Terracon GeoReport

Geotechnical Engineering Report

The Shops at Sedona Lakes

Manvel, Texas

February 6, 2019

Terracon Project No. 91195001

Prepared for:

NewQuest Properties

Houston, Texas

Prepared by:

Terracon Consultants, Inc.

League City, Texas

February 6, 2019

NewQuest Properties
8827 W. Sam Houston Parkway North, Suite 200
Houston, Texas 28203

Attn: Mr. Michael Harney

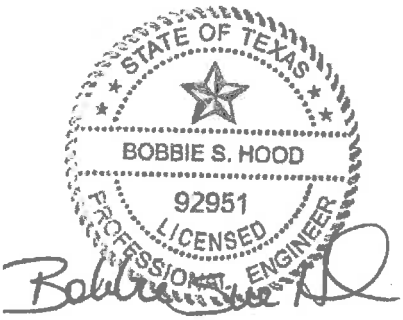
Re: Geotechnical Engineering Report
The Shops at Sedona Lakes
County Road 94 and County Road 101
Manvel, Texas
Terracon Project No. 91195001

Dear Mr. Harney:

Terracon Consultants, Inc. (Terracon) is pleased to submit our geotechnical engineering report for the project referenced above in Manvel, Texas. We trust that this report is responsive to your project needs. Please contact us if you have any questions or if we can be of further assistance.

We appreciate the opportunity to work with you on this project and look forward to providing additional geotechnical engineering and construction materials testing services in the future.

Sincerely,
Terracon Consultants, Inc.
(Texas Firm Registration No.: F-3272)



Rehan Khan, E.I.T.
Staff Geotechnical Engineer

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Geotechnical Services Manager

Enclosures
Copies submitted: Addressee (1) Electronic

REPORT TOPICS

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

ATTACHMENTS

Geotechnical Engineering Report

The Shops at Sedona Lakes
County Road 94 and County Road 101
Manvel, Texas

Terracon Project No. 91195001
February 6, 2019

INTRODUCTION

Terracon Consultants, Inc. (Terracon) is pleased to submit our geotechnical engineering report for the proposed construction of retail shops in Manvel, Texas. This project was authorized by Mr. Michael Harney, Development Manager of NewQuest Properties, through signature of our "Agreement for Services" on January 4, 2019. The project scope was performed in general accordance with Terracon Proposal No. P91195001, dated January 4, 2019.

The purpose of this report is to describe the subsurface conditions observed at the 5 borings drilled for this project, analyze and evaluate the test data, and provide recommendations with respect to:

- Site and subgrade preparation;
- Foundation design and construction;
- Requirements for fill to be used on-site, including engineering properties and placement and compaction; and
- Pavement design guidelines.

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

PROJECT DESCRIPTION

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

Item	Description
Proposed structures	■ A single-story building with a footprint area of 14,350 square feet. ■ Adjacent parking lots and driveways.

Item	Description
Building construction (assumed)	Either wood-frame or steel-frame construction with grade-supported concrete floor slab.
Finished floor elevation (assumed)[1]	Within approximately one to two feet above existing grade.
Maximum loads (assumed)	■ **Column loads:** 100 kips ■ **Floor slab pressure:** 125 pounds per square foot (psf).
Recommended foundation system	Either drilled-and-underreamed footings or shallow spread/strip footings.

1. If the grading and/or finished floor elevation is planned to be altered from what has been previously described, Terracon should be contacted to review and/or modify our recommendations given in this report.

SITE CONDITIONS

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

Item	Description
Parcel information	The project site is located at the northwest quadrant of the intersection of County Road 94 and County Road 101 in Manvel, Texas. See Site Location.
Existing improvements	The site was vacant at the time of our field program.
Current ground cover	Grass.
Existing topography	Relatively level.

GEOTECHNICAL CHARACTERIZATION

Geology

Based on the geologic maps published by the Bureau of Economic Geology, the site for the proposed construction is located on the Beaumont formation, a deltaic nonmarine Pleistocene deposit. The Beaumont formation is heterogeneous containing thick interbedded layers of clay, fine sand, and silt.

The coastal plain in this region has a complex tectonic geology, several major features of which are: Gulf Coastal geosyncline, salt domes, and major sea level fluctuations during the glacial stages, subsidence and geologic faulting activities. Most of these geologic faulting activities have ceased for millions of years, but some are still active. A detailed geologic fault investigation and study of the site geology are beyond the scope of this report.

Subsurface Profile

The particular subsurface stratigraphy, as evaluated from our field and laboratory programs, is shown in detail on the Boring Logs in the **Exploration Results** section of this report. Stratification boundaries on the Boring Logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual.

Fill soils were observed at the ground surface at borings B-2 through B-5 and extended to depths that ranged from approximately 2 to 4 feet. The underlying native subsurface soil generally consisted of lean clay, sandy lean clay, and silty sand soils that extended to the termination depths of the borings (approximately 5 to 20 feet).

The results of our field and laboratory programs can be summarized as follows:

Description	Plasticity Index	Moisture Content (%)	Moisture Content vs. Plastic Limit [1]	Undrained Shear Strength [2] (psf)	SPT N-Value (bpf) [3]	Percentage of Fines [4] (%)
Fill : Lean Clay and Sandy Lean Clay	8 to 16	15 to 20	-2 to +1	1.25 to 3 [5]	---	39
Lean Clay and Sandy Lean Clay	16 to 35	14 to 19	2 to 6	1,100 to 2,700	13	56
Silty Sand	---	---	---	---	5 to 9	---

1. The difference between a soil sample's moisture content and its corresponding plastic limit.
2. Based on unconfined compressive strength tests.
3. bpf = blows per foot.
4. Percent passing the No. 200 sieve.
5. Hand penetrometer readings in tons per square foot (tsf).

Groundwater Conditions

In an effort to evaluate groundwater conditions at the time of our field program, borings B-1 through B-3 were advanced using dry drilling techniques to depths that ranged from approximately 13 to 15 feet and borings B-4 and B-5 were advanced using dry drilling techniques to their termination depth (about 5 feet). Wet rotary techniques were used thereafter to the termination depth of borings B-1 through B-3 (about 20 feet). Upon reaching groundwater, drilling was suspended for a period of about 15 minutes to allow the groundwater to rise and the groundwater levels to be recorded. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results**, and are summarized below.

Summary of Groundwater Level Observations					
Boring No.	Boring Depth (feet) [1]	Depth of Dry Drilling (feet) [1]	Approximate Depth of Groundwater Below Existing Grade (feet)		
			Initial/During Dry Drilling	After 5 Minutes	After 15 Minutes
B-1	20	15	15	7	5½
B-2	20	13	13	7	6
B-3	20	13	13	7	6
B-4	5	5	Groundwater not observed.		
B-5	5	5			

1. Below existing grade.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than 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 and should be evaluated prior to construction.

