GEOTECHNICAL ENGINEERING REPORT
W.W. HASTINGS SURFACE PARKING
TAHLEQUAH, OKLAHOMA

Prepared for:

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PPI PROJECT NUMBER: 281188

July 12, 2022

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July 12, 2022
(Revised)

Childers Architect
142 Howell Street, Suite 170
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Attn: Mr. Matthew Thomas, Associate AIA
Email: mthomas@childersarchitect.com

RE: Geotechnical Engineering Report
W.W. Hastings Replacement Surface Parking
Tahlequah, Oklahoma
PPI Project Number: 281188

Dear Mr. Thomas:

Attached, please find the report summarizing the results of the Geotechnical Investigation conducted for the above referenced project. We appreciate this opportunity to be of service and if you have any questions, please don't hesitate to contact this office.

PALMERTON & PARRISH, INC.
By:

R. Todd Hercules, P.E.
Geotechnical Engineer

PALMERTON & PARRISH, INC.
By:

BRANDON ROSS PARRISH
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July 12, 2022

Brandon R. Parrish, P.E.
Vice President

Submitted: One (1) Electronic .pdf Copy

BRP/SMR/RTH/cl

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EXECUTIVE SUMMARY

A Geotechnical Investigation was performed at the site planned for construction of the new Cherokee Nation W.W. Hastings Surface Parking located directly north of the recently constructed Cherokee Nation Outpatient Health Center in Tahlequah, Oklahoma. This project is anticipated to include construction of a new surface parking area, three (3) detention basins, and a bus shelter. The parking area will extend south of E. Downing Street to the existing Cherokee Nation Outpatient Health Center's existing parking area.

A total of twenty-five (25) geotechnical borings were drilled within the proposed development footprint. Twenty-one (21) borings were located within the proposed pavement area footprint, while four (4) borings were located within the proposed detention basins. Pavement borings were proposed to depths of 5 to 7.5 ft. below the ground surface, while the detention basin borings were to extend to proposed depths of 10 ft. All borings were extended to the depths specified above or auger refusal, whichever was shallower.

Based upon the information obtained from the borings and subsequent laboratory testing, the site is suitable for construction of the proposed new W.W. Surface Parking, detention basins, and bus shelter. Important geotechnical considerations for the project are summarized below. However, users of the information contained in the report must review the entire report for specific details pertinent to geotechnical design considerations.

- The project site primarily consists of grass-covered lawn or field with some areas of mature trees and existing structures. The existing structures are anticipated to be demolished prior to parking lot construction;
- A layer of topsoil (approximately 4 to 6 inches) was encountered within all borings. This material is not suitable in areas of new fill, pavement sections and building areas;

EXECUTIVE SUMMARY (CONTINUED)

- Existing structures including all building components, old pavements, and terminated utilities should be removed and replaced prior to the construction of pavements;
- Overburden soils generally consisted of clayey gravels and sands, gravelly clays, or lean clay with sand and gravel as is typical in the Tahlequah area. These soils were primarily logged as medium dense to very dense or stiff to very hard and sometimes exhibited significant drilling difficulty when using standard drilling methods;
- Foundation loads for the new bus shelter may be supported upon shallow foundations bearing upon stiff to very hard or medium dense to dense natural overburden soils, or controlled fill. Foundations bearing on native soils may be designed for an allowable bearing capacity of 3,500 psf for column footings and 3,000 psf for continuous footings. Foundations bearing on newly placed controlled fill may be designed for allowable bearing capacities of 2,500 psf for column footings and 2,000 psf for continuous footings;
- Due to the stiffness and density of the existing subgrade soils, sufficient support is anticipated to be provided for pavements if subgrades are prepared in accordance with Section 7.0;
- In order to provide temporary parking as well as a staging area for the upcoming Hospital project, the parking lot is understood to be initially asphalt paved, followed by a concrete overlay, i.e. white topping, once Hospital construction is complete. Refer to Section 10.0 for additional details regarding concrete white topping;
- The project site classifies as a Site Class C in accordance with Section 1613 of the 2018 International Building Code (IBC), as determined by on-site standard penetration resistance testing;

EXECUTIVE SUMMARY (CONTINUED)

- Excavation and mass earth moving at this project site is anticipated to generally be somewhat difficult and variable. Excavation difficulty and rippability of the existing overburden soils at the site is further discussed in Section 7.7 of this report; and
- Palmerton & Parrish, Inc. should be retained for construction observation and construction materials testing. Close monitoring of subgrade preparation work is considered critical to achieve adequate foundation and subgrade performance.

GEOTECHNICAL ENGINEERING REPORT
W.W. HASTINGS SURFACE PARKING
TAHLEQUAH, OKLAHOMA

1.0 INTRODUCTION

This is the report of the Geotechnical Investigation performed at the site planned for construction of the new Cherokee Nation W.W. Hastings Surface Parking in Tahlequah, Oklahoma. This investigation was authorized by Mr. J. Breck Childers, Managing Principal, representing Childers Architect. The approximate site location is shown below for reference.

The purpose of the Geotechnical Investigation was to provide recommendations for foundation design and construction planning, and to aid in site development. Palmerton & Parrish Inc.'s (PPI) scope of services included field and laboratory investigation of the subsurface conditions in the vicinity of the proposed project site, engineering analysis of the collected data, development of recommendations for foundation design and construction planning, and preparation of this engineering report.

2.0 PROJECT DESCRIPTION

Item	Description
Site Layout	See Figure 1: Boring Location Plan
Pavements	The lot is anticipated to be asphalt paved initially and used for temporary parking and a construction staging area for the upcoming Hospital project. Once construction of the Hospital is complete, a concrete overlay, i.e. white topping, will be constructed for the final wearing surface.
Detention Basins	A total of three (3) detention basins are planned at the project site on the west side of the proposed parking area.
Retaining Walls	None anticipated.
Foundation Loading	Light foundation loads for the bus shelter are anticipated.
Existing Structure	Based on aerial imagery, the subject site contains an existing residential house and several shed buildings. Demolition of the existing structures is anticipated prior to project construction.
Anticipated Grading	Site grading plans were not provided at the time of this report. It is PPI's understanding that approximately 2 to 3 feet of cut will be performed on the east side of the proposed new surface parking area and 1 to 2 feet of cut and/or fill will be performed across the remaining parking areas.

3.0 SITE DESCRIPTION

Item	Description
Township/Range/Section	T17N R22E S34
Location	The site is located in Cherokee County and will be located south of East Downing Street near its intersection with Old River Road in Tahlequah, Oklahoma.
Latitude: Longitude: (± Center of Project Site)	35.913336° -94.945408°
Available Historic Aerial Photography	Based on available historic aerial imagery from Google Earth Pro, the project site has not visibly been altered since the year 1985.
Current Ground Cover	The project site is primarily covered in grass covered topsoil with some trees and existing buildings/pavements on the north half of the subject site.
Existing Topography	The project site ranges in elevation from approximately 920 feet to 930 feet based on information from Google Earth Pro.
Drainage Characteristics	The project site drains to the northwest, with poor to moderate drainage.

4.0 SUBSURFACE INVESTIGATION

Subsurface conditions were investigated through completion of subsurface borings and subsequent laboratory testing.

4.1 Subsurface Borings

As requested by the Design Team, a total of twenty-five (25) borings were drilled at the project site. A site plan of the boring locations is attached as Figure 1: Boring Location Plan. Boring locations were selected by the Design Team and staked in the field by PPI. Boring identifications were assigned to the borings according to the table below:

Borings	Location	Proposed Boring Depths (ft)
DB1 thru DB4	Detention Basin	10
EP1 thru EP5	Eastern Parking	7.5
P1 thru P16	Primary Parking Area	5

Borings were discontinued in natural overburden soils or upon auger refusal at depths ranging from 3.8 ft. to 10 ft. below the existing ground surface. The Oklahoma One-Call System, as well as hospital maintenance personnel, were notified prior to the investigation to assist in locating buried public and private utilities, respectively. Logs of the borings showing descriptions of soil and rock units encountered, as well as results of field and laboratory tests and a “Key to Symbols” are presented in Appendix I.

