APPENDIX B:
GEOTECHNICAL REPORT

Geotechnical Engineering Report

Maverik Fueling Station Sacramento
Sacramento, California
May 28, 2019
Terracon Project No. NB195036

Prepared for:
Maverik, Inc.
Salt Lake City, Utah

Prepared by:
Terracon Consultants, Inc.
Sacramento, California

May 28, 2019

Maverik, Inc.
185 South State Street, Ste 800
Salt Lake City, Utah 84111

Attn: Ms. Ashley Olsen
P: (801) 677-2930
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Re: Geotechnical Engineering Report
Maverik Fueling Station Sacramento
Northeast Corner of Power Inn Road and 14th Avenue
Sacramento, California
Terracon Project No. NB195036

Dear Ms. Olsen:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PNB195036 dated April 18, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Nicholas M. Novotny
Professional Geologist 9626
Senior Staff Geologist

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Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS
SUPPORTING INFORMATION

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	The project will consist of a new Maverik Fueling Station. Improvements will include a new, approximately 5,780 square foot C-store, fueling islands, underground storage tanks (UST's), pavements, and landscaping areas.
Geotechnical Characterization	■ Surface conditions encountered at the site generally consisted of fill material consisting of loose poorly to well graded gravel with clay to medium stiff lean clay with gravel to depths of 1½ to 4 feet below the existing ground surface (bgs). ■ Native subgrade materials encountered at the site generally consisted of medium stiff to hard silty clay to lean clay with sand to a depth of 3 to 6 feet bgs underlain by cemented hard silt with variable sand (hardpan) to a depth of 13 to 17½ feet bgs. Silt soils were generally underlain by medium dense to very dense silty sand to well graded gravel to the maximum depth explored of 21½ feet bgs. ■ Groundwater was not encountered at any time during our investigation.
Earthwork	■ Fill materials consisting of poorly to well graded gravel with clay to lean clay with gravel were encountered at the site to a depth of 1½ to 4 feet bgs. No documentation is available to verify the placement and compaction of these materials; therefore, they are considered undocumented and are not suitable to support the proposed improvements at this site. ■ Earthwork for this project will consist of over-excavation of existing fills, excavation, and fill placement. ■ Existing fill materials may be suitable for reuse as engineered fill for this project provided they are processed to conform with the requirements for engineered fill presented in **Earthwork**.
Shallow Foundations	■ The proposed C-store structure may be supported on a shallow spread footing foundation bearing directly on a minimum of 12 inches of compacted engineered fill.
Deep Foundations	The proposed fueling canopies may be supported on drilled shaft foundations bearing in native soils.
Pavements	On-site drives and parking area pavements for automobile and truck/RV traffic are anticipated to consist of asphalt concrete (AC) and Portland cement concrete (PCC). The following are anticipated design Traffic Indexes (TI's) for onsite pavements: Anticipated traffic Index (TI) is as follows: ■ Auto parking and drives: TI = 4.5 ■ Auto and light truck drives: TI = 5.5 ■ Heavy truck drives: 6.5

	The Pavement design period is 20 years
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report

Maverik Fueling Station Sacramento
Northeast Corner of Power Inn Road and 14th Avenue
Sacramento, California
Terracon Project No. NB195036
May 28, 2019

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed Maverik Gas Station to be located at the Northeast Corner of Power Inn Road and 14th Avenue in Sacramento, California. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Excavation considerations
- Seismic site classification per 2016 CBC
- Foundation design and construction
- Floor slab design and construction
- Lateral earth pressures
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of six (6) test borings to depths ranging from approximately 6½ to 21½ feet below existing site grades (bgs).

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and/or as separate graphs in the **Exploration Results** section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located at the northeast corner of Power Inn Road and 14th Avenue in Sacramento, California. See **Site Location**

Item	Description
Existing Improvements	The site is mostly undeveloped and is bordered by roadways to the west and south, and asphalt paved parking to the north. A high-power monopole is present in the southwestern corner of the site. A pump station and large manhole typically associated with an underground pipeline also are present in the southwestern portion of the site.
Current Ground Cover	Bare soils, grass, and weeds.
Existing Topography	Relatively level site with minor topographic relief. Site topography generally slopes down to the
Geology	■ The project area is situated within the Great Valley Geomorphic Provence of California. The Great Valley is an alluvial plain located between the Coast Ranges and the Sierra Nevada and consists of an alluvial basin and flood plain. ■ The native materials underlying the site are considered to consist of Riverbank Formation (Q_{r1}), as described in the geologic map of the area[1]. According to the map, the Riverbank Formation is Pleistocene in age (duration about 2.6 million years ago to 14,000 years ago) and consists primarily of arkosic sediments derived mainly from the interior of the Sierra Nevada, underlying terraces and coalescing alluvial fans along most of the eastern San Joaquin Valley. The subsurface materials encountered in our investigation are generally consistent with the mapped geology.

[1]*Helley, E.J., 1979, Preliminary geologic map of Cenozoic deposits of the Davis, Knights Landing, Lincoln, and Fair Oaks quadrangles, California: U.S. Geological Survey, scale 1:62,500*

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Email and site plan provided by Ashley Olsen on Monday 4/15/2019.
Project Description	The project will consist of a new Maverik Fueling Station. Improvements will include a new approximately 5,780 square foot C-store, fueling islands, underground storage tanks (UST's), pavements, and landscaping areas.
Finished Floor Elevation (assumed)	±2 feet of existing ground surface.

Item	Description
Maximum Loads (assumed)	■ Columns: 40 kips (max) ■ Walls: 2 kips per linear foot (klf) ■ Slabs: 100 pounds per square foot (psf)
Grading/Slopes	Minor grading, no slopes.
Below-Grade Structures	UST approximately 10 to 12 feet below grade.
Free-Standing Retaining Walls	None.
Pavements	We assume both rigid (concrete) and flexible (asphalt) pavement sections should be considered. Anticipated traffic is as follows: ■ TI = 4.5 (Parking Lot) ■ TI = 5.5 (Drive Lanes) ■ TI = 6.5 (Heavy Truck Drives) The pavement design period is 20 years.

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Fill**	Fill varied from well and poorly graded gravels to clay with gravel. Fill varied in plasticity and density/consistency
2	**Lean Clay with Sand**	Brown, low to medium plasticity, medium stiff to hard, fine to medium grained, black mottled
3	**Silt (Hardpan)**	Low to non-plastic, hard, weak to moderate cementation, varying sand contents
4	**Silty Sands and Well Graded Gravels**	Fine to coarse grained, non-plastic, medium to very dense, gravel up to 4 inches in dimension

GROUNDWATER

The boreholes were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not encountered in our test borings while drilling, or for the short duration the borings could remain open. The state Department of Water Resources identified the groundwater depth in a monitoring well located approximately 1 mile southwest of the site (Well No. 08N05E21H002M). According to the nearby monitoring well, historical high groundwater is expected to be greater than 50 feet bgs.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than anticipated. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the 2016 California Building Code (CBC). Based on the soil properties encountered at the site and as described on the exploration logs and results, it is our professional opinion that the **Seismic Site Classification is D**. Subsurface explorations at this site were extended to a maximum depth of 21½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

LIQUEFACTION

Liquefaction is a mode of ground failure that results from the generation of high pore water pressures during earthquake ground shaking, causing loss of shear strength. Liquefaction is typically a hazard where loose sandy soils or non-plastic fine-grained soils exist below groundwater. The California Geologic Survey (CGS) has designated certain areas within California as potential liquefaction hazard zones. These are areas considered at a risk of liquefaction-related ground failure during a seismic event, based upon mapped surficial deposits and the presence of a relatively shallow water table. The project site is not located within a liquefaction hazard zone mapped by the CGS.

A liquefaction analysis was not part of our scope of services; however, based on the silt and clay content of the subsurface soils, density of subgrade soils, and the relative depth to groundwater at this site, we conclude that the potential for liquefaction at this site is low. Therefore, other seismically induced hazards, such as lateral spreading, should also be considered low.

PERCOLATION TESTING

One (1) percolation boring was advanced at the site to a depth of approximately 5 feet bgs on the southeast portion of the site. The percolation test hole was excavated using a 6-inch diameter solid flight auger. After excavation, the percolation test hole was presoaked with clean water. The test was conducted by adding water to bring the depth of water in the test hole to approximately 20 to 27 inches above the bottom of the hole. The drop in head was measured every 30 minutes until the rate of drop off did not vary by more than 10% from the previous measurement. The percolation test was conducted over the span of 4 hours.

The results are provided in the table below:

Sample Location	Field Infiltration Rate (in/hr)	Percolation Rate (min/in)
Boring B-6	0.24	250

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary						
Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (%)	Soluble Chloride (%)	Electrical Resistivity (Ω-cm)	pH
B-5	2.0	Clayey Gravel	99	35	2,910	8.7

The sulfate test results indicate that the soil from boring B-5 classifies as Class S0 according to Table 19.3.1.1 of ACI 318-14. This indicates that the sulfate level is negligible when considering corrosion to concrete.

The chloride test results indicate that the soils have a relatively low chloride content present. According to Table 19.3.1.1 of ACI 318-14, the soil should not be considered an external source of chloride (i.e. sea water, etc.) to concrete foundations. Consequently, chloride classes of C0 and C1 should be used where applicable. C0 is defined as, "Concrete dry or protected from moisture" and C1 is defined as, "Concrete exposed to moisture but not to an external source of chlorides". For the amount of chlorides allowed in concrete mix designs, Table 19.3.2.1 of ACI 318-14 shall be adhered to as appropriate.

Based on the results of the sulfate content test results, ACI 318-14, Section 19.3 does not specify the type of cement or a maximum water-cement ratio for concrete for sulfate Class S0. For further information, see ACI 318-14, Section 19.3.

GEOTECHNICAL OVERVIEW

Subsurface undocumented fill material consisting of well graded gravel with clay to lean clay with gravel was encountered to a depth of approximately 1½ to 4 feet across the site. Undocumented fill materials are not suitable to support the proposed improvements for this project and should be completely over excavated down to native soil. Additional recommendations for removal of onsite undocumented fill are provided in the **Earthwork** section.

The near surface, low to medium plasticity lean clay beneath the surficial fill soils could become unstable with typical earthwork and construction traffic, especially after surficial fills are removed. Effective site drainage should be completed early in the construction sequence and maintained after construction to avoid potential issues. If possible, the grading should be performed during the warmer and drier time of the year. If unstable subgrade conditions persist during construction, subgrade clay soils may be stabilized through chemical treatment. Additional site preparation recommendations including subgrade improvement and fill placement are provided in the **Earthwork** section.

The proposed C-store structure may be supported on shallow spread footing foundations bearing directly on a minimum of 12 inches of compacted non-expansive or low volume change (LVC) engineered fill. The **Shallow Foundations** section addresses support of the building bearing on a minimum of 12 inches of compacted engineered fill. Floor slabs should be supported on a minimum of 12 inches of LVC, non-expansive engineered fill.

Fueling canopies may be supported on drilled shaft foundations bearing in native soils. The **Deep Foundations** section addresses foundation support for the proposed fueling canopies.