GEOTECHNICAL OVERVIEW

- Fill soils were observed at the ground surface at borings B-2 through B-5 and extended to depths that ranged from approximately 2 to 4 feet. Fill may be present at varying depths and at other locations not explored during our field program. Support of the foundation elements, slabs, pavements and flatworks on or above fill soils is discussed in this report. However, even with the recommended construction testing services, an inherent risk exists for the owner that compressible fill or unsuitable material within or buried by the fill will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill.

- Expansive soils were observed at this site. This report provides recommendations to help reduce the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and distress in the building should be anticipated. The severity of distress will increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement associated with expansive soils may not be feasible. However, this risk can be significantly reduced if the building addition is designed as a structural slab over a void space with the structural loads supported by a foundation system terminated below the active zone. Terracon can provide recommendations for this option, if requested.

- A foundation system consisting of either drilled-and-underreamed footings or shallow spread/strip footings may be utilized to support the proposed retail building planned at this site.

- A minimum 24-inch thick select fill building pad should be placed under the proposed building to provide uniform support to the floor slab and reduce the estimated Potential Vertical Rise (PVR) of the subgrade to approximately one inch or less.

- Flexible pavement sections vary from 2.0 to 2.5 inches of asphaltic concrete over 8.0 to 10.0 inches of base material with chemically treated subgrade.

- Rigid pavement sections vary from 5.0 to 7.0 inches of reinforced concrete with chemically treated subgrade.

This summary should be used in conjunction with the entire report for design purposes. Details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **General Comments** should be read for an understanding of the report limitations.

EARTHWORK

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

Site Preparation

Construction areas should be stripped of vegetation, topsoil, and other debris/unsuitable surface material. Proper site drainage should be maintained during construction so that ponding of surface runoff does not occur and cause construction delays and/or inhibit site access.

Once final subgrade elevations have been achieved, the exposed subgrade should be carefully proofrolled with a 20-ton pneumatic roller or equivalent equipment, such as a fully loaded dump truck, to detect weak zones in the subgrade. Special care should be exercised when proofrolling areas containing fill soils in an attempt to observe soft/weak zones within the fill soils. Weak areas detected during proofrolling, as well as zones of fill containing organic matter and/or debris, should be removed and replaced with soils exhibiting similar classification, moisture content, and density as the adjacent in-situ soils. Proofrolling should be performed under the direct observation of the geotechnical engineer or his/her representative.

Subsequent to proofrolling, and just prior to placement of fill, the exposed subgrade within the construction area should be evaluated for moisture and density. If the moisture and/or density do not meet the criteria described in **Fill Compaction Requirements** for on-site soils, the subgrade should be scarified to a minimum depth of 6 inches, moisture adjusted, and compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density

Fill Material Types

Select fill and on-site soils to be used at this site for grade adjustments should meet the following criteria:

Fill Type	USCS Classification	Acceptable Location for Placement
Select fill	CL and/or SC (10≤PI≤20)	Must be used to construct the building pad under the floor slab and for all grade adjustments in the building area.
On-site soils	Varies	The on-site soils, including the undocumented fill soils, appear suitable for use as fill within the pavement areas, provided they are free of organics and debris.

If blended or mixed soils are intended for use to construct the building pad, Terracon should be contacted to provide additional recommendations. Blended or mixed soils do not occur naturally. These soils are a blend of sand and clay and will require mechanical mixing with a pulvimixer at the site. If these soils are not mixed thoroughly to break down the clay clods and blend-in the sand to produce a uniform soil matrix, the fill material may be detrimental to the slab performance. If blended soils are used, we recommend that additional samples of the blended soils, as well as the clay clods, be obtained prior to and during earthwork operations to evaluate if the blended soils can be used in lieu of select fill. The actual type and amount of mechanical mixing at the site will depend on the amount of clay and sand, and properties of the clay.

Fill Compaction Requirements

Select fill and on-site soils should meet the following compaction requirements.

Structural Fill	General Fill
Fill Lift Thickness	The fill soils should be placed on prepared surfaces in lifts not to exceed 8 inches loose measure, with compacted thickness not to exceed 6 inches.
Compaction Requirements	■ The select fill and on-site soils should be compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density. ■ The select fill soils should be moisture adjusted to within 2 percent of the optimum moisture content. ■ The on-site clay soils should be moisture conditioned to between optimum and +4 percent of the optimum moisture content.

Prior to any filling operations, samples of the proposed borrow 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 evaluate that proper levels of compaction, including dry unit weight and moisture content, are being attained.

Utility Trench Backfill

Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the structures should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the building. We recommend constructing an effective clay “trench plug” that extends at least 5 feet out from the face of the building exterior. The plug material should consist of clay compacted at a water content at or above the soils optimum water content. The clay fill should be placed to completely surround the utility line and be compacted in accordance with recommendations in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction. Water permitted to pond next to the building can result in distress in the building. These greater movements can result in unacceptable differential floor slab movements, cracked slabs and walls, and roof leaks. Building slab and foundation performances described in this report are based on effective drainage for the life of the structures and cannot be relied upon if effective drainage is not maintained.

Exposed ground should be sloped away from the building for at least 10 feet beyond the perimeter of the building. After building construction and landscaping, we recommend verifying final grades to document that effective drainage has been achieved. Grades around the building should also be periodically inspected and adjusted as necessary, as part of the building’s maintenance program.

Planters located within 10 feet of the proposed building should be self-contained to prevent water accessing the building and pavement subgrade soils. Locate sprinkler mains and spray heads a minimum of 5 feet away from the building lines. Low-volume, drip-style landscaped irrigation should not be used near the building. Collect roof runoff in drains or gutters. Discharge roof drains and downspouts onto pavements and/or flatworks which slope away from the proposed building or extend down spouts a minimum of 10 feet away from building.

Flatworks and pavements will be subject to post construction movement. Maximum grades practical 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 movement would be critical. Where paving or flatwork abuts the building, effectively seal and maintain joints to prevent surface water infiltration.

Wet Weather/Soft Subgrade Considerations

Construction operations may encounter difficulties due to the wet or soft surface soils becoming a general hindrance to equipment due to rutting and pumping of the soil surface, especially during and soon after periods of wet weather. If the subgrade cannot be adequately compacted to minimum densities as described above, one of the following measures will be required: 1) removal and replacement with select fill, 2) chemical treatment of the soil to dry and improve the condition of the subgrade, or 3) drying by natural means if the schedule allows. In our experience with similar soils in this area, chemical treatment is an efficient and effective method to increase the supporting value of wet and weak subgrade. Terracon should be contacted for additional recommendations if chemical treatment of the soils is planned due to soft and/or wet subgrade.

FOUNDATION SYSTEM

Based on the subsurface conditions observed during our field and laboratory programs, a foundation system consisting of either drilled-and-underreamed footings or shallow spread footings may be utilized to support the proposed building planned at this site, provided the subgrade is properly prepared as described in this report. Recommendations for these foundation systems are provided in the following sections, along with other geotechnical considerations for this project.

