ACD St. Philip's College – Black Box Theater Addition

Geotechnical Engineering Report

January 30, 2024 | Terracon Project No. 90235311

Prepared for:

PBK Architects, Inc.
601 Northwest Loop 410 # 400
San Antonio, Texas 78216

6000 Northwest Parkway, Suite 100
San Antonio, TX 78249
P (210) 641-2112
Terracon.com

January 30, 2024

PBK Architects, Inc.
601 Northwest Loop 410 # 400
San Antonio, Texas 78216

Attn: Mr. Chris Fincke
P: (210) 829-0123
E: Chris.Fincke@pbk.com

Re: Geotechnical Engineering Report
ACD St. Philip's College – Black Box Theater Addition
1801 Martin Luther King Drive
San Antonio, Texas
Terracon Project No. 90235311

Dear Mr. Fincke:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P90235250 dated December 15, 2023. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and pavement for the proposed project.

We appreciate the opportunity to work with you on this project and look forward to contributing to the ongoing success of this project by providing Materials Testing services during construction. If you have any questions concerning this report, or if we may be of further service, please contact us

Sincerely,
Terracon Consultants, Inc.
(Firm Registration No. F3272)

Shasanka Dutta, P.E.
Project Engineer

STATE OF TEXAS
SHASANKA DUTTA
132647
LICENSED
PROFESSIONAL ENGINEER

for: Arin Barkataki, P.E.
Principal

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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 theater building addition to be located at 1801 Martin Luther King Drive in San Antonio, Texas. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Foundation design and construction
- Pavement design and construction

The Geotechnical Engineering Scope of Services for this project included drilling, laboratory testing, engineering analysis, and preparation of this report. The field program for this project included the advancement of five (5) test borings, each drilled to a depth of about 40 feet below existing site grades.

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 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
Project Description	The project includes a theater building addition to an existing building. Based on our conversation with Mr, Chris Fincke with PBK Architects, we understand the foundation of the building addition will be similar the existing building's foundation which is a suspended floor supported on drilled piers with crawl space of about 4 feet deep.

Item	Description
Finished Floor Elevation	FFEs were not provided. Assumed to match existing FFE.
Maximum Loads (Assumed)	Columns loads: 100 kips Wall: 1.5 kips per linear foot Slab: 100 to 125 psf
Pavements	Asphalt/Concrete is considered
Building Code	2021 IBC

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

Item	Description
Parcel Information	The project is located at 1801 Martin Luther King Drive in San Antonio, Texas. See **Site Location**
Existing Improvements	Asphalt parking lot with adjacent buildings.
Current Ground Cover	Asphalt parking lot
Existing Topography	A grading plan has not been provided. Based on a Google Earth imagery, the site is relatively level with an elevation of EL. 729 feet.

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 site preparation and foundation options.

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 No	Layer Name	General Description
--	Pavement	Asphalt: 2 inches thick Base: 5 to 8 inches thick
1	Clayey Sand	Brown, Light Brown and Dark Brown; Medium Dense to Very Dense
2	Clayey Gravel	Brown to Light Brown, Gray to Light Gray; Very Dense
3	Fat Clay	Light Brown and Gray; Very Stiff to Hard
1/ The CLAYEY GRAVEL AND CLAYEY SAND materials are primarily granular in nature and are expected to possess a negligible potential for volumetric changes due to moisture fluctuations. These strata can be water bearing.		
2/ The FAT CLAY materials could undergo high to very high volumetric changes (shrink/swell) should they experience changes in their in-place moisture content. However, due to the depth, the shrink swell activity of this stratum is limited.		

Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the **GeoModel** can be found in the **Figures** section of this report. It should be emphasized the stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

The borings were advanced to the required depths using dry drilling techniques to evaluate groundwater conditions at the time of our field program. The boreholes were observed for the presence of groundwater during and after completion of drilling. Groundwater was observed in the boring B-4 at about 31 feet while drilling.

Seasonal variations such as amount of rainfall and runoff, climatic conditions and other factors generally result in fluctuations of the groundwater level over time. A relatively long period may be necessary for groundwater level to develop and stabilize in a borehole. Additionally, the granular strata can be water bearing after a precipitation event. 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 foundation contractor should check the groundwater conditions just before foundation excavation activities.

Seismic Site Class

Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with 1613.2.2 in the 2021 IBC and Table 20.3-1 in the 2016 ASCE-7. Based on the soil properties observed at the site and as described on the exploration logs and results, our professional opinion is for that a **Seismic Site Classification of D** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 40 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area.

Geotechnical Overview

We understand the proposed building addition will be supported by a structurally elevated slab on drilled pier foundation system.

The foundation being considered must satisfy two independent engineering criteria with respect to the subsurface conditions encountered at this site. One criterion is the foundation system must be designed with an appropriate factor of safety to reduce the possibility of a bearing capacity failure of the soils underlying the foundation when subjected to axial and lateral load conditions. The other criterion is that the movement of the foundation system due to compression (consolidation or shrinkage) or expansion (swell) of the underlying soils must be within tolerable limits.

Expansion Potential

Surficial soils at the site have low potential for shrink swell. Based on our findings and the presence of fat clay at deeper depths, the subsurface soils at this site generally exhibit moderate shrink/swell potential. Based on the information developed from our field and laboratory programs and on method TEX-124-E of the Texas Department of Transportation (TxDOT) Manual of Testing Procedures, we estimate that the subgrade soils at this site exhibit a Potential Vertical Rise (PVR) of about 1 inch in their present condition. It should be emphasized that the actual movements could be greater than the values presented in this report because of inadequate drainage, ponded water and moisture infiltration beneath the structures after construction.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and (at least minor) cracking in the pavement and the structure should be anticipated. The severity of cracking and other damage such as uneven floor slabs will probably increase if modification of the site results in excessive wetting or drying of the expansive soils.

Demolition Considerations

We understand that part of the buildings will be demolished to accommodate the new additions. As a result, abandoned (or to be abandoned) underground utilities may be present within the footprint area of the planned structures. Utilities and associated backfill and granular bedding material can provide avenues for subsurface water to enter under the structure subgrade. We recommend that all abandoned utility lines be completely removed from the proposed structure areas. Abandoned pipes which remain underground should be grouted.

Any below-grade foundation or utility structures removal associated with demolition will likely create large subsurface voids. It is very important that all subsurface voids formed from the removal of the foundation system be backfill completely with moisture conditioned, compacted, engineered fill as described in the Earthwork section of this report. It is our experience that improperly backfilled excavations can cause significant settlement under and around the proposed structures.

As an alternative to compacted soil backfill, a flowable fill material may be considered. Flowable fill, or slurry, when properly designed provides a competent subgrade and can still be readily excavated if the utilities require repair or maintenance. In addition, flowable fill does not need to be placed in lifts, compacted, or tested.

