

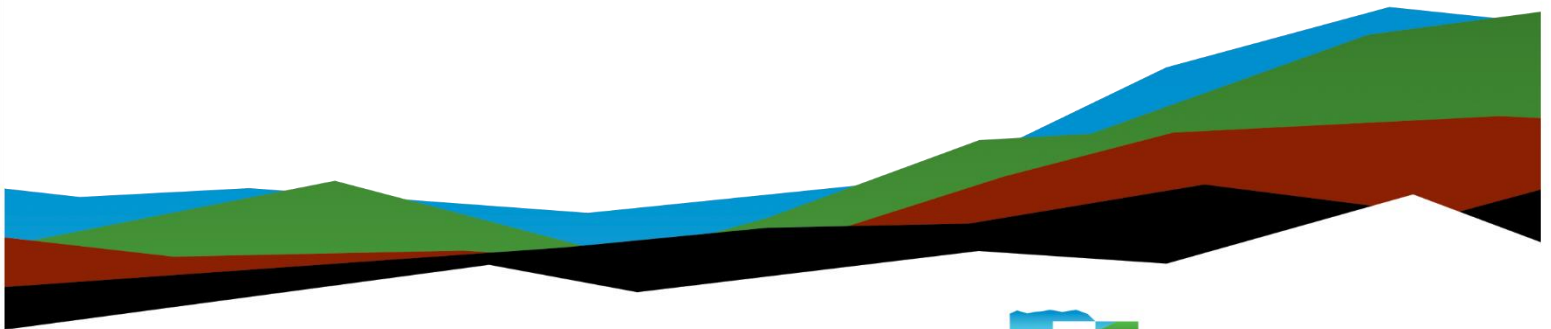
Yucca Valley Walmart Fuel Station

Geotechnical Engineering Report

May 7, 2024 | Terracon Project No. LA245053

Prepared for:

Kimley-Horn
1100 W Town and Country Road,
Suite 700
Orange, CA 92868



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May 7, 2024

Kimley-Horn
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Attn: Ryan Alvarez
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Re: Geotechnical Engineering Report
Yucca Valley Walmart Fuel Station
58501 Twenty Nine Palms Hwy.
Yucca Valley, San Bernardino County, CA
Terracon Project No. LA245053

Dear Mr. Alvarez:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. PLA245053 dated March 14, 2023 between Terracon and Kimley-Horn. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork, construction of floor slabs, underground storage tanks, pavements and the design and construction of foundations for the proposed fuel center.

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

Janna Valdez, E.I.T.

Staff Engineer



Joshua R. Morgan, P.E.

Regional Geotechnical Manager

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Exploration and Testing Procedures

Site Location and Exploration Plans

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Supporting Information

Note: This report was originally delivered in a web-based format. **Blue 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  Terracon logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed fuel station to be located at within the existing parking lot of a Walmart Supercenter at 58501 Twentynine Palms Hwy., Yucca Valley, San Bernardino County, CA. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Seismic site classification per California Building Code (CBC)
- Lateral Earth Pressures
- Site preparation and earthwork
- Foundation design and construction
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of test borings, laboratory testing, engineering analysis, and preparation of this report. The geotechnical engineering Scope of Services for our current scope of work included the following:

- Two (2) soil test borings to depths of 21.5, two (2) to approximately 16.5 feet, and two (2) to 6.5 feet below ground surface (bgs) in the proposed fuel station areas
- Corrosion testing on soil samples obtained from one (1) location

Drawings showing the site and boring locations are shown on the [Site Location](#) and [Exploration Plan](#), respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the [Exploration Results](#) section.

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	An email request for proposal was provided by Ryan Alvarez on March 7, 2024. The request included a conceptual site plan.
Project Description	The project includes a fuel station area with a footprint up to 1.2 acres in the northeast portion of an existing Walmart Supercenter parking lot.
Proposed Structure	The project includes a single-story fuel station serviced building with a footprint up to 1500 square feet (30x50 feet). The building will be slab-on-grade (non-basement). The project will also include the construction of a fuel station canopy (160 feet by 30 ft). The improvements will also include reconfiguration of drive lanes and landscape areas. A below grade fuel tank is also proposed.
Maximum Structural Loads	<p>Fuel Station Service Building Structural Load Data: We understand that the fuel service building will have dimensions of 1,500 square feet. The typical gravity load to an interior column is 12 kips. The estimated maximum gravity load that may occasionally occur due to severe live loading is 25 kips. Maximum column uplift force from wind is estimated at 15 kips. The light gauge steel stud wall gravity loads range from 0.5 to 1.0 kips per lineal foot. Estimated maximum uniform floor slab live load is 100 psf. Estimated maximum floor slab concentrated load is 1.0 kip.</p> <p>Fuel Station Canopy (typical for multi-column layouts) Structural Load Data: For the canopy, the isolated column loads consist of axial gravity and uplift loads in conjunction with shear and overturning moments. The typical gravity axial load to a canopy column is 20 kips. The estimated maximum gravity load that may occasionally occur due to severe live loading is 40 kips. Maximum column uplift force from wind is estimated at 25 kips. The estimated maximum shear load from wind is estimated at 8 kips. The estimated maximum overturning moment from wind is estimated at 120 kip-feet.</p>
Grading/Slopes	We anticipate that the field grade will follow the existing site grades with minimum grading required to bring the site to finish grade. The fuel tank is anticipated to be on the order of 15 feet below existing site grades.

Item	Description
Pavements	<p><u>Standard Duty Pavement:</u> Design life of 20 years based on a minimum ESAL (18 kip) load of 2,200, terminal serviceability = 2.0, reliability = 85%, initial serviceability = 4.2, standard deviation = 0.45 for flexible pavements and 0.35 for rigid pavements.</p> <p><u>Heavy Duty Pavement:</u> A design life of 20 years, based on a minimum ESAL (18 kip) load of 335,800, terminal serviceability = 2.0, reliability = 85%, initial serviceability = 4.2, standard deviation = 0.45 for flexible pavements and 0.35 for rigid pavements.</p>
Infiltration Systems	<p>The realignment of the storm drain line is included in the site plan and outfalls into an existing stormwater infiltration basin, therefore we did not include percolation testing for infiltration rates is not part of this project.</p>
Building Code	<p>2022 California Building Code (CBC)</p>

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

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	<p>The project is located at 58501 Twentynine Palms Hwy., Yucca Valley, San Bernardino County, CA.</p> <p>The proposed canopy portion of the site encompasses an approximate footprint of 1.2 acres. The coordinates of the approximate center of the site are 34.1340°N, 116.3833°W. See Site Location</p>
Existing Improvements	<p>The site is currently a parking lot for an existing Walmart shopping center. Existing improvements consist of paved parking and drive areas, hardscaping, and landscaping.</p>
Current Ground Cover	<p>Primarily asphalt pavements for parking and drive areas.</p>

Item	Description
Existing Topography	The site is relatively flat with an approximate elevation ranging from 3206 to 3210 feet (from Google Earth Pro™).

Geotechnical Characterization

Subsurface Conditions

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 the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the [Exploration Results](#) and the GeoModel can be found in the [Figures](#) attachment 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	Density/Consistency
01	Fill – Silty Sand	Medium dense to dense
02	Silty Sand or Poorly Graded Sand with Silt	Loose to dense

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. As noted in [General Comments](#), the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Lab Results

Laboratory tests were conducted on selected soil samples and the test results are presented in the [Exploration Results](#) section and on the boring logs. Atterberg limit test results indicate that the on-site soils generally non-plastic. A consolidation test indicated that the sandy soils encountered at an approximate depth of 2.5 feet and 5 feet bgs have a negligible collapse potential when saturated under normal footing loads of 2,000 psf. Direct shear testing on clayey soils encountered at 7.5 feet indicate soils

have an effective friction angle of approximately 35 degrees with apparent cohesion value of 170 psf. Maximum density/optimum moisture content testing conducted in accordance with ASTM D1557 (Modified Proctor) indicate that near surface soils tested have maximum dry density of 125.5 pounds per cubic feet (pcf) and optimum water content of 9 percent. R-value tests on soils tested in the surface indicate that the soils have an approximate R-value of 65.

Groundwater

The borings were advanced using a hollow-stem-auger technique that allow short term groundwater observations to be made while drilling. Groundwater seepage was not encountered within the maximum allowed drilling depth at the time of our field exploration. Groundwater conditions may be different at the time of construction.

According to data collected from the Water Data Library for the State of California from a nearby well, located approximately 0.7 miles southwest of the site in the State Well Number 01N06E31G001S, historic groundwater levels between July 3, 2008, and December 20, 2009 were recorded at greater than 100 feet bgs.¹

Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Seismic Site Class

The 2022 California Building Code (CBC) Seismic Design Parameters have been generated using the SEAOC/OSHPD Seismic Design Maps Tool. This web-based software application calculates seismic design parameters in accordance with ASCE 7-16, and 2022 CBC. The 2022 CBC requires that a site-specific ground motion study be performed

¹ Groundwater elevation was obtained from the Water Data Library for the State of California Well Name 01N06E31G001S

in accordance with Section 11.4.8 of ASCE 7-16 for Site Class D sites with a mapped S_1 value greater than or equal 0.2.

However, Section 11.4.8 of ASCE 7-16 includes an exception from such analysis for specific structures on Site Class D sites. The commentary for Section 11 of ASCE 7-16 (Page 534 of Section C11 of ASCE 7-16) states that “In general, this exception effectively limits the requirements for site-specific hazard analysis to very tall and or flexible structures at Site Class D sites.” Based on our understanding of the proposed structures, it is our assumption that the exception in Section 11.4.8 applies to the proposed structure. However, the structural engineer should verify the applicability of this exception.

Based on this exception, the spectral response accelerations presented below were determined using the site coefficients (F_a and F_v) from Tables 1613.2.3(1) and 1613.2.3(2) presented in Section 16.4.4 of the 2022 CBC.

Description	Value
2022 California Building Code Site Classification (CBC)¹	D ²
Site Latitude (°N)	34.1340
Site Longitude (°W)	116.3833
S_s Spectral Acceleration for a 0.2-Second Period	2.279
S_1 Spectral Acceleration for a 1-Second Period	0.813
F_a Site Coefficient for a 0.2-Second Period	1.0
F_v Site Coefficient for a 1-Second Period	1.7

1. Seismic site classification in general accordance with the *2022 California Building Code*.
2. The 2022 California Building Code (CBC) requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the 100-foot soil profile determination. Borings were extended to a maximum depth of 21.5 feet, and this seismic site class definition considers that similar or denser soils continue below the maximum depth of the subsurface exploration. Additional exploration to deeper depths would be required to confirm the conditions below the current depth of exploration.

