Geotechnical Investigation Report

PROPOSED COMMERCIAL BUILDING

23241 FM 1093
RICHMOND, TEXAS 77406

RSB Project No.: RT18-322

RSB ENVIRONMENTAL

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August 31, 2018

REPORT
GEOTECHNICAL INVESTIGATION
PROPOSED COMMERCIAL BUILDING
23241 FM 1093
RICHMOND, TEXAS 77406

PREPARED FOR:

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1.0 INTRODUCTION AND SUMMARY

1.1 Introduction

This report presents the results of a geotechnical investigation pertaining to the design of foundations for the proposed commercial building and associated pavements that will be constructed at 23241 FM 1093 in Richmond, Texas. The area for the proposed development project is relatively flat that has presence of vegetation consisting of underbrush and grasses. The project site location is shown on Plates 1 and 2 in the Appendix.

The purpose of this geotechnical investigation was to provide data and parameters that could be used for the design and construction of foundations for the proposed building and associated pavements.

This geotechnical investigation was performed by RSB Environmental for Bella Terra Montessori in accordance with an email authorization by Mr. Rajesh Arora on August 17, 2018.

The scope of work for this geotechnical investigation consisted of:

- drilling and sampling 5 geotechnical borings to depths of 5 and 20 feet beneath the surface within the project area as shown on Plate 2 in the Appendix,

- performing field tests and recovering relatively both disturbed and relatively undisturbed soil samples,

- measuring depth to groundwater in the geotechnical borings during drilling and after the completion of drilling,

- backfilling the bore holes with soil cuttings after the completion of the drilling operations,

- visually classifying samples obtained and conducting laboratory tests to determine the physical and mechanical properties of the soils,

- analyzing the field and laboratory test data,

- preparing boring logs based on visual soil classifications and the results of the laboratory tests,

- performing potential vertical rise, bearing capacity, and settlement analyses for foundations which may be used to support the loads of the proposed building,

- developing and presenting guidelines concerning subgrade preparation for the area of the proposed building,

- providing pavement section recommendations as well as subgrade stabilization recommendations for the proposed pavements, and

- submitting 2 copies of a report of the geotechnical investigation.

1.2 Summary of Findings

The pertinent findings of this geotechnical investigation are provided in the following sections.

1.2.1 Subsurface Soil Strata

The subsurface soil strata at the location of the proposed development are described by the boring logs for Boring Nos. B-1 through B-5 as provided in the Appendix.

Data from the 5 geotechnical borings drilled suggest that the upper 20 feet of the overburden soils are generally composed of 2 soil layers described as follows:

LAYER	DEPTH BELOW GROUND SURFACE (FT)	SOIL DESCRIPTION
I	0 – 4	Tan SANDY SILT (ML) w/ clay pockets.
II	4 - 20	Gray and tan LEAN CLAY WITH SAND (CL) and SANDY LEAN CLAY (CL), very stiff to hard.

Laboratory testing was performed on selected samples of the subsurface materials obtained to classify the soils in accordance with ASTM D 2487 and to define the engineering properties of the soils. Portions of the test results indicating the high and low values of specific testing are provided in the table below:

LAYER	DEPTH (FT)	LIQUID LIMIT (%)		PLASTICITY INDEX (%)		MOISTURE CONTENT (%)		PASSING NO. 200 SIEVE (%)	
		HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW
I	0 – 4	Non-Plastic				9	5	69.5	50.6
II	4 - 20	42	37	24	20	17	6	79.1	61.2

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1.2.2 Groundwater Condition

Groundwater was not encountered during the drilling of the borings. The bore holes were immediately backfilled with soil cuttings after the completion of the drilling activities.

1.2.3 Soil Swell Potential

The results of laboratory plasticity tests indicated that the site clayey soils within the development area have medium to high plasticity with moderate to high and shrink/swell potential. A Potential Vertical Rise (PVR) value less than 1.0 inch was calculated for the upper 8 feet of the site soils using the Texas Department of Transportation (TxDOT) Method (TEX-124-E). This method uses the maximum percent swell through the entire active depth.

1.3 Summary of Recommendations

Recommendations are provided below pertaining to the design and construction of the foundations for the proposed building and associated pavements that may be planned for development in the project area.

1.3.1 Site and Subgrade Preparation

It is recommended that existing vegetation, organics, topsoil, wet, soft, loose, unstable soils, and the upper sandy soils in the construction area be removed. The depth of removal, typically to a depth of about 6 inches, may vary across the site and could be as much as 2 feet especially in areas where wet, loose, soft, or unstable soils are encountered. The actual depth of removal should be determined by a representative of the geotechnical engineer at the time of construction.

After stripping and excavating as discussed above, the exposed soil should be proof-rolled to locate any soft, loose, or unstable areas. Soils which are observed to rut or deflect excessively under the moving load should be undercut and replaced with properly compacted structural fill. The proof-rolling and undercutting activities should be witnessed by a RSB Environmental representative and should be performed during a period of dry weather. The exposed soils should be compacted to at least 95% of the maximum dry density at a moisture content within ± 3% of the optimum moisture content as determined by ASTM D-698.

After subgrade preparation and observation have been completed as stated above, any necessary structural fill material that is required to achieve the desired grade may be placed over the foundation areas and the specified minimum distance beyond the perimeters of the foundation. The first layer of fill should be placed in a relatively uniform horizontal lift and be adequately keyed into the subgrade soils. Structural fill materials should consist of a clayey sand or inactive lean clay free of organic or other deleterious materials, have a liquid limit not greater than 35, and a plasticity index between 8 and 20. Structural fill should be placed in maximum loose lifts of 8 inches and should be compacted to at least 95% of maximum dry density at moisture content within ± 3% of the optimum moisture content as determined by ASTM D-698. If water must be added, it should be uniformly applied and thoroughly mixed into the soil by discing or scarifying. Each lift of structural fill should be tested by a representative of the geotechnical engineer prior to placement of subsequent lifts. Care should be taken in the application of compactive effort throughout the fill and fill scope areas.