Design Recommendations – Drilled-and-Underreamed Footings

Description	Design Parameters
Minimum embedment depth [1]	8 feet below existing grade (grade at the time of our field program)
Allowable bearing pressures [2]	Net dead plus sustained live load – 3,000 psf Net total load – 4,500 psf

Description	Design Parameters
Maximum underream-to-shaft diameter ratio	3:1
Minimum underream-to-shaft diameter ratio [3]	2:1
Estimated uplift pressure due to post-construction heave of the clay soils [4]	1,000 psf
Minimum percentage of steel [5]	0.5 percent
Approximate post-construction settlement [6]	one inch or less
Estimated differential settlement [7]	Approximately ½ of post-construction settlement
Allowable passive pressure [8]	1,000 psf

1. The footings should bear within the native undisturbed clay soils.
2. Whichever condition yields a larger bearing area.
3. This minimum underream-to-shaft diameter ratio should result in a large enough diameter of the underream to overcome uplift forces on the footing without casing local soil failure to the overlying soils.
4. The magnitude of uplift is difficult to predict and will vary with in-situ moisture contents. This uplift pressure can be approximated over the entire perimeter of the shaft from the top of the underream to the bottom of the select fill pad.
5. The footings should contain sufficient vertical reinforcing steel throughout the entire shaft length to resist uplift (tensile) forces due to post-construction heave of the clay soils. The amount of reinforcing steel required can be computed by assuming that the dead load of the structure surcharges the footing, that the above estimated tensile force acts vertically on the shaft, and that the underream acts as a rigid.
6. This estimated post-construction settlement of the drilled-and-underreamed footings is without considering the effect of stress distribution from adjacent foundations and assuming proper construction practices are being followed. A clear distance between the footings of one underream diameter of the larger footing should be provided between the underreams to develop the recommended bearing pressures and to control settlements. If a clearance of one diameter cannot be maintained in every case, the above bearing capacities should be reduced by 20 percent for a clearance between one half and one underream diameters. Underreams closer than a clearance of one half of an underream diameter are not recommended.
7. The differential settlement will result from variances in subsurface conditions, loading conditions and construction procedures, such a cleanliness of the bearing area or flowing water in the shaft.
8. For footings placed against an undisturbed vertical face of the in-situ soils. Lateral resistance of the drilled-and-underreamed footings is primarily developed by passive resistance of the soils against the side of the footing. Due to surface effects and the presence of fill and expansive soils, the lateral resistance of the upper 4 feet of the soils at the surface for exterior footings should be neglected unless area paving is provided up to the edge of the building.
9. Structural uplift loads on the drilled-and-underreamed footings will be resisted by the dead weight of the footings and supported structure plus the weight of a soil wedge above the footing. The soil wedge can be assumed to extend upward from the bottom of the underream at a slope of 4 vertical to 1 horizontal.

Construction Considerations – Drilled-and-Underreamed Footings

Drilled excavations to a depth of 8 feet below existing grade will be necessary for installation of drilled-and-underreamed footings for the proposed buildings planned at this site. The excavations should be performed with equipment capable of providing a relatively clean bearing area. The presence of secondary structures such as roots, ferrous and calcareous nodules, etc., can cause sloughing during footing excavation. Thus, the drilling contractor should have casing available in the event that sloughing causes improperly formed shafts.

Based on our groundwater observations (refer to **Groundwater Conditions**), groundwater is not expected to be a major concern during construction at the recommended bearing depth. However, depending on climatic conditions, groundwater levels may vary from the levels observed during our field program. Water must not be allowed to accumulate in the bottom of the footing excavations. The contractor should be prepared to remove water from the drilled footings, if necessary. To reduce the potential for water seepage into the footing excavation and to minimize disturbance to the bearing area, we recommend that concrete and steel be placed as soon as possible after footing excavations are completed. Preferably, footing excavations should be backfilled with concrete within about 2 to 4 hours of completion of the drilling and in no case should an excavation be left open overnight. The concrete placed in the excavations should have a 6-inch slump with a plus or minus one inch tolerance. The bottom of each footing excavation should be free of all loose materials and/or water, and the bearing surface should be evaluated immediately prior to placing concrete.

Additionally, the subgrade soils tend to become very silty/sandy below a depth of about 12 feet below existing grade at boring B-3. If underreams were attempted below the recommended bearing depth, they would likely become unstable. In addition, significant groundwater seepage could occur. Thus, we recommend the footing depths not be lowered below the recommended bearing depth without discussion and consideration of the consequences. The contractor should not auger the shaft deeper than the recommended bearing depth under any circumstances without contacting us.

Based on the available field and laboratory data, the underreams constructed as described in this report should remain stable for a short period of time. However, if underreams are marginally stable due to water seepage and/or the presence of sloughing soils, successful construction of underreamed footings may be possible by performing the sequence of construction without interruption, that is, each footing drilled, underreamed, and backfilled with concrete in one continuous operation. The contractor must coordinate the operation very closely to have concrete on site at the time each footing is drilled and underreamed so that no shaft or underream is drilled without concrete standing by, ready to be placed. Additional measures to reduce the potential for caving of the underream would be to limit the underream-to-shaft diameter ratio to 2.5:1 or 2:1 or to install straight shaft footings in isolated problem areas. If straight-shaft footings are planned at the site, Terracon should be contacted for additional recommendations.

Grade Beams – Drilled-and-Underreamed Footings

Grade beams associated with the drilled-and-underreamed footings should be designed to span between the footings without subgrade support. Often, a vertical void of about 6 to 8 inches is provided beneath the grade beams in clay soils such as those observed at this site. However, recent experience indicates that the voids beneath the grade beams often fill with water, providing moisture to the surrounding subgrade. Therefore, provided that the subgrade is prepared as recommended in this report, grade beams may be constructed without a void at this site. However,

due to the underlying clay soils, nominal upward movement of the grade beams may occur during moisture variations of the subgrade.

If construction of voids beneath the grade beams is planned, proper construction of the voids and soil retainers is very important. If a cardboard carton system is used on this project, we recommend that the carton form supplier provide, during the initial concrete operations, a representative to instruct the work force on the proper installation methods for both the forms and the concrete. In addition, measures should be implemented to provide proper surface drainage away from the structures to reduce the potential for water to access the voids.

Backfill against the outside face of the grade beams should consist of select fill used to prepare the building pad. The select fill should be uniformly compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density at a moisture content within 2 percent of optimum moisture content.

