ECS Southwest, LLP

Geotechnical Engineering Report

Greater Heights School
4724 N Main Street
Houston, Texas

ECS Project Number 43:1665

April 12, 2019

ECS SOUTHWEST, LLP
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April 12, 2019

Mr. Harold Norris
CEO
Greater Heights School
609 Gardner
Houston, Texas 77009

ECS Project No. 43:1665

Reference: Geotechnical Engineering Report
Greater Heights School
4724 N Main Street
Houston, Texas

Dear Mr. Norris:

ECS Southwest (ECS) has completed the subsurface exploration, laboratory testing, and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our Proposal No. 43:1669-GP, dated March 18, 2019. The notice-to-proceed was received through your signature on 'Proposal Acceptance Form' dated March 18, 2019. This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted. The report also contains our findings and recommendations for design and construction for the proposed educational development and associated site work.

It has been our pleasure to be of service to Greater Heights School during the design phase of this project. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Southwest, LLP

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The electronic seal in this document was authorized by Shahed Manzur, P.E. No 120056, on April 12, 2019

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EXECUTIVE SUMMARY

ECS Southwest, LLP (ECS) has completed the subsurface exploration and geotechnical engineering analyses for the the proposed Greater Heights School development and associated site work located at 4724 N Main Street in Houston, Texas. The proposed development will include a one to two story educational development with playground, parking areas, driveways and associated site improvements. The project information summarized below is based exclusively on the information made available to us during this study. Our findings, conclusions and recommendations are below.

PROJECT INFORMATION:

- Site Location : 4724 N Main Street in Houston, Texas
- Building Scope: One (1) to two (2) story building with parking areas, driveways, playground, and associated site improvements
- Foundation Type: Slab on grade supported by drilled piers and/or spread footings and/or monolithic slab on grade type foundations
- Floor Slab: 150 psf (Maximum)
- Pavement Type: Rigid reinforced concrete and/or flexible asphalt pavement
- Traffic Type: Light duty traffic with allowance for occasional heavier vehicles
- Grading: Not available; minor cut/fill within the structural area
- Site Work: Utilities, parking areas, and driveways

SUBSURFACE CONDITIONS:

- Field Exploration: Thirteen (13) borings to depths ranging from 5 feet to 20 feet
- Surficial Materials: Lean Clay Fill (CL FILL), Silty Clay Fill (CL-ML FILL) and natural Lean Clay (CL)
- Generalized Soils: Surficial Lean Clay Fill (CL FILL), Silty Clay Fill (CL-ML FILL) and natural Lean Clay (CL) underlain by Fat Clay and Lean Clay (CL) type soils to depths ranging from 5 feet to 20 feet below the existing site grades
- Groundwater: During drilling – Dry
  Shortly after completion of drilling – Dry

GEOTECHNICAL CONCERNS:

- The majority of the project site was previously developed with structures, parking areas and associated site improvements. These structures were demolished at a later stage and the project site is currently vacant. Therefore, we anticipate existing foundation elements, utility lines, and other non-structural elements may still remain in place within the footprint of the proposed development and will need to be removed during the construction phase, as/if encountered.

- Undocumented fill soils were encountered to a depth of about 2 feet below the existing grade in Borings B-10 and B-13. The presence of these undocumented fill raise concerns for the uniformity of the soil density and may cause differential settlements of the proposed structures beyond tolerable limits. Therefore, without controlled density tests, these soils should be removed, reworked, and replaced in accordance to the 'Site Construction Recommendations' section of this report.

- The onsite soils are considered low expansive with Potential Vertical Movement (PVM) of less than 1.0 inch for the surface supported structure. Therefore, no special subgrade improvements are necessary to limit the Potential Vertical Movements (PVM) for the building pad construction.

DESIGN & CONSTRUCTION RECOMMENDATIONS:

- Foundations: Please refer to Foundation Recommendation section.

- Slabs on Grade: Slab on grade supported by drilled piers and/or shallow foundations and/or monolithic slab on-grade on engineered fill soils.

- Pavement Areas and Driveways: Rigid Concrete and/or Flexible Asphalt type pavements for light truck traffic for main drives and heavy duty (drives) pavements to accommodate occasional heavier loadings due to fire trucks, delivery vehicles.

This summary should not be considered apart from the entire text of the report with all the qualifications and considerations mentioned herein. Details of our conclusions and recommendations are discussed in the report text.

1.0 INTRODUCTION

1.1 GENERAL

The purpose of this study was to provide geotechnical information for the design and construction of the proposed Greater Heights School development and associated site work located at 4724 N Main Street in Houston, Texas. The proposed development will include a one to two story educational development with parking areas, driveways and associated site improvements.

The recommendations developed for this report are based on project information provided by Greater Heights School and W [Squared] Architects. This report contains the results of our subsurface explorations and geotechnical laboratory testing programs, engineering analyses, and recommendations for the design and construction of the proposed educational development and associated site work.

1.2 SCOPE OF SERVICES

To obtain the necessary geotechnical information required for the evaluation of subsurface soil conditions supporting the planned developments, thirteen (13) soil test borings were performed, at locations selected by representatives of ECS. A laboratory-testing program was also implemented to characterize the physical and geotechnical engineering properties of the subsurface soils.

This report discusses our exploratory and testing procedures, presents our findings and evaluations and includes the following:

- A brief review and description of our field and laboratory test procedures and the results of testing conducted.
- A review of surface topographical features and site conditions.
- A review of area and site geologic conditions.
- A review of subsurface soil stratigraphy with pertinent available physical properties.
- A final copy of our soil test borings.
- Recommendations for site preparation and construction of compacted fills, including an evaluation of on-site soils for use as compacted fills.
- Recommended foundation type(s) with pertinent design recommendations.
- Evaluation and recommendations relative to groundwater control.
- An evaluation of soil excavation issues.

1.3 AUTHORIZATION

Our services were performed in general accordance with our Proposal No. 43:1669-GP, dated March 18, 2019. The notice-to-proceed was received through your signature on 'Proposal Acceptance Form' dated March 18, 2019.

2.0 PROJECT INFORMATION

2.1 PROJECT LOCATION

The project site is located at 4724 N Main Street in Houston, Texas. The location is presented in Appendix A of the report.

2.2 PAST SITE HISTORY/USES

The project site is generally flat with elevations ranging from ±52 feet MSL to ±54 feet MSL. The elevations and topographic variations were obtained from the U.S. Geological Survey website (http://www.usgs.gov), which provided elevation contours in 5 feet intervals.

While preparing this report, we reviewed available documents consisting of historical aerial photos, USGS topographic maps, FWS wetland maps, and USDA soil maps. The project site is currently vacant and covered with light to moderate vegetative growth. A final grading plan is currently unavailable at the time when this report is prepared.

We reviewed Historical Aerial photographs to identify the past usage and location of the previously existing development (if there was any) within the project site. Our aerial photo review summary is presented below:

Year	Subject Property Usage	Adjacent Property Usage
2004	Developed with structures, surficial parking areas, driveways and associated site improvements.	The near vicinity of the project site is generally developed with residential, commercial and retail developments.
2011	No special improvements were noted.	No special improvements were noted.
2017	Existing structures were demolished.	No special improvements were noted.

2.3 CURRENT SITE CONDITIONS

The project site is currently vacant and covered with light to moderate vegetative growth. Residential, retail and commercial developments are located in the vicinity of the project site. No special features were noted from our review of the topographic map.

2.4 PROPOSED CONSTRUCTION

The proposed development will include a one to two story educational development with playground, parking areas, driveways and associated site improvements. The structure will be supported on slab on-grade supported with spread footings and/or drilled piers and/or monolithic slab on grade type foundations. Detailed structural loading information was not available at the time this report was prepared. However, we anticipate the wall and column loads to be in the order of 3 to 5 kips/foot and 30 to 50 kips, respectively. We understand that the parking areas and driveways will consist of rigid pavements to support light duty automobile and heave duty semitrailer type traffic. While site grading was not provided, we anticipate that final grades will largely be within 2 feet of the existing site grades without any major cut/fill across the site.

3.0 FIELD EXPLORATION

3.1 FIELD EXPLORATION PROGRAM

The field exploration was planned with the objective of characterizing the project site in general geotechnical and geological terms and to evaluate subsequent field and laboratory data to assist in the determination of geotechnical recommendations.

3.1.1 TEST BORINGS

Pursuant to the request of our client, the subsurface conditions were explored by drilling a total of thirteen (13) borings. The borings were drilled to depths ranging from 5 feet to 20 feet below the existing site grades.

The boring locations were selected by representatives of ECS based on the site plan provided by the client. The approximate as-drilled boring locations are shown on the Boring Location Diagram in Appendix A. The ground surface elevations noted in this report were obtained from the U.S. Geological Survey website (http://www.usgs.gov), which provided elevation contours in 5 feet intervals.

The soil borings were performed with a truck mounted auger drill rig, which utilized continuous-flight, solid-stem augers to advance the boreholes. Drilling fluid was not used in this process. Following completion of the drilling process, the boreholes were backfilled with the spoils generated during drilling operations.

Representative soil samples were obtained by means of the Shelby tube sampling procedure in accordance with ASTM Specifications D 1587. In the Shelby tube sampling procedure, a thin walled, steel seamless tube with sharp cutting edges is pushed hydraulically into the soil, and a relatively undisturbed sample is obtained.

Field logs of the soils encountered in the borings were maintained by the drill crew. After recovery, each geotechnical soil sample was removed for the sampler and visually classified. Representative portions of each soil sample was then wrapped in plastic and transported to our laboratory for further visual examination and laboratory testing.

3.2 REGIONAL GEOLOGY

The site is located within the Beaumont Formation (Qb), which consists predominantly of clay and mud soils, with silt. These soils can contain beds and lenses of fine sand, and decayed organic matter and many buried organic-rich soil zones that contain calcareous and ferruginous nodules.

This material includes plastic and potentially compressible clay that was deposited in flood basins, coastal lakes and former stream channels on a deltaic plain. The thickness of this formation is approximately 5-10 feet along the north edge of the outcrop, and thickens southward in the subsurface to more than 100 feet.

3.3 SOIL SURVEY MAPPING

Based on our review of the Soil Survey (USDA - Natural Resources Conservation Service (websoilsurvey.ncrs.usda.gov), the onsite soils are mapped as Bernard-Urban Land Complex (Bg)type soils. Please refer to the 'Soil Survey of Harris County, Texas' for the detailed soil characteristics and additional information.

3.4 SUBSURFACE CHARACTERIZATION

The subsurface conditions encountered were generally consistent with published geological mapping. The following sections provide generalized characterizations of the soil strata encountered during our subsurface exploration. For subsurface information specific information refer to the Boring Logs in Appendix B.

Approximate Depth Below Grade (ft)	Material Description	Consistency
0 – 2	LEAN CLAY FILL (CL FILL), Dark Brown to Reddish Brown and Tan, with Root Fibers, Ferrous Nodules, Sand Seams, Trace Gravels; in Boring B-13	Hard
0 – 2	SILTY CLAY FILL (CL-ML FILL), Dark Brown to Reddish Brown, with Root Fibers, Trace Gravels, Sand Seams; in Boring B-10	Stiff
(0-18) – (13-20)	LEAN CLAY (CL), Light Gray to Tan, Brown, Dark Brown to Reddish Brown, with Calcareous and Ferrous Nodules, Trace Gravels Sand Seams	Soft to Hard
(13-18) – (18-20)	LEAN CLAY (CL), Light Gray to Tan, Dark Brown to Reddish Brown, with Calcareous and Ferrous Nodules	Stiff to Hard

Please refer to the attached boring logs and laboratory data summary for this field exploration for a more detailed description of the subsurface conditions encountered in the borings as the stratification descriptions above are generalized for presentation purposes.

3.5 GROUNDWATER OBSERVATIONS

Groundwater level observations were made in the borings during drilling and shortly after completion of drilling operations. In auger drilling operations, water is not introduced into the borehole and the groundwater position can often be determined by observing water flowing into and out of the excavation. Furthermore, visual observation of soil samples retrieved can often be used in evaluating the groundwater conditions. Groundwater was not encountered during drilling the borings. The borings remained dry shortly after completion of drilling the borings.

The highest groundwater observations are normally encountered in the late winter and early spring. Fluctuation in the location of the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities and other factors not immediately apparent at the time of his investigation. Therefore, the groundwater conditions at this site are expected to be significantly influenced by surface water runoff and rainfall.

4.0 LABORATORY TESTING

The laboratory testing was performed by an experienced Geotechnical Engineer on selected samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples obtained from the test borings in order to aid in classifying soils according to the Unified Soil Classification System and to quantify and correlate engineering properties. The soil samples were tested for moisture content (ASTM D 2216), and Atterberg Limits (ASTM D 4318), and Unconfined Compression tests (ASTM D 2166).

An experienced Geotechnical Engineer visually classified each soil sample from the test borings on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS) and ASTM D 2488 (Description and Identification of Soils-Visual/Manual Procedures). After classification, the geotechnical engineer grouped the various soil types into the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs. The stratification lines designating the interfaces between earth materials on the boring logs are approximate; in situ, the transitions may be gradual.

The soil samples will be retained in our laboratory for a period of 30 days, after which, they will be discarded unless other instructions are received as to their disposition.

5.0 DESIGN RECOMMENDATIONS

The following sections present more detailed recommendations with regard to the proposed development. These include recommendations with regard to building foundations, drainage, earthwork, ground slabs, and pavements. The following recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions. If there are any changes to the project characteristics or if different subsurface conditions are encountered during construction, ECS should be consulted so that the recommendations of this report can be reviewed.

Site grading information was not provided during this report; however, we have assumed that the finished floor elevation will be within 2 feet from the existing site elevations. If the finished floor elevation deviates from this assumed site grades, the recommendations provided below should be evaluated by our office. Discussion of the factors affecting the building foundations for the proposed structures, as well as additional recommendations regarding design and construction at the project site are included below.

5.1 EXISTING ONSITE FEATURES

The subject property was previously developed and occupied with structures, surficial parking areas and associates site improvements. These structures were demolished and the project site is currently vacant. Therefore, we anticipate encountering buried (abandoned) foundations and/or utilities and/or non-structural elements within the limits of the proposed structures footprint. The presence of these obstructions (if encountered at the time of construction) may cause unwarranted delays with the installation of the foundation system and will need to be fully removed, as necessary. The contractor should be aware of this situation and be prepared to encounter such conditions during construction. Recommendations can best be made at the time of construction.

5.2 EXISTING FILL MATERIALS

Existing fill soils were encountered within the project site that extended to a depth of about 2 feet below the existing site grades. These soils were generally free of deleterious materials. The presence of this undocumented fill raises concerns for the uniformity of the soil density and may cause differential settlements of the proposed structure beyond tolerable limits. The depths of the existing undocumented fill soils vary across the site and should be carefully evaluated at the time of construction under the direct supervision of the Geotechnical Engineer of Record. Please note, the presence, quality and location of undocumented fill will impact the performance of the foundation systems and should be properly addressed at the time of construction. Without controlled density tests, these soils should be removed, reworked, and replaced in accordance to the 'Site Construction Recommendations' section of this report.