Faulting and Estimated Ground Motions

The site is located in the southern California, which is a seismically active area. The type and magnitude of seismic hazards affecting the site are dependent on the distance to causative faults, the intensity, and the magnitude of the seismic event. As calculated using the USGS Unified Hazard Tool, the Eureka Peak fault, which is considered to have the most significant effect at the site from a design standpoint, has a maximum credible earthquake magnitude of 6.47 and is located approximately 2.21 kilometers from the site.

Based on the USGS Design Maps Summary Report, using the American Society of Civil Engineers (ASCE 7-16) standard, the peak ground acceleration (PGA_M) at the project site is expected to be 1.152g. Based on the USGS Unified Hazard Tool, the project site has a mean magnitude of 6.72. Furthermore, the site's parcel partially overlaps an Alquist Priolo (AP) Earthquake Fault Zone based on our review of the State Fault Hazard Maps.² However, the specific project site is not located within the AP Fault Zone.

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 the condition of loose sandy soils exists below groundwater. The California Geological Survey (CGS) has designated certain areas as potential liquefaction hazard zones.³ 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.

Based on our review of the CGS map, the project site has not been mapped for liquefaction hazard. However, according to the San Bernadino County Geologic Maps, the site's potential for liquefaction hazard is low. Furthermore, based on the anticipated depth to groundwater, liquefaction hazard potential at the site is considered low.⁴

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.

² California Geological Survey. <https://maps.conservation.ca.gov/cgs/informationwarehouse>.

³ California Geologic Survey, "Earthquake Zones of Required Investigation," <https://maps.conservation.ca.gov/cgs/EQZApp/app/>

⁴ San Bernardino County Zoning and Overlay Maps, Geologic Hazard Maps, <https://lus.sbcounty.gov/planning-home/zoning-and-overlay-maps/geologic-hazard-maps/>

Corrosivity Test Results Summary

Boring	Sample Depth (feet)	Soluble Sulfate (%)	Sulfides (ppm)	Soluble Chloride (mg/kg)	Red-Ox Potential (mV)	Total Salts (ppm)	Electrical Resistivity (Ω-cm)	pH
B-1	0-5	0.01	Nil	55	+733	286	4,020	8.22
B-3	0-5	0.01	0.01	95	+732	339	6,499	8.46

Results of soluble sulfate testing indicate samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 19.3.1.1 of the ACI Design Manual. Concrete should be designed in accordance with the exposure class S0 provisions of the ACI Design Manual, Section 318, Chapter 19.

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

The subsurface materials generally consisted of loose to dense sand with varying amounts silts extending to the maximum depth of the borings. Groundwater was not encountered within the maximum depths of exploration during or at the completion of drilling and is not expected to affect foundation construction on this site.

Our explorations indicate the site has approximately 5 feet of fill material across the site. The fill soils consisted of silty sand. The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils. Typically, fill soils should be removed and replaced prior to new construction. However, this fill was likely placed during the grading and relatively recent construction of the Wal-Mart shopping center and based on past history with Wal-Mart projects grading and inspection documentation likely exists. Furthermore, In-situ density tests measured from samples taken from our borings indicate that these soils are compacted to greater than 95% of the modified proctor value and are generally homogenous. It is our opinion that these soils received adequate compaction testing during placement. However, Terracon recommends that records of the testing and inspection of grading in this area be reviewed prior to start of construction of this outlying Fuel Facility.

The proposed structures may be supported on shallow spread footing foundations bearing on engineered fill, or on drilled shafts.. Engineered fill should extend to a minimum depth of 1 feet below the bottom of foundations, or the depth of undocumented fill, or 3 feet below existing grades, whichever is greater. The excavation

should be widened laterally at least 8 inches for each 12 inches of fill placed below footing base elevations. Grading for the proposed station should incorporate the limits of the overexcavation plus a lateral distance of 1 foot beyond the outside edge of perimeter footings, where possible. Overexcavation and replacement is not required for support of drilled shaft foundations.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the [Exploration Results](#)), engineering analyses, and our current understanding of the proposed project.

The [General Comments](#) section provides an understanding of the report limitations.

Earthwork

The following presents recommendations for site preparation, excavation, subgrade preparation, and placement of engineered fills on the project. The recommendations presented for the design and construction of foundations are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, foundation of bearing soils, and other geotechnical conditions exposed during construction of the project.

Site Preparation

Prior to placing fill, existing debris, pavements, and other deleterious materials should be removed from proposed foundation and pavement areas. Exposed surfaces within these areas should be free of mounds and depressions which could prevent uniform compaction. The site should be initially graded to create a relatively level surface to receive fill and provide for a relatively uniform thickness of fill beneath proposed structures.

Our explorations indicate the site has approximately 5 feet of fill materials across the site. The fill soils consisted of silty sand. The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils. Based on our review of Google Earth imagery, it is apparent that the fill materials are associated with the grading and development of the existing shopping center onsite between March 2013 and January 2015.

Terracon does not have any documentation to show if the grading operations were monitored or the fill materials have been compacted and tested. Typically fill soils should be removed and replaced prior to new construction. However, this fill was likely placed

during the grading and relatively recent construction of the Wal-Mart shopping center and based on past history with Wal-Mart projects grading and inspection documentation likely exists. Furthermore, In-situ density tests measured from samples taken from our borings indicate that these soils are compacted to greater than 95% of the modified proctor value and are generally homogenous. It is our opinion that these soils received adequate compaction testing during placement.. If such documentation exists, Terracon should be notified and the recommendations in this report may be appropriately modified or confirmed.

Evidence of utilities such as manhole covers and utility markings was observed onsite. Although no evidence underground facilities such as septic tanks, cesspools, or basements were observed during the site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Subgrade Preparation

The proposed service building and canopies may be supported by a shallow concrete foundation system bearing on engineered fill or drilled shafts.

The proposed structures may be supported by a shallow foundation supported on engineered fill extending to a minimum depth of 1 feet below the bottom of foundations, or 3 feet below existing grade, whichever is greater. Grading for the proposed station should incorporate the limits of the overexcavation plus a lateral distance of 1 feet beyond the outside edge of perimeter footings. Overexcavation and replacement is not required for support of drilled shaft foundations.

Subgrade soils beneath proposed exterior slabs should be scarified to a minimum depth of 12 inches, moisture conditioned, and compacted. The moisture content and compaction of subgrade soils should be maintained until slab or pavement construction.

All exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 10 inches, moisture conditioned as necessary, and compacted per the compaction requirements in this report. Compacted structural fill soils should then be placed to the proposed design grade and the moisture content and compaction of subgrade soils should be maintained until foundation construction.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable; however, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Excavation

We anticipate that excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Onsite soils consist of cohesionless sandy soils. Such soils have the tendency to cave and slough during excavations. Therefore, formwork may be needed for foundation excavations.

The walls of the proposed excavation should be shored or sloped in conformance with OSHA excavation and trench safety standards. If any excavation is extended to a depth of more than 20 feet, it will be necessary to have the side slopes designed by a professional engineer.

We recommend that the underground storage tanks be over-excavated by about 2 feet in plan area to provide adequate access around the excavation for underground storage tanks construction. The walls of the proposed excavation should be shored or sloped in conformance with OSHA excavation and trench safety standards. If any excavation is extended to a depth of more than 20 feet, it will be necessary to have the side slopes designed by a professional engineer.

Soils from the excavation should not be stockpiled higher than six 6 feet or within ten 10 feet of the edge of an open trench. Construction of open cuts adjacent to existing structures, including underground pipes, is not recommended within a 1½ H:1V plane extending beyond and down from the perimeter of the structure. Cuts that are proposed within five 5 feet of light standards, other utilities, underground structures, and pavement should be provided with temporary shoring.

Onsite soils consist of cohesionless sandy soils. Therefore, OSHA Soil Type C should be utilized for sloping considerations and on-site soils shall be sloped at a minimum of 1.5H:1V. Furthermore, benching is not permitted.

It may be necessary for the contractor to retain a geotechnical engineer to monitor the soils exposed in all excavations and provide engineering services for slopes. This will provide an opportunity to monitor the soils encountered and to modify the excavation slopes as necessary. It also offers an opportunity to verify the stability of the excavation slopes during construction

Individual contractors are responsible for designing and constructing stable, temporary excavations. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

Fill Material and Placement

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than six inches in size. Pea gravel or other open-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
- foundation backfill
- pavement areas

Imported soils for use as fill material within proposed structure areas should conform to low volume change materials as indicated in the following specifications:

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

*ASTM D4829

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.

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.

Compaction Requirements

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

<u>Material Type and Location</u>	<u>Per the Modified Proctor Test (ASTM D 1557)</u>		
	<u>Minimum Compaction Requirement</u>	<u>Range of Moisture Contents for Compaction Above Optimum</u>	
		<u>Minimum</u>	<u>Maximum</u>
On-site soils and low volume change imported fill:			
Beneath foundations:	90%	-1%	+3%
Beneath interior slabs:	90%	-1%	+3%
Fill greater than 5 feet in depth:	95%	-1%	+3%
Beneath pavements:	95%	-1%	+3%
Aggregate base (beneath pavements):	95%	-1%	+3%
Utility trenches*:	90%	-1%	+3%
Exterior Slabs:	90%	-1%	+3%
Bottom of excavation receiving fill:	90%	-1%	+3%
Miscellaneous backfill:	90%	-1%	+3%
*upper 12 inches should be compacted to 95% within structural areas. Low-volume change imported soils should be used in structural areas			

Utility Trench Backfill

We anticipate that the on-site soils will provide suitable support for underground utilities and piping that may be installed. Any soft and/or unsuitable material encountered at the bottom of excavations should be removed and be replaced with an adequate bedding material.

A non-expansive granular material with a sand equivalent greater than 30 should be used for bedding and shading of utilities, unless allowed or specified otherwise by the utility manufacturer.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill

discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

Grading and Drainage

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

Planters and other surface features which could retain water in areas adjacent to the building or pavements should be sealed or eliminated. In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a minimum grade of approximately 5 percent for at least 10 feet from perimeter walls. Backfill against footings, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration. We recommend a minimum horizontal setback distance of 10 feet from the perimeter of any structure and the high-water elevation of the nearest storm-water retention basin.

Roof and canopy drainage should discharge into splash blocks or extensions when the ground surface beneath such features is not protected by exterior slabs or paving. Sprinkler systems and landscaped irrigation should not be installed within 5 feet of foundation walls.

Exterior Slab Design and Construction

Exterior slabs-on-grade, exterior architectural features, and utilities founded on, or in backfill may experience some movement due to the volume change of the backfill. To reduce the potential for damage caused by movement, we recommend:

- minimizing moisture increases in the backfill;
- controlling moisture-density during placement of backfill;
- using designs which allow vertical movement between the exterior features and adjoining structural elements;
- placing effective control joints on relatively close centers

Earthwork Construction Considerations

Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of pavements. Construction traffic over the completed subgrades should be avoided to the extent practical. 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 desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to pavement construction.