Design Recommendations – Shallow Spread/Strip Footings

Item	Description
Minimum embedment depth [1]	3 feet below existing grade (grade at the time of our field program)
Allowable bearing pressures (individual footings) [2]	Net dead plus sustained live load – 2,500 psf Net total load – 3,750 psf
Allowable bearing pressure (strip footing) [3]	Net total load – 2,500 psf
Approximate post-construction settlement [4]	Approximately one inch
Estimated post-construction differential settlement [5]	Approximately ½ of post-construction settlement
Allowable passive pressure [6]	1,000psf
Allowable frictional resistance [7]	250 psf
Uplift resistance [8]	Foundation Weight (150 pcf) & Soil Weight (120 pcf)

1. The footings should bear upon native undisturbed clay soils.
2. Whichever condition yields a larger bearing area.
3. Defined as a footing at least twice as long as it is wide.
4. This estimated post-construction settlement of the shallow footings is without considering the effect of stress distribution from adjacent foundations and assuming proper construction practices are followed. A clear distance between footings of one footing size of the larger of the two footings should not produce overlapping stress distributions and would essentially behave as independent foundations. If the footing widths are planned to be larger than presented herein or if the footings are planned to be in close proximity to each other, Terracon should be contacted to perform a detailed settlement analysis.
5. The post-construction differential settlements may result from variances in subsurface conditions, loading conditions, and construction procedures. The settlement response of the footings will be more dependent upon the quality of construction than upon the response of the subgrade to the foundation loads.
6. The passive pressure along the exterior face of the footings should be neglected within the upper 4 feet due to surface effects and the presence of fill and expansive soils unless pavement is provided up to the edge of the structures. For interior footings, the allowable passive pressure may be used for the entire depth of the footing.

Item	Description
7. To be utilized on the base of the footings.	
8. Structural uplift loads on the shallow footings may be resisted by the weight of the foundation plus the weight of any soil directly above the foundation. The ultimate uplift capacity of shallow footings should be reduced by an appropriate factor of safety to compute allowable uplift capacity.	

Construction Considerations – Shallow Spread/Strip Footings

Excavations for shallow footings should be performed with equipment capable of providing a relatively clean bearing area. The bottom 6 inches of the foundation excavations should be completed with a smooth-mouthed bucket or by hand labor. The excavations should be neatly excavated and properly formed. Debris in the bottom of the excavation should be removed prior to steel placement. Based on the groundwater observations obtained during our field program (refer to **Groundwater Conditions**), significant groundwater seepage is not anticipated for shallow footings at the recommended bearing depth. However, water should not be allowed to accumulate at the bottom of the foundation excavations. To reduce the potential for groundwater seepage into the excavations and to minimize disturbance to the bearing area, we recommend that concrete and steel be placed as soon as possible after the excavations are completed. Excavations should not be left open overnight. The bearing surface of the shallow footings should be evaluated immediately prior to placing concrete or a seal slab.

A thin seal slab of lean concrete (approximately 2 to 4 inches thick) should be placed at the bottom of the footing excavation to protect the bearing surface of the footings from disturbance and/or infiltration of ground/surface water if the footing cannot be poured within the same day of excavation.

Foundation Construction Monitoring

The performance of the foundation system for the proposed structure will be highly dependent upon the quality of construction. Thus, we recommend that fill pad compaction and foundation installation be observed full time by an experienced Terracon soil technician under the direction of our geotechnical engineer. During foundation installation, the base of the foundations should be observed to evaluate the condition of the subgrade. We would be pleased to develop a plan for compaction and foundation installation observation to be incorporated in the overall quality control program.

FLOOR SLAB

Planned finished grades for the proposed building was not available at the time of this report. We anticipate that the finished floor elevation of the proposed building is planned to be within about one to two feet above the existing grade. If the grading is planned to be altered from what has

been previously described, Terracon should be notified to review and/or modify our recommendations given in this subsection.

The near surface soils observed at this site generally exhibit a variable expansion potential. These soils can subject the interior floor slab of the building to significant movements (due to shrinking and swelling) with fluctuations in their moisture content. This movement potential is influenced primarily by the properties of the subgrade soils, as well as the moisture content of the subgrade at the time of construction, overburden pressures, and the stability of the moisture contents throughout the life of the building. Based on the information developed from our field and laboratory programs and on method TEX-124-E in 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 up to approximately 2 inches. Therefore, we highly recommend that the near-surface soils be prepared as stated below to reduce the potential for slab movement associated with volumetric changes of the near-surface clay soils due to moisture variations to a more acceptable level. The actual movements could be greater if poor drainage, ponded water, and/or other sources of moisture are allowed to infiltrate beneath the structure after construction.

The most common method of subgrade preparation to reduce potential expansion of the subgrade would be to provide a pad of properly placed and compacted select fill beneath the grade-supported floor slabs. The corresponding decrease in the potential soil movements is primarily a function of the fill pad thickness and the moisture levels of the underlying clay subgrade. While the indicated preparations do not eliminate the potential for soil movement, the magnitude of such movements should be reduced to more acceptable levels. To provide uniform support to the floor slab and to reduce the estimated PVR to approximately one inch or less, we recommend that a minimum 24 inches of properly placed and compacted select fill material be constructed immediately beneath the floor slab. The select fill pad should extend a minimum of 5 feet beyond the edge of the building area. The final exterior grade adjacent to the structure should be sloped to promote effective drainage away from the structure.

Select fill should be utilized for all grade adjustments within the proposed building area. The subgrade and select fill soils should be prepared as outlined in **Earthwork**, which contains material and placement requirements for select fill, as well as other subgrade preparation recommendations.

The subgrade soils for flatwork outside of the structure which will be sensitive to movement should be prepared as discussed previously. This preparation will be important on surrounding sidewalks and paving immediately adjacent to the structure. If these adjacent flatwork areas are not prepared as stated above for the building area, the estimated PVR for these areas could approach those indicated previously for in-situ conditions. If the soils swell in these areas, this movement could result in significant distress to the adjacent sidewalks and paving and possibly result in reversed drainage (flow of runoff toward the structure) around the perimeter of the structure.

PAVEMENTS

Once the subgrade is properly prepared, both flexible pavement systems (consisting of asphaltic concrete and base material) and rigid pavement systems may be considered for this project. Detailed traffic loads and frequencies were not available. However, we anticipate that traffic will consist primarily of passenger vehicles in the parking areas and passenger vehicles combined with garbage trucks and large multi-axle delivery trucks from time-to-time in driveway areas.

Tabulated in the following table are the assumed traffic frequencies and loads used to design pavement sections for this project. When actual traffic conditions have been determined Terracon should be contacted to review the information to consider a need for revision of the pavement designs and related recommendations.