Recommendations for both rigid (concrete) and flexible (asphalt) pavement systems are provided for this site. The **Pavements** section addresses the design of pavement systems.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork will include clearing and grubbing, excavations, over excavation of undocumented fill and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria as necessary to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas.

Existing Fill

As noted in **Geotechnical Characterization** section, undocumented fill material consisting of well graded gravel with clay to lean clay with gravel was encountered to a depth of approximately 1½ to 4 feet bgs across the site. Undocumented fill materials are not suitable to support the proposed improvements for this project and should be completely over excavated down to native soil. The upper 12 inches of the resulting subgrade shall be scarified and compacted as engineered fill.

Over excavated materials may be stockpiled for reuse as general purpose fill, if desired. Over-excavated material may be suitable for use as engineered fill provided it is processed to conform with the requirements for engineered fill provided in this report.

The exposed native subgrade should be proof-rolled with an adequately loaded vehicle such as a fully loaded tandem axle dump truck. The proof-rolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed or modified by stabilizing with lime or cement or with aggregate base and geotextiles. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

Subgrade Preparation

Foundations and floor slabs shall bear on a minimum of 12 inches of engineered fill. Once undocumented fill materials are removed from the footing areas, the upper 12 inches of the resulting subgrade soils should be scarified and compacted as engineered fill.

Grading for the proposed C-store structure should incorporate the limits of the structure plus a lateral distance of 3 feet beyond the outside edge of perimeter footings.

Fill Material Types

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than three inches in size. Pea gravel or other similar non-cementitious, poorly-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

Clean on-site soils or approved imported materials may be used as fill material for the following:

- general site grading
- foundation areas
- interior floor slab areas
- foundation backfill
- pavement areas
- exterior slab areas

Soils for use as compacted engineered fill material within the proposed building pad area should conform to non-expansive or low volume change (LVC) materials as indicated in the following recommendations:

Gradation	Percent Finer by Weight (ASTM C 136)
3”	100
No. 4 Sieve	50-100
No. 200 Sieve	10-40
■ Liquid Limit	30 (max)
■ Plasticity Index	15 (max)
■ Maximum expansion index*	20 (max)

*ASTM D 4829

The contractor shall notify the Geotechnical Engineer of import sources sufficiently ahead of their use so that the sources can be observed and approved as to the physical characteristic of the import material. For all import material, the contractor shall also submit current verified reports from a recognized analytical laboratory indicating that the import has a "not applicable" (Class S0) potential for sulfate attack based upon current ACI criteria and is "mildly corrosive" to ferrous metal and copper. The reports shall be accompanied by a written statement from the contractor that the laboratory test results are representative of all import material that will be brought to the job.

The native near surface clayey soils are low to medium plasticity and may meet the above criteria for non-expansive engineered fill. Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed 10 inches loose thickness.

Fill Compaction Requirements

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

Material Type and Location	Per the Modified Proctor Test (ASTM D 1557)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction Above Optimum	
		Minimum	Maximum
On-site non-expansive soils and low volume change (non-expansive) imported fill:			
Beneath foundations:	90	0%	+3%
Beneath slabs	90	0%	+3%
On-site clayey soils:	90	+2%	+4%
Miscellaneous backfill:	90	0%	+3%
Beneath pavement:	95	0%	+3%
Utility Trenches*:	90	0%	+4%
Bottom of native soil excavation receiving fill:	90	+2%	+4%

*The upper 12 inches beneath pavement should be compacted to 95% of the maximum dry density as determined in the ASTM D1557 test method.

We recommend that compacted native soil or any engineered fill be tested for moisture content and relative compaction during placement. Should the results of the in-place density tests indicate the specified moisture content or compaction requirements have not been met, the area represented by the test should be reworked and retested as required until the specified moisture content and relative compaction requirements are achieved.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

The proposed structure may be supported on shallow spread footing foundations bearing on a minimum of 12 inches of compacted engineered fill. As noted in **Earthwork**, existing fill materials will be over excavated and the upper 12 inches of native subgrade scarified and compacted as engineered fill. Over-excavated material may be suitable for use as engineered fill provided it is processed to conform with the requirements for engineered fill provided in this report.

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	2,500 psf for foundations bearing on minimum 12 inches of engineered fill
Required Bearing Stratum [3]	Minimum of 12 inches of engineered fill.
Minimum Foundation Dimensions	Columns: 24 inches Continuous: 12 inches
Ultimate Passive Resistance [4] **(equivalent fluid pressures)**	350 pcf
Ultimate Coefficient of Sliding Friction [5]	0.40
Minimum Embedment below Finished Grade [6]	12 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About 2/3 of total settlement

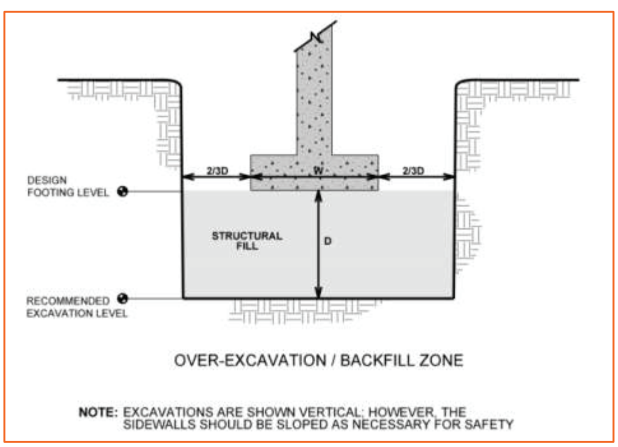
Item	Description

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Values assume that exterior grades are relatively flat around the structure.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. If passive resistance is used to resist lateral loads, the base friction should be reduced by 25 percent.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of seasonal water content variations. Finished grade is defined as the lowest adjacent grade within five feet of the foundation for perimeter (exterior) footings.
7. Differential settlements are as measured over a span of 50 feet.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

Over-excavation for engineered fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with engineered fill placed, as recommended in the **Earthwork** section.



To ensure foundations have adequate support, special care should be taken when footings are located adjacent to trenches. The bottom of such footings should be at least 1 foot below an imaginary plane with an inclination of 1.5 horizontal to 1.0 vertical extending upward from the nearest edge of the adjacent trench.

DEEP FOUNDATIONS

We recommend that the proposed fueling canopies be supported on drilled shaft foundations bearing into firm native silt (hardpan) soils. Recommendations for drilled shaft foundations are presented in the following paragraphs.

Drilled Shaft Design Parameters

Soil design parameters are provided below in the **Drilled Shaft Design Summary** table for the design of drilled shaft foundations. The values presented for allowable side friction and end bearing include a factor of safety.

Drilled Shaft Design Summary [1]

Approximate Depth (feet)	Stratigraphy [2]		Allowable Skin Friction (psf) [3]	Allowable End Bearing Pressure (psf) [4]
	No.	Material		
2 to 6	2	Lean Clay with Sand	250	--
6 to 15	3	Silt (Hardpan)	450	7,500
15 to 20	4	Silty to Poorly Graded Sand	200	11,750

1. Design capacities are dependent upon the method of installation, and quality control parameters. The values provided are estimates and should be verified when installation protocol have been finalized.
2. See **Subsurface Profile** in **Geotechnical Characterization** for more details on stratigraphy.
3. Applicable for compressive loading only. Reduce to 2/3 of values shown for uplift loading. Effective weight of shaft can be added to uplift load capacity.
4. Shafts should extend at least one diameter into the bearing stratum (or to a depth equal to the bell diameter for belled shafts) for end bearing to be considered.

Tensile reinforcement should extend to the bottom of shafts subjected to uplift loading. Buoyant unit weights of the soil and concrete should be used in the calculations below the highest anticipated groundwater elevation.

Drilled shaft should have a minimum (center-to-center) spacing of three diameters. Closer spacing may require a reduction in axial load capacity. Axial capacity reduction can be determined by comparing the allowable axial capacity determined from the sum of individual piles in a group versus the capacity calculated using the perimeter and base of the pile group acting as a unit. The lesser of the two capacities should be used in design.

A minimum shaft diameter of 12 inches should be used. Drilled shafts should have a minimum length of 7 feet and should extend into the bearing strata at least one shaft diameter for the allowable end-bearing pressures listed in the above table.

Post-construction settlements of drilled shafts designed and constructed as described in this report are estimated to range from about ½ to ¾ inch. Differential settlement between individual shafts is expected to be ½ to ⅔ of the total settlement.

Drilled Shaft Lateral Loading

The following table lists input values for use in LPILE analyses. LPILE estimates values of k_h and ε_{50} based on strength; however, non-default values of k_h should be used where provided. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Stratigraphy [1]		L-Pile Soil Model	S_u (psf) [2]	ϕ [2]	γ (pcf) [2,3]	Strain Factor ε_{50} [2]	k_h (pci) [2]
No.	Material						
2	Lean Clay with Sand	Clay w/o Free Water	1,300	---	120	0.007	500
3	Silt (Hardpan)	Silt (cemented c-phi)	2,500	23°	115	0.005	1,000
4	Silty Sand	Sand (Reese)	---	33°	115	---	225

1. See **Subsurface Profile** in **Geotechnical Characterization** for more details on Stratigraphy.
2. Definition of Terms:
   S_u: Undrained shear strength
   ϕ: Internal friction angle,
   γ: Moist unit weight
   ε_{50}: Non-default ε_{50} strain
   k_h: Horizontal modulus of subgrade reaction, static
3. Buoyant unit weight values should be used below water table.

The load capacities provided herein are based on the stresses induced in the supporting soil strata. The structural capacity of the shafts/piles should be checked to assure they can safely accommodate the combined stresses induced by axial and lateral forces. Lateral deflections of shafts/piles should be evaluated using an appropriate analysis method, and will depend upon the pile's diameter, length, configuration, stiffness and "fixed head" or "free head" condition. We can provide additional analyses and estimates of lateral deflections for specific loading conditions upon request. The load-carrying capacity of shafts/piles may be increased by increasing the diameter and/or length.

Drilled Shaft Construction Considerations

Sandy subgrade materials were encountered within the area of the proposed improvements. To prevent collapse of the sidewalls, the use of temporary steel casing may be required for construction of the drilled shaft foundations. The drilled shaft contractor and foundation design engineer should be informed of these risks.

Some of the soils encountered in our borings are very dense and cemented, and the potential for hard drilling conditions should be anticipated by the installation contractor. If casing is removed during concrete placement, care should be exercised to maintain concrete inside the casing at a sufficient level to resist earth and hydrostatic pressures present on a casing exterior. Water or loose soil should be removed from the bottom of the drilled shafts prior to placement of the concrete.

Care should be taken to not disturb the sides and bottom of the excavation during construction. The bottom of the shaft excavation should be free of loose material before concrete placement. Concrete should be placed as soon as possible after the foundation excavation is completed, to reduce potential disturbance of the bearing surface.

Concrete for "dry" drilled shaft construction should have a slump of about 5 to 7 inches. Concrete should be directed into the shaft utilizing a centering chute. Concrete for "wet" shaft construction would require higher slump concrete.