Structure Interaction and Possible Distress

The construction of additions to an existing structure can often create a situation that leads to the formation of distress in both structures if both structures are connected to each other. Typically, such distress occurs due to the use of different foundations and as a result of the structures having different framing stiffness. These differences often lead to dissimilar performances between the additions and existing structure. Such performance dissimilarities typically manifest themselves as differential movements and can cause significant amounts of distress. The risks associated with dissimilar performances between the additions and existing structure may be reduced by the following:

- Designing the foundation of the addition using the type and geometry similar to the existing foundation system (when appropriate);
- Using dowels in the addition and existing foundations/floor slabs together to prevent differential vertical movements across the joint;
- Constructing an expansion joint between the new and existing structure to allow for differential horizontal movement between the addition and existing structure; and
- If the addition is supported on piers, then the new piers should be at least 2 pier diameters away from the closest existing piers.

Excavating adjacent to the existing foundation should be performed with care. Excavations adjacent to the existing structure could cause the foundation to become undermined and the foundation or structure could suffer damages. We recommended that the contractor monitor the existing foundation carefully during construction and be prepared to brace the existing foundation if necessary.

Sulfate Testing

The sulfate test results indicate that the sulfate concentration of the subgrades soils at the project site is varies from about 67 to 126 mg/Kg. The sulfate concentration values are below the threshold level for adverse reactions based on TxDOT (>3,000mg/Kg), the National Lime Association (>3,000mg/Kg) and AASHTO (>5,000mg/Kg). Based on the test results, the severity of potential exposure of concrete to sulfate attack falls under Class 0.

Water Soluble Sulfate Content in Soil (mg/kg)	Severity of Potential Exposure
> 10,000	Class 3
1,500 – 10,000	Class 2
150 – 1,500	Class 1
0 – 150	Class 0

Earthwork

Earthwork is anticipated to include removal of existing pavements, excavations for utilities, and engineered fill placement for any grading. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, and pavements.

General Site Preparation

Prior to construction, the work area should be cleared off loose topsoil and any unsuitable materials from the construction area. After stripping and grubbing, the exposed subgrade should be proof-rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with a fully loaded dump truck or comparable pneumatic tired vehicle. Soils that are observed to rut or deflect excessively (typically greater than 1-inch) under the moving load should be overexcavated to provide a firm, uniform bearing layer. The proof rolling and overexcavation activities should be witnessed by a representative of the

Geotechnical Engineer and should be performed during a period of dry weather. Subgrade stabilization may also be performed as described below if the exposed subgrade exhibits yielding or pumping under construction traffic.

- Removal and replacement with select fill.
- Chemical treatment of the soil to dry and increase the stability of the subgrade.
- Drying by natural means if the schedule allows.

Pad Preparation

We understand the floor slab will be constructed as a structurally suspended floor system**. Therefore, remedial earthwork measures in building pad area will not be required other than general site grading.**

Flatwork

As previously stated, we estimate that the subgrade soils at this site exhibit a PVR of about 1 inch in their present condition. It is our professional opinion that the flatwork maybe grade supported. Some movement and cracking should be expected that may result in uneven flatwork which in turn may cause trip hazard or reverse surface flow or doors which drag on the flatwork when opened. Consider including the door stoops into the suspended slab to prevent interference with door operations. Eliminating the risk of movement and distress may not be feasible unless the flatwork is suspended

Fill Material Types

Earthen materials used for select and general fill should meet the following material property requirements.

Fill Type	USCS Classification	Comments
Select Fill	CL, SC ➢ LL≤40 and 7<PI≤20 ➢ % passing #200 sieve ≥35% ➢ Maximum particle size 1½"	Note 1
Onsite Soils	GC, SC, CH	Note 2 and 3

1/ Prior to any filling operations, samples of the proposed Select Fill and on-site materials should be obtained for laboratory moisture-density testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A qualified soil technician should perform sufficient in-place density tests during the filling operations to ensure that proper levels of compaction, including dry unit weight and moisture content are attained.

Fill Type	USCS Classification	Comments

2/ CH soils should not be used as Select Fill. Can be used as general fill and in landscaping areas

3/Onsite SC soils can be used as Select Fill if they meet the criteria of Select Fill. The onsite soils, if selected to be used as Select Fill, should be tested prior to their use.

Fill Placement and Compaction Requirements

Select fill and general fill should meet the following compaction requirements.

Item	Requirements
Fill Lift Thickness	All fill should be placed in thin, loose lifts of about 8 inches, with compacted thickness not exceeding 6 inches.
Compaction of On-Site Soil and Select Fill	95 percent of the material's Standard Proctor maximum dry density (ASTM D 698)
Moisture Content of On-Site Soil and Select Fill	Between -2 and +3 percentage points of the optimum moisture content.

Grading and Drainage

Effective drainage should be provided during construction and maintained throughout the life of the new improvements. After pad construction, we recommend verifying final grades to document that effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

Proper site drainage should be maintained during the entire construction phase so that ponding of surface runoff does not occur and cause construction delays and/or inhibit site access, particularly in cut areas. During construction, it is possible that the surficial soils may become excessively wet because of inclement weather conditions. When the moisture content of these clay soils elevates above what is considered to be the optimum range of moisture for compaction operations, they can become difficult to handle and compact. If such conditions create a hindrance to compaction operations or site access, lime or cement may be mixed with these soils to improve their workability. The additive can be mixed as per 2014 TxDOT Item 275 (cement). . The purpose of the additive is to dry out the subgrade and improve sire access. The strict requirements for curing and actual quantity of additive can be at the discretion of the contractor.

Flatwork will be subjected to post-construction movement. Maximum grades that are feasible should be used for paving and flatwork to prevent water from ponding. Allowances in final grades should also consider post-construction movement of flatwork, particularly if such movements are deemed critical. Where paving or flatwork abuts the structure, joints should be effectively sealed and maintained to prevent surface water infiltration. In areas where sidewalks or paving do not immediately adjoin the structure, we recommend that protective slopes be provided with a grade of at least five percent for at least 10 feet from perimeter walls (except in areas where ADA ramps are required; these should comply with state and local regulations). Backfill against grade beams, exterior walls, and in utility and sprinkler line trenches should be well compacted and free of construction debris to reduce the possibility of moisture infiltration.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

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 slabs or 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. Utility trench backfill compaction should be 95 percent of Standard Proctor for paved and structure areas and 90 percent of Standard Proctor for unpaved and non-structure areas.

Utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Earthwork Construction Considerations

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively stable. However, the stability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If conditions develop, workability may be improved by scarifying and drying.

Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of foundation elements and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to construction.

