Report of Subsurface Exploration
and Geotechnical Evaluation
Cherokee Nation Child Development Center
and Safe Room Facility
Sallisaw, Oklahoma
Building & Earth Project No.: OK210172

Prepared For:
James R Childers Architect

September 28, 2021

Geotechnical, Environmental, and Materials Engineers

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September 28, 2021

CHILDERS
ARCHITECT

45 South 4th Street
Fort Smith, AR 72901

Attention: Mr. Graham Sharum, AIA, LEED AP, NCARB

Subject: Report of Subsurface Exploration and Geotechnical Evaluation
Cherokee Nation Child Development Center and Safe Room
Sallisaw, Oklahoma
Building & Earth Project No: OK210172

Dear Mr. Sharum:

Building & Earth Sciences, Inc. has completed the authorized subsurface exploration and geotechnical engineering evaluation for the proposed Cherokee Nation Child Development Center and Safe Room Facility in Sallisaw, 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 fifteen (15) 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 6/30/2022

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cc: Mr. Danny Baldwin, P.E., LEED GA; Wallace Design Collective

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1.0 PROJECT & SITE DESCRIPTION

The subject site is located on the west side of J T Stites Boulevard, approximately 0.5 miles south of the Highway 64 and J T Stites Boulevard intersection in Sallisaw, Oklahoma. General information relative to the proposed site and the proposed development is listed in Table 1 below. Google Earth satellite imagery of the site and photographs depicting the current site conditions are presented on the following pages.

Development Item	Detail	Description
General Site	Size (Ac.)	Approx. 4
	Existing Development	Undeveloped tract of land
	Vegetation	The site was covered with grass and topsoil
	Slopes	The project site slopes down from the southeast corner in all directions with a grade differential of roughly 23 feet across the proposed construction area
	Retaining Walls	None noted or planned
	Drainage	Natural surface drainage to the north, west, and northwest
	Proposed Cuts & Fills	Less than 4 feet of fill and less than 7 feet of cut will be required across the building footprint and most of the pavement areas
Proposed Buildings	No. of Buildings	Two (2) – Child Development Center (CDC) and Safe Room
	Square Ft.	CDC: 30,000 Safe Room: 4,200
	Stories	One-story
	Construction	CDC: Conventional steel construction with (brick) veneer Safe Room: Precast concrete wall construction with roof precast double tees
	Column Loads	Child Development Center: 15 to 65 kips (provided)
	Wall Loads	CDC: 0.5 to 1 kip per linear foot (provided) Safe Room: 4 to 12 kips per linear foot (provided)
	Preferred Foundation	Conventional shallow foundation (assumed)
	Preferred Slab	Slab-on-grade (assumed)
Pavements	Traffic	Not Provided
	Standard Duty	Rigid and Flexible, assumed 150,000 ESALs (given)
	Heavy Duty	Rigid and Flexible, assumed 500,000 ESALs (given)

Table 1: Project and Site Description

References:

- Guidelines for geotechnical reports with Bore Hole Locations, prepared by Wallace Design Collective, Wallace Project No. 2111342, dated August 4, 2021
- Google Earth file with Project Boundaries, provided by Wallace Design Collective, undated
- Grading Plan, prepared by Wallace Design Collective, dated September 2, 2021.

Table 1 Notes:

- If final loading conditions exceed given preliminary loads, Building & Earth should be allowed to review the proposed structural design and its effects on recommendations for foundation design.
- Review of provided grading plan indicated that existing grades within the proposed building area range between roughly 529 to 539.5 feet. We understand that consideration is being given to a finished floor elevation (FFE) of 533.5 feet for the planned building. Fill heights of less than about 4 feet and cut depths of less than about 7 feet will be required to achieve design grades within the planned building area. If changes are made to the provided grading plan, Building & Earth should be allowed to review its effects on our recommendations.

At the time of our exploration and site reconnaissance, the project site was covered with grass and topsoil. An existing chain link fence was noted along the eastern property boundary. A swale with shallow stormwater was observed to the north of the planned construction area. Overhead utilities were noted along the east and south easements of the property.

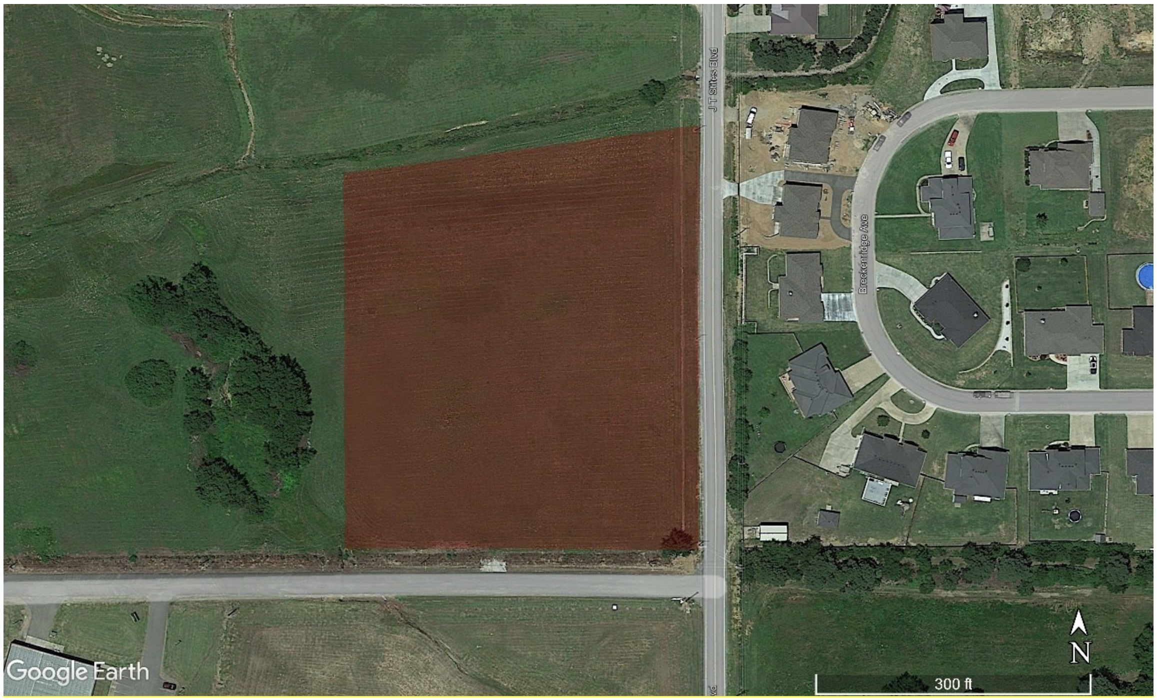


Figure 1: Google Earth aerial image, dated 6/2019

Figure 2: View looking west

Figure 3: View looking east

Figure 4: View looking southeast

2.0 SCOPE OF SERVICES

The authorized subsurface exploration was performed on September 9th, 2021, in conformance with our proposal OK23289, dated August 9, 2021. Notice to proceed was provided to our office via an email by Mr. Danny Baldwin with Wallace Design Collective on August 25, 2021.

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 fifteen (15) test borings. The site was drilled using a CME 550X ATV drill rig equipped with solid flight augers and an automatic hammer.

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

The soil/rock 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	55
Atterberg Limits	D4318	10
Material Finer Than No. 200 Sieve by Washing	D1140	1
Organic Content	D2974	1

Table 2: 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 determine a suitable foundation type for the proposed structures. The information was also evaluated to help determine if any special 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 the 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.
- Recommendations to be used for shallow footing design, including appropriate bearing material types, bearing pressures, and depths. For shear load resistance, recommended coefficient of friction and passive earth pressure values are provided.
- Presentation of expected total and differential settlements.

- Recommendations to be used for design of slabs-on-grade, including modulus of subgrade reaction.
- Seismic Site Classification per IBC 2015 based on SPT test boring information.
- Compaction requirements and recommended criteria to establish suitable material for structural backfill.
- Recommended typical minimum flexible and rigid pavement sections based on given traffic loading conditions.

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 at the site, and it will be necessary to evaluate the assumed conditions during site grading and foundation 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 Middle Pennsylvanian age, McAlester and Hartshorne Formations which are noted to consist of shale, some sandstone, and coal. The conditions encountered at the project site correlate with the McAlester and Hartshorne Formations.

3.2 EXISTING SURFACE CONDITIONS

At the time of our subsurface exploration, the project site was covered with grass and topsoil that had a thickness of about 2 to 2.5 inches. The topsoil conditions reported apply only to the specific boring locations. It should be noted that topsoil thicknesses likely vary at unexplored locations of the project site. No testing has been performed to verify that soils meet the requirements of “topsoil”. For this report, topsoil is defined as the soil horizon which contains the root mat of the noted vegetation.

3.3 SUBSURFACE CONDITIONS

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 and rock conditions and stratum types encountered during our field investigation.

Stratum No.	Typical Thickness	Description	Consistency/ Rock Hardness	Lab Test Data [5]
1[1]	2.1 to 4.9′	**Clayey Residuum:** Lean Clays (CL), Silty Clays (CL-ML), and shaley lean clay (CL) with varying amounts of sandstone fragments and gravel, fine roots, and ferrous staining Various combinations and shades of gray, brown, red, and yellow	Typically, medium stiff to very stiff Soft in boring P-01 in the upper 2.5 feet. In borings B-01 and P-03, soft to medium stiff within the upper 2.5 feet	*Atterberg Limits:* *LL = 27 to 39* *PL = 18 to 25* *PI = 7 to 17* *Organic Content Near-Surface Clays (P-06): 4.2%* *General Moisture Content Range [2]: 14 to 22%*
2[3]	1.8 to 11.9′	**Weathered Rock:** Clayey Shale and weathered shale with sandstone gravel/lenses and ferrous staining Weathered sandstone with clay seams and layers, shale seams, and sandstone partings Various combinations and shades of brown, gray, yellow, and red	Typically, soft clayey shale and weathered shale Soft to moderately hard weathered shale in B-08 at depth of about 4 ft Poorly cemented, weathered sandstone	*Atterberg Limits:* *LL = 32 to 40* *PL =19 to 23* *PI = 11 to 18* *Moisture Content Range: 2 to 15%* *Percent Fines: 58%*
3 [4]	Termination or Auger Refusal Layer	**McAlester and Hartshorne Formations:** Shale, fissile with ferrous staining and sandstone seams Sandstone Various combinations and shades of gray and yellowish brown	Shale: moderately hard to hard Sandstone: hard, cemented	*Moisture Content Range: 3 to 12%*

Table 3: Stratification Summary

Notes:

(1) Where present, residual soils were typically encountered below the topsoil with exception of boring P-04 in which shaley clay was encountered at the surface. Sandstone cobbles and boulders were noted in the near-surface sample in P-04, which may have exaggerated the N-value recorded. Residuum was not encountered in borings B-04 through B-09, and P-02.

(2) Relatively high moisture contents of 28% and 30% recorded in near-surface residual soils at boring locations P-01 and P-05. Low moisture contents of 9% and 10% in recorded in near-surface residual soils in borings P-04 and P-06.

(3) Encountered in all borings, except pavement boring P-04. Encountered immediately below the topsoil layer in borings B-04 through B-09, and P-02.

(4) Auger refusal was encountered on apparent sandstone unit at depths of about 13 and 12.5 feet below present grades in borings B-05 and B-06, respectively. Shale was encountered in all building borings. Sandstone was encountered in pavement borings P-04 and P-06 only.

(5) For Atterberg limits, LL = Liquid Limit, PL = Plastic Limit, and PI = Plasticity Index

Subsurface profiles have been prepared based on the data obtained at the specific boring locations and are presented in the Appendix. For specific details on the information obtained from individual borings, refer to the Boring Logs included in the Appendix. The ground surface elevations at the boring locations shown on the attached Boring Logs were estimated from the grading plan provided to our office.

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. Auger refusal was encountered on apparent sandstone at depths of about 13 and 12.5 feet in borings B-05 and B-06, respectively.

3.3.2 GROUNDWATER

Groundwater seepage was not encountered in any of the borings during drilling. All borings were dry upon the completion of drilling operations and prior to backfilling.

Although groundwater seepage was not recorded in the borings during our subsurface exploration, it should be noted that relatively high moisture contents were recorded for the near-surface residuum near the contact with the weathered rock in borings P-01 and P-05. The relatively high moisture contents of the residuum near the contact with the underlying weathered rock units suggest a high probability for development of perched water within portions of the site, especially in low lying areas.

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. The borings were either backfilled the same day that they were drilled, after completion of drilling.

3.4 SEISMIC SITE CLASSIFICATION

Basis of Evaluation	Recommended Site Classification
2015 International Building Code (IBC) and ASCE 7, Chapter 20	C
This recommended seismic site classification is based on the 2015 Edition of the International Building Code, the subsurface conditions encountered in the borings, and our knowledge of the geologic conditions of the site. Our subsurface exploration extended to a maximum depth of about 14 feet; hence the seismic site classification should be re-evaluated in the event subsurface information is made available to a depth of 100 feet.	

Table 5: Seismic Site Classification

4.0 SITE DEVELOPMENT CONSIDERATIONS

The provided grading plan indicated that existing grades within the proposed building area range between roughly 529 to 539.5 feet. We understand that consideration is being given to a finished floor elevation (FFE) of 533.5 feet for the planned building. Fill heights of less than about 4 feet and cut depths of less than about 7 feet will be required to achieve finished subgrade elevation within the planned building area.

Cut and fill depths of up to about 2.5 feet will be required to achieve finished grades in proposed pavement areas. ***If changes are made to the provided grading plan, Building & Earth should be allowed to review its effects on our recommendations.***

Based on our evaluation of the subsurface conditions, and the anticipated foundation loads, it appears that construction of the planned building with a conventional shallow foundation system is feasible. The site development recommendations outlined below are intended for development of the site to support construction of the building with conventional shallow foundations. ***If a different type of foundation system is preferred, Building & Earth should be contracted to review the site development recommendations to verify that they are appropriate for the preferred foundation system.***

The primary geotechnical considerations for this project are:

- Soft to medium stiff residual clay soils were encountered within the upper 2.5 feet in the north portion of the building area (borings B-01, B-02, and B-03). Soft and soft to medium stiff residual clays were also encountered within the upper 2.5 feet in the northeast area of proposed pavements (borings P-01 and P-03).
- The near-surface silty clays (CL-ML) have a significant silt and organic fraction. These types of soil are moisture sensitive, prone to losing strength and stability with slight increases in soil moisture contents.
- Residual clays and weathered shale exhibited low to medium plasticity characteristics with a low shrink-swell potential.
- Weathered rock, comprised of weathered shale, clayey shale, and weathered sandstone, was encountered immediately below the topsoil, or below a relatively thin cover of residuum at depths of about 2.5 to 5 feet.
- Based on given FFE, it is anticipated that shallow footings bear in weathered shale and clayey shale within the southern 2/3 of the building, and in structural fill over residuum in the northern 1/3 of the building.

