hazard.
- Assumed depth to groundwater of 10 feet bgs.
- A Factor-of-Safety of 1.3 was used for analysis.

The results of our liquefaction and seismic settlement analysis based upon data from B-13 and B-4 are provided on Figures C-1. Based on our liquefaction analysis, during the design seismic event, the liquefaction potential is low.

C2.6 Lateral Spread

Lateral spreading is a potential hazard commonly associated with liquefaction where extensional ground cracking and settlement occur as a response to lateral migration of subsurface liquefiable material. These phenomena typically occur adjacent to free faces such as slopes and creek channels. Sloped ground or channel free-faces are not present in the area, therefore the potential for lateral spreading to take place at the site is low.

C2.7 Dynamic Compaction/Seismic Settlement

Another type of seismically induced ground failure, which can occur as a result of seismic shaking, is dynamic compaction, or seismic settlement. Such phenomena typically occur in loose granular material or uncompacted fill soils.

A seismic settlement analysis was performed using the program Liquefy Pro version 5.8k using soil boring data from B-13 and B-14. Input parameters for the liquefaction and settlement analysis were based upon:

- PGA based upon the geometric mean peak ground acceleration or 0.403g.
- Magnitude 5.1 of controlling earthquake from Deaggregation of the seismic hazard.
- Assumed depth to groundwater of 10 feet bgs.
- A Factor-of-Safety of 1.3 was used for analysis.

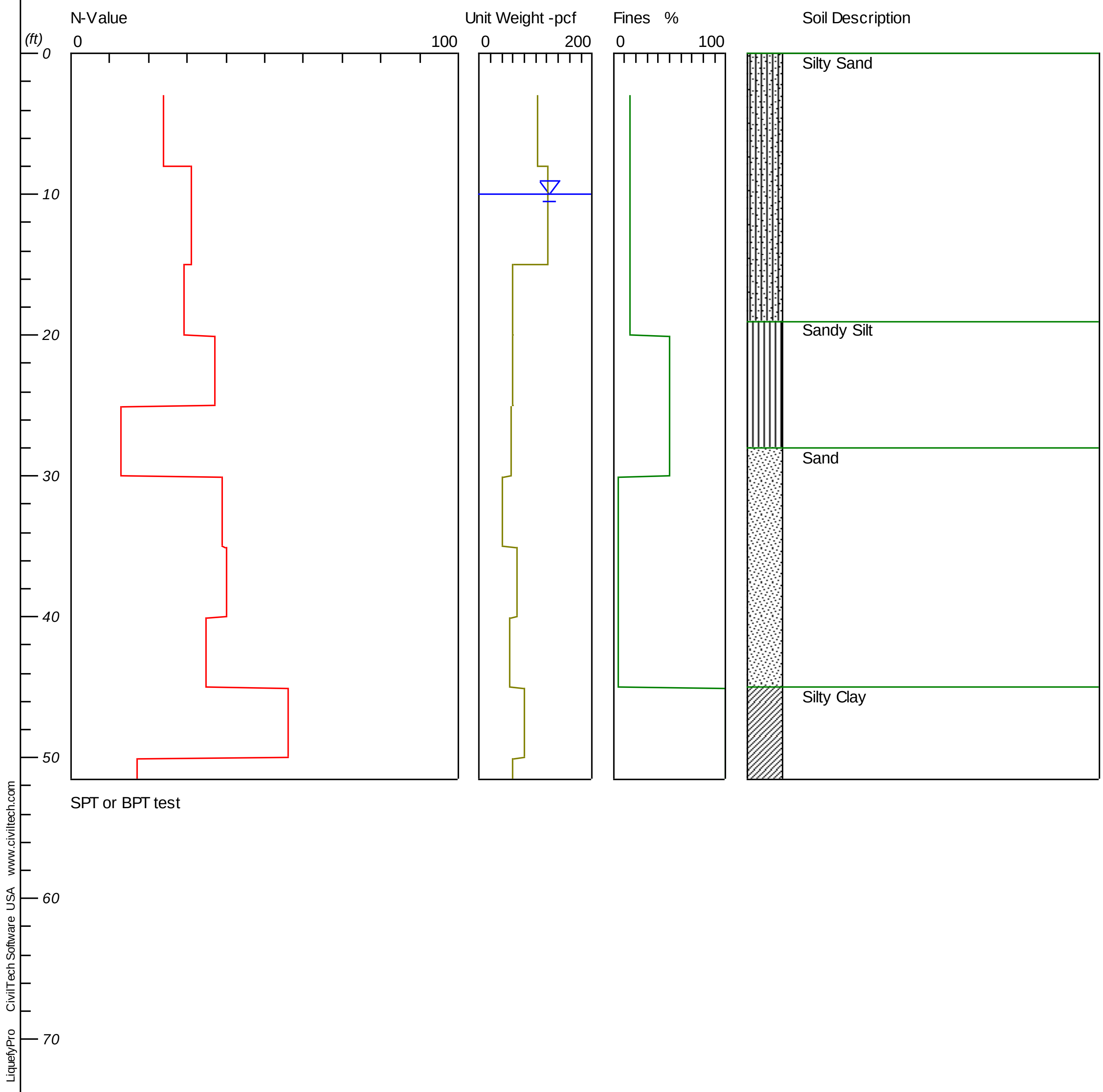
Based on the analysis the total seismic settlement is estimated to be minimal. Data and results of the seismic settlement are presented on Figures C-1.