Should unstable subgrade conditions develop stabilization measures will need to be employed. Stabilization measures may include placement of aggregate base and multi-axial geogrid. Use of lime, fly ash, kiln dust or cement could also be considered as a stabilization technique. Laboratory evaluation is recommended to determine the effect of chemical stabilization on subgrade soils prior to construction.

We recommend that the earthwork portion of this project be completed during extended periods of dry weather if possible. If earthwork is completed during the wet season (typically November through April) it may be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork operations may require additional mitigative measures beyond that which would be expected during the drier summer and fall months. This could include diversion of surface runoff around exposed soils and draining of ponded water on the site. Once subgrades are established, it may be necessary to protect the exposed subgrade soils from construction traffic.

Based on our understanding of the project, we anticipate that excavations up to 15 feet below existing grade for the installation of the underground storage tanks are planned for this project. The sides of below grade structure excavations may either be sloped or formed with vertical cuts. For vertical sided excavations greater than 5 feet in depth, the excavations will require the use of shoring, bracing or some form of retention to prevent sloughing and caving of the soil into the excavation.

As a safety measure, no equipment should be operated within 5 feet of the edge of the excavation and no materials should be stockpiled within 10 feet of the excavation. Excavations should not approach closer than a distance equal to the depth of excavation from existing structures/facilities without some form of protection for the facilities. Proper berming or ditching should be performed to divert any surface runoff away from the excavation.

The individual contractor(s) is responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. Excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current Occupational Safety and Health Administration (OSHA) excavation and trench safety standards.

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 geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proof-rolling, placement and compaction of controlled compacted fills, backfilling of excavations to the completed subgrade.

The exposed subgrade and each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended 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. Where not specified by local ordinance, one density and water content test should be performed for every 50 linear feet of compacted utility trench backfill. This testing frequency criteria may be adjusted during construction as specified by the geotechnical engineer of record.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, 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

We anticipate that the proposed service building and canopies may be supported on spread footings.

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

Shallow Foundation Design Recommendations

Item	Description
Foundation System	Spread footings
Maximum Net Allowable Bearing Pressure¹	3,000 psf up to 4 feet wide 2,500 psf up to 6 feet wide 2,000 psf up to 10 feet wide
Required Bearing Stratum²	Engineered fill extending to a minimum of 1 feet below the bottom of foundations, or the depth of undocumented fill, or 3 feet below existing grade, whichever is greater.
Ultimate Passive Resistance³	375 pcf
Ultimate Coefficient of Sliding Friction⁴	0.34
Minimum Embedment Below Finished Grade⁵	18 inches
Minimum Dimensions	Columns: 24 inches Walls: 18 inches
Estimated Total Settlement from Structural Loads	About 1 inch
Estimated Differential Settlement^{2,6}	About 1/2 of total settlement over a horizontal distance of 40 feet

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.
2. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in [Earthwork](#).
3. 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. Assumes no hydrostatic pressure.
4. 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. A factor of safety of 1.5 is recommended.
5. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure
6. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.

Settlement calculations were performed utilizing Westergaard and Hough's methods⁵ to estimate the static settlement for various foundations widths with an allowable settlement of 1-inch.

Finished grade is defined as the lowest adjacent grade within five feet of the foundation for perimeter (or exterior) footings.

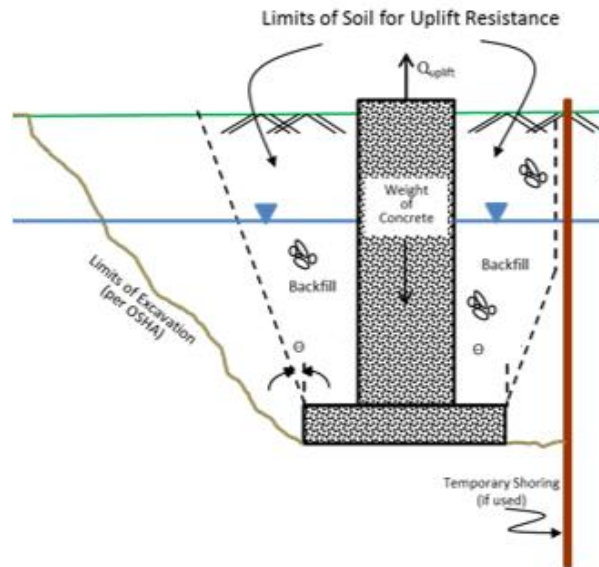
The allowable foundation bearing pressure applies to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of foundation concrete below grade may be neglected in dead load computations.

Foundation should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendation will be required.

Design Parameters – Overturning and Uplift Loads

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, θ , of 20 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 120 pcf should be used for the backfill.

⁵ FHWA Geotechnical Engineering Circular No. 6 – Shallow Foundations, FHWA – SA-02-054



Foundations subject to overturning loads should be sized to maintain the entire foundation area in contact with the bearing surface during the load event. This condition requires that the load eccentricity be maintained in the central third of the foundation (e.g., $e < b/6$), and may require foundation widening or additional foundation weight beyond that provided by proportioning for uplift alone.

Foundation Construction Considerations

Finished grade is defined as the lowest adjacent grade within five feet of the foundation for perimeter (or exterior) footings.

The allowable foundation bearing pressure applies to dead loads plus design live load conditions. The design bearing pressure may be increased by one-third when considering total loads that include wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

Deep Foundations

Drilled Shaft Design Recommendations

Proposed canopies may be supported on drilled shafts. Total required embedment of the drilled shaft should be determined by the structural engineer based on structural loading and parameters provided in this report.

Drilled Shaft Axial Loading

Allowable skin friction and total capacity charts are attached to our [Supporting Information](#) section at the end of this report. The values presented for allowable side friction and end bearing include a factor of safety of 2.5.

Drilled piers 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 piers in a group versus the capacity calculated using the perimeter and base of the pier group acting as a unit. The lesser of the two capacities should be used in design.

The allowable uplift capacities should only be based on the side friction of the shaft; however, the weight of the foundation should be added to these values to obtain the actual allowable uplift capacities for drilled shafts. Tensile reinforcement should extend to the bottom of shafts subjected to uplift loading.

Drilled Shaft Lateral Loading

Based on our review of the subsurface conditions in the area of the proposed hydrogen station, our laboratory testing, and the Standard Penetration Test (SPT) results, engineering properties have been estimated for the soils conditions as shown in the following table. Due to potential for disturbance within the upper soils around the shaft, lateral and axial capacity of soils within the upper 2 feet should be neglected.

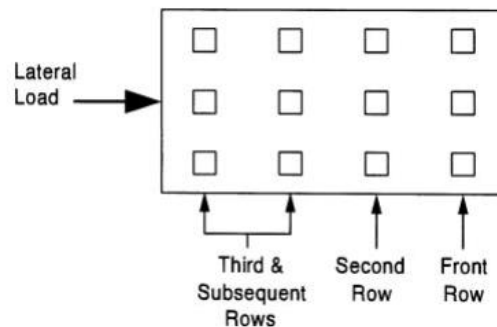
Recommended geotechnical parameters for lateral load analyses by others of drilled shaft foundations have been developed for use in the LPILE computer program. The following table summarizes input values for use in LPILE analyses. LPILE estimated values of k_h may be used. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included with the parameters.

Stratigraphy ¹		L-Pile Soil Model	ϕ^2	γ' (pcf) ²
Layer	Depth Below Finished Grade (feet)			
1	2	Sand	34	120
	5			
2	5	Sand	30	110
	20			

1. See Subsurface Profile in [Geotechnical Characterization](#) for more details on Stratigraphy.
2. Definition of Terms:
3. ϕ : Internal friction angle
4. γ' : Effective unit weight
5. Default K and E50 values may be utilized.

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.

When piers are used in groups, the lateral capacities of the piers in the second, third, and subsequent rows of the group should be reduced as compared to the capacity of a single, independent pier. Guidance for applying p-multiplier factors to the p values in the p-y curves for each row of pier foundations within a pier group are as follows:



1. Front row: $P_m = 0.8$

2. Second row: $P_m = 0.4$
3. Third and subsequent row: $P_m = 0.3$

For the case of a single row of piers supporting a laterally loaded grade beam, group action for lateral resistance of piers would need to be considered when spacing is less than five pier diameters (measured center-to-center). However, spacing closer than $3D$ (where D is the diameter of the pier) is not recommended due to the potential for the installation of a new pier disturbing an adjacent installed pier, likely resulting in axial capacity reduction.

Drilled Shaft Construction Considerations

Drilling to design depths should be possible with conventional single flight power augers. Due to presence of granular soils, caving of soils within the drilled shaft excavations should be anticipated. Temporary steel casing will likely be required to properly drill and clean shafts prior to concrete placement.

We do not anticipate drilled shafts to extend below the depth of groundwater. However, if foundation concrete cannot be placed in dry conditions, a tremie should be used for concrete placement. If shafts extend below the depth of groundwater, a tremie should be used for concrete placement.

Drilled shaft foundation concrete should be placed immediately after completion of drilling and cleaning. If foundation concrete cannot be placed in dry conditions, a tremie should be used for concrete placement. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes.

In the event drilled hole walls slough during drilling, temporary steel casing may be required to properly drilled shafts prior to concrete placement. We recommend the use of slurry drilling methods with polymers method to keep the solids in suspension during the drilling. Drilled shaft foundation concrete should be placed within 6 inches of the shaft base of the slurry-filled excavation immediately after completion of drilling and cleaning. The tremie should remain inserted several feet into the fresh concrete as it displaces the slurry upward and until placement is complete. The slurry should have a sand content no greater than 1% at the time concrete placement commences. The maximum unit weight of the slurry should be established in consultation with Terracon.

As an alternative to temporary casing, the shaft excavation may be backfilled with a slurry mix in order to help stabilize sloughing sidewalls of the excavation, allowed to dry, and re-drilled through the backfill. The slurry mix design should be submitted to the Geotechnical Engineer for review and approval

If casing is used for drilled shaft construction, it should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete to prevent infiltration of

water or the creation of voids in shaft concrete. Shaft concrete should have a relatively high fluidity when placed in cased shaft holes or through a tremie. Shaft concrete with slump in the range of 6 to 8 inches is recommended.

Closely spaced shafts should be drilled and filled alternatively, allowing the concrete to set at least eight hours before drilling the adjacent shaft. All excavations should be filled with concrete as soon after drilling as possible. In no event should shaft holes be left open overnight.

Formation of mushrooms or enlargements at the tops of shafts should be avoided during shaft drilling. If mushrooms develop at the tops of the shafts during drilling, sono-tubes should be placed at the shaft tops to help isolate the shafts.