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

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

Deep Foundation

Drilled Shaft Axial Load Design Parameters

The structures may be supported on straight-sided (non-underreamed) drilled piers at a depth no shallower than 25 feet below the bottom of the crawl space. Depths are based on the grades at the time of our geotechnical field activities. Due to the presence of very dense gravel, chert and sandy zones, underreamed piers are not a viable option at the project site. Therefore, only straight-sided piers will be discussed in this report. Soil design parameters for the design of drilled shaft foundations are provided in the table below.

Approximate Depth (feet)	Allowable Skin Friction[1,3] (psf)	Allowable End Bearing Pressure[2] (psf)
Bottom of crawl space – 5	---	---
5 – 25	600	---
25 – 40	700	12,000

1/ The allowable skin friction values include a factor of safety of 2.
2/ The allowable bearing pressure includes a factor of safety of 3.
3/ Top 5 feet of the soil are considered not to contribute to side friction due potential separation of the surficial soil due to construction disturbance.

The bearing pressures presented in the table assume that the bearing surface will be free and clean of soft or moist material and loose debris. The allowable end bearing and skin friction values presented in this report are based on center-to-center spacing of at least three shaft or three bell diameters. A closer spacing may be considered but it may reduce the axial capacity of the foundation depending on the spacing pattern of the foundations. If a clearance of three shaft diameters or three bell diameters cannot be maintained in every case, the above bearing capacities should be reduced by 20 percent. Drilled piers installed at a center-to-center clearance of two shaft diameters or less are not recommended.

Axial tension force due to the swelling soils is deemed not a concern at the site. Note that the standard of practice in the San Antonio area is for the cross-sectional area of the reinforcing steel to be not less than one (1) percent of the gross cross-sectional area of the drilled pier shaft. The reinforcing steel should extend from the top to the bottom of the shaft.

The allowable uplift resistance of the straight-sided drilled piers can be evaluated using the following equation:

$$Q_{ar} = 2.5 \cdot d \cdot D_p + 0.9W_p + P_{DL}$$

Where: Q_{ar} = Allowable uplift resistance of pier in kips (k)

D = Diameter of pier shaft in feet (ft)

D_p = Anchorage Zone (Pier length below the upper 5 feet) (ft)

W_p = Weight of the drilled pier in kips (k)

P_{DL} = Permanent sustained dead Load acting on the drilled pier in kips (k)

Total settlements, based on the indicated bearing pressures, should be approximately ¾ inch or less for properly designed and constructed drilled piers. Differential settlement may also occur between adjacent piers. The amount of differential settlement could approach 50 to 75 percent of the total pier settlement. For properly designed and constructed piers, differential settlement between adjacent piers is estimated to be less than ½ of an inch. Settlement response of drilled piers is impacted more by the quality of construction than by soil-structure interaction.

Improper pier installation could result in differential settlements significantly greater than we have estimated. In addition, larger magnitudes of settlement should be expected if the soil is subjected to bearing pressures higher than the allowable values presented in this report.

Lateral Load Design Parameters

The following table lists input values for use in LPILE analyses for the design of the piers supporting the building. Since deflection or a service limit criterion will most likely control lateral capacity design, no safety/resistance factor is included.

Depth below Existing Grade	L-Pile Soil Model	S_u (psf) [1]	γ (pcf) [1]	Φ [1]	ε_{50} [1]	K (pci) [1]
0 – 5	Sand	---	115	30	---	Default
5 – 20	Sand	--	115	35	--	Default
20 – 25	Sand	---	115	35	---	Default
20 – 40	Stiff Clay Without Free Water	4,000	63		Default	---

1/ Definition of Terms:
γ: Effective unit weight
ε_{50}: Non-default E_{50} strain
K: Horizontal modulus of subgrade reaction
S_u: Undrained shear strength (Cohesion)
Φ: Angle of friction

Drilled Shaft Construction Considerations

The pier excavations should be augered and constructed in a continuous manner. Steel and concrete should be placed in the pier excavation immediately following drilling and evaluation for proper bearing stratum, embedment, and cleanliness. In no circumstances should the pier excavation remain open overnight.

During the time of our drilling operations, subsurface water was encountered in one of the borings (B-4) at about 31 feet below existing grades. Subsurface water levels are influenced by seasonal and climatic conditions which result in fluctuations in subsurface water elevations. Sand and gravel encountered in the borings are prone to sloughing. Therefore, the contractor should be prepared to use temporary casing or use slurry drilling methods should water be encountered and/or sloughing of the excavation sidewalls occur. Slurry method may be considered since casing may not seal groundwater due to the presence of sand/gravel and a watertight seal maybe not achieved if not socketed into the clay. **It is emphasized that due to water bearing sand and gravel strata, installation of shafts below the water level may be difficult.** The casing and slurry methods are discussed below.

Casing Method - Casing will provide stability of the excavation walls but may not completely eliminate subsurface water influx potential or stability of the pier excavation bottom unless the casing penetrates below any pervious soils. Casing that terminates in pervious soils may generate "boils" due to the head differential between the inside and outside of the casing and require that the casing be extended until the excess seepage or boils are eliminated. The drilling subcontractor should determine casing depths and casing procedures. Water that accumulates in excess of six (6) inches in the bottom of the pier excavation should be pumped out prior to steel and concrete placement. If the water is not pumped out, a long closed-end tremie should be used to place the concrete completely to the bottom of the pier excavation in a controlled manner to effectively displace the water during concrete placement. If this operation is not successful or to the satisfaction of the foundation contractor and engineer, the pier excavation should be flooded with fresh water to offset the differential water pressure caused by the unbalanced water levels inside and outside of the casing. If water is not a factor, concrete should be placed with a short tremie so that the concrete is directed to the bottom of the pier excavation. The concrete should not be allowed to ricochet off the walls of the pier excavation nor off reinforcing steel. When the pier excavation depth is achieved, and the bearing area has been cleaned, steel and concrete should then be placed immediately in the excavation.

Removal of casing should be performed with extreme care and under proper supervision to reduce mixing of the surrounding soil and water with the fresh concrete. Rapid withdrawal of casing or the auger may develop suction that could cause the soil to intrude into the excavation. An insufficient head of concrete in the casing during its withdrawal could also allow the soils to intrude into the wet concrete. Both of these conditions may induce "necking", a section of reduced diameter, in the pier.

Slurry Method - As an alternate to the use of casing to install the pier foundations, water or a weighted drilling fluid may be considered. Slurry displacement drilling can only prevent sloughing and water influx but cannot control sloughing once it has occurred. Therefore, slurry displacement drilling techniques must begin at the ground surface, not after sloughing materials are encountered.