Depending on weather conditions, difficulty may be encountered in adequately densifying/compacting the surficial soils. If the surficial soils are unsuitably wet, excess pore pressures (“pumping”) may develop and excess displacement of the subgrade soils may occur during site preparation. If the site subgrade soils become unsuitably wet, the construction contractor should:

- dry the soils to within ± 3% of the optimum moisture content by discing these materials,

- dry the soils by blending a stabilizing agent such as lime or fly ash with the unsuitably wet soils, or

- remove the unsuitably wet soils and replace with properly compacted structural fill having an acceptable moisture content.

1.3.2 Foundation Recommendations – Proposed Building

The loads of the proposed building may be supported on foundation systems as provided below.

Drilled and Underreamed Pier Foundation – The loads of the proposed building may be supported on drilled and underreamed pier ~~foundation system. The piers (maximum bell~~ diameter of 6 feet) should be founded at a depth of at least 10 feet below the existing grade at the time of our field investigation or at least 10 feet beneath finished grade. The drilled piers may be designed for maximum allowable net bearing pressures of 3,400 psf for dead loads plus sustained live loads and 5,100 psf for dead loads plus sustained and transient live loads, whichever results in a larger bearing area. These values consider a safety factor of at least 3 and 2, respectively, against a bearing capacity failure.

For a slab-on-grade floor system, wall loads can be transmitted to the drilled piers by grade beams. The grade beam should be at least 12 inches wide, extend at least 1.5 feet below finished grade, and be founded on drilled piers.

Allowable shaft friction in compression and tension for the portions of the drilled pier shafts below a depth of 5 feet beneath the finished grade surface is 250 psf.

A single isolated pier designed as discussed should experience a settlement of less than 1 inch. However, if a cluster of closely spaced piers is planned, RSB Environmental should be contacted to calculate the amount of settlement or to determine the appropriate reduction values in the allowable bearing pressures.

The edge-to-edge spacing of the drilled piers should be equal to a minimum of 1.2 times the average drilled pier bell diameter of adjacent drilled piers. Should piers be located closer than 1.2 bell diameters, measured edge-to-edge, reduction in the allowable net bearing pressures will be required. RSB Environmental should be notified for further evaluation in order to determine the appropriate reduction values.

We recommend that the drilled pier excavations be observed by a representative of the geotechnical engineer or a qualified personnel to verify that the properties of the foundation materials are consistent with the properties of the materials discussed in this report, to ensure that the piers are installed in accordance with the specifications, and to verify that the excavation is free from excess water and loose cuttings. Placement of concrete in the excavations should commence immediately after the excavation is completed. A bell shaft ratio of 3 to 1 is recommended.

In the event that caving of pier bell excavations occur during the construction of the drilled piers, where drilled pier side wall or bell excavations cave so rapidly that concrete cannot be placed quickly enough to allow construction of the piers, it will be necessary that casing be used to maintain an open pier excavation or consider the use of drilled straight shafts.

The floor for the proposed building may consist of a slab-on-grade floor placed over at least **2.0 feet** of properly compacted structural fill prepared in accordance with site preparation as described in Section 1.3.1 of this report. An allowable net bearing pressure of 600 psf can be used for slab-on-grade bearing on properly compacted structural fill. It is suggested that cushion sand (leveling sand) not be placed within the area of the slab-on-grade floor. If cushion sand becomes wet, erosion and/or settling of the sand may occur which can result in the formation of voids beneath the floor and associated structural distress. The structural fill soils should be placed and extend at least five (5) feet beyond the perimeters of the foundation.

In lieu of the use of a slab-on-grade floor system, a floor placed over void boxes or an elevated floor system (structural floor system) may be considered where the floor is not affected by shrinking/swelling of the subsoil beneath the floor. The loads of these floor systems are supported on grade beams or structural beams that are then supported on drilled piers.

Continuous Footing/Grade Beam Foundation - Provided the site and subgrade preparation recommendations provided in Section 1.3.1 of this report are followed and at least **2.0 feet** of properly compacted structural fill is placed over the foundation area and to a distance of at least five (5) feet beyond the perimeters of the foundation, it is our opinion that the planned building construction can also be supported on a conventional continuous footing and/or grade beam foundation system. Foundations bearing on the properly compacted structural fill soil or natural soil should be placed at least two (2) feet below finished grade and be designed for a net allowable bearing pressure of 2,000 psf for dead load plus sustained live loads and 3,000 psf for dead loads plus sustained and transient live loads, whichever results in a larger bearing area. These values consider a safety factor of at least 3 and 2, respectively, against a bearing capacity failure.

Footing foundations should be prepared by excavating the overburden soils to the final foundation grade elevation, compacting the foundation subgrade soils to an in-place dry density equal to at least 95% of the maximum dry density at a moisture content within ± 3% of the optimum moisture content as determined by ASTM D 698. A tamping plate hand compactor or other suitable impact compactor should be used to perform the compaction. Without proper compaction of the spread footing/grade beam foundation soils, settlement of the shallow spread/grade beam footings could exceed 1 inch.

The foundation excavations should be observed by a representative of RSB Environmental or qualified personnel prior to steel or concrete placement to assess that the foundation materials are capable of supporting the design loads and are consistent with the materials discussed in this report. Soft, loose, or unstable soil zones encountered at the bottom of the footing excavations should be removed and replaced with properly compacted structural fill as directed by the geotechnical engineer.

After opening, footing excavations should be observed and concrete placed as quickly as possible to avoid exposure of the footing bottoms to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. The foundation concrete should be placed during the same day the excavation is made. If it is required that footing excavations be left open for more than one day, they should be protected to minimize evaporation or entry of moisture.

Shallow Spread Footing Foundation - Provided the site and subgrade preparation recommendations provided in Section 1.3.1 ~~of this report are followed and at least~~ **2.0 feet** of properly compacted structural fill is placed over the foundation area and to a distance of at least five (5) feet beyond the perimeters of the foundation, it is our opinion that the planned building construction can also be supported by shallow spread footings. The shallow spread footings should be a maximum of 5-ft square, be founded at a depth of at least 3 feet below the desired finished grade and be designed for maximum allowable net bearing pressures of 2,400 psf for axial compression dead loads plus sustained loads and 3,600 psf for axial compression dead loads plus sustained and transient live loads.