5.3 POTENTIAL VERTICAL MOVEMENTS

Based upon the laboratory test results performed on selected soil samples, the subsoils encountered at this site are considered to be low active. These low active soils generally have a low potential to experience minor volumetric changes with fluctuations in moisture content also known as 'Potential Vertical Movement (PVM)'. These soils can subject slabs, foundations and paving to movements (due to shrinking and swelling) with fluctuations in their moisture content, throughout the life of the structures and after construction is complete.

Several methods exist to evaluate swell potential of expansive clay soils. We have estimated potential heave for this site utilizing the TxDOT method (Tex 124-E). The Tex 124-E method provides an estimate of potential vertical movement (PVM) using the liquid limits, plasticity indices, and existing water contents for soils. The PVM is estimated in the seasonally active zone, which can be up to about 8 feet in the site vicinity.

Based on test method TEX-124-E in the Texas Department of Transportation (TxDOT) Manual of Testing Procedures, and our experience with similar soils, we estimate potential vertical movements (PVM) to be less than 1.0 inches, in 'dry' conditions. The actual movements could be greater if poor drainage, ponded water, and/or other unusual sources of moisture are allowed to saturate the soils beneath the structure after construction.

In this general area, most structural and geotechnical engineers consider a PVM of 1 inch or less to be within acceptable tolerances for properly designed slab on-grade type foundation systems. However, this movement does not take into consideration the movement criteria required or perceived by the owner or occupants. These "operational" performance criteria may be, and often are, more restrictive than the structural criteria or tolerances.

Our laboratory test results indicate that the project site is generally underlain by subsoils with relatively low swell-shrinkage potential. Therefore, we do not recommend any special subgrade improvements to limit the PVM at the subject site for the proposed structure. However, the existing fill materials, encountered in some of the borings, need to be removed and reworked prior to the construction of the new development.

5.4 FOUNDATION RECOMMENDATIONS

During field exploration, moisture sensitive surficial semi-cohesive Silty Clay Fill (CL-ML FILL) type soil was encountered near Boring B-10 to a depth of about 2 feet below the existing site grades. These permeable soils, underlain by low permeability clays, may create perched water condition that can lead to the reduced bearing pressure under the building pad during the wet season. Additionally, presence of these semi-cohesive soils may pose undesirable construction delays through (pumping and rutting) during wet season. These conditions should be anticipated before commencing the construction operation during wet season. However, these soils can be opened up for natural drying purposes and/or removed and replaced with select fill. Additional subsoil stabilization/improvements may be required if a very aggressive construction schedule is expected.

Based on our subsurface exploration and laboratory testing, we are providing the following recommendations to support the proposed structure on slab on-grade supported by shallow foundations and/or drilled pier and/or monolithic slab on-grade type foundations. The suitable foundation systems should be selected based upon the discussion between the owner and by the design team members (The Owner, Project Architect and Structural Engineer of Record).

5.5 SPREAD AND/OR CONTINUOUS FOOTINGS

Existing undocumented fill soil was encountered within portion of the project site that extended to a depth of about 2 feet below the existing site grades. The spread and/continuous footings should not be supported on the existing undocumented fill soils; unless the existing undocumented fill soils are removed, reworked and/or recompacted in accordance to the 'Site Construction Recommendations' section of the report. The actual depth of fill soils may vary at different locations across the site and must be identified at the time of construction under the supervision of an authorized representative of the Geotechnical Engineer of Record (GER).

The shallow foundations may be designed for a net allowable soil bearing capacity of 2,000 psf. In order to achieve this bearing capacity column footings and continuous footings should be supported on properly placed and natural subgrades as defined in this report. Shallow foundations should be placed at a minimum depth of 30 inches (spread footing) and 24 inches (continuous footing), below existing site grades and should have a minimum lateral dimension of 18 inches to avoid punching shear.

The net allowable soil bearing pressure refers to that pressure which may be transmitted to the foundation bearing soils in excess of the final minimum surrounding overburden pressure. The final footing and/or grade beam elevation should be evaluated by competent geotechnical engineering personnel to verify that the bearing soils are capable of supporting the recommended net allowable bearing pressure and suitable for foundation construction. These evaluations should include visual observations and use of the Dynamic Cone Penetrometer (DCP). Evaluations should be performed within each column footing excavation (minimum of 2 tests per column footing) and at intervals not greater than 25 feet in continuous footings. The DCP testing should extend at least 2 feet below the final foundation subgrade. A minimum DCP value of 8 blows may be used for the evaluation of the foundations.

The settlement of a structure is a function of the compressibility of the bearing materials, bearing pressure, actual structural loads, fill depths, and the bearing elevation of footings with respect to the final ground surface elevation. Estimates of settlement for foundations bearing on engineered or non-engineered fills are strongly dependent on the quality of fill placed. Factors that may affect the quality of fill include maximum loose lift thickness of the fills placed and the amount of compactive effort placed on each lift. If the recommendations outlined in this report are followed, we expect total settlements for the proposed construction to be in the range of 1 inch or less, while the differential settlement will be approximately half of the anticipated total settlement. This evaluation is based on our engineering experience and the anticipated loadings for this type of structure, and is intended to aid the structural engineer with his design.

Exposure to the environment may weaken the soils at the foundation bearing level if the foundation excavations remain exposed during periods of inclement weather. Therefore, foundation concrete should be placed the same day that final excavation is achieved and the design bearing pressure verified. If the bearing soils are softened by surface water absorption or exposure to the environment, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the foundation excavation must remain open overnight, or if rainfall is apparent while the bearing soils are exposed, we recommend that a 1 to 3-inch thick "mud mat" of "lean" concrete be placed over the exposed bearing soils before the placement of reinforcing steel.

5.6 DRILLED PIER FOUNDATIONS

As an alternative, a drilled pier foundation system may be utilized to support the proposed structure. Drilled piers should be proportioned and founded at sufficient depths to provide both axial compressive load capacity and uplift resistance. Based on the results from the field exploration and laboratory test results data the allowable loads for the drilled piers are recommended as:

Drilled Piers Recommendations	
Foundation Type	Under-reamed
Minimum Depth below Existing Grade	8 Feet
Net Allowable Bearing Pressure for Dead Load (Dead and Sustained Live Load)	2,500 PSF
Net Allowable Bearing Pressure for Total Load (Dead Load and Live Load)	3,750 PSF

The above recommended drilled pier allowable end bearing pressures incorporate a design safety factor of 3 against axial compression dead loads plus sustained live loads and a design safety factor of 2 against axial compression dead loads plus sustained and transient live loads. The minimum clear spacing between edges of adjacent piers should be at least one (1) bell diameter, with larger bell size governing. Drilled pier foundations that are designed and constructed in accordance with the recommendations in this report could be subjected to long term total and differential movements of about 1.0 and 0.5 inch, respectfully.

The following items should be considered during the design and construction of the drilled piers:

- The bell to shaft ratio should be between 2:1 to 3:1.
- Based on our current groundwater observations, the drilled pier excavations should not encounter groundwater. If groundwater is encountered during construction, water inflow must be pumped out immediately using a sump-pump. The drilling contractor must be prepared for this condition and be prepared to case the piers.
- We anticipate that the drilled pier may be installed using dry method of construction. However, a slurry method of construction may be required for the drilled pier installations due to the potential seasonal variations in groundwater depth, variations in the subsoils stratigraphy, strengths and corresponding potential borehole collapsing. The drilling contractor should be prepared to encounter for any such situations.

Due to the potential subsoil variations and potential groundwater fluctuations, we recommend that the four corner and two center piers be drilled first to better evaluate the constructability of the drilled piers recommended herein. Once this information is field verified, other piers need to be constructed accordingly.

The drilled pier excavations should be free of loose materials and water prior to concrete placements. Concrete should be poured immediately after drilling the pier holes. The drilled piers installations should be followed in accordance with the American Concrete Institute (ACI) Reference Specifications for the construction of drilled piers (ACI 336.1) and commentary (ACI 336.1R-98). Additionally, The U.S. Department of Transportation publication No. FHWA-NHI-10-016, “Drilled Shafts: Construction Procedures and LRFD Design Methods” should be followed during the design and construction of the drilled piers.

The construction of the piers should be observed as a means to verify compliance with design assumptions and to verify: (1) the bearing stratum; (2) length and diameter; (3) the removal of smear zones and cuttings; (4) that groundwater seepage, when encountered, is correctly handled; and (5) that the piers are vertical (within the acceptable tolerance).

5.6.1 UPLIFT CONSIDERATIONS

The drilled piers should contain sufficient reinforcing steel throughout their entire length to resist uplift (tensile) forces due to post-construction heave of the clay soils. The magnitude of uplift is difficult to predict and will vary with the insitu moisture contents at the time of construction. Based on the planned building subgrade preparation, we recommend using a uniform uplift of

800 psf over the entire pier perimeter to a depth of 8 feet.

The uplift forces created due to the expansive soils and imposed structural loadings can be resisted by the underreamed portion the pier, weight of the pier itself and the dead load on the pier. The uplift resistance of underreamed drilled piers at the site can be estimated using the following equation:

$$U_r = B_r + W_p + P_{DL}$$

Where: U_r = Uplift resistance of the pier (kips)
B_r = Resistance contributed by the underreamed portion of the pier (kips)
W_p = Weight of the pier (kips)
P_{DL} = Dead Load acting on the pier (kips)

The resistance contributed by the underreamed portion of the pier should be calculated as shown in the following equations. The following formulas incorporate a factor of safety of approximately 2.

$B_r = 1\bullet(D^2 - d^2)$ Piers at least 12 feet below adjacent finished grade
$B_r = 3\bullet(D^2 - d^2)$ Piers at least 15 feet below adjacent finished grade
$B_r = 7\bullet(D^2 - d^2)$ Piers at least 18 feet below adjacent finished grade
B_r should be ignored should the pier depth is less than 12 feet below adjacent finished grade

Where: D = Diameter of the under-ream (feet)
d = Diameter of the pier shaft (feet)

5.6.2 LATERAL CONSIDERATIONS

Resistance to lateral loads and the expected pier behaviour under the applied loading conditions will depend not only on the subsurface conditions, but also on loading conditions, the pier size, and the engineering properties of the pier. We recommend the designer use a performance based design methodology using non-linear soil support springs (“p-y curves”) to model the soil behaviour. Several computer programs are commercially available for this purpose; we recommend LPILE (Ensoft, Inc.) since the software is relatively current and actively supported.

The graphical relationship between the soil resistance (p) and pile deflection (y) is commonly referred to as a “p-y curve”. Along the depth of the shaft, soil resistance (p) is expressed as a non-linear function of lateral shaft deflection (y). Various researchers developed “p-y” criteria for different kinds of soils. The “p-y” curves can be automatically generated by LPILE. Recommended design soil properties needed for generating “p-y” curves are provided in the table below.

Description	Approximate Depth (ft)	Effective Unit Weight (pcf)	Allowable Passive Pressure (psf)	Cohesion (psf)	Friction Angle (degree)	E_{50}	K_s (pci)
Clay	0 to 4	115	Disregard Capacities				
Clay	4 to 8	115	1,000	1,000	-	0.007	100
Clay	8 to 12	115	1,500	1,500	-	0.007	200

5.6.3 SLAB ON-GRADE

Upon addressing the undocumented fill soils, the floor slab can be supported on engineered fill soils for the surface supported structure. We recommend that the upper six-inch of subgrade soils in the floor slab areas be compacted to at least 95% of standard density (ASTM D 698) at a moisture content between ±2% of the optimum value. Positive drainage should always be maintained to drain surface water away from the structure. A soil modulus of subgrade reaction (ks) of 120 pci can be used in the design of floor slab. Positive drainage should be developed and strictly maintained during the lifetime of the structure to direct surface water away from the foundation area.

We recommend that floor slabs be isolated from the foundation footings so differential settlement of the structure will not induce shear stresses in the floor slab. Furthermore, the existing near surface loose or poorly compacted soils should be removed and compacted prior to the slab construction. In order to minimize the crack width of shrinkage cracks that may develop near the surface of the slab, we recommend mesh reinforcement be included in the design of the floor slab. The mesh should be in the top half of the slab to be effective.

A bedding layer of leveling sand, one to two inch in thickness, may be placed beneath the floor slab. If floor treatments that are sensitive to moisture will be used, a 10-mil vapor barrier of polyethylene sheeting or similar material should be placed beneath the slab to minimize moisture migration through the slab. If a vapor barrier is considered to provide moisture protection, special attention should be given to the surface curing of the slabs to minimize uneven drying of the slabs and associated cracking and/or slab curling. The use of a blotter or cushion layer above the vapor barrier can also be considered for project specific reasons. Please refer to ACI 302.1R96 *Guide for Concrete Floor and Slab Construction* and ASTM E 1643 *Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs* for additional guidance on this issue.

While site grading was not provided, we anticipate that planned grading will largely be within 2 feet of the existing contours across the site. In the event that fill is placed on the site, specifications should require placement in accordance with our recommendations given in the "Site Preparation" section.

5.7 MONOLITHIC SLAB ON-GRADE

As an alternative, upon addressing the undocumented fill, the planned structure can be supported by a monolithic slab-on-grade/grade beam structural foundation system. This system may be designed with conventional reinforcing or by post-tensioning. The slab should be designed in accordance with WRI/CRSI “Design Slab-On-Ground Foundations” or PTI “Design and Construction of Post-Tensioned Slabs-On-Ground”. The following design parameters are recommended for the Post-Tensioning Institute's slab-on-grade design method (3rd Edition):

POST-TENSIONED SLAB PARAMETERS - PTI 3RD EDITION WITH 2008 SUPPLEMENTS	
Design Parameters	**Existing Conditions; PVM = 1.0 (inch)**
e_m Edge (feet)	4.8
y_m Edge (inches)	0.6
e_m Center (feet)	9.0
y_m Center (inches)	0.8
Effective PI	20
Design Suction Profile	Post-Equilibrium
Thornthwaite Moisture Index	18
Minimum Fill-Soil Undrained Shear Strength	1,000 psf
Slab Subgrade Coefficient (Slab-on-Vapor Sheeting over Sand)	0.75

The following design parameters are recommended for the WRI/CRSI “Design Slab-On-Ground Foundations (August, 1981)”:

BRAB/WRI SLAB PARAMETERS	
Design Parameters	**Existing Conditions; PVM = 1.0 (inch)**
Allowable Bearing Capacity	2,500 psf
Design PI	20
Climatic Rating (Cw)	26
Unconfined Compressive Strength	1.0 tsf
Soil-Climate Support Index (1-C)	0.03

A net allowable soil bearing pressure of 2,000 psf can be used to design grade beams founded on competent onsite natural soils and/or engineered fill, as described in the section titled ‘Site Construction Recommendations’. Grade beams should have a minimum width of 12 inches to reduce the possibility of foundation bearing failure and excessive settlement due to local shear or "punching" failures. Additionally, the grade beams should extend at least 18 inches below final adjacent grade to utilize this bearing pressure for both interior and exterior beams, respectively.

Fills should be sloped to drain surface water away from the structures. We anticipate that foundations, grade beams and slabs designed using the recommended allowable bearing pressures will experience minor settlements that will be within the tolerable limit (less than an inch) for the proposed structures.