Free-fall concrete placement in drilled piers will only be acceptable if provisions are taken to avoid striking the concrete on the sides of the hole or reinforcing steel. The use of a bottom-dump hopper, or an "elephant's trunk" discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

We recommend that all drilled shaft installations be observed on a full-time basis by an experienced geotechnical engineer in order to evaluate that the soils encountered are consistent with the recommended design parameters. If the subsurface soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required. The Geotechnical Engineer should observe the installation of drilled piers to verify the soil conditions and the diameter and depth of piers. Drilled piers should be constructed true and plumb.

Drilled pier end bearing surfaces must be thoroughly cleaned prior to concrete placement. A representative of the Geotechnical Engineer should inspect the bearing surface and foundation pier configuration. If the subsurface soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

The contractor should check for gas and/or oxygen deficiency before any workers enter the excavation for observation and manual cleanup. All necessary monitoring and safety precautions as required by OSHA, State or local codes should be strictly enforced.

Floor Slabs

Description	Recommendation
Interior floor system	Slab-on-grade concrete

Description	Recommendation
Floor slab support	Engineered fill extending to a minimum depth of 1 foot below the bottom of foundations, or to the depth of undocumented fill, or 3 feet below existing grade whichever is greater.
Subbase	Minimum 4-inches of Aggregate Base
Modulus of subgrade reaction	200 pounds per square inch per inch (psi/in) (The modulus was obtained based on estimates obtained from NAVFAC 7.1 design charts). This value is for a small loaded area (1 Sq. ft or less) such as for forklift wheel loads or point loads and should be adjusted for larger loaded areas.

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.

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.

Lateral Earth Pressures

Design Parameters

Recommended equivalent fluid pressures for cantilever shoring based on onsite native soils are as follows:

Item	Recommended Value ^{1,2}
Active Case	38 psf/ft
Passive Case³	375 psf/ft
At-Rest Case	58 psf/ft

1. The values are based on engineered fill materials used as backfill.
2. Uniform, horizontal backfill, compacted to at least 90% of the ASTM D1557 maximum dry density, rendering a maximum unit weight of 120 pcf.
3. Use of passive earth pressures require the sides of the excavation for the foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the foundation forms be removed and compacted engineered fill be placed against the vertical foundation face

The lateral earth pressures herein do not include any factor of safety and are not applicable for submerged soils/hydrostatic loading. Additional recommendations may be necessary if such conditions are to be included in the design.

The design of retaining structures and shoring systems should consider surcharge loads imposed on the foundations. In addition, the design should take into consideration new and existing footing loads and anticipated vehicular loads in the vicinity of the proposed basement walls. In general, surcharge loads should be considered where they are located within a horizontal distance behind the wall equal to the height of the wall.

Surcharge loads acting at the top of the wall should be applied to the wall over the backfill as a uniform pressure over the entire wall height and should be added to the static earth pressures. Surcharge stresses due to point loads, line loads, and those of limited extent, such as compaction equipment, should be evaluated using elastic theory.

For the design of braced shoring, we recommend such shoring be designed using a rectangular-shaped distribution of lateral earth pressure of 23H psf, where H (in units of feet) is the height of the braced shoring. Surcharge loads from the drive lanes should be also considered in the design of the shoring.

Fill against foundation and retaining walls should be compacted to densities specified in the Earthwork section of this report. Compaction of each lift adjacent to walls should be

accomplished with hand-operated tampers or other lightweight compactors. Over-compaction may cause excessive lateral earth pressures on the wall.

The design of the shored excavation should be performed by an engineer knowledgeable and experienced with the on-site soil conditions. The contractor should be aware that slope height, slope inclination or excavation depths should in no case exceed those specified in local, state or federal safety regulations, e.g., OSHA Health and Safety Standards for Excavation, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if not followed, the owner or the contractor could be liable for substantial penalties.

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.

Pavement Design Parameters

Asphalt concrete the Portland cement concrete pavement sections thickness was based on lab testing results. The results of R-value testing exceeded the maximum value of 50 recommended in the Caltrans method for design of flexible pavements, therefore an R-value of 50 was used in the following design. R-value testing may be required prior to pavement construction to verify the design R-value.

The structural sections are predicated upon proper compaction of the utility trench backfills and the subgrade soils as prescribed by in [Earthwork](#), with the upper 12 inches of subgrade soils and all aggregate base material brought to a minimum relative compaction of 95 percent in accordance with ASTM D 1557 prior to paving. The aggregate base should meet Caltrans requirements for Class 2 base.

Assuming the pavement subgrades will be prepared as recommended within this report, the following pavement sections should be considered minimums for this project for the traffic loading listed in the table below.

Pavement calculations are based on geotechnical specifications provided by Wal-Mart using the AASHTO 1993 method. Design criteria for both standard and heavy-duty pavements are based on 18-kip Equivalent Single Axle Load (ESAL) values as shown in

the tables below, using a terminal serviceability of 2.0, reliability of 85%, initial serviceability of 4.2, and a standard deviation of 0.45 for flexible pavements and 0.35 for rigid pavements. If more specific traffic information becomes available for the site, we should be contacted to reevaluate the pavement calculations.

Pavement Section Thicknesses

The following table provides our opinion of minimum thickness for AC sections:

Asphaltic Concrete Design

Layer	Thickness (inches)	
	Standard Duty ²	Heavy Duty ³
AC ^{1, 3}	3	3
Aggregate Base ¹	4	6

1. All materials should meet the Caltrans Standard Specifications for Highway Construction.
2. 2,200 ESAL
3. 335,800 ESAL
4. Flexible pavement structural sections were calculated utilizing the AASHTO 1993 method.

The following table provides our estimated minimum thickness of PCC pavements.

Portland Cement Concrete Design

Layer	Thickness (inches)	
	Standard Duty ²	Heavy Duty ³
PCC ¹	5	6
Aggregate Base ¹	4	4

1. All materials should meet the Caltrans Standard Specifications for Highway Construction.
2. 2,200 ESAL
3. 335,800 ESAL
4. Flexible pavement structural sections were calculated utilizing the AASHTO 1993 method.

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.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. 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. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation 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:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay 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. 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 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 effect 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. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. 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.

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Yucca Valley Walmart Fuel Station | Yucca Valley, San Bernardino County, CA
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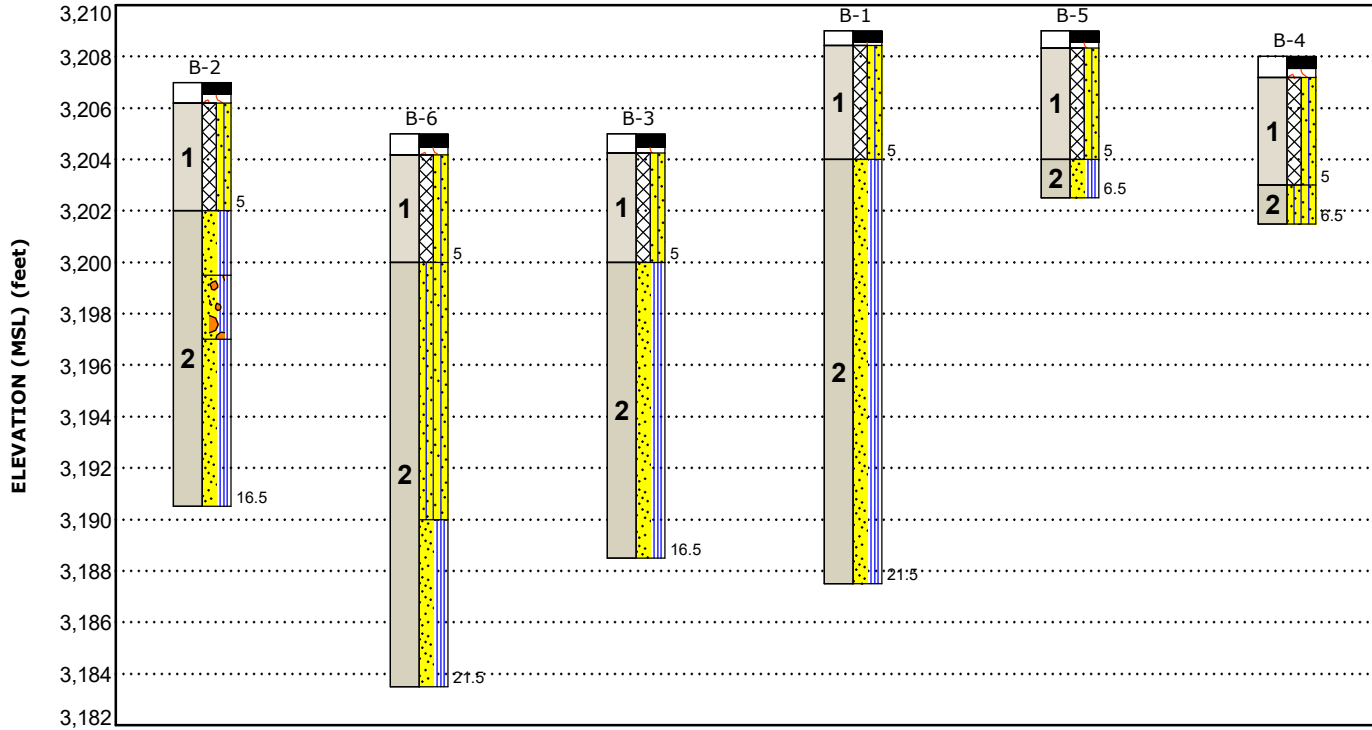


Figures

Contents:

GeoModel

GeoModel



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	Legend	
1	Fill - SM	Fill - Silty Sand	Asphalt	Aggregate Base Course
2	SP-SM / SM	Poorly Graded Sand with Silt / Silty Sand	Silty Sand	Poorly-graded Sand with Silt
			Poorly-graded Sand with Silt and Gravel	

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.

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Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
1	20 feet	Proposed Underground Storage Tanks
1	20 feet	Proposed Service Building
2	15 feet	Proposed Fuel Station – Canopy Area
1	5 feet	Proposed pavement area

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ± 10 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings in the proposed fuel station with a truck-mounted drill rig using continuous hollow stem flight. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Test samples were collected during drilling in general accordance with the appropriate ASTM methods using Standard Penetration Testing (SPT) and sampling using either standard split-spoon or Modified California samplers. A 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 was recorded as the Standard Penetration Test (SPT) resistance value, also referred to as N-values. The N-values are indicated on the boring logs at the test depths. The samples were placed in appropriate containers, taken to our soil laboratory for testing, and classified by a geotechnical engineer.

For safety purposes, all borings were backfilled with auger cuttings after their completion.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. Groundwater was not encountered during exploration.