LIQUEFACTION ANALYSIS

Lemoore ES (Update)

Hole No.=B-13 (2002)   Water Depth=10 ft

Magnitude=5.10
Acceleration=0.403g



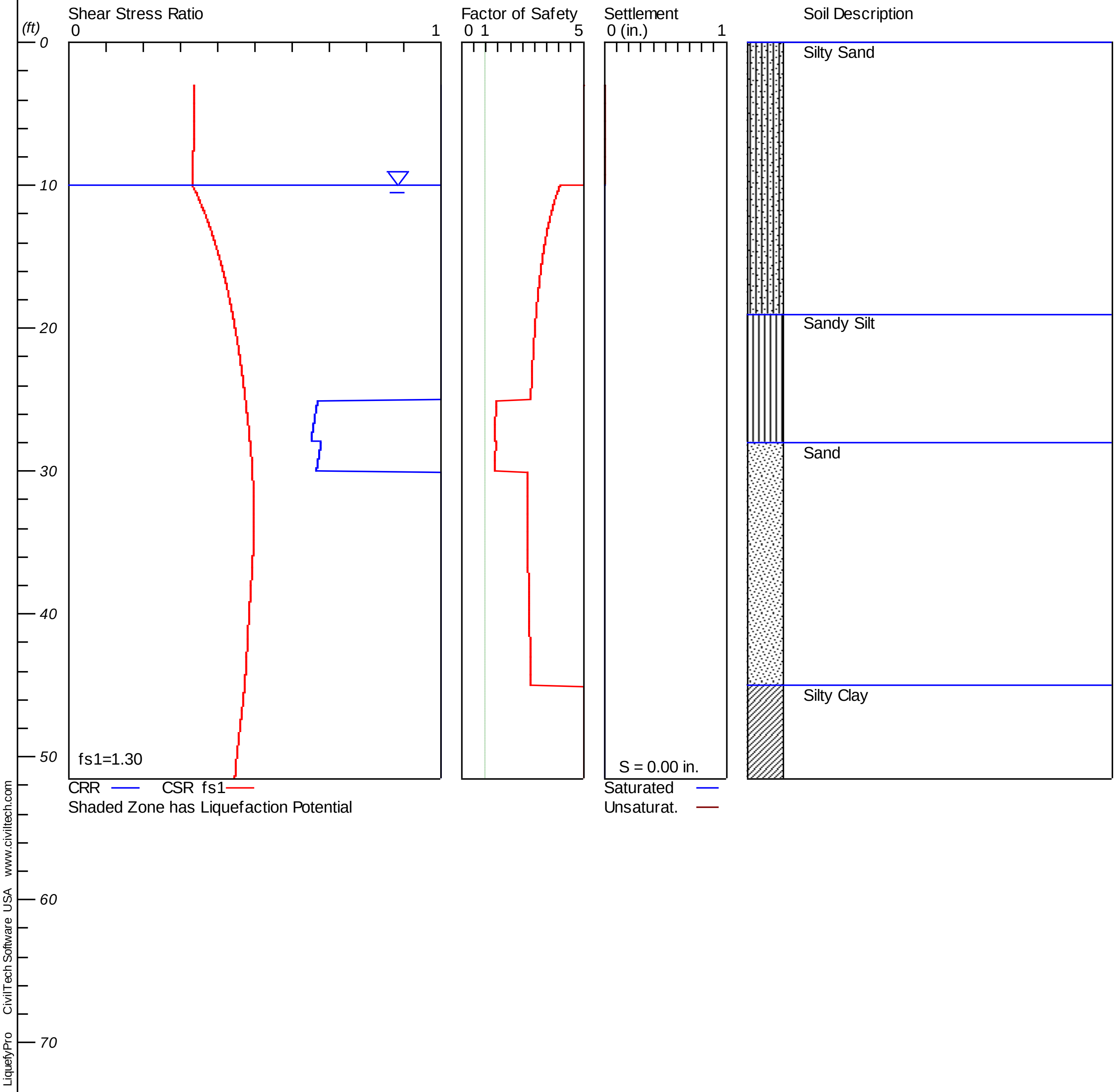
BSK Associates

LIQUEFACTION ANALYSIS

Lemoore ES (Update)

Hole No.=B-13 (2002) ***Water Depth=10 ft***

Magnitude=5.10
Acceleration=0.403g



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                                         Copyright by CivilTech Software
                                               www.civiltech.com
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       Subtitle:

       Surface Elev.=
       Hole No.=B-13 (2002)
       Depth of Hole= 51.50 ft
       Water Table during Earthquake= 10.00 ft
       Water Table during In-Situ Testing= 15.00 ft
       Max. Acceleration= 0.4 g
       Earthquake Magnitude= 5.10

 Input Data:
       Surface Elev.=
       Hole No.=B-13 (2002)
       Depth of Hole=51.50 ft
       Water Table during Earthquake= 10.00 ft
       Water Table during In-Situ Testing= 15.00 ft
       Max. Acceleration=0.4 g
       Earthquake Magnitude=5.10
       No-Liquefiable Soils:   Based on Analysis

       1. SPT or BPT Calculation.