Pavement Area	Traffic Design Index [1]	Description
Automobile Parking Areas	DI-1	Light traffic (Few vehicles heavier than passenger cars, no regular use by heavily loaded two axle trucks.) (EAL [2] < 6)
Driveways (Light Duty)	DI-2	Medium to light traffic (Similar to DI-1 including not over 50 loaded two axle trucks or lightly loaded larger vehicles per day. No regular use by heavily loaded trucks with three or more axles.) (EAL = 6-20)
Driveways and Truck Traffic Areas (Medium Duty)	DI-3	Medium traffic (Including not over 300 heavily loaded two axle trucks plus lightly loaded trucks with three or more axles and no more than 30 heavily loaded trucks with more than three axles per day.) (EAL = 21-75)

1. Based on NSSGA traffic design indices.
2. Equivalent daily 18-kip single-axle load applications.

The top 6 inches of the finished subgrade soils directly beneath the pavements be chemically treated with either lime or a mixture of lime-flyash. The decision about the type and proper amount of additive should be made after the subgrade is open for inspection. Chemical treatment will increase the supporting value of the subgrade and decrease the effect of moisture on subgrade soils. These 6 inches of treatment is a required part of the pavement design and is not a part of the site and subgrade preparation for wet/soft subgrade conditions.

Listed below are pavement component thicknesses, which may be used as a guide for pavement systems at the site for the traffic classifications stated herein. These systems were derived based on general characterization of the subgrade. Specific testing (such as CBR's, resilient modulus tests, etc.) was not performed for this project to evaluate the support characteristics of the subgrade.

Flexible Pavement System		
Component	**Material Thickness, Inches**	
	DI-1	**DI-2**
Asphaltic concrete	2.0	2.5
Base material	8.0	10.0
Treated subgrade	6.0	6.0

Rigid Pavement System			
Component	**Material Thickness, Inches**		
	DI-1	**DI-2**	**DI-3**
Reinforced concrete	5.0	6.0	7.0
Treated subgrade	6.0	6.0	6.0

Waste dumpster areas should be constructed of at least 7 inches of reinforced concrete pavement. The concrete pad areas should be designed so that the vehicle wheels of the collection truck are supported on the concrete while the dumpster is being lifted to support the large wheel loading imposed during waste collection.

Presented below are our recommended material requirements for the various pavement sections.

Reinforced Concrete Pavement – The materials and properties of reinforced concrete pavement should meet applicable requirements in the ACI Manual of Concrete Practice. The portland cement concrete mix should have a minimum 28-day compressive strength of 3,500 psi.

Reinforcing Steel – ACI recommendations indicate that distributed steel reinforcement is not necessary when the pavement is properly jointed to form short panel lengths that will help reduce intermediate cracking. Provided the concrete pavement is designed and constructed as stated herein, the installation of reinforcing steel is optional and should be evaluated by the design team. Proper layout and installation of the joints within the pavement is critical to help control intermediate cracking.

If reinforcing steel is planned to be utilized in the concrete pavement by the design team, the following amount of reinforcing steel should be used as a guideline:
DI-1: #3 bars spaced at 18 inches or #4 bars spaced at 24 inches on centers in both directions.
DI-2: #3 bars spaced at 12 inches or #4 bars spaced at 18 inches on centers in both directions.
DI-3: #4 bars spaced at 18 inches on centers in both directions.

Control Joint Spacing – ACI recommendations indicate that control joints should be spaced at a maximum spacing of 30 times the thickness of the pavement for unreinforced parking lot pavements. Furthermore, ACI recommends a maximum control joint spacing of 12.5 feet for 5-inch pavements and a maximum control joint spacing of 15 feet for 6-inch or thicker pavements. Sawcut control joints should be cut within 4 to 12 hours of concrete placement to help control the formation of plastic shrinkage cracks as the concrete cures. The depth of the joint should be at

least one-quarter of the slab depth when using a conventional saw or one inch when using early entry saws. The width of the cut should be in accordance with the joint sealant manufacturer recommendations.

Expansion Joint Spacing – ACI recommendations indicate that regularly spaced expansion joints may be deleted from concrete pavements. Therefore, the installation of expansion joints is optional and should be evaluated by the design team.

Construction Joints – When concrete is planned to be placed at different times, we recommend the use of a construction joint between paving areas. The construction joint should consist of a butt joint (not a keyway joint).

Concrete Curing Compound – A concrete curing compound, such as a Type 2 membrane curing compound conforming to TxDOT DMS-4650, "Hydraulic Cement Concrete Curing Materials and Evaporation Retardants" or equivalent, should be applied to the concrete surface immediately after placement of the concrete in accordance with TxDOT 2014 Standard Specifications Item 360.

Dowels at Expansion/Construction Joints – The dowels at expansion/construction joints should be spaced at 12-inch centers and consist of the following:
DI-1: 5/8-inch diameter, 12-inches long with 5-inch embedment.
DI-2: 3/4-inch diameter, 14-inches long with 6-inch embedment.
DI-3: 7/8-inch diameter, 14-inches long with 6-inch embedment.

Hot Mix Asphaltic Concrete Surface Course – The asphaltic concrete surface course should be plant mixed, hot laid Type D (Fine Graded Surface Course) meeting the requirements in TxDOT 2014 Standard Specifications Item 340. Specific criteria for the job specifications should include compaction to within an air void range of 5 to 9 percent calculated using the maximum theoretical specific gravity of the mix measured by TxDOT Tex-227-F. The asphalt cement content by percent of total mixture weight should be within ± 0.5 percent asphalt cement from the job mix design.

Base Material – Base material should be composed of crushed limestone or crushed concrete meeting the requirements of TxDOT 2014 Standard Specifications Item 247, Type A or D, Grade 1-2. The base material should be compacted to at least 95 percent of the Modified Effort (ASTM D1557) maximum dry density at moisture content within 2 percent of the optimum moisture content.

Lime-Flyash Treated Subgrade – The low to medium plasticity clay soils (PI<15 percent) should be treated with lime-flyash in accordance with TxDOT 2014 Standard Specifications Item 265. Based on the classification test results, we recommend about 2 to 3 percent lime and 7 to 8 percent flyash by dry weight be used for estimating and planning. The percentages are given

as application by dry weight and are typically equivalent to about 10 to 15 pounds of lime and 35 to 40 pounds of flyash per square yard per 6-inch depth. Lime-flyash is also available pre-mixed, typically in percentages of 20 to 30 percent lime and 70 to 80 percent flyash. These pre-mixed products may be used if preferred at a rate of 50 pounds per square yard per 6-inch depth. The actual quantity of lime-flyash should be determined at the time of construction based on laboratory testing conducted using bulk samples of the subgrade soils. The subgrade should be compacted to at least 95 percent of the Standard Effort (ASTM D 698) maximum dry density at a moisture content within 2 percent of the optimum moisture content.

Lime Treated Subgrade – The medium to high plasticity clay fill soils (PI>15 percent) should be treated with lime in accordance with the TXDOT 2014 Standard Specifications Item 260. The amount of lime should be determined for subgrade soils by conducting laboratory tests just prior to construction. Based on the classification test results, we recommend that about 5 to 6 percent lime by dry weight be used for estimating and planning. The percentages are given as application by dry weight and are typically equivalent to about 25 to 30 pounds of lime per square yard per 6-inch depth. The pulverization, mixing and curing of the lime treated subgrade is of particular importance in these clays. The subgrade should be compacted to a minimum of 95 percent of the Standard Effort (ASTM D 698) maximum dry density at a moisture content between optimum and 4 percent wet of the optimum moisture content.