If a cluster of closely spaced footings (i.e., if the center to center spacing of the footings is less than two times the width of the footing) are planned, RSB Environmental should be contacted to calculate the amount of settlement.

Footing foundations should be prepared by excavating the overburden soils to the final foundation grade elevation, compacting the foundation subgrade soils to an in-place dry density equal to at least 95% of the maximum dry density at a moisture content within ± 3% of the optimum moisture content as determined by ASTM D 698. A tamping plate hand compactor or other suitable impact compactor should be used to perform the compaction. Without proper compaction of the spread footing/grade beam foundation soils, settlement of the shallow spread/grade beam footings could exceed 1 inch.

The foundation excavations should be observed by a representative of RSB Environmental or qualified personnel prior to steel or concrete placement to assess that the foundation materials are capable of supporting the design loads and are consistent with the materials discussed in this report. Soft, loose, or unstable soil zones encountered at the bottom of the footing excavations should be removed and replaced with properly compacted structural fill as directed by the geotechnical engineer.

After opening, footing excavations should be observed and concrete placed as quickly as possible to avoid exposure of the footing bottoms to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. The foundation concrete should be placed during the same day the excavation is made. If it is required that footing excavations be left open for more than one day, they should be protected to minimize evaporation or entry of moisture.

1.3.3 Pavement Recommendations

The following recommendations pertain to the design and construction of the pavements that may be constructed as part of the proposed development project.

Subgrade Preparation and Stabilization - It is recommended that existing vegetation, topsoil, and any unstable soils in the construction area be stripped from the site and be disposed. The depth of removal of the natural soils, typically to a depth of about 6 inches, may vary across the development area and could be as much as 2 feet especially in areas where wet, soft, or unstable soils are encountered. The exposed soils should be proof-rolled and compacted to at least 95% of the maximum dry density at a moisture content within ± 3% of the optimum moisture content as determined by ASTM D-698.

After subgrade preparation and observation have been completed as stated above, placement of any necessary fill material that is required to achieve the desired grade may begin. The first layer of fill should be placed in a relatively uniform horizontal lift and be adequately keyed into the subgrade soils. Suitable earth fill or structural fill soils may be used as fill material. Suitable earth fill material may consist of on-site soils that are free of organics or other deleterious materials. Structural fill material should consist of a clayey sand or inactive lean clay free of organic or other deleterious materials, have a liquid limit not greater than 35, and a plasticity index between 8 and 20. Fill material (suitable earth fill or structural fill) should be placed in maximum loose lifts of 8 inches and should be compacted to at least 95% of maximum dry density at a moisture content within ± 3% of the optimum moisture content as determined by ASTM D-698.

The results of our laboratory plasticity tests indicate that the near surface soils within the development area consisted of sandy silts. Stabilization of these soils will be necessary in order to improve the strength and performance of the pavement subgrade soils. Subgrade stabilization may be performed using 3% lime and 8% fly ash, expressed as percent of the dry weight of the exposed soils. Using a unit dry weight of 110 pounds per cubic foot for the site surfical soils, the amounts of stabilization should be about 15 pounds of lime per square yard for a depth of 6 inches and 40 pounds of fly ash per square yard for a depth of 6 inches. The blended soil-lime-fly ash mixture should be compacted to an in-place dry density equal to at least 95% of the maximum standard dry density (ASTM D 698).

Stabilization procedures may be performed in accordance with Section 02337 titled “Lime/Fly-Ash Stabilized Subgrade” from the most recent City of Houston Department of Public Works and Engineering (COH-DPWE) Standard Specifications entitled “Standard Construction Specifications for Wastewater Collection Systems, Water Lines, Storm Drainage, Street Paving, and Traffic”, or Section 223 titled “Fly Ash or Lime-Fly Ash Stabilized Subgrade” from the most recent Harris County Engineering Department Specifications, or Item 265 titled “Fly Ash or Lime-Fly Ash

Treatment (Road-Mixed)" of the 2014 Texas Department of Transportation Specifications or the applicable guidelines and requirements of the governing agency within the project area.

Lime-fly ash stabilization should extend a minimum of 1 foot beyond the edges of the pavement in order to preclude edge failure of the pavement. It is recommended that the percentages of lime and fly ash for use in stabilization be determined on the exposed pavement subgrade soils during construction.

Recommended Rigid Pavement Section - The proposed pavements that are associated with the proposed development project should consist of at least 6 inches of reinforced concrete pavement on at least 6 inches of properly compacted stabilized subgrade.

Large front loading trash dump-trucks frequently impose concentrated front-wheel loads on pavements during loading. This type of loading typically results in rutting of the pavement and ultimately, pavement failures. Therefore, we recommend that the pavement in trash pickup areas, and other areas where heavy haul and heavy duty trucks will be allowed to operate, consist of a minimum 7-inch thick reinforced concrete slab on 6 inches of properly compacted stabilized subgrade soil.

All related civil design factors such as drainage, cross-sectional configurations, surface elevations, and environmental factors that will significantly affect the service life of the pavement should be included in the preparation of the construction drawings and specifications.

2.0 FIELD INVESTIGATION

For the current geotechnical study, 5 geotechnical borings (Boring Nos. B-1 through B-5) were drilled and sampled on August 22, 2018 by RSB Environmental. The boring locations, as shown on Plate 2 in the Appendix, were selected and staked in the field by a representative of RSB Environmental, measuring from existing points of reference. Drilling, sampling, and testing were performed in accordance with applicable ASTM procedures.

Soil sampling during the drilling of the geotechnical borings consisted of continuous sampling to 10 feet and intermittent sampling thereafter, with both disturbed and relatively undisturbed soil samples being obtained.

Relatively undisturbed samples were obtained by hydraulically forcing sections of 2-inch outside diameter steel tube sampler into the subsoils. The tube samples were extruded in the field, sealed with foil, and placed into airtight plastic bags. Estimates of the undrained shear strengths of the cohesive soils were obtained with pocket penetrometer readings being taken on the tube samples.