       2. Settlement Analysis Method: Tokimatsu, M-correction
       3. Fines Correction for Liquefaction: Stark/Olson et al.*
       4. Fine Correction for Settlement: During Liquefaction*
       5. Settlement Calculation in: All zones*
       6. Hammer Energy Ratio,                                  Ce = 1.3
       7. Borehole Diameter,                                        Cb= 1
       8. Sampling Method,                                         Cs= 1
       9. User request factor of safety (apply to CSR) ,   User= 1.3
          Plot one CSR curve (fs1=User)
       10. Use Curve Smoothing: No
       * Recommended Options

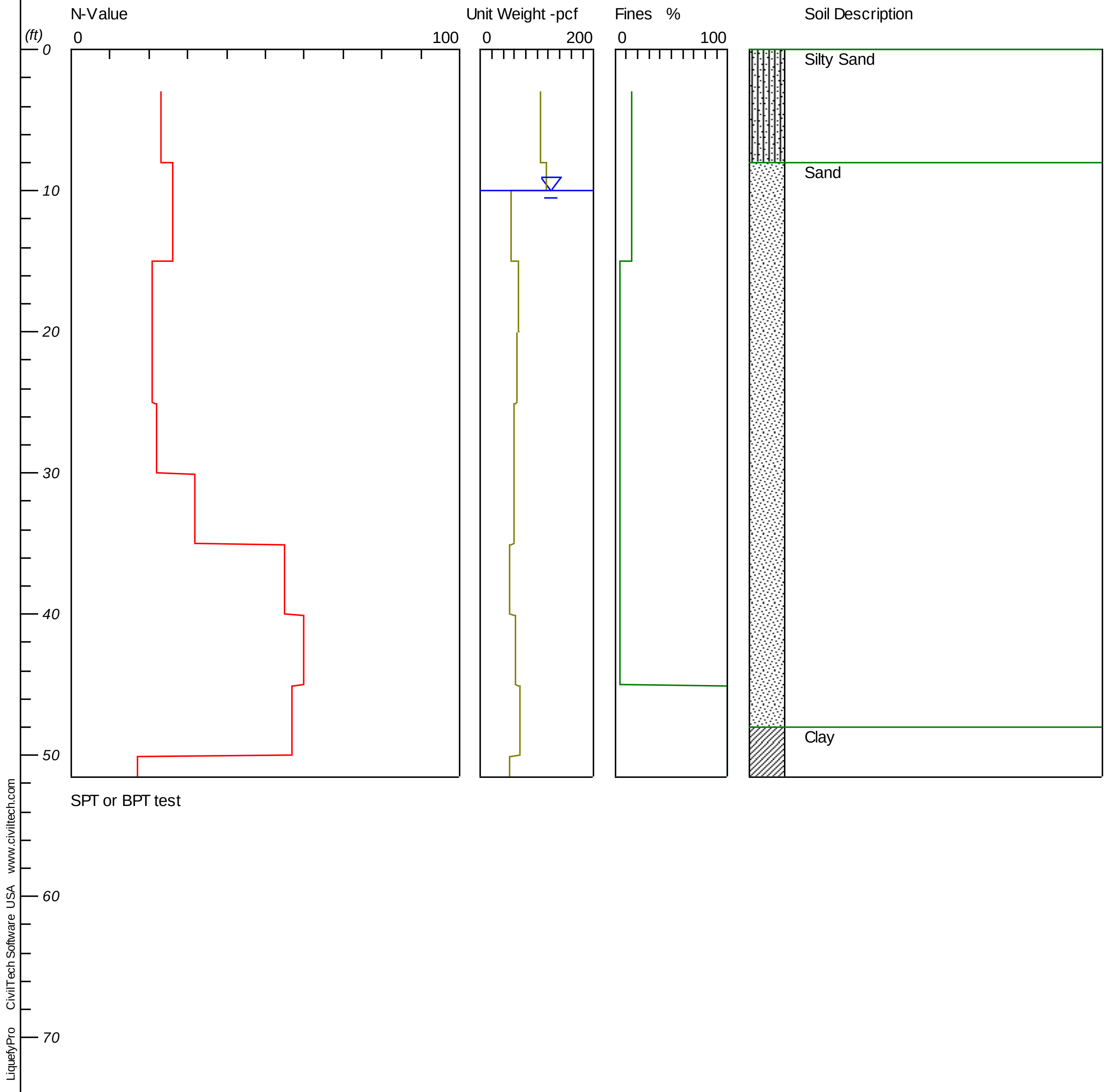
       In-Situ Test Data:
       Depth  SPT    gamma  Fines
       ft            pcf    %
       ____________________________________
       3.00   24.00  102.00 15.00
       8.00   31.00  122.00 15.00
       15.00  29.00  122.00 15.00
       20.00  37.00  121.00 50.00
       25.00  13.00  118.00 50.00
       30.00  39.00  104.00 5.00
       35.00  40.00  129.00 5.00
       40.00  35.00  116.00 5.00
       45.00  56.00  142.00 NoLiq
       50.00  17.00  121.00 NoLiq
       ____________________________________