While withdrawing casing, care should be exercised to maintain concrete inside the casing at a sufficient level to resist earth pressures acting on the casing exterior. Arching of the concrete, loss of seal and other problems can occur during casing removal and result in contamination of the drilled shaft. These conditions should be considered during the design and construction phases. Placement of loose soil backfill should not be permitted around the casing prior to removal.

The drilled shaft installation process should be performed under the direction of the Geotechnical Engineer. The Geotechnical Engineer should document the shaft installation process including soil/rock and groundwater conditions encountered, consistency with expected conditions, and details of the installed shaft.

FLOOR SLABS

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	■ Minimum 4 inches of free-draining (less than 6% passing the U.S. No. 200 sieve) crushed aggregate [2] ■ At least 12 inches of compacted LVC (non-expansive) engineered fill material
Estimated Modulus of Subgrade Reaction [3]	150 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Free-draining granular material should have less than 5% fines (material passing the No. 200 sieve). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.
3. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

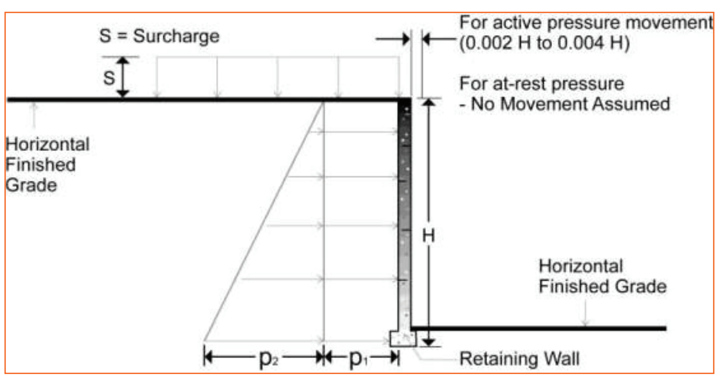
Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The “at-rest” condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters			
Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3, 4, 5] p_1 (psf)	Effective Fluid Pressures (psf) [2, 4, 5]
Active (Ka)	0.31	(0.31)S	(35)H
At-Rest (Ko)	0.53	(0.53)S	(60)H
Passive (Kp)	3.25	---	(375)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, compacted to at least 90% of the ASTM D 1557 maximum dry density, rendering a maximum unit weight of 115 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values.

Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Design of Asphaltic Concrete (AC) pavements are based on the procedures in the Caltrans Highway Design Manual, 2018 edition. Design of Portland Cement Concrete (PCC) pavements are based upon American Concrete Institute (ACI) 330R-01; Guide for Design and Construction of Concrete Parking Lots.

One sample of the near surface soils was obtained and classified at our laboratory by a geologist. The sample was tested to determine its Resistance Value (R-value). The location of the R-value sample is shown on the Exploration Plan. The test produced an R-value of 43. Therefore, a design R-value of 43 was used for the AC and PCC pavement designs. The design pavement sections are based on a minimum subgrade R-value of 43. Any import fill used in the pavement areas should have a minimum R-value of 43. We have provided pavement sections for traffic indices (TI) of 4.5, 5.5, and 6.5. The project civil engineer should determine the appropriate traffic index for the anticipated traffic loading conditions. If additional pavement sections are required, we should be contacted to provide the additional design sections.

Pavement Section Thicknesses

The following table provides options for AC and PCC Sections:

Typical Pavement Section (inches)					
Traffic Area	Alternative	Asphalt Concrete (AC) Surface Course	Portland Cement Concrete (PCC) [1]	Aggregate Base (AB) Course	Total Thickness
Auto Parking Assumed Traffic Index (TI) = 4.5	PCC	--	4.5	--	4.5
	AC	2.5	--	4.0	6.5
Auto Drive Areas Assumed Traffic Index (TI) = 5.5	PCC	--	5.0	--	5.0
	AC	3.0	--	5.0	8.0
Light Truck Drive Areas Assumed Traffic Index (TI) = 6.5	PCC	--	5.0	--	5.0
	AC	4.0	--	5.5	9.5

1. PCC pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic.

The estimated pavement sections provided in this report are minimums for the assumed design criteria, and as such, periodic maintenance should be expected. Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (i.e. concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles. A maintenance program including surface sealing, joint cleaning and sealing, and timely repair of cracks and deteriorated areas will increase the pavement's service life. As an option, thicker sections could be constructed to decrease future maintenance.

Concrete for rigid pavements should have a minimum 28-day compressive strength of 4,000 psi, a modulus of rupture of 500 psi, and be placed with a maximum slump of 4 inches. Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. Joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

Where practical, we recommend early-entry cutting of crack-control joints in PCC pavements. Cutting of the concrete in its "green" state typically reduces the potential for micro-cracking of the pavements prior to the crack control joints being formed, compared to cutting the joints after the concrete has fully set. Micro-cracking of pavements may lead to crack formation in locations other than the sawed joints, and/or reduction of fatigue life of the pavement.

Pavement design methods are intended to provide structural sections with adequate thickness over a subgrade such that wheel loads are reduced to a level the subgrade can support.

Openings in pavements, such as decorative landscaped areas, are sources for water infiltration into surrounding pavement systems. Water can collect in the islands and migrate into the surrounding subgrade soils thereby degrading support of the pavement. This is especially applicable for islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils. The civil design for the pavements with these conditions should include features to restrict or to collect and discharge excess water from the islands. Examples of features are edge drains connected to the storm water collection system, longitudinal subdrains, or other suitable outlet and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

Dishing in parking lots surfaced with AC is usually observed in frequently-used parking stalls (such as near the front of buildings), and occurs under the wheel footprint in these stalls. The use of higher-grade asphaltic cement, or surfacing these areas with PCC, should be considered. The dishing is exacerbated by factors such as irrigated islands or planter areas, sheet surface drainage to the front of structures, and placing the ACC directly on a compacted clay subgrade.

Rigid PCC pavements will perform better than AC in areas where short-radii turning and braking are expected (i.e. entrance/exit aprons) due to better resistance to rutting and shoving. In addition, PCC pavement will perform better in areas subject to large or sustained loads. An adequate number of longitudinal and transverse control joints should be placed in the rigid pavement in accordance with ACI and/or AASHTO requirements. Expansion (isolation) joints must be full depth and should only be used to isolate fixed objects abutting or within the paved area.

PCC pavement details for joint spacing, joint reinforcement, and joint sealing should be prepared in accordance with American Concrete Institute (ACI 330R-01 and ACI 325R.9-91). PCC pavements should be provided with mechanically reinforced joints (doweled or keyed) in accordance with ACI 330R-01.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

The pavement surfacing and adjacent sidewalks should be sloped to provide rapid drainage of surface water. Water should not be allowed to pond on or adjacent to slabs, since it could saturate the subgrade and contribute to premature pavement or slab deterioration.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

1. Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
2. Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
3. Install below pavement drainage systems surrounding areas anticipated for frequent wetting.
4. Install joint sealant and seal cracks immediately.
5. Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
6. Place compacted, low permeability backfill against the exterior side of curb and gutter.
7. Place curb, gutter and/or sidewalk directly on subgrade soils rather than on unbound granular base course materials.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

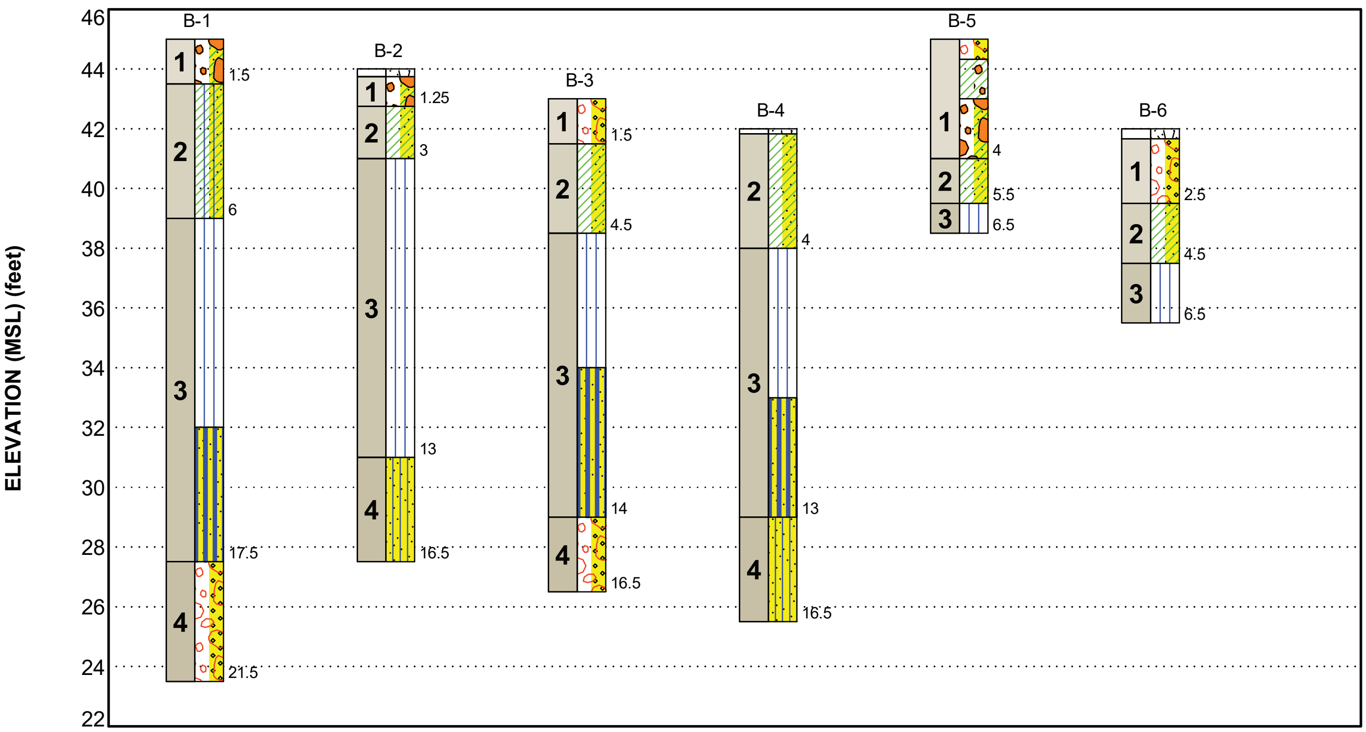
Contents:

GeoModel

GEOMODEL

Maverik Fueling Station Sacramento ■ Sacramento, CA
5/28/2019 ■ Terracon Project No. NB195036

Terracon GeoReport



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Fill	Fill varied from well and poorly graded gravels to clay with gravel. Fill varied in plasticity and density/consistency
2	Lean Clay with Sand	Brown, low to medium plasticity, medium stiff to hard, fine to medium grained, black mottled
3	Silt (Hardpan)	Low to non-plastic, hard, weak to moderate cementation, varying sand contents
4	Silty Sands and Well Graded Gravels	Fine to coarse grained, non-plastic, medium to very dense, gravel up to 4 inches in dimension

LEGEND

- Poorly-graded Gravel with Clay and Sand
- Sandy Silt
- Lean Clay with Sand
- Silty Clay with Sand
- Well-graded Gravel w/sand
- Silty Sand
- Silt
- Topsoil
- Lean Clay with Gravel

- First Water Observation
- Second Water Observation
- Third Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
2	15 to 20	New C-Store
1	15	New Auto Fueling Island
1	15	New UST
2	5	Asphalt Parking and Drives

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous hollow stem flight augers. We obtained samples at depths of 1 foot and 5 feet and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. A 2.5-inch O.D. split-barrel Modified California sampling spoon with 2.0-inch I.D. tube lined sampler was used for sampling. Tube-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are not equivalent to the SPT blow counts. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion. Pavements were patched with cold-mix asphalt and/or pre-mixed concrete, as appropriate.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a geologist. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project geologist reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
- ASTM D1140 Standard Test Method for Determining the Amount of Material Finer than No. 200 Sieve by Soil Washing
- ASTM D2844 Standard Test Method for Resistance Value R-Value

The laboratory testing program included examination of soil samples by a geologist. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan
Exploration Plan
1998 Historic Site Map
2002 Historic Site Map

Note: All attachments are one page unless noted above.