Borings were drilled between June 8 and 10, 2022 using 4.5-inch outside diameter (O.D.) continuous flight augers (CFA) or a 3-inch O.D. carbide tricone with wash rotary methods. Boring DB2 encountered a chert layer that was not penetrable with CFA’s; however, drilling was continued using a 3-inch O.D. carbide tricone.

All borings were advanced utilizing a track-mounted Dietrich D-50 drill-rig. Soil samples were collected at 2.5 ft. centers during drilling using a split spoon sampler while performing the Standard Penetration Test (SPT) in general accordance with ASTM D1586.

Auger refusal occurred in Borings DB1, DB2, DB3, EP1, EP2, EP5, P1, P2, P6, P11, P13, P15, and P16. The refusal was either a result of the auger itself or the split spoon sampler failing to penetrate the chert-laden soils.

4.2 Laboratory Testing

Collected samples from the borings were sealed and transported to the laboratory for further evaluation and visual examination. Laboratory soil testing included the following:

- Atterberg Limits (ASTM D4318);
- Grain Size (ASTM D6913);
- Moisture Content (ASTM D2216); and
- Pocket Penetrometer Strength.

Laboratory soil test results are shown on each boring log in Appendix I and are summarized in the following table. Grain size analysis results are attached as Appendix III.

Soil Laboratory Testing Results

Boring	Depth (ft.)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Moisture Content (%)	USCS Symbol	% Passing No. 200 Sieve
DB2	8.5	22	14	8	11.0	SC	-
DB3	6.0	-	-	-	11.3	SC	38
EP2	3.5	33	18	15	13.5	GC	-
EP5	6.0	-	-	-	10.3	SC	33
P3	1.0	26	17	9	18.5	CL	-
P3	3.5	-	-	-	11.3	GC	28
P9	1.0	33	16	17	17.1	CL	-
P16	1.0	33	20	13	21.2	CL	-

5.0 SITE GEOLOGY

According to the United States Geologic Survey's Geological Map of Oklahoma, the general site is underlain at depth by the Keokuk and Reeds Spring formation and the St. Joe Group. Within the site area, the primary rock type is chert with other rock types consisting of limestone, shale, and marlstone. Overburden soils at the site are typically residual having developed through chemical and physical weathering of the underlying parent bedrock, consisting primarily of chert fragments, boulders and clay layers. The boundary between overburden soils and relatively unweathered limestone is usually abrupt.

6.0 GENERAL SITE & SUBSURFACE CONDITIONS

Based upon subsurface conditions encountered within the borings drilled at the project site, generalized subsurface conditions are fairly consistent across the project site, and similar to typical overburden soils found within the Tahlequah area. Surficial materials primarily consist of topsoil, overlying lean clays with varying amounts of gravel and sand or clayey gravels/sands. Gravels and sands were generally noted to consist of chert. Zones of relatively chert free lean clays were sometimes encountered and were generally noted to be within the upper 3 feet were present in isolated areas.

These conditions are presented on each boring log attached in Appendix I. Soil stratification lines on the boring logs indicate approximate boundary lines between different types of soil units based upon observations made during drilling. In-situ transitions between soil and some rock types are typically gradual.

6.1 Detention Basins

The overburden soils encountered within Borings DB1, DB2, DB3, and DB4 were consistent with soils containing large amounts of chert gravels. Chert cobbles and boulders may also be found within this material that are not distinguishable with a 2-inch split-spoon sampler. Therefore, special attention must be made to the rippability of the soils in the detention basin areas, as explained in Section 7.7.

6.2 Groundwater

Shallow groundwater was not observed within the borings on the date drilled, except within Boring EP1. Perched groundwater was encountered within Boring EP1 at a depth of 1 ft. It is anticipated that perched water had collected over a relatively impermeable layer of fat clay, causing the water to be locally isolated within the boring location. The free-water encountered within this boring is not anticipated to reflect the depth of a more stable layer of groundwater at the subject site.

It should be noted that water-based drilling fluid was used during field drilling in Boring DB2. As a result, obtaining groundwater levels was not possible once tricone rotary methods were initiated. Based upon previous borings drilled within the general site area, groundwater is not anticipated to be encountered. It should be noted that during wet periods, perched groundwater may be encountered at the limestone/shale/chert and overburden soil contact, if present. Groundwater levels should be expected to fluctuate with changes in site grading, precipitation, and regional groundwater levels. Groundwater may be encountered at shallower depths during wetter periods.

7.0 EARTHWORK

7.1 Site Preparation

The initial phase of site preparation should include the following:

- Topsoil and all vegetative matter including trees/root bulbs should be removed from all pavement locations, building locations, and areas scheduled to receive new fill. Removal should include tree roots of 6-inches or greater; and

- Areas scheduled to receive controlled fill should be proof-rolled and approved in accordance with the following section of this report.

After the initial phase is complete, it is recommended that all building, pavement and undercut bottoms be proof-rolled to assure a stable subgrade. Proof-rolling consists essentially of rolling the ground surface with a loaded tandem axle dump truck or similar heavy rubber-tired construction equipment and noting any areas which rut or deflect during rolling. All soft subgrade areas, if any, identified during proof-rolling should be undercut and replaced with compacted fill as outlined below. Proof-rolling, undercutting, and replacement should be monitored by a representative of PPI. **The depth and areal extent of undercutting soft subgrade areas will be largely**

dependent upon the time of year and related soil moisture conditions. If construction is initiated during or immediately following wetter months, the requirement for undercutting areas of isolated soft surficial soils below planned cut depths should be anticipated and reflected in the contract documents, but anticipated to be minimal.

After evaluation by proof-rolling and approval, the subgrade should be scarified to a depth of at least 8 inches, adjusted to within the optimum moisture content ranges and compacted to specified density, provided below (See Section 7.3). Placement of controlled fill may then proceed.

7.2 Fill Material Types

Fill Type[1]	USCS Classification	Acceptable Location for Placement
On-Site Soils / Imported Fill	GC, SC, SW or GW	Acceptable for all areas/elevations.
Low Volume Change (LVC) Engineered Fill & Onsite Soils[2]	CL, GC, or SC (LL < 50)	Acceptable for all areas/elevations; however, CL soils containing less than 30 percent gravels may be difficult to establish proper compaction with and it may be advisable to limit these materials to non-pavement and building areas.
Non-LVC Imported Fill	CH with less than 30% gravel content	Should **not** be placed within the upper 2 ft. beneath foundations and pavements.

[1] Controlled, compacted fill should consist of approved materials that are free of organic matter and debris and contain maximum rock size of 12 inches, or the lift thickness, whichever is less. Frozen material should not be used and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to its use.

[2] Low plasticity cohesive soil or granular soil having a liquid limit of less than 50%, containing at least 15% fines retained on the No. 200 sieve, and preapproved by the Geotechnical Engineer.

7.3 Compaction Requirements

Item	Description
Subgrade Scarification Depth	At least 8 inches
Fill Lift Thickness	8-inch (loose)
Compaction Requirements[1]	• Coarse Grained Material: 70% Relative Density, or compacted by a minimum of three (3) passes of a large diameter self-propelled vibratory compactor. • Fine Grained Material: 95% Standard Proctor Density (ASTM D-698)
Moisture Content	• ± 2% optimum moisture for CL, SC, or GC soil types; or • 0 to 4% above optimum for CL-CH or CH soil types.
Recommended Testing Frequency	• One (1) Field Density (compaction) test for each 2,500 sq. ft. of fill within bus shelter areas; • One (1) Field Density (compaction) test for each 5,000 sq. ft. of fill within paving areas; and • A minimum of three (3) tests per lift.

[1] We recommend that engineered fill (including scarified compacted subgrade) be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

7.4 Landscaping & Site Drainage

Discharge from roof downspouts, if any, should be collected and diverted well away from the parking area perimeter and incorporated into the design plans. Rapid, efficient runoff away from the project site should also be provided.