Disturbed samples of soils were taken through the flight auger of the sampler. The samples recovered were removed from the auger of the sampler and placed into airtight plastic bags.

All samples were transported to laboratory for purposes of performing laboratory tests on selected samples.

3.0 LABORATORY TESTING

A laboratory testing program was conducted to obtain engineering properties for use in performing engineering analyses and to adjust field soil classifications. The following laboratory tests were performed:

LABORATORY TEST	TEST STANDARD
Moisture Content of Soils	ASTM D 2216
Percent Soil Particles Passing a No. 200 Sieve	ASTM D 1140
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D 4318

The numbers of tests and the test results are presented in the boring logs provided in the Appendix. All tests were performed in accordance with applicable ASTM procedures and methods and soils classifications were completed in accordance with the guidelines of ASTM D 2487 and ASTM D 2488.

4.0 SUBSURFACE CONDITIONS

4.1 Subsoils

The subsurface soil conditions as determined from the drilling of the geotechnical borings are described in Section 1.2.1 of this report and provided on the boring logs in the Appendix.

The boring logs were prepared by using both field visual classifications and the results of laboratory testing. The stratification lines, shown on the boring logs, represent the approximate boundaries between soil types and the transitions between soil types may be gradual.

4.2 Groundwater

Groundwater conditions are described in Section 1.2.2 of this report and on the boring logs provided in the Appendix. The depth to groundwater was obtained by observing the drilling operations and the free moisture contained in the samples recovered during drilling and determining presence or absence of water in the borings during drilling and after the completion of drilling.

Groundwater was not encountered during the drilling of the geotechnical borings. However, it is possible that seasonal variations may cause fluctuations in the water level data obtained during our field investigation. If necessary, we recommend that the contractor determine the actual groundwater level at the time of construction in order to determine the impact, if any, of the groundwater on the construction procedures. It should be noted that the recommendations contained in this report are based on groundwater information at the time of this geotechnical investigation and that an accurate determination of the true groundwater level may require several days or even months of observations.

5.0 CONSTRUCTION CONSIDERATIONS

The following recommendations should be followed with regard to construction of proposed building and associated pavements that are being planned for development in the project area.

5.1 Moisture Sensitive Soils/Weather Related Concerns

Soils at the site are extremely sensitive to moisture changes, the subgrade soils should be protected and adequate drainage should be maintained at the time of the construction. During inclement weather, the subgrade soils may get disturbed due to construction traffic. It is extremely important to provide good site drainage during construction.

During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

5.2 Drainage and Groundwater Concerns

Water should not be allowed to collect in the foundation excavation or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff. Positive site surface drainage should be provided to reduce infiltration of surface water around the perimeter of the foundation. The grades should be sloped away from the foundation and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and foundation area. Excessive wetting or drying of foundations should be avoided. Trees and other vegetation capable of withdrawing significant amounts of moisture from the subsoils should be located a distance from the nearest foundation equal to at least the expected extent of the root system of the vegetation, or appropriate moisture barriers should be provided.

Groundwater was not encountered during the drilling of the borings. It is not anticipated that groundwater will be present nor will the groundwater pose a problem with the construction activities associated with the proposed project. However, if groundwater is encountered during the construction activities, it is expected that the use of sumps and sump pumps will be effective for groundwater dewatering where the exposed soils consist of the site clays. Should excessive and uncontrolled amounts of seepage occur, the geotechnical engineer should be consulted.

5.3 Drilled and Underreamed Piers

The successful completion of drilled and underreamed excavations will depend, to a large extent, on the suitability of the drilling and underreaming equipment together with the skill of the operator. The sequence of operations should be scheduled so that each underream can be completed, reinforcing steel placed, and the concrete poured in a continuous, rapid and orderly manner to reduce the time that the excavation is open.

Shafts and underreams should be clear and be free of all loose materials prior to placement of concrete. Concrete placed for drilled piers should have a 4 to 6-inch slump and be placed continuously in the shaft. Concrete may be allowed to drop freely in dry drilled pier excavations containing 1 inch or less of water, provided that the concrete does not fall against the steel reinforcing or the shaft sides. Drilled piers with more than 1 inch of water in the bottom should be filled with concrete by the tremie method of concrete placement. If casing is required, the casing should be removed as concrete is being placed. The casing should be removed in a manner that precludes the surrounding soil from invading the fresh concrete. This will require a vertical, smooth removal of the casing while maintaining the bottom of the casing below the top of the concrete a distance sufficient enough to offset the surrounding material pressure.

A qualified representative of the geotechnical engineer should verify that the underream installation procedures meet specifications.

5.4 Federal Excavation Safety Regulations

In Federal Register, Volume 54, No. 209 (October 1989), the United States Dep~~artment of Labor, Occupational Safety~~ and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better insure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that all excavations, whether they be utility trenches, basement excavation or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person”, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

6.0 CLOSING REMARKS

RSB Environmental has performed a geotechnical investigation and provided soils data and parameters that may be used for the design and construction of the foundations for the proposed commercial building and associated pavements that will be constructed at 23241 FM 1093 in Richmond, Texas. This report has been prepared for the exclusive use of Bella Terra Montessori and its authorized representatives in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

In the event that changes are made in the nature, design, or location of the proposed development, the conclusions, parameters, and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the findings and guidelines included in this report are modified or verified in writing. The analyses and guidelines presented in this report are based upon data obtained from 5 geotechnical borings drilled on August 22, 2018. The nature and extent of variations within the subsurface materials may not become evident until after construction is initiated. If significant variations in the subsurface materials are encountered during construction, it may be necessary to re-evaluate the parameters and recommendations provided in this report.

We appreciate the opportunity to be of service to you on this project. If we can answer any questions concerning the contents of this report, or be of further service, please do not hesitate to contact us.