- Auger refusal occurred on apparent sandstone at depths of about 13 feet and 12.5 feet below present grades in borings B-05 and B-06, respectively. Hard, cemented sandstone was also encountered in pavement borings P-04 and P-06 at depths of about 2.3 and 4.3 feet, respectively.
- Groundwater was not encountered in borings during drilling, and they remained dry at the time of backfilling. Although groundwater seepage was not recorded in the borings, relatively high moisture contents of the residuum were noted near the contact with the underlying weathered rock units in two borings, which suggests a probability for development of perched water within parts of the site.

Recommendations addressing the site conditions are presented in the following sections.

4.1 INITIAL SITE PREPARATION

All vegetation, roots, topsoil, and any other deleterious materials, should be removed from the proposed construction areas. The geotechnical engineer or their designated representative should observe stripping operations to evaluate that all unsuitable materials are removed from locations for proposed construction. Approximately 2 to 2.5 inches of topsoil was observed across the project site; however, topsoil thickness could extend to greater depths in unexplored areas of the site.

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 silty clays (CL-ML) with a significant silt and organic fraction were encountered across parts of the site. 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 BUILDING PAD PREPARATION

Based on given FFE, it is anticipated that shallow footings bear in weathered shale and clayey shale, and weathered sandstone within the southern 2/3 of the building, and in structural fill over residuum in the northern 1/3 of the building (see Figure 5). Differing bearing conditions for shallow footings increases the risk of differential settlement within the transition zone from weathered rock units to the structural fill over residuum, and the potential development of cracks in grade supported slabs and walls.

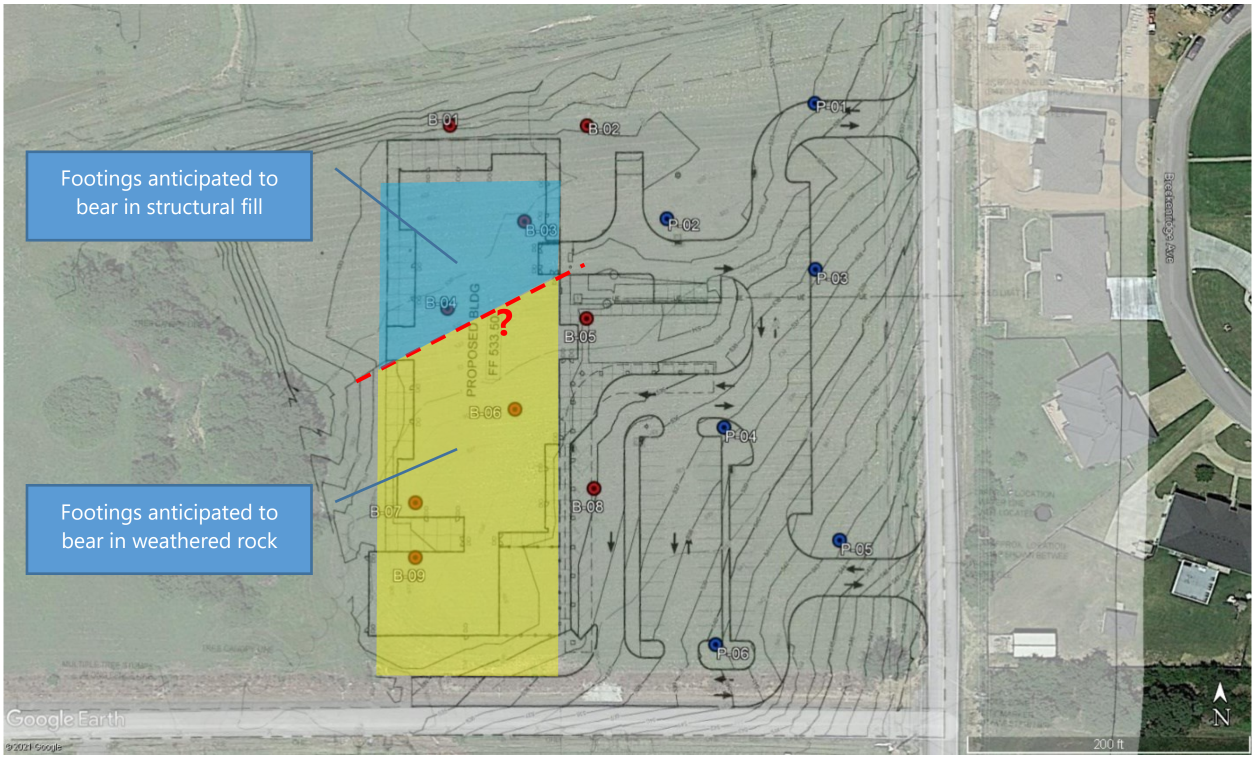


Figure 5: Transition Zone for Footings Bearing in Weathered Rock vs. Structural Fill over Residuum

If structural design can tolerate and the owner accepts the risk of potential differential settlement of ½- to ¾-inch within the transition zone, the building pad preparation recommendations presented in the following Subsection 4.3.1 can be followed, otherwise the recommendations of Subsection 4.3.2 are to be implemented for reduced risk of differential settlement.

4.3.1 BUILDING PAD PREPARATION FOR FOOTINGS BEARING IN DIFFERING MATERIALS

Where weathered rock units (weathered shale, clayey shale, and weathered sandstone) are exposed at finished subgrade level, these materials are to be undercut to a level that will allow for placement of at least 12 inches of structural fill. Confined trench excavations for under-slab utilities and footings should anticipate weathered rock units with potentially hard sandstone lenses.

Within the northern 1/3 portion of the building area, soft to medium stiff residual silty clays are anticipated to be exposed. All silty clays should be undercut to underlying stiff lean clays. Based on the subsurface conditions encountered in borings B-01, B-02, and B-03, an undercut depth of about 2.5 feet is to be anticipated.

Following undercutting and prior to fill placement, the exposed subgrade should be evaluated by the geotechnical engineer or designated representative by means of proofrolling with a loaded tandem-axle dump truck (20- to 25-ton). Following evaluation, the exposed subgrade should be prepared in accordance with the *Subgrade Preparation and Evaluation* section of this report.

4.3.2 BUILDING PAD PREPARATION FOR FOOTINGS BEARING IN UNIFORM MATERIAL

Varying bearing conditions across the proposed building area pose an increased risk of differential settlement of shallow footings and grade supported slabs, difficulties with confined trench excavations where shale and sandstone are encountered, and an unstable work platform for start of fill placement where soft soils are exposed within the northern portion of the building area.

To remove most of the low consistency soils, provide for uniform floor slab subgrade and footing bearing material conditions, and to facilitate trench excavations for under-slab utility lines, the residuum and weathered rock units should be undercut to a level at least **4 feet below finished floor elevation** during mass grading. With a given FFE of 533.5, the proposed building area is to be undercut to an elevation of at least 529.5. The undercut should extend at least 5 feet outside the proposed building perimeter lines.

Following undercutting and prior to fill placement, the exposed subgrade should be evaluated by the geotechnical engineer or designated representative by means of proofrolling with a loaded tandem-axle dump truck (20- to 25-ton). Following evaluation, the exposed subgrade should be prepared in accordance with the *Subgrade Preparation and Evaluation* section of this report.

Based on subsurface conditions encountered within the northern 1/3 portion of the proposed building area, we anticipate that soft and unstable silty clays will be exposed at the recommended undercut level that likely will not pass a proofroll. Where encountered, soft/unstable materials should be undercut to underlying stiff and stable soils. Based on the subsurface conditions encountered in borings B-01, B-02, and B-03, an undercut depth of about 2.5 feet is to be anticipated.

4.4 PAVEMENT SUBGRADE PREPARATION

Following initial site preparation, residual clays are anticipated to be exposed across most of the planned pavement areas. Soft to medium stiff lean clays (CL) and silty clays (CL-ML) are anticipated in the northeast portion of the proposed pavement areas (borings P-01 and P-03). Clayey shale is anticipated to be exposed in boring P-02. Sandstone cobbles and boulders may be present within the shaley residuum in portions of the site.

As a minimum, following initial site preparation, we recommend evaluating the exposed subgrade by means of proofrolling with a loaded tandem-axle dump truck weighing 20 to 25 tons.

In areas of passing proofroll observation, we recommend the exposed subgrade be prepared in accordance with the *Subgrade Evaluation and Preparation* section of this report. Soft/unstable soils identified during proofroll observation (to be expected in the northeast portion of the site) must be removed full depth from construction areas and replaced with low plasticity structural fill. For areas where unstable soils extend to levels greater than 2 feet below finished subgrade, alternate in-place stabilization recommendations using a combination of geogrid and graded crushed aggregate or tracking of surge stone/broken sandstone can be considered during construction based on the specific site conditions encountered at that time.

Where weathered shale and clayey shale are exposed at finished subgrade, these materials should be scarified to depth of at least 8 inches, moisture conditioned, and recompacted in-place as recommended in the *Subgrade Preparation and Evaluation* section of this report. Where hard sandstone and shale are exposed, we recommend undercutting to a level that will allow placement of at least 8 inches of structural fill to provide uniform subgrade conditions for pavement support.

4.5 SUBGRADE PREPARATION AND EVALUATION

Prior to start of structural fill placement in building and pavement areas, the exposed clay and subgrade should be scarified to a depth of 8 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.

In building areas where weathered rock units and competent sandstone and shale are exposed, scarification and moisture conditioning will not be required prior to start of structural fill placement.

In pavement areas where weathered rock units are exposed at finished subgrade, these materials will need to be scarified, moisture conditioned and recompacted as recommended above. Hard sandstone and shale at finished subgrade in pavements are to be undercut to a level that will allow placement of at least 8 inches of structural fill.

We recommend that the project geotechnical engineer or a qualified representative evaluate the subgrade after the site is prepared. Some unsuitable or unstable areas may be present in unexplored areas of the site. All areas that will require fill or that will support structures 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 stripped and building pad undercut, prior to the placement of any fill.
- After grading an area to the finished subgrade elevation in building and pavement areas.
- After areas have been exposed to any precipitation, and/or have been exposed for more than 48 hours.

Some instability may exist during construction, depending on climatic and other factors immediately preceding and during construction. If any soft or otherwise unsuitable soils are identified during the proofrolling process, they must be undercut or stabilized prior to fill placement, floor slab, or pavement construction. All unsuitable material identified during the construction shall be removed and replaced in accordance with the *Structural Fill* section of this report.

4.6 STRUCTURAL FILL

Requirements for lower plasticity 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, 7<PI<20, γ_d>100 pcf, P200>15%, Maximum 3" particle size in any dimension	**Lower Plasticity Structural Fill** to be used for construction of building pad and pavement subgrade
Onsite Residual Lean Clays, Weathered Shale, Clayey Shale, and Weathered Sandstone	CL	As noted above	**Suitable** for use as structural fill in building and pavement areas (see notes 6 and 7)
Onsite Residual Silty Clays	CL-ML	Not Applicable	**Not Suitable** for use as structural fill in building and pavement areas because of high silt and organic contents

Table 6: Structural Fill Requirements

Table 6 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; P200 indicates the percent of material by weight that passes the #200 sieve; γ_d indicates the maximum dry density as defined by the density standard outlined in the table below.
3. Laboratory testing of the soils proposed for fill must be performed to verify their conformance with the above recommendations. Any fill to be placed at the site should be reviewed by the geotechnical engineer. 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. Based upon the residual lean clays and weathered rock units encountered in the borings, these onsite materials appear suitable for use as structural fill. Sandstone gravel, lenses, seams, and layers are present within the residuum and weathered rock units. The onsite materials are suitable for use as structural fill, provided they are free of debris, over-sized rock fragments (i.e., greater than 6 inches in any dimension), topsoil, organics, and any other deleterious materials. The maximum particle size should be limited to 3 inches in any dimension within the top 12 inches of structural fill placed in building and pavement areas.
5. The residual silty clays have a high silt and organic content that are prone to losing strength and stability with slight increases in soil moisture levels; therefore, they should not be used as structural fill in proposed building and pavement areas. The onsite silty clays can be used as fill in green scape areas of the site.

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	**Building:** at least 98% of standard Proctor (ASTM D698) maximum dry density **Pavement:** at least 95% of standard Proctor (ASTM D698) max. dry density
Moisture	±2% of the optimum moisture content as determined by ASTM D698
Density Testing Frequency	**Building and foundation areas**: One test per 2,500 square feet (SF) per lift with a minimum of three tests performed per lift **Pavement areas**: One test per 5,000 SF per lift with a minimum of three tests performed per lift **Utility trenches**: One test per 150 linear feet per lift with a minimum of 2 tests per lift.

Table 7: Structural Fill Placement Requirements

4.7 EXCAVATION CONSIDERATIONS

All excavations performed at the site should follow OSHA guidelines for temporary excavations. Excavated soils should be stockpiled according to OSHA regulations to limit the potential cave-in of soils.

4.7.1 EXCAVATION DIFFICULTY

Residual soils, weathered sandstone, weathered shale, and clayey shale are anticipated to be encountered during excavations for mass grading and underground utility line installation. Based on the information gathered during our subsurface exploration, we anticipate that the overburden soils, soft clayey shale and weathered shale, and poorly cemented weathered sandstone can be excavated using a large trackhoe in good working condition, equipped with rock teeth.

Excavation difficulty should be anticipated in the moderately hard to hard shale and sandstone units encountered at depths of about 8 to 12 feet below existing grades across the site. Hard, cemented sandstone was encountered at shallower depths of about 2.3 and 4.3 feet in borings P-04 and P-06, respectively. Auger refusal occurred on apparent hard and well cemented sandstone at depths of about 13 and 12.5 feet in borings B-05 and B-06, respectively. Rock excavation techniques are to be anticipated for excavations extending into the moderately hard to hard shale and sandstone units.

The depth that weathered rock and rock can be excavated is a function of the material, the equipment used, the skill of the operator, the desired rate of removal and other factors. The contractor should review the site conditions and determine the excavation techniques needed.

4.7.2 GROUNDWATER

Groundwater was not encountered in the borings at the time of the subsurface exploration or after drilling was completed.

Although groundwater seepage was not recorded in the borings, relatively high moisture contents in some of the residuum encountered near the contact with the underlying rock units suggest a high probability for development of perched water in portions of the site during and following periods of wet weather.

Depending on weather conditions prior to and during construction, groundwater or perched water may be encountered in undercut areas for building pad construction, and in utility trenches.

It should be noted that fluctuations in the water level could occur due to seasonal variations in rainfall. The contractor must be prepared to remove groundwater seepage from excavations if encountered during construction. Excavations extending below groundwater levels will require dewatering systems (such as sump pumps or trench drains). The contractor should evaluate the most economical and practical dewatering method based on the conditions encountered during construction.