In addition, provisions should be implemented to reduce the potential for large fluctuations in moisture within the subgrade soils adjacent to the structure. Ponding of surface water immediately adjacent to the structures and pavements can significantly increase subgrade moisture and may result in undesirable subgrade movement. As previously mentioned, careful consideration should be given to the landscaping and drainage elements to be installed at the project site adjacent to bus shelter and pavement areas. **Trees and some large bushes can draw significant moisture from the subgrade soils, resulting in shrinkage and subsequent foundation/pavement movement.**

7.5 Earthwork Construction Considerations

Once grading and filling operations have been completed, the moisture within the subgrade should be maintained, and soils not be allowed to dry and desiccate prior to construction of footings. Grading of the site should be performed in such a manner so that ponding of surface water on prepared subgrade or in excavations is avoided. During construction, if the prepared subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be scarified or removed, moisture conditioned, and recompacted prior to construction.

7.6 Excavations

Based upon the subsurface conditions encountered during this investigation, the on-site soils typically classify as Type B in accordance with OSHA regulations. Temporary excavations in soils classifying as Type B with a total height of less than 20 ft. should be cut no steeper than 1H:1V in accordance with OSHA guidelines. **Confirmation of soil classification during construction, as well as construction safety (including shoring, if required), is the responsibility of the contractor.**

7.7 Rippability

As mentioned throughout this report, the overburden soils at the project site primarily consist of dense to very dense clayey gravels with possible chert cobbles and boulders. Sometimes significant difficulty was experienced when drilling the geotechnical borings within this chert-laden material. Based upon this information, the overburden soils are anticipated to be rippable with dozers, but with difficulty. **In addition, areas resistant to ripping consisting of large chert boulders, requiring other removal methods (pneumatic breakers or blasting, if allowed) should be anticipated.** The Earthwork Contractor should review the attached boring logs when assessing excavation difficulty at this site. Mass grading at this site is anticipated to occur at a slower rate as compared to sites where overburden soils are primarily fine grained (silts and clays).

8.0 FOUNDATIONS

8.1 Shallow Foundation Design Recommendations

The table below contains recommendations regarding shallow foundations for the bus shelter structure.

Description	Column (Spread Footing)	Wall (Continuous Footing)
Net allowable bearing pressure[1]	• Native Soil: 3,500 psf • Controlled Fill: 2,500 psf	• Native Soil: 3,000 psf • Controlled Fill: 2,000 psf
Minimum dimensions	2.5 feet	1.5 feet
Minimum embedment below finished grade for frost protection and variation in soil moisture[2] (footings on soil)	2 feet	2 feet
Estimated total settlement[3]	1 inch or less	1 inch or less
Allowable passive pressure[4]	600 psf	600 psf
Coefficient of sliding friction[5]	0.4 (natural soils/controlled fill)	0.4 (natural soils/controlled fill)

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended pressure considers all unsuitable and/or soft or loose soils, if encountered, are undercut and replaced with tested and approved new engineered fill. Footing excavations should be free of loose and disturbed material, debris, and water when concrete is placed. A factor of safety value of 3 has been applied to these values.
2. For perimeter footings and footings beneath unheated areas.
3. The foundation movement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations.
4. Allowable passive pressure value considers a factor of safety of about 2. Passive pressure value applies to undisturbed native clay or properly compacted fill. If formed footings are constructed, the space between the formed side of a footing and excavation sidewall should be cleaned of all loose material, debris, and water and backfilled with tested and approved fill compacted to at least 95% of the material's Standard Proctor dry density. Passive resistance should be neglected for the upper 2.5 feet of the soil below the final adjacent grade due to strength loss from freeze/thaw and shrink/swell.
5. Coefficient of friction value is an ultimate value and does not contain a factor of safety.

8.2 Uplift

Resistance of shallow spread footings to uplift (Up) may be based upon the dead weight of the concrete footing structure (W_C) and the weight of soil backfill contained in an inverted cone or pyramid directly above the footings (W_S). The following parameters may be used in design:

Description	Weights
Weight of Concrete (W_c)	150 pcf
Weight of Soil Resistance (W_s)	100 pcf
Weight for on-site soils placed in accordance with Section 7.0	

The base of the cone or pyramid should be the top of the footing and the pyramid or cone sides should form an angle of 30 degrees with the vertical. Allowable uplift capacity (U_p) should be computed as the lesser of the two (2) equations listed below:

$$U_P = (W_S/2.0) + (W_C/1.25) \text{ or } U_P = (W_S + W_C)/1.5$$

8.3 Construction Considerations for Shallow Foundations

It is essential that footing bottoms should not be allowed to become dry and desiccate prior to concrete placement to help reduce the potential for shrink/swell behavior. Footings should be clean and free of standing water, debris, and loose soil at the time of concrete placement. Footing/mat excavations should be observed by a representative of PPI prior to placement of reinforcing steel and concrete placement.

9.0 SEISMIC CONSIDERATIONS

Code Used	Site Classification
2018 International Building Code (IBC)[1]	C
1. In general accordance with the *2018 International Building Code*, Section 1613	

10.0 PAVEMENT

The parking lot is anticipated to be asphalt paved initially and used for temporary parking and a construction staging area for the upcoming Hospital project. Once construction of the Hospital is complete, a concrete overlay, i.e. white topping, will be constructed for the final wearing surface. Prior to initial asphalt pavement placement, preparation of the pavement subgrade should be performed in accordance with Section 7.0 of this report.

10.1 Flexible Pavement

As mentioned above, asphalt is anticipated to be placed as the temporary driving surface to be used for parking and a construction staging area. Below the asphaltic paving, the aggregate base may be a granular compacted crushed limestone with a gradation and quality conforming to the requirements of the Oklahoma Department of Transportation (ODOT), Standard Specification 703.01 for Type A aggregate. The maximum lift thickness for the granular base is 4 in. Granular base thicknesses in excess of 4 inches should be placed in multiple lifts with each lift being of approximately equal thickness. The granular base should be compacted to at least 100% of Standard Proctor Compaction (ASTM D-698).

Asphaltic concrete, both base and surface, should conform to the applicable requirements of ODOT Standard Specification 708. Asphaltic concrete should be compacted to 92 to 96% of Maximum Theoretical Specific Gravity (ASTM D-2041). Substitution of an appropriate Superpave Mix Design, SP 190C or SP 250C, can be used in place of the bituminous base. SP 190C or SP 125C may be used for the surface. All bituminous mix designs should have been prepared or verified within 6 months of the date of placement on the project.

10.2 Concrete White Topping

Following temporary use of the asphalt driving surface, it is understood that a thin concrete white topping will be placed on top of the asphalt as the final driving surface. A bonded overlay is considered the most appropriate overlay due to the anticipated relatively good condition of the previously placed asphalt. In a bonded overlay, preparation of the underlying asphalt is key to the satisfactory performance of the white topping. **A bonded white topping is not recommended to be placed over new asphalt.** However, the asphalt is anticipated to be in place at least 1 year prior to white topping placement. The following steps should be performed prior to white topping placement:

- Mill asphalt surface 0.5-inch, minimum, maintaining at least a 4-inch underlying asphalt thickness to promote satisfactory bonding;

- Mill deeper, or completely remove, where the asphalt is heavily damaged, if any by construction equipment; and

- The milled asphalt surface should be swept multiple times, air blasted to remove remaining debris and dust and wetted prior to concrete placement.