The recommended differential movement values are based on climate controlled soil conditions and are not valid when influenced by significant other conditions, such as trees, poor drainage, slope, cut and fill sections, etc. These design parameters also assume that positive drainage will be provided away from the structures and with moderate irrigation of surrounding lawn and planter areas with no excessive wetting or drying of soils adjacent to the foundations. Greater potential movements may occur with extreme wetting or drying of the soils due to ponding of water, plumbing leaks or lack of irrigation. In the event that sprinkler systems are used, we recommend that the sprinkler system be placed all around the structure to provide a uniform moisture condition throughout the year. This will reduce fluctuations in subsoil moisture and corresponding movement.

If floor treatments that are sensitive to moisture will be used, a 10-mil vapor barrier of polyethylene sheeting or similar material should be placed beneath the slab to minimize moisture migration through the slab. If a vapor barrier is considered to provide moisture protection, special attention should be given to the surface curing of the slabs to minimize uneven drying of the slabs and associated cracking and/or slab curling. The use of a blotter or cushion layer above the vapor barrier can also be considered for project specific reasons. Please refer to ACI 302.1R96 *Guide for Concrete Floor and Slab Construction and ASTM E 1643 Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs* for additional guidance on this issue.

While site grading was not provided, we anticipate that planned grading will largely be within 2 feet of the existing contours across the site. In the event that fill is placed on the site, specifications should require placement in accordance with our recommendations given in the "Site Construction Recommendations" section.

5.8 GRADE BEAMS AND PERIMETER CONDITIONS

Soils placed along the exterior of grade beams should be on-site clay soils placed and compacted in accordance with this report. The purpose of this backfill is to reduce the opportunity for surface or subsurface water infiltration beneath the structure. The overbuild zone of select granular soils should be removed outside of the perimeter grade beams and backfilled with on-site clay soils.

We recommend paving/sidewalks be placed adjacent to the structures to reduce seasonal drying of the moisture conditioned soils near the perimeter of the structures. Irrigation of lawn and landscaped areas should be moderate, with no excessive wetting or drying of soils around the perimeter of the structures allowed. Positive drainage away from the structures should also be provided.

Trees and bushes/shrubs planted near the perimeter of the structures can withdraw large amounts of water from the soils. We recommend trees not be planted or left in place (existing trees) closer than half the canopy diameter of mature trees from the grade beams, typically a minimum of 20 feet. If vegetation is planted closer than the anticipated mature height away from the buildings then a root barrier should be installed to a depth of at least 5 feet below finished grade.

5.9 PAVEMENT SUBGRADE

Existing undocumented fill soil was encountered within portion of the project site that extended to a depth of about 2 feet below the existing site grades. The degree of compaction must be carefully evaluated during the construction. Proposed paved areas should be proofrolled with heavy compaction equipment with load of at least 25 tons to attempt to locate soft or undesirable soils so they can be removed and replaced with properly placed and compacted soils. Pumping or rutting identified during proofroll should be conducted in accordance with TxDOT Standard Specification Item 216. The proofrolling operations should be observed by the representative of Geotechnical Engineer of Record.

If lime is used, we estimated approximately 4% hydrated lime (by dry weight of soil) be used to modify and stabilize the clay subgrade soils. The application rate corresponding to this additive amount would be approximately 18 pounds per square yard for each six-inch of compacted thickness. The hydrated lime should meet the requirements of Item 264 (Type A) in the TxDOT Standard Specifications for Construction of Highways, Streets and Bridges, and should be thoroughly mixed and blended with the upper 6 inches of the clay subgrade (TxDOT Item 260). This mixture should be uniformly compacted to a minimum of 95% of its maximum Standard Proctor dry density (ASTM D 698) at a moisture content within optimum and +3% above optimum as determined by that test. Lime treatment should extend at least 1 foot beyond exposed pavement edges to reduce the effects of shrinkage and associated loss of subgrade support. Density tests should be performed at a frequency of 1 test per 5,000 square feet of pavement. The actual amount of lime required should be confirmed by additional laboratory tests (lime series) during the construction phase.

5.9.1 PAVEMENT SUBGRADE

Specific traffic loading information was not provided; however, light duty (automobile parking) pavements are expected to receive passenger vehicles. Based on our experience with local soils, we anticipate CBR of the onsite subsoil will range from 3 to 5. Our pavement section recommendations for heavy duty (drives) pavements should accommodate occasional heavier loadings due to fire trucks, delivery vehicles and light truck traffic and may be considered for main drives. Typical pavement sections are presented below. Actual pavements sections and joint spacing should be designed based on actual traffic loads by the Civil Engineer of Record.

Material Designation	**Asphaltic Concrete**		**Portland Cement Concrete**	
	Automobile Light Duty	**Fire Lane Heavy Duty**	**Automobile Light Duty**	**Fire Lane Heavy Duty**
Asphalt Surface Course	2 inches	2 inches	-	-
Asphalt Binder Course[1]	3 inches	4.5 inches	-	-
Portland Cement Concrete	-	-	5 inches	6 inches
Reworked Subgrade	6 inches	-	6 inches	-
Lime Stabilized Subgrade[2,3]	-	6 inches	-	6 inches

[1] Flexible base material may be substituted for the asphalt binder using a substitute ratio of three inches of flexible base for each inch of asphalt binder.

[2] In lieu of lime stabilized subgrade, the PCC pavement thickness may be increased by 1 inch.

[3] Granular base (or flexbase) materials may be substituted with the lime stabilization at an equivalent thickness substitution.

An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should reduce the possibility of the subgrade materials becoming saturated during the normal service period of the pavement.

Please note, the recommended pavement sections provided above are considered the minimum necessary to provide satisfactory performance based on the provided traffic loading. In some cases, jurisdictional minimum standards for pavement section construction may exceed those provided above.

Front-loading trash dumpsters frequently impose concentrated front-wheel loads on pavements during loading. This type of loading typically results in rutting of bituminous pavements and ultimately pavement failures and costly repairs. Therefore, we suggest that the pavements in trash pickup areas utilize an 8 inch thick Portland Cement Concrete (PCC) pavement section. Appropriate jointing should also be incorporated into the design of the PCC pavement. Reinforcing steel may consist of #4 reinforcing steel bars placed at 18 inches on center all directions.

Pavement should be specified, constructed and tested to meet the following requirements:

1. Reinforcing steel may consist of #3 reinforcing steel bars placed at 18 inches on center all directions. Saw cuts contraction joints should be spaced 15 feet in any directions. Expansion joints should be maintained 60 feet apart through the entire depth of pavement.

2. Hot Mix Asphaltic Concrete: Item 340 of the TxDOT Standard Specifications, Type A or B Base Course (binder), Type D Surface Course. The coarse aggregate in the surface course should be crushed limestone rather than gravel.

3. Portland Cement Concrete: Minimum compressive strength of 3,500 lbs per sq inch at 28 days. Concrete should be designed with 3 to 6 percent entrained air.

4. Crushed Limestone Base Material: Item 247 of the TxDOT Standard Specifications, Type A or B, Grade 2 or better. The material should be compacted to a minimum 95 percent of standard Proctor maximum dry density (ASTM D 698) and within three percentage points of the material's optimum moisture content.

6.0 SITE CONSTRUCTION RECOMMENDATIONS

6.1 SUBGRADE PREPARATION

A portion of the project site is underlain by undocumented fill soils to a depth of about 2 feet below the existing site grades. The presence of loose and poorly compacted undocumented fill within structural areas may result in lower net available bearing capacities and settlements that may exceed tolerable limits. Therefore, the degree of compaction must be carefully evaluated within the structural areas prior to the construction of the foundations. If there are any soft/unstable soils present during construction, these soils should be removed, reworked and/or replaced.

During field exploration, moisture sensitive surficial semi-cohesive Silty Clay Fill (CL-ML FILL) type soil was encountered near Boring B-10 to a depth of about 2 feet below the existing site grades. These permeable soils, underlain by low permeability clays, may create perched water condition that can lead to the reduced bearing pressure under the building pad during the wet season. Additionally, presence of these semi-cohesive soils may pose undesirable construction delays through (pumping and rutting) during wet season. These conditions should be anticipated before commencing the construction operation during wet season. However, these soils can be opened up for natural drying purposes and/or removed and replaced with select fill. Additional subsoil stabilization/improvements may be required if a very aggressive construction schedule is expected.

Good site drainage should be maintained during earthwork operations, which would help maintain the integrity of the soil. The surface of the site should be kept properly graded in order to enhance drainage of the surface water away from the proposed building areas during the construction phase. We recommend that an attempt be made to enhance the natural drainage without interrupting its pattern.

The soils at the site are moisture and disturbance sensitive, and contain fines which are considered moderately erodible. Therefore, the contractor should carefully plan his operation to minimize exposure of the subgrade to weather and construction equipment traffic, and provide and maintain good site drainage during earthwork operations to help maintain the integrity of the surficial soils. Erosion and sedimentation shall be controlled in accordance with sound engineering practice and current jurisdictional requirements.

6.1.1 STRIPPING AND GRUBBING

In preparing the site for construction, all loose, poorly compacted existing soils, vegetation, organic soil, foundations or utilities, existing fill material, or other unsuitable materials should be removed from all proposed building and paving areas, and any areas receiving new fill.

6.1.2 PROOFROLLING

After stripping and removing all unsuitable surface materials, cutting to the proposed grade, and prior to the placement of any structural fill, the exposed subgrade should be examined by the Geotechnical Engineer or authorized representative. The exposed subgrade should be thoroughly proof rolled with previously approved construction equipment having a minimum axle load of 25 tons (e.g. fully loaded tandem-axle dump truck). The areas subject to proof rolling should be traversed by the equipment in two perpendicular (orthogonal) directions with overlapping passes of the vehicle under the observation of the Geotechnical Engineer or authorized representative.

This procedure is intended to assist in identifying any localized yielding materials. In the event that unstable or “pumping” subgrade is identified by the proof rolling, those areas should be marked for repair prior to the placement of any subsequent structural fill or other construction materials. Methods of repair of unstable subgrade, such as undercutting or moisture conditioning or chemical stabilization, should be discussed with the Geotechnical Engineer to determine the appropriate procedure with regard to the existing conditions causing the instability.

6.2 EARTHWORK OPERATIONS

The onsite cohesive soil may result in difficulties during access and workability from poor site drainage, wet season, or site geohydrology. Should this condition develop, drying of the soils for support of pavement and floor slabs may be improved by the addition of 4% lime by dry weight, as a minimum. The application rate corresponding to this additive amount would be approximately 18 pounds per square yard for each six-inch of compacted thickness. Texas Department of Transportation (TxDOT) Specifications, Items 260 and 263, shall be used as procedural guides for placing, mixing, and compacting lime stabilizer and the soils.

Prior to placement of new fill, subgrades should be scarified to a minimum depth of 6 inches, moisture conditioned and compacted to at least 95% of Maximum Dry Density as obtained by the Standard Proctor Method (ASTM D 698) moisture conditioned within ±2% of the optimum value.

Soil moisture levels should be preserved (by various methods that can include covering with plastic, watering, etc.) until new fill, pavements or slabs are placed. Fill soils should be placed in 8 inch loose lifts for mass grading operations and 4 inches for trench type excavations where walk behind or “jumping jack” compaction equipment is used.

Upon completion of the filling operations, care should be taken to maintain the soil moisture content prior to construction of floor slabs and pavements. If the soil becomes desiccated, the affected material should be removed and replaced, or these materials should be scarified, moisture conditioned and recompacted.

Utility cuts should not be left open for extended periods of time and should be properly backfilled. Backfilling should be accomplished with properly compacted on-site soils, rather than granular materials. If granular materials are used, a utility trench cut-off at the structure line is recommended to help prevent water from migrating through the utility trench backfill to beneath the proposed structure.

Field density and moisture tests should be performed on each lift as necessary to verify that adequate compaction is achieved. As a guide, one test per 2,500 square feet per lift is recommended in the foundation slab and paving areas (two tests minimum per lift). Utility trench backfill should be tested at a rate of one test per lift per each 150 linear feet of trench (two tests minimum per lift). Certain jurisdictional requirements may require testing in addition to that noted previously. Therefore, these specifications should be reviewed and the more stringent specifications should be followed.

6.3 MATERIAL SPECIFICATIONS FOR SELECT FILL

Final site grading plan was not available at the time of this report's preparation. However, we anticipate that imported fill soils may be required to raise the site grade.

For the purposes of this report, select fill soil may consist of imported material that is free of debris and organic matter and have a Plasticity Indices (PI) ranging 8 to 20. Soils classified as CH, MH, ML, SM, GM, OH, OL and Pt in accordance to USCS should not be considered as suitable material as select fill materials. Based on our limited test information performed during the current geotechnical study, we anticipate that majority of the onsite Lean Clay Fill (CL FILL) and natural Lean Clay (CL) materials should qualify to be used as select fill material within the structural area. The properties of the imported materials must be verified prior to use as 'Select Fill' within the structural area by an authorized representative of Geotechnical Engineer of Record (GER) at the time of construction.

Crushed limestone may be used for this purpose. The crushed limestone used for this process should have a minimum Dry Density of 115 pcf. The properties of this material should be evaluated by ECS at the time of construction and will largely be based on the gradation, rather than the PI. The crushed limestone should have a maximum dimension of 1 inch (if used within the final 4 feet of fill) or 4 inches if used deeper than 4 feet below the slab subgrade.

This material should be placed and compacted at workable moisture contents within ±2% of optimum moisture content and compacted to at least 95% of the Maximum Dry Density within the structural and paving area as obtain using the Standard Proctor Method (ASTM D 698).

6.4 CONSTRUCTION GROUNDWATER CONTROL

Groundwater was not encountered during field exploration. These conditions should be anticipated and can be handled through the use of trenching and pumping. One of the more cost effective techniques that can be utilized is through the prudent utilization of spot drains, and in planning utility installations. For example, any utility installation that requires a gravity feed can be effectively converted into a drainage line to help assist in groundwater control during construction.

If groundwater is encountered during construction of footings or buried utilities, an ECS geotechnical engineer should be consulted to determine if additional permanent drainage provisions are necessary in the design and construction. Groundwater levels should be maintained at least 3 feet below subgrade levels to provide dry working condition and firm bedding. Sump pumping and surface runoff ditches may be adequate for temporary control of surface runoff and groundwater during construction.

The surface of the site should be kept properly graded to enhance drainage of surface water away from the proposed construction area during construction. ECS recommends that an attempt be made to enhance the natural drainage without interrupting its pattern.

6.5 EXCAVATION

Based on soils strength data, temporary (less than 24 hours), open trenched, non-surcharged and unsupported excavations can be built on a slope flatter than 1.5(h):1(v) provided this will not impact the stability of the existing/nearby structures. Flatter slopes may be required in the areas where soft soils or a large amount of sands are encountered. Vertical cuts can be constructed, provided shoring and bracing is used for excavation wall stability. Benched excavation can also be used with average slopes of about 1(h):1(v) and steps should not be higher than five-ft. In all cases, excavation construction should conform to OSHA (Occupational Safety and Health Administration) guidelines.

