REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL EVALUATION
SEQUOYAH HIGH SCHOOL – FOOTBALL FIELD IMPROVEMENTS
TAHLEQUAH, OKLAHOMA
BUILDING & EARTH PROJECT NO. TU230024

PREPARED FOR:
Blue River Architects

MARCH 1, 2023

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

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March 1, 2023

Blue River Architects
320 South Boston Avenue, Suite 103
Tulsa, Oklahoma 74103

Attention: Mr. Chris Seat – Blue River Architects

Subject: Report of Subsurface Exploration and Geotechnical Evaluation
Sequoyah High School
Football Field Improvements
Tahlequah, Oklahoma
Building & Earth Project No: TU230024

Dear Mr. Seat:

Building & Earth Sciences, Inc. has completed the authorized subsurface exploration and geotechnical engineering evaluation services for the above referenced project in Tahlequah, Oklahoma.

The purpose of this exploration and evaluation was to determine general subsurface conditions at the site and to address applicable geotechnical aspects of the proposed construction and site development. The recommendations in this report are based on a physical reconnaissance of the site and observation and classification of samples obtained from fourteen (14) test borings conducted at the site. Confirmation of the anticipated subsurface conditions during construction is an essential part of geotechnical services.

We appreciate the opportunity to provide consultation services for the proposed project. If you have any questions regarding the information in this report or need any additional information, please call us.

Respectfully Submitted,
BUILDING & EARTH SCIENCES, INC.
Certificate of Authorization, #3975, Expires 6/30/2024

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1.0 PROJECT & SITE DESCRIPTION

We understand that improvements will be made to the football field at Sequoyah High School located at 17091 South Muskogee Avenue in Tahlequah, Oklahoma. General information relative to the proposed site and the proposed development is listed in the paragraphs below.

Based on the information provided to our office, we understand the project will be done in two phases. During the first phase, a new synthetic turf field will be constructed within the area outlined in green shown in Figure 1 below. During the second phase, retaining walls will be constructed within the area in blue, and a new building and bleacher pad will be constructed within the area in red.

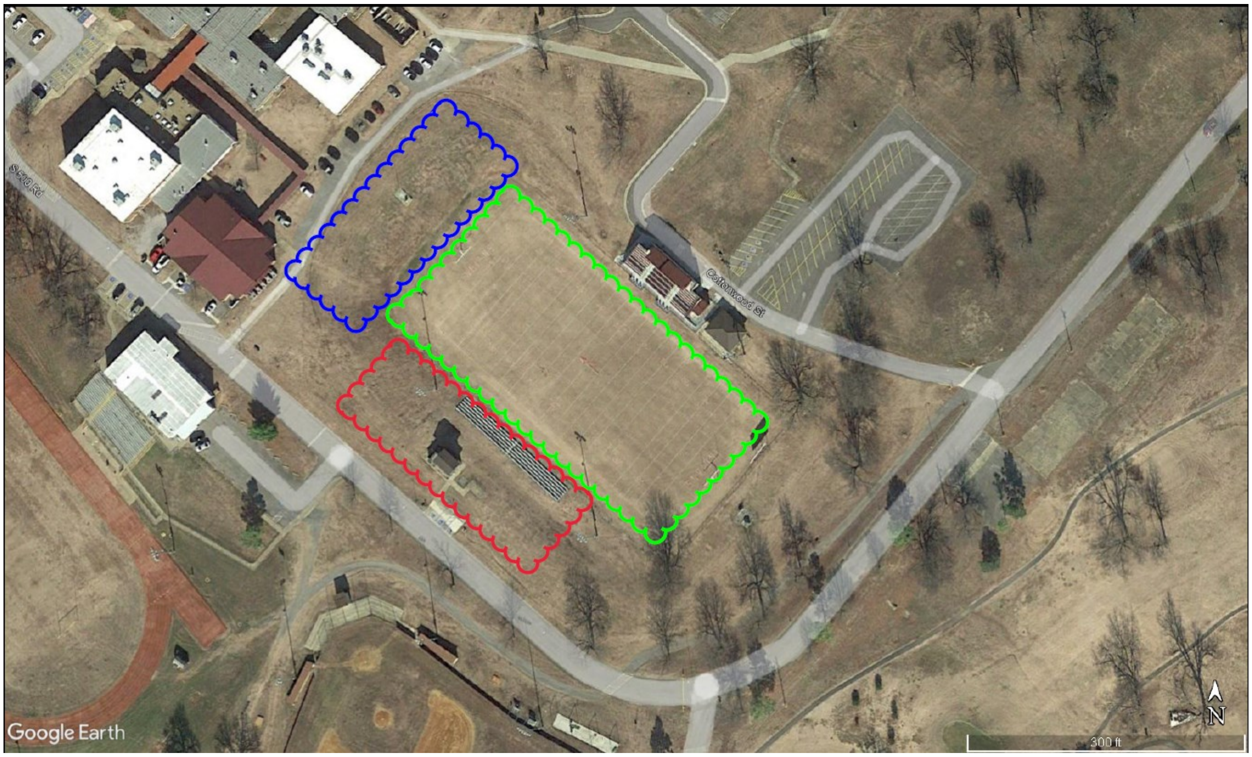

Figure 1: Google Earth Satellite Image, dated January 2018

We also understand the area outlined in blue will likely include a tiered retaining wall system to accommodate a grass covered terrace for spectators. The existing site conditions include an estimated 5H:1V slope with height of about 20 feet.

The area outlined in red will include a new press box building with bleachers. Specific details about the heights of the retaining walls, and size of the press box building was unknown at the time or preparing this report.

At the time of our site reconnaissance, the proposed project area was a football field covered with grass with bleachers to the north and south. Underground utility lines consisting of sewage, gas, electric, and water were noted in the project area.

Figure 2: Northwest of the project site, looking southeast across the football field

Figure 3: Southeast side of the football field, facing northwest

2.0 SCOPE OF SERVICES

The authorized subsurface exploration was performed on February 9 and 10, 2023, in conformance with our proposal TU25030, dated January 27, 2023. Notice to proceed was provided by signing and returning our proposal on January 31, 2023.

The purpose of the geotechnical exploration was to determine general subsurface conditions at specific boring locations and to gather data on which to base a geotechnical evaluation with respect to the proposed construction. The subsurface exploration for this project consisted of fourteen (14) test borings.

The site was drilled using a track mounted Diedrich D-50 drill-rig equipped with solid flight augers and an automatic hammer for performing Standard Penetration Tests (SPT) to help evaluate the relative soil strength.

The boring locations were determined in the field by a representative of our staff using a handheld GPS unit. As such, the boring locations shown on the Boring Location Plan attached to this report should be considered approximate.

The samples recovered during our site investigation were visually classified and specific samples were selected by the project engineer for laboratory analysis. The laboratory analysis consisted of:

Test	ASTM	No. of Tests
Natural Moisture Content	D2216	58
Atterberg Limits	D4318	7
Material Finer Than No. 200 Sieve by Washing	D1140	3

Table 1: Scope of Laboratory Tests

The results of the laboratory analysis are presented on the enclosed Boring Logs and in tabular form in the Appendix of this report. Descriptions of the laboratory tests that were performed are also included in the Appendix.

The information gathered from the exploration was evaluated to help determine if any special turf subgrade preparation procedures will be required during the earthwork phase of the project.

The results of the work are presented within this report that addresses:

- General site geology.
- Summary of existing surface conditions.
- A description of the subsurface conditions encountered at the boring locations.
- A description of the groundwater conditions observed in the boreholes during drilling. Long-term monitoring was not included in our scope of work.
- Presentation of laboratory test results.
- Site preparation considerations including material types to be expected at the site, treatment of any encountered unsuitable soils, excavation considerations, and surface drainage.
- Potential Vertical Rise (PVR) evaluation for proposed synthetic turf system.
- Subgrade preparation considerations for synthetic turf.
- Compaction requirements and recommended criteria to establish suitable material for structural backfill.

Specific details about the heights of the retaining walls, and size and locations of the press box building, and bleachers was unknown at the time of preparing this report. Following a phone conversation with Mr. King on February 28, 2023, it was mutually agreed to exclude recommendations pertaining to retaining walls, press box building, and bleachers from this report due to limited project information. Building & Earth can assist with providing recommendations for the referenced structures upon request once more information is made available.

The information presented in Sections 3 through 8 of this report are based on the subsurface conditions encountered in borings TF-01 through TF-08. Logs of borings B-01, B-02, B-03, RW-01, RW-02, and RW-03 included in the Appendix of this report are included for informational purposes only and can be relied upon for any future recommendations intended for the referenced structures provided that no site modifications are made.

3.0 GEOTECHNICAL SITE CHARACTERIZATION

The following discussion is intended to create a general understanding of the site from a geotechnical engineering perspective. It is not intended to be a discussion of every potential geotechnical issue that may arise, nor to provide every possible interpretation of the conditions identified. The following conditions and subsequent recommendations assume that significant changes in subsurface conditions do not occur between boreholes. However, anomalous conditions can occur due to variations in existing fill that may be present, or the geologic conditions, and it will be necessary to evaluate the assumed conditions during subgrade preparation, and turf installation.

3.1 GENERAL SITE GEOLOGY

According to the Oklahoma State Geologic Map published by the United States Geological Survey (USGS), the subject site is underlain by Early Mississippian age, Keokuk and Reeds Spring Formations. These formations are noted to consist of chert and limestone. The conditions encountered at the project site correlate with residuum associated with the Keokuk and Reeds Spring Formations.

3.2 EXISTING SURFACE CONDITIONS

At the time of the subsurface exploration, the project site was an existing football field covered with grass and topsoil. The topsoil thickness ranged from about 3 to 5 inches. Topsoil thicknesses could vary in unexplored portions of the site.

For this report, topsoil is defined as the soil horizon which contains the root mat of the noted vegetation. No testing has been performed to verify that these soils meet the requirement of “topsoil”.

3.3 SUBSURFACE CONDITIONS – FOOTBALL FIELD BORINGS

A generalized stratification summary has been prepared using data from the test borings and is presented in the table below. The stratification depicts the general soil conditions and stratum types encountered during our field investigation.

Stratum No.	Typical Thickness	Description	Consistency/Relative Density	Lab Testing Data [(2)]
1	1.2 to 7.7'	**Near-Surface Residual Clays:** Silty Clay (CL-ML) and Lean Clay (CL) with chert fragment and roots Various shades and combinations of brown, gray, and red	Soft to medium stiff clays were encountered across majority of the football field area to depths of about 1 to 1.5 feet. The clay soils below depths of 1 to 1.5 feet generally exhibited stiff to very stiff consistencies	*Atterberg Limits: LL = 23 and 25 PI = 6 and 8* *Moisture contents: 16 to 27%*
2 (1)	Termination Layer	**Gravelly Residuum:** Clayey Chert Gravel with chert cobbles and boulders (GC), with interbedded Fat Clay (CH), and Lean to Fat Clay (CL-CH) Various shades and combinations of brown, gray, red, yellow, and white	Chert gravel generally was medium dense to very dense Clay layers generally exhibited stiff to very stiff consistencies	***Fat Clay and Lean to Fat Clay Layers*** *Atterberg Limits: LL = 91; PI = 59* *Passing #200 Sieve: 91%* *Moisture contents: 18 to 45%* ***Chert Gravel*** *Passing #200 Sieve: 17%* *Typical Moisture content Range: 7 to 22%*

Table 2: Stratification Summary (Borings TF-01 through TF-08)

Notes:

(1) Borings TF-01 through TF-08 were terminated within this stratum at depths of about 5.5 to 10 feet. Auger refusal was encountered in boring TF-03 at a depth of about 5.5 feet. It should be noted that auger refusal material could not be ascertained due to poor recovery of the sample. Auger refusal may likely have occurred on chert boulders in the gravelly residuum or on intact rock unit associated with Keokuk Formation. High SPT N-values noted within the gravelly residuum are likely affected by the presence of chert cobbles and boulders and they may not be presentative of in-place relative density of the material.