Following surface asphalt preparation, installation of the concrete white topping is anticipated. Construction of a concrete white topping is similar to standard concrete pavement, although it does require some additional requirements, including:

- Concrete panel size of 6-ft by 6-ft. to aid in concrete crack control;

- Joints sawed as soon as concrete has gained sufficient strength to allow sawing without raveling;

- Due to the increased number of saw joints, a gang of concrete saws spaced along a guide bar is often used for the longitudinal joints, with the transverse joints sawed first. Regardless, the paving contractor should have sufficient equipment and manpower available for the saw jointing process, as this requirement is greater than conventional concrete pavement jointing and curing occurs at a faster pace due to the thinner concrete section. If jointing is not performed in a timely manner, undesirable cracking may occur; and

- Refer to "Tech Brief, Thin Concrete Overlays, FHWA-HIF-17-012, October 2017" found at https://www.fhwa.dot.gov/pavement/pubs/hif17012.pdf for additional information.

The Portland Cement Concrete (PCC) mix should have a minimum 28-day compressive strength of 4000 pounds per square inch (psi). Concrete should be placed at a low slump (1 to 3 inches) and have an entrained air content of 5 to 7%. If an increased slump is desired, use of Super Plasticizer is recommended.

10.3 Pavement Subgrade CBR

Based upon relatively high SPT-N values obtained during drilling, the natural soil deposits should exhibit stiff to hard subgrades for pavement construction. A CBR value equal to 5.0 for the natural subgrade soils or natural overburden soils that have been properly recompacted is recommended to be used in pavement design.

10.4 Pavement Thickness

Typical pavement design for this type of development would generally generate a Structural Number of 3.0 to 3.5 within heavy duty areas and 2.4 to 2.6 within light duty areas, depending on the subgrade conditions. The lower table presents corresponding typical flexible and rigid pavement thickness using the general Structural Numbers where conventional pavement placement is anticipated, i.e. standard thickness concrete or asphalt only. However, the upper table below presents recommended thickness if a temporary asphalt layer is placed, utilized during hospital construction, followed by placement of a concrete white topping once Hospital construction is complete.

Recommended Temporary Asphalt Placement Followed by Concrete White Topping Thicknesses (If utilized)

Pavement Type	Anticipated Traffic Frequency	Asphaltic Surface (in.)	Asphaltic Base (in.)	Concrete Thickness (in.)	Aggregate Base (in.)
Initial Flexible (Asphalt) Pavement Layer	Medium Duty	*2.0	3.0	-	6.0
Concrete White Topping	Medium Duty	-	-	5.0	N/A

*This layer will be milled 0.5-inches and thoroughly cleaned prior to concrete white topping placement, and repaired (if required) in areas where construction traffic damages the asphalt pavement.

Conventional Pavement Thicknesses (If utilized)					
Pavement Type	**Anticipated Traffic Frequency**	**Asphaltic Surface (in.)**	**Asphaltic Base (in.)**	**Concrete Thickness (in.)**	**Aggregate Base (in.)**
Flexible Pavement	Heavy Duty	3.0	4.0	-	6.0
	Medium Duty	2.0	3.0	-	6.0
	Light Duty	2.0	2.0	-	6.0
Rigid Pavement	Heavy Duty	-	-	7.0	4.0
	Medium Duty	-	-	6.0	4.0
	Light Duty	-	-	5.0	4.0

11.0 CONSTRUCTION OBSERVATION & TESTING

The construction process is an integral design component with respect to the geotechnical aspects of a project. Since geotechnical engineering is influenced by variable depositional and weathering processes and because we sample only a small portion of the soils affecting the performance of the proposed structures, unanticipated or changed conditions can be disclosed during grading. Proper geotechnical observation and testing during construction is imperative to allow the Geotechnical Engineer the opportunity to evaluate assumptions made during the design process. Therefore, we recommend that PPI be kept apprised of design modifications and construction schedule of the proposed project to observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this study. We recommend that during construction all earthwork be monitored by a representative of PPI, including site preparation, placement of all engineered fill and trench backfill, and all foundation excavations as outlined below.

- An experienced Geotechnical Engineer or Engineering Technician of PPI should observe the subgrade throughout the proposed project site immediately following stripping to evaluate the native clay, identify areas requiring additional undercutting, and evaluate the suitability of the exposed surface for fill placement;
- An experienced Engineering Technician of PPI should monitor and test all fill placed within the building and pavement areas to determine whether the type of

material, moisture content, and degree of compaction are within recommended limits. **Refer to Section 7.3 for recommendations regarding Field Density (compaction) testing frequency**;

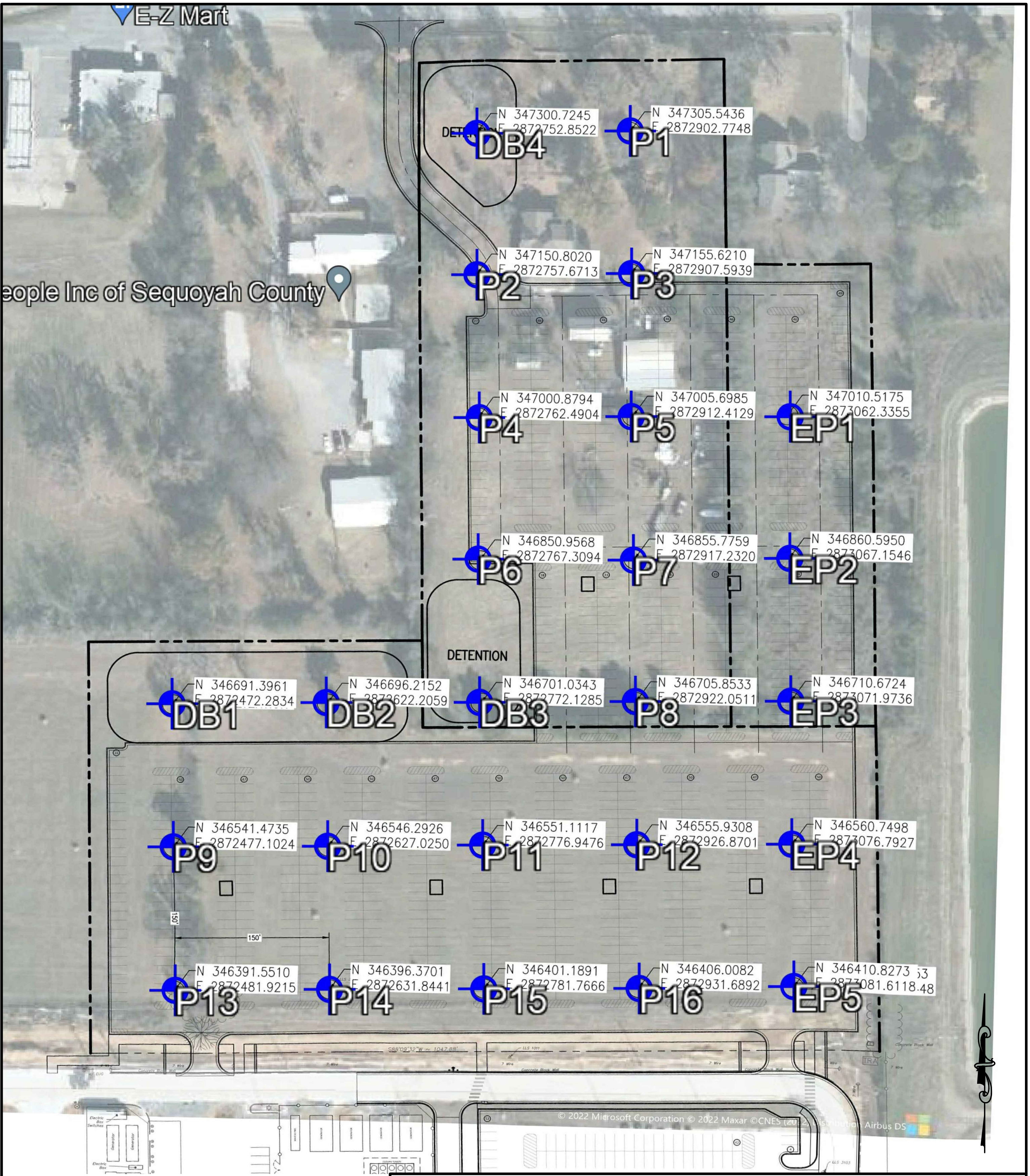
- An experienced Technician or Engineer of PPI should observe and test all footing excavations. Where unsuitable bearing conditions are observed, remedial procedures can be established in the field to avoid construction delays; and
- An experienced Technician or Engineer of PPI should observe and test all footing excavations. Where unsuitable bearing conditions are observed, remedial procedures can be established in the field to avoid construction delays.