Typical drilling fluids include those which contain polymers or bentonite. If a polymer is used with "hard" mixing water, a water softening agent may be required to achieve intimate mixing and the appropriate viscosity. The polymer manufacturer should be consulted concerning proper use of the polymer. If bentonite slurry is used, the bentonite should be mixed with water several hours before placing in the pier excavation. Prior mixing gives the bentonite sufficient time to hydrate properly. The drilling fluid should only be of sufficient viscosity to control sloughing of the excavation walls and subsurface water flow into the excavation. Care should be exercised while extracting the auger so that suction does not develop and cause disturbance or create "necking" in the excavation walls as described above. Casing should not be employed in conjunction with the slurry drilling technique due to possible trapping of loose soils and slurry between the concrete and natural soil.

The use of weighted drilling fluid when installing drilled pier foundations requires extra effort to ensure an adequate bearing surface is obtained. A clean-out bucket should be used just prior to pier completion in order to remove any cuttings and loose soils which may have accumulated in the bottom of the excavation. Steel and concrete should be placed in the excavation immediately after pier completion. A closed-end tremie should be used to place the concrete completely to the bottom of the excavation in a controlled manner to effectively displace the slurry during concrete placement. The concrete should be placed completely to the bottom of the excavation with a closed-end tremie in the pier excavation if more than six (6) inches of water is ponded on the bearing surface or the water should be pumped from the excavation. A short tremie may be used if the excavation has less than 6 inches of ponded water. The fluid concrete should not be allowed to strike the pier reinforcement, temporary casing (if required) or excavation sidewalls during concrete placement.

All aspects of concrete design and placement should comply with the American Concrete Institute (ACI) 318 Code Building Code Requirements for Structural Concrete, ACI 336.1 Standard Specification for the Construction of Drilled Piers, and ACI 336.3R entitled Suggested Design and Construction Procedures for Pier Foundations.

Floor Slabs

We understand a structurally suspended floor slab with a crawl space will be considered for this project. **Note that we do not recommend use of carton forms to establish the voids.**

For a structurally suspended floor slab system at this site, Terracon recommends a void space of at least 12 inches beneath the floor slabs, structural beams, and subfloor plumbing systems. In many cases, the thickness of the void space is several feet to facilitate maintenance activities in the crawl space. Subfloor plumbing pipes should be installed using an approved suspended system and should have a similar void space between the pipe and the subgrade.

Drainage beneath the structure must be designed to remove and/or reduce the possibility of water accumulation in these areas. The subgrade below the floor slab should be sloped to appropriate drainage outlets. Surface and subsurface drainage of water away from the building will enhance the performance of the foundation.

In addition, proper ventilation should be provided to reduce the possibility that a high humidity environment could develop in the void space areas. Measures should be taken to maintain voids beneath the perimeter beams.

Lateral Earth Pressure

Below Grade Walls

The below grade walls will need to be designed for "At-Rest" lateral earth pressure condition. It is important that the backfill materials be free of organic matter and rock fragments or clods larger than 4 inches. The values furnished in the table are ultimate values. A factor of safety of 2 should be used to determine allowable values.

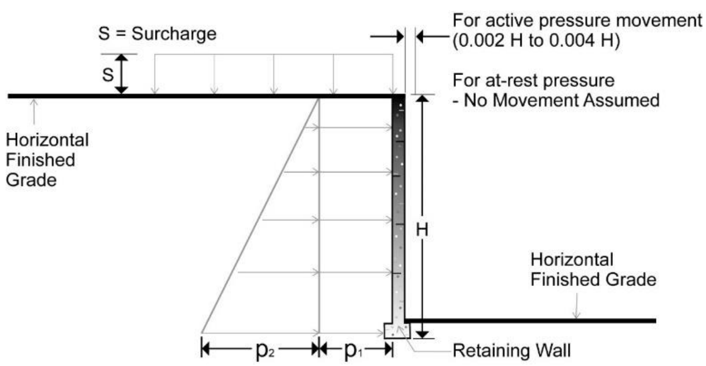
Earth Pressure Condition	Coefficient for Backfill	Surcharge Pressure (psf)[1]	Undrained Equivalent Fluid Density (pcf)	Drained Equivalent Fluid Density (pcf)
At-Rest (Ko)	Select Lean Clay - 0.58 Onsite Clayey Sand – 0.50	(0.58)S (0.50)S	95 91	70 60

1/ S is surcharge pressure.

Retaining Walls

The recommendations given in the following paragraphs are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. Note that the parameters are not applicable to the design of mechanically stabilized earth (MSE) or modular block wall.

Walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls. Presented below are earth pressure coefficients that may be used to design the wall.



Undrained Condition					
Earth Pressure Conditions	**Backfill Type**	**Coefficient of Earth Pressure**	**Equivalent Fluid Density (pcf)**	**Lateral Pressure due to Surcharge (psf)**	**Earth Pressure (psf)**
Active (K_a)	Granular Select Fill[1]	0.33	85	0.33S	85H
	Onsite Clayey Sand	0.33	82	0.33S	82H
	Free Draining Granular Fill[2]	0.22	77	0.22S	77H
At-Rest (K_o)	Granular Select Fill	0.50	96	0.50S	96H

Undrained Condition					
Earth Pressure Conditions	**Backfill Type**	**Coefficient of Earth Pressure**	**Equivalent Fluid Density (pcf)**	**Lateral Pressure due to Surcharge (psf)**	**Earth Pressure (psf)**
	Onsite Clayey Sand	0.50	91	0.50S	91H
	Free Draining Granular Fill	0.36	87	0.36S	87H
Passive (K_p)	Granular Select Fill	3.0	265	---	---
	Onsite Clayey Sand	3.0	235	---	----
	Free Draining Granular Fill	4.6	373	---	---

1/ Granular Select Fill should conform to the gradation requirements of 2014 TxDOT Item 247, Type A, Grade 1-2 material.
2/ Free Draining Granular Fill should conform to the gradation requirements of ASTM C33, Grade 57 coarse aggregate material.

Drained Condition					
Earth Pressure Conditions	**Backfill Type**	**Coefficient of Earth Pressure**	**Equivalent Fluid Density (pcf)**	**Lateral Pressure due to Surcharge (psf)**	**Earth Pressure (psf)**
Active (K_a)	Granular Select Fill[1]	0.33	43	0.33S	43H
	Onsite Clayey Sand	0.33	40	0.33S	40H
	Free Draining Granular Fill[2]	0.22	28	0.22S	28H
At-Rest (K_o)	Granular Select Fill	0.50	65	0.5S	65H
	Onsite Clayey Sand	0.50	60	0.50S	60H
	Free Draining Granular Fill	0.36	46	0.36S	46H
Passive (K_p)	Granular Select Fill	3.0	390	---	---
	Onsite Clayey Sand	3.0	360	---	---

Drained Condition					
Earth Pressure Conditions	**Backfill Type**	**Coefficient of Earth Pressure**	**Equivalent Fluid Density (pcf)**	**Lateral Pressure due to Surcharge (psf)**	**Earth Pressure (psf)**
	Free Draining Granular Fill	4.6	600	---	---

1/ Granular Select Fill should conform to the gradation requirements of 2014 TxDOT Item 247, Type A, Grade 1-2 material.
2/ Free Draining Granular Fill should conform to the gradation requirements of ASTM C33, Grade 57 coarse aggregate material.