4.8 UTILITY TRENCH BACKFILL

All utility trenches must 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.

At the perimeter wall crossings, we recommend that clay soils or a flowable fill be used to backfill the utility trench. The clay or flowable fill will act as a relatively impermeable plug reducing the risk of water migration from the outside into the interior of the building. The plug should be at least 36 inches wide and should extend below the perimeter walls to provide for a proper seal.

4.9 LANDSCAPING AND DRAINAGE CONSIDERATION

The potential for soil moisture fluctuations within building areas and pavement subgrades should be reduced to lessen the potential of subgrade movement. Site grading should include positive drainage away from buildings and pavements. Excessive irrigation of landscaping poses a risk of saturating and softening soils below footings and pavements, which could result in settlement of footings and premature failure of pavements.

4.10 WET WEATHER CONSTRUCTION

Excessive movement of construction equipment across the site 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 site and establish/maintain an acceptable subgrade. The difficulty will increase in areas where clay or silty soils are exposed at the subgrade elevation, as is seen throughout this project site. 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 FOUNDATION RECOMMENDATIONS

Based on information provided to our office, maximum column and continuous footing loads for the Child Development Center are anticipated to be 15 to 65 kips and 0.5 to 1 kip per linear foot, respectively. Maximum continuous footing loads for the Safe Room are anticipated to be on the order of 4 to 12 kips per linear foot.

Based on the conditions encountered during our field investigation and after implementation of one of the recommended building pad preparation alternates (Subsection 4.3.1 or 4.3.2), the proposed structure can be supported on conventional shallow footings.

When using building pad preparation with allowance for footings to bear in a combination of weathered rock units and structural fill (Subsection 4.3.1), footings will bear in differing materials with an increased risk for differential settlement and a potential for development of cracks in floor slabs and walls.

When using building pad preparation for all footings to bear in structural fill (Subsection 4.3.2), uniform bearing material conditions will be provided across the entire building.

Footings bearing in weathered rock units and new structural fill can be dimensioned for a maximum net allowable bearing pressure of 2,500 pounds per square foot (psf).

Total long-term settlement of spread footings bearing in weathered rock units is estimated to be less than ½-inch. For footings bearing in structural fill, total settlement is estimated at less than 1-inch.

When implementing building pad preparation recommendations presented in Subsection 4.3.2, differential settlement between any two points spaced 40 feet across the slab, or along continuous footings is estimated to be ½-inch or less. For building pads prepared in accordance with Subsection 4.3.1, differential settlement of ½- to ¾-inch could occur over a distance less than 40 feet within the transition zone of footings bearing in weathered rock units to footings bearing in structural fill over residuum.

Column footings should be at least 24 inches wide and strip footings should be at least 18 inches wide. These dimensions facilitate hand cleaning of footing subgrades disturbed by the excavation process and the placement of reinforcing steel. They also reduce the potential for localized punching shear failure. ***All exterior footings should bear at least 24 inches below the adjacent exterior grade.***

The following items should be considered during the preparation of construction documents and foundation installation:

- The geotechnical engineer of record should observe the exposed foundation bearing surfaces prior to concrete placement to verify that the conditions anticipated during the subsurface exploration are encountered.
- All bearing surfaces must be free of soft or loose soil and debris prior to placing concrete.
- The bottom surface of all footings should be level.
- Concrete should be placed the same day the excavations are completed and bearing materials verified by the engineer. If the excavations are left open for an extended period, or if the bearing surfaces are disturbed after the initial observation, then the bearing surfaces should be re-evaluated prior to concrete placement.
- Water should not be allowed to pond in foundation excavations prior to concrete placement or above the concrete after the foundation is completed.

- Wherever possible, the foundation concrete should be placed "neat", using the sides of the excavations as forms. Where this is not possible, the excavations created by forming the foundations must be backfilled with suitable structural fill and properly compacted.
- Grades around the building pad should be sloped to drain away from the building foundations.
- Roof drains should be routed away from the foundation soils. All drains should be collected in pipes or discharged on pavements to prevent drainage into the subsurface.

5.1 SHEAR RESISTANCE

Passive earth pressures of materials adjacent to the footings as well as bearing material friction at the base may be used to resist shear.

The following table presents recommended friction coefficient and passive earth pressure values for new structural fill comprised of onsite available residuum and weathered rock. The structural engineer should use a factor of safety of at least 1.5 when sizing the foundations to resist shear loads using the below ultimate soil parameter values.

Material	Friction Coefficient	Equivalent Fluid Unit Weight for Passive Condition Lateral Earth Pressures (pcf)
New Structural Fill and Weathered Rock	0.40	300

Table 8: Soil Parameter Values Resisting Shear

6.0 FLOOR SLABS

Site development recommendations presented in this report should be followed to provide for subgrade conditions suitable for support of grade supported slabs.

When implementing building pad preparation recommendations presented in Subsection 4.3.1, floor slabs are to be supported on at least 12 inches of new structural fill. When implementing building pad preparation recommendations presented in Subsection 4.3.2, floor slabs are to be supported on new structural fill material that extends at least 4 feet below finished floor elevation.

Floor slabs should be supported on a minimum four-inch layer of ½-inch up to 1½-inch, free-draining, gap-graded gravel, such as AASHTO No. 57 stone, with no more than 5 percent passing the ASTM No. 200 sieve. The purpose of this layer is to help distribute concentrated loads and act as a capillary break for moisture migration through the subgrade soil. This gravel material should be consolidated in-place with vibratory equipment. The surface of these bases should be choked off with finer material. A clean fine-graded material with a least 10 to 30 percent of particles passing a No. 100 sieve but not contaminated with clay, silt or organic material is recommended.

We recommend a minimum 10-mil thick vapor retarder meeting ASTM E 1745, Class C requirements be placed directly below the slab-on-grade floors. A higher quality vapor retarder (Class A or B) may be used if desired to further inhibit the migration of moisture through the slab-on-grade and should be evaluated based on the floor covering and use. The vapor retarder should extend to the edge of the slab-on-grade floors and should be sealed at all seams and penetrations.

The slab should be appropriately reinforced (if required) to support the proposed loads. With the gravel material, such as AASHTO No. 57 stone, an effective modulus of subgrade reaction of 150 pci can be used in the design of a grade-supported building floor slab.

7.0 PAVEMENT CONSIDERATIONS

Specific traffic information was not provided. For pavement design purposes, we were given two levels of 18-kip Equivalent Single Axle Loads (ESAL) shown in the table below.

Type	Assumed Equivalent Single Axle Loads (ESAL)
Standard Duty	150,000
Heavy Duty	500,000

Table 9: Given ESAL Capacities

In addition, we have assumed the following design parameters:

Design Criteria	Value
Design life (Years)	20
Terminal Serviceability	2.0
Reliability	85%
Initial Serviceability	4.2 (Flexible) 4.5 (Rigid)
Standard Deviation	0.45 (Flexible) 0.35 (Rigid)

Table 10: Assumed Design Parameters

All subgrade, base and pavement construction operations should meet minimum requirements of the Oklahoma Department of Transportation (ODOT), Standard Specifications for Highway Construction, dated 2019. The applicable sections of the specifications are identified as follows:

Material	Specification Section
Portland Cement Concrete Pavement	414 & 701
Bituminous Asphalt Wearing Layer	411 & 708
Bituminous Asphalt Binder Layer	411 & 708
Mineral Aggregate Base Materials	303 & 703

Table 11: ODOT Specification Sections

7.1 FLEXIBLE PAVEMENT

The asphalt pavement sections described herein were designed using the "AASHTO Guide for Design of Pavement Structures, 1993". Alternative pavement sections were designed by establishing the structural numbers used for the AASHTO design system and substituting materials based upon structural equivalency as follows:

Material	Structural No.
Asphalt Concrete	0.44
Crushed Stone Base	0.14

Table 12: Structural Equivalent Coefficient

Based on the materials encountered at the boring locations and after our recommendations for site preparation are implemented, flexible pavements at the subject site may be designed based on an estimated California Bearing Ratio (CBR) of 4. The following flexible pavement sections are based on the design parameters presented above:

Minimum Recommended Thickness (in)		Material
Standard Duty	Heavy Duty	
1.5	2.0	HMAC Surface Course (Superpave "S4")
2.5	3.5	HMAC Binder Course (Superpave "S3")
6.0	6.0	Crushed Aggregate Base (ODOT Type "A")

Table 13: Asphalt Pavement Recommendations

7.2 RIGID PAVEMENT

The following rigid pavement sections are based on the design parameters presented above. We assume a modulus of subgrade reaction (k) of 125 pci. We have assumed concrete elastic modulus (E_c) of 3.1 X 10^6 psi, and a concrete modulus of rupture (S'_c) of 600 psi.

Minimum Recommended Thickness (in)		Material
Standard Duty	Heavy Duty	
5.0	6.0	Portland Cement Concrete, f'_c=3,500 psi
4.0	4.0	Crushed Aggregate Base (ODOT Type "A")

Table 14: Rigid Pavement Recommendations

For access drive approaches, trash compactor pads, loading areas, and other pavement areas that are frequently subject to high traffic loads with frequent braking and turning of wheels, consideration should be given to using a rigid pavement section comprised of seven (7) inches of Portland cement concrete over six (6) inches of crushed aggregate base course.

The concrete should be protected against moisture loss, rapid temperature fluctuations, and construction traffic for several days after placement. All pavements should be sloped for positive drainage. We suggest that a curing compound be applied after the concrete has been finished.

Although not referenced in the ODOT specifications, based on our experience with project sites in this region and anticipated traffic loads, we recommend Portland cement concrete should have a minimum 28-day compressive strength of 3,500 psi, maximum slump of 4 inches, and air content of 5 to 7 percent.

For rigid pavements, we recommend a jointing plan be developed to control cracking and help preclude surficial migration of water into the base course and subgrade. If a jointing plan includes a widely spaced pattern (spacing typically greater than 30 times the slab thickness), consideration should be given to include steel reinforcement in rigid pavements, per Section 3.4 of the American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures 1993, and Section 3.8 of the American Concrete Institute (ACI) Guide for the Design and Construction of Concrete Parking Lots. Additionally, we recommend the joints be sealed to further preclude surficial moisture migration into the underlying supporting soils.

All pavements should be sloped, approximately ¼ inch per foot, to provide rapid surface drainage. Water allowed to pond on or adjacent to the pavement could saturate the subgrade and cause premature deterioration of the pavements because of loss of strength and stability. Periodic maintenance of the pavement should be anticipated. This should include sealing of cracks and joints and maintaining proper surface drainage to avoid ponding of water on or near the pavement areas.

8.0 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 to receive pavement and/or concrete slab base materials. 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 building construction. The 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.

9.0 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 grading
- Field density tests during structural fill placement on a continuous basis
- Observation and verification of the bearing surfaces exposed after foundation excavation
- Reinforcing steel inspections
- Molding and testing of concrete cylinders

- Structural steel inspections
- Continuous monitoring and testing during pavement installation

10.0 CLOSING AND LIMITATIONS

This report was prepared for James R Childers Architects and Wallace Design Collective for specific application to the subject project located in Sallisaw, 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. In the event that 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.

Appendix Table of Contents

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.

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.

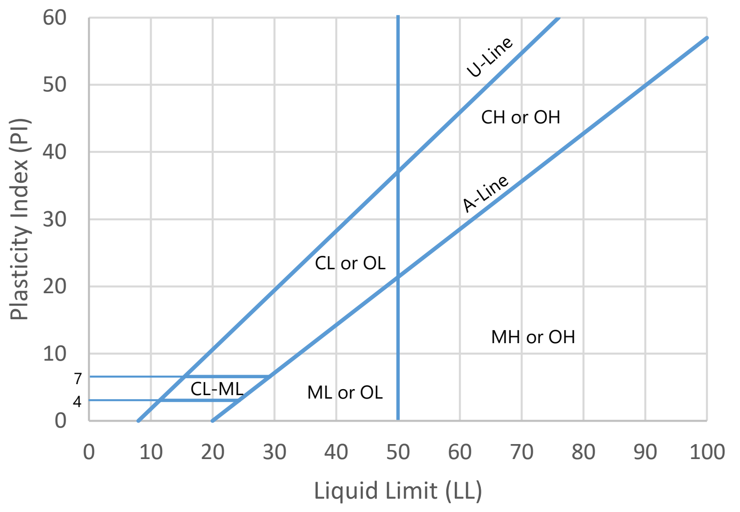


Figure 1: Plasticity Chart (based on ASTM D2487)

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.

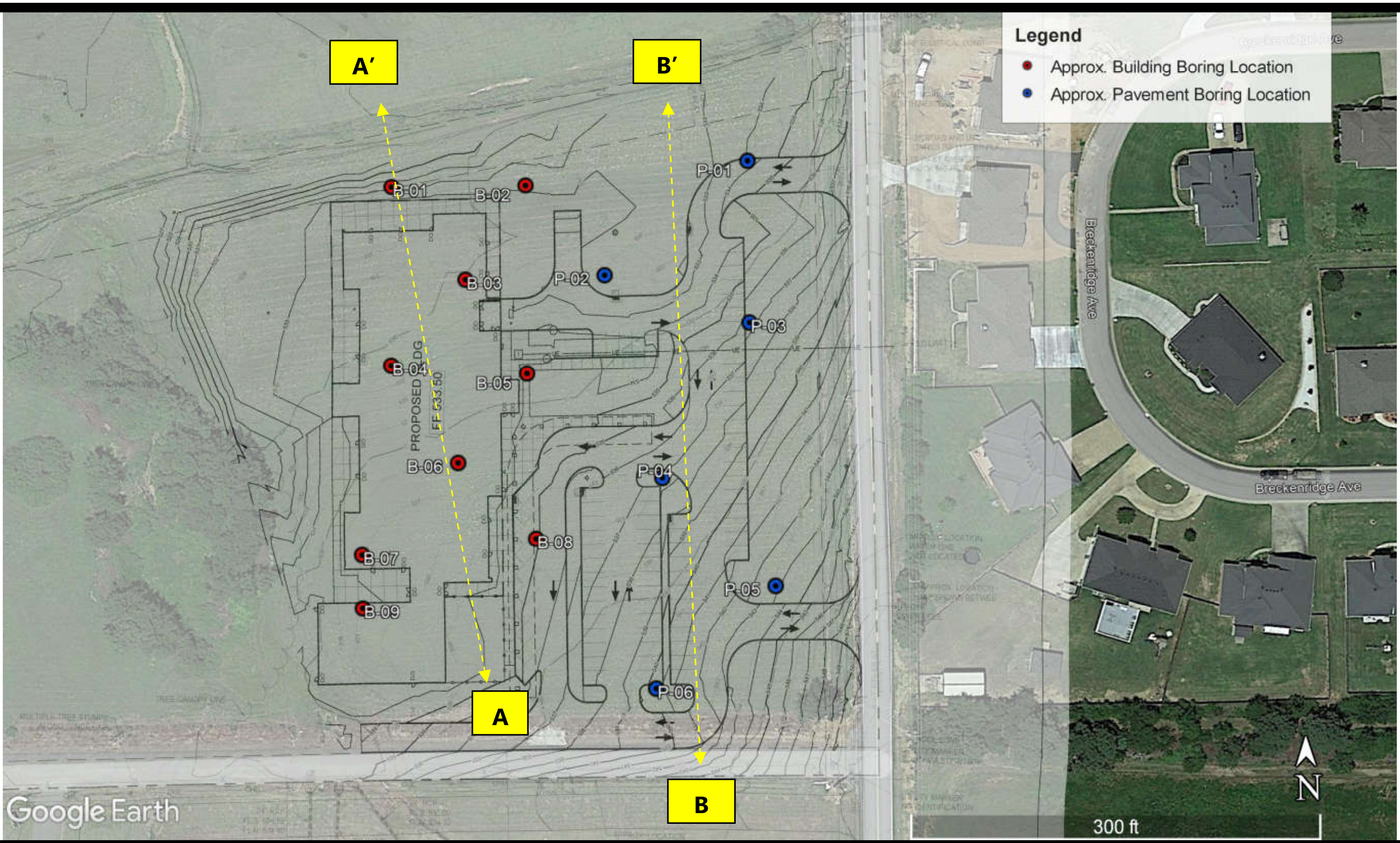
Table 9: Structure

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:

Google Earth Satellite Imagery Dated June 2019 with Grading Plan overlay, prepared by Wallace Design Collective, 9-02-2021

BORING LOCATION PLAN

DATE: 9/24/2021

PROJECT NO.