12.0 REPORT LIMITATIONS

This report has been prepared in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area. Palmerton & Parrish, Inc. observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. Palmerton & Parrish's findings and conclusions must be considered not as scientific certainties, but as opinions based on our professional judgment concerning the significance of the data gathered during the course of this investigation. Other than this, no warranty is implied or intended.

FIGURES

S:_MASTER PROJECT FILE\2022\OK\C\Childers Architect-281188-WW Hastings Surface Parking-Sub\Figures\281188-CAD.dwg



SCALE: 1' = 125'

LEGEND

⌖ Boring Location

Drawing and Aerial Image provided by the Client. Not intended for use in design.

Project: W.W. Hastings Surface Parking - Tahlequah, Oklahoma
Client: Childers Architect

Boring Location Plan

DATE: June 24, 2022

Project Number: 281188

PALMERTON & PARRISH, INC.
GEOTECHNICAL AND MATERIALS ENGINEERS/MATERIALS TESTING LABORATORIES/ENVIRONMENTAL SERVICES

FIGURE 1

APPENDIX I

BORING LOGS & KEY TO SYMBOLS

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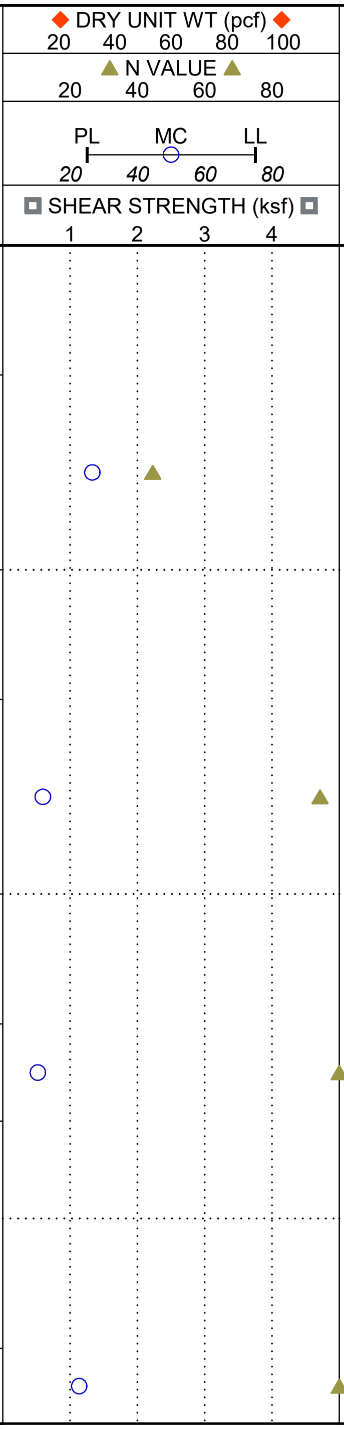
GEOTECHNICAL BORING LOG

BORING NUMBER DB1

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/9/22 **COMPLETED** 6/9/22
SURFACE ELEVATION ____ **BENCHMARK EL.** ____
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING ____
NOTES ____

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
			CLAYEY GRAVEL, With Sand, Reddish Brown to Red, Dense to Very Dense, Moist (GC)					
				SPT 1		5-21-24 (45)	0	
2.5								
				SPT 2		28-48-46 (94)	1.75	
5.0			5.5 ft					
			CHERT LAYER 6.4 ft	SPT 3		59-66/3"	1.75	
			GRAVELLY LEAN CLAY, With Sand, Red, Very Hard, Moist (CL) 7.7 ft					
7.5			CLAYEY GRAVEL, With Sand, Red, Very Dense, Moist (GC)					
			9.1 ft	SPT 4		66-66/1"	3.25	



Refusal at 9.1 feet.
Bottom of borehole at 9.1 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER DB2

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME WW Hastings Surface Parking

PROJECT NO. 281188

PROJECT LOCATION Tahlequah, OK

DATE STARTED 6/9/22 **COMPLETED** 6/9/22

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER SP **DRILL RIG** Dietrich D-50

GROUND WATER LEVELS

HAMMER TYPE Auto

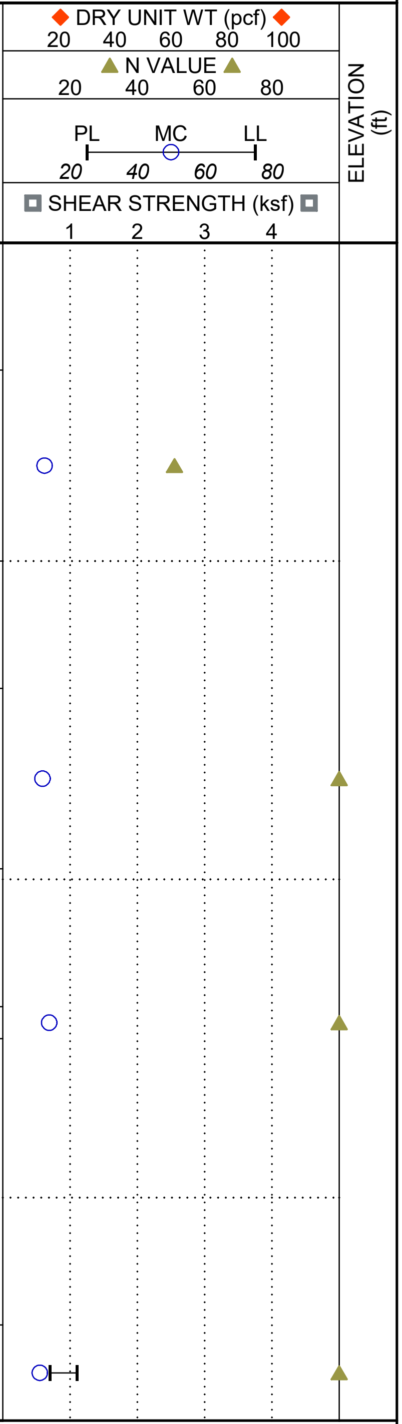
AT TIME OF DRILLING None

LOGGED BY MV **CHECKED BY** CL

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
0.0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft				
		CLAYEY GRAVEL, With Sand, Brown, Very Dense, Moist (GC)	SPT 1		12-21-30 (51)	0
2.5		3.0 ft				
		CLAYEY SAND, With Gravel, Red, Very Dense, Moist (SC)	SPT 2		20-52-66/5"	2.75
5.0	ROTARY - 3" O.D.		SPT 3		66/3"	0.75
7.5						
		9.3 ft	SPT 4		47-66/3"	2.75



Refusal at 9.3 feet.
Bottom of borehole at 9.3 feet.