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 H to 0.004 H, where H is wall height.
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance.
- Uniform surcharge, where S is surcharge pressure.
- In-situ soil backfill weight a maximum of 120 pcf.
- Horizontal backfill, compacted to 95 percent of standard Proctor maximum dry density.
- Loading from heavy compaction equipment not included.
- No hydrostatic pressures acting on wall.
- No dynamic loading.
- No safety factor included in lateral earth pressures.
- Ignore passive pressure in upper 2 feet.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out from the base of the wall at an angle of at least 30, 45, and 60 degrees from vertical for the active, at rest, and passive cases, respectively. If it is not possible to construct a wedge of granular backfill, then a minimum of 12 inches of clean gravel should be placed behind the wall for drainage purposes and the onsite soil values presented in the table should be used.

To control hydrostatic pressure behind the wall we recommend that a drain be installed at the foundation wall with a collection pipe leading to a reliable discharge. If this is not possible, then combined hydrostatic and lateral earth pressures should be calculated for lean clay backfill using an equivalent fluid weighing 95 pcf. For granular backfill, an equivalent fluid weighing 90 pcf should be used. For on-site soils, an equivalent fluid pressure of 105 pcf should be used. These pressures do not include the influence of surcharge, equipment or floor loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided.

To calculate the resistance to sliding, a value of 0.35 should be used as the ultimate coefficient of friction between the footing and the underlying soil or select fill. The "active" earth pressures need to be resisted by the passive earth pressures on the face of the retaining wall base or a key (if applicable), and by the friction that will develop along the base of the wall. Passive fluid density values furnished in the table above should be used to calculate passive earth pressure. It should be noted that values furnished in the table are ultimate values. A factor of safety of 2 should be used to determine allowable values. Allowable bearing pressure along the base of the wall should be 2,000 psf. This bearing pressure includes a factor of safety against a bearing capacity failure of at least 3. Allowable bearing pressures are also based on the bearing surface being comprised of compacted soil that is free and clean of all debris and loose material.

A drainage system is recommended regardless of the backfill used. Weep holes along the front of, and a drain system located behind, the wall will provide an outlet for water which may collect in the wall backfill. The wall backfill should drain much more effectively if a granular material is used behind the wall. The free-draining backfill should be protected from clogging by surrounding finer-grained soils through use of a geotextile filter fabric. The filter fabric should prevent the finer-grained materials from infiltration into the interstitial space between the individual grains of the free-draining backfill.

It is critical that surface water infiltration be reduced behind the wall. The upper 1 to 2 feet of backfill should be a clay soil having a Plasticity Index in the range of 25 to 40; or, the backfill material should be covered with pavement. This clay soil cap or pavement coupled with sloping the ground surface away from the wall will help to reduce infiltration of surface water into the backfill. The clay soil should be at least 12 inches in thickness and compacted to at least 95 percent of the maximum dry density as evaluated by the ASTM D 698 test method. The clay should be moisture conditioned between -2 and +3 percentage points of the optimum moisture content.

Pavements

Both flexible and rigid pavement systems may be considered for the project. Based on our knowledge of the project, we anticipate that traffic loads will be produced primarily by automobile traffic, delivery trucks, trash removal trucks and occasional fire trucks.

Subgrade Preparation

Prior to construction, any vegetation, existing pavements and any otherwise unsuitable materials should be removed from the new pavement areas. After stripping, the subgrade should be proof-rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with a 15-ton roller or fully loaded dump truck. Wet, soft, low-density or dry material should either be removed or moisture conditioned and recompacted to the moisture contents and densities described in section **Fill Compaction Requirements** prior to placing fill.

Pavement Design Recommendations

For this project both Light and Heavy pavement section alternatives have been provided. Light is for areas expected to receive only passenger vehicles. Heavy assumes areas with heavy traffic, such as trash pickup areas, delivery areas, and main access drive areas.

The flexible pavement section was designed in general accordance with the National Asphalt Pavement Association (NAPA) Information Series (IS-109) method. The rigid pavement section was designed using the American Concrete Institute (ACI 330R-01) method. If heavier traffic loading is expected, Terracon should be provided with the information and allowed to review these pavement sections.

Asphalt Pavement		
Layer	**Light Duty (inch)**	**Heavy Duty (inch)**
Hot Mix Asphaltic Concrete	2.0	3.0
Granular Base Material	8.0	12.0
Moisture Conditioned Subgrade	6.0	6.0

Concrete Pavement		
Layer	**Light Duty (inch)**	**Heavy Duty (inch)**
Reinforced Concrete	5.0	6.0
Moisture Conditioned Subgrade	6.0	6.0

Pavement areas that will be subjected to heavy wheel and traffic volumes, such as waste bin or "dumpster" areas, entrance/exit ramps, and delivery areas, should be a rigid pavement section constructed of reinforced concrete.

Pavement Section Materials

Presented below are selection and preparation guidelines for various materials that may be used to construct the pavement sections. Submittals should be made for each pavement material. The submittals should be reviewed by the Geotechnical Engineer and appropriate members of the design team and should provide test information necessary to verify full compliance with the recommended or specified material properties.

Hot Mix Asphaltic Concrete Surface Course - The asphaltic concrete surface course should be plant mixed, hot laid Type D Surface. Each mix should meet the specifications requirements of TXDOT Special Specifications Item 3076.

- **Concrete** - Concrete should have a minimum 28-day design compressive strength of 4,000 psi.
- **Granular Base Material** - Base material may be composed of crushed limestone base meeting all of the requirements of 2014 TxDOT Item 247, Type A, Grade 1-2; including triaxial strength. The material should be compacted to at least 95 percent of the maximum dry density as determined in accordance with ASTM D 1557 at moisture contents ranging from -2 and +3 percentage points of the optimum moisture content.
- **Moisture Conditioned Subgrade -** The subgrade should be scarified to a depth of 6 inches and then moisture conditioned between -2 and +3 percentage points of the optimum moisture content and then compacted to at least 95 percent of the maximum dry density determined as per ASTM D 698.

Pavement Joints and Reinforcement

The following is recommended for all concrete pavement sections in this report. Refer to ACI 330 "Guide for Design and Construction of Concrete Parking Lots" and "TxDOT Standard Specifications" for additional information.