Preferably, traffic should be kept off the treated subgrade for 7 days to facilitate curing of the soil-chemical mixture. In addition, the subgrade is not suitable for heavy construction traffic prior to paving.

The pavement design methods described above are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade such as the soils encountered at this site. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. Post-construction subgrade movements and some cracking of pavements are not uncommon for clay subgrade conditions such as those observed at this site. Reducing moisture changes in the subgrade is important to reduce shrink/swell movements. Although chemical treatment will help to reduce such movement/cracking, this movement/cracking cannot be feasibly eliminated.

Related civil design factors such as subgrade drainage, shoulder support, cross-sectional configurations, surface elevations and environmental factors which will significantly affect the service life must be included in the preparation of the construction drawings and specifications. Normal periodic maintenance will be required.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventative maintenance. The following recommendations should be implemented to help promote long-term pavement performance:

- 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 treated subgrade for a depth of at least 4 inches to help reduce moisture migration into the subgrade soils beneath the pavement section; and
- Place compacted, low permeability clayey backfill against the exterior side of the curb and gutter.

Preventative maintenance should be planned and provided for the pavements at this site. Preventative maintenance activities are intended to slow the rate of pavement deterioration, and consist of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Prior to implementing any maintenance, additional engineering observations are recommended to determine the type and extent of preventative maintenance.

GENERAL COMMENTS

Our work is conducted with the understanding of the project as described in the proposal, and incorporates collaboration with the design team as we complete our services to verify assumptions. Revision of our understanding to reflect actual conditions important to our work was based on these verifications and it is reflected in this report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the geotechnical conditions in the area, the data obtained from our site exploration and from our understanding of the project. Variations will occur between exploration point locations, across the site, 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 the final report, to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project. 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 only. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

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

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Planned Boring Depth (feet) [1]	Planned Location
3	20	Within the proposed building footprint.
2	5	Parking lot/driveways

1. Below existing grade.

Boring Layout and Elevations: We use handheld GPS equipment to locate borings with an estimated horizontal accuracy of +/-25 feet. Field measurements from existing site features are also utilized. If available, approximate elevations are obtained by interpolation from a site specific, surveyed topographic map.

Subsurface Exploration Procedures: We advance soil borings with an all-terrain vehicle (ATV) drilling equipment using continuous flight augers (solid stem). Six samples are obtained in the upper 12 feet of each boring and at intervals of 5 feet thereafter.

Cohesive soil samples are generally recovered using open-tube samplers. Hand penetrometer tests are performed on samples of cohesive soils to serve as a general measure of consistency.

Cohesionless soils and soils for which good quality open-tube samples cannot be recovered are generally sampled by means of the Standard Penetration Test (SPT). This test consists of measuring the number of blows (N) required for a 140-pound hammer free falling 30 inches to drive a standard split-spoon sampler 12 inches into the subsurface material after being seated six inches. This blow count or SPT N-value is used to evaluate the stratum.

The samples are placed in appropriate containers, taken to our soil laboratory for testing, and classified by a geotechnical engineer. In addition, we observe and record groundwater levels during drilling and sampling.

Our exploration team prepares field boring logs as part of standard drilling operations. Field boring logs include sampling depths, penetration distances, and other relevant sampling information. Field logs include visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Final boring logs, prepared from field logs, represent the geotechnical engineer's interpretation, and include modifications based on observations and laboratory tests.

Property Disturbance: We backfill borings with auger cuttings after completion. Our services do not include repair of the site beyond backfilling our borings. Excess auger cuttings are dispersed

in the general vicinity of the boring. Because backfill material often settles below the surface after a period, we recommend borings be checked periodically and backfilled, if necessary.

Laboratory Testing

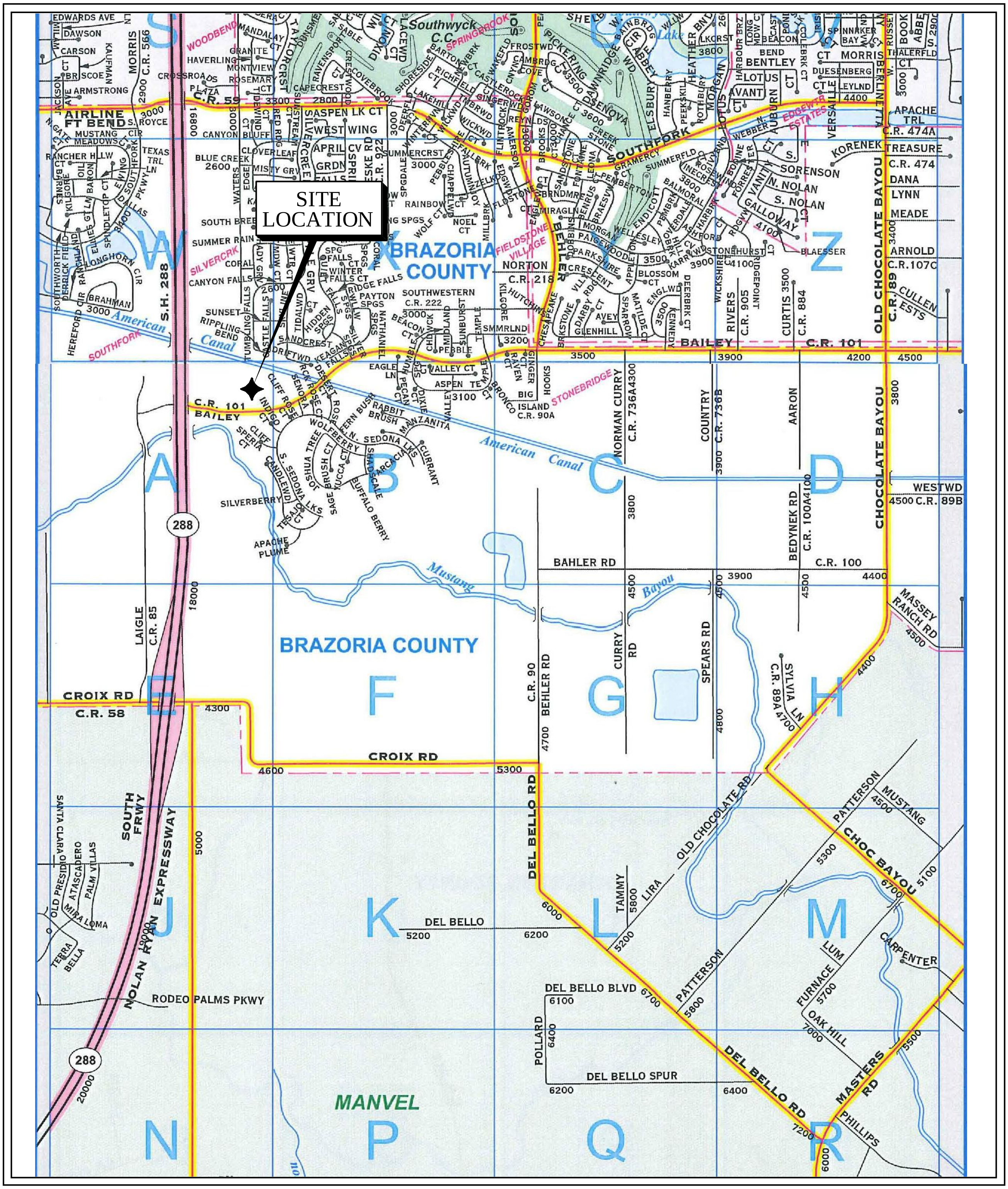
The project engineer reviews field data and assigns various laboratory tests to better understand the engineering properties of various soil strata. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practices and professional judgment. Standards noted below include reference to other related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
- ASTM D1140 Standard Test Methods for Amount of Materials in Soils Finer than the No. 200 Sieve