Excavations should be performed with equipment capable of providing a relatively clean bearing area. Excavation equipment should not disturb the soil beneath the design excavation bottom and should not leave large amounts of loose soil in the excavation. Foundation excavations should be protected against significant change in soil moisture content and disturbance by construction activity. Specification should require that water not be allowed to pond in excavations.

7.0 CLOSING

ECS has prepared this report of findings, evaluations, and recommendations to guide geotechnical-related design and construction aspects of the project.

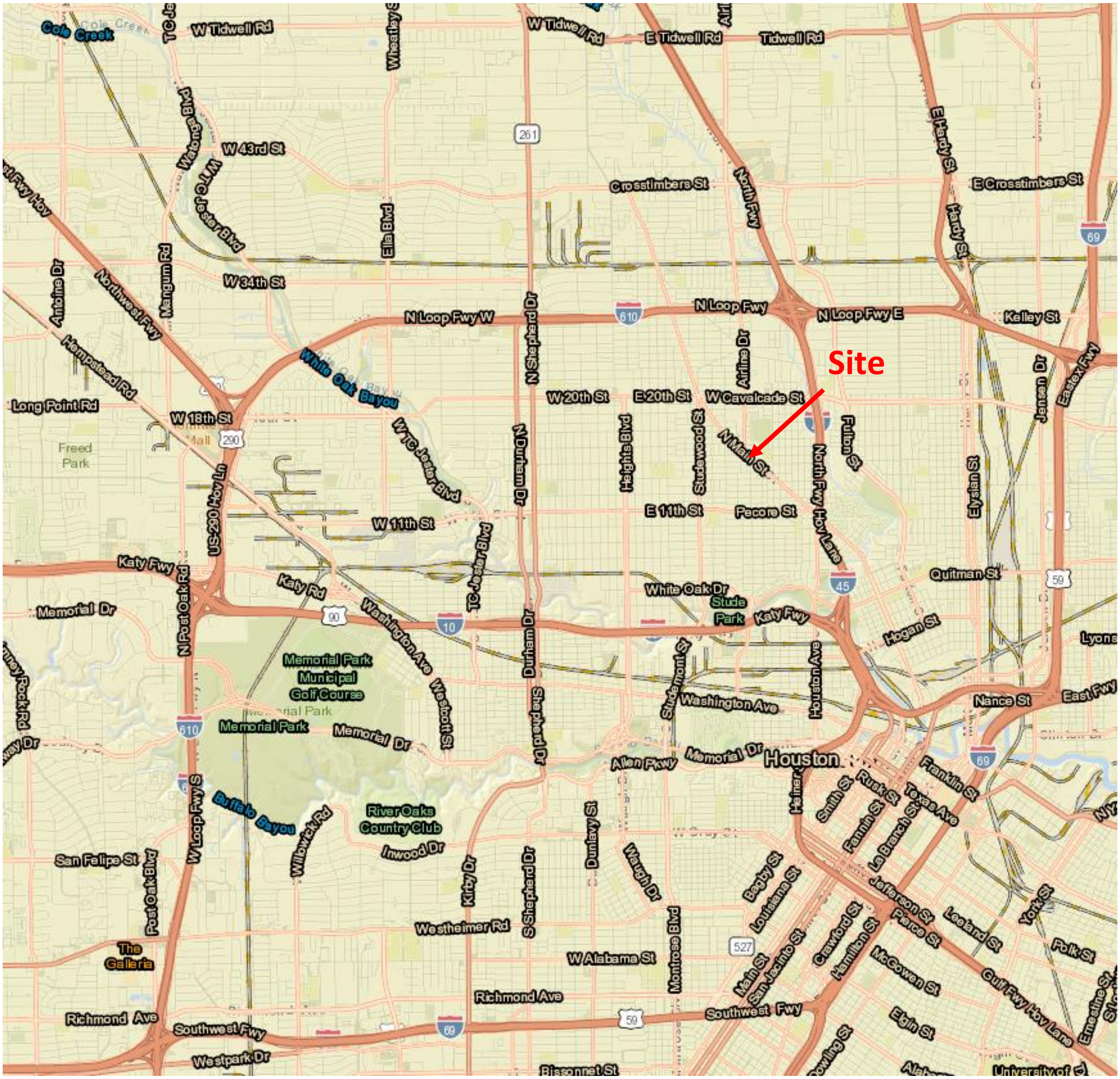
The description of the proposed project is based on information provided to ECS by Greater Heights School and W [Squared] Architects. If any of this information is inaccurate, either due to our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted immediately in order that we can review the report in light of the changes and provide additional or alternate recommendations as may be required to reflect the proposed construction.

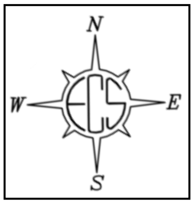
We recommend that ECS be allowed to review the project's plans and specifications pertaining to our work so that we may ascertain consistency of those plans/specifications with the intent of the geotechnical report.

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of and integral to the geotechnical design recommendation. We recommend that the owner retain these quality assurance services and that ECS be allowed to continue our involvement throughout these critical phases of construction to provide general consultation as issues arise. ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

APPENDIX A – Figures

Site Location Map
Boring Location Diagram
Regional Geology
Aerial Photograph – 2017
Aerial Photograph – 2011
Aerial Photograph – 2004
Topographic Map





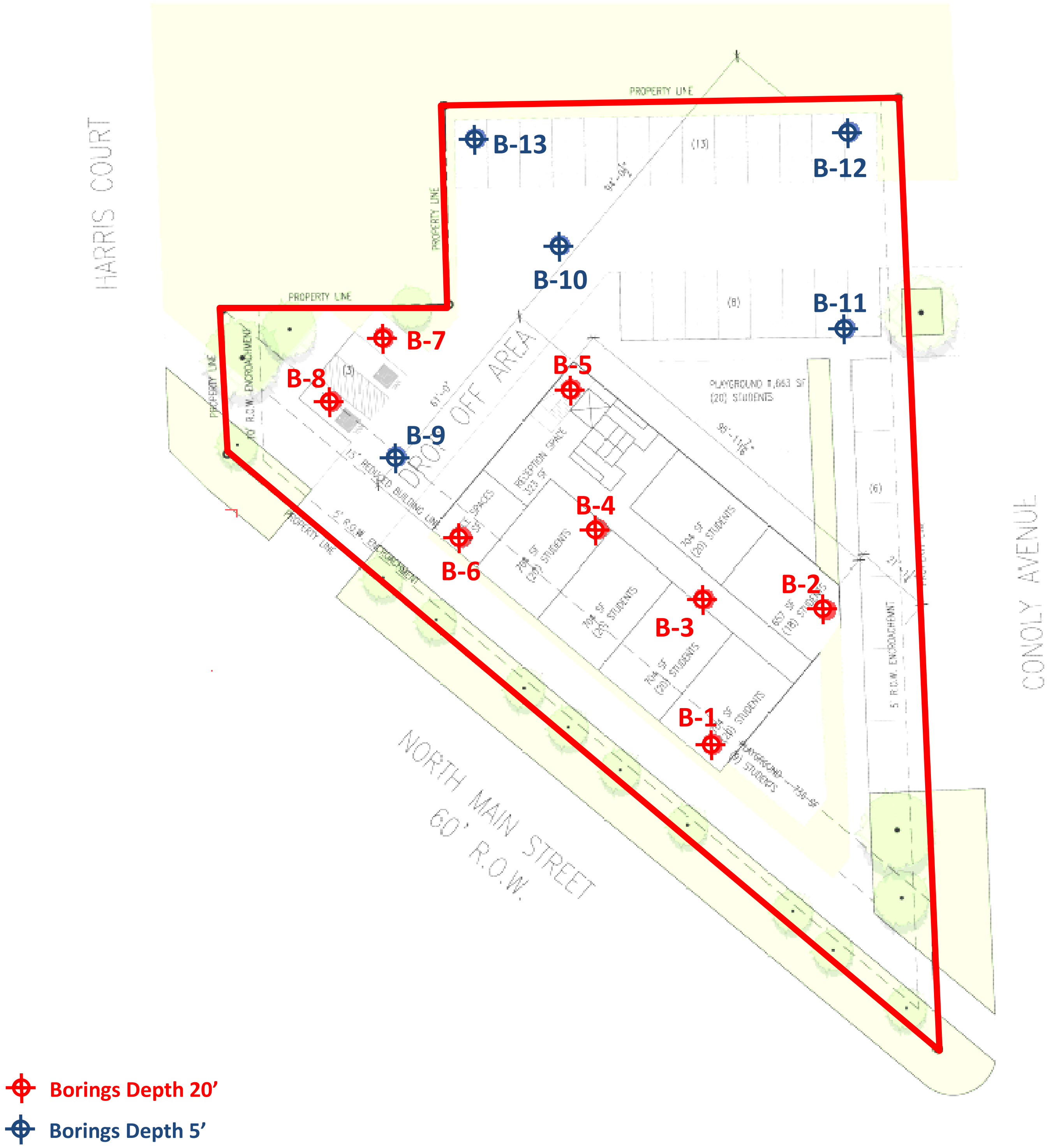
Site Location Map

Greater Heights School
4724 N Main Street
Houston, Texas

ECS SOUTHWEST, LLP

1050 North Post Oak Road, Suite 130
Houston, Texas 77055

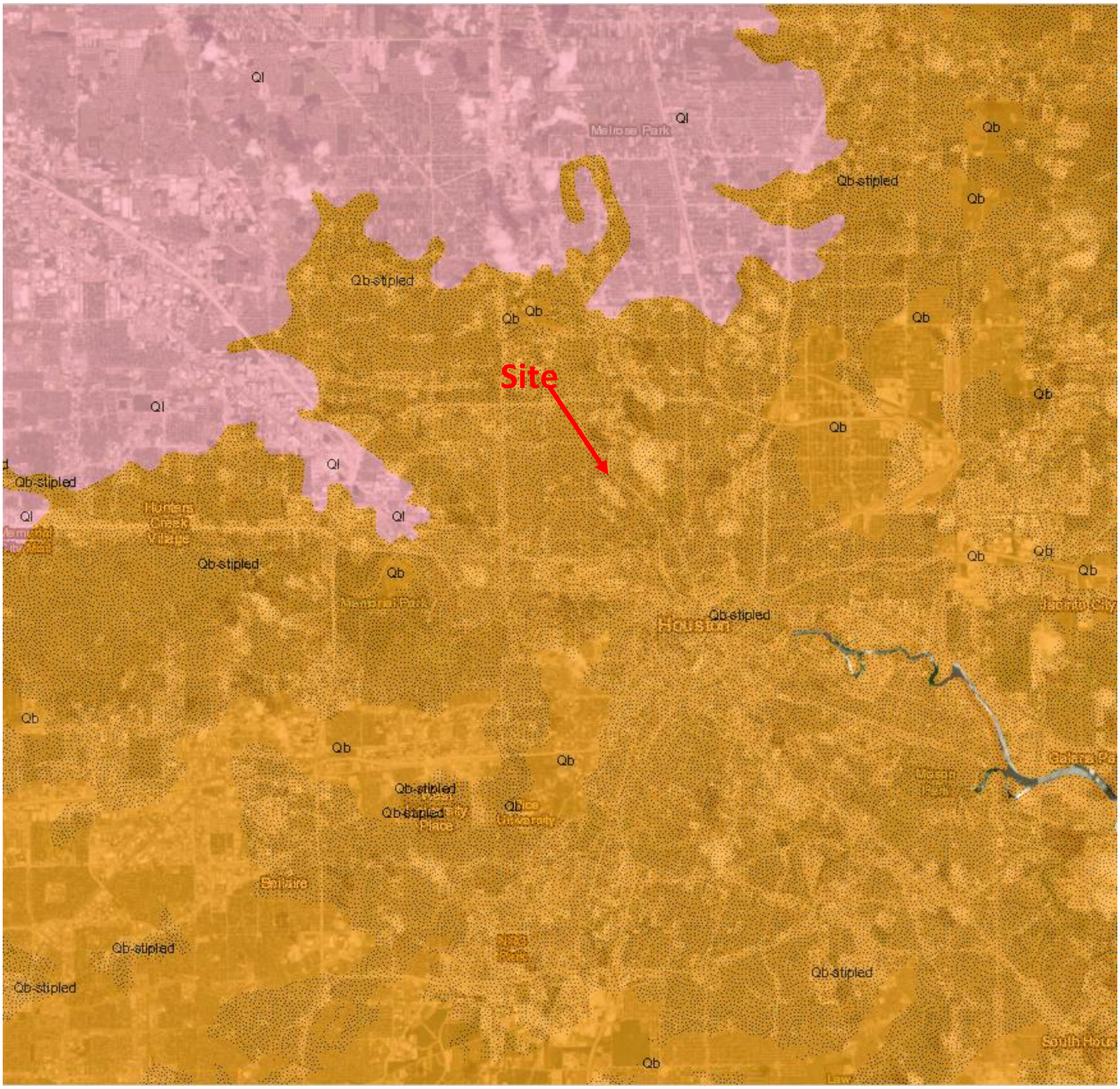
	Scale: NTS	PROJECT NO: 43-1665
PM: DRB	Date: 04/12/2019	FIGURE: SSM