OK210172

PROJECT NAME / LOCATION:

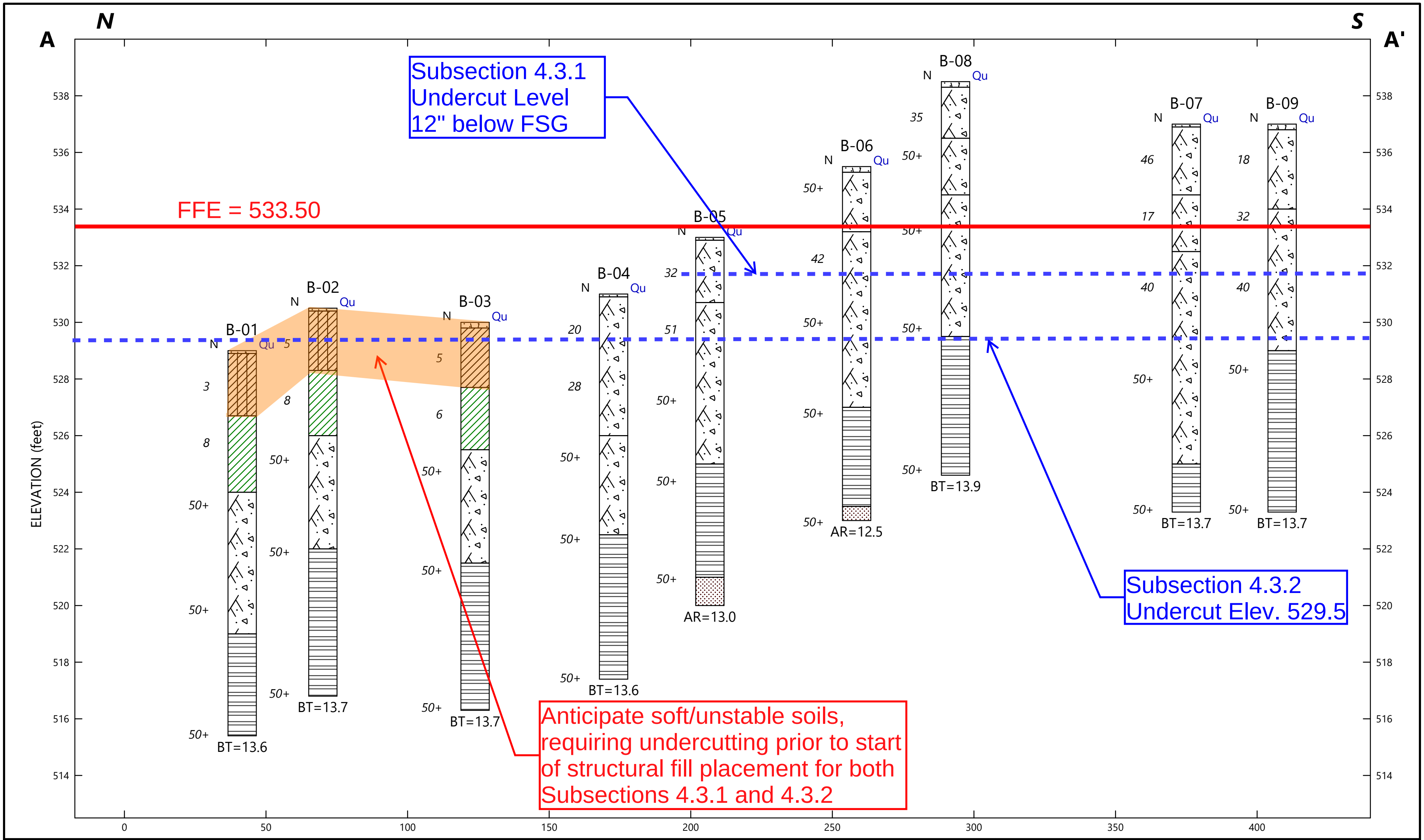
Cherokee Nation Child
Development Center and Safe Room
Facility
Sallisaw, OK

SCALE:

As Shown

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

SUBSURFACE PROFILES

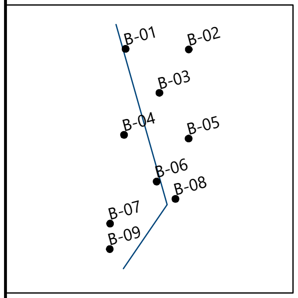


FFE = 533.50

Subsection 4.3.1
Undercut Level
12" below FSG

Subsection 4.3.2
Undercut Elev. 529.5

Anticipate soft/unstable soils,
requiring undercutting prior to start
of structural fill placement for both
Subsections 4.3.1 and 4.3.2



Site Map Scale 1 inch equals 305 feet

Key to Hatches

▨ Topsoil	▨ USCS Silty Clay
▨ USCS Low Plasticity Clay	▨ Weathered Rock
▤ Shale	▨ USCS Low Plasticity Silty Clay
▨ Sandstone	

Legend

BT=Boring Termination, TPT=Test Pit Terminated
AR=Auger Refusal, ER=Excavation Refusal
N=Standard Penetration Test N-Value
Qu=Unconfined compressive strength estimate
from pocket penetrometer test (tsf)
▽ Water Level Reading at time of drilling.
▼ Water Level Reading after drilling.

0 50

Horizontal Scale (feet)
Vertical Exaggeration: 10x

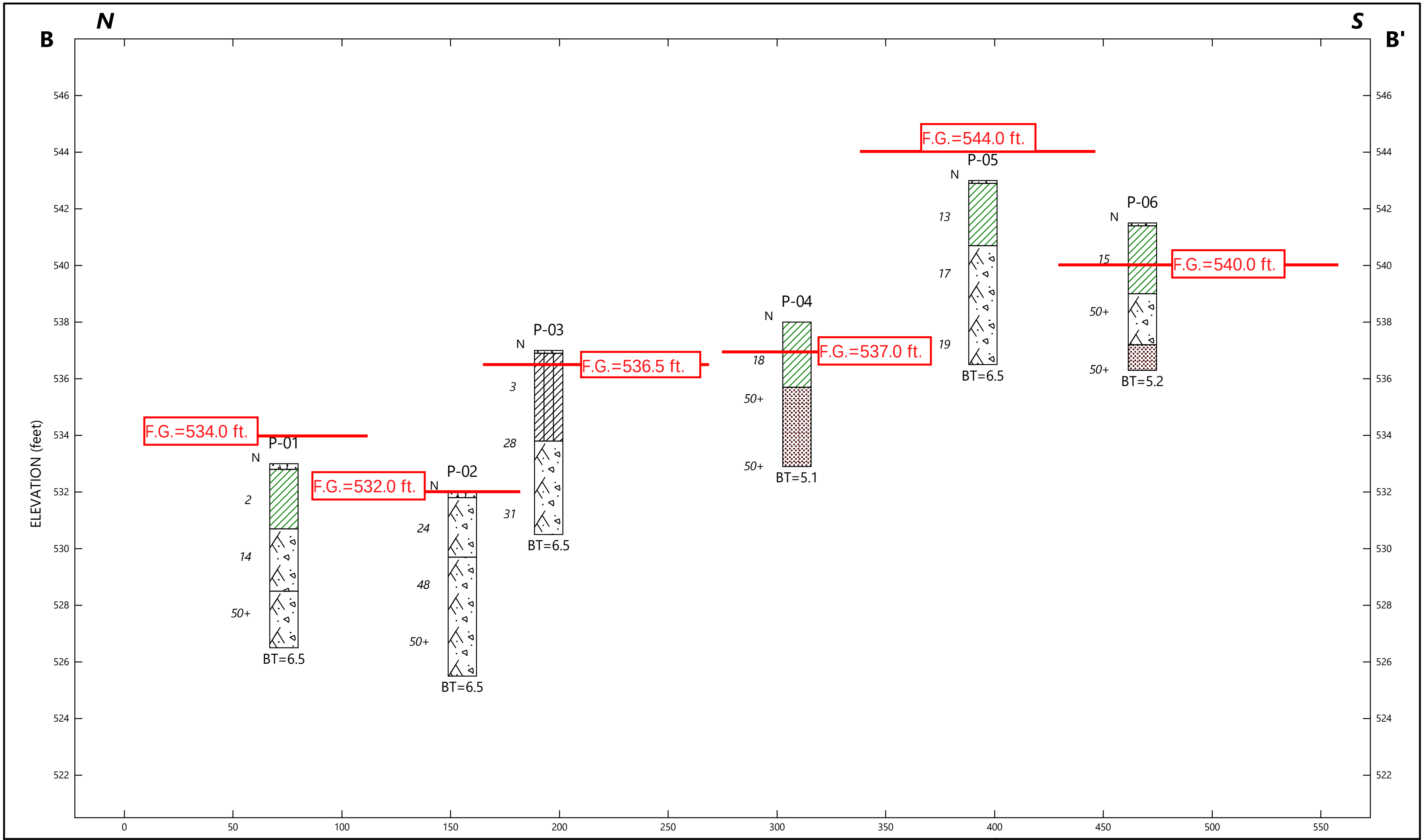
Building & Earth Sciences, Inc.
5545 Derby Drive, Birmingham, AL 35210

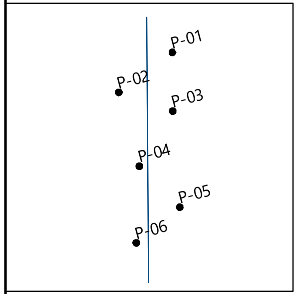
Sallisaw Child Development Center
Sallisaw, OK

Section Name A-A': Subsurface Profile
Building Borings

PROJECT NO: OK210172	PLATE NO: A-1	DATE: 9/22/21

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers





Site Map Scale 1 inch equals 400 feet

Key to Hatches

▨	Topsoil
▨	USCS Silty Clay
🟩	USCS Low Plasticity Clay
▨	Sandstone
▨	Weathered Rock

Legend

BT=Boring Termination, TPT=Test Pit Terminated
AR=Auger Refusal, ER=Excavation Refusal
N=Standard Penetration Test N-Value
Qu=Unconfined compressive strength estimate
from pocket penetrometer test (tsf)

▽ Water Level Reading at time of drilling.
▼ Water Level Reading after drilling.

0 65

Horizontal Scale (feet)
Vertical Exaggeration: 13x

Building & Earth Sciences, Inc.
5545 Derby Drive, Birmingham, AL 35210

Sallisaw Child Development Center
Sallisaw, OK

Section Name B-B': Subsurface Profile
Pavement Borings

PROJECT NO: OK210172	PLATE NO: B-1	DATE: 9/22/21

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BORING LOGS

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LOG OF BORING

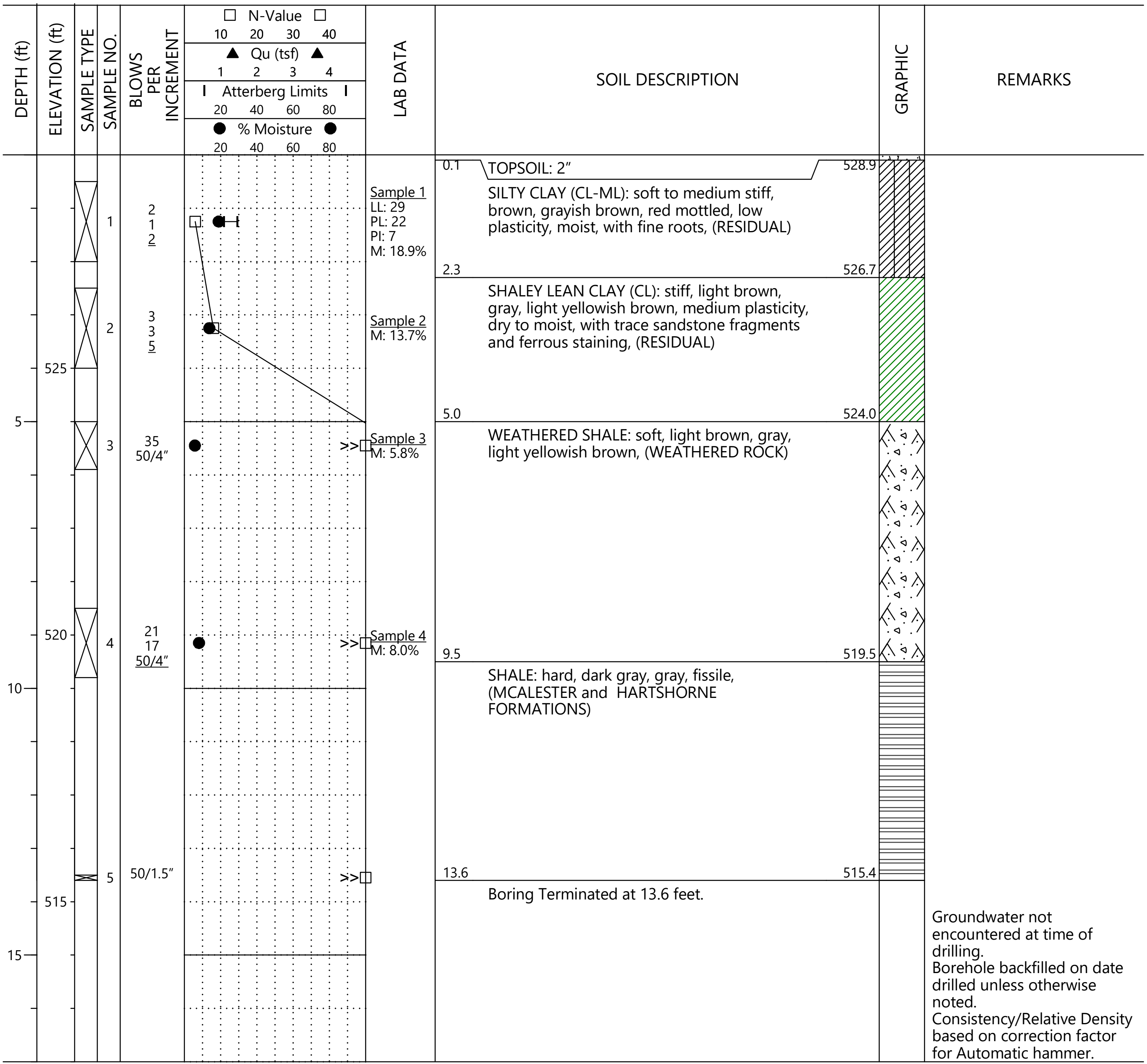
Designation: B-01

Sheet 1 of 1

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

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.453682° -94.815317°

LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 529
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