The laboratory testing program includes examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we describe and classify soil samples in accordance with the Unified Soil Classification System (USCS).

Samples not tested in the laboratory will be stored for a period of 30 days subsequent to submittal of this report and will be discarded after this period, unless we are notified otherwise.

SITE LOCATION AND EXPLORATION PLANS



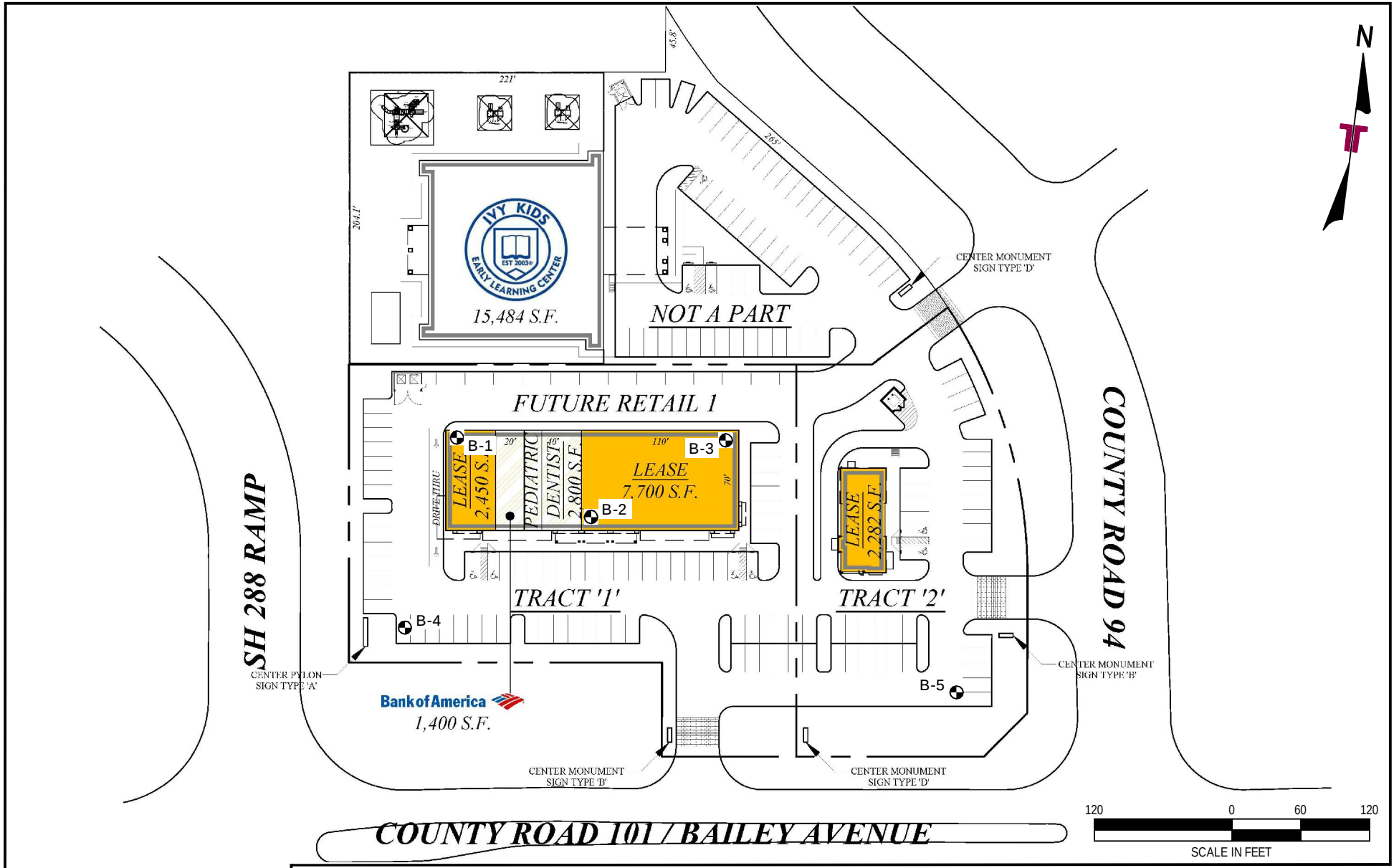
SOURCE
2010 BRAZORIA COUNTY
KEY MAP
Page 653 - A

1/2 0 1/4 1/2
APPROX. SCALE 1"= 1/2 MILE

SITE LOCATION PLAN

The Shops at Sedona Lakes ■ Manvel, TX

January 6, 2019 ■ Terracon Project No. 91195001



LEGEND

SOIL BORING LOCATIONS

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

EXPLORATION PLAN

The Shops at Sedona Lakes ■ Manvel, TX

January 6, 2019 ■ Terracon Project No. 91195001

EXPLORATION RESULTS

BORING LOG NO. B-1

PROJECT: The Shops at Sedona Lakes

CLIENT: NewQuest Properties
Houston, Texas

SITE: County Road 94 and County Road 101
Manvel, Texas

LOCATION See Exploration Plan

Latitude: 29.5274° Longitude: -95.3839°

DEPTH	GRAPHIC LOG	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
LEAN CLAY (CL), dark gray, stiff to very stiff -with scattered roots 0 to 4 feet				2.0 (HP)							
-gray 2 to 6 feet				2.25 (HP)	UC	1.18	9.3	18	103	49-14-35	
- with calcareous and ferrous nodules 4 to 15 feet				3.0 (HP)							
- tan and light gray 6 to 15 feet		▼		3.25 (HP)							
		▽		2.0 (HP)	UC	2.67	14.8	16	113		
				2.25 (HP)							
-with silt pockets 13 to 15 feet				2.5 (HP)							
15.0		▽									
SANDY LEAN CLAY (CL), reddish brown and light gray, stiff											
				3-6-7 N=13							
20.0											
Boring Terminated at 20 Feet											

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

Advancement Method:
Dry augered to a depth of about 15 feet and wet rotary drilling thereafter.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

▽ *After 5 minutes*

▼ *After 15 minutes*

Terracon
551 W League City Pkwy, Ste F
League City, TX

Boring Started: 01-08-2019 | Boring Completed: 01-08-2019

Drill Rig: ATV | Driller: D.A.S.