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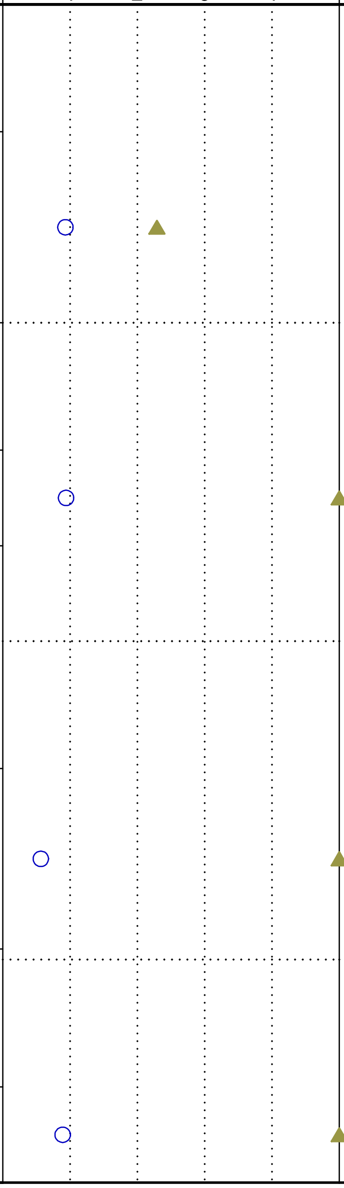
GEOTECHNICAL BORING LOG

BORING NUMBER DB3

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/9/22
COMPLETED 6/9/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	◆ DRY UNIT WT (pcf) ◆ 20 40 60 80 100 ▲ N VALUE ▲ 20 40 60 80 PL MC LL 20 40 60 80 ▣ SHEAR STRENGTH (ksf) ▣ 1 2 3 4	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft						
			CLAYEY SAND, With Gravel, Red With Gray, Dense to Very Dense, Moist (SC)						
				SPT 1		5-17-29 (46)	1.5		
2.5									
				SPT 2		21-66/3"	2.25		
5.0									
				SPT 3		30-63-66/5"	2.25		
7.5									
			9.3 ft	SPT 4		12-66/3"	2.75		

Refusal at 9.3 feet.
Bottom of borehole at 9.3 feet.

BORING LOG - PPI - PPI STD TEMPLATE.GDT - 6/24/22 09:36 - S:_MASTER PROJECT FILE\2022\OK\C\CHILDERS ARCHITECT-281188-WW HASTINGS SURFACE PARKING-SUB\BORING LOGS\281188 - GINT.GPJ

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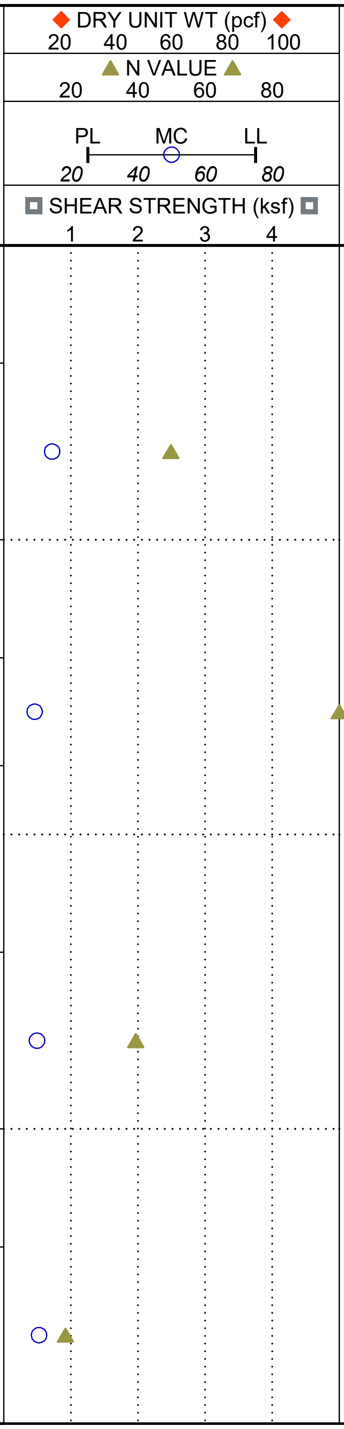
GEOTECHNICAL BORING LOG

BORING NUMBER DB4

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/10/22 **COMPLETED** 6/10/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft					
		CLAYEY GRAVEL, With Sand, Red to Brown, Dense to Very Dense, Moist (GC)					
			SPT 1		5-13-37 (50)	1.5	
2.5							
			SPT 2		66-66/5"	3.5	
5.0							
			SPT 3		20-22-17 (39)	1.75	
7.5							
		8.5 ft					
		GRAVELLY LEAN CLAY, With Sand, Red, Very Stiff, Moist (CL)	SPT 4		7-7-12 (19)	1.25	
		10.0 ft					
10.0		Bottom of borehole at 10.0 feet.					



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GEOTECHNICAL BORING LOG

BORING NUMBER EP1

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME WW Hastings Surface Parking

PROJECT NO. 281188

PROJECT LOCATION Tahlequah, OK

DATE STARTED 6/10/22 **COMPLETED** 6/10/22

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER SP **DRILL RIG** Dietrich D-50

GROUND WATER LEVELS

HAMMER TYPE Auto

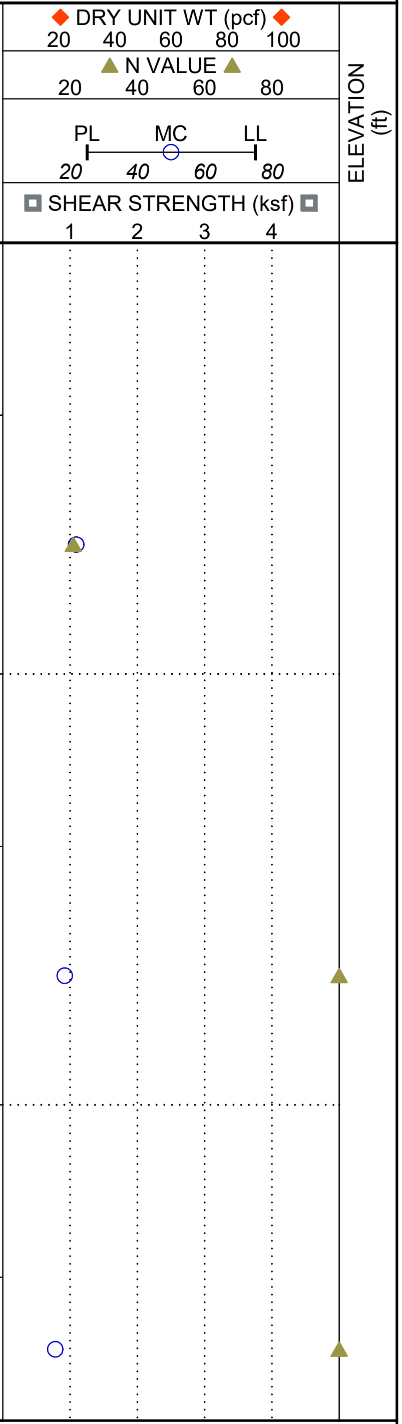
AT TIME OF DRILLING 1 ft

LOGGED BY MV **CHECKED BY** CL

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
0.0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft				
		GRAVELLY LEAN CLAY, With Sand, Red to Brown, Very Stiff, Moist (CL) ∇				
			SPT 1		1-4-17 (21)	0.75
2.5		3.0 ft				
		CLAYEY GRAVEL, With Sand, Red, Very Dense, Moist (GC)				
			SPT 2		39-66-59 (125)	0.5
5.0						
		6.8 ft	SPT 3		30-66/4"	1.5



Refusal at 6.8 feet.
Bottom of borehole at 6.8 feet.