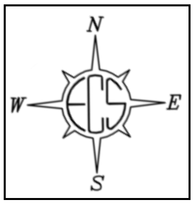


Boring Location Diagram
Greater Heights School
4724 N Main Street
Houston, Texas

ECS SOUTHWEST, LLP
1050 North Post Oak Road, Suite 130
Houston, Texas 77055

Scale: NTS
PROJECT NO: 43-1665
PM: SRM
Date: 04/12/2019
FIGURE: SRM





Geologic Atlas of Texas, Houston Sheet, 1982

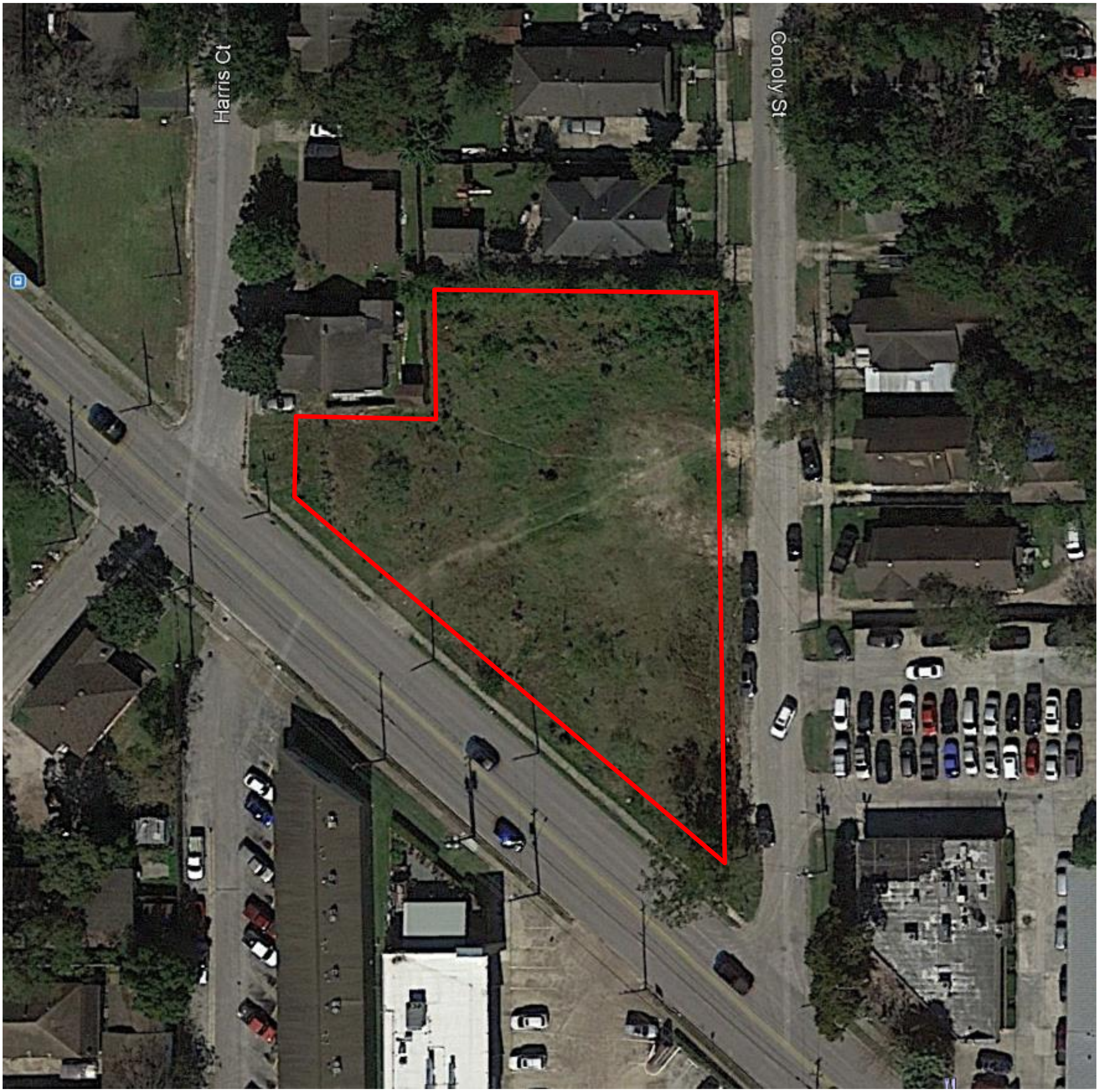
Qb- Beaumont Formation

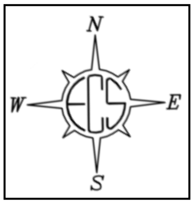
Regional Geology Map

Greater Heights School
4724 N Main Street
Houston, Texas

ECS SOUTHWEST, LLP
1050 North Post Oak Road, Suite 130
Houston, Texas 77055

	Scale: NTS	PROJECT NO: 43-1665
PM: DRB	Date: 04/12/2019	FIGURE: SSM





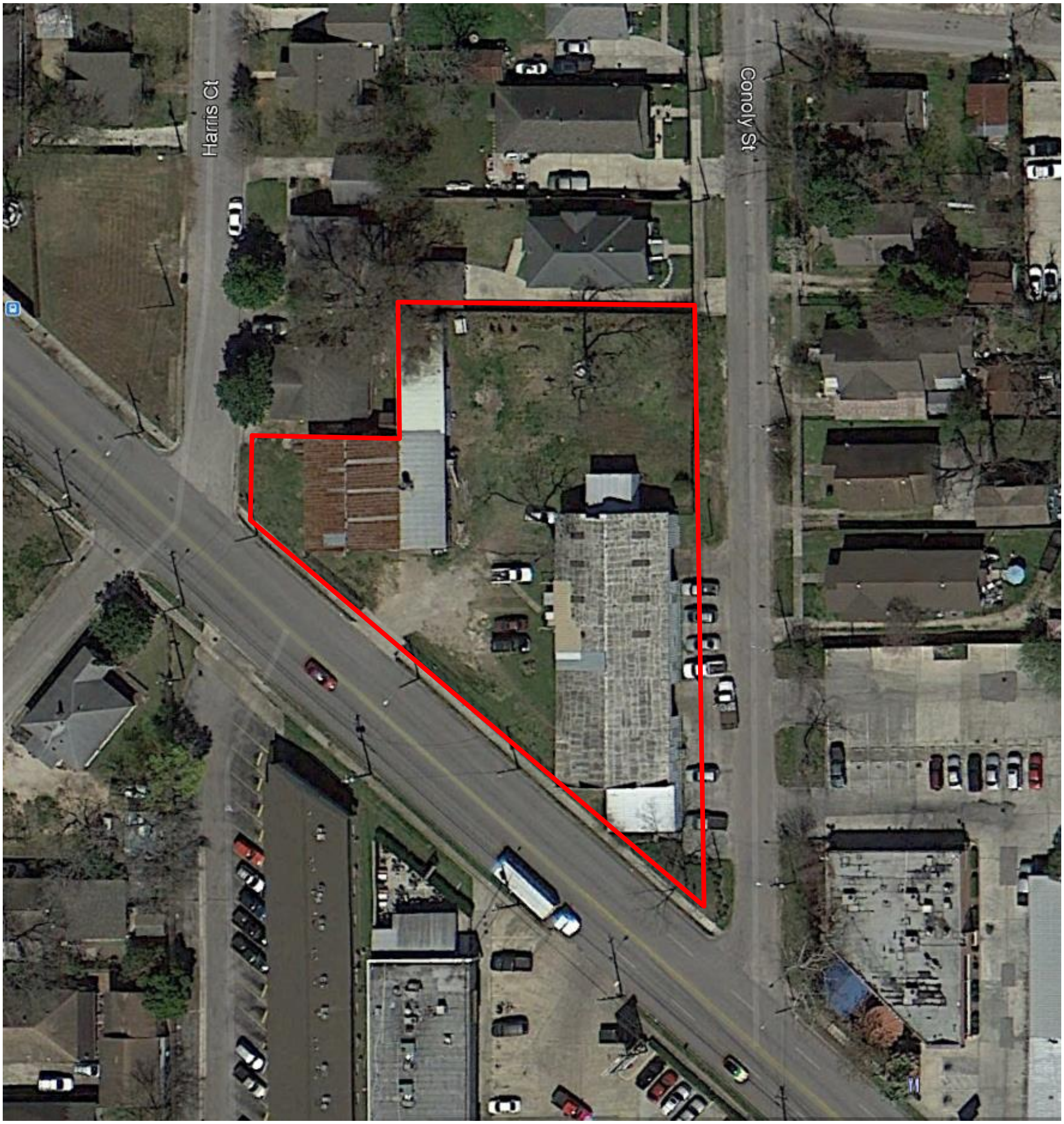
Aerial Photograph - 2017

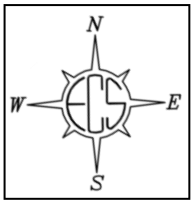
Greater Heights School
4724 N Main Street
Houston, Texas

ECS SOUTHWEST, LLP

1050 North Post Oak Road, Suite 130
Houston, Texas 77055

Scale: NTS
PROJECT NO: 43-1665
PM: DRB
Date: 04/12/2019
FIGURE: SSM

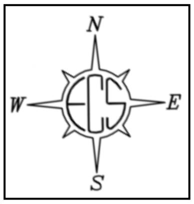




Aerial Photograph - 2011
Greater Heights School
4724 N Main Street
Houston, Texas

ECS SOUTHWEST, LLP
1050 North Post Oak Road, Suite 130
Houston, Texas 77055

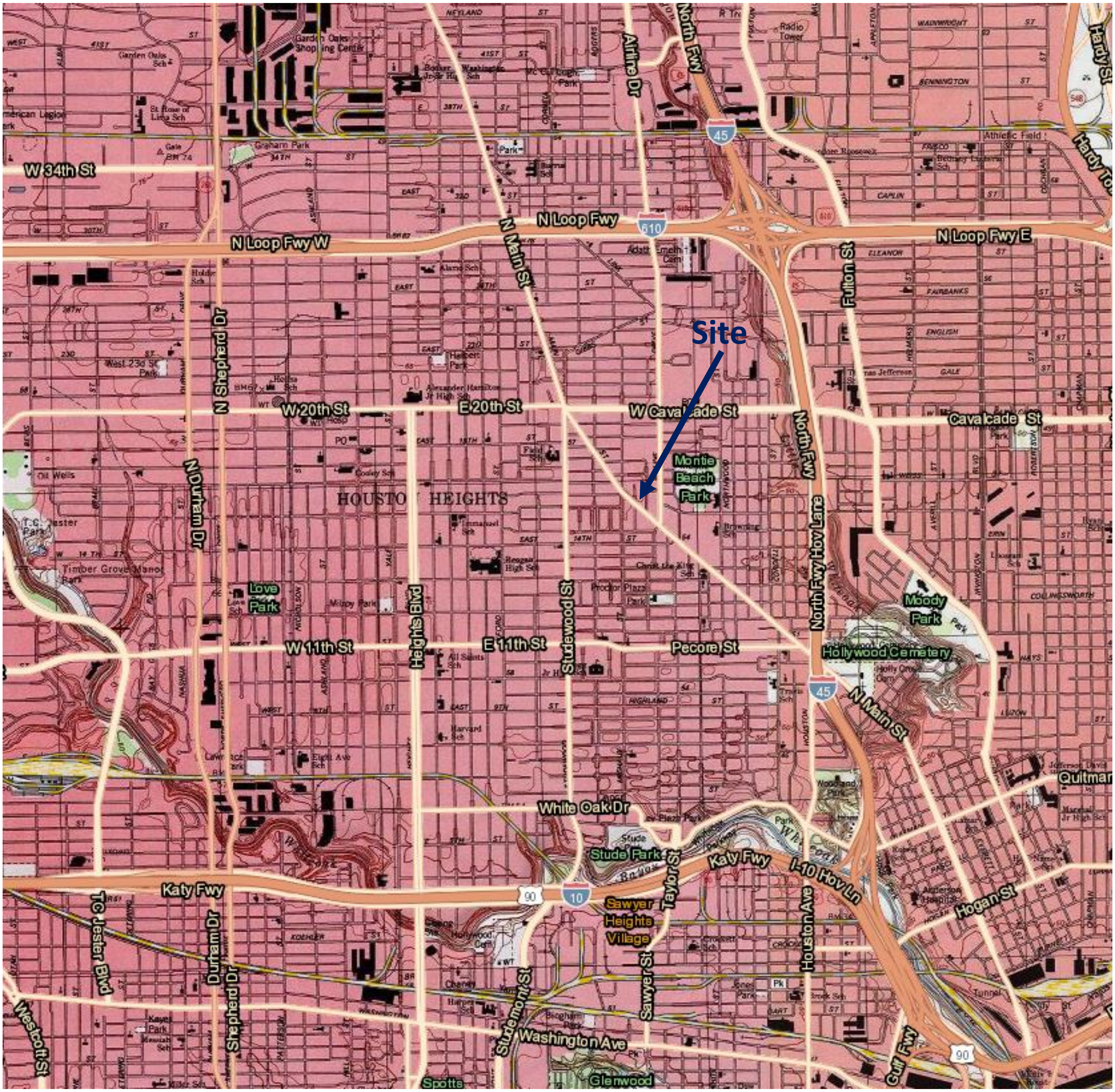
	Scale: NTS	PROJECT NO: 43-1665
PM: DRB	Date: 04/12/2019	FIGURE: SSM



Aerial Photograph - 2004
Greater Heights School
4724 N Main Street
Houston, Texas

ECS SOUTHWEST, LLP
1050 North Post Oak Road, Suite 130
Houston, Texas 77055

	Scale: NTS	PROJECT NO: 43-1665
PM: DRB	Date: 04/12/2019	FIGURE: SSM



Topographical Map

Greater Heights School
4724 N Main Street
Houston, Texas

ECS SOUTHWEST, LLP

1050 North Post Oak Road, Suite 130
Houston, Texas 77055

	Scale: NTS	PROJECT NO: 43-1665
PM: DRB	Date: 04/11/2019	FIGURE: SSM

Appendix B – Field Operations

Reference Notes for Boring Logs
Unified Soil Classification System
Boring Logs B-1 through B-13

REFERENCE NOTES FOR BORING LOGS

MATERIALS[1,2]

■	**ASPHALT**		
▨	**CONCRETE**		
▨	**GRAVEL**		
▨	**TOPSOIL**		
□	**VOID**		
▨	**BRICK**		
▨	**ABC STONE**		
▨	**FILL**[3]		Man-placed or disturbed soils
▨	**GW**	**WELL-GRADED GRAVEL**	gravel-sand mixtures, little or no fines
▨	**GP**	**POORLY-GRADED GRAVEL**	gravel-sand mixtures, little or no fines
▨	**GM**	**SILTY GRAVEL**	gravel-sand-silt mixtures
▨	**GC**	**CLAYEY GRAVEL**	gravel-sand-clay mixtures
▨	**SW**	**WELL-GRADED SAND**	gravelly sand, little or no fines
▨	**SP**	**POORLY-GRADED SAND**	gravelly sand, little or no fines
▨	**SM**	**SILTY SAND**	sand-silt mixtures
▨	**SC**	**CLAYEY SAND**	sand-clay mixtures
▨	**ML**	**SILT**	non-plastic to medium plasticity
▨	**MH**	**ELASTIC SILT**	high plasticity
▨	**CL**	**LEAN CLAY**	low to medium plasticity
▨	**CH**	**FAT CLAY**	high plasticity
▨	**OL**	**ORGANIC SILT or CLAY**	non-plastic to low plasticity
▨	**OH**	**ORGANIC SILT or CLAY**	high plasticity
▨	**PT**	**PEAT**	highly organic soils
+ + + +	**IGNEOUS ROCK**		
▨	**METAMORPHIC ROCK**		
▨	**SEDIMENTARY ROCK**		

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS

SS	Split Spoon Sampler	PM	Pressurementer Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION

DESIGNATION		PARTICLE SIZES
Boulders		12 inches (300 mm) or larger
Cobbles		3 inches to 12 inches (75 mm to 300 mm)
Gravel:	Coarse	¾ inch to 3 inches (19 mm to 75 mm)
	Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand:	Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
	Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
	Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")		<0.074 mm (smaller than a No. 200 sieve)

WATER LEVELS[4]

▽	WL	Water Level (WS)(WD)
		(WS) While Sampling
		(WD) While Drilling
▽	SHW	Seasonal High WL
▼	ACR	After Casing Removal
▽	WL	Water Level as stated
	DCI	Dry Cave-In
	WCI	Wet Cave-In

RELATIVE PROPORTIONS	COARSE GRAINED	FINE GRAINED
Trace	<5%	<5%
Dual Symbol *(ex: SW-SM)*	10%	
With	15% - 20%	15%-25%
Adjective *(ex: "Silty")*	25% - <50%	30% - <50%

COHESIVE SILTS & CLAYS

UNCONFINED COMP. STRENGTH, Q_P[5] (TSF)	SPT[6] (BPF)	CONSISTENCY (COHESIVE
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Medium Stiff
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS

SPT[6]	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
51 - 99	Very Dense
100+	Partially Weathered Rock to Intact Rock

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[1] Classifications and symbols per ASTM D 2488-09 (Visual-Manual Procedure) unless noted otherwise.