Sincerely,

RSB Environmental

STATE OF TEXAS
SACHIN M. BUTALA
98514
LICENSED
PROFESSIONAL ENGINEER

Sachin Butala

Sachin Butala, P.E.
Project Engineer

APPENDIX

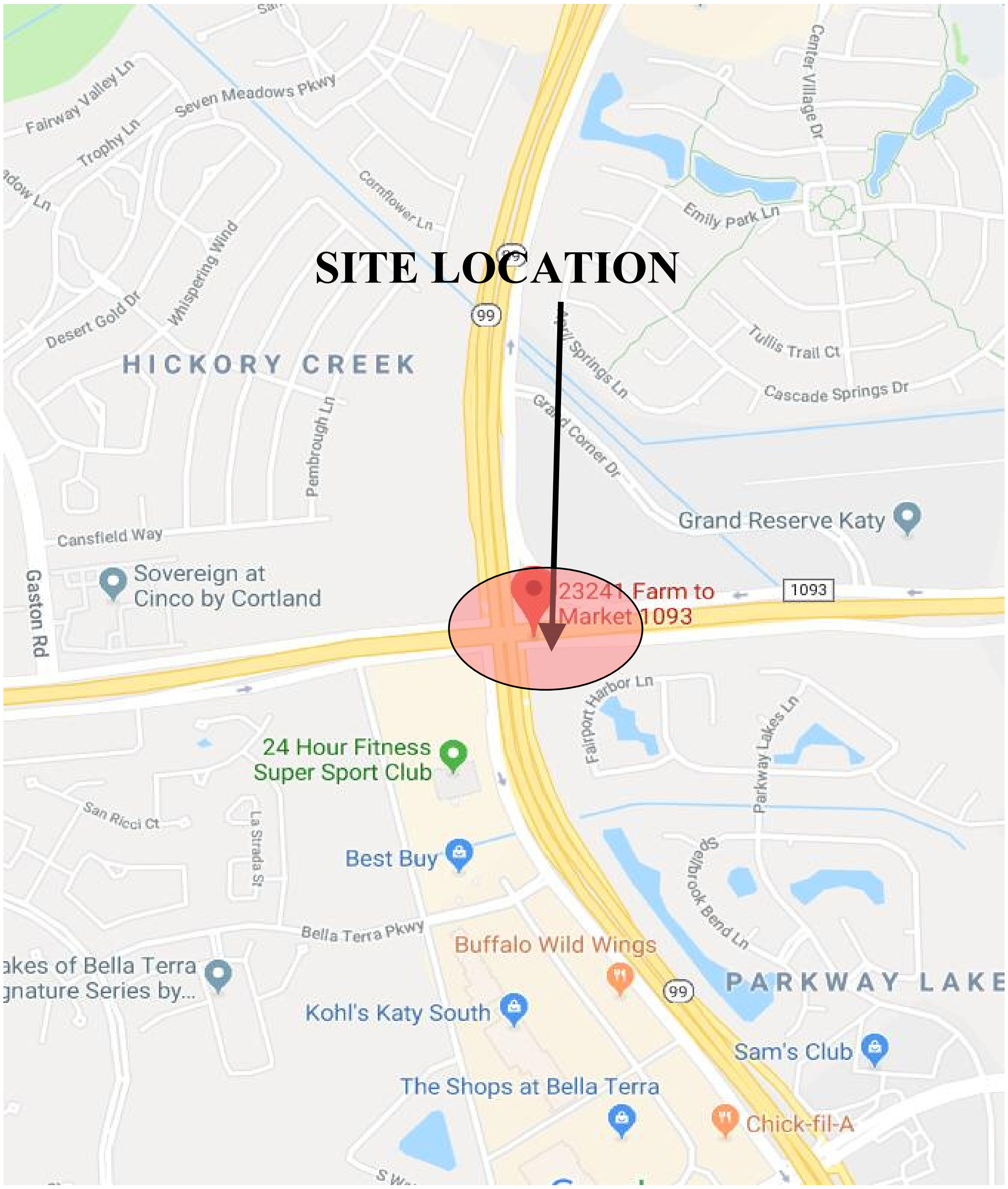
Site Location,

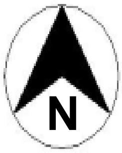
Locations of Borings,

Boring Logs (Boring Nos. B-1 through B-5),

and

Key to Terms and Symbols Used on Boring Logs





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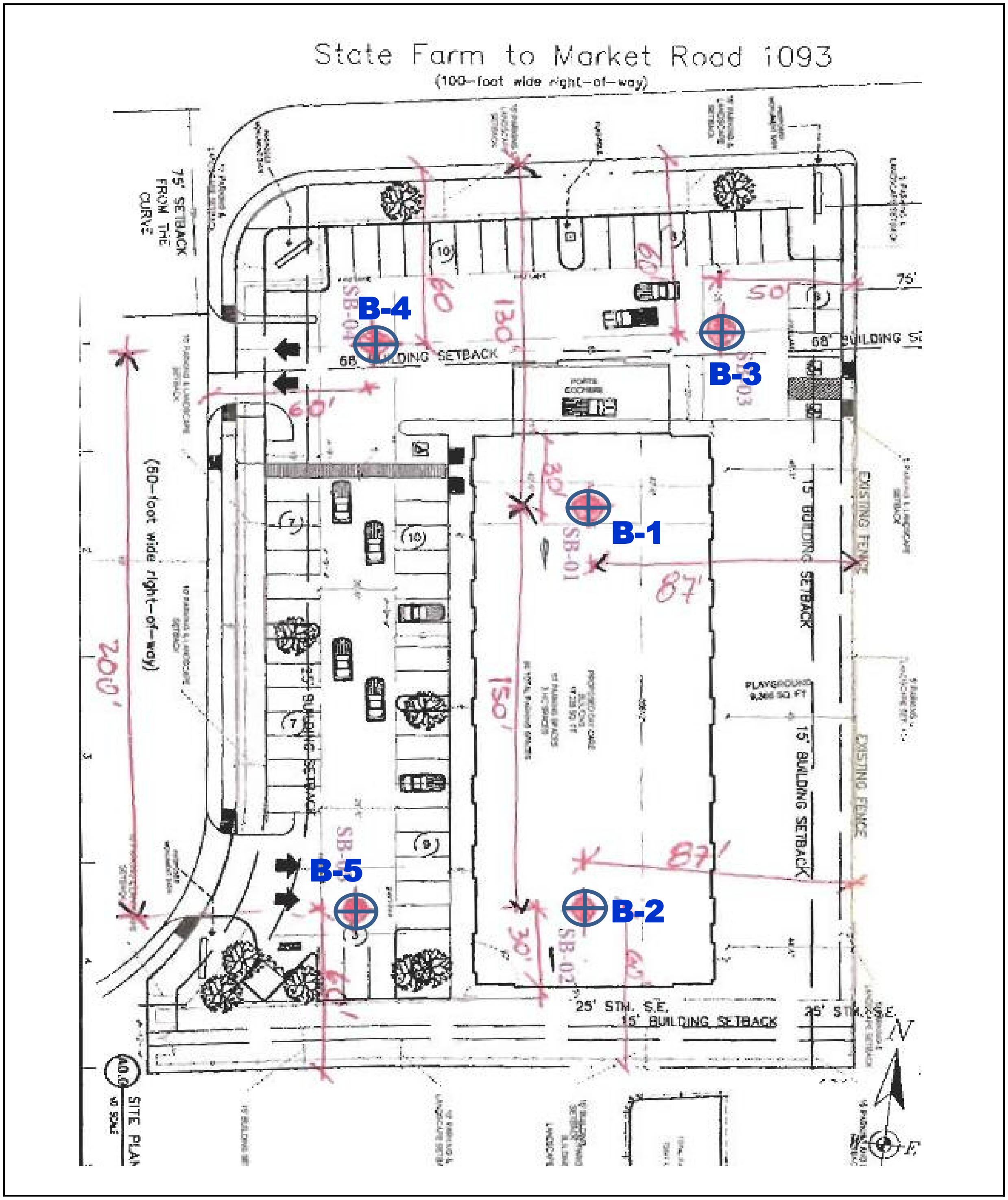
PROPOSED COMMERCIAL BUILDING
23241 FM 1093
RICHMOND, TEXAS 77406