Sample No.	Blows per Increment	Lab Data
1	2 1 2	Sample 1 LL: 29 PL: 22 PI: 7 M: 18.9%
2	3 3 5	Sample 2 M: 13.7%
3	35 50/4"	Sample 3 M: 5.8%
4	21 17 50/4"	Sample 4 M: 8.0%
5	50/1.5"	

Depth (ft)	Soil Description	Elevation (ft)
0.1	TOPSOIL: 2"	528.9
2.3	SILTY CLAY (CL-ML): soft to medium stiff, brown, grayish brown, red mottled, low plasticity, moist, with fine roots, (RESIDUAL)	526.7
5.0	SHALEY LEAN CLAY (CL): stiff, light brown, gray, light yellowish brown, medium plasticity, dry to moist, with trace sandstone fragments and ferrous staining, (RESIDUAL)	524.0
9.5	WEATHERED SHALE: soft, light brown, gray, light yellowish brown, (WEATHERED ROCK)	519.5
13.6	SHALE: hard, dark gray, gray, fissile, (MCALESTER and HARTSHORNE FORMATIONS)	515.4
	Boring Terminated at 13.6 feet.	

REMARKS:
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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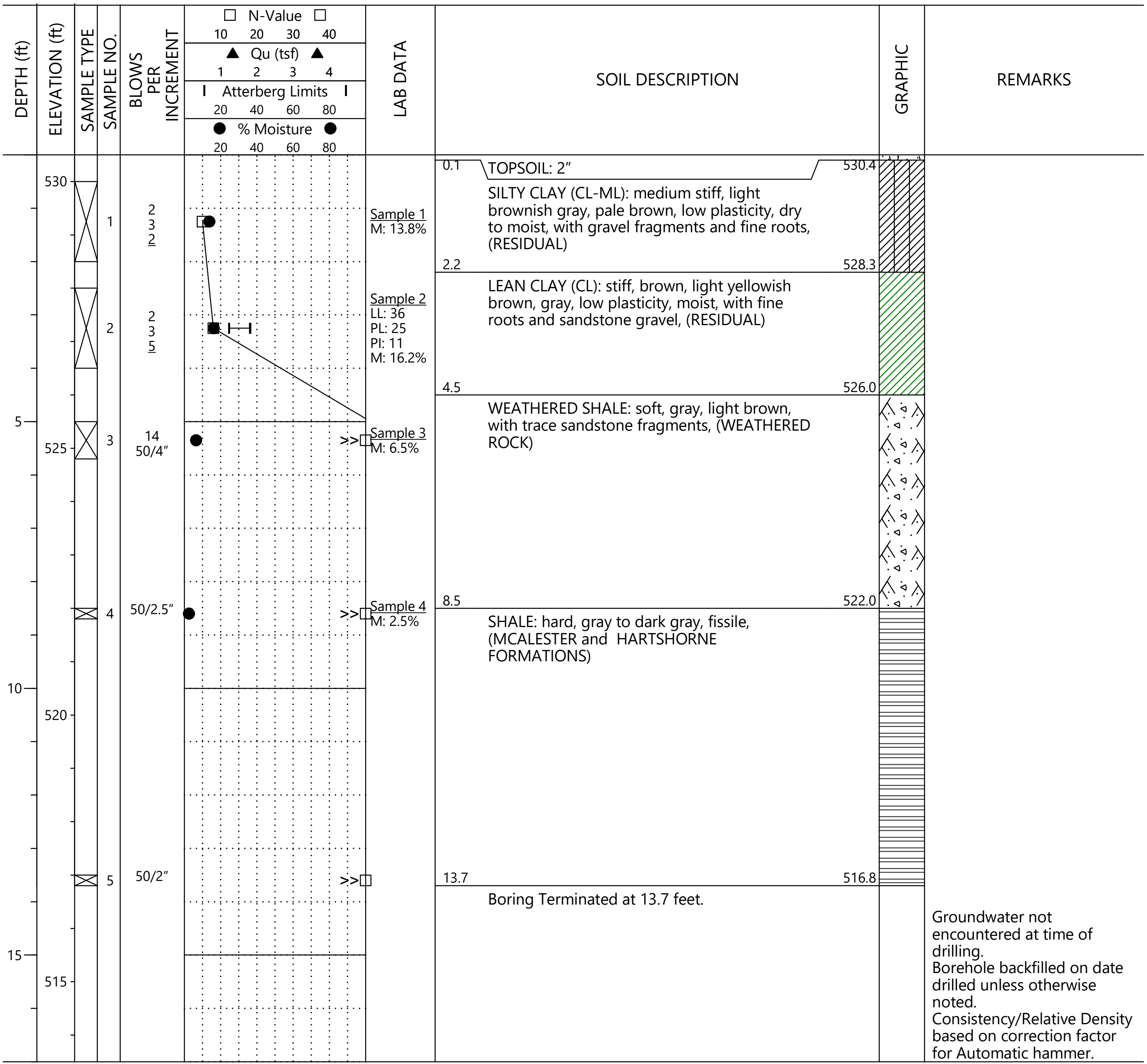
Office: (918) 439-9005

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

PROJECT NAME:	Cherokee Nation Child Development Center and Safe Room	LOCATION:	Sallisaw, OK
PROJECT NUMBER:	OK210172	DATE DRILLED:	9/9/21
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Sunny
EQUIPMENT USED:	CME 550X ATV	ELEVATION:	530.5
HAMMER TYPE:	Automatic	DRILL CREW:	Aimright
BORING LOCATION:	35.453680° -94.814973°	LOGGED BY:	T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
1	2 3 2	Sample 1 M: 13.8%
2	2 3 5	Sample 2 LL: 36 PL: 25 PI: 11 M: 16.2%
3	14 50/4”	Sample 3 M: 6.5%
4	50/2.5”	Sample 4 M: 2.5%
5	50/2”	

DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)
0.1	TOPSOIL: 2”	530.4
2.2	SILTY CLAY (CL-ML): medium stiff, light brownish gray, pale brown, low plasticity, dry to moist, with gravel fragments and fine roots, (RESIDUAL)	528.3
4.5	LEAN CLAY (CL): stiff, brown, light yellowish brown, gray, low plasticity, moist, with fine roots and sandstone gravel, (RESIDUAL)	526.0
8.5	WEATHERED SHALE: soft, gray, light brown, with trace sandstone fragments, (WEATHERED ROCK)	522.0
13.7	SHALE: hard, gray to dark gray, fissile, (MCALESTER and HARTSHORNE FORMATIONS)	516.8
	Boring Terminated at 13.7 feet.	

REMARKS:
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
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:**	PLASTIC LIMIT
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:**	PLASTICITY INDEX
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

BUILDING & EARTH
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LOG OF BORING

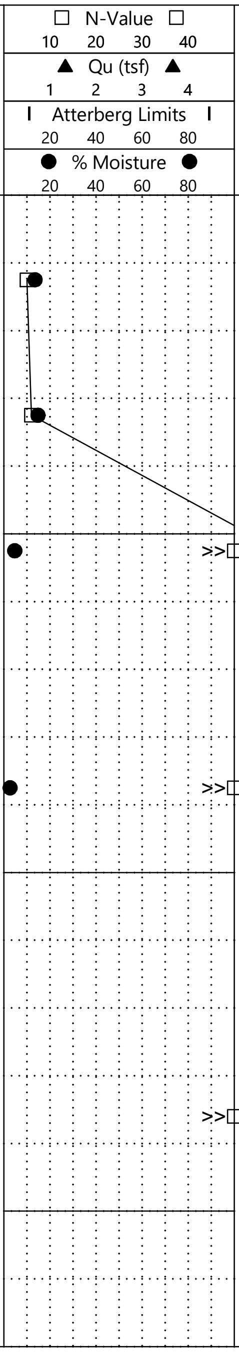
Designation: B-03

Sheet 1 of 1

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

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.453486° -94.815129°
LOCATION: Sallisaw, OK
DATE DILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 530
DRILL CREW: Aimright
LOGGED BY: T. Brizendine

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
0	530				
		☒	1	2 2 3	Sample 1 M: 13.5%
		☒	2	2 2 4	Sample 2 M: 14.8%
5	525	☒	3	50/6"	Sample 3 M: 4.7%
		☒	4	50/5.5"	Sample 4 M: 2.7%
10	520				
		☒	5	50/2"	
15	515				



DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)	GRAPHIC
0.2	TOPSOIL: 2.5"	529.8	
2.3	SILTY CLAY (CL-ML): medium stiff, light brownish gray, pale brown, low plasticity, dry to moist, with trace fine roots and sandstone fragments, (RESIDUAL)	527.7	▨
4.5	LEAN CLAY (CL): medium stiff to stiff, light brown, light yellowish brown, gray, medium plasticity, moist, with ferrous staining and fine roots, (RESIDUAL)	525.5	▨
8.5	WEATHERED SHALE: soft, light yellowish brown, light brown, gray, (WEATHERED ROCK)	521.5	
13.7	SHALE: hard, gray, fissile, (MCALESTER and HARTSHORNE FORMATIONS)	516.3	☰
	Boring Terminated at 13.7 feet.		

REMARKS

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

Geotechnical, Environmental, and Materials Engineers

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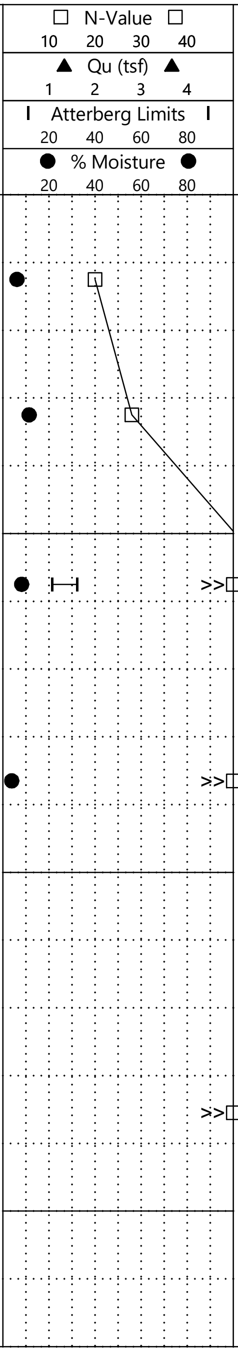
LOG OF BORING

Designation: B-04

Sheet 1 of 1

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.453308° -94.815321°

LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 531
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.1	530.9					TOPSOIL: 2"	
		☒	1	8 10 10	Sample 1 M: 6.1%	CLAYEY SHALE: soft, brown, light brown, yellow, with sandstone gravel, (WEATHERED ROCK)	
		☒	2	12 16 12	Sample 2 M: 11.4%		
5.0	526.0	☒	3	44 34 50/5.5"	Sample 3 LL: 32 PL: 21 PI: 11 M: 8.2%	WEATHERED SHALE: soft, gray, light brownish gray, light brown, with ferrous staining, (WEATHERED ROCK)	
8.5	522.5	☒	4	50/3"	Sample 4 M: 3.8%	SHALE: moderately hard to hard, gray, dark gray, (MCALESTER and HARTSHORNE FORMATIONS)	
13.6	517.4	☒	5	50/0.5"		hard Boring Terminated at 13.6 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

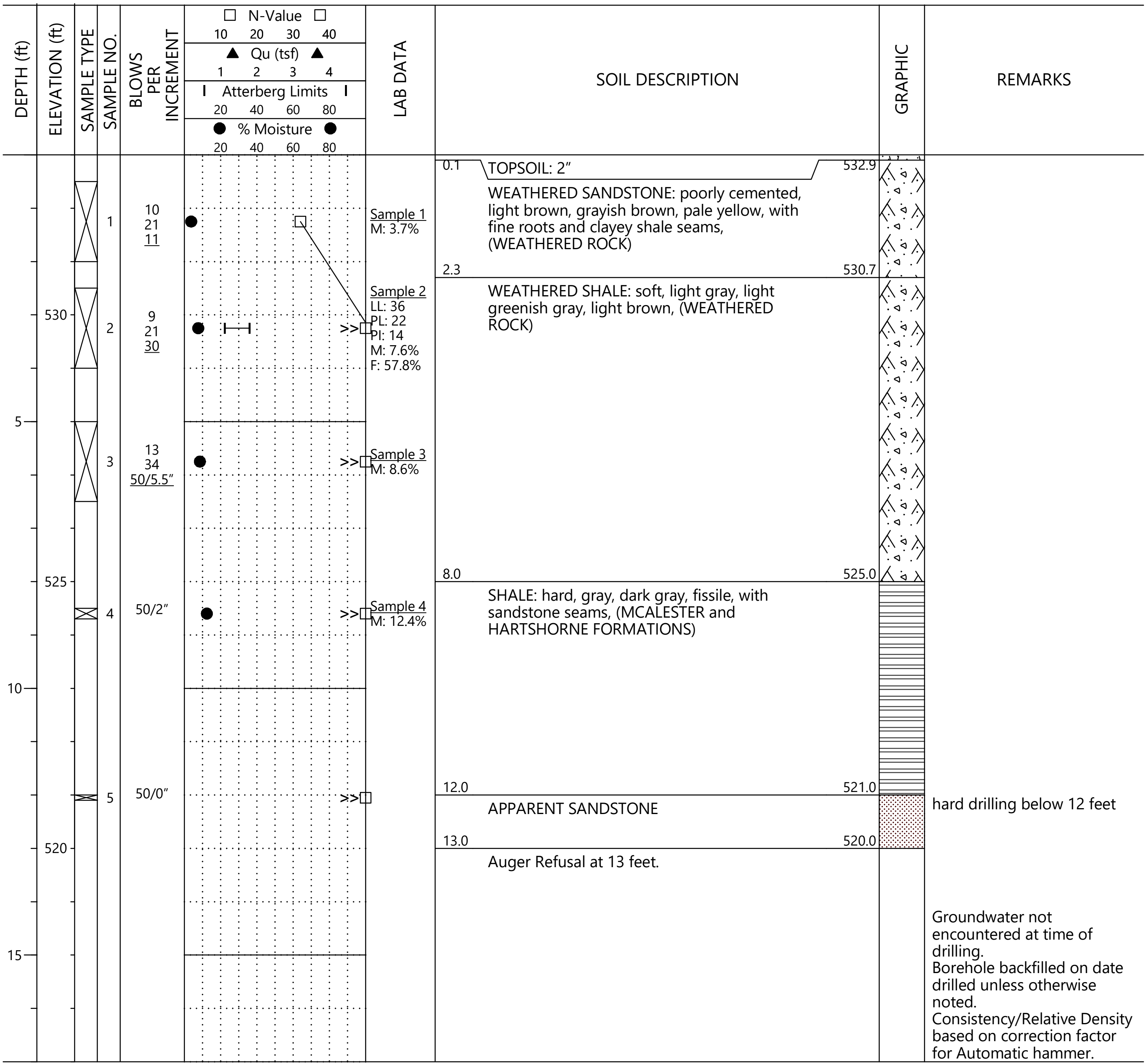
N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:**	LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:**	PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME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