SITE LOCATION

Maverik Fueling Station Sacramento ■ Sacramento, California
May 28, 2019 ■ Terracon Project No. NB195036

Terracon GeoReport

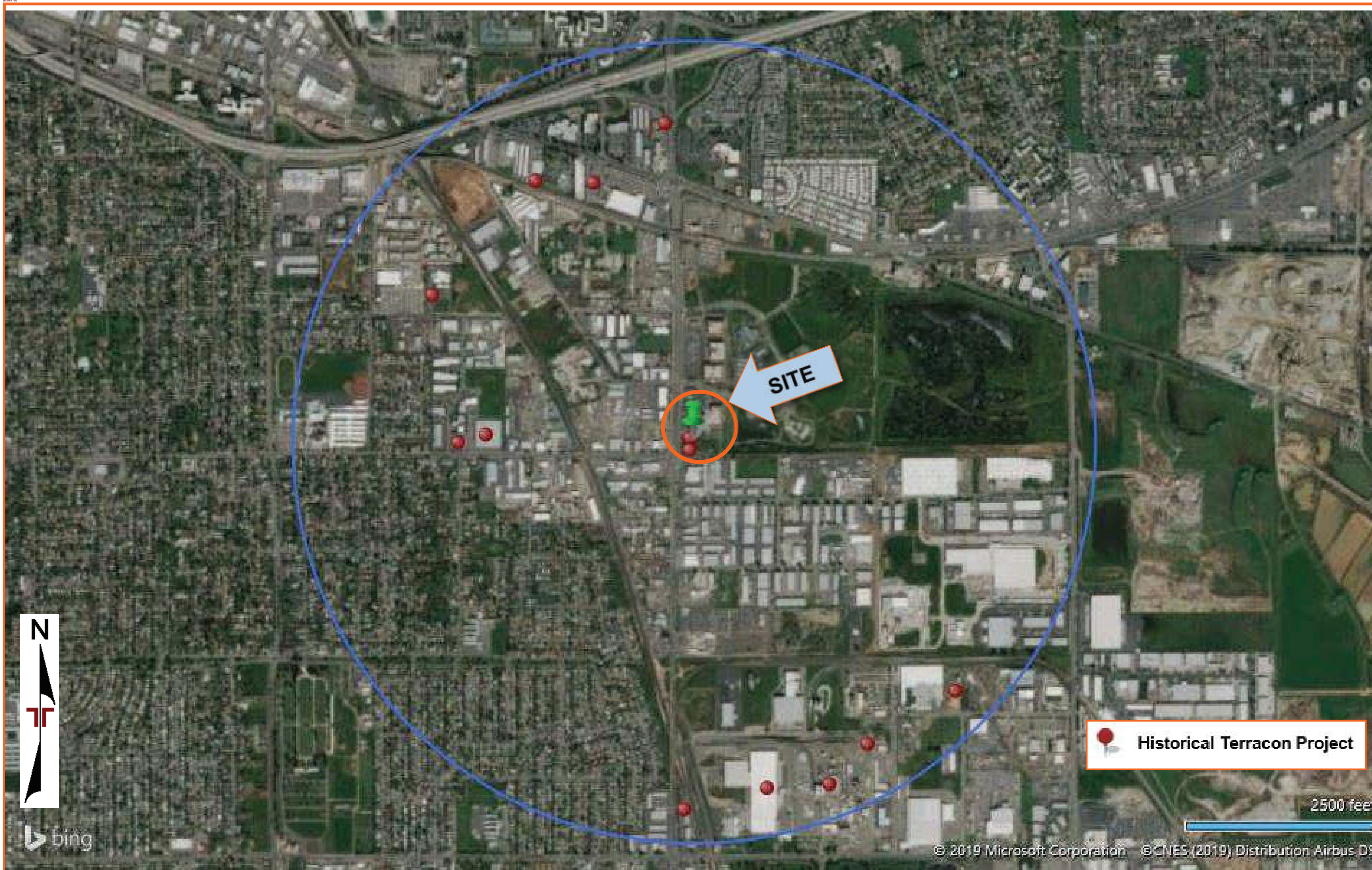


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Maverik Fueling Station Sacramento ■ Sacramento, California

May 28, 2019 ■ Terracon Project No. NB195036

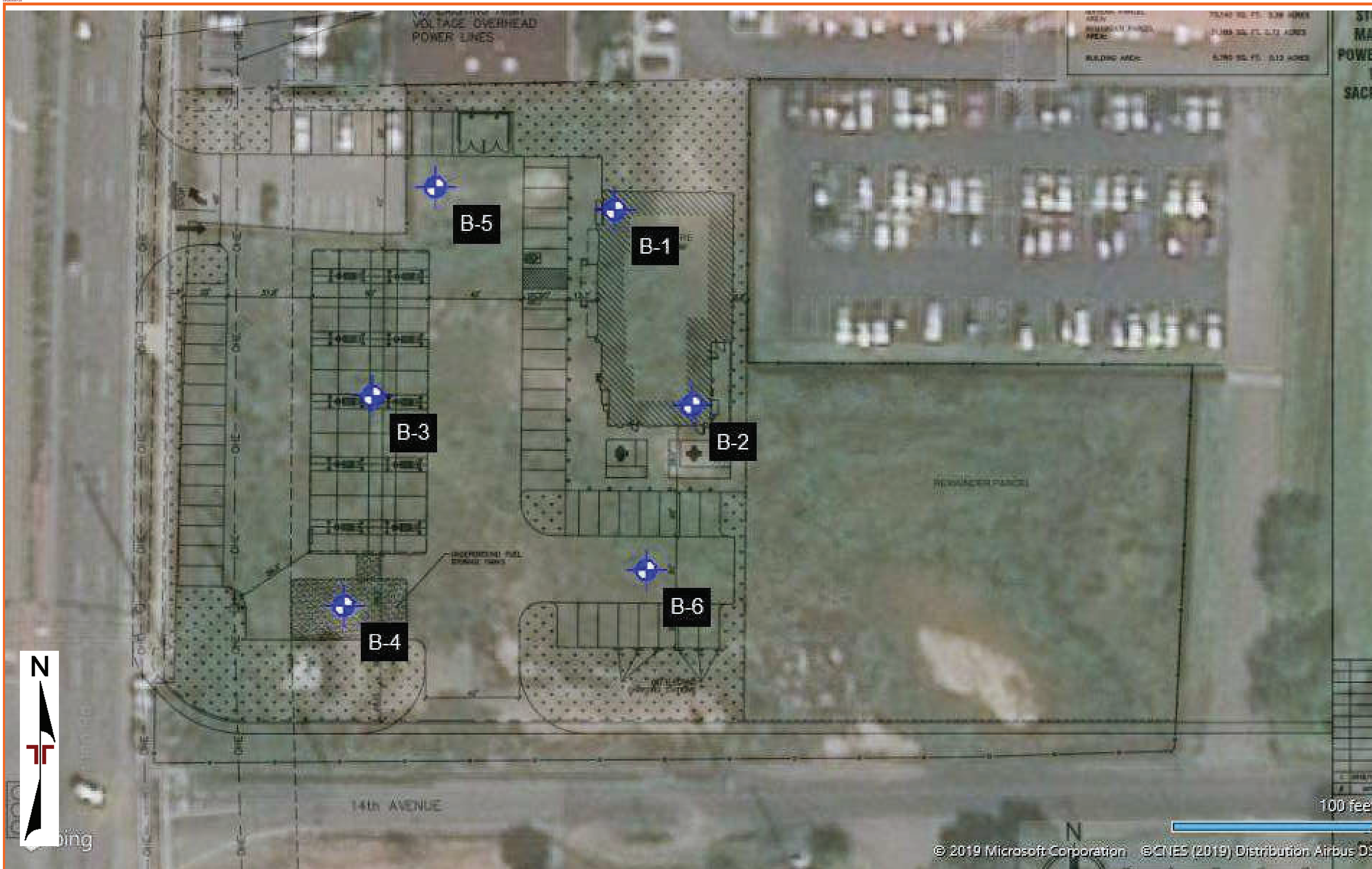


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

1998 HISTORIC SITE MAP

Maverik Fueling Station Sacramento ■ Sacramento, California
May 28, 2019 ■ Terracon Project No. NB195036