(2) LL=Liquid Limit, PL=Plastic Limit, PI=Plasticity Index

For specific details on the information obtained from individual borings, refer to the Boring Logs included in the Appendix.

3.3.1 AUGER REFUSAL

Auger refusal is the drilling depth at which the borehole can no longer be advanced using soil drilling procedures. Auger refusal can occur on boulders, buried debris or bedrock. Coring is required to sample the material below auger refusal, which was beyond the scope of work presented in this report.

Auger refusal was encountered in boring TF-03 at a depth of about 5.5 feet. It should be noted that auger refusal material could not be ascertained due to poor recovery of the sample. Auger refusal may likely have occurred on chert boulders in the gravelly residuum or on intact rock unit associated with the Keokuk Formation.

3.3.2 GROUNDWATER

At the time of drilling, groundwater was encountered in three of the eight borings. The groundwater levels encountered during drilling and measured after the completion of drilling and prior to backfilling are reported in the following table.

Boring No.	Groundwater Seepage Depth During Drilling (ft)	Groundwater Depth at Time of Backfilling (ft)
TF-04	Not encountered	2.5 (~ 24 hours after completion of drilling)
TF-06	5.0	4.0 (~ 24 hours after completion of drilling)
TF-07	Not encountered	4.0 (~ 24 hours after completion of drilling)

Table 3: Groundwater levels during drilling and at time of backfilling

Although groundwater seepage was not encountered in the remaining borings, elevated moisture contents were recorded in some of the borings, which suggest a high probability for development of perched groundwater during and following wet seasons.

Fluctuations in the water level can occur due to seasonal rainfall. Water levels reported are accurate only for the time and date that the borings were drilled. Long term monitoring of the boreholes was not included as part of our subsurface exploration. All borings were backfilled on February 10, 2023.

4.0 SITE DEVELOPMENT CONSIDERATIONS

A site grading plan was not available for our review at the time of preparing this report. For this report, we assume finished design grades will match existing grades. ***When final site and grading plans become available, it will be necessary for Building & Earth to review the recommendations presented in this report to determine if any additional considerations would be appropriate based on the final grading.***

The primary geotechnical considerations for installation of a new synthetic turf system at the project site are listed below:

- Near surface low consistency soils were encountered across the football field, extending to depths of about 1 to 1.5 feet below current grades. These low consistency soils pose a concern for unstable subgrade, and they may not provide a stable platform for fill placement and for long-term support of the proposed synthetic turf field.
- The near-surface low plasticity lean clays and silty clays are moisture sensitive, prone to losing strength and stability with slight increases in soil moisture contents and when subjected to repeat traffic loads.
- Chert cobbles and boulders were encountered within the gravelly residuum.
- Fat clay soils interbedded in the clayey gravel stratum exhibited high plasticity characteristics with a high shrink-swell potential.
- Auger refusal was encountered in boring TF-03 at a depth of about 5.5 feet.
- Groundwater was encountered in borings TF-04, TF-06, and TF-07 at the time of backfilling at depths ranging between 2.5 to 4 feet below current grades. In addition, portions of residual soils had relatively high soil moisture contents in borings that remained dry at the time of our subsurface exploration. Localized perched water should be anticipated within the residuum during and following wet weather seasons.

4.1 INITIAL SITE PREPARATION

All vegetation, roots, topsoil, and other deleterious materials should be removed from the proposed construction areas. Approximately 3 to 5 inches of topsoil were observed in the borings. A geotechnical engineer should observe stripping operations to evaluate that all unsuitable materials are removed from locations for proposed construction.

Materials disturbed during clearing operations should be stabilized in place or, if necessary, undercut to undisturbed materials and backfilled with properly compacted, approved structural fill. During site preparation activities, the contractor should identify borrow source materials that will be used as structural fill and provide samples to the testing laboratory so that conformance to the structural fill requirements outlined below and appropriate moisture-density relationship curves can be determined.

4.2 MOISTURE SENSITIVE SOILS

Moisture sensitive, near-surface low plasticity lean clay and silty claysoils were encountered in the borings drilled across the football field. These soils will degrade if allowed to become saturated. Therefore, not allowing water to pond by maintaining positive drainage and temporary dewatering methods (if required) is important to help avoid degradation and softening of the soils.

The contractor should anticipate some difficulty during the earthwork phase of this project if moisture levels are moderate to high during construction. Increased moisture levels will soften the subgrade and the soils may become unstable under the influence of construction traffic. Accordingly, construction during wet weather conditions should be avoided, as this could result in soft and unstable soil conditions that would require ground modification, such as in place stabilization or undercutting.

4.3 EVALUATION OF SHRINK-SWELL POTENTIAL

Most of the residuum encountered within the football field generally exhibited low to medium plasticity characteristics with a low to moderate shrink-swell potential. It should be noted that layers of fat clays with high plasticity characteristics were encountered in isolated areas of the football field (for example, boring TP-02).

The potential vertical rise of the soils encountered in the borings was evaluated using the Texas Department of Transportation's test method TEX-124-E, Potential Vertical Rise (PVR). This method estimates the PVR of the onsite soils based on the plasticity characteristics, thickness of the soil strata, and surcharge loads.

For this project site, an active zone of 8 feet was used in the calculations. The profile generated for PVR estimation purposes included a layer of high plasticity fat clay between depths of about 2 to 6 feet. The TxDOT method estimates a PVR of about 1-inch based on the soil moisture contents at the time of subsurface exploration.

4.4 FOOTBALL FIELD SUBGRADE PREPARATION

Following initial site preparation and the anticipated grading (< 1 foot of grade change) within the areas proposed for synthetic turf, we anticipate low plasticity lean clays (CL) and silty clays (CL-ML) to be exposed after initial site preparation.

Based on subsurface conditions encountered and depending on grade adjustments, low consistency near-surface soils are anticipated to be exposed across the football field. The low consistency soils generally extended to depths of about 1 to 1.5 feet below grades that existed at the time of drilling.

As a minimum, prior to start of fill placement or turf installation, the exposed subgrade should be scarified to a depth of 12 inches, moisture conditioned within range of 2 percent below to 2 percent above the optimum moisture content, and recompacted to at least 95 percent of the standard Proctor maximum dry density.

The project geotechnical engineer or a qualified representative should evaluate the subgrade once moisture conditioned and recompacted. Some unstable areas may be present in parts of the site. All areas should be carefully proofrolled with a heavy (20- to 25-ton), loaded tandem-axle dump truck at the following times:

- After an area has been prepared as recommended, prior to fill placement.
- After areas have been exposed to any precipitation, and/or have been exposed for more than 48 hours prior to synthetic turf installation.

It should be emphasized that depending on weather conditions at the time of construction, the near-surface soils may be unstable. If scarification, moisture conditioning, and recompaction is not effective to establish a stable platform, the soft/unstable soils should be undercut full depth to expose underlying stable material. The area should then be replaced with structural fill in accordance with the recommendation noted within the *Structural Fill* section of this report. Evaluation of the exposed subgrade should be performed by the geotechnical engineer or their qualified representative.

4.5 STRUCTURAL FILL

Requirements for structural fill on this project are as follows:

Soil Type	USCS Classification	Property Requirements	Placement Location
Imported Lean Clay, Clayey Sand or Shale	CL, SC	LL<40, PI<18, γ_d>100 pcf, P200>15%, Maximum 3" particle size in any dimension	**Low Plasticity Structural Fill** to be used for construction of football field
Onsite Clayey Chert Gravel, Lean Clays, Silty Clays	GC, CL, CL-ML	As listed above for imported structural fill	***Likely Suitable*** for placement as low plasticity structural fill (see note 5)
Onsite Lean to Fat Clays, and Fat Clays	CL-CH, and CH	Not Applicable	***Not Suitable*** for placement as low plasticity structural fill

Table 4: Structural Fill Requirements

Table 4 Notes:

1. All structural fill should be free of vegetation, topsoil, and any other deleterious materials. The organic content of materials to be used for fill should be less than 3 percent.
2. LL indicates the soil Liquid Limit; PI indicates the soil Plasticity Index; γ_d indicates the maximum dry density as defined by the density standard outlined in the table below.
3. Representative bulk samples for any onsite and imported offsite materials are to be collected for soil classification and moisture-density relationship determination purposes as part of evaluating suitability for their intended use.
4. Material native to the region that may not meet the above structural fill criteria may be used if it contains more than 70% cherty sand and gravel retained on a No. 200 sieve (with maximum particle size of 3 inches) and is approved by the geotechnical engineer. Bulk samples of such material should be provided for, but not necessarily limited to, particle size analysis, Atterberg limits, and moisture-density relationship testing.
5. Cobble- and boulder-sized chert were encountered in the gravelly residuum. Materials placed within depth of 18 inches below finished subgrade should have maximum particle size of 3 inches in any dimension. Below depth of 18 inches, a maximum particle-size up to 6 inches in any dimension is allowed.

Placement requirements for structural fill are as follows:

Specification	Requirement
Lift Thickness	Maximum loose lift thickness of 8 to 12 inches, depending on type of compaction equipment used.
Density	95% of the standard Proctor (ASTM D698) maximum density
Moisture	±2% of the optimum moisture content as determined by ASTM D698
Density Testing Frequency	**Football Fields**: One test per 10,000 SF per lift with a minimum of three tests performed per lift **Utility trenches**: One test per 150 linear feet per lift The testing frequency can be increased or decreased by the Geotechnical Engineer of Record in the field based on uniformity of material being placed and compactive effort used.

Table 5: Structural Fill Placement Requirements

4.6 UTILITY TRENCH BACKFILL

All utility trenches should be backfilled and compacted in the manner specified above for structural fill. It may be necessary to reduce the lift thickness to 4 to 6 inches to achieve compaction using hand-operated equipment.

4.7 WET WEATHER CONSTRUCTION

Excessive movement of construction equipment across the football field during wet weather may result in ruts, which will collect rainwater, prolonging the time required to dry the subgrade soils.

During rainy periods, additional effort will be required to properly prepare the field and establish/maintain an acceptable subgrade. The difficulty will increase in areas where clay or silty soils are exposed at the subgrade elevation.

Likewise, rainwater may become perched on the clay soils encountered across the site, which could require additional dewatering efforts not needed during dry conditions.