Item	Description
Reinforcing Steel	No 3 reinforcing steel bars at 18 inches on-center-each-way, Grade 60. It is imperative that the distributed steel be positioned accurately in the pavement cross section, namely 2 inches from the top of the pavement.
Contraction Joint Spacing	12.5 feet each way for pavement thickness of 5 to 5.5 inches. 15 feet each way for pavement thickness of 6 inches or greater.

Item	Description
	Saw cut control joints should be cut within 6 to 12 hours of concrete placement.
Contraction Joint Depth	At least ¼ of pavement thickness.
Contraction Joint Width	One-fourth inch or as required by joint sealant manufacturer.
Construction Joint Spacing	To attempt to limit the quantity of joints in the pavement, consideration can be given to installing construction joints at contraction joint locations, where it is applicable.
Construction Joint Depth/Width	Full depth of pavement thickness. Construct sealant reservoir along one edge of the joint. Width of reservoir to be ¼ inch or as required by joint sealant manufacturer. Depth of reservoir to be at least ¼ of pavement thickness.
Isolation Joint Spacing	As required to isolate pavement from structures, etc.
Isolation Joint Depth	Full depth of pavement thickness.
Isolation Joint Width	½ to 1 inch or as required by the joint sealant manufacturer.
Expansion Joint	In this locale, drying shrinkage of concrete typically significantly exceeds anticipated expansion due to thermal affects. As a result, the need for expansion joints is eliminated provided all joints (including saw cuts) are sealed. Construction of an unnecessary joint may be also become a maintenance problem. All joints should be sealed. If all joints, including saw cuts, are not sealed then expansion joints should be installed.

All construction joints have dowels. Dowel information varies with pavement thickness as presented as follows:

Pavement Thickness	5 inches	6 inches
Dowels Diameter	⅝ inch diameter	3/4 inch diameter
Dowel Spacing on Center	12 inches on center	12 inches on center
Dowel Length	12 inches long	12 inches long
Dowel Embedment	5 inches	6 inches

Pavement Thickness	5 inches	6 inches

1/ In relatively thin pavement sections (7 inches or less) round dowels can be impractical or counterproductive. The use of dowels may be economically justified where there are poor subgrade support conditions or heavy truck traffic.

Pavement Maintenance and Drainage

It is of paramount importance to maintain proper drainage, maintain subgrade moisture levels and provide routine maintenance on the pavement to help long-term pavement performance. The following recommendations should be implemented:

- The subgrade and the pavement surface should be designed to promote proper surface drainage, preferably at a minimum grade of 2 percent.
- Install joint sealant and seal cracks immediately.
- Extend curbs into the subgrade for a depth of at least 3 inches to help reduce moisture migration into the subgrade soils beneath the pavement section.
- Place compacted, low permeability clayey backfill against the exterior side of the curb and gutter.
- Slope subgrade in landscape islands to low points should drain to an appropriate outlet.
- Edge drains are recommended along pavement/ landscape borders.
- Strip (wick) drains installed behind the curbs will also help protect the pavements from water which ponds behind the curbs.

Note that even with the subgrade preparation and pavement maintenance measures, minor pavement distress should be anticipated.

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.

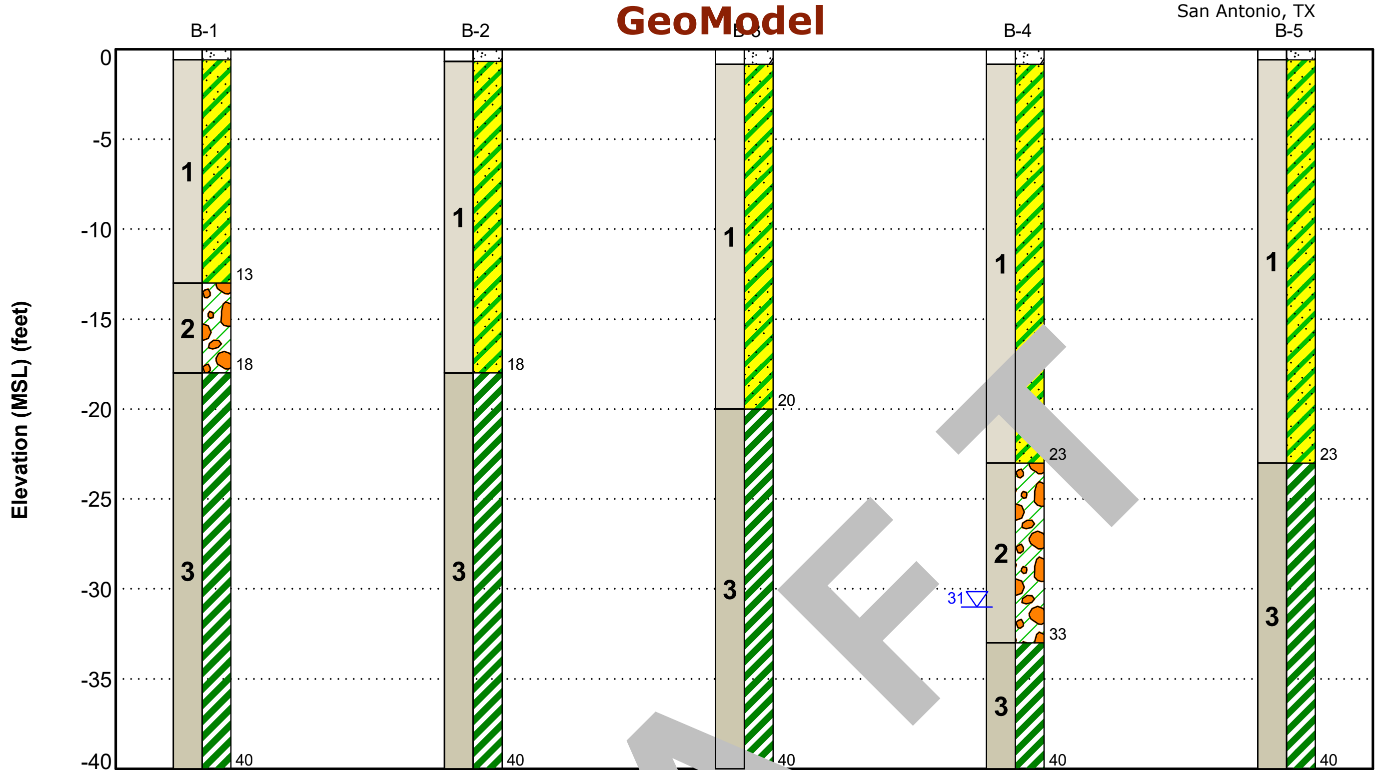
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly effect excavation 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.