SITE LOCATION

Date: 08/27/18	Project No: RT18-322	**Plate 1**



⊕ - Geotechnical borings included in the study

PROPOSED COMMERCIAL BUILDING
23241 FM 1093
RICHMOND, TEXAS 77406

LOCATIONS OF BORINGS

Date: 08/27/18	Project No: RT18-322	Plate 2

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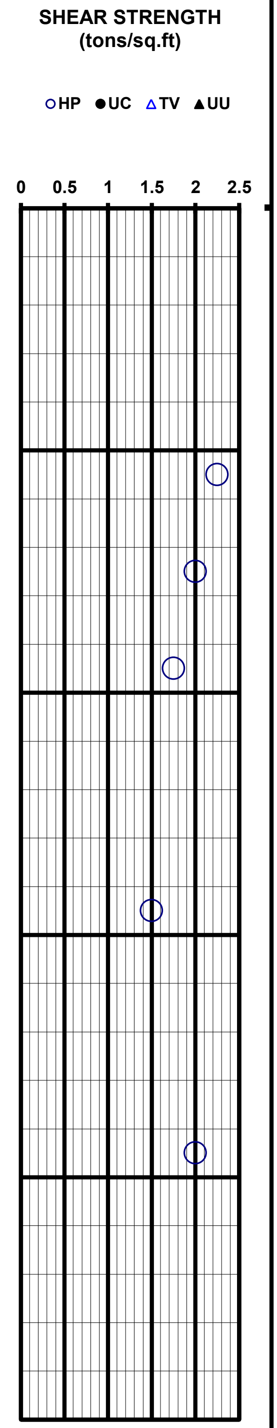
LOG OF BORING NO. B-1
PROPOSED COMMERCIAL BUILDING
23241 FM 1093
RICHMOND, TEXAS 77406

TYPE OF BORING: **FLIGHT AUGER**
SURFACE ELEVATION: **N/A**
LOCATION: **See Plate 2**
PROJECT NO.: **RT18-322**
DATE DRILLED: **08/22/18**

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	HAND PEN. RDG. (TSF)	MOISTURE CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASS #200 SIEVE, %	DRY DENSITY (PCF)
			SANDY SILT (ML), tan w/ clay pockets							
					5	Non-Plastic			54.3	
			4'		7					
5			**SANDY LEAN CLAY (CL),** very stiff to hard, gray and tan							
			- tan at 6'	4.50	7	42	18	24	65.2	
			8'	4.00	13					
			LEAN CLAY WITH SAND (CL), very stiff, tan							
10				3.50	14	40	17	23	79.1	
15				3.00	15					
			- gray and tan at 18'							
20			20'	4.00	17					
			(Boring terminated at 20')							
25										



Groundwater was not encountered during the drilling of the boring. The boring was backfilled with soil cuttings after the completion of the drilling activities.

RSB ENVIRONMENTAL

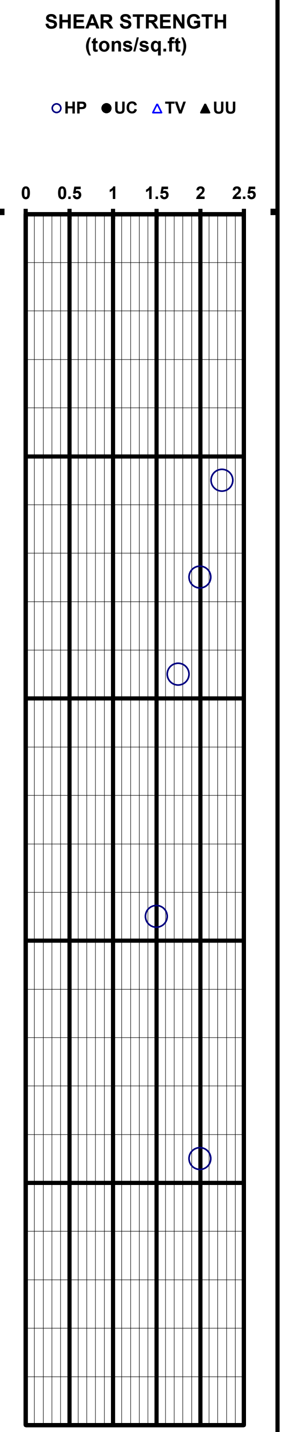
LOG OF BORING NO. B-2

PROPOSED COMMERCIAL BUILDING

23241 FM 1093
RICHMOND, TEXAS 77406

TYPE OF BORING: **FLIGHT AUGER**
SURFACE ELEVATION: **N/A**
LOCATION: **See Plate 2**
PROJECT NO.: **RT18-322**
DATE DRILLED: **08/22/18**