Project No.: 91195001

BORING LOG NO. B-2

PROJECT: The Shops at Sedona Lakes

CLIENT: NewQuest Properties
Houston, Texas

SITE: County Road 94 and County Road 101
Manvel, Texas

LOCATION See Exploration Plan

Latitude: 29.5272° Longitude: -95.3836°

DEPTH	GRAPHIC LOG	DESCRIPTION	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
0		**FILL - LEAN CLAY (CL)**, reddish brown and gray, with scattered roots			2.25 (HP)							
					3.0 (HP)							
4.0		**LEAN CLAY (CL)**, light gray, very stiff -with ferrous and calcareous nodules 4 to 8 feet			2.25 (HP)							
5			▼									
			▽		2.75 (HP)				14		28-12-16	
		-tan and light gray with ferrous nodules and silt pockets 8 to 10 feet			2.25 (HP)							
10.0		**SANDY LEAN CLAY**, brown, stiff			1.5 (HP)	UC	1.10	15	19	102		56
10												
					1.5 (HP)							
15.0		**SILTY SAND (SM)**, tan, loose										
15												
		-light gray below 18 feet			1-2-3 N=5							
20.0		***Boring Terminated at 20 Feet***										
20												

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

Advancement Method:
Dry augered to a depth of about 13 feet and wet rotary drilling thereafter.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

- *While drilling*
- *After 5 minutes*
- *After 15 minutes*

Terracon
551 W League City Pkwy, Ste F
League City, TX

Boring Started: 01-08-2019 | Boring Completed: 01-08-2019

Drill Rig: ATV | Driller: D.A.S.

Project No.: 91195001

BORING LOG NO. B-3

PROJECT: The Shops at Sedona Lakes

CLIENT: NewQuest Properties
Houston, Texas

SITE: County Road 94 and County Road 101
Manvel, Texas

LOCATION See Exploration Plan

Latitude: 29.5274° Longitude: -95.3833°

DEPTH	GRAPHIC LOG	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
0											
	FILL - LEAN CLAY (CL), dark gray, with scattered roots and silt pockets			2.0 (HP)				20		35-19-16	
2.0	**LEAN CLAY (CL)**, dark gray, stiff to very stiff			2.5 (HP)							
5		▼		3.25 (HP)	UC	1.36	15	17	102	33-11-22	
	-with ferrous and calcareous nodules 6 to 10 feet -light gray 6 to 8 feet	▽		3.75 (HP)							
	-tan and light gray 8 to 12 feet			2.0 (HP)							
10	-with sand seams 10 to 12 feet			2.5 (HP)							
12.0	**SILTY SAND (SM)**, brown, loose	▽									
				1-4-5 N=9							
15											
	-with clay pockets below 18 feet			1-3-4 N=7							
20.0	***Boring Terminated at 20 Feet***										
20											

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

Advancement Method:
Dry augered to a depth of about 13 feet and wet rotary drilling thereafter.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

▽ *After 5 minutes*

▼ *After 15 minutes*

Terracon
551 W League City Pkwy, Ste F
League City, TX

Boring Started: 01-08-2019 | Boring Completed: 01-08-2019

Drill Rig: ATV | Driller: D.A.S.

Project No.: 91195001

BORING LOG NO. B-4

PROJECT: The Shops at Sedona Lakes

CLIENT: NewQuest Properties
Houston, Texas

SITE: County Road 94 and County Road 101
Manvel, Texas

GRAPHIC LOG	LOCATION / DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
	LOCATION See Exploration Plan Latitude: 29.5277° Longitude: -95.3841°											
	FILL - SANDY LEAN CLAY (CL), dark gray, with silt pockets				1.25 (HP)				15		25-17-8	
					1.5 (HP)							
	4.0 **LEAN CLAY (CL)**, dark gray, stiff, with calcareous nodules				2.0 (HP)							
	5.0 ***Boring Terminated at 5 Feet***	5										

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

Advancement Method:
Dry augered to a depth of about 5 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
551 W League City Pkwy, Ste F
League City, TX

Boring Started: 01-08-2019 | Boring Completed: 01-08-2019

Drill Rig: ATV | Driller: D.A.S.

Project No.: 91195001

BORING LOG NO. B-5

PROJECT: The Shops at Sedona Lakes

CLIENT: NewQuest Properties
Houston, Texas

SITE: County Road 94 and County Road 101
Manvel, Texas

GRAPHIC LOG	LOCATION / DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS: LL-PL-PI	PERCENT FINES
	See Exploration Plan Latitude: 29.5269° Longitude: -95.3828°											
	FILL - LEAN CLAY (CL), brown and dark gray, with silt pockets				1.25 (HP)				15		27-16-11	
	2.0											
	LEAN CLAY (CL), light gray, stiff to very stiff -with silt pockets 2 to 4 feet				3.0 (HP)							
	-with calcareus nodules below 4 feet				2.0 (HP)							
	5.0											
	Boring Terminated at 5 Feet	5										

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

Advancement Method:
Dry augered to a depth of about 5 feet.

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
551 W League City Pkwy, Ste F
League City, TX

Boring Started: 01-08-2019 | Boring Completed: 01-08-2019

Drill Rig: ATV | Driller: D.A.S.

Project No.: 91195001

SUPPORTING INFORMATION

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

The Shops at Sedona Lakes ■ Manvel, Texas

February 1, 2019 ■ Terracon Project No. 91195001

Terracon GeoReport

SAMPLING

Shelby Tube

Standard Penetration Test

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

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

FIELD TESTS

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

DESCRIPTIVE SOIL CLASSIFICATION

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

LOCATION AND ELEVATION NOTES

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

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS

(More than 50% retained on No. 200 sieve.)
Density determined by Standard Penetration Resistance

Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.
Very Loose	0 - 3
Loose	4 - 9
Medium Dense	10 - 29
Dense	30 - 50
Very Dense	> 50

CONSISTENCY OF FINE-GRAINED SOILS

(50% or more passing the No. 200 sieve.)
Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance

Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (tsf)	Standard Penetration or N-Value Blows/Ft.
Very Soft	less than 0.25	0 - 1
Soft	0.25 to 0.50	2 - 4
Medium Stiff	0.50 to 1.00	4 - 8
Stiff	1.00 to 2.00	8 - 15
Very Stiff	2.00 to 4.00	15 - 30
Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	<15
With	15-29
Modifier	>30

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	<5
With	5-12
Modifier	>12

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Thompson Intermediate School ■ Pearland, Texas

January 3, 2019 ■ Terracon Project No. 91185096

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

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

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

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

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

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

[F] If soil contains ≥ 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.