A perched-water condition occurs when water seeping downward is slowed by a low permeability soil layer, such as the underlying clays. The perched-water level can be any number of feet above the true groundwater level. Due to the prevalence of clay soils encountered across the project site, the successful contractor should expect to encounter perched water during wet weather construction.

Grading contractors typically postpone grading operations during wet weather to wait for conditions that are more favorable. Contractors can typically disk or aerate the upper soils to promote drying during intermittent periods of favorable weather. When deadlines restrict postponement of grading operations, additional measures such as undercutting and replacing saturated soils or stabilization can be utilized to facilitate placement of additional fill material.

5.0 GENERAL GRADING AND DRAINAGE CONSIDERATIONS

Effective removal of water from the surface of the synthetic turf field and direction of the surface water towards the drainage areas is one of the most important features of the field. Different systems are available depending on the manufacturer and geographic location. Requirements will vary depending on site conditions, local weather, and regulations regarding storm water management.

Various types of subsurface drainage systems can be considered. A common system uses perforated pipes, with diameters ranging between 4 and 10 inches, depending on the amount of water they can be expected to handle. These perforated pipes are laid in trenches, surrounded by filter and clean stone. The trench drains are sloped to the edges of the field, or sometimes just to the long sidelines, where the water is deposited in drains on the perimeter. The perimeter collector pipes move the water to a disposal site such as a storm drain or catch basin. The provider of the synthetic turf system needs to design a drainage system based on the budgetary constraints and expectations of the owner.

The subgrade, free draining and open graded base stone layer, and trench drains should be graded such as to provide slopes of at least 1 percent to allow for gravity flow of the water to the point(s) of discharge.

6.0 SUBGRADE REHABILITATION

The subgrade soils often become disturbed during the period between initial site grading and construction of surface improvements. The amount and depth of disturbance will vary with soil type, weather conditions, construction traffic, and drainage. The engineer should evaluate the subgrade soil during final grading to verify that the subgrade is suitable for installation of a synthetic turf system. The final evaluation may include proofrolling or density tests.

Subgrade rehabilitation can become a point of controversy when different contractors are responsible for site grading and turf installation. Construction documents should specifically state which contractor will be responsible for maintaining and rehabilitating the subgrade. Rehabilitation may include moisture conditioning and re-compacting soils. When deadlines or weather restrict grading operations, additional measures such as undercutting and replacing saturated soils or chemical stabilization can often be utilized.

7.0 CONSTRUCTION MONITORING

Field verification of site conditions is an essential part of the services provided by the geotechnical consultant. To confirm our recommendations, it will be necessary for Building & Earth personnel to make periodic visits to the site during site grading. Typical construction monitoring services are listed below.

- Periodic observations and consultations by a member of our engineering staff during site preparation
- Continuous monitoring during undercutting, subgrade preparation, and structural fill placement
- Field density tests during structural fill placement

8.0 CLOSING AND LIMITATIONS

This report was prepared for Blue River Architects and Cherokee Nation for specific application to subject project located in Tahlequah, Oklahoma. The information in this report is not transferable. This report should not be used for a different development on the same property without first being evaluated by the engineer.

The recommendations in this report were based on the information obtained from our field exploration and laboratory analysis. The data collected is representative of the locations tested. Variations are likely to occur at other locations throughout the site. Engineering judgment was applied in regard to conditions between borings. It will be necessary to confirm the anticipated subsurface conditions during construction.

This report has been prepared in accordance with generally accepted standards of geotechnical engineering practice. No other warranty is expressed or implied. If changes are made, or anticipated to be made, to the nature, design, or location of the project as outlined in this report, Building & Earth must be informed of the changes and given the opportunity to either verify or modify the conclusions of this report in writing, or the recommendations of this report will no longer be valid.

The scope of services for this project did not include any environmental assessment of the site or identification of pollutants or hazardous materials or conditions. If the owner is concerned about environmental issues Building & Earth would be happy to provide an additional scope of services to address those concerns.

This report is intended for use during design and preparation of specifications and may not address all conditions at the site during construction. Contractors reviewing this information should acknowledge that this document is for design information only.

An article published by the Geoprofessional Business Association (GBA), titled *Important Information About Your Geotechnical Report*, has been included in the Appendix. We encourage all individuals to become familiar with the article to help manage risk.

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GEOTECHNICAL INVESTIGATION METHODOLOGIES

The subsurface exploration, which is the basis of the recommendations of this report, has been performed in accordance with industry standards. Detailed methodologies employed in the investigation are presented in the following sections.

DRILLING PROCEDURES – STANDARD PENETRATION TEST (ASTM D1586)

At each boring location, soil samples were obtained at standard sampling intervals with a split-spoon sampler. The borehole was first advanced to the sample depth by augering and the sampling tools were placed in the open hole. The sampler was then driven 18 inches into the ground with a 140-pound automatic hammer free-falling 30 inches. The number of blows required to drive the sampler each 6-inch increment was recorded. The initial increment is considered the "seating" blows, where the sampler penetrates loose or disturbed soil in the bottom of the borehole.

The blows required to penetrate the final two (2) increments are added together and are referred to as the Standard Penetration Test (SPT) N-value. The N-value, when properly evaluated, gives an indication of the soil's strength and ability to support structural loads. Many factors can affect the SPT N-value, so this result cannot be used exclusively to evaluate soil conditions.

The SPT testing was performed using a drill rig equipped with an automatic hammer. Automatic hammers mechanically control the height of the hammer drop, and doing so, deliver higher energy efficiency (90 to 99 % efficiency) than manual hammers (60 % efficiency) which are dropped using a manually operated rope and cathead system. Because historic data correlations were developed based on use of a manual hammer, it is necessary to adjust the N-values obtained using an automatic hammer to make these correlations valid. Therefore, an energy correction factor of 1.3 was applied to the recorded field N-values from the automatic hammer for the purpose of our evaluation. The N-values discussed or mentioned in this report and shown on the boring logs are recorded field values.

Samples retrieved from the boring locations were labeled and stored in plastic bags at the jobsite before being transported to our laboratory for analysis. The project engineer prepared Boring Logs summarizing the subsurface conditions at the boring locations.

BORING LOG DESCRIPTION

Building & Earth Sciences, Inc. used the gINT software program to prepare the attached boring logs. The gINT program provides the flexibility to custom design the boring logs to include the pertinent information from the subsurface exploration and results of our laboratory analysis. The soil and laboratory information included on our logs is summarized below:

DEPTH AND ELEVATION

The depth below the ground surface and the corresponding elevation are shown in the first two columns.

SAMPLE TYPE

The method used to collect the sample is shown. The typical sampling methods include Split Spoon Sampling, Shelby Tube Sampling, Grab Samples, and Rock Core. A key is provided at the bottom of the log showing the graphic symbol for each sample type.

SAMPLE NUMBER

Each sample collected is numbered sequentially.

BLOWS PER INCREMENT, REC%, RQD%

When Standard Split Spoon sampling is used, the blows required to drive the sampler each 6-inch increment are recorded and shown in column 5. When rock core is obtained the recovery ration (REC%) and Rock Quality Designation (RQD%) is recorded.

SOIL DATA

Column 6 is a graphic representation of four different soil parameters. Each of the parameters use the same graph, however, the values of the graph subdivisions vary with each parameter. Each parameter presented on column 6 is summarized below:

- N-value- The Standard Penetration Test N-value, obtained by adding the number of blows required to drive the sampler the final 12 inches, is recorded . The graph labels range from 0 to 50.
- Qu – Unconfined Compressive Strength estimate from the Pocket Penetrometer test in tons per square foot (tsf). The graph labels range from 0 to 5 tsf.
- Atterberg Limits – The Atterberg Limits are plotted with the plastic limit to the left, and liquid limit to the right, connected by a horizontal line. The difference in the plastic and liquid limits is referred to as the Plasticity Index. The Atterberg Limits test results are also included in the Remarks column on the far right of the boring log. The Atterberg Limits graph labels range from 0 to 100%.
- Moisture – The Natural Moisture Content of the soil sample as determined in our laboratory.

SOIL DESCRIPTION

The soil description prepared in accordance with ASTM D2488, Visual Description of Soil Samples. The Munsel Color chart is used to determine the soil color. Strata changes are indicated by a solid line, with the depth of the change indicated on the left side of the line and the elevation of the change indicated on the right side of the line. If subtle changes within a soil type occur, a broken line is used. The Boring Termination or Auger Refusal depth is shown as a solid line at the bottom of the boring.

GRAPHIC

The graphic representation of the soil type is shown. The graphic used for each soil type is related to the Unified Soil Classification chart. A chart showing the graphic associated with each soil classification is included.

REMARKS

Remarks regarding borehole observations, and additional information regarding the laboratory results and groundwater observations.

SOIL CLASSIFICATION METHODOLOGY

Major Divisions			***Symbols***		***Group Name & Typical Description***
			Lithology	***Group***	
Coarse Grained Soils *More than 50% of material is larger than No. 200 sieve size*	***Gravel and Gravelly Soils*** *More than 50% of coarse fraction is larger than No. 4 sieve*	***Clean Gravels*** *(Less than 5% fines)*	●	**GW**	*Well-graded gravels, gravel – sand mixtures, little or no fines*
			○	**GP**	*Poorly-graded gravels, gravel – sand mixtures, little or no fines*
		Gravels with Fines *(More than 12% fines)*	○	**GM**	*Silty gravels, gravel – sand – silt mixtures*
			▨	**GC**	*Clayey gravels, gravel – sand – clay mixtures*
	Sand and Sandy Soils *More than 50% of coarse fraction is smaller than No. 4 sieve*	***Clean Sands*** *(Less than 5% fines)*	⁘	**SW**	*Well-graded sands, gravelly sands, little or no fines*
			⁘	**SP**	*Poorly-graded sands, gravelly sands, little or no fines*
		Sands with Fines *(More than 12% fines)*	⁘	**SM**	*Silty sands, sand – silt mixtures*
			▨	**SC**	*Clayey sands, sand – clay mixtures*
Fine Grained Soils *More than 50% of material is smaller than No. 200 sieve size*	***Silts and Clays*** *Liquid Limit less than 50*	***Inorganic***	▥	**ML**	*Inorganic silts and very find sands, rock flour, silty or clayey fine sands or clayey silt with slight plasticity*
			▨	**CL**	*Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays*
		Organic	▤	**OL**	*Organic silts and organic silty clays of low plasticity*
	Silts and Clays *Liquid Limit greater than 50*	***Inorganic***	▥	**MH**	*Inorganic silts, micaceous or diatomaceous fine sand, or silty soils*
			▨	**CH**	*Inorganic clays of high plasticity*
		Organic	≈	**OH**	*Organic clays of medium to high plasticity, organic silts*
Highly Organic Soils			⁂	**PT**	*Peat, humus, swamp soils with high organic contents*

Table 1: Soil Classification Chart (based on ASTM D2487)

SOIL CLASSIFICATION METHODOLOGY

Building & Earth Sciences classifies soil in general accordance with the Unified Soil Classification System (USCS) presented in ASTM D2487. Table 1 and Figure 1 exemplify the general guidance of the USCS. Soil consistencies and relative densities are presented in general accordance with Terzaghi, Peck, & Mesri's (1996) method, as shown on Table 2, when quantitative field and/or laboratory data is available. Table 2 includes Consistency and Relative Density correlations with N-values obtained using either a manual hammer (60 percent efficiency) or automatic hammer (90 percent efficiency). The *Blows Per Increment* and *SPT N-values* displayed on the boring logs are the unaltered values measured in the field. When field and/or laboratory data is not available, we may classify soil in general accordance with the Visual Manual Procedure presented in ASTM D2488.