Figures

Contents:

Terracon
6911 Blanco Rd
San Antonio, TX

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
1	Sand	Clayey Sand with chert Gravel (SC), Clayey Sand with silt (SC), Dark brown to light brown, calcareous; medium dense to very dense
2	Gravel	Clayey Gravel with chert Gravel (GC) brown to light brown, and gray to light gray ; very dense
3	Clay	Fat Clay (CH), Fat Clay with trace chert Gravel (CH) light brown and gray, calcareous; very stiff to hard

LEGEND

- Concrete
- Clayey Sand
- Clayey Gravel
- Fat Clay

First Water Observation

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.

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

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
5	40	Planned building addition 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. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the soil borings with a truck-mounted drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Soils were sampled by means of split barrel sampling procedure. In the split barrel sampling procedure, a standard 2-inch outer diameter split barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration was recorded as the Standard Penetration Test (SPT) resistance value. The samples were removed from the samplers in the field, visually classified, and appropriately sealed in sample containers to preserve in-situ moisture contents. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings and patched with asphalt after their completion.

Our exploration team prepared field boring logs as part of the drilling operations. The sampling depths, visual classification of the materials encountered, SPT values, pocket penetrometer readings, other pertinent sampling information were recorded on the field boring logs.

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
- Atterberg limits
- Percent Passing No. 200 sieve
- Sulfate Test

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.

Site Location and Exploration Plans

Contents:

Site Location

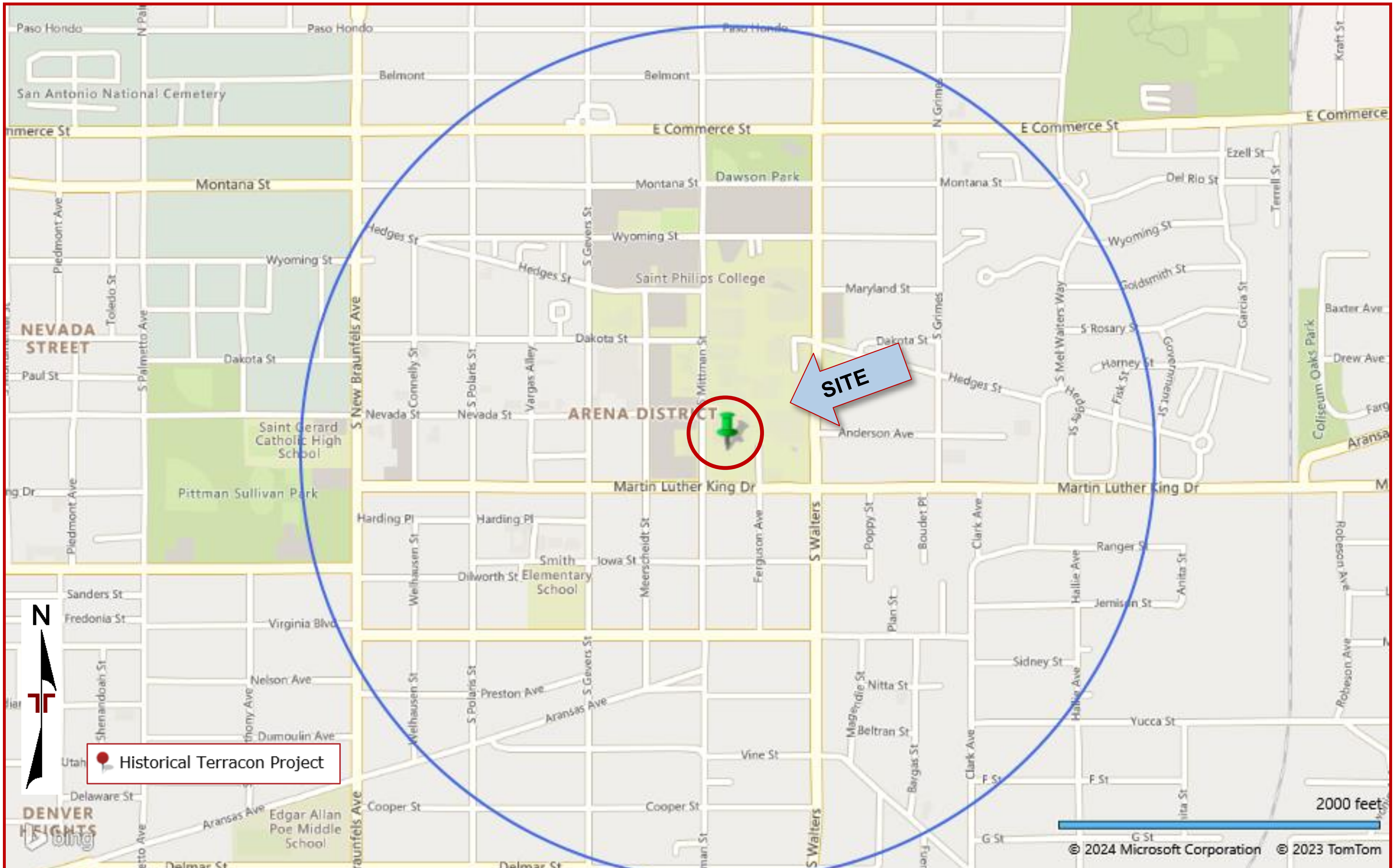


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES
MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

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

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

6000 Northwest Pkwy Ste 100
San Antonio, TX

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 29.4140° Longitude: -98.4544°

Model Layer	Depth (Ft.)	Material Description	Sample Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	0.2	**ASPHALT**, **2 Inches Thick**							
	0.6	**AGGREGATE BASE COURSE**, **5 Inches Thick**							
1	13.0	**CLAYEY SAND (SC)**, light brown, medium dense to dense, calcareous with trace gravel - silty in upper 2 feet - very dense between 4 and 8 feet - dense below 8 feet	0.5–2		X	14-12-14 N=26	18.5	27-20-7	
			2.5–4		X	13-25-12 N=37	10.8		28
			4.5–6		X	17-24-35 N=59	7.1		
			6.5–8		X	31-26-24 N=50	8.0		31
			8.5–10		X	19-23-19 N=42	9.9		
2	18.0	**CLAYEY GRAVEL (GC)**, light brown and light gray, very dense, chert gravel	13.5–15		X	16-30-35 N=65	6.9		17
3	40.0	**FAT CLAY (CH)**, light brown and gray, very stiff to hard - calcareous between 18 and 20 feet	18.5–20		X	21-10-13 N=23	27.2	19-17-2	
			23.5–25		X	8-12-18 N=30	24.8		
			28.5–30		X	13-16-21 N=37	24.3		
			32.5–34		X	12-18-18 N=36	22.2		
			38.5–40		X	12-16-21 N=37	24.7		
		Boring Terminated at 40 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.