BORING LOG - PPI - PPI STD TEMPLATE.GDT - 6/24/22 09:36 - S:_MASTER PROJECT FILE\2022\OK\C\CHILDERS ARCHITECT-281188-WW HASTINGS SURFACE PARKING-SUB\BORING LOGS\281188 - GINT.GPJ

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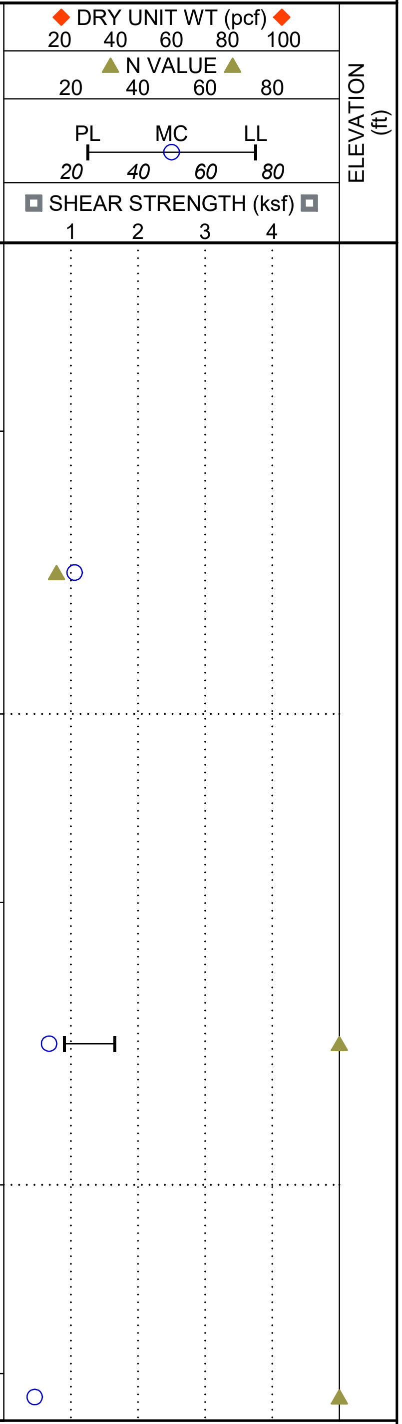
GEOTECHNICAL BORING LOG

BORING NUMBER EP2

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/10/22 **COMPLETED** 6/10/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
0.0	CFA - 4.5" O.D.	TOPSOIL (5")				
		0.4 ft				
		LEAN CLAY, With Gravel and Sand, Red to Brown, Very Stiff, Moist (CL)				
			SPT 1		1-3-13 (16)	0.5
2.5						
		3.0 ft				
		CLAYEY GRAVEL, With Sand, Red, Very Dense, Moist (GC)				
			SPT 2		24-45-64 (109)	1.5
5.0						
		6.3 ft	SPT 3		66/3"	1.5



Refusal at 6.3 feet.
Bottom of borehole at 6.3 feet.

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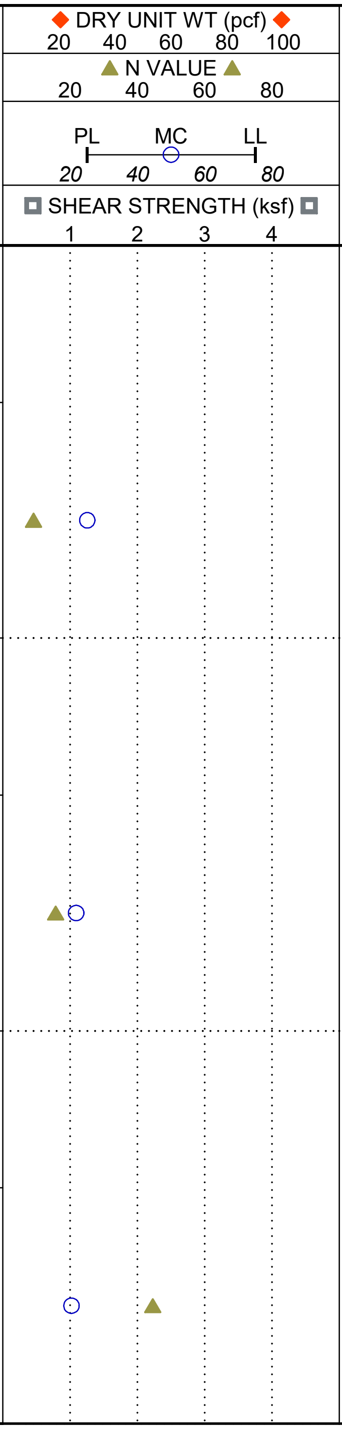
GEOTECHNICAL BORING LOG

BORING NUMBER EP3

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/8/22
COMPLETED 6/8/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT (pcf) / N VALUE / PL MC LL / SHEAR STRENGTH (ksf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft						
			LEAN CLAY, Trace Sand & Gravel, Red to Brown, Stiff, Moist (CL)	SPT 1		3-4-5 (9)	0.75		
2.5			- With Gravel, Red, Very Stiff Below 3.5'	SPT 2		5-7-9 (16)	2		
5.0			5.5 ft						
			CLAYEY GRAVEL, With Sand, Red, Dense, Moist (GC) 7.5 ft	SPT 3		16-29-16 (45)	3.25		
7.5			Bottom of borehole at 7.5 feet.						



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GEOTECHNICAL BORING LOG

BORING NUMBER EP4

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME WW Hastings Surface Parking

PROJECT NO. 281188

PROJECT LOCATION Tahlequah, OK

DATE STARTED 6/8/22 **COMPLETED** 6/8/22

SURFACE ELEVATION ______ **BENCHMARK EL.** ______

DRILLER SP **DRILL RIG** Dietrich D-50

GROUND WATER LEVELS

HAMMER TYPE Auto

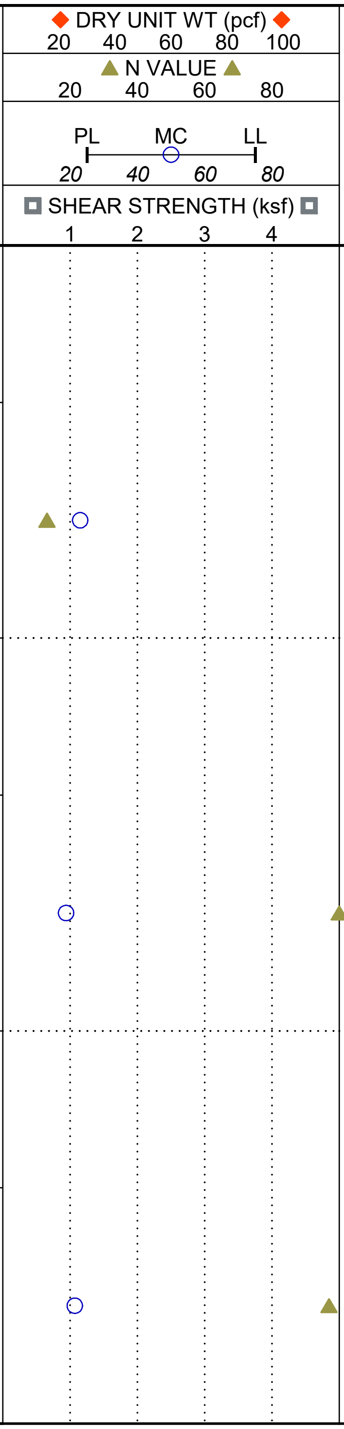
AT TIME OF DRILLING None

LOGGED BY MV **CHECKED BY** CL

AT END OF DRILLING ______

NOTES ______

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
			LEAN CLAY, With Sand and Gravel, Red to Brown, Stiff, Moist (CL)	SPT 1		4-7-7 (14)	1.5	
2.5			3.0 ft					
			CLAYEY GRAVEL, With Sand, Red, Very Dense, Moist (GC)	SPT 2		25-62-64 (126)	3.75	
5.0								
			- Wet Below 6'	SPT 3		34-45-52 (97)	0.5	
			7.5 ft					
7.5			Bottom of borehole at 7.5 feet.					