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 Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field

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logs included visual classifications of the materials observed 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 engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Dry Unit Weight
- Atterberg Limits
- Compaction
- Swell Consolidation Test
- Direct Shear
- Corrosivity
- R-value

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

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Site Location and Exploration Plans

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

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Site Location



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

MAP PROVIDED BY MICROSOFT BING MAPS

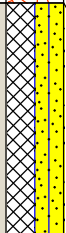
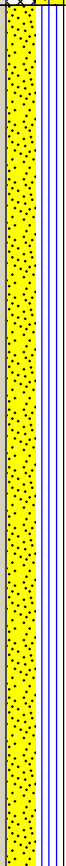
Exploration and Laboratory Results

Contents:

Boring Logs (B-1 through B-6)
Atterberg Limits
Compaction Graph
Swell Consolidation Test Graph (2 pages)
Direct Shear Graph
Corrosion Results
R-value Results

Note: All attachments are one page unless noted above.

Boring Log No. B-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 34.1338° Longitude: -116.3835°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
									LL-PL-PI	Percent Fines
		Depth (Ft.) 0.4 ASPHALT , 5" thickness								
		0.6 AGGREGATE BASE COURSE , 2" thickness FILL - SILTY SAND (SM) , brown								
1		dense				18-17-13 N=30	4.7		NP	14
		5.0 POORLY GRADED SAND WITH SILT (SP-SM) , brown, medium dense	5			6-10-13	2.0	109		
						5-7-9 N=16				
		loose	10			9-8-10	3.6	112		
						5-8-10 N=18				
2		medium dense	15							
			20			11-15-19	2.5	116		
		Boring Terminated at 21.5 Feet								

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.
 The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Notes
 The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Water Level Observations
 The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Drill Rig
CME-75
Hammer Type
Automatic
Driller
2R Drilling

Advancement Method
8" Hollow Stem Auger

Logged by
TA

Abandonment Method
Boring backfilled with Auger Cuttings
Surface capped with asphalt

Boring Started
04-02-2024
Boring Completed
04-02-2024

Boring Log No. B-2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 34.1340° Longitude: -116.3837°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
									LL-PL-PI	Percent Fines
		Depth (Ft.)								
		0.5 ASPHALT , 5.5" thickness								
		0.8 AGGREGATE BASE COURSE , 4" thickness								
1		FILL - SILTY SAND (SM) , brown dense								14
		5.0								
		POORLY GRADED SAND WITH SILT (SP-SM) , brown, loose	5			18-29-45	5.9	122		
		7.5				4-4-5 N=9				
		POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM) , brown, medium dense				15-25-23	4.1	119		
		10.0								
2		POORLY GRADED SAND WITH SILT (SP-SM) , trace gravel, brown, dense medium dense	10			8-12-27 N=39				6
		16.5								
		Boring Terminated at 16.5 Feet	15			7-12-10	3.8	119		

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.

The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Notes

The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Water Level Observations
Groundwater not encountered

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Advancement Method
8" Hollow Stem Auger

Logged by
TA

Abandonment Method
Boring backfilled with Auger Cuttings
Surface capped with asphalt

Boring Started
04-02-2024

Boring Completed
04-02-2024

Boring Log No. B-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 34.1340° Longitude: -116.3834°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
									LL-PL-PI	Percent Fines
		Depth (Ft.)								
	ASPHALT	0.5 ASPHALT , 6" thickness								
	AGGREGATE BASE COURSE	0.8 AGGREGATE BASE COURSE , 3" thickness								
1	FILL - SILTY SAND (SM)	FILL - SILTY SAND (SM) , brown medium dense				13-25-29	4.7	120		
		5.0	5			3-4-5 N=9			NP	
	POORLY GRADED SAND WITH SILT (SP-SM)	POORLY GRADED SAND WITH SILT (SP-SM) , brown, loose				6-9-8	3.7	106		
2	SAND	SAND medium dense				3-4-5 N=9				
		16.5	15			7-11-14	2.1	111		
		Boring Terminated at 16.5 Feet								

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.

The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Notes

The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Water Level Observations
Groundwater not encountered

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Advancement Method
8" Hollow Stem Auger

Logged by
TA

Abandonment Method
Boring backfilled with Auger Cuttings
Surface capped with asphalt

Boring Started
04-02-2024

Boring Completed
04-02-2024

Boring Log No. B-4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 34.1338° Longitude: -116.3833°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
									LL-PL-PI	Percent Fines
		Depth (Ft.)								
	0.5	ASPHALT , 5.5" thickness								
	0.8	AGGREGATE BASE COURSE , 4" thickness								
1		FILL - SILTY SAND (SM) , brown dense				23-38-43	5.9	122		
		5.0								
2		SILTY SAND (SM) , brown, medium dense	5			10-11-15	2.9	110		
		6.5								
Boring Terminated at 6.5 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.</p>	<p>Water Level Observations Groundwater not encountered</p>	<p>Drill Rig CME-75</p> <p>Hammer Type Automatic</p> <p>Driller 2R Drilling</p>
<p>Notes</p> <p>The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.</p>	<p>Advancement Method 8" Hollow Stem Auger</p> <p>Abandonment Method Boring backfilled with Auger Cuttings Surface capped with asphalt</p>	<p>Logged by TA</p> <p>Boring Started 04-02-2024</p> <p>Boring Completed 04-02-2024</p>

Boring Log No. B-5

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 34.1336° Longitude: -116.3835°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
									LL-PL-PI	Percent Fines
		Depth (Ft.)								
	0.4	ASPHALT , 5" thickness								
	0.7	AGGREGATE BASE COURSE , 3" thickness								
1	5.0	FILL - SILTY SAND (SM) , brown dense				32-46-40	6.6	122		
2	6.5	POORLY GRADED SAND WITH SILT (SP-SM) , brown, medium dense	5			13-11-11	2.6	107		
		Boring Terminated at 6.5 Feet								

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.</p>	<p>Water Level Observations Groundwater not encountered</p>	<p>Drill Rig CME-75</p> <p>Hammer Type Automatic</p> <p>Driller 2R Drilling</p>
<p>Notes</p> <p>The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.</p>	<p>Advancement Method 8" Hollow Stem Auger</p> <p>Abandonment Method Boring backfilled with Auger Cuttings Surface capped with asphalt</p>	<p>Logged by TA</p> <p>Boring Started 04-02-2024</p> <p>Boring Completed 04-02-2024</p>

Boring Log No. B-6

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 34.1342° Longitude: -116.3835°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	
									LL-PL-PI	Percent Fines
		Depth (Ft.)								
	0.5	ASPHALT , 6" Thickness								
	0.8	AGGREGATE BASE COURSE , 4" thickness								
1		FILL - SILTY SAND (SM) , brown medium dense	5.0		7-11-13 N=24					
2		SILTY SAND (SM) , brown, medium dense loose	10.0		9-10-10	3.7	113			10
		POORLY GRADED SAND WITH SILT (SP-SM) , brown, medium dense	15.0		3-3-3 N=6					
		POORLY GRADED SAND WITH SILT (SP-SM) , brown, medium dense	20.0		5-7-9	4.1	111			
		POORLY GRADED SAND WITH SILT (SP-SM) , brown, medium dense	21.5		3-5-5 N=10					6
		Boring Terminated at 21.5 Feet			7-8-11	3.3	114			

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.

The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Notes

The estimated depth of fill should not be considered exact due to the similarity of lithology, color, and densities of the graded materials and native soils.

Water Level Observations
Groundwater not encountered

Drill Rig
CME-75

Hammer Type
Automatic

Driller
2R Drilling

Advancement Method
8" Hollow Stem Auger

Logged by
TA

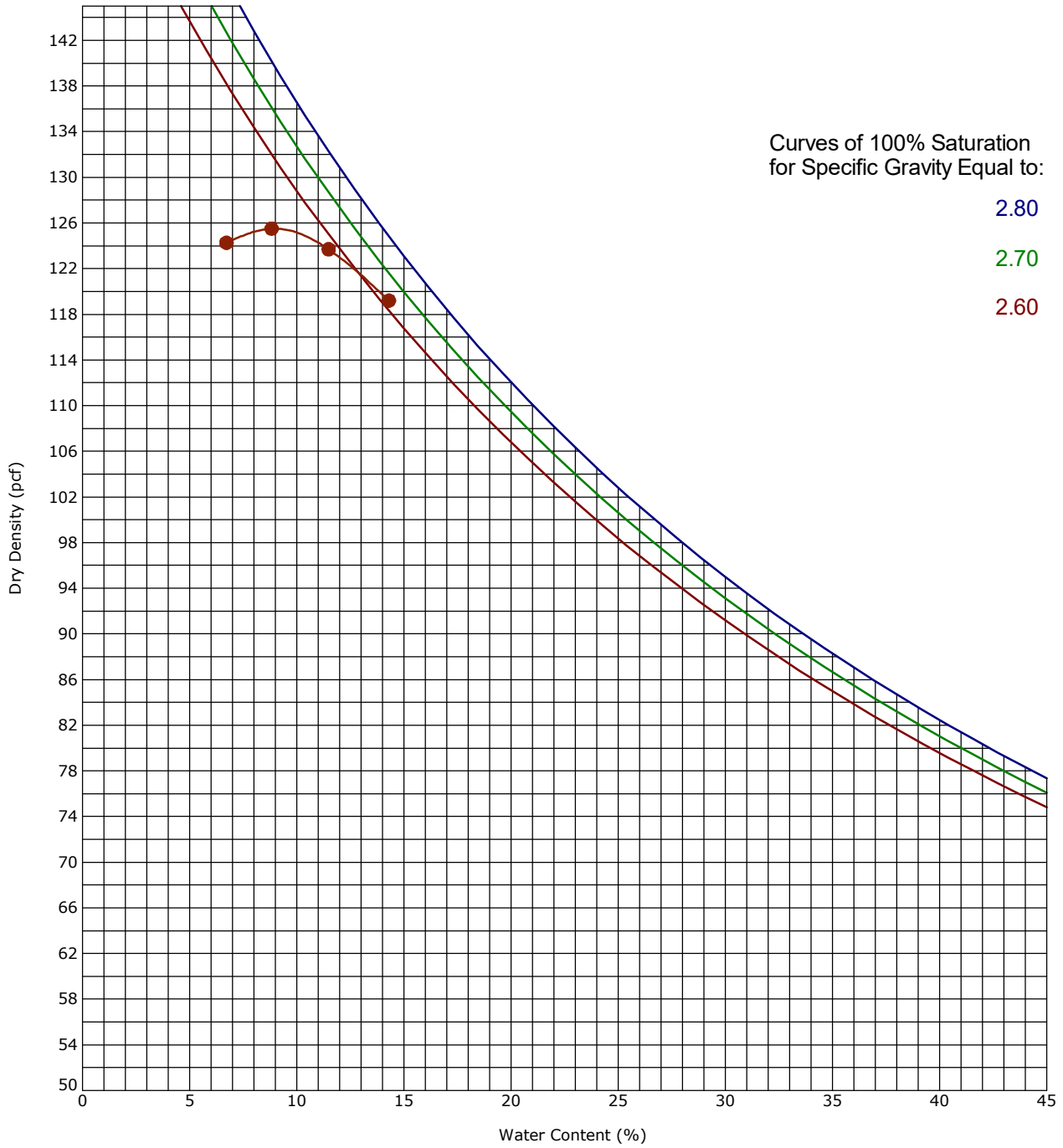
Abandonment Method
Boring backfilled with Auger Cuttings
Surface capped with asphalt