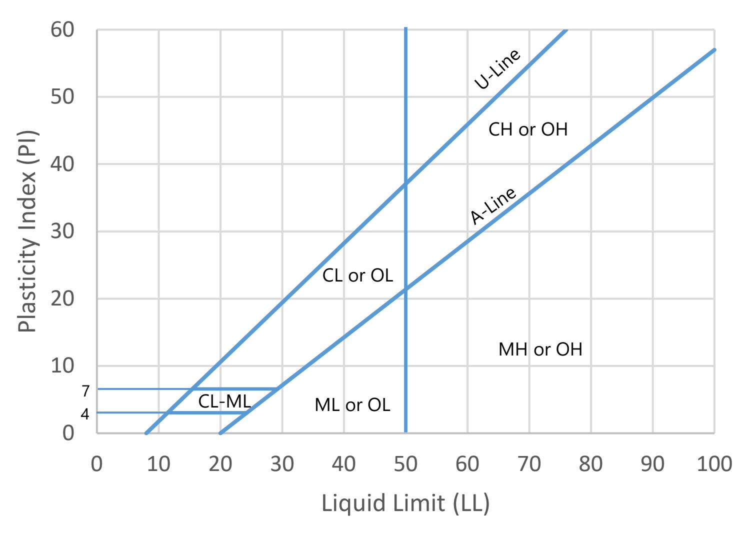


Figure 1: Plasticity Chart (based on ASTM D2487)

Non-cohesive: Coarse-Grained Soil			**Cohesive: Fine-Grained Soil**			
SPT Penetration (blows/foot)		**Relative Density**	**SPT Penetration (blows/foot)**		**Consistency**	**Estimated Range of Unconfined Compressive Strength (tsf)**
			Automatic Hammer*	Manual Hammer		
Automatic Hammer*	Manual Hammer		< 2	< 2	Very Soft	< 0.25
0 - 3	0 - 4	Very Loose	2 - 3	2 - 4	Soft	0.25 – 0.50
3 - 8	4 - 10	Loose	3 - 6	4 - 8	Medium Stiff	0.50 – 1.00
8 - 23	10 - 30	Medium Dense	6 - 12	8 - 15	Stiff	1.00 – 2.00
23 - 38	30 - 50	Dense	12 - 23	15 - 30	Very Stiff	2.00 – 4.00
> 38	> 50	Very Dense	> 23	> 30	Hard	> 4.00

Table 2: Soil Consistency and Relative Density (based on Terzaghi, Peck & Mesri, 1996)

* - Modified based on 80% hammer efficiency

KEY TO LOGS

☒	Standard Penetration Test ASTM D1586 or AASHTO T-206	⬇	Dynamic Cone Penetrometer (Sower DCP) ASTM STP-399
■	Shelby Tube Sampler ASTM D1587	○	No Sample Recovery
▥	Rock Core Sample ASTM D2113	▽	Groundwater at Time of Drilling
▮	Auger Cuttings	▼	Groundwater as Indicated

Table 1: Symbol Legend

Soil	Particle Size	U.S. Standard
Boulders	Larger than 300 mm	N.A.
Cobbles	300 mm to 75 mm	N.A.
Gravel	75 mm to 4.75 mm	3-inch to #4 sieve
Coarse	75 mm to 19 mm	3-inch to ¾-inch sieve
Fine	19 mm to 4.75 mm	¾-inch to #4 sieve
Sand	4.75 mm to 0.075 mm	#4 to #200 Sieve
Coarse	4.75 mm to 2 mm	#4 to #10 Sieve
Medium	2 mm to 0.425 mm	#10 to #40 Sieve
Fine	0.425 mm to 0.075 mm	#40 to #200 Sieve
Fines	Less than 0.075 mm	Passing #200 Sieve
Silt	Less than 5 μm	N.A.
Clay	Less than 2 μm	N.A.

Table 2: Standard Sieve Sizes

N-Value ☐	Standard Penetration Test Resistance calculated using ASTM D1586 or AASHTO T-206. Calculated as sum of original, field recorded values.	Atterberg Limits ├─┤ PL LL	A measure of a soil's plasticity characteristics in general accordance with ASTM D4318. The soil Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL).
Qu ▲	Unconfined compressive strength, typically estimated from a pocket penetrometer. Results are presented in tons per square foot (tsf).	% Moisture ●	Percent natural moisture content in general accordance with ASTM D2216.

Table 3: Soil Data

Hollow Stem Auger	Flights on the outside of the shaft advance soil cuttings to the surface. The hollow stem allows sampling through the middle of the auger flights.
Mud Rotary / Wash Bore	A cutting head advances the boring and discharges a drilling fluid to support the borehole and circulate cuttings to the surface.
Solid Flight Auger	Flights on the outside bring soil cuttings to the surface. Solid stem requires removal from borehole during sampling.
Hand Auger	Cylindrical bucket (typically 3-inch diameter and 8 inches long) attached to a metal rod and turned by human force.

Table 4: Soil Drilling Methods

Descriptor	Meaning
Trace	Likely less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

Table 5: Descriptors

Manual Hammer	The operator tightens and loosens the rope around a rotating drum assembly to lift and drop a sliding, 140-pound hammer falling 30 inches.
Automatic Trip Hammer	An automatic mechanism is used to lift and drop a sliding, 140-pound hammer falling 30 inches.
Dynamic Cone Penetrometer (Sower DCP) ASTM STP-399	Uses a 15-pound steel mass falling 20 inches to strike an anvil and cause penetration of a 1.5-inch diameter cone seated in the bottom of a hand augered borehole. The blows required to drive the embedded cone a depth of 1-3/4 inches have been correlated by others to N-values derived from the Standard Penetration Test (SPT).

Table 6: Sampling Methods

Non-plastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Table 7: Plasticity

Dry	Absence of moisture, dusty, dry to the touch.
Moist	Damp but no visible water.
Wet	Visible free water, usually soil is below water table.

Table 8: Moisture Condition

Stratified	Alternating layers of varying material or color with layers at least ½ inch thick.
Laminated	Alternating layers of varying material or color with layers less than ¼ inch thick.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensides	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Table 9: Structure

KEY TO HATCHES

Hatch	*Description*	*Hatch*	*Description*	*Hatch*	*Description*
▨	***GW*** *- Well-graded gravels, gravel – sand mixtures, little or no fines*	▨	*Asphalt*	▨	*Clay with Gravel*
▨	***GP*** *- Poorly-graded gravels, gravel – sand mixtures, little or no fines*	▨	*Aggregate Base*	▨	*Sand with Gravel*
▨	***GM*** *- Silty gravels, gravel – sand – silt mixtures*	▨	*Topsoil*	▨	*Silt with Gravel*
▨	***GC*** *- Clayey gravels, gravel – sand – clay mixtures*	▨	*Concrete*	▨	*Gravel with Sand*
▨	***SW*** *- Well-graded sands, gravelly sands, little or no fines*	▨	*Coal*	▨	*Gravel with Clay*
▨	***SP*** *- Poorly-graded sands, gravelly sands, little or no fines*	▨	***CL-ML*** *- Silty Clay*	▨	*Gravel with Silt*
▨	***SM*** *- Silty sands, sand – silt mixtures*	▨	*Sandy Clay*	▨	*Limestone*
▨	***SC*** *- Clayey sands, sand – clay mixtures*	▨	*Clayey Chert*	▨	*Chalk*
▨	***ML*** *- Inorganic silts and very find sands, rock flour, silty or clayey fine sands or clayey silt with slight plasticity*	▨	*Low and High Plasticity Clay*	▨	*Siltstone*
▨	***CL*** *- Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays*	▨	*Low Plasticity Silt and Clay*	▨	*Till*
▨	***OL*** *- Organic silts and organic silty clays of low plasticity*	▨	*High Plasticity Silt and Clay*	▨	*Sandy Clay with Cobbles and Boulders*
▨	***MH*** *- Inorganic silts, micaceous or diatomaceous fine sand, or silty soils*	▨	*Fill*	▨	*Sandstone with Shale*
▨	***CH*** *- Inorganic clays of high plasticity*	▨	*Weathered Rock*	▨	*Coral*
▨	***OH*** *- Organic clays of medium to high plasticity, organic silts*	▨	*Sandstone*	▨	*Boulders and Cobbles*
▨	***PT*** *- Peat, humus, swamp soils with high organic contents*	▨	*Shale*	▨	*Soil and Weathered Rock*

Table 1: Key to Hatches Used for Boring Logs and Soil Profiles

BORING LOCATION PLAN

REFERENCE USED TO PRODUCE THIS DRAWING:	**BORING LOCATION PLAN**		**DATE: 02/10/2023**	BUILDING & EARTH Geotechnical, Environmental, and Materials Engineers
Google Earth Satellite Imagery dated January 2018	**PROJECT NO.** TU230024	**PROJECT NAME / LOCATION:** Sequoyah High School – Football Field Improvements Tahlequah, Oklahoma	**SCALE:** As Shown	