Output Results:
       Settlement of Saturated Sands=0.00 in.
       Settlement of Unsaturated Sands=0.00 in.
       Total Settlement of Saturated and Unsaturated Sands=0.00 in.
       Differential Settlement=0.001 to 0.002 in.
```

LIQUEFACTION ANALYSIS

Lemoore ES (Update)

Hole No.=B-14 (2002) Water Depth=10 ft ***Magnitude=5.10***
Acceleration=0.403g



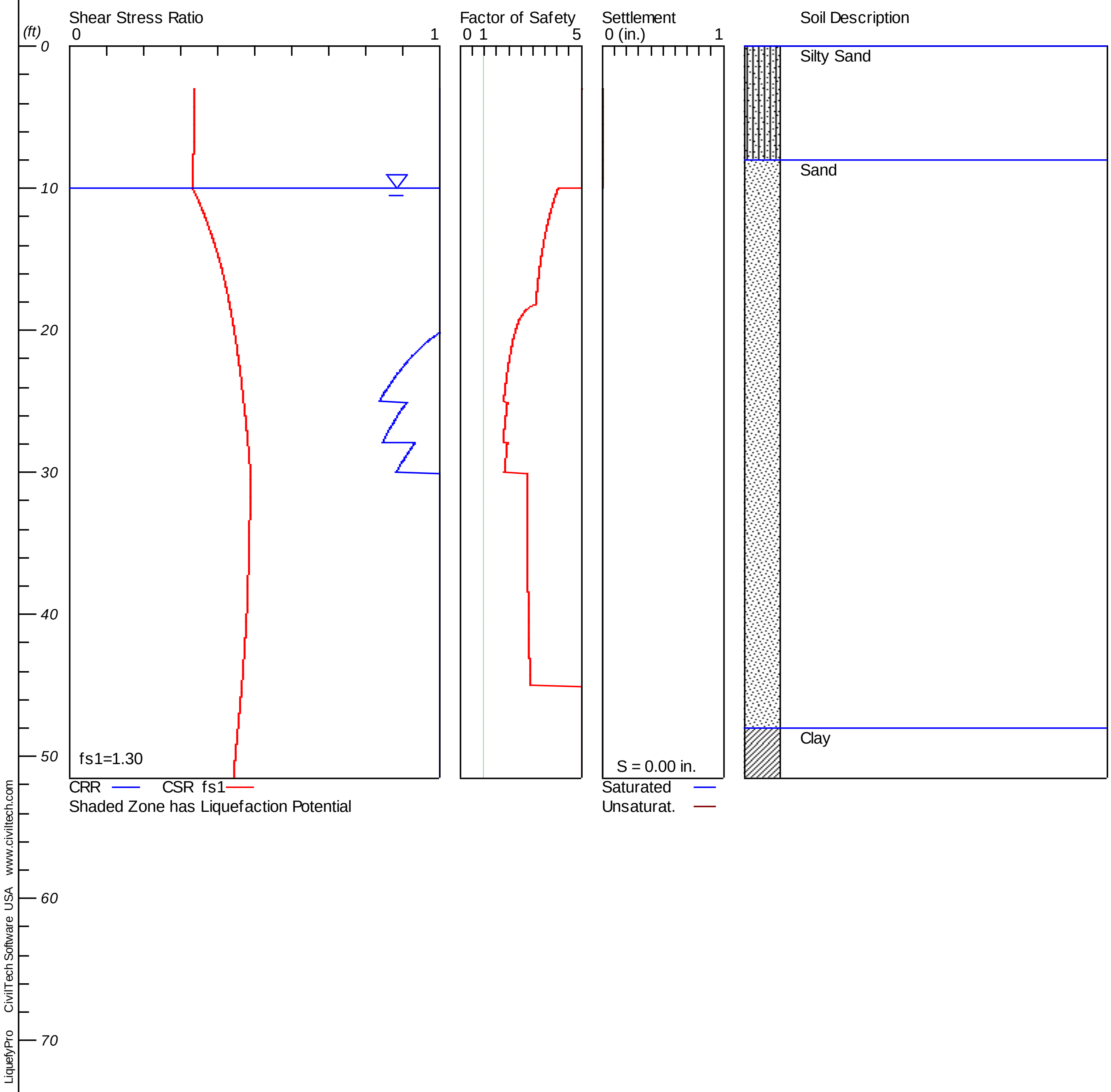
BSK Associates

LIQUEFACTION ANALYSIS

Lemoore ES (Update)

Hole No.=B-14 (2002) ***Water Depth=10 ft***

Magnitude=5.10
Acceleration=0.403g



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        Hole No.=B-14 (2002)
        Depth of Hole= 51.50 ft
        Water Table during Earthquake= 10.00 ft
        Water Table during In-Situ Testing= 10.00 ft
        Max. Acceleration= 0.4 g
        Earthquake Magnitude= 5.10

 Input Data:
        Surface Elev.=
        Hole No.=B-14 (2002)
        Depth of Hole=51.50 ft
        Water Table during Earthquake= 10.00 ft
        Water Table during In-Situ Testing= 10.00 ft
        Max. Acceleration=0.4 g
        Earthquake Magnitude=5.10
        No-Liquefiable Soils:   Based on Analysis

        1. SPT or BPT Calculation.
        2. Settlement Analysis Method: Tokimatsu, M-correction
        3. Fines Correction for Liquefaction: Stark/Olson et al.*