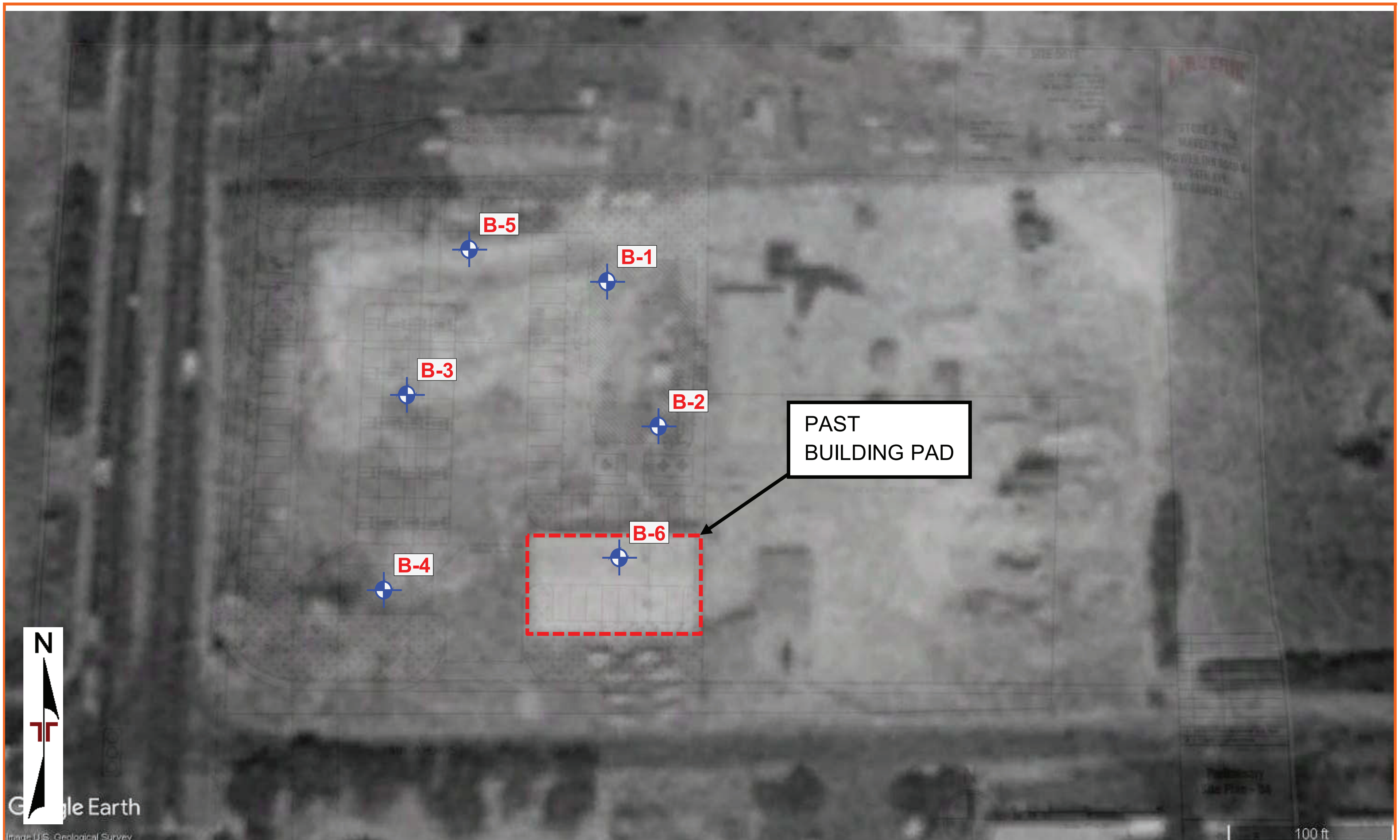


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

2002 HISTORIC SITE MAP

Maverik Fueling Station Sacramento ■ Sacramento, California
May 28, 2019 ■ Terracon Project No. NB195036

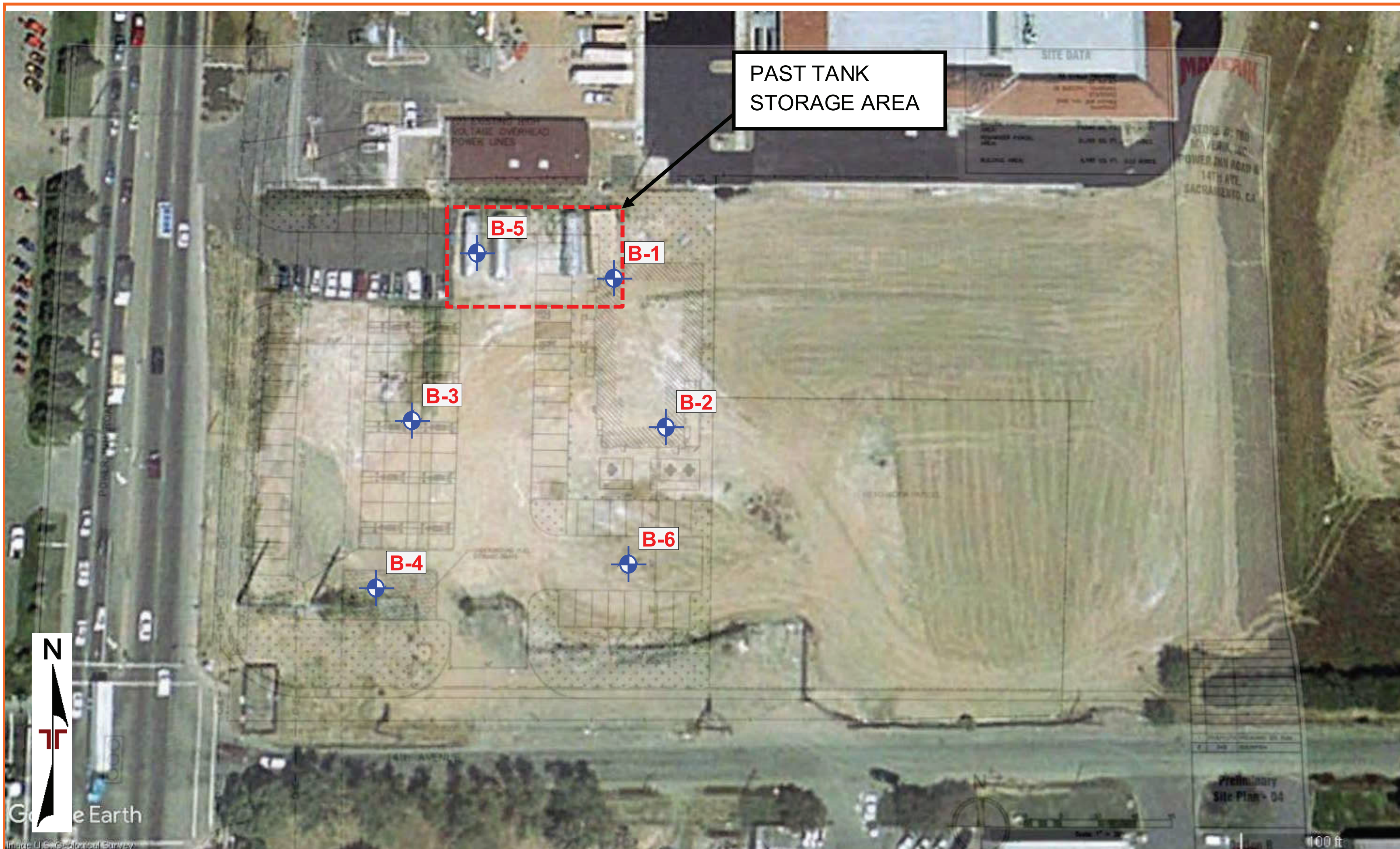


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Logs (B-1 through B-6)
Atterberg Limits
Grain Size Distribution
Unconfined Compression (3 pages)
R-Value Test Results
Corrosion Test Results

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: Maverik Fueling Station Sacramento

CLIENT: Maverik, Inc
Salt Lake City, UT

SITE: 3855 Power Inn Road
Sacramento, CA

LOCATION See Exploration Plan

Latitude: 38.5404° Longitude: -121.4081°

MODEL LAYER	DEPTH	DESCRIPTION
1	1.5	**FILL - POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC)**, fine to coarse grained, subrounded, nonplastic, light brown to brown, ~18" thickness
2	6.0	**SILTY CLAY WITH SAND (CL-ML)**, fine to medium grained, brown, stiff, black mottled
3	13.0	**SILT (ML)**, low plasticity, brown to light brown, hard, moderate cementation, hardpan tan to light orange
3	17.5	**SANDY SILT (ML)**, fine grained, nonplastic, light brown, hard
4	21.5	**WELL GRADED GRAVEL WITH SAND (GW)**, fine to coarse grained, subrounded, brown, very dense, gravel >2.5" in dimension
		Boring Terminated at 21.5 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
2.5			2-4-5	2.5 (HP)	1.44	16	105	22-15-7	74
5			5-7-12	4.5 (HP)		21	96		
7.5			18-39-50/4"	6.0+ (HP)		16	100		
10			8-21-37	6.0+ (HP)		29	89		
15			8-11-14	4.5 (HP)		38	76		67
20			37-50/3"			4			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

Boring Started: 05-02-2019 | Boring Completed: 05-02-2019
Drill Rig: CME 75 | Driller: R.A.
Project No.: NB195036

BORING LOG NO. B-2

PROJECT: Maverik Fueling Station Sacramento

CLIENT: Maverik, Inc
Salt Lake City, UT

SITE: 3855 Power Inn Road
Sacramento, CA

LOCATION See Exploration Plan

Latitude: 38.5401° Longitude: -121.4079°

MODEL LAYER	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**TOPSOIL**, ~3" thickness										
1	1.3	**FILL - POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC)**, fine to coarse grained, subrounded, light brown to light gray, ~12" thickness				44-9-6			8		NP	8
2	3.0	**LEAN CLAY WITH SAND (CL)**, fine to medium grained, low to medium plasticity, brown, medium stiff to stiff, black mottled				4-37-50/5"	2.5 (HP)		19	87		
3		**SILT (ML)**, low plasticity, light brown to orange, hard, hardpan	5			19-30-40	6.0 (HP)		17	95		
	13.0	hard	10			4-12-23	6.0+ (HP)	2.68	23	94		
4	16.5	**SILTY SAND (SM)**, fine grained, nonplastic, light brown to orange, medium dense	15			3-11-14			20	85		24

Boring Terminated at 16.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

Boring Started: 05-02-2019	Boring Completed: 05-02-2019
Drill Rig: CME 75	Driller: R.A.
Project No.: NB195036	

BORING LOG NO. B-3

PROJECT: Maverik Fueling Station Sacramento

CLIENT: Maverik, Inc
Salt Lake City, UT

SITE: 3855 Power Inn Road
Sacramento, CA

LOCATION See Exploration Plan

Latitude: 38.5402° Longitude: -121.4085°

MODEL LAYER	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1	1.5	**FILL - WELL GRADED GRAVEL WITH SAND (GW)**, fine to coarse grained, subangular, light brown to light gray, ~18" thickness, large concrete piece ~14" in dimension encountered										
2	4.5	**LEAN CLAY WITH SAND (CL)**, fine to medium grained, brown, medium stiff, black mottled				2-3-4	1.9 (HP)		20	102	28-15-13	82
3		**SILT (ML)**, light brown, hard, weak to moderate cementation, hardpan	5			9-17-27	6.0+ (HP)		17	106		
3	9.0	light brown to orange				11-24-32	6.0+ (HP)		28	87		
3	14.0	**SANDY SILT (ML)**, fine to medium grained, nonplastic, light brown to orange, hard	10			6-11-16	6.0 (HP)		37	80		
4	16.5	**WELL GRADED GRAVEL WITH SAND (GW)**, fine to coarse grained, subrounded, light brown to gray, very dense, >4" in dimension	15			9-36-42			3	118		5

Boring Terminated at 16.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

Boring Started: 05-02-2019	Boring Completed: 05-02-2019
Drill Rig: CME 75	Driller: R.A.
Project No.: NB195036	

BORING LOG NO. B-4

PROJECT: Maverik Fueling Station Sacramento

CLIENT: Maverik, Inc
Salt Lake City, UT

SITE: 3855 Power Inn Road
Sacramento, CA

LOCATION See Exploration Plan

Latitude: 38.5399° Longitude: -121.4085°

MODEL LAYER	DEPTH	Description	SAMPLE DEPTH (Ft.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.2	~2" thickness							
2	4.0	**LEAN CLAY WITH SAND (CL)**, fine to medium grained, low to medium plasticity, brown, stiff to hard	1–2.5	11-14-10	6.0+ (HP)	13	111		79
			2.5–4	5-5-12	3.5 (HP)	22	101		
3	9.0	**SILT (ML)**, light brown to gray, hard, moderate cementation, hardpan	5–6.5	10-15-21	6.0+ (HP)	23	95		
			7.5–9	13-35-41	6.0+ (HP)	19	103		
3	13.0	**SANDY SILT (ML)**, fine grained, low plasticity, light brown to orange, hard, weak cementation	10–11.5	10-17-20 N=37		27			
4	16.5	**SILTY SAND (SM)**, fine grained, low plasticity, light gray to light brown, medium dense	15–16.5	7-8-8 N=16		14			22

Other columns (WATER LEVEL OBSERVATIONS, UNCONFINED COMPRESSIVE STRENGTH (tsf)) contain no entries.