BORING LOGS

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

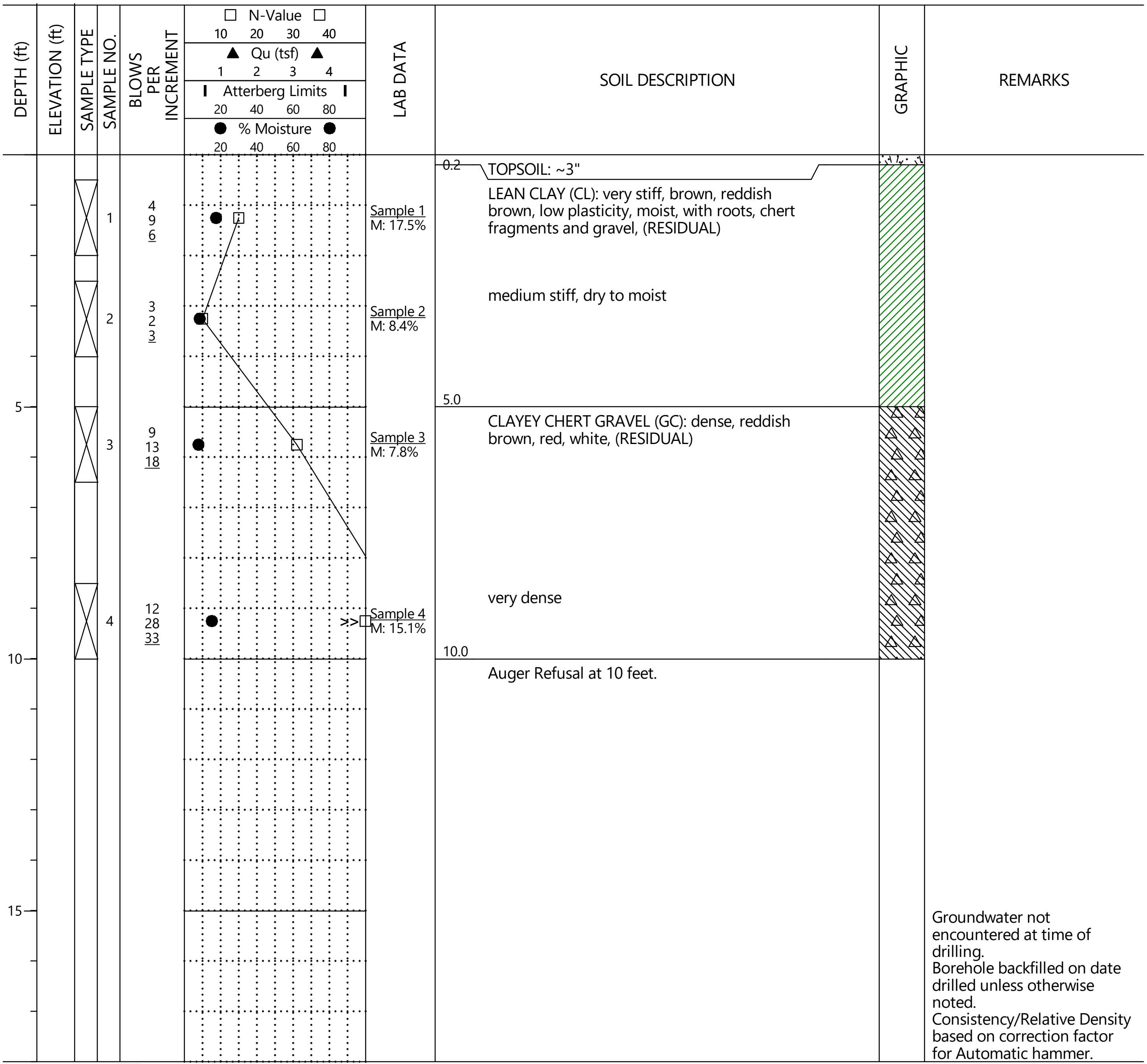
LOG OF BORING

Designation: B-01

Sheet 1 of 1

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/10/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: S. Harris



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.2						TOPSOIL: ~3"	
		☒	1	4 9 6	Sample 1 M: 17.5%	LEAN CLAY (CL): very stiff, brown, reddish brown, low plasticity, moist, with roots, chert fragments and gravel, (RESIDUAL)	
		☒	2	3 2 3	Sample 2 M: 8.4%	medium stiff, dry to moist	
5.0		☒	3	9 13 18	Sample 3 M: 7.8%	CLAYEY CHERT GRAVEL (GC): dense, reddish brown, red, white, (RESIDUAL)	
		☒	4	12 28 33	Sample 4 M: 15.1%	very dense	
10.0						Auger Refusal at 10 feet.	
							Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
∇ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

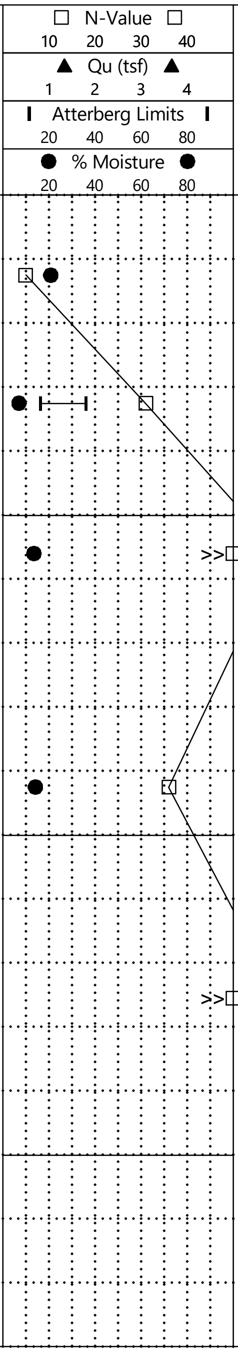
Designation: B-02

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/10/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: S. Harris



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.3						TOPSOIL: ~4"	
		☒	1	1 2 3	Sample 1 M: 20.8%	LEAN CLAY (CL): medium stiff, brown, reddish brown, low plasticity, moist, with trace of roots, and chert fragments, (RESIDUAL)	Soft to about 1 foot
2.5		☒	2	7 16 15	Sample 2 LL: 36 PL: 16 PI: 20 M: 7.0%	CLAYEY CHERT GRAVEL (GC): dense, reddish brown, red, white, medium plasticity, moist, (RESIDUAL)	
5		☒	3	9 22 50/2.25"	Sample 3 M: 13.5%	very dense	
		☒	4	30 19 17	Sample 4 M: 14.1%	dense	
10							
		☒	5	50/0.25"		with chert cobbles and boulders	
12.5						Auger Refusal at 12.5 feet.	
15							Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
∇	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

LOG OF BORING

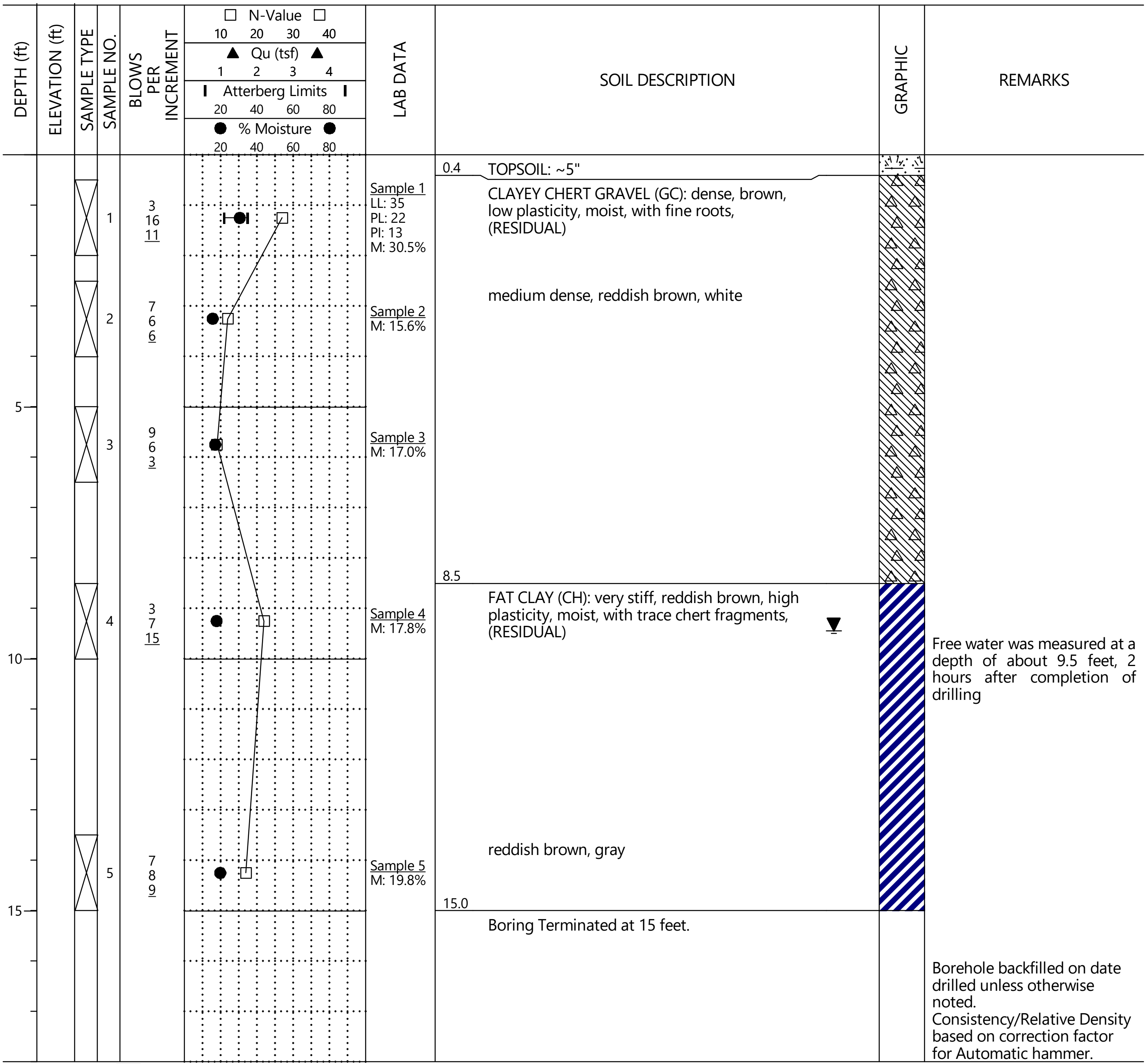
Designation: B-03

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/10/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: S. Harris



DEPTH (ft)	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.4				TOPSOIL: ~5"	
	1	3 16 11	Sample 1 LL: 35 PL: 22 PI: 13 M: 30.5%	CLAYEY CHERT GRAVEL (GC): dense, brown, low plasticity, moist, with fine roots, (RESIDUAL)	
	2	7 6 6	Sample 2 M: 15.6%	medium dense, reddish brown, white	
	3	9 6 3	Sample 3 M: 17.0%		
8.5	4	3 7 15	Sample 4 M: 17.8%	FAT CLAY (CH): very stiff, reddish brown, high plasticity, moist, with trace chert fragments, (RESIDUAL) ▼	Free water was measured at a depth of about 9.5 feet, 2 hours after completion of drilling
	5	7 8 9	Sample 5 M: 19.8%	reddish brown, gray	
15.0				Boring Terminated at 15 feet.	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
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M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

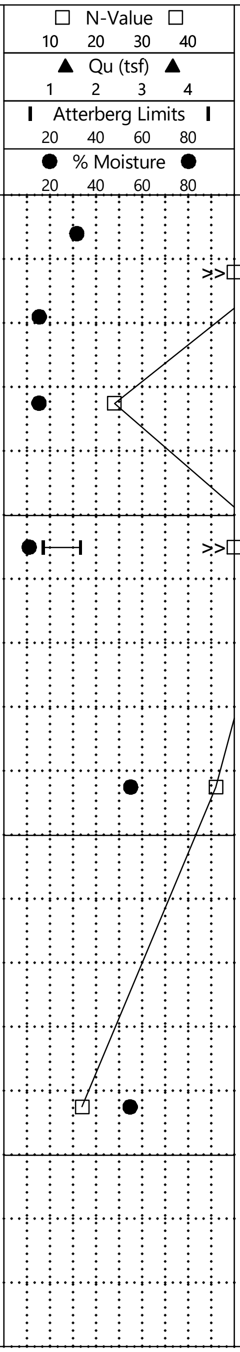
BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING
Designation: RW-01
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/10/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: S. Harris