        4. Fine Correction for Settlement: During Liquefaction*
        5. Settlement Calculation in: All zones*
        6. Hammer Energy Ratio,                                   Ce = 1.3
        7. Borehole Diameter,                                         Cb= 1
        8. Sampling Method,                                         Cs= 1
        9. User request factor of safety (apply to CSR) ,   User= 1.3
           Plot one CSR curve (fs1=User)
        10. Use Curve Smoothing: No
        * Recommended Options

        In-Situ Test Data:
        Depth   SPT    gamma  Fines
        ft             pcf    %
        ____________________________________
        3.00    23.00  106.00 15.00
        8.00    26.00  117.00 15.00
        15.00   21.00  129.00 5.00
        20.00   21.00  126.00 5.00
        25.00   22.00  121.00 5.00
        30.00   32.00  121.00 5.00
        35.00   55.00  114.00 5.00
        40.00   60.00  123.00 5.00
        45.00   57.00  132.00 NoLiq
        50.00   17.00  113.00 NoLiq
        ____________________________________

Output Results:
        Settlement of Saturated Sands=0.00 in.
        Settlement of Unsaturated Sands=0.00 in.
        Total Settlement of Saturated and Unsaturated Sands=0.00 in.
        Differential Settlement=0.001 to 0.002 in.
```