Boring Started
04-02-2024

Boring Completed
04-02-2024

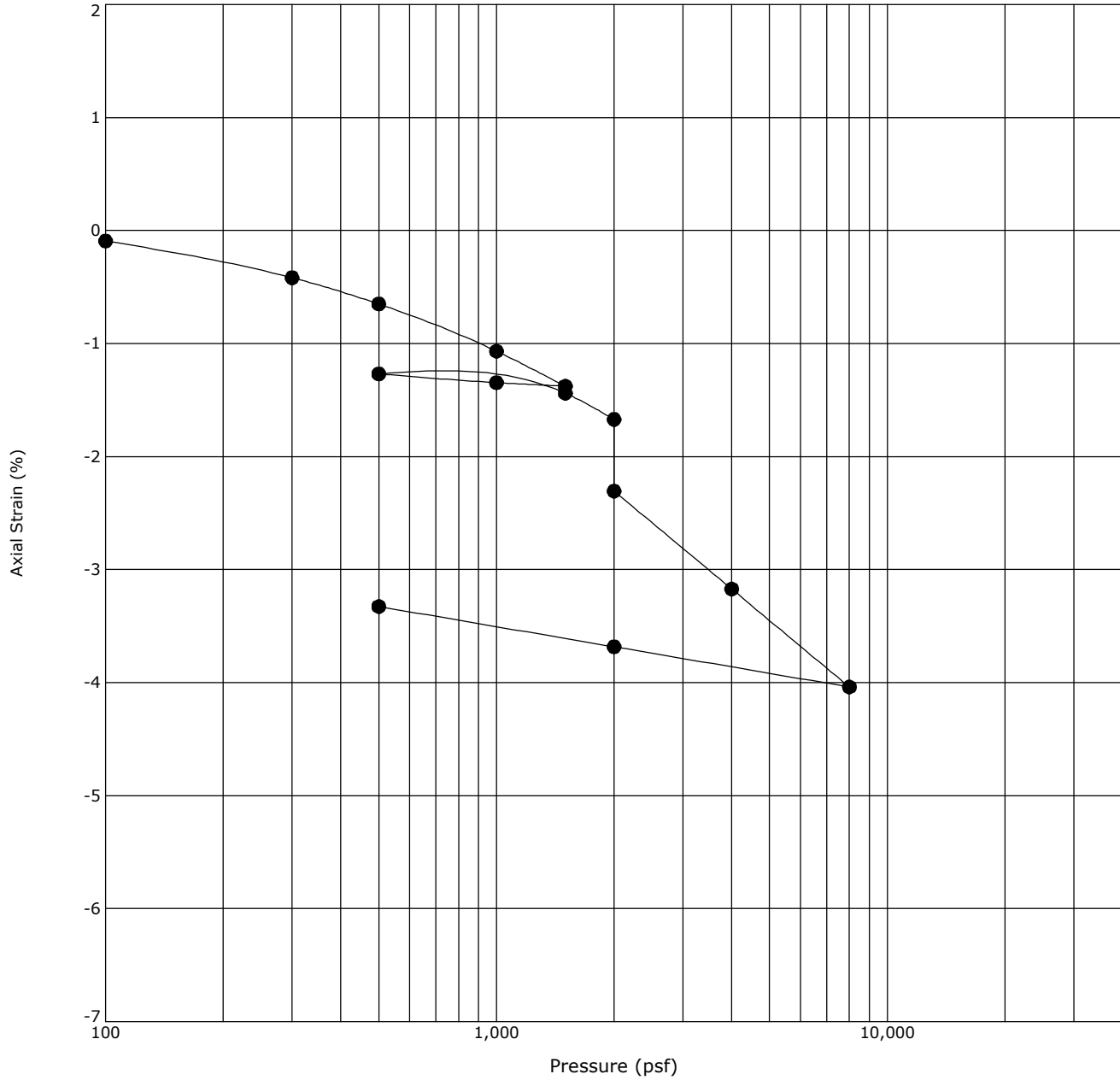
Moisture-Density Relationship

ASTM D1557-Method B



Boring ID		Depth (Ft)		Description of Materials			
B-5		0.66 - 5		SILTY SAND			
Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
					ASTM D1557-Method B	125.5	9.0

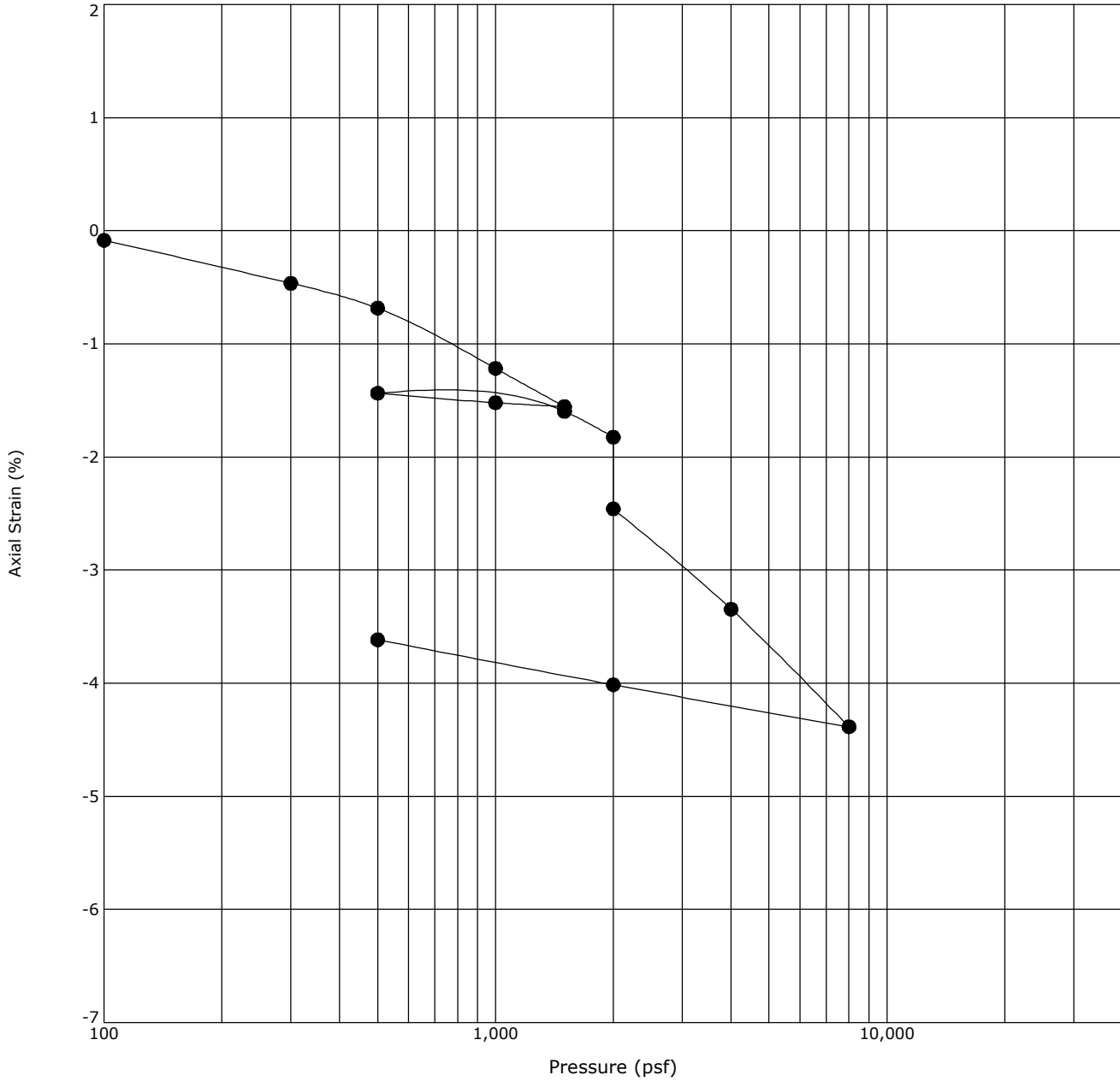
One-Dimensional Swell or Collapse ASTM D4546



Boring ID	Depth (Ft)	Description	USCS	γ_d (pcf)	WC (%)
● B-1	5 - 6.5	POORLY GRADED SAND WITH SILT	SP-SM	109	2.0