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
						0.3 TOPSOIL: ~4"	
		☒	1T	3 18 50/4"	Sample 1T M: 31.6%	1.0 LEAN CLAY (CL): medium stiff, brown, grayish brown, low plasticity, wet, with trace of roots, (RESIDUAL)	
			1B		Sample 1B M: 15.4%	CLAYEY CHERT GRAVEL (GC): very dense, white, red, brown, medium plasticity, moist, with chert cobbles, (RESIDUAL)	
		☒	2	12 6 18	Sample 2 M: 15.2%	dense	
5		☒	3	29 50/6"	Sample 3 LL: 33 PL: 17 PI: 16 M: 11.0%	very dense, with chert cobbles	
						▽ ▼	
		☒	4	18 25 21	Sample 4 M: 55.0%	wet, with fat clay layers	Groundwater encountered at 8 feet (EL) at time of drilling and stabilized at 8.5 feet (EL).
10							
		☒	5	29 9 8	Sample 5 M: 54.8%	medium dense, with ferrous staining	
15						15.0 Boring Terminated at 15 feet.	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

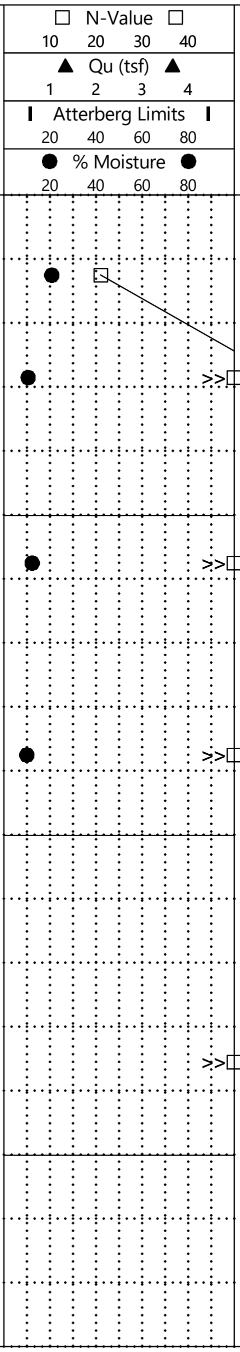
BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING
Designation: RW-02
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/10/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.2						TOPSOIL: ~3"		
		☒	1	3 9 12	Sample 1 M: 20.8%	CLAYEY CHERT GRAVEL (GC): medium dense, brown, reddish brown, low plasticity, moist, (RESIDUAL)		
		☒	2	31 50/2"	Sample 2 M: 10.5% F: 12%	very dense, reddish brown, white		
5		☒	3	19 22 29	Sample 3 M: 12.3%			
		☒	4	50/5.5"	Sample 4 M: 9.9%	with chert cobbles and boulders below 8.5 feet		
10								
		☒	5	50/0.25"				
14.5						Auger Refusal at 14.5 feet.		
15								Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

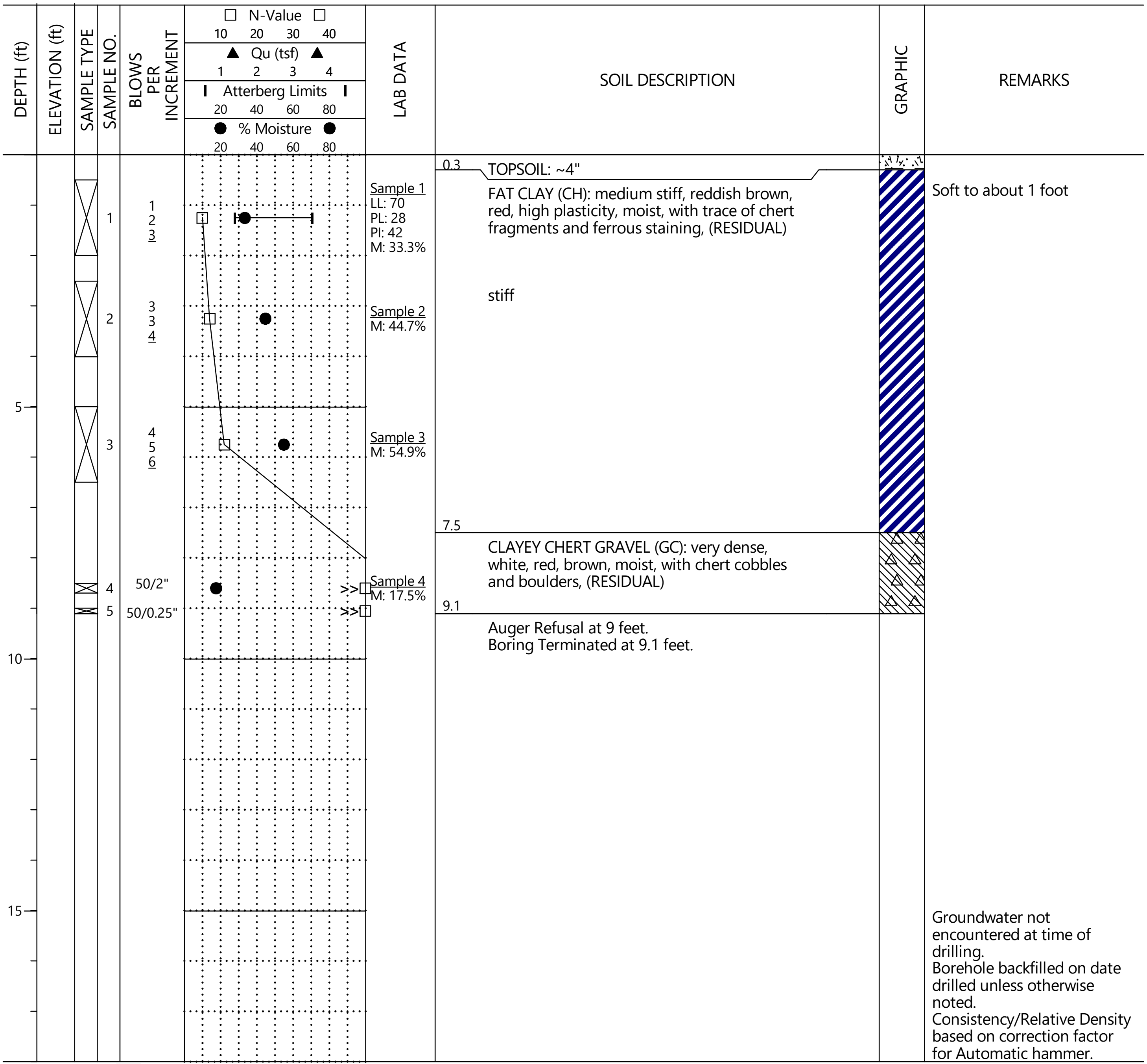
N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
∇ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING
Designation: RW-03
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan
LOCATION: Tahlequah, OK
DATE DRILLED: 2/10/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



Depth (ft)	Sample No.	Blows per Increment	Lab Data	Soil Description	Remarks
0.3				TOPSOIL: ~4"	
	1	1 2 3	Sample 1 LL: 70 PL: 28 PI: 42 M: 33.3%	FAT CLAY (CH): medium stiff, reddish brown, red, high plasticity, moist, with trace of chert fragments and ferrous staining, (RESIDUAL)	Soft to about 1 foot
	2	3 3 4	Sample 2 M: 44.7%	stiff	
	3	4 5 6	Sample 3 M: 54.9%		
7.5				CLAYEY CHERT GRAVEL (GC): very dense, white, red, brown, moist, with chert cobbles and boulders, (RESIDUAL)	
	4	50/2"	Sample 4 M: 17.5%		
	5	50/0.25"			
9.1				Auger Refusal at 9 feet. Boring Terminated at 9.1 feet.	Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
∇ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

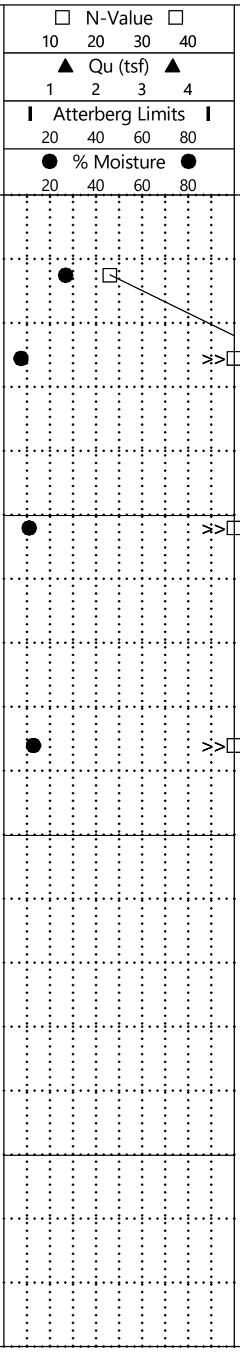
LOG OF BORING

Designation: TF-01

Sheet 1 of 1

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/9/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.3						TOPSOIL: ~4"		
		☒	1	1 4 19	Sample 1 M: 26.8%	LEAN CLAY (CL): medium stiff, dark brown, low plasticity, moist to wet, with roots, (RESIDUAL)		Soft to about 1 foot
1.5						CLAYEY CHERT GRAVEL (GC): medium dense, red, reddish brown, low plasticity, moist, (RESIDUAL) very dense below 2.5 feet, with chert cobbles and boulders		
		☒	2	50/1.25"	Sample 2 M: 7.4%			
5		☒	3	50/5"	Sample 3 M: 10.9%			
		☒	4	50/2"	Sample 4 M: 12.8%			
8.7						Boring Terminated at 8.7 feet.		
10								
15								Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
∇ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

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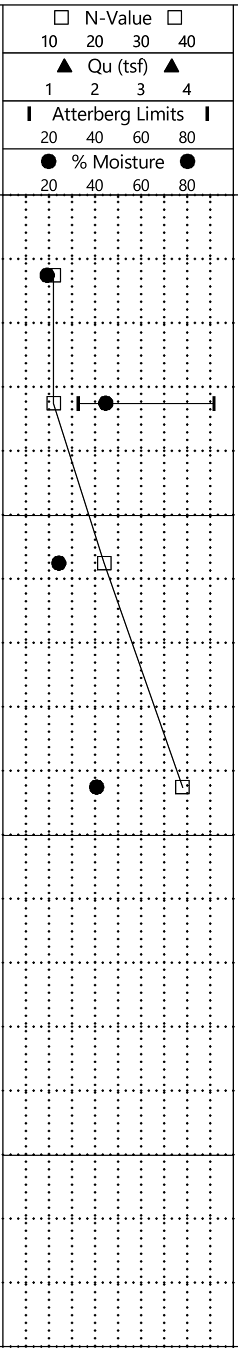
LOG OF BORING

Designation: TF-02

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME:	Sequoyah High School - Football Field Improvements	LOCATION:	Tahlequah, OK
PROJECT NUMBER:	TU230024	DATE DRILLED:	2/9/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Overcast
EQUIPMENT USED:	Diedrich D-50 ATV	ELEVATION:	
HAMMER TYPE:	Automatic	DRILL CREW:	Building & Earth
BORING LOCATION:	See boring location plan	LOGGED BY:	Q. Mann