Boring Terminated at 16.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

Boring Started: 05-02-2019	Boring Completed: 05-02-2019
Drill Rig: CME 75	Driller: R.A.
Project No.: NB195036	

BORING LOG NO. B-5

PROJECT: Maverik Fueling Station Sacramento

CLIENT: Maverik, Inc
Salt Lake City, UT

SITE: 3855 Power Inn Road
Sacramento, CA

LOCATION See Exploration Plan

Latitude: 38.5404° Longitude: -121.4084°

MODEL LAYER	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1	0.7	**FILL - WELL GRADED GRAVEL WITH SAND (GW)**, angular, nonplastic, light gray, ~8" thickness										
1	2.0	**FILL - LEAN CLAY WITH GRAVEL (CL)**, fine to coarse grained, subangular, low plasticity, light brown to tan, medium stiff, ~16" thickness				10-5-6			25	86	45-21-24	83
1	4.0	**FILL - POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC)**, fine to coarse grained, subangular, nonplastic, light brown to tan, loose, ~24" thickness				5-7-5			19	103		
2	5.5	**LEAN CLAY WITH SAND (CL)**, low to medium plasticity, brown, medium stiff	5									
3	6.5	**SILT (ML)**, low plasticity, light brown, hard, moderate cementation, hardpan				4-20-50		1.47	22	96		

Boring Terminated at 6.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

Not encountered

Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

Boring Started: 05-02-2019 | Boring Completed: 05-02-2019

Drill Rig: CME 75 | Driller: R.A.

Project No.: NB195036

BORING LOG NO. B-6

PROJECT: Maverik Fueling Station Sacramento

CLIENT: Maverik, Inc
Salt Lake City, UT

SITE: 3855 Power Inn Road
Sacramento, CA

LOCATION See Exploration Plan

Latitude: 38.54° Longitude: -121.4081°

MODEL LAYER	DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	LABORATORY HP (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**TOPSOIL**, ~4" thickness										
1	2.5	**FILL - WELL GRADED GRAVEL WITH SAND (GW)**, fine to coarse grained, subangular, nonplastic, light brown, very loose, ~26" thickness				3-2-2			8	81		
2	4.5	**LEAN CLAY WITH SAND (CL)**, fine grained, low to medium plasticity, brown										
3	6.5	**SILT (ML)**, low plasticity, light brown, hard, moderate cementation, hardpan	5			7-24-31			17	103		
		Boring Terminated at 6.5 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
6" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

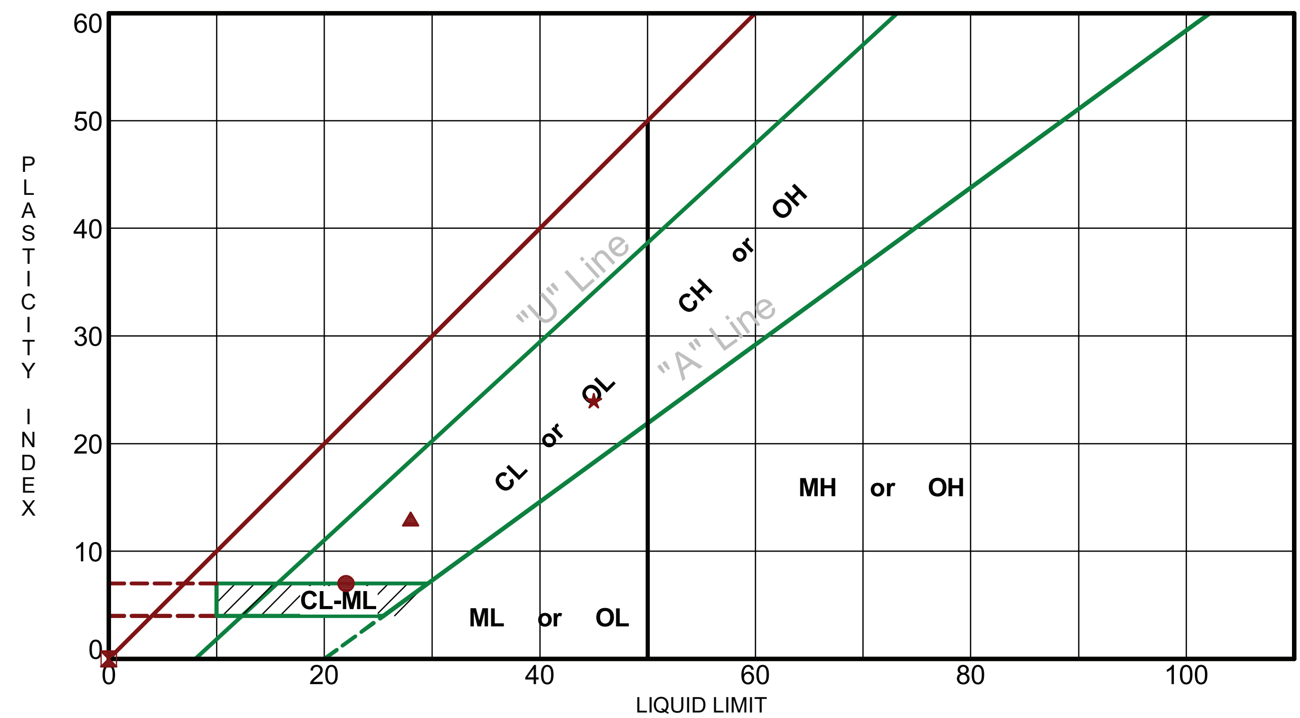
Not encountered

Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

Boring Started: 05-02-2019	Boring Completed: 05-02-2019
Drill Rig: CME 75	Driller: R.A.
Project No.: NB195036	

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	B-1	2.5 - 4	22	15	7	74	CL-ML	SILTY CLAY with SAND
⊠	B-2	1 - 2.5	NP	NP	NP	8	GP-GC	POORLY GRADED GRAVEL with CLAY
▲	B-3	1 - 2.5	28	15	13	82	CL	LEAN CLAY with SAND
★	B-5	1 - 2.5	45	21	24	83	CL	LEAN CLAY with SAND

PROJECT: Maverik Fueling Station
Sacramento

SITE: 3855 Power Inn Road
Sacramento, CA

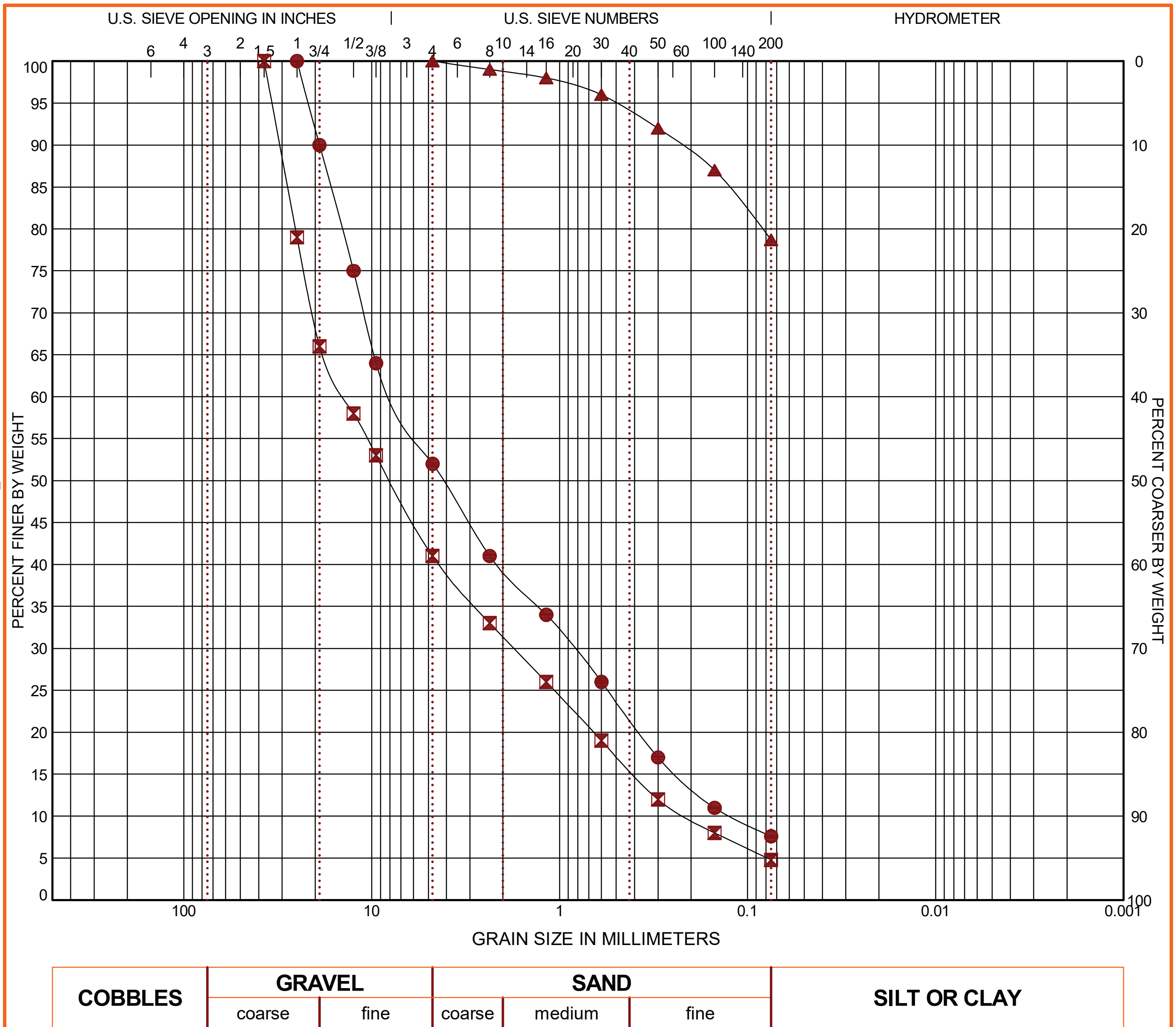
Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

PROJECT NUMBER: NB195036

CLIENT: Maverik, Inc
Salt Lake City, UT

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-2	1 - 2.5	0.0	48.0	44.4		7.6		GP-GC
⊠	B-3	15 - 16.5	0.0	59.0	36.2		4.8		GW
▲	B-4	1 - 2.5	0.0	0.0	21.3		78.7		CL