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	HAND PEN. RDG. (TSF)	MOISTURE CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASS #200 SIEVE, %	DRY DENSITY (PCF)
			SANDY SILT (ML), tan w/ clay pockets							
					6					
			4'		7	Non-Plastic			62.8	
5			**LEAN CLAY WITH SAND (CL),** very stiff, gray and tan	4.50	7					
			- tan at 6'							
				4.00	14	39	17	22	76.7	
10				3.50	14					
15				3.00	15	40	17	23	77.0	
			- gray and tan at 18'							
20			20'	4.00	16					
			(Boring terminated at 20')							
25										



Groundwater=10' during drilling and was measured at a depth of 13' after the completion of drilling. The boring was backfilled with soil cuttings after the completion of the drilling activities.

RSB ENVIRONMENTAL

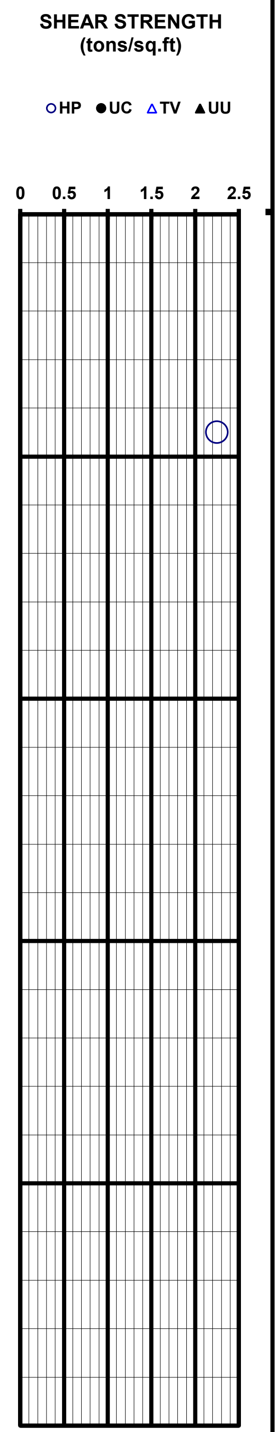
LOG OF BORING NO. B-3

PROPOSED COMMERCIAL BUILDING

23241 FM 1093
RICHMOND, TEXAS 77406

TYPE OF BORING: **FLIGHT AUGER**
SURFACE ELEVATION: **N/A**
LOCATION: **See Plate 2**
PROJECT NO.: **RT18-322**
DATE DRILLED: **08/22/18**

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	HAND PEN. RDG. (TSF)	MOISTURE CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASS #200 SIEVE, %	DRY DENSITY (PCF)
			SANDY SILT (ML), tan w/ clay pockets		6	Non-Plastic			50.6	
		4'			7					
5		5'	**SANDY LEAN CLAY (CL),** hard, tan	4.50	6	37	17	20	61.2	
			(Boring terminated at 5')							
10										
15										
20										
25										



Groundwater was not encountered during the drilling of the boring. The boring was backfilled with soil cuttings after the completion of the drilling activities.

RSB
ENVIRONMENTAL

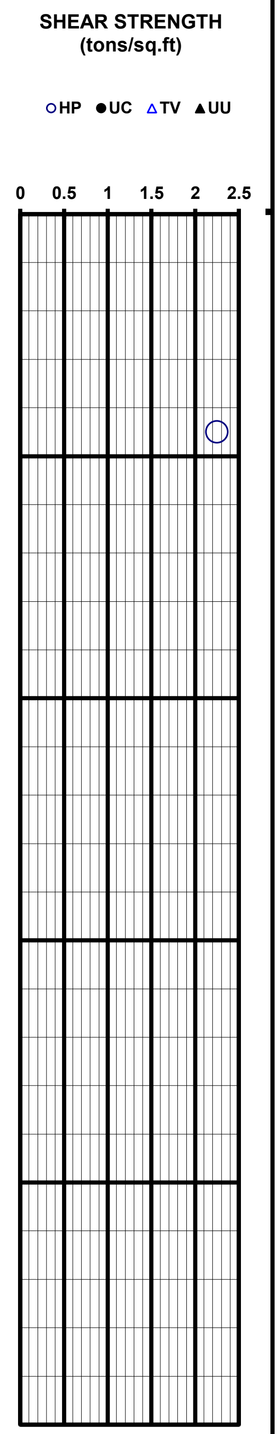
LOG OF BORING NO. B-4

PROPOSED COMMERCIAL BUILDING

23241 FM 1093
RICHMOND, TEXAS 77406

TYPE OF BORING: **FLIGHT AUGER**
SURFACE ELEVATION: **N/A**
LOCATION: **See Plate 2**
PROJECT NO.: **RT18-322**
DATE DRILLED: **08/22/18**

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	HAND PEN. RDG. (TSF)	MOISTURE CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASS #200 SIEVE, %	DRY DENSITY (PCF)
			SANDY SILT (ML), tan w/ clay pockets							
					7					
		4'			6	Non-Plastic			58.0	
5		5'	**SANDY LEAN CLAY (CL),** hard, tan	4.50	7					
			(Boring terminated at 5')							
10										
15										
20										
25										



Groundwater was not encountered during the drilling of the boring. The boring was backfilled with soil cuttings after the completion of the drilling activities.