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING
Designation: B-05
Sheet 1 of 1

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

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.453288° -94.814974°
LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 533
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
1	10 21 11	Sample 1 M: 3.7%
2	9 21 30	Sample 2 LL: 36 PL: 22 PI: 14 M: 7.6% F: 57.8%
3	13 34 50/5.5"	Sample 3 M: 8.6%
4	50/2"	Sample 4 M: 12.4%
5	50/0"	

Depth	SOIL DESCRIPTION	Elevation	REMARKS
0.1	TOPSOIL: 2"	532.9	
	WEATHERED SANDSTONE: poorly cemented, light brown, grayish brown, pale yellow, with fine roots and clayey shale seams, (WEATHERED ROCK)		
2.3	WEATHERED SHALE: soft, light gray, light greenish gray, light brown, (WEATHERED ROCK)	530.7	
8.0	SHALE: hard, gray, dark gray, fissile, with sandstone seams, (MCALESTER and HARTSHORNE FORMATIONS)	525.0	
12.0	APPARENT SANDSTONE	521.0	hard drilling below 12 feet
13.0	Auger Refusal at 13 feet.	520.0	

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

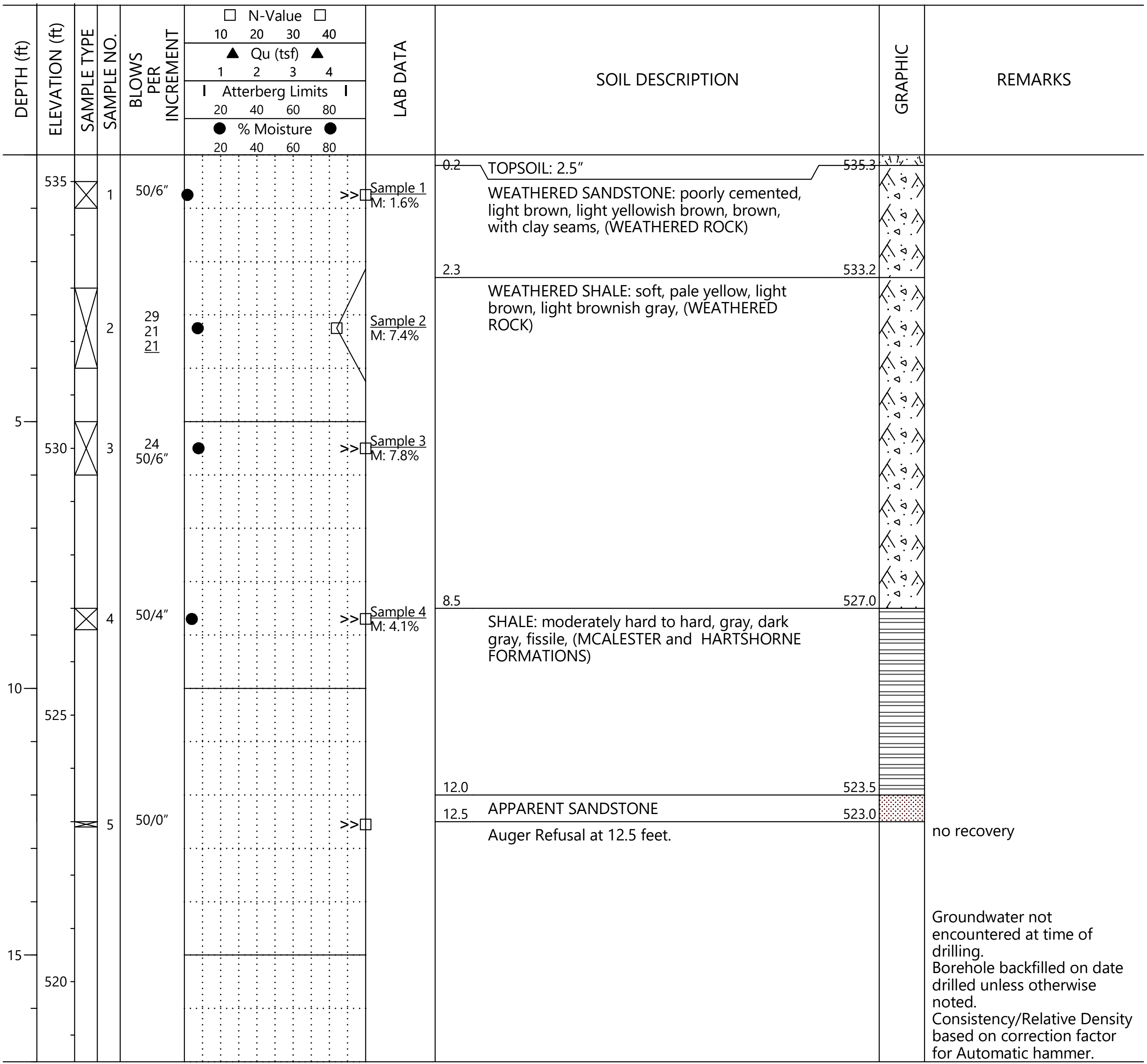
N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME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

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

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

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

PROJECT NAME:	Cherokee Nation Child Development Center and Safe Room	LOCATION:	Sallisaw, OK
PROJECT NUMBER:	OK210172	DATE DRILLED:	9/9/21
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Sunny
EQUIPMENT USED:	CME 550X ATV	ELEVATION:	535.5
HAMMER TYPE:	Automatic	DRILL CREW:	Aimright
BORING LOCATION:	35.453104° -94.815151°	LOGGED BY:	T. Brizendine



DEPTH (ft)	ELEVATION (ft)	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.2	535.3				TOPSOIL: 2.5"	
		1	50/6"	>> Sample 1 M: 1.6%	WEATHERED SANDSTONE: poorly cemented, light brown, light yellowish brown, brown, with clay seams, (WEATHERED ROCK)	
2.3	533.2	2	29 21 21	Sample 2 M: 7.4%	WEATHERED SHALE: soft, pale yellow, light brown, light brownish gray, (WEATHERED ROCK)	
		3	24 50/6"	>> Sample 3 M: 7.8%		
8.5	527.0	4	50/4"	>> Sample 4 M: 4.1%	SHALE: moderately hard to hard, gray, dark gray, fissile, (MCALESTER and HARTSHORNE FORMATIONS)	
12.0	523.5				APPARENT SANDSTONE	
12.5	523.0	5	50/0"	>>	Auger Refusal at 12.5 feet.	no recovery

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		

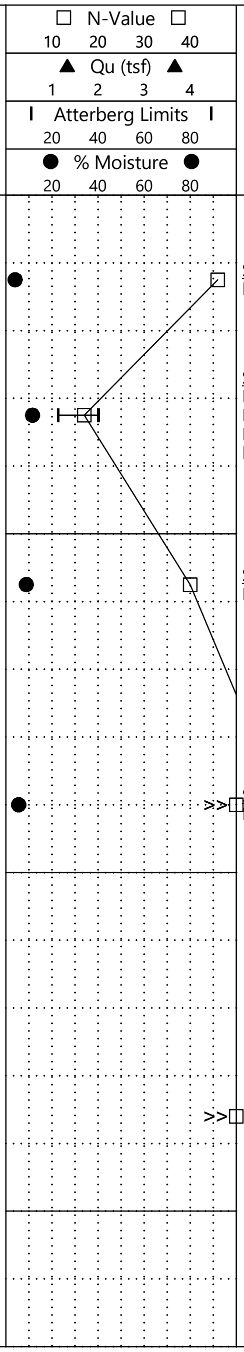
BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

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

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

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.452916° -94.815397°
LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 537
DRILL CREW: Aimright
LOGGED BY: T. Brizendine

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
		☒	1	18 22 24	Sample 1 M: 4.0%
		☒	2	8 9 8	Sample 2 LL: 40 PL: 23 PI: 17 M: 11.6%
		☒	3	8 14 26	Sample 3 M: 8.8%
		☒	4	36 50/5.5"	Sample 4 M: 5.5%
		☒	5	50/2"	



DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)
0.1	TOPSOIL: 2"	536.9
2.5	WEATHERED SANDSTONE: poorly cemented, brown, brownish yellow, gray, dry, with clay seams, (WEATHERED ROCK)	534.5
4.5	CLAYEY SHALE: soft, light gray, light brown, light yellowish brown, (WEATHERED ROCK)	532.5
12.0	WEATHERED SHALE: soft, brown, light brown, with ferrous staining, (WEATHERED ROCK) gray	525.0
13.7	SHALE: hard, gray, dark gray, fissile, (MCALESTER and HARTSHORNE FORMATIONS)	523.3
	Boring Terminated at 13.7 feet.	

Depth scale: 5, 10, 15. Elevation scale: 535, 530, 525, 520.

REMARKS: 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		

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

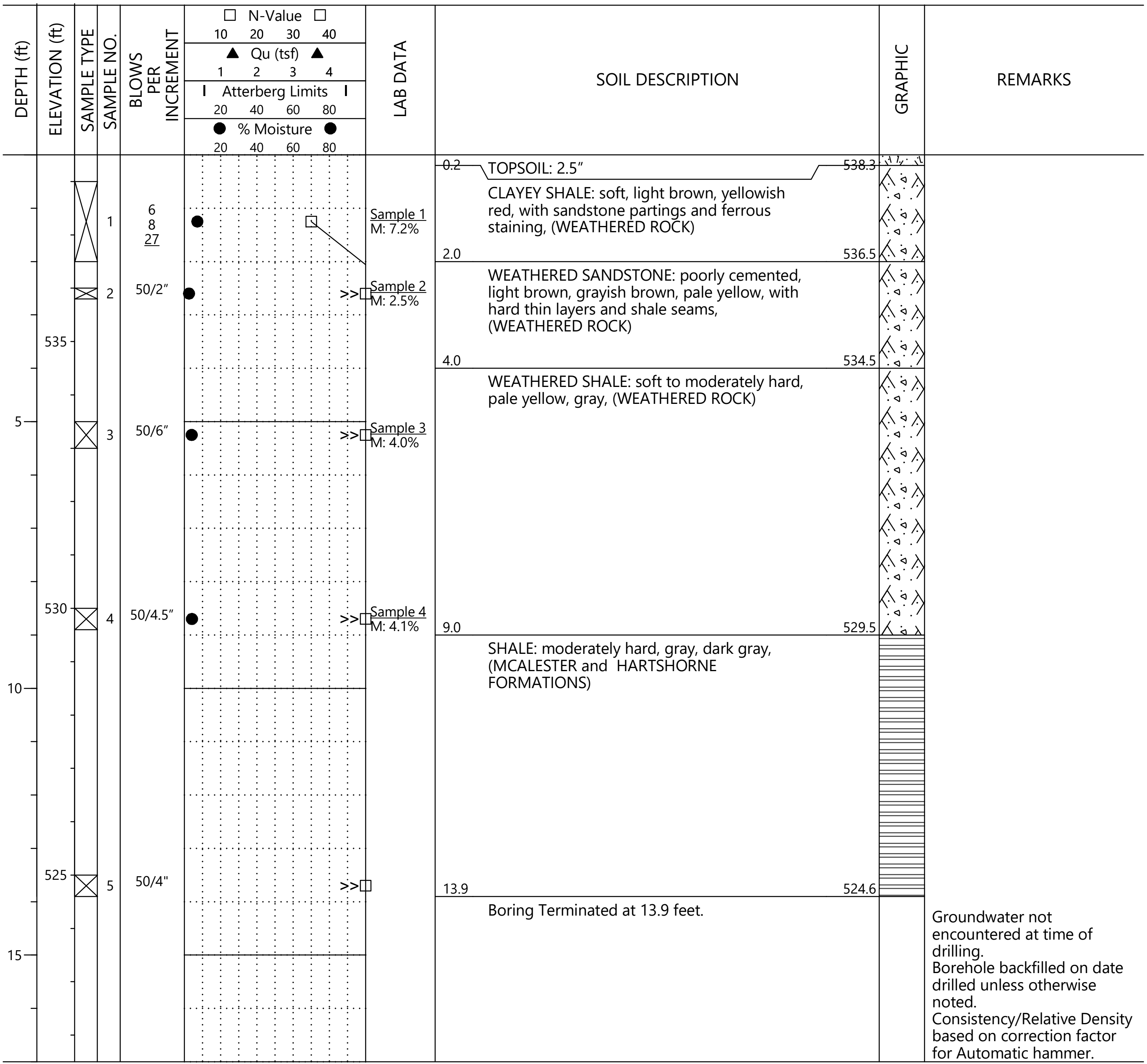
LOG OF BORING

Designation: B-08

Sheet 1 of 1

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

PROJECT NAME:	Cherokee Nation Child Development Center and Safe Room	LOCATION:	Sallisaw, OK
PROJECT NUMBER:	OK210172	DATE DRILLED:	9/9/21
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Sunny
EQUIPMENT USED:	CME 550X ATV	ELEVATION:	538.5
HAMMER TYPE:	Automatic	DRILL CREW:	Aimright
BORING LOCATION:	35.452945° -94.814955°	LOGGED BY:	T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
1	6 8 27	Sample 1 M: 7.2%
2	50/2”	Sample 2 M: 2.5%
3	50/6”	Sample 3 M: 4.0%
4	50/4.5”	Sample 4 M: 4.1%
5	50/4"	

	SOIL DESCRIPTION	
0.2	TOPSOIL: 2.5”	538.3
2.0	CLAYEY SHALE: soft, light brown, yellowish red, with sandstone partings and ferrous staining, (WEATHERED ROCK)	536.5
4.0	WEATHERED SANDSTONE: poorly cemented, light brown, grayish brown, pale yellow, with hard thin layers and shale seams, (WEATHERED ROCK)	534.5
9.0	WEATHERED SHALE: soft to moderately hard, pale yellow, gray, (WEATHERED ROCK)	529.5
13.9	SHALE: moderately hard, gray, dark gray, (MCALESTER and HARTSHORNE FORMATIONS)	524.6
	Boring Terminated at 13.9 feet.	