GRAIN SIZE

	●	⊠	▲
D_{60}	7.54	13.879	
D_{30}	0.841	1.753	
D_{10}	0.122	0.212	

COEFFICIENTS

	●	⊠	▲
C_C	0.77	1.04	
C_U	61.63	65.43	

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
1"	100.0	1 1/2"	100.0	#4	100.0
3/4"	90.0	1"	79.0	#8	99.0
1/2"	75.0	3/4"	66.0	#16	98.0
3/8"	64.0	1/2"	58.0	#30	96.0
#4	52.0	3/8"	53.0	#50	92.0
#8	41.0	#4	41.0	#100	87.0
#16	34.0	#8	33.0	#200	78.7
#30	26.0	#16	26.0		
#50	17.0	#30	19.0		
#100	11.0	#50	12.0		
#200	7.6	#100	8.0		
		#200	4.8		

SOIL DESCRIPTION

- ● POORLY GRADED GRAVEL with CLAY (GP-GC)
- ⊠ WELL GRADED GRAVEL with SAND (GW)
- ▲ LEAN CLAY with SAND (CL)

REMARKS

- ●
- ⊠
- ▲

PROJECT: Maverik Fueling Station
Sacramento

SITE: 3855 Power Inn Road
Sacramento, CA

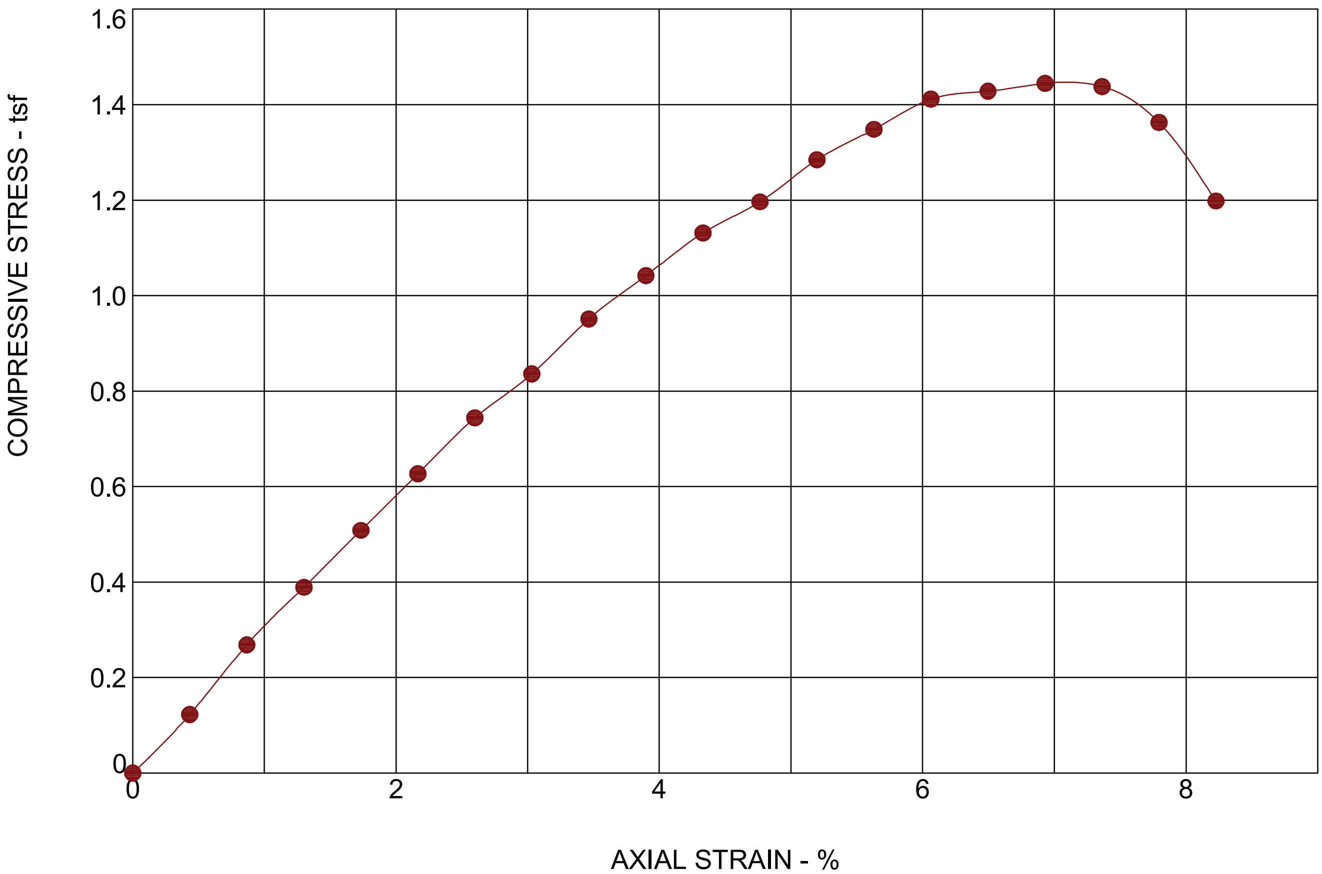
Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

PROJECT NUMBER: NB195036

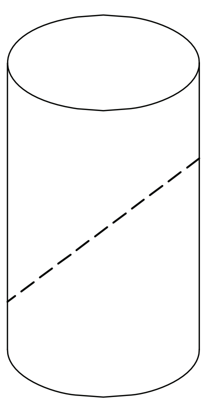
CLIENT: Maverik, Inc
Salt Lake City, UT

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	16
	Dry Density:	pcf	105
	Diameter:	in.	1.93
	Height:	in.	4.62
	Height / Diameter Ratio:		2.39
	Calculated Saturation:	%	
	Calculated Void Ratio:		
	Assumed Specific Gravity:		
	Failure Strain:	%	6.93
	Unconfined Compressive Strength	(tsf)	1.44
	Undrained Shear Strength:	(tsf)	0.72
	Strain Rate:	in/min	
	Remarks:		



Failure Mode: Shear (dashed)

SAMPLE TYPE: CARS

SAMPLE LOCATION: B-1 @ 2.5 - 4 feet

DESCRIPTION	LL	PL	PI	Percent < #200 Sieve
SILTY CLAY with SAND(CL-ML)	22	15	7	74

PROJECT: Maverik Fueling Station
Sacramento

SITE: 3855 Power Inn Road
Sacramento, CA

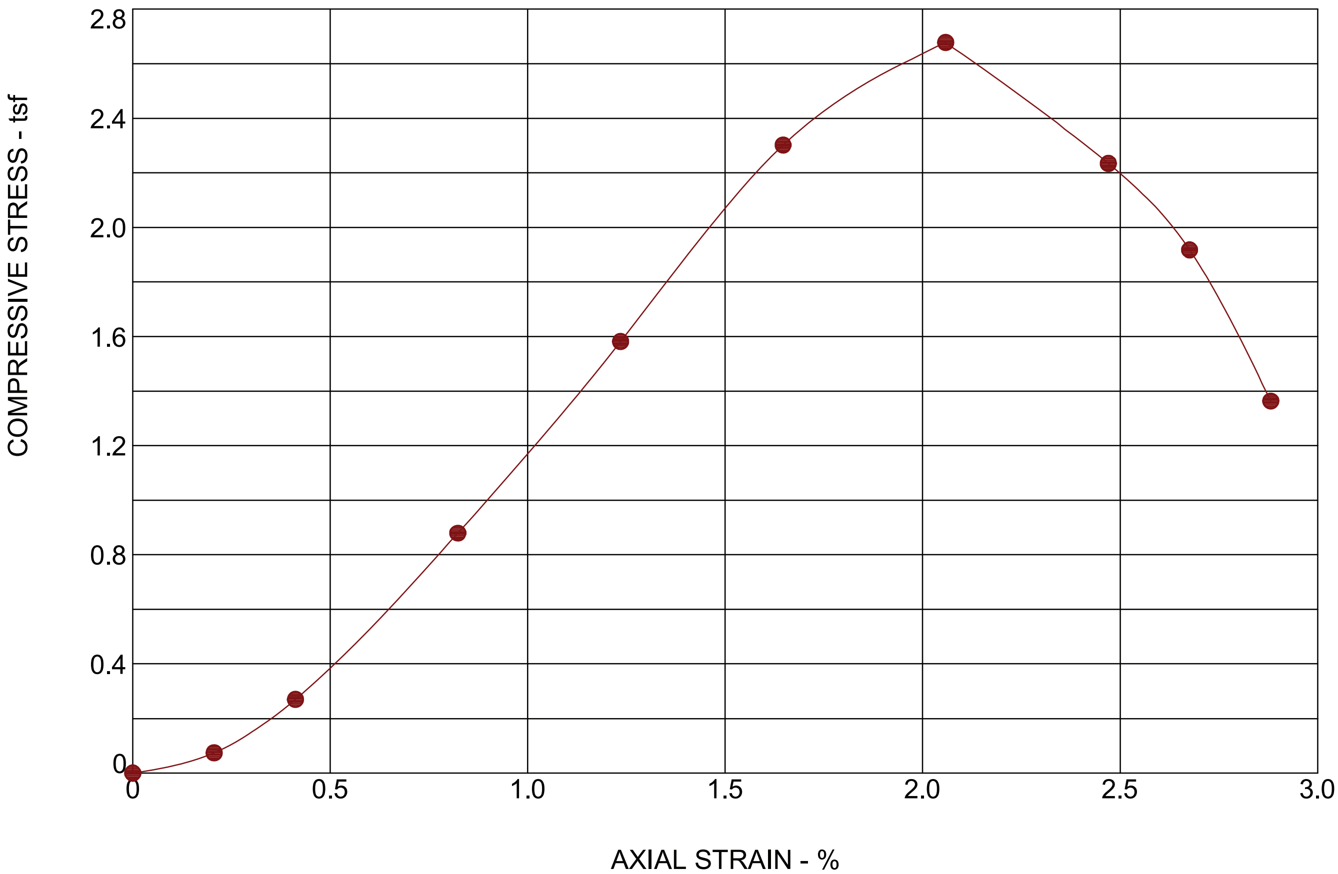
Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

PROJECT NUMBER: NB195036

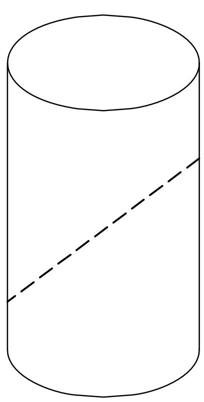
CLIENT: Maverik, Inc
Salt Lake City, UT

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	23
	Dry Density:	pcf	94
	Diameter:	in.	1.93
	Height:	in.	4.86
	Height / Diameter Ratio:		2.52
	Calculated Saturation:	%	
	Calculated Void Ratio:		
	Assumed Specific Gravity:		
	Failure Strain:	%	2.06
	Unconfined Compressive Strength	(tsf)	2.68
	Undrained Shear Strength:	(tsf)	1.34
	Strain Rate:	in/min	
	Remarks:		