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.2						TOPSOIL: ~3"		
2.0		☒	1	1 4 7	Sample 1 M: 19.2%	LEAN CLAY (CL): stiff, dark brown, low plasticity, moist, with chert fragments, (RESIDUAL)		Soft to about 1 foot
		☒	2	5 5 6	Sample 2 LL: 91 PL: 32 PI: 59 M: 44.6% F: 90.9%	FAT CLAY (CH): stiff, reddish brown, red, high plasticity, moist, with chert fragments, (RESIDUAL)		
6.0		☒	3	6 9 13	Sample 3 M: 24.3%	very stiff		
10.0		☒	4	18 16 23	Sample 4 M: 40.7%	CLAYEY CHERT GRAVEL (GC): very dense, red, reddish brown, moist to wet, (RESIDUAL)		
						Boring Terminated at 10 feet.		Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

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LOG OF BORING

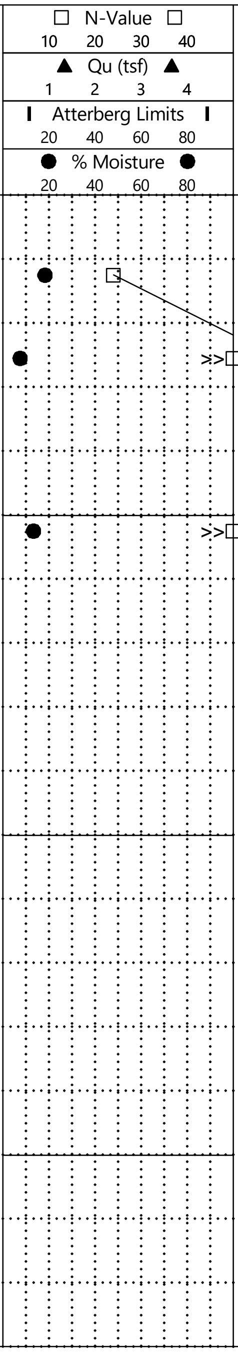
Designation: TF-03

Sheet 1 of 1

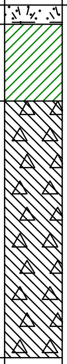
1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/9/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.3						TOPSOIL: ~4"	
		☒	1	2 5 19	Sample 1 M: 18.3%	LEAN CLAY (CL): stiff, dark brown, low plasticity, moist, with trace roots and chert fragments, (RESIDUAL)	
1.5						CLAYEY CHERT GRAVEL (GC): dense, reddish brown, low plasticity, moist, (RESIDUAL) very dense below 2.5 feet, with chert cobbles and boulders	
		☒	2	50/1.5"	Sample 2 M: 7.5%		
5		☒	3	50/6"	Sample 3 M: 13.3%		
5.5						Auger Refusal at 5.5 feet.	
10							
15							Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.



SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
∇ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

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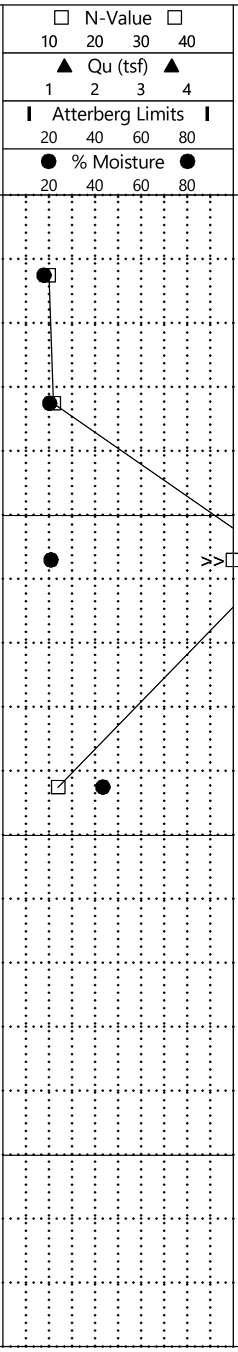
LOG OF BORING

Designation: TF-04

Sheet 1 of 1

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/9/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
☒	1	2 2 8	Sample 1 M: 17.8%
☒	2	5 5 6	Sample 2 M: 20.3%
☒	3	3 3 50/4"	Sample 3 M: 20.9%
☒	4	3 5 7	Sample 4 M: 43.4%

DEPTH (ft)	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.3	TOPSOIL: ~4"		
4.0	LEAN CLAY (CL): stiff, dark brown, brown, low plasticity, moist, with trace roots and chert fragments, (RESIDUAL) ▼ red, reddish brown	▨	Free water was measured at a depth of about 2.5 feet, 24 hours after completion of drilling
8.0	CLAYEY CHERT GRAVEL (GC): very dense, very dark grayish brown, white, red, low plasticity, moist, with chert cobbles, (RESIDUAL)	▨	
10.0	FAT CLAY (CH): stiff to very stiff, dark red, high plasticity, moist, with ferrous staining and trace chert fragments, (RESIDUAL)	▨	
	Boring Terminated at 10 feet.		

DEPTH (ft): 5, 10, 15

Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

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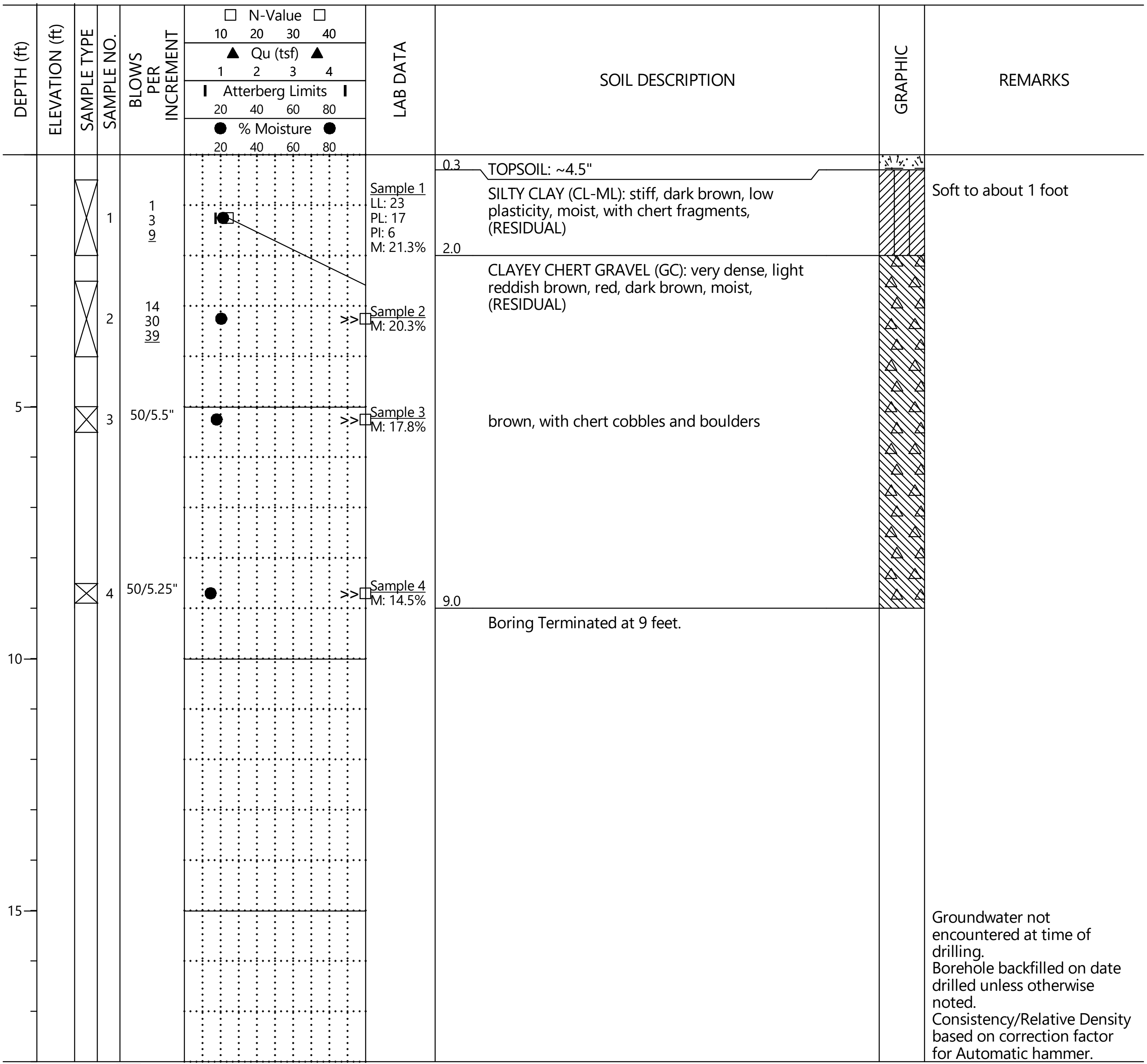
LOG OF BORING

Designation: TF-05

Sheet 1 of 1

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/9/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



Depth (ft)	Sample No.	Blows per Increment	Lab Data	Soil Description	Remarks
0.3				TOPSOIL: ~4.5"	
	1	1 3 9	Sample 1 LL: 23 PL: 17 PI: 6 M: 21.3%	SILTY CLAY (CL-ML): stiff, dark brown, low plasticity, moist, with chert fragments, (RESIDUAL)	Soft to about 1 foot
2.0	2	14 30 39	Sample 2 M: 20.3%	CLAYEY CHERT GRAVEL (GC): very dense, light reddish brown, red, dark brown, moist, (RESIDUAL)	
	3	50/5.5"	Sample 3 M: 17.8%	brown, with chert cobbles and boulders	
	4	50/5.25"	Sample 4 M: 14.5%		
9.0				Boring Terminated at 9 feet.	