[2] To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types.

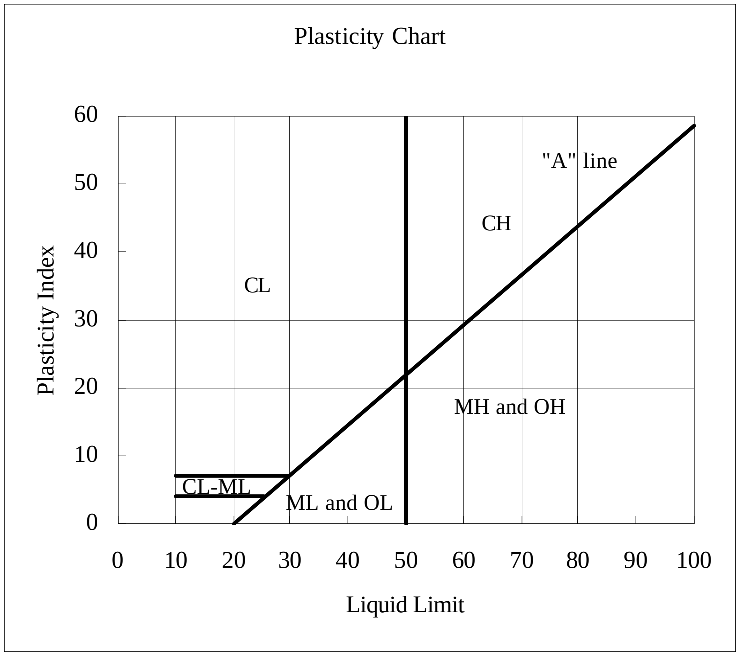
[3] Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-***FILL***)].

[4] The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally taken.

[5] Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

[6] Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf).

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 Sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ greater than 4 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ greater than 6 $C_c = (D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 Sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			

[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

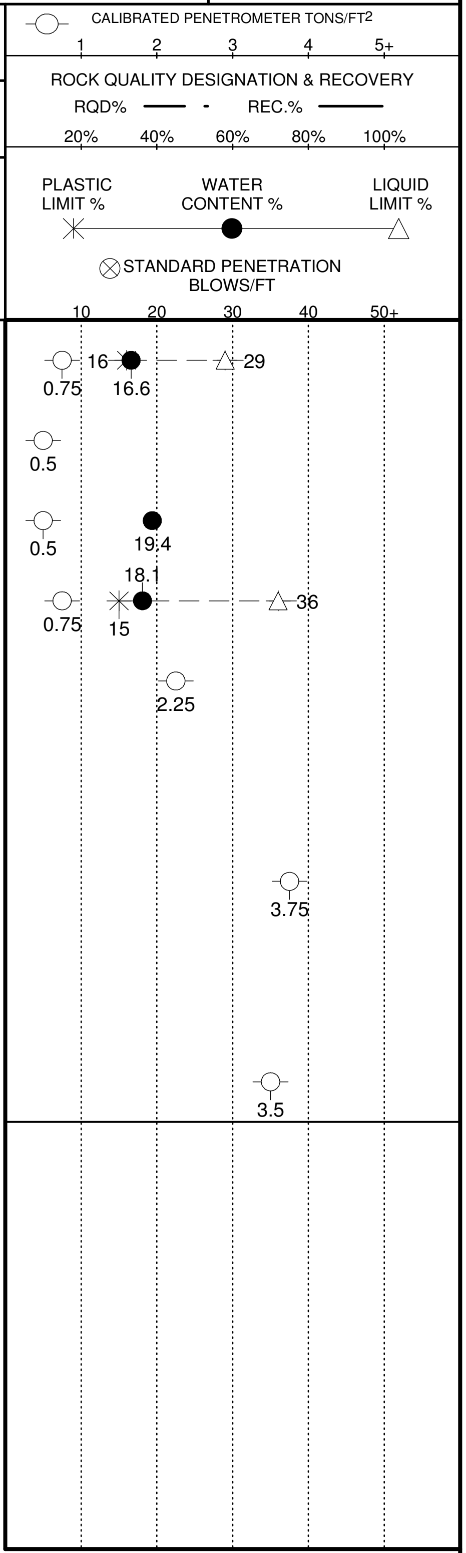
CLIENT Greater Heights School	Job #: 43:1665	BORING # B-1	SHEET 1 OF 1
PROJECT NAME Greater Heights School	ARCHITECT-ENGINEER W [squared] Architects		
SITE LOCATION 4724 N Main Street, Houston, Texas			
NORTHING	EASTING	STATION	

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION

SURFACE ELEVATION 54' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Medium Stiff to Very Stiff, with Root Fibers, Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
5	S-3	ST	24	24	***- Dry Unit Weight = 109.7 pcf & Su = 0.52 tsf***			
	S-4	ST	24	24				
	S-5	ST	24	24			45	
10								
	S-6	ST	24	24			40	
15								
	S-7	ST	24	24	(CH) FAT CLAY, Light Gray to Tan and Reddish Brown, Very Stiff, with Ferrous and Calcareous Nodules		35	
20					END OF BORING @ 20'			
25							30	
30							25	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

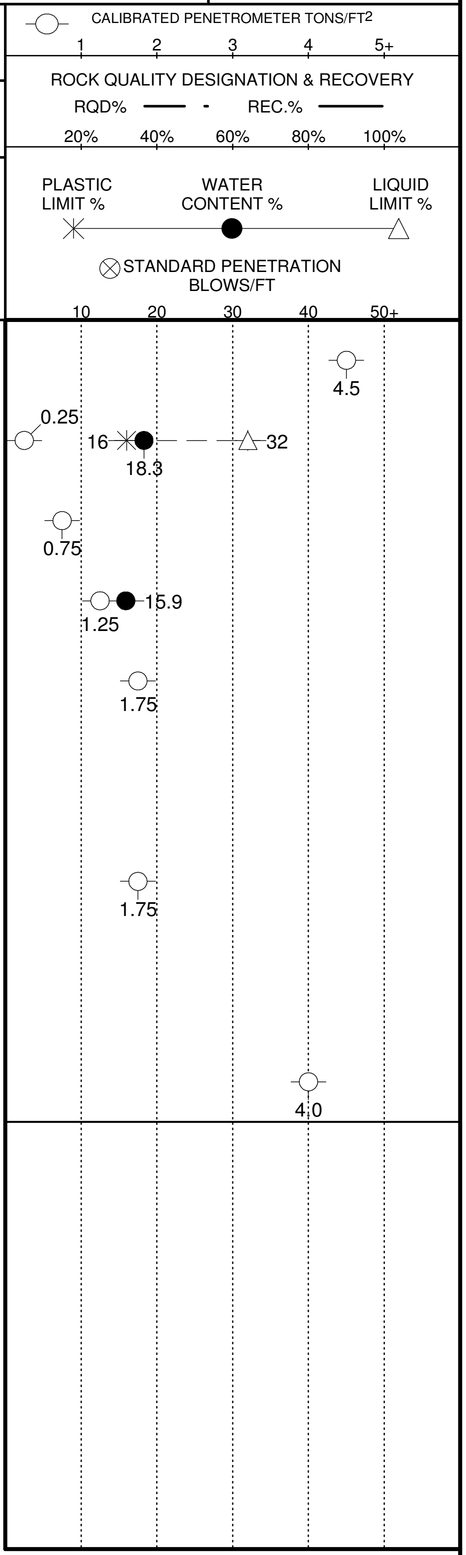
CLIENT Greater Heights School	Job #: 43:1665	BORING # B-2	SHEET 1 OF 1
PROJECT NAME Greater Heights School	ARCHITECT-ENGINEER W [squared] Architects		
SITE LOCATION 4724 N Main Street, Houston, Texas			
NORTHING	EASTING	STATION	

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 53' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Soft to Hard, with Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
5	S-3	ST	24	24				
	S-4	ST	24	24	***- Dry Unit Weight = 115.7 pcf & Su = 1.00 tsf***			
	S-5	ST	24	24			45	
10								
					(CH) FAT CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Stiff to Hard, with Ferrous Nodules		40	
15	S-6	ST	24	24				
							35	
20	S-7	ST	24	24				
					END OF BORING @ 20'			
25							30	
30							25	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

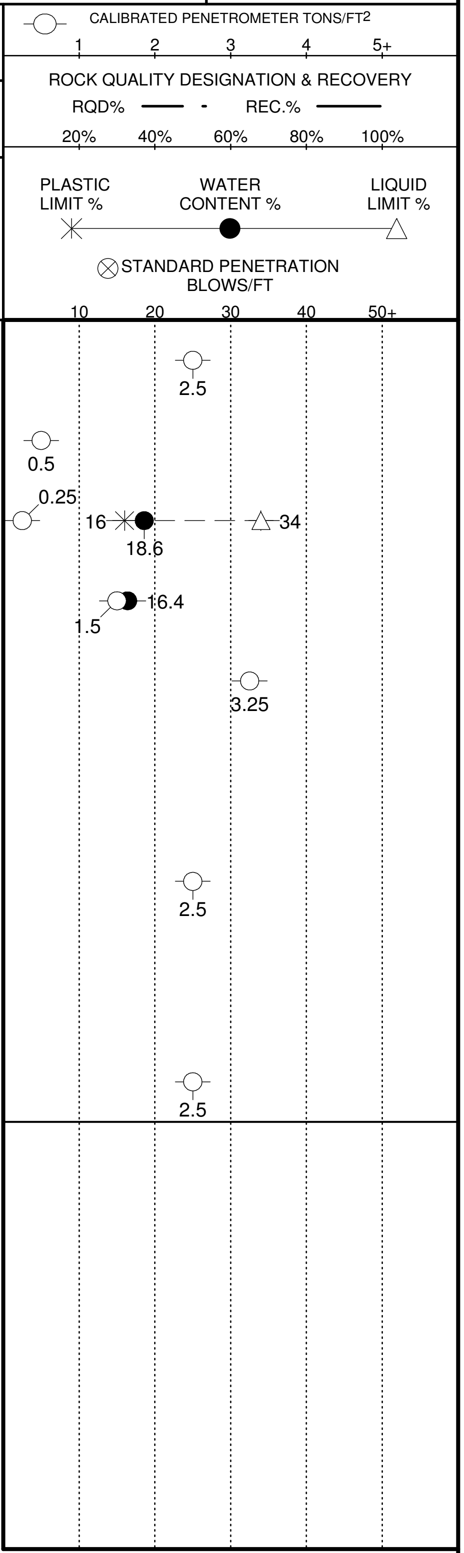
CLIENT Greater Heights School	Job #: 43:1665	BORING # B-3	SHEET 1 OF 1
PROJECT NAME Greater Heights School	ARCHITECT-ENGINEER W [squared] Architects		
SITE LOCATION 4724 N Main Street, Houston, Texas			
NORTHING	EASTING	STATION	

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION

SURFACE ELEVATION 54' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Soft to Very Stiff, with Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
5	S-3	ST	24	24				
	S-4	ST	24	24	***- Dry Unit Weight = 114.9 pcf & Su = 1.25 tsf***			
	S-5	ST	24	24			45	
10								
	S-6	ST	24	24	(CH) FAT CLAY, Light Gray and Dark Brown to Reddish Brown, Very Stiff, with Ferrous and Calcareous Nodules		40	
15								
	S-7	ST	24	24			35	
20					END OF BORING @ 20'			
							30	
25								
							25	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT
Greater Heights School

Job #: 43:1665

BORING # B-4

SHEET 1 OF 1

PROJECT NAME
Greater Heights School

ARCHITECT-ENGINEER
W [squared] Architects

SITE LOCATION
4724 N Main Street, Houston, Texas

NORTHING

EASTING

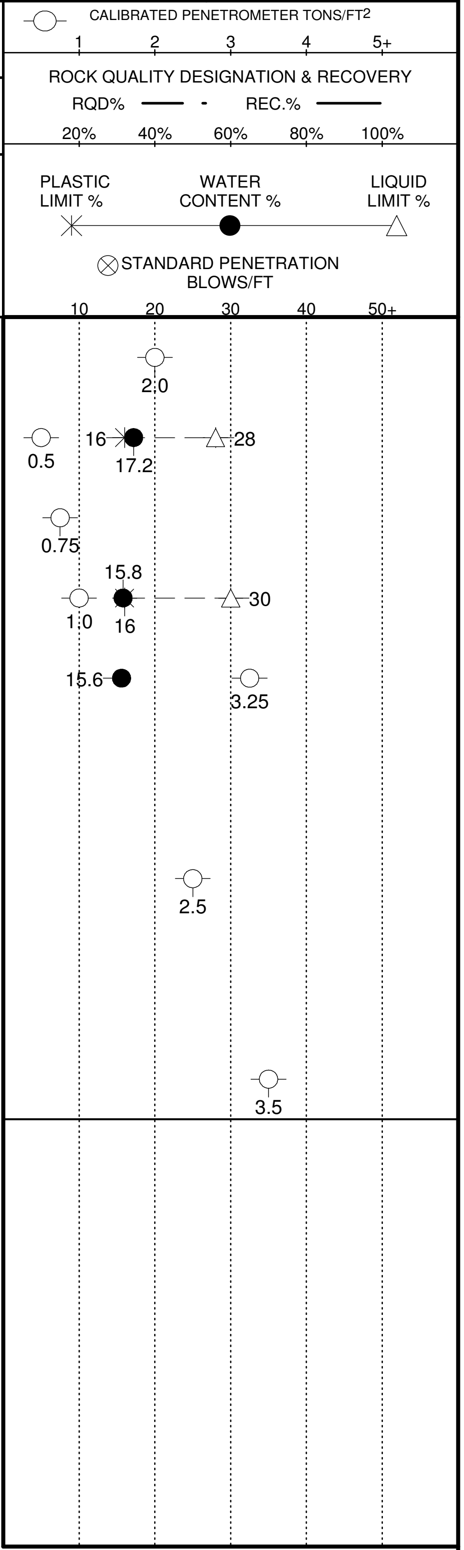
STATION

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION

SURFACE ELEVATION 53' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Medium Stiff to Very Stiff, with Root Fibers, Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
5	S-3	ST	24	24				
	S-4	ST	24	24				
							45	
	S-5	ST	24	24	***- Dry Unit Weight = 118.1pcf & Su = 1.41 tsf***			
10								
					(CH) FAT CLAY, Light Gray and Dark Brown to Reddish Brown, Very Stiff, with Ferrous and Calcareous Nodules		40	
	S-6	ST	24	24				
15								
							35	
	S-7	ST	24	24				
20					END OF BORING @ 20'			
							30	
25								
							25	
30								