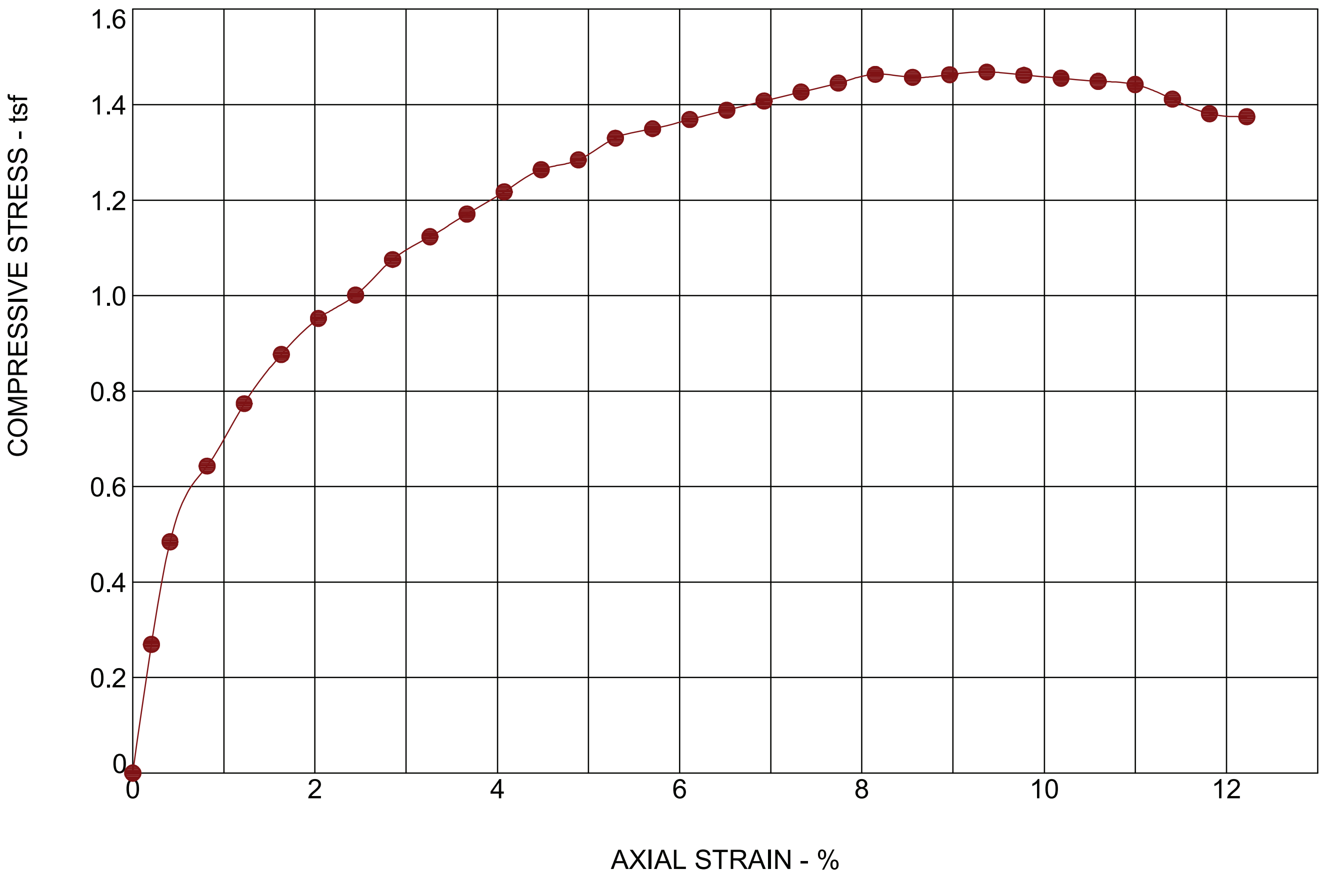
Failure Mode: Shear (dashed)

SAMPLE TYPE: CARS	SAMPLE LOCATION: B-2 @ 10 - 11.5 feet			
DESCRIPTION: Silt (ML)	LL	PL	PI	Percent < #200 Sieve

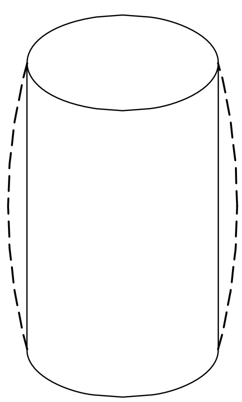
PROJECT: Maverik Fueling Station Sacramento	Terracon 50 Golden Land Ct, Ste 100 Sacramento, CA	PROJECT NUMBER: NB195036
SITE: 3855 Power Inn Road Sacramento, CA		CLIENT: Maverik, Inc Salt Lake City, UT

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	22
	Dry Density:	pcf	96
	Diameter:	in.	1.84
	Height:	in.	4.91
	Height / Diameter Ratio:		2.66
	Calculated Saturation:	%	
	Calculated Void Ratio:		
	Assumed Specific Gravity:		
	Failure Strain:	%	9.37
	Unconfined Compressive Strength	(tsf)	1.47
	Undrained Shear Strength:	(tsf)	0.73
	Strain Rate:	in/min	
	Remarks:		



Failure Mode: Bulge (dashed)

SAMPLE TYPE: CARS	SAMPLE LOCATION: B-5 @ 5 - 6.5 feet			
DESCRIPTION: LEAN CLAY with SAND (CL)	LL	PL	PI	Percent < #200 Sieve

PROJECT: Maverik Fueling Station
Sacramento

SITE: 3855 Power Inn Road
Sacramento, CA

Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA

PROJECT NUMBER: NB195036

CLIENT: Maverik, Inc
Salt Lake City, UT

SUMMARY OF LABORATORY RESULTS

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Corrosivity					Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits			pH	Resistivity (ohm-cm)	Water Soluble			
						LL	PL	PI			Salts (ppm)	Sulfates (ppm)	Chlorides (ppm)	
B-5	2	GP-GC							8.7	2910	35	99	35	2

REMARKS
1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.

PROJECT: Maverik Fueling Station Sacramento

SITE: 3855 Power Inn Road
Sacramento, CA

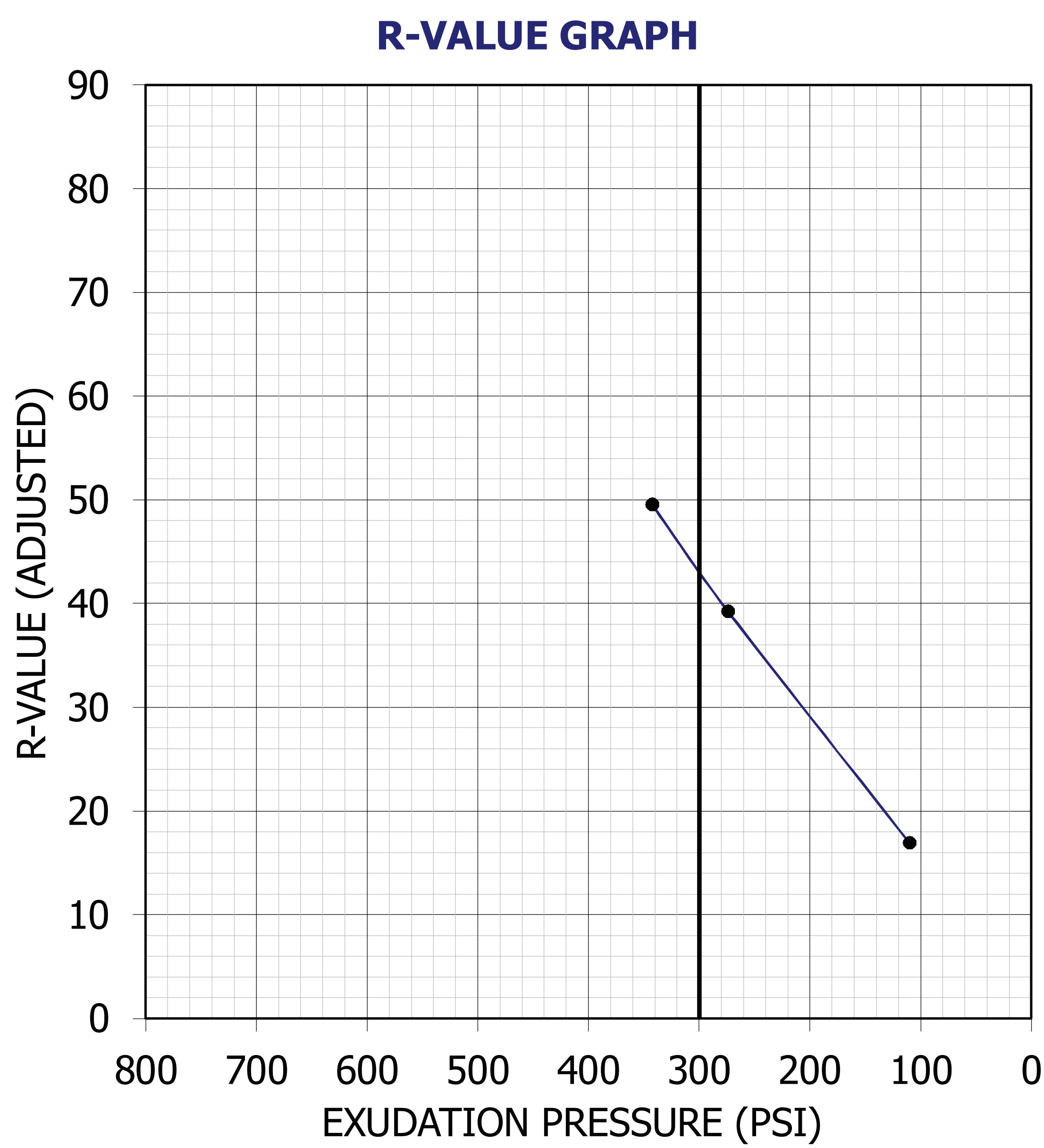
Terracon
50 Golden Land Ct, Ste 100
Sacramento, CA
PH. 916-928-4690 FAX. 916-928-4697

PROJECT NUMBER: NB195036

CLIENT: Maverik, Inc
Salt Lake City, UT

EXHIBIT: B-1

JOB NAME: Maverick
JOB #: NB195036
SAMPLE NUMBER: 1
Location: B-5
SAMPLE CLASSIFICATION: Silty Clay with Sand and Gravel



R-VALUE AT 300 PSI EXUDATION PRESSURE: 43

NOTES:

SUPPORTING INFORMATION

Contents:

General Notes
Unified Soil Classification System

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Maverik Fueling Station Sacramento ■ Sacramento, CA

May 22, 2019 ■ Terracon Project No. NB195036

Terracon GeoReport

SAMPLING

Modified California Ring Sampler

Standard Penetration Test

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
UC	**Unconfined Compressive Strength**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL		RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12

GRAIN SIZE TERMINOLOGY		PLASTICITY DESCRIPTION	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI $\geq$ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.