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

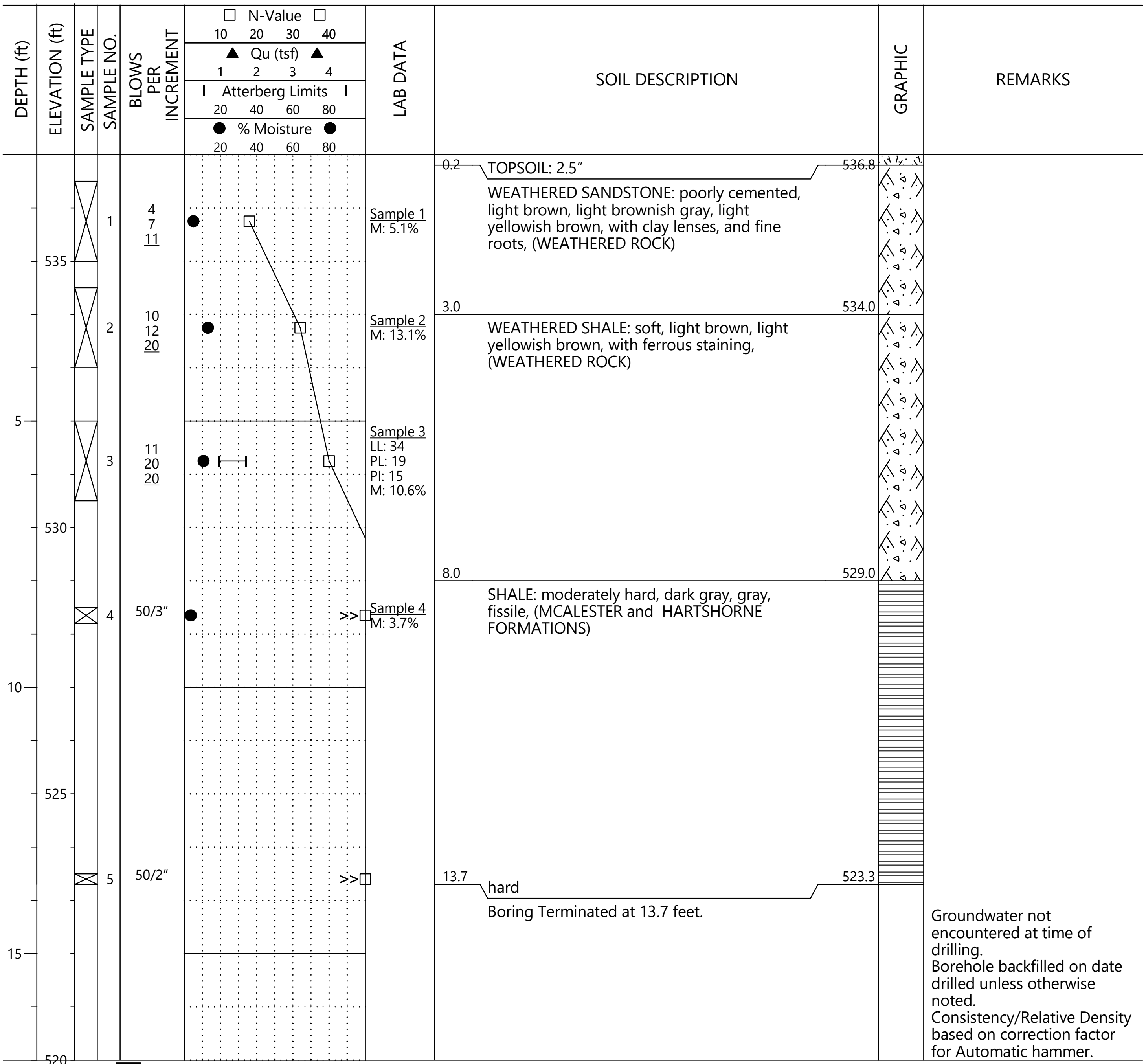
LOG OF BORING

Designation: B-09

Sheet 1 of 1

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.452806° -94.815397°

LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 537
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
1	4 7 11	Sample 1 M: 5.1%
2	10 12 20	Sample 2 M: 13.1%
3	11 20 20	Sample 3 LL: 34 PL: 19 PI: 15 M: 10.6%
4	50/3"	Sample 4 M: 3.7%
5	50/2"	

0.2 TOPSOIL: 2.5" 536.8

WEATHERED SANDSTONE: poorly cemented, light brown, light brownish gray, light yellowish brown, with clay lenses, and fine roots, (WEATHERED ROCK)

3.0 534.0

WEATHERED SHALE: soft, light brown, light yellowish brown, with ferrous staining, (WEATHERED ROCK)

8.0 529.0

SHALE: moderately hard, dark gray, gray, fissile, (MCALESTER and HARTSHORNE FORMATIONS)

13.7 hard 523.3

Boring Terminated at 13.7 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

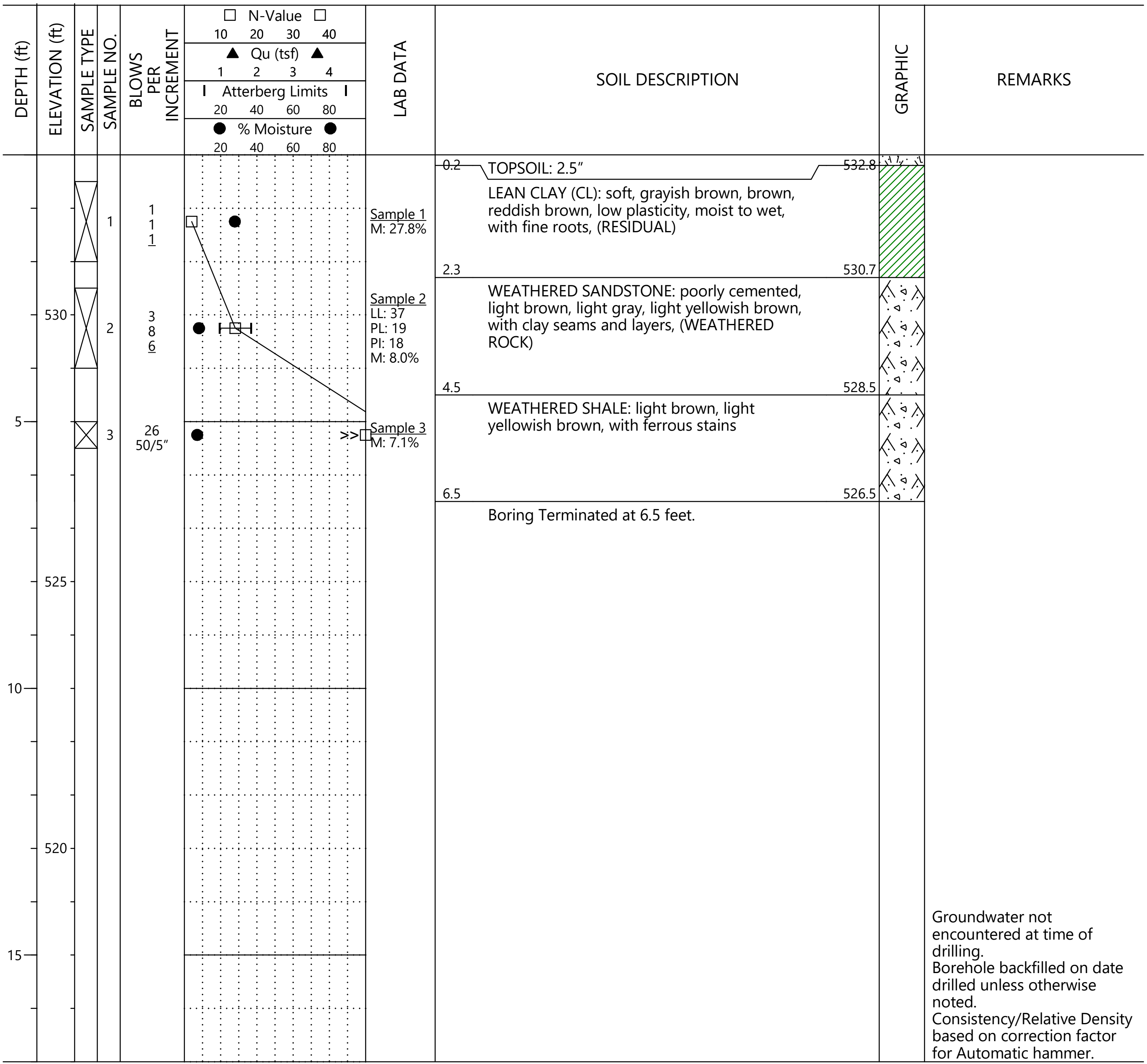
N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
∇	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME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

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

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

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

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.453723° -94.814406°
LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 533
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
1	1 1 1	Sample 1 M: 27.8%
2	3 8 6	Sample 2 LL: 37 PL: 19 PI: 18 M: 8.0%
3	26 50/5”	Sample 3 M: 7.1%

Depth	SOIL DESCRIPTION	Elevation
0.2	TOPSOIL: 2.5”	532.8
2.3	LEAN CLAY (CL): soft, grayish brown, brown, reddish brown, low plasticity, moist to wet, with fine roots, (RESIDUAL)	530.7
4.5	WEATHERED SANDSTONE: poorly cemented, light brown, light gray, light yellowish brown, with clay seams and layers, (WEATHERED ROCK)	528.5
6.5	WEATHERED SHALE: light brown, light yellowish brown, with ferrous stains	526.5
	Boring Terminated at 6.5 feet.	

REMARKS: 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: P-02

Sheet 1 of 1

1403 South 70th East Avenue
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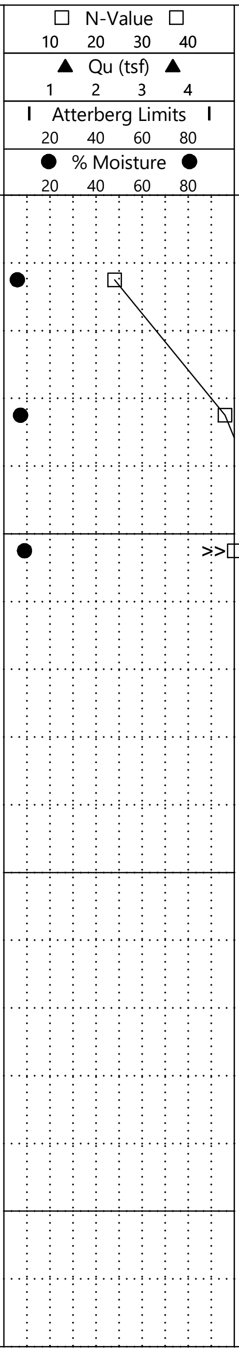
Office: (918) 439-9005

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.453490° -94.814774°

LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 532
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.2	531.8					TOPSOIL: 2"		
		☒	1	5 11 13	Sample 1 M: 5.8%	CLAYEY SHALE: soft, light brown, light yellowish brown, light gray, with sandstone lenses, (WEATHERED ROCK)		
2.3	529.7							
		☒	2	10 14 34	Sample 2 M: 7.2%	WEATHERED SHALE: soft, light brown, light yellowish brown, pale brown, (WEATHERED ROCK)		
5		☒	3	21 50/6"	Sample 3 M: 8.9%	gray		
6.5	525.5					Boring Terminated at 6.5 feet.		
10	520							
15	515							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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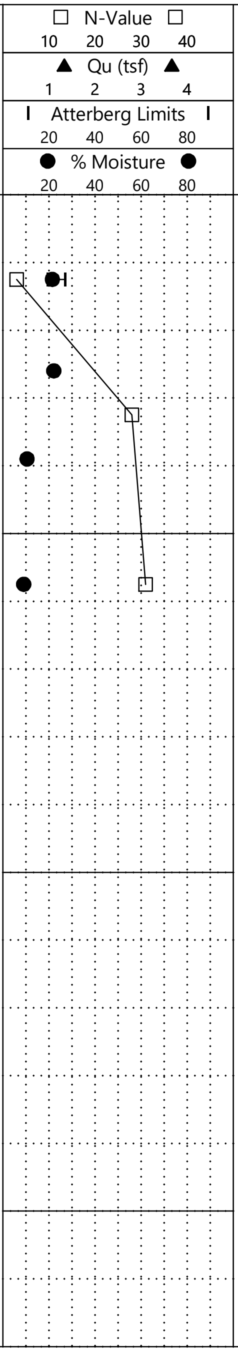
LOG OF BORING

Designation: P-03

Sheet 1 of 1

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

PROJECT NAME:	Cherokee Nation Child Development Center and Safe Room	LOCATION:	Sallisaw, OK
PROJECT NUMBER:	OK210172	DATE DRILLED:	9/9/21
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Sunny
EQUIPMENT USED:	CME 550X ATV	ELEVATION:	537
HAMMER TYPE:	Automatic	DRILL CREW:	Aimright
BORING LOCATION:	35.453386° -94.814407°	LOGGED BY:	T. Brizendine



SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
Split Spoon	1	2 1 2	Sample 1 LL: 27 PL: 20 PI: 7 M: 21.5%
Split Spoon	2	2 14 14	
Split Spoon	3	8 11 20	Sample 3 M: 9.0%

DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)	REMARKS
0.1	TOPSOIL: 2″	536.9	
	SILTY CLAY (CL-ML): soft to medium stiff, light brown, brown, light reddish brown, low plasticity, moist, with fine roots, (RESIDUAL)		
3.2	WEATHERED SANDSTONE: poorly cemented, brownish yellow, light brown, light yellowish brown, with shale partings, (WEATHERED ROCK)	533.8	wet zone at 5 feet
6.5	Boring Terminated at 6.5 feet.	530.5	