Notes

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite
Surface Capped with Asphalt

Drill Rig
CME75

Hammer Type
Automatic

Driller
Eric

Logged by
J. Morney

Boring Started
12-22-2023

Boring Completed
12-22-2023

6000 Northwest Pkwy Ste 100
San Antonio, TX

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 29.4138° Longitude: -98.4544°

Model Layer	Depth (Ft.)	Material Description	Sample Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	0.2	**ASPHALT**, **2 Inches Thick**							
1	0.7	**AGGREGATE BASE COURSE**, **6 Inches Thick**							
1		**CLAYEY SAND (CL)**, light brown, medium dense to dense, calcareous with trace gravel			X	12-12-16 N=28	11.7	31-16-15	
1					X	10-13-11 N=24	12.3		
1			5		X	12-20-17 N=37	5.8		30
1		- very dense; marly below 6 feet			X	21-30-38 N=68	4.1		
1		- chert gravel below 8 feet			X	19-50/5"	1.9		
1			10						
1	18.0				X	15-50/4"	4.5		32
3		**FAT CLAY (CH)**, light brown and gray, very stiff to hard	15						
3		- calcareous, trace chert gravel between 18 and 20 feet			X	29-15-8 N=23	33.2		
3			20						
3					X	6-11-16 N=27	23.4	82-22-60	
3			25						
3					X	12-17-21 N=38	22.1		
3			30						
3					X	12-18-22 N=40	22.8		
3			35						
3	40.0				X	11-18-23 N=41	24.3		
		Boring Terminated at 40 Feet	40						

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

See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite
Surface Capped with Asphalt

Drill Rig
CME75

Hammer Type
Automatic

Driller
Eric

Logged by
J. Morney

Boring Started
12-22-2023

Boring Completed
12-22-2023

Terracon
6000 Northwest Pkwy Ste 100
San Antonio, TX

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 29.4140° Longitude: -98.4537°

Model Layer	Depth (Ft.)	Material Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
	0.2	**ASPHALT, 2 Inches Thick**							
	0.8	**AGGREGATE BASE COURSE, 8 Inches Thick**							
1		**CLAYEY SAND (SC)**, dark brown to light brown, medium dense to dense, calcareous with trace gravel				14-12-12 N=24	8.3	30-17-13	27
						26-25-40 N=65	12.1		
			5			20-20-22 N=42	8.8		
						12-18-28 N=46	9.7	28-14-14	
		- very dense; marly below 6 feet				18-23-31 N=54	6.3		37
			10						
						50/3"	7.2		
			15						
		- chert gravel below 18 feet				50/4"	6.2		56
	20.0								
3		**FAT CLAY (CH)**, light brown and gray, hard	20						
		- calcareous, trace chert gravel between 23 and 25 feet				23-24-19 N=43	13.8		
			25						
		- very stiff; calcareous between 28 and 30 feet				8-11-16 N=27	22.5		
			30						
		- hard between 33 and 35 feet				10-15-17 N=32	19.5		
			35						
		- very stiff below 38 feet				11-12-16 N=28	24.4		
	40.0		40						
		Boring Terminated at 40 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.

Notes

Water Level Observations
No free water observed

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite
Surface Capped with Asphalt

Drill Rig
CME75

Hammer Type
Automatic

Driller
Eric

Logged by
J. Morney

Boring Started
12-22-2023

Boring Completed
12-22-2023

Boring Log No. B-4

Location: See Exploration Plan

Latitude: 29.4138° Longitude: -98.4535°

Model Layer	Depth (Ft.)	Description
	0.2	**ASPHALT**, **2 Inches Thick**
	0.8	**AGGREGATE BASE COURSE**, **8 Inches Thick**
1	23.0	**CLAYEY SAND (SC)**, dark brown to light brown, medium dense to very dense, calcareous - silty in upper 2 feet
2	33.0	**CLAYEY GRAVEL (GC)**, brown and gray, very dense, chert gravel - medium dense below 26 feet - groundwater encountered at 31 feet while drilling
3	40.0	**FAT CLAY (CH)**, light brown and gray, very stiff to hard, wet
		Boring Terminated at 40 Feet

Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
10-12-14 N=26	12.6	26-21-5	
11-13-12 N=25	11.1		50
11-12-11 N=23	10.3		
4-11-8 N=19	11.3		
4-15-16 N=31	21.5		
18-14-22 N=36	15.1	31-15-16	
30-50/5"	12.4		
20-25-24 N=49	3.8		11
5-7-11 N=18	11.5		8
7-8-12 N=20	27.4		
10-15-20 N=35	17.1		

Depth (Ft.): 5, 10, 15, 20, 25, 30, 35, 40

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

See Supporting Information for explanation of symbols and abbreviations.

Notes

Water Level Observations
While drilling

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite
Surface Capped with Asphalt

Drill Rig
CME75

Hammer Type
Automatic

Driller
Eric

Logged by
J. Morney

Boring Started
12-22-2023

Boring Completed
12-22-2023

Boring Log No. B-5

Location: See Exploration Plan

Latitude: 29.4140° Longitude: -98.4539°

Model Layer	Depth (Ft.)	Description
	0.2	**ASPHALT**, **2 Inches Thick**
	0.6	**AGGREGATE BASE COURSE**, **5 Inches Thick**
1	23.0	**CLAYEY SAND (SC)**, brown to light brown, dense to very dense, calcareous with trace gravel - chert gravel below 13 feet - very dense; cemented below 18 feet
3	40.0	**FAT CLAY (CH)**, light brown and gray, very stiff to hard, calcareous
		Boring Terminated at 40 Feet

Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
26-24-20 N=44	16.3		29
16-20-18 N=38	14.0		34
17-16-14 N=30	14.4	26-21-5	
13-16-21 N=37	13.8		
20-34-38 N=72	12.5	24-16-8	
31-21-13 N=34	12.7		
33-50/5"	5.6		15
7-12-16 N=28	27.3		
12-17-22 N=39	21.0		
10-14-19 N=33	19.3		
13-17-20 N=37	23.3		

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.

Water Level Observations
No free water observed

Notes

Advancement Method
Flight Auger

Abandonment Method
Boring backfilled with Auger Cuttings and/or Bentonite
Surface Capped with Asphalt

Drill Rig
CME75

Hammer Type
Automatic

Driller
Eric

Logged by
J. Morney

Boring Started
12-22-2023

Boring Completed
12-22-2023

Supporting Information

Contents:

Note: All attachments are one page unless noted above.

General Notes

Sampling	Water Level	Field Tests
Auger Cuttings Rock Core Grab Sample Shelby Tube Split Spoon	Water 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.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

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

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 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 ≥ 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 ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 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.