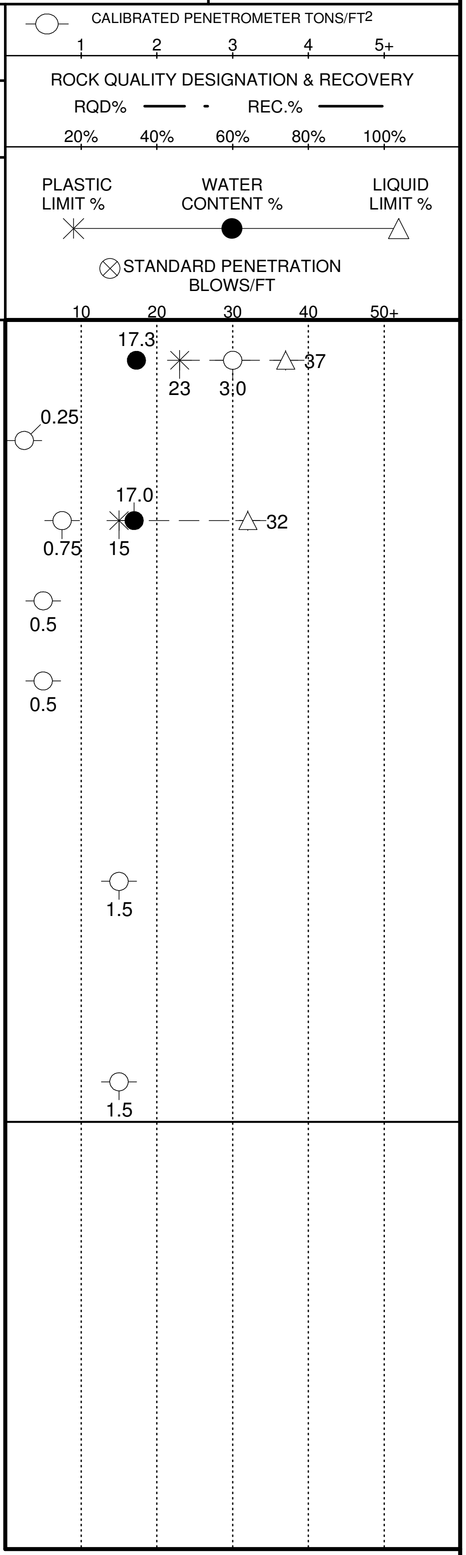
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT Greater Heights School
Job #: 43:1665
BORING # B-5
SHEET 1 OF 1
PROJECT NAME Greater Heights School
ARCHITECT-ENGINEER W [squared] Architects
SITE LOCATION 4724 N Main Street, Houston, Texas
NORTHING
EASTING
STATION

DESCRIPTION OF MATERIAL ENGLISH UNITS
BOTTOM OF CASING
LOSS OF CIRCULATION
SURFACE ELEVATION 54' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Soft to Very Stiff, with Root Fibers, Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24				
5	S-3	ST	24	24			50	
	S-4	ST	24	24				
	S-5	ST	24	24			45	
10								
	S-6	ST	24	24	(CH) FAT CLAY, Light Gray to Tan and Reddish Brown, Stiff, with Ferrous Nodules		40	
15								
	S-7	ST	24	24			35	
20					END OF BORING @ 20'			
25							30	
30							25	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐
BORING STARTED 03/26/19
CAVE IN DEPTH
WL(SHW) WL(ACR)
BORING COMPLETED 03/26/19
HAMMER TYPE Manual
WL Dry 15 Mins.
RIG Truck FOREMAN HDC
DRILLING METHOD ASTM D 1587

CLIENT	Job #:	BORING #	SHEET
Greater Heights School	43:1665	B-6	1 OF 1

PROJECT NAME: Greater Heights School

ARCHITECT-ENGINEER: W [squared] Architects

SITE LOCATION: 4724 N Main Street, Houston, Texas

NORTHING:

EASTING:

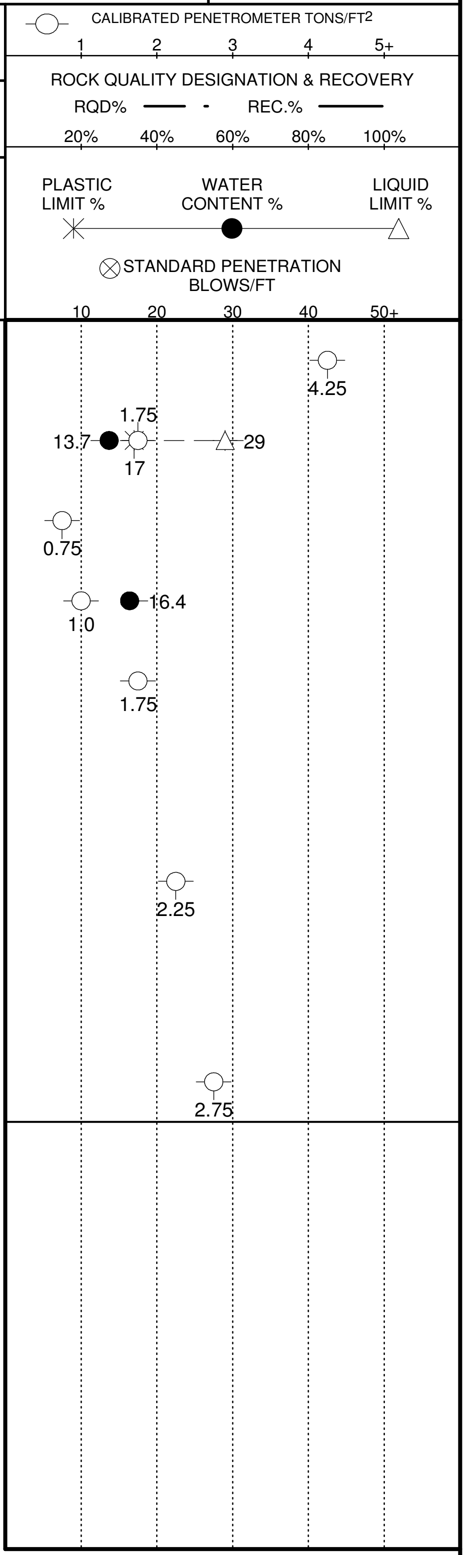
STATION:

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 53' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Medium Stiff to Hard, with Root Fibers, Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
5	S-3	ST	24	24				
	S-4	ST	24	24	***- Dry Unit Weight = 115.4 pcf & Su = 0.92 tsf***			
	S-5	ST	24	24			45	
10								
					(CH) FAT CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Very Stiff, with Calcareous Nodules		40	
15	S-6	ST	24	24				
	S-7	ST	24	24			35	
20					END OF BORING @ 20'			
							30	
25								
							25	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT: Greater Heights School

Job #: 43:1665

BORING #: B-7

SHEET: 1 OF 1

PROJECT NAME: Greater Heights School

ARCHITECT-ENGINEER: W [squared] Architects

SITE LOCATION: 4724 N Main Street, Houston, Texas

NORTHING:

EASTING:

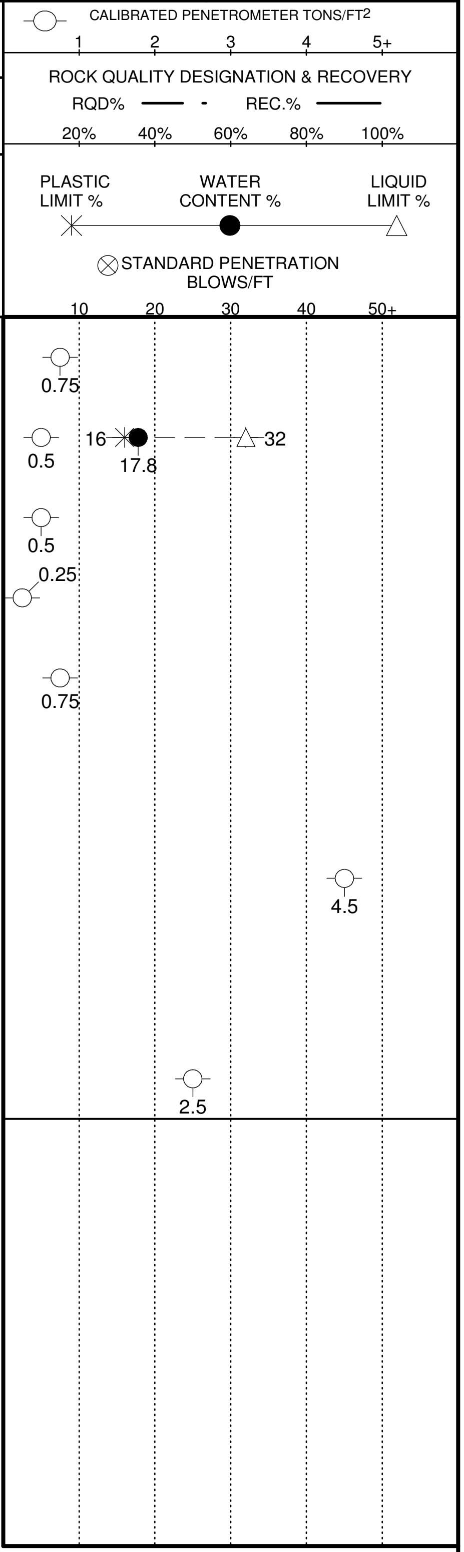
STATION:

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION ▷

SURFACE ELEVATION 54' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Soft to Medium Stiff, with Root Fibers, Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
5	S-3	ST	24	24				
	S-4	ST	24	24				
	S-5	ST	24	24			45	
10								
	S-6	ST	24	24	(CH) FAT CLAY, Light Gray to Tan and Reddish Brown, Hard, with Ferrous and Calcareous Nodules		40	
15								
	S-7	ST	24	24	(CL) LEAN CLAY, Brown to Reddish Brown and Tan, Very Stiff, with Ferrous Nodules and Sand Seams		35	
20					END OF BORING @ 20'			
							30	
25								
							25	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT
Greater Heights School

Job #: 43:1665

BORING # B-8

SHEET 1 OF 1

PROJECT NAME
Greater Heights School

ARCHITECT-ENGINEER
W [squared] Architects

SITE LOCATION
4724 N Main Street, Houston, Texas

NORTHING

EASTING

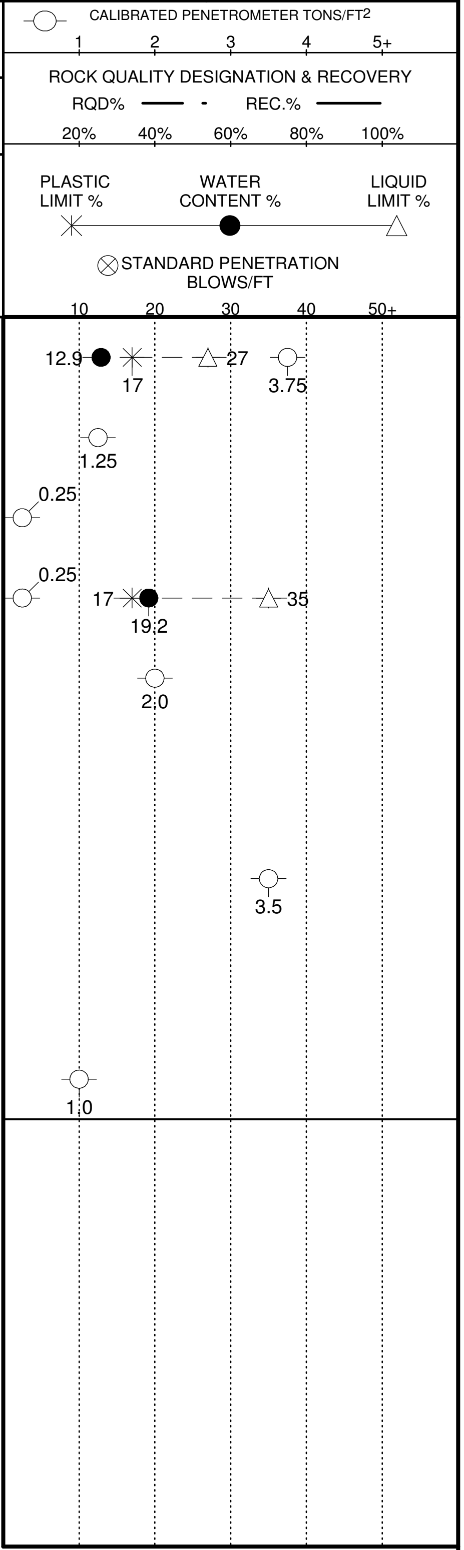
STATION

DESCRIPTION OF MATERIAL ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 54' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown and Tan, Soft to Very Stiff, with Root Fibers, Ferrous and Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-1	ST	24	24				
	S-2	ST	24	24				
							50	
5	S-3	ST	24	24				
	S-4	ST	24	24				
	S-5	ST	24	24			45	
10								
					(CH) FAT CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Stiff to Very Stiff, with Ferrous Nodules			
	S-6	ST	24	24			40	
15								
	S-7	ST	24	24			35	
20					END OF BORING @ 20'			
							30	
25								
							25	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT Greater Heights School	Job #: 43:1665	BORING # B-9	SHEET 1 OF 1
PROJECT NAME Greater Heights School	ARCHITECT-ENGINEER W [squared] Architects		
SITE LOCATION 4724 N Main Street, Houston, Texas			
NORTHING	EASTING	STATION	

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION 100%

SURFACE ELEVATION 53' MSL

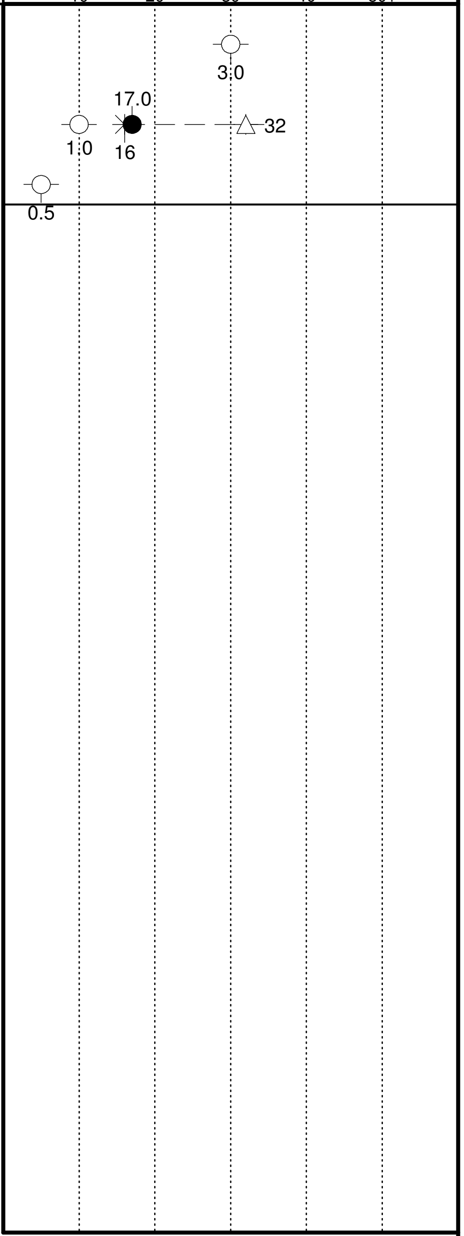
DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Dark Brown to Reddish Brown and Light Gray to Tan, Medium Stiff to Very Stiff, with Root Fibers, Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
	S-3	ST	12	12				
5					END OF BORING @ 5'			
							45	
10								
							40	
15								
							35	
20								
							30	
25								
							25	
30								