Groundwater not encountered at time of drilling.
Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:**	LIQUID LIMIT	**M:**	NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:**	PLASTIC LIMIT	**F:**	PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:**	PLASTICITY INDEX		
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH				

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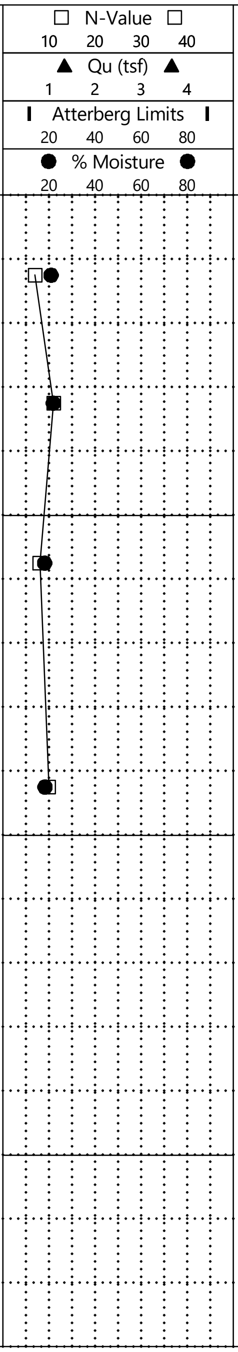
LOG OF BORING
Designation: TF-06
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/9/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.3						TOPSOIL: ~3"		
		☒	1	1 3 4	Sample 1 M: 20.9%	LEAN CLAY (CL): stiff, dark brown, very dark grayish brown, dark reddish brown, low to medium plasticity, moist, with roots, (RESIDUAL)		Soft to about 1 foot
2.5		☒	2	5 5 6	Sample 2 M: 21.9%	CLAYEY CHERT GRAVEL (GC): medium dense, dark brown, very dark grayish brown, medium plasticity, moist to wet, with chert fragments, (RESIDUAL) ▼ ▽		Groundwater encountered at 5 feet (EL) at time of drilling and stabilized at 4 feet (EL). Free water was measured at a depth of about 4 feet, 24 hours after completion of drilling
5		☒	3	4 4 4	Sample 3 M: 18.2% F: 16.6%	loose to medium dense		
8.5		☒	4	2 4 6	Sample 4 M: 18.3%	LEAN TO FAT CLAY (CL-CH): stiff, grayish brown, brown, reddish brown, medium to high plasticity, moist, (RESIDUAL)		
10.0						Boring Terminated at 10 feet.		
15								Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

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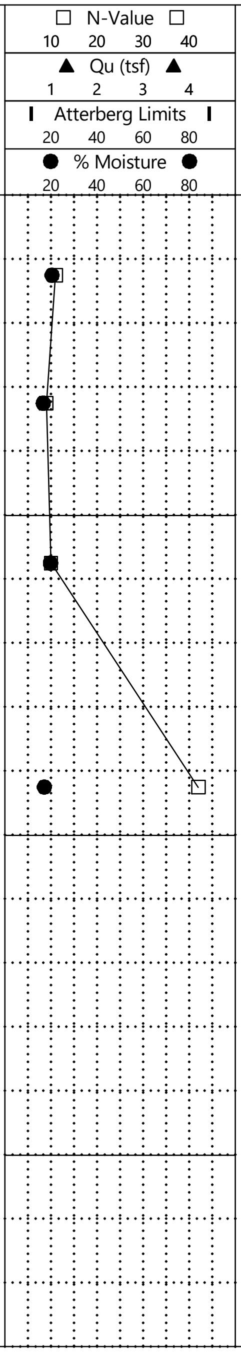
LOG OF BORING
Designation: TF-07
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74112
Office: (918) 439-9005

PROJECT NAME: Sequoyah High School - Football Field Improvements
PROJECT NUMBER: TU230024
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50 ATV
HAMMER TYPE: Automatic
BORING LOCATION: See boring location plan

LOCATION: Tahlequah, OK
DATE DRILLED: 2/9/23
WEATHER: Overcast
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
						0.3 TOPSOIL: ~4"		
		☒	1	2 4 7	Sample 1 M: 20.4%	LEAN CLAY (CL): stiff, dark brown, dark reddish brown, very dark grayish brown, low plasticity, moist, with trace chert fragments, (RESIDUAL)	▨	
		☒	2	3 6 3	Sample 2 M: 16.6%	2.5 CLAYEY CHERT GRAVEL (GC): medium dense, brown, dark brown, reddish brown, medium plasticity, moist to wet, (RESIDUAL) ▼	▨	Free water was measured at a depth of about 4 feet, 24 hours after completion of drilling
5		☒	3	4 6 4	Sample 3 M: 19.8%		▨	
		☒	4	5 18 24	Sample 4 M: 17.1%	very dense	▨	
10						10.0 Boring Terminated at 10 feet.		
15								Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

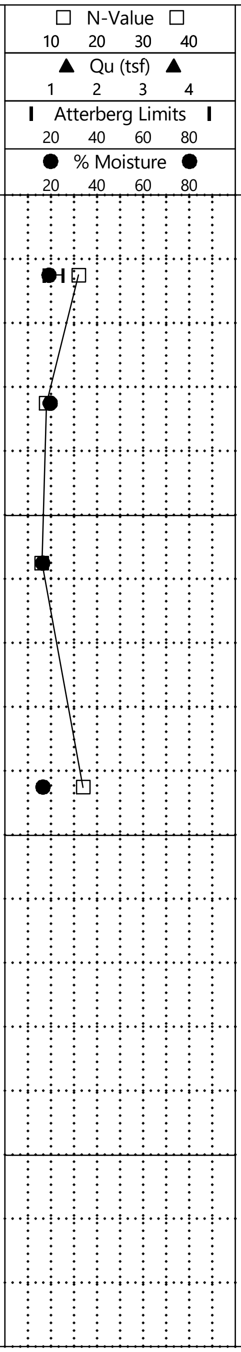
N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

LOG OF BORING

Designation: TF-08

Sheet 1 of 1

PROJECT NAME:	Sequoyah High School - Football Field Improvements	LOCATION:	Tahlequah, OK
PROJECT NUMBER:	TU230024	DATE DRILLED:	2/9/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Overcast
EQUIPMENT USED:	Diedrich D-50 ATV	ELEVATION:	
HAMMER TYPE:	Automatic	DRILL CREW:	Building & Earth
BORING LOCATION:	See boring location plan	LOGGED BY:	Q. Mann



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.3						TOPSOIL: ~4"		
		☒	1	2 5 11	Sample 1 LL: 25 PL: 17 PI: 8 M: 19.2%	LEAN CLAY (CL): stiff to very stiff, dark brown, dark reddish brown, low plasticity, moist, with chert fragments, (RESIDUAL)		
		☒	2	3 4 5	Sample 2 M: 19.6%	stiff, medium plasticity		
5		☒	3	3 4 4	Sample 3 M: 16.4%			
8.0						CLAYEY CHERT GRAVEL (GC): medium dense, brown, red, white, low plasticity, moist, (RESIDUAL)		
		☒	4	10 13 4	Sample 4 M: 16.5%			
10.0						Boring Terminated at 10 feet.		
15								Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

LABORATORY TEST PROCEDURES

A brief description of the laboratory tests performed is provided in the following sections.

DESCRIPTION OF SOILS (VISUAL-MANUAL PROCEDURE) (ASTM D2488)

The soil samples were visually examined by our engineer and soil descriptions were provided. Representative samples were then selected and tested in accordance with the aforementioned laboratory-testing program to determine soil classifications and engineering properties. This data was used to correlate our visual descriptions with the Unified Soil Classification System (USCS).

NATURAL MOISTURE CONTENT (ASTM D2216)

Natural moisture contents (M%) were determined on selected samples. The natural moisture content is the ratio, expressed as a percentage, of the weight of water in a given amount of soil to the weight of solid particles.

ATTERBERG LIMITS (ASTM D4318)

The Atterberg Limits test was performed to evaluate the soil's plasticity characteristics. The soil Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid. The Plastic Limit is the moisture content at which the soil is between "plastic" and the semi-solid stage. The Plasticity Index (PI = LL - PL) is a frequently used indicator for a soil's potential for volume change. Typically, a soil's potential for volume change increases with higher plasticity indices.

MATERIAL FINER THAN NO. 200 SIEVE BY WASHING (ASTM D1140)

Grain-size tests were performed to determine the partial soil particle size distribution. The amount of material finer than the openings on the No. 200 sieve (0.075 mm) was determined by washing soil over the No. 200 sieve. The results of wash #200 tests are presented on the boring logs included in this report and in the table of laboratory test results.

LABORATORY TEST RESULTS

The results of the laboratory testing are presented in the following tables.

BORING NO.	DEPTH	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE	CLASSIFICATION
B-01	0.5 - 2.0	17.5					
B-01	2.5 - 4.0	8.4					
B-01	5.0 - 6.5	7.8					
B-01	8.5 - 10.0	15.1					
B-02	0.5 - 2.0	20.8					
B-02	2.5 - 4.0	7.0	36	16	20		
B-02	5.0 - 6.2	13.5					
B-02	8.5 - 10.0	14.1					
B-03	0.5 - 2.0	30.5	35	22	13		
B-03	2.5 - 4.0	15.6					
B-03	5.0 - 6.5	17.0					
B-03	8.5 - 10.0	17.8					
B-03	13.5 - 15.0	19.8					
RW-01	0.6	31.6					
RW-01	1.9	15.4					
RW-01	2.5 - 4.0	15.2					
RW-01	5.0 - 6.0	11.0	33	17	16		
RW-01	8.5 - 10.0	55.0					
RW-01	13.5 - 15.0	54.8					
RW-02	0.5 - 2.0	20.8					
RW-02	2.5 - 3.2	10.5				12	
RW-02	5.0 - 6.5	12.3					
RW-02	8.5 - 9.0	9.9					
RW-03	0.5 - 2.0	33.3	70	28	42		
RW-03	2.5 - 4.0	44.7					
RW-03	5.0 - 6.5	54.9					
RW-03	8.5 - 8.7	17.5					
TF-01	0.5 - 2.0	26.8					
TF-01	2.5 - 2.6	7.4					
TF-01	5.0 - 5.4	10.9					
TF-01	8.5 - 8.7	12.8					

TABLE L-1: General Soil Classification Test Results

Soils with a Liquid Limit (LL) greater than 50 and Plasticity Index (PI) greater than 25 usually exhibit significant volume change with varying moisture content and are considered to be highly plastic

(1) Indicates visual classification. WR indicates weathered rock.

LABORATORY TEST RESULTS

The results of the laboratory testing are presented in the following tables.

BORING NO.	DEPTH	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE	CLASSIFICATION
TF-02	0.5 - 2.0	19.2					
TF-02	2.5 - 4.0	44.6	91	32	59	91	CH
TF-02	5.0 - 6.5	24.3					
TF-02	8.5 - 10.0	40.7					
TF-03	0.5 - 2.0	18.3					
TF-03	2.5 - 2.6	7.5					
TF-03	5.0 - 5.5	13.3					
TF-04	0.5 - 2.0	17.8					
TF-04	2.5 - 4.0	20.3					
TF-04	5.0 - 6.4	20.9					
TF-04	8.5 - 10.0	43.4					
TF-05	0.5 - 2.0	21.3	23	17	6		
TF-05	2.5 - 4.0	20.3					
TF-05	5.0 - 5.5	17.8					
TF-05	8.5 - 8.9	14.5					
TF-06	0.5 - 2.0	20.9					
TF-06	2.5 - 4.0	21.9					
TF-06	5.0 - 6.5	18.2				17	
TF-06	8.5 - 10.0	18.3					
TF-07	0.5 - 2.0	20.4					
TF-07	2.5 - 4.0	16.6					
TF-07	5.0 - 6.5	19.8					
TF-07	8.5 - 10.0	17.1					
TF-08	0.5 - 2.0	19.2	25	17	8		
TF-08	2.5 - 4.0	19.6					
TF-08	5.0 - 6.5	16.4					
TF-08	8.5 - 10.0	16.5					

TABLE L-1: General Soil Classification Test Results

Soils with a Liquid Limit (LL) greater than 50 and Plasticity Index (PI) greater than 25 usually exhibit significant volume change with varying moisture content and are considered to be highly plastic

(1) *Indicates visual classification. WR indicates weathered rock.*

Important Information about This
Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GBC GEOTECHNICAL BUSINESS COUNCIL
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