RSB ENVIRONMENTAL

LOG OF BORING NO. B-5

PROPOSED COMMERCIAL BUILDING

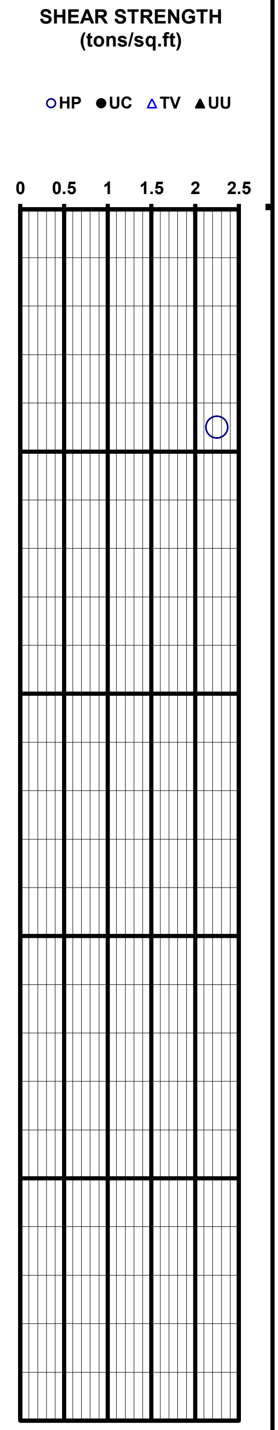
23241 FM 1093
RICHMOND, TEXAS 77406

TYPE OF BORING: **FLIGHT AUGER**
SURFACE ELEVATION: **N/A**

LOCATION: **See Plate 2**

PROJECT NO.: **RT18-322**
DATE DRILLED: **08/22/18**

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	HAND PEN. RDG. (TSF)	MOISTURE CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASS #200 SIEVE, %	DRY DENSITY (PCF)
			SANDY SILT (ML), tan w/ clay pockets							
					9	Non-Plastic			69.5	
		4'			7					
5		5'	**SANDY LEAN CLAY (CL),** hard, tan	4.50	6	38	17	21	63.5	
			(Boring terminated at 5')							
10										
15										
20										
25										

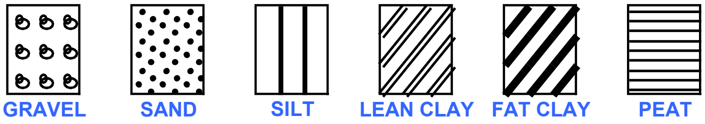


Groundwater was not encountered during the drilling of the boring. The boring was backfilled with soil cuttings after the completion of the drilling activities.

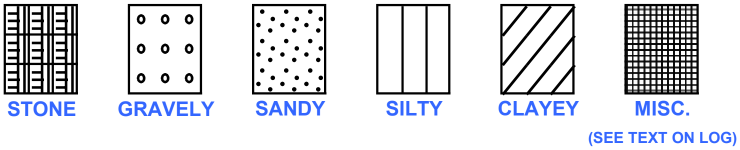
RSB ENVIRONMENTAL

KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

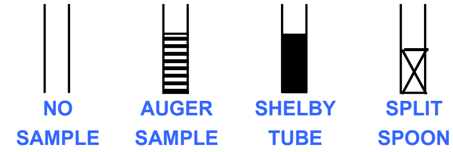
SOIL TYPE

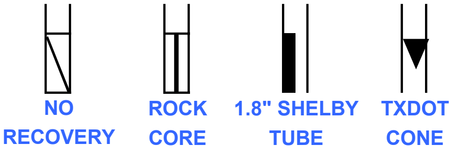


MODIFIERS

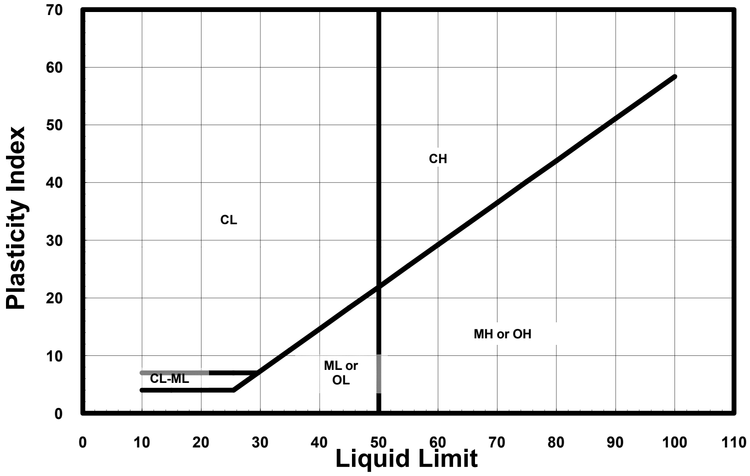


SAMPLER TYPE





UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487



CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	SHEAR STRENGTH (Tons/ft^2)
Very Soft	0 - 0.125
Soft	0.125 - 0.25
Firm	0.25 - 0.5
Stiff	0.5 - 1.0
Very Stiff	1.0 - 2.0
Hard	> 2.0 or 2.0+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (Blows/Foot)
Very Loose	O - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50 or 50+

DEGREE OF PLASTICITY OF FINE-GRAINED SOILS

DEGREE OF PLASTICITY	PLASTICITY INDEX	SWELL POTENTIAL
None	0 - 4	Low
Slight	5 - 10	Low
Medium	11 - 20	Low to Medium
High	21 - 40	Medium to High
Very High	> 40	Very High

MOISTURE CONDITION COHESIVE SOILS

DESCRIPTION	CONDITION
Absence of moisture, dusty, dry to touch	DRY
Damp but no visible water	MOIST
Visible free water	WET

CONSISTENCY OF COHESIVE SOILS AFTER TERZAGHI (1948)

CONSISTENCY	N-VALUE (Blows/Foot)
Very Soft	< 2
Soft	2 - 4
Firm	4 - 8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	> 30

ABBREVIATIONS

HP - Hand Penetrometer
TV - Torvane
MV - Miniature Vane

UC - Unconfined Compression Test
UU - Unconsolidated Undrained Triaxial Test
CU - Consolidated Undrained Triaxial Test

NOTE: Plot indicates shear strength as obtained by above tests.

▼ Final Groundwater Level

▽ Initial Groundwater Level

CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

6" 3" 3/4" 4 10 40 200

BOUL- -DERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152 76.2 19.1 4.76 2.0 0.42 0.074 0.005 0.001

GRAIN SIZE IN MM

Plate 8