CALIBRATED PENETROMETER TONS/FT2: 1 2 3 4 5+

ROCK QUALITY DESIGNATION & RECOVERY: RQD% —— - REC.% ——— 20% 40% 60% 80% 100%

PLASTIC LIMIT % — WATER CONTENT % — LIQUID LIMIT %

⊗ STANDARD PENETRATION BLOWS/FT: 10 20 30 40 50+



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT	Job #:	BORING #	SHEET
Greater Heights School	43:1665	B-10	1 OF 1

PROJECT NAME
Greater Heights School

ARCHITECT-ENGINEER
W [squared] Architects

SITE LOCATION
4724 N Main Street, Houston, Texas

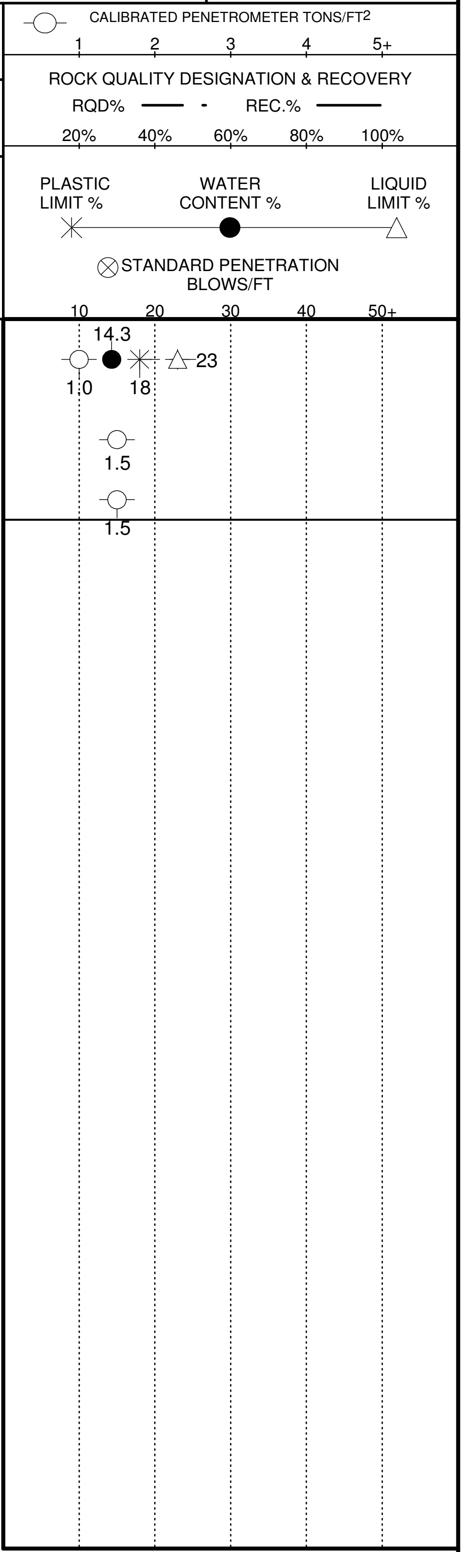
NORTHING
EASTING
STATION

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION 54' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL-ML FILL) SILTY CLAY FILL, Dark Brown to Reddish Brown, Stiff, with Root Fibers, Trace Gravels, and Sand Seams			
	S-2	ST	24	24	(CL) LEAN CLAY, Brown to Tan, Stiff, with Trace Gravels and Sand Seams			
	S-3	ST	12	12			50	
5					END OF BORING @ 5'			
10							45	
15							40	
20							35	
25							30	
30							25	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

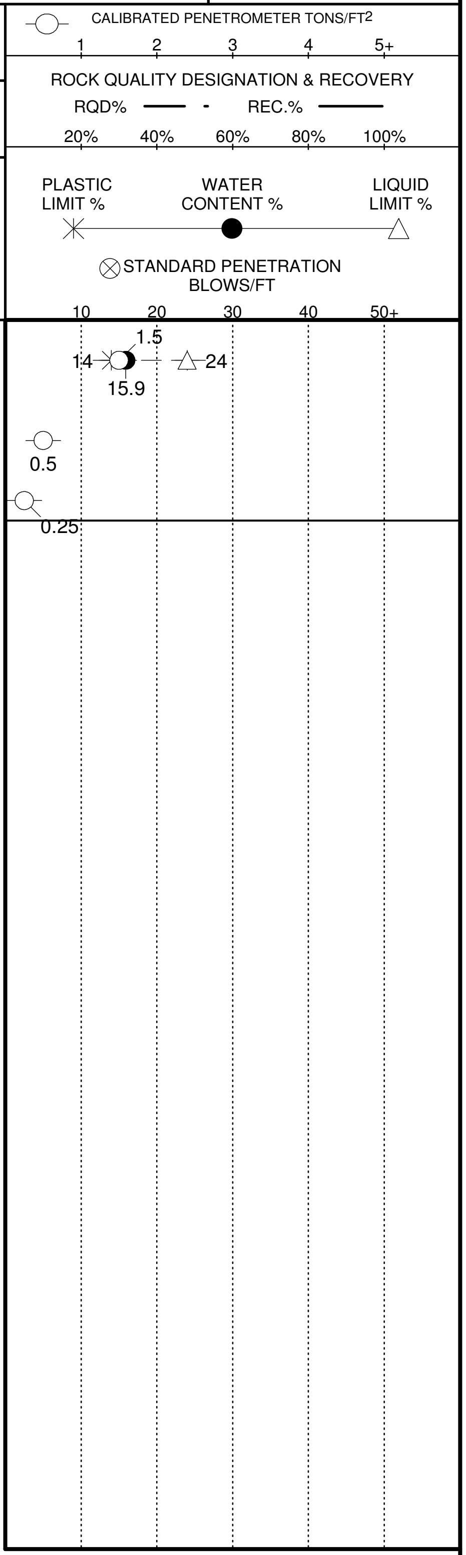
CLIENT Greater Heights School	Job #: 43:1665	BORING # B-11	SHEET 1 OF 1
PROJECT NAME Greater Heights School	ARCHITECT-ENGINEER W [squared] Architects		
SITE LOCATION 4724 N Main Street, Houston, Texas			
NORTHING	EASTING	STATION	

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➤ LOSS OF CIRCULATION

SURFACE ELEVATION 54' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Light Gray to Tan and Dark Brown to Reddish Brown, Soft to Stiff, with Root Fibers, Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24				
	S-3	ST	12	12			50	
5					END OF BORING @ 5'			
10							45	
15							40	
20							35	
25							30	
30							25	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT Greater Heights School	Job #: 43:1665	BORING # B-12	SHEET 1 OF 1
PROJECT NAME Greater Heights School	ARCHITECT-ENGINEER W [squared] Architects		
SITE LOCATION 4724 N Main Street, Houston, Texas			
NORTHING	EASTING	STATION	

CALIBRATED PENETROMETER TONS/FT2: 1 2 3 4 5+

ROCK QUALITY DESIGNATION & RECOVERY
RQD% —— - REC.% ——
20% 40% 60% 80% 100%

PLASTIC LIMIT % ✳ WATER CONTENT % ● LIQUID LIMIT % △

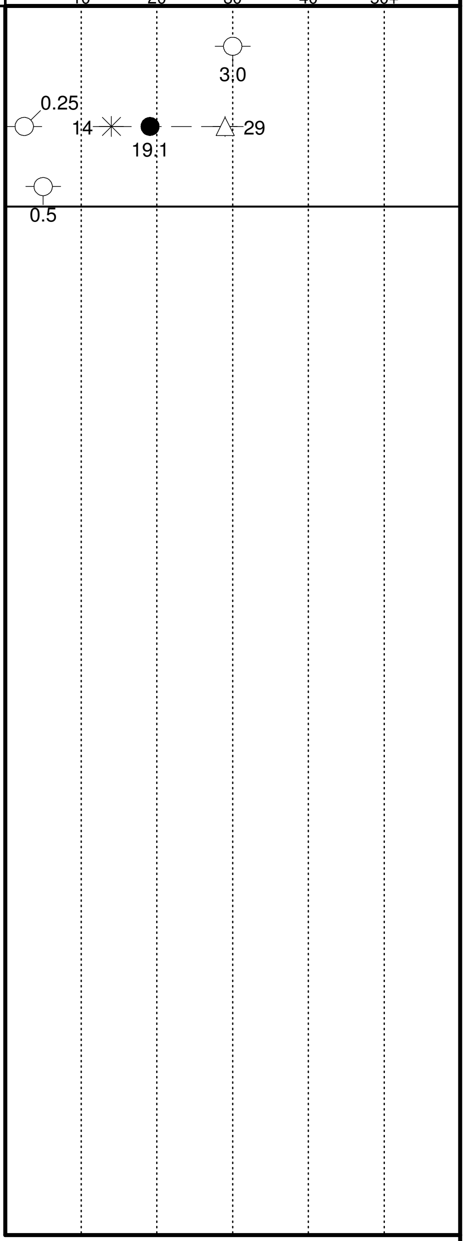
⊗ STANDARD PENETRATION BLOWS/FT
10 20 30 40 50+

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION 53' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL) LEAN CLAY, Dark Brown to Reddish Brown and Tan, Soft to Very Stiff, with Root Fibers, Calcareous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24			50	
	S-3	ST	12	12				
5					END OF BORING @ 5'			
10							45	
15							40	
20							35	
25							30	
30							25	



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

CLIENT	Job #:	BORING #	SHEET
Greater Heights School	43:1665	B-13	1 OF 1

PROJECT NAME: Greater Heights School

ARCHITECT-ENGINEER: W [squared] Architects

SITE LOCATION: 4724 N Main Street, Houston, Texas

NORTHING:

EASTING:

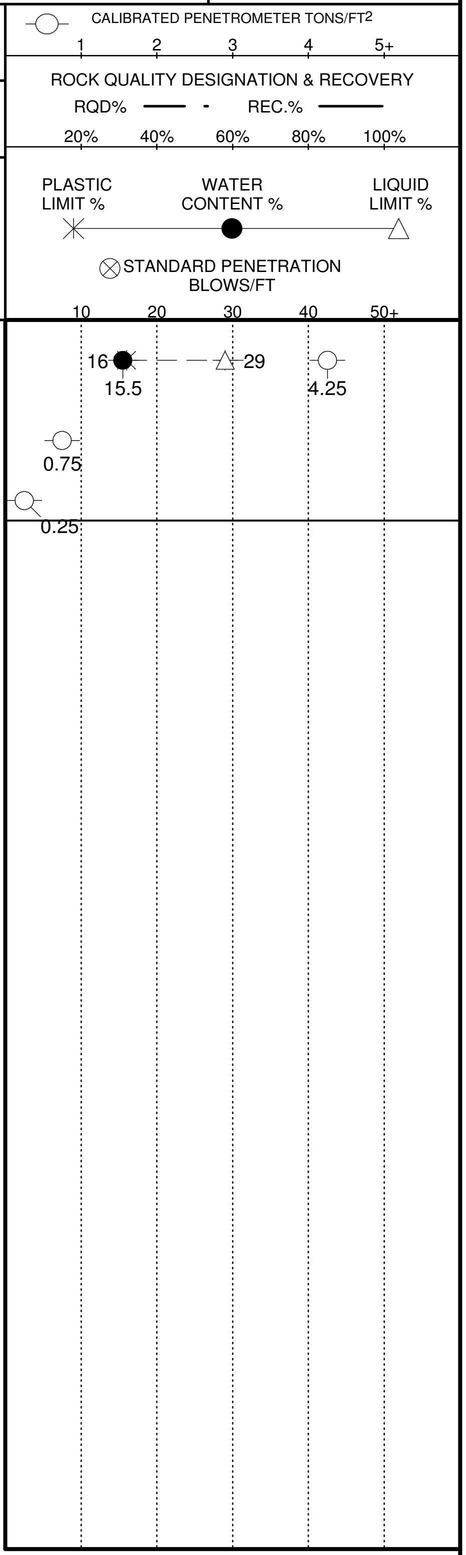
STATION:

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING ➡ LOSS OF CIRCULATION

SURFACE ELEVATION 53' MSL

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0	S-1	ST	24	24	(CL FILL) LEAN CLAY FILL, Dark Brown to Reddish Brown and Tan, Hard, with Root Fibers, Ferrous Nodules, Trace Gravels, and Sand Seams			
	S-2	ST	24	24	(CL) LEAN CLAY, Dark Brown to Reddish Brown and Tan, Soft to Medium Stiff, with Ferrous Nodules, Trace Gravels, and Sand Seams		50	
	S-3	ST	12	12				
5					END OF BORING @ 5'			
							45	
10								
							40	
15								
							35	
20								
							30	
25								
							25	
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL Dry WS ☐ WD ☐	BORING STARTED 03/26/19	CAVE IN DEPTH
WL(SHW) WL(ACR)	BORING COMPLETED 03/26/19	HAMMER TYPE Manual
WL Dry 15 Mins.	RIG Truck FOREMAN HDC	DRILLING METHOD ASTM D 1587

Appendix C – Laboratory Testing

Laboratory Testing Summary

Laboratory Testing Summary

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-1												
	S-1	0.00 - 2.00	16.6	CL	29	16	13					
	S-3	4.00 - 6.00	19.4	CL								
	S-4	6.00 - 8.00	18.1	CL	36	15	21					
B-2												
	S-2	2.00 - 4.00	18.3	CL	32	16	16					
	S-4	6.00 - 8.00	15.9	CL								
B-3												
	S-3	4.00 - 6.00	18.6	CL	34	16	18					
	S-4	6.00 - 8.00	16.4	CL								
B-4												
	S-2	2.00 - 4.00	17.2	CL	28	16	12					
	S-4	6.00 - 8.00	15.8	CL	30	16	14					
	S-5	8.00 - 10.00	15.6	CL								
B-5												
	S-1	0.00 - 2.00	17.3	CL	37	23	14					
	S-3	4.00 - 6.00	17.0	CL	32	15	17					
B-6												
	S-2	2.00 - 4.00	13.7	CL	29	17	12					
	S-4	6.00 - 8.00	16.4	CL								
B-7												
	S-2	2.00 - 4.00	17.8	CL	32	16	16					
B-8												
	S-1	0.00 - 2.00	12.9	CL	27	17	10					
	S-4	6.00 - 8.00	19.2	CL	35	17	18					
B-9												
	S-2	2.00 - 4.00	17.0	CL	32	16	16					
B-10												

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No. 43:1665

Project Name: Greater Heights School

Client: Greater Heights School

Printed On: Friday, April 12, 2019

ECS SOUTHWEST, LLP
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Houston, TX 77055
Phone: (713) 955-1980
Fax: (281) 520-4367

Laboratory Testing Summary

Boring Number	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
	S-1	0.00 - 2.00	14.3	CL-ML FILL	23	18	5					
B-11												
	S-1	0.00 - 2.00	15.9	CL	24	14	10					
B-12												
	S-2	2.00 - 4.00	19.1	CL	29	14	15					
B-13												
	S-1	0.00 - 2.00	15.5	CL FILL	29	16	13					

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

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