Notes: water added at 2,000 psf

One-Dimensional Swell or Collapse ASTM D4546



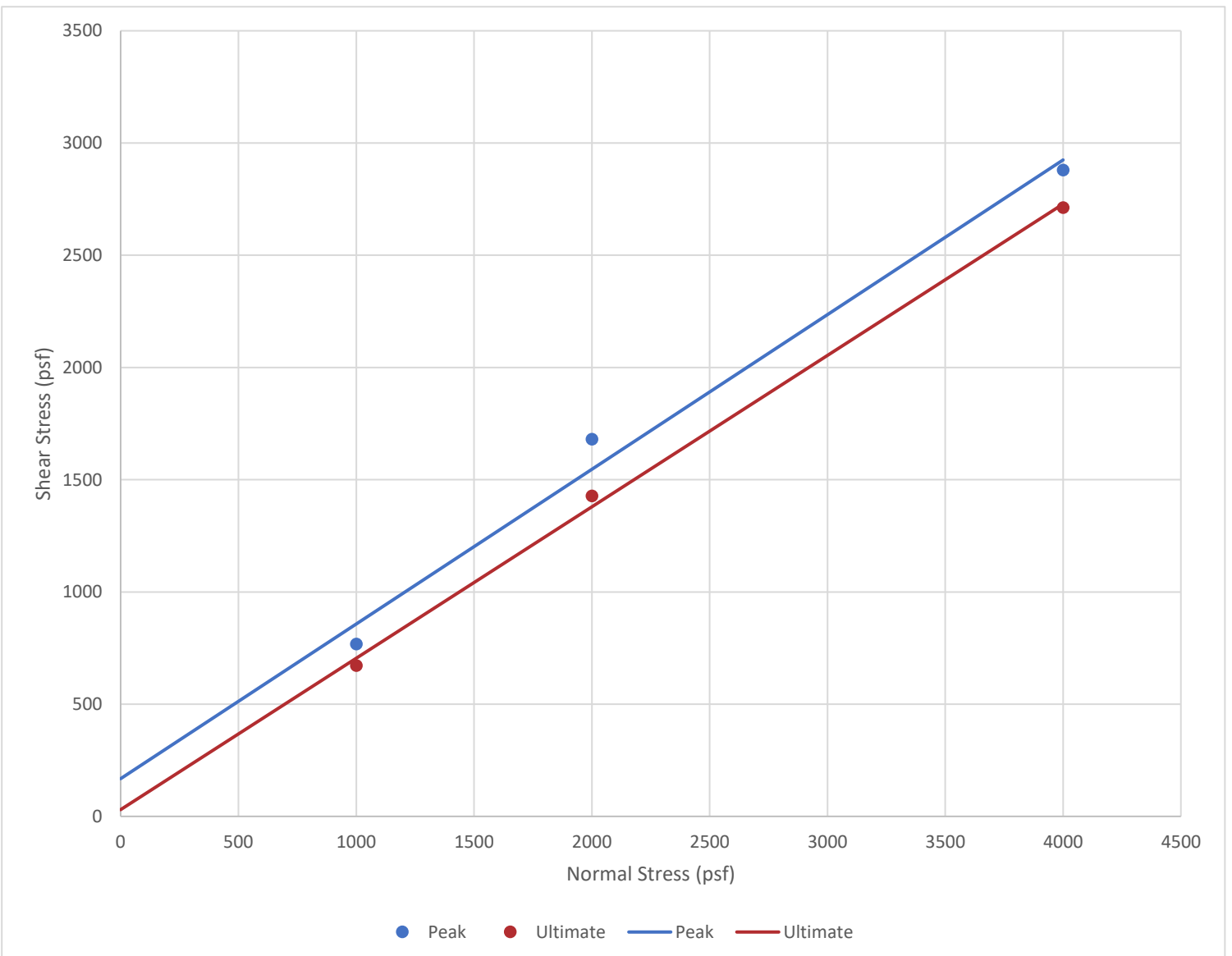
Boring ID	Depth (Ft)	Description	USCS	γ_d (pcf)	WC (%)
● B-3	2.5 - 4	SILTY SAND	SM	120	4.7

Notes: water added at 2000 psf

Direct Shear Test ASTM D3080

Boring ID	Depth (ft)	Description	USCS	γ_d (pcf)	W(%)
B-3	7.5	Poorly Graded Sand with Silt	SP-SM	106	7.6

Normal Stress (psf)	Peak Shear Stress (psf)	Ultimate Shear Stress (psf)	Peak		Ultimate	
			ϕ°	C (psf)	ϕ°	C (psf)
1000	768	672	35.0	170	34.0	30
2000	1680	1428				
4000	2880	2712				



750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393



Client

Kimley-Horn and Associates Inc

Project

WM Fuel Yucca Valley Fuel 1915

Sample Submitted By: Terracon (LA)

Date Received: 4/10/2024

Lab No.: 24-0140

Results of Corrosion Analysis

Sample Number	--	--
Sample Location	B-1	B-3
Sample Depth (ft.)	0.0-5.0	0.0-5.0
pH Analysis, ASTM G51	8.22	8.46
Water Soluble Sulfate (SO4), ASTM C 1580 (Percent %)	0.01	0.01
Sulfides, AWWA 4500-S D, (mg/Kg)	Nil	Nil
Chlorides, ASTM D512, (mg/kg)	55	95
Red-Ox, ASTM G200, (mV)	+733	+732
Total Salts, AWWA 2520 B, (mg/Kg)	286	339
Saturated Minimum Resistivity, ASTM G-57, (ohm-cm)	4020	6499

A handwritten signature in black ink, appearing to read "N. Campo".

Analyzed By _____

Nathan Campo
Laboratory Coordinator

The tests were performed in general accordance with applicable ASTM and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

Job No. LA245053
 Date. 4/13/2024

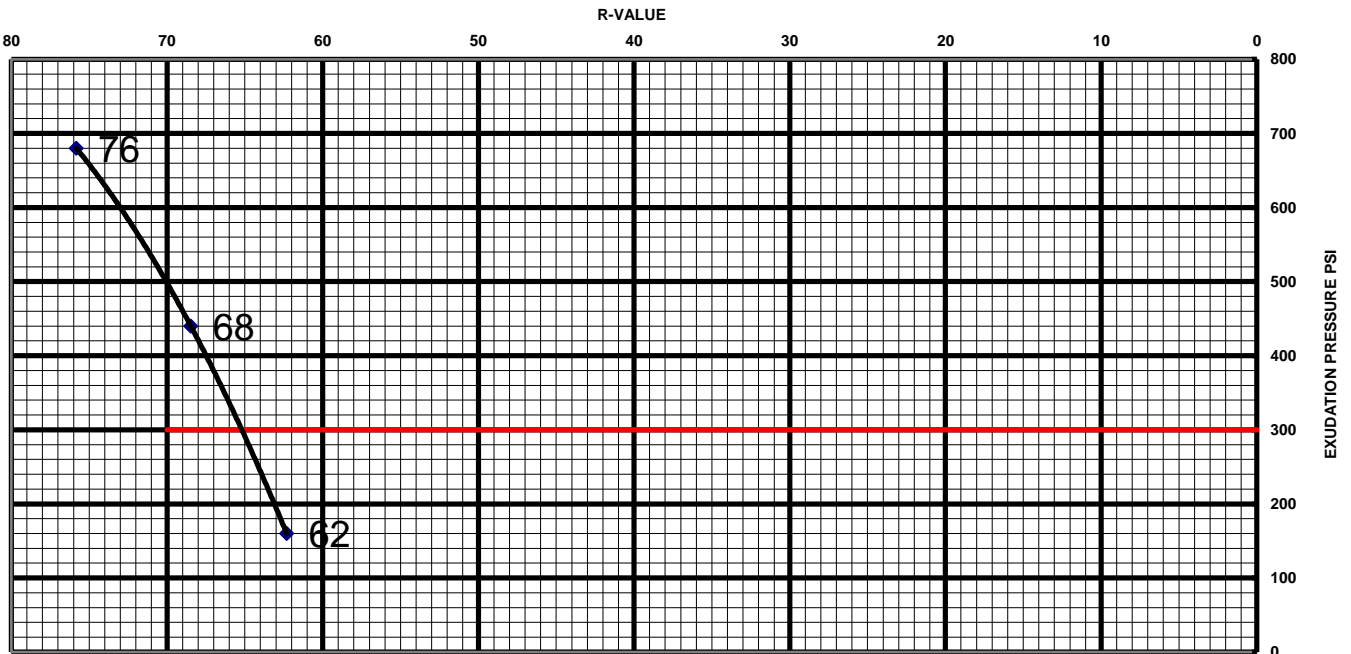
**LABORATORY RECORD OF TESTS MADE ON
 BASE, SUBBASE, AND BASEMENT SOILS**

CLIENT: Kimley-Horn and Associates
PROJECT Yucca Valley Fuel Center
LOCATION:
R-VALUE # : B-4
T.I. :

COMPACTOR AIR PRESSURE P.S.I.
 INITIAL MOISTURE %
 WATER ADDED, ML
 WATER ADDED %
 MOISTURE AT COMPACTION %
 HEIGHT OF BRIQUETTE
 WET WEIGHT OF BRIQUETTE
 DENSITY LB. PER CU.FT.
 STABILOMETER PH AT 1000 LBS.
 2000 LBS.
 DISPLACEMENT
 R-VALUE
 EXUDATION PRESSURE
 THICK. INDICATED BY STAB.
 EXPANSION PRESSURE
 THICK. INDICATED BY E.P.

	A	B	C	D
COMPACTOR AIR PRESSURE P.S.I.	350	350	350	
INITIAL MOISTURE %	4.4	4.4	4.4	
WATER ADDED, ML	50	40	30	
WATER ADDED %	4.6	3.7	2.7	
MOISTURE AT COMPACTION %	9.0	8.1	7.1	
HEIGHT OF BRIQUETTE	2.45	2.47	2.51	
WET WEIGHT OF BRIQUETTE	1134	1138	1147	
DENSITY LB. PER CU.FT.	128.7	129.2	129.2	
STABILOMETER PH AT 1000 LBS.	21	17	14	
2000 LBS.	35	29	22	
DISPLACEMENT	5.40	5.20	5.00	
R-VALUE	62	68	76	
EXUDATION PRESSURE	160	440	680	
THICK. INDICATED BY STAB.	0.00	0.00	0.00	
EXPANSION PRESSURE	0	0	0	
THICK. INDICATED BY E.P.	0.00	0.00	0.00	

EXUDATION CHART



R-Value: 65

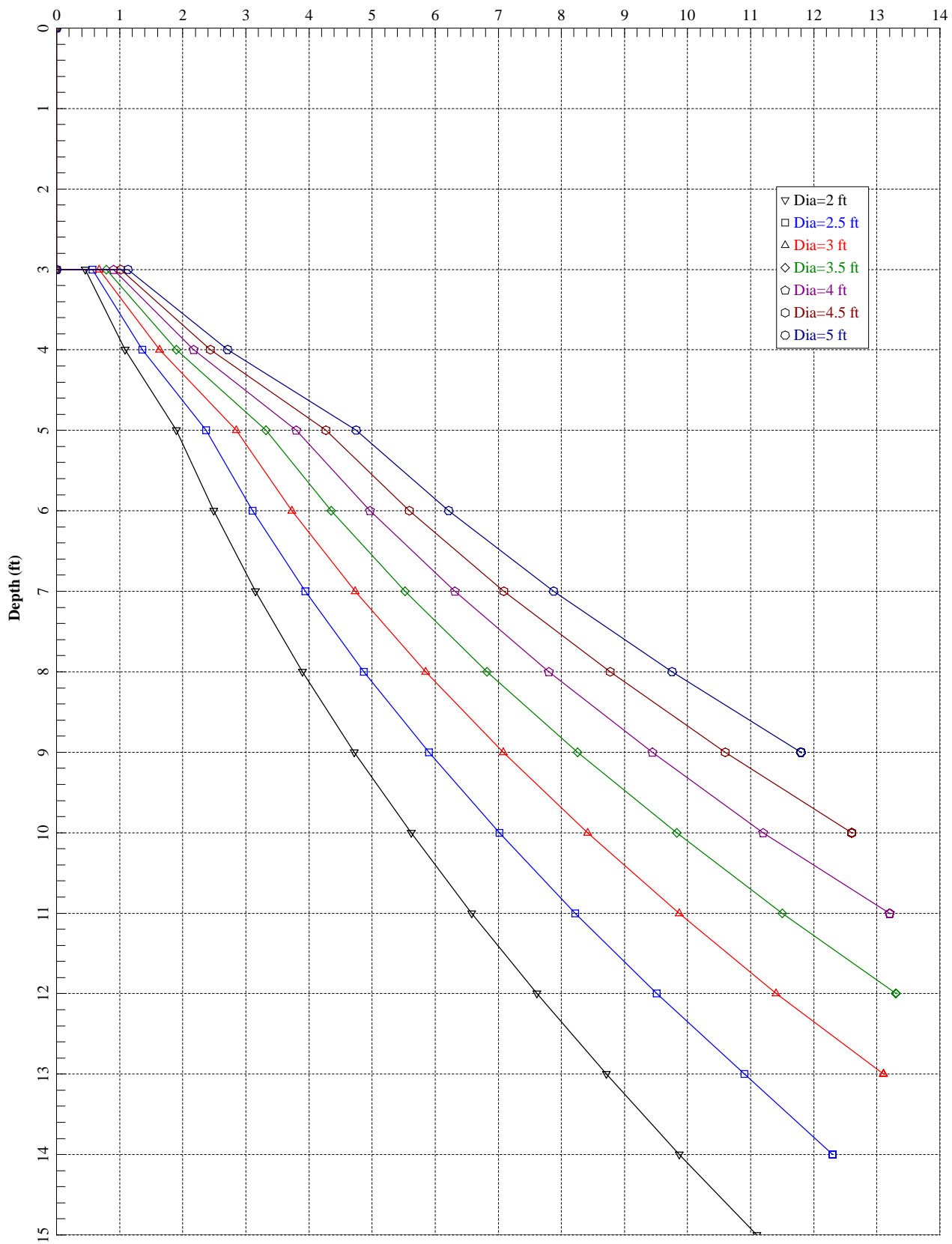
Supporting Information

Contents:

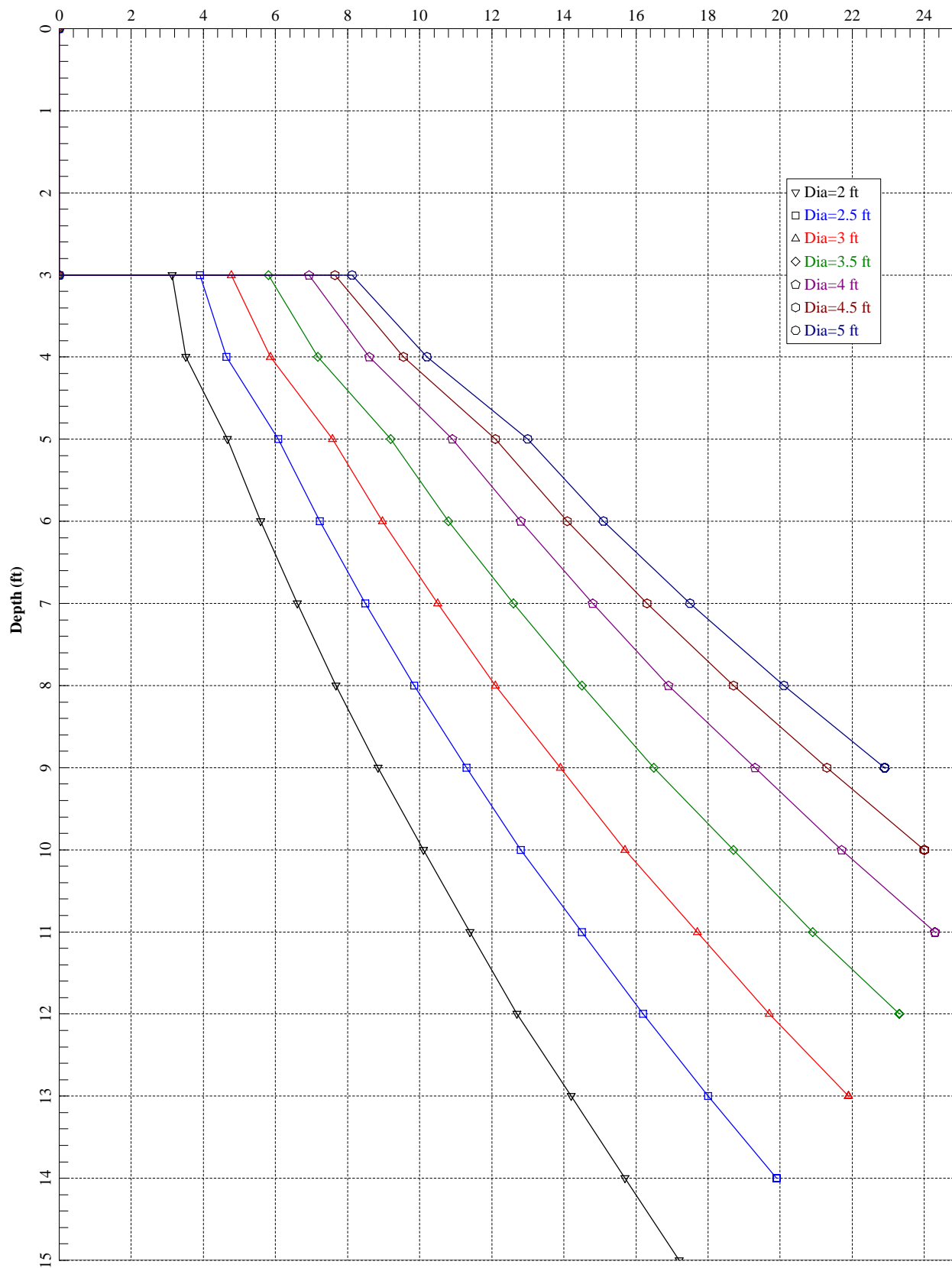
Shaft Analyses
General Notes
Unified Soil Classification System
Geotechnical Investigation Fact Sheet

Note: All attachments are one page unless noted above.









Allowable Skin Friction
Side Resistance/F.S. (tons)



**Allowable Downward Capacity
Total Resistance/F.S. (tons)**



General Notes

Sampling	Water Level	Field Tests
 Auger Cuttings  Grab Sample  Modified Dames & Moore Ring Sampler  Standard Penetration Test	 Water Level Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time  Cave In Encountered 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.	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 as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. 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			
Relative Density	Standard Penetration or N-Value (Blows/Ft.)	Ring Sampler (Blows/Ft.)	Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)	Ring Sampler (Blows/Ft.)
Very Loose	0 - 3	0 - 6	Very Soft	less than 0.25	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	0.50 to 1.00	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	2.00 to 4.00	15 - 30	19 - 42
			Hard	> 4.00	> 30	> 42

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	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
		Gravels with Fines: More than 12% fines ^C	$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	GP	Poorly graded gravel ^F
			Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}
		Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Fines classify as CL or CH	GC
	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E			SW	Well-graded sand ^I
	Sands with Fines: More than 12% fines ^D		$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	SP	Poorly graded sand ^I
			Fines classify as ML or MH	SM	Silty 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 above "A" line ^J	CL
PI < 4 or plots below "A" line ^J				ML	Silt ^{K, L, M}
Organic:			$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	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
PI plots below "A" line		MH			Elastic silt ^{K, L, M}
Organic:		$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$		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	

^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.

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

^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.

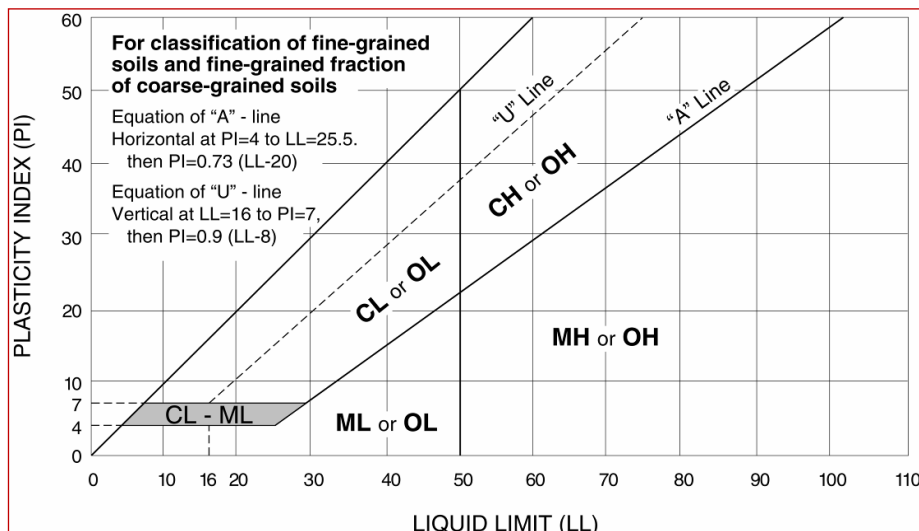
^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N PI ≥ 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.



GEOTECHNICAL INVESTIGATION FACT SHEET

Include this form in the Geotechnical Report as an Appendix.

PROJECT LOCATION: 58501 Twenty Nine Palms Hwy., Yucca Valley, CA

Engineer: Joshua R. Morgan Phone #: (949) 864-2048

Geotechnical Engineering Co.: Terracon Consultants Report Date: 5/7/2024

Ground Water Elevation: ^{Not encountered to a maximum} explored depth of 21.5 feet Fill Soils Characteristics:
(If encountered)

Date Groundwater Measured: N/A Maximum Liquid Limit: NP

Topsoil/Stripping Depth: N/A Maximum Plasticity Index: NP

Undercut (If Required): 24 inches beneath slab and footings Specified Compaction: Per **Fill Compaction Requirements**

Standard Proctor Results: (Attach plots.) Moisture Content Range: _____

pH: 8.22 - 8.46

Corrective actions required for construction based on pH level noted: Consult Corrosion Engineer

Resistivity: 4,020 - 6,499 ohm-cm

Corrective actions required for construction based on resistivity level noted:
Consult Corrosion Engineer

Cement Type: No restrictions

Recommended local DOT subbase/base material (reference section plan in Foundation Subsurface Preparation):

Base course shall conform to Section 26 of Caltrans "Standard Specifications"

Recommended Compaction Control Tests:

- 1 Test for Each 2,500 Sq. Ft. each Lift (bldg. area)
- 1 Test for Each 5,000 Sq. Ft. each Lift (parking area)

Structural Fill Maximum Lift Thickness 10 in. (Measured loose)

Subgrade Design CBR value = R-value = 65

<u>COMPONENT</u>	<u>ASPHALT</u>		<u>CONCRETE</u>	
	Standard	heavy	standard	heavy
Stabilized Subgrade (If Applicable)	<u>3 "</u>	<u>3 "</u>	<u>5 "</u>	<u>6 "</u>
Base Material (Stone, Sand/Shell, etc.)	<u>4 "</u>	<u>6 "</u>	<u>4 "</u>	<u>4 "</u>
Asphalt Base Course	_____	_____	_____	_____
Leveling Binder Course	_____	_____	_____	_____
Surface Course	_____	_____	_____	_____

NOTE: This information shall not be used separately from the geotechnical report.