DEPTH (ft): 5, 10, 15
ELEVATION (ft): 535, 530, 525, 520

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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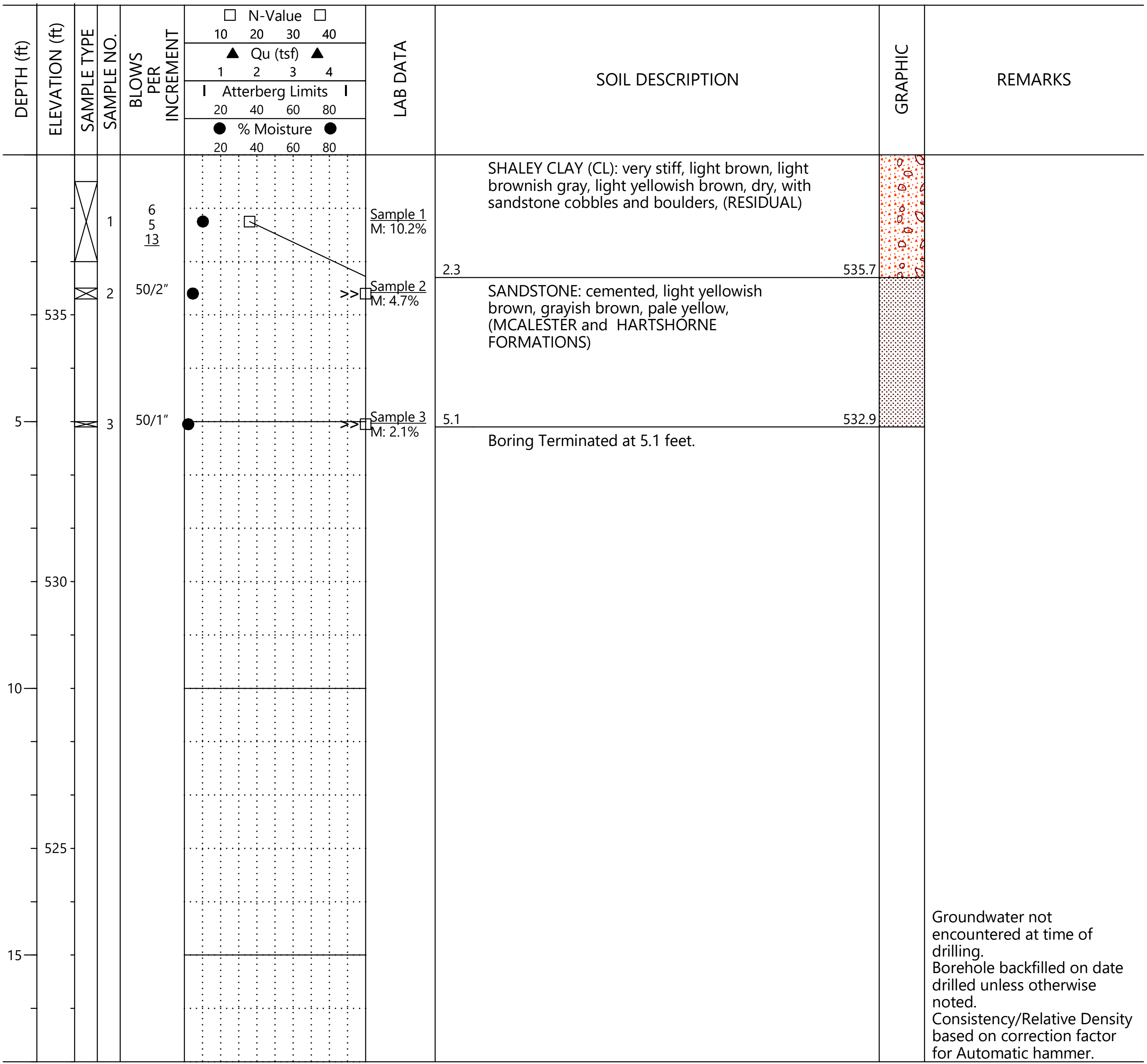
LOG OF BORING

Designation: P-04

Sheet 1 of 1

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

PROJECT NAME:	Cherokee Nation Child Development Center and Safe Room	LOCATION:	Sallisaw, OK
PROJECT NUMBER:	OK210172	DATE DRILLED:	9/9/21
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Sunny
EQUIPMENT USED:	CME 550X ATV	ELEVATION:	538
HAMMER TYPE:	Automatic	DRILL CREW:	Aimright
BORING LOCATION:	35.453068° -94.814633°	LOGGED BY:	T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
1	6 5 13	Sample 1 M: 10.2%
2	50/2"	Sample 2 M: 4.7%
3	50/1"	Sample 3 M: 2.1%

SHALEY CLAY (CL): very stiff, light brown, light brownish gray, light yellowish brown, dry, with sandstone cobbles and boulders, (RESIDUAL)

SANDSTONE: cemented, light yellowish brown, grayish brown, pale yellow, (MCALESTER and HARTSHORNE FORMATIONS)

Boring Terminated at 5.1 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)	**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: P-05
Sheet 1 of 1

1403 South 70th East Avenue
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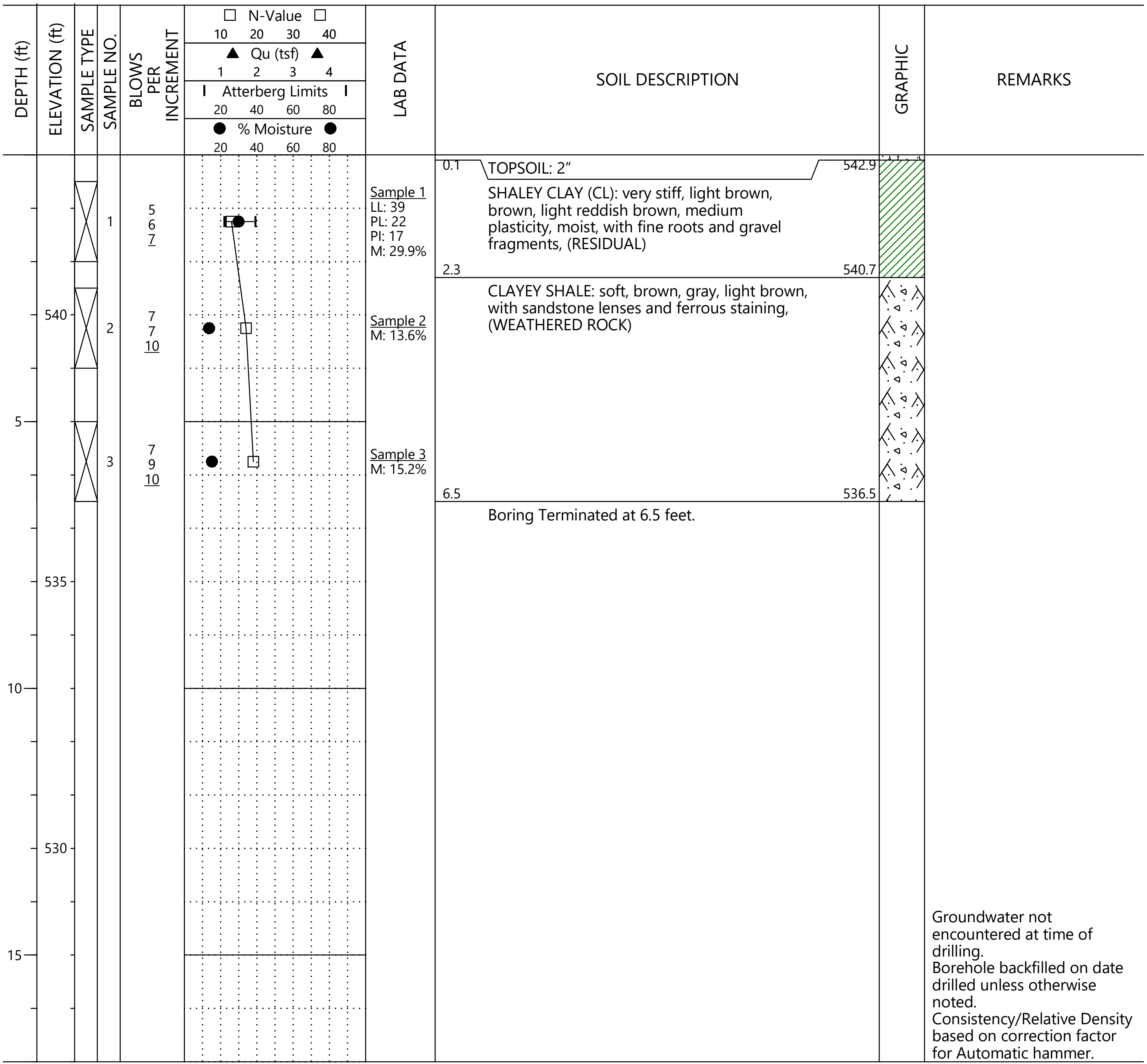
Office: (918) 439-9005

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.452844° -94.814352°
LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 543
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION
			0.1 TOPSOIL: 2" 542.9
1	5 6 7	Sample 1 LL: 39 PL: 22 PI: 17 M: 29.9%	SHALEY CLAY (CL): very stiff, light brown, brown, light reddish brown, medium plasticity, moist, with fine roots and gravel fragments, (RESIDUAL)
			2.3 540.7
2	7 7 10	Sample 2 M: 13.6%	CLAYEY SHALE: soft, brown, gray, light brown, with sandstone lenses and ferrous staining, (WEATHERED ROCK)
3	7 9 10	Sample 3 M: 15.2%	
			6.5 536.5
			Boring Terminated at 6.5 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

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LOG OF BORING

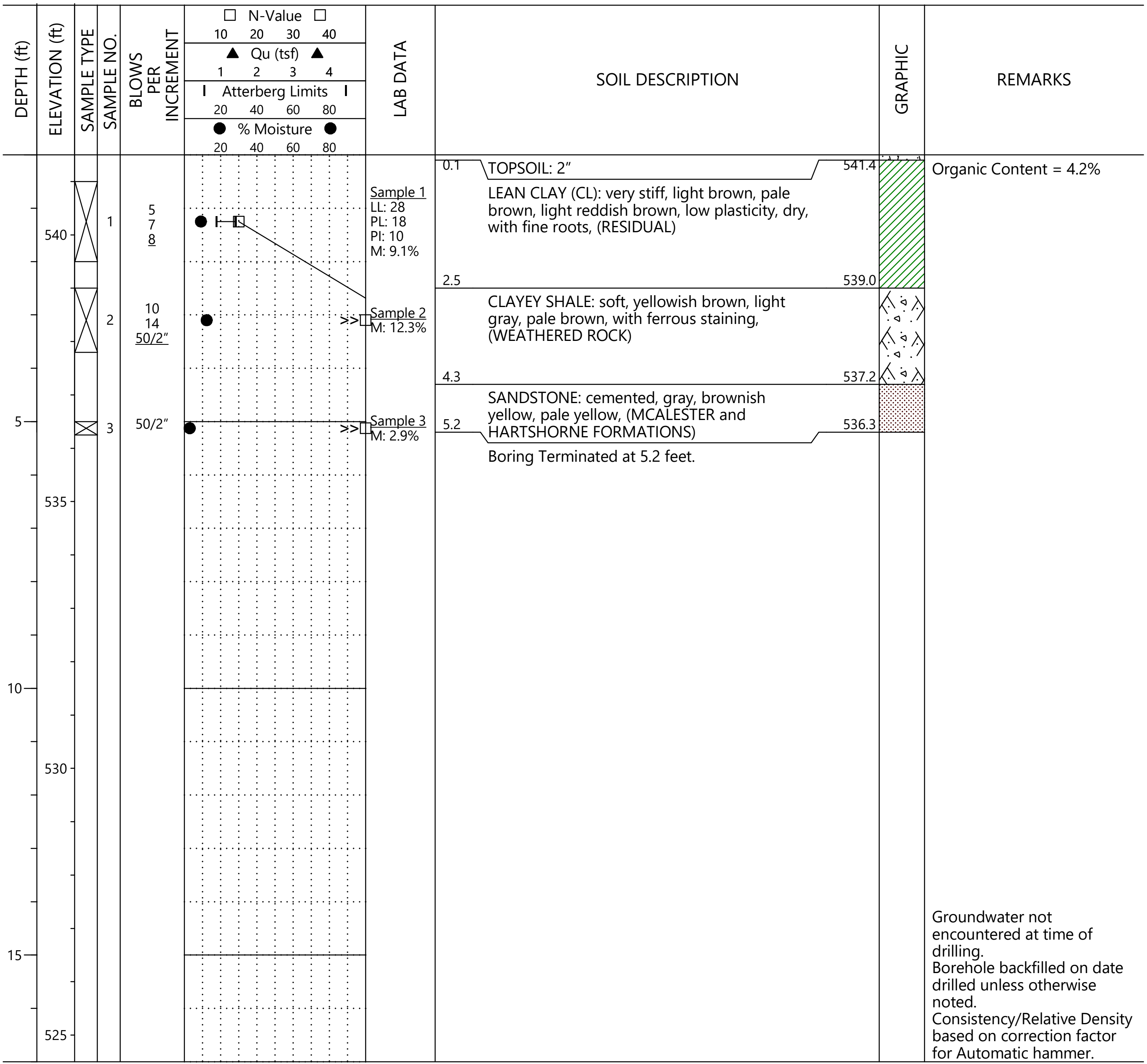
Designation: P-06

Sheet 1 of 1

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

PROJECT NAME: Cherokee Nation Child Development Center and Safe Room
PROJECT NUMBER: OK210172
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: CME 550X ATV
HAMMER TYPE: Automatic
BORING LOCATION: 35.452635° -94.814656°

LOCATION: Sallisaw, OK
DATE DRILLED: 9/9/21
WEATHER: Sunny
ELEVATION: 541.5
DRILL CREW: Aimright
LOGGED BY: T. Brizendine



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
1	5 7 8	Sample 1 LL: 28 PL: 18 PI: 10 M: 9.1%
2	10 14 50/2"	Sample 2 M: 12.3%
3	50/2"	Sample 3 M: 2.9%

Depth	Soil Description	Elevation
0.1	TOPSOIL: 2"	541.4
2.5	LEAN CLAY (CL): very stiff, light brown, pale brown, light reddish brown, low plasticity, dry, with fine roots, (RESIDUAL)	539.0
4.3	CLAYEY SHALE: soft, yellowish brown, light gray, pale brown, with ferrous staining, (WEATHERED ROCK)	537.2
5.2	SANDSTONE: cemented, gray, brownish yellow, pale yellow, (MCALESTER and HARTSHORNE FORMATIONS)	536.3

Boring Terminated at 5.2 feet.

REMARKS:

Organic Content = 4.2%

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		