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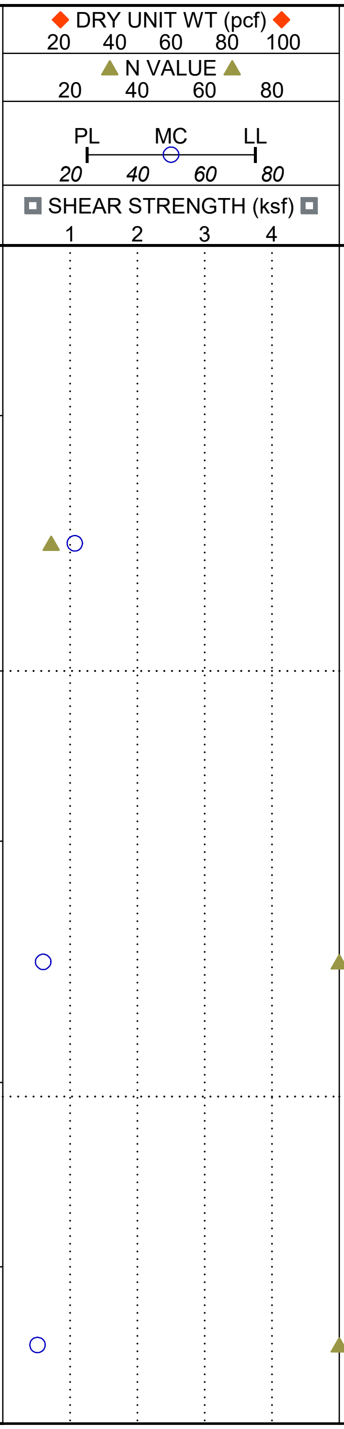
GEOTECHNICAL BORING LOG

BORING NUMBER EP5

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/8/22
COMPLETED 6/8/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
			LEAN CLAY, Trace Gravel, Gray to Brown, Stiff, Moist (CL)	SPT 1		3-4-10 (14)	2.5	
2.5			3.0 ft					
			CLAYEY GRAVEL, With Sand, Red, Very Dense, Moist (GC)	SPT 2		39-47-66/5"	2.25	
5.0			5.5 ft					
			CLAYEY SAND, With Gravel, Red, Very Dense, Moist (SC) 6.9 ft	SPT 3		47-66/5"	2.5	



Refusal at 6.9 feet.
Bottom of borehole at 6.9 feet.

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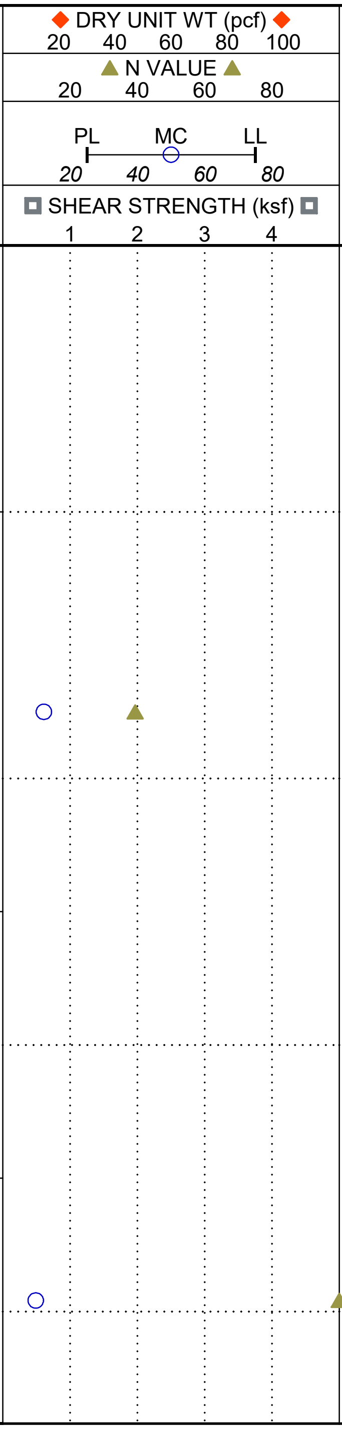
GEOTECHNICAL BORING LOG

BORING NUMBER P1

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/9/22 **COMPLETED** 6/9/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
			CLAYEY GRAVEL, With Sand, Brown, Dense, Moist (GC)					
1				SPT 1		7-16-24 (40)	1.5	
2								
3			3.0 ft CLAYEY SAND, With Gravel, Red, Very Dense, Moist (SC)					
4			4.4 ft	SPT 2		35-66/5"	1.5	



Refusal at 4.4 feet.
Bottom of borehole at 4.4 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER **P2**

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME WW Hastings Surface Parking

PROJECT NO. 281188

PROJECT LOCATION Tahlequah, OK

DATE STARTED 6/10/22 **COMPLETED** 6/10/22

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER SP **DRILL RIG** Dietrich D-50

GROUND WATER LEVELS

HAMMER TYPE Auto

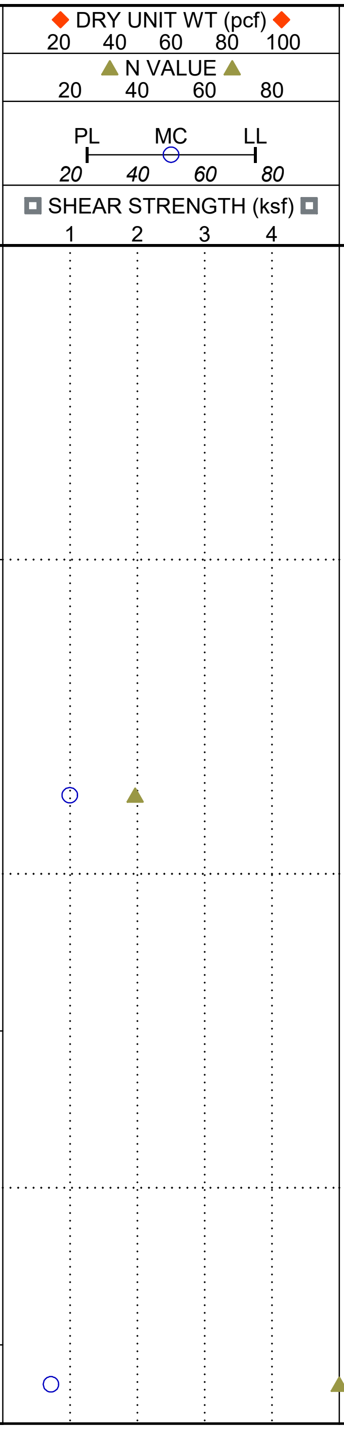
AT TIME OF DRILLING None

LOGGED BY MV **CHECKED BY** CL

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
1			CLAYEY GRAVEL, Wtih Sand, Brown, Dense, Wet (GC)	SPT 1		5-10-29 (39)	1	
2								
3			- Red, Very Dense, Moist Below 3.5' 3.8 ft	SPT 2		66/3"	1	



Refusal at 3.8 feet.
Bottom of borehole at 3.8 feet.

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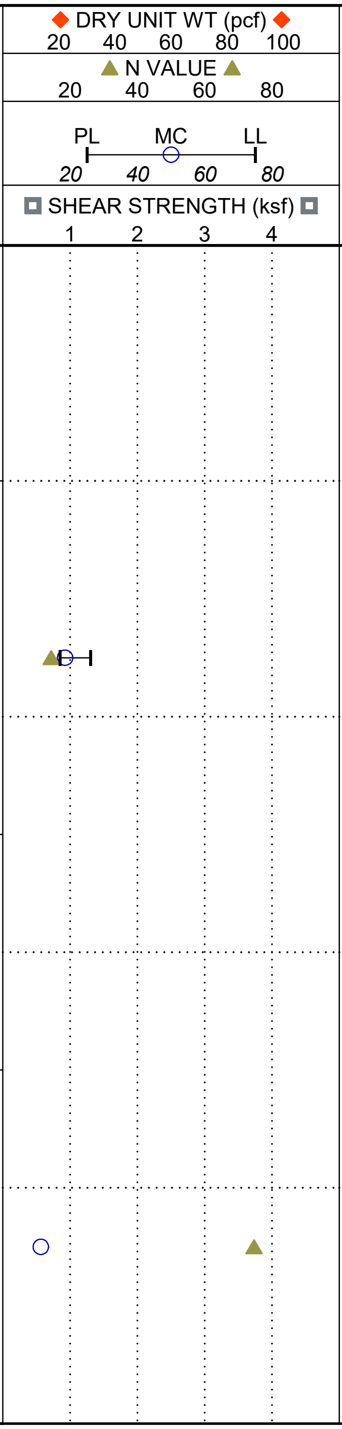
GEOTECHNICAL BORING LOG

BORING NUMBER P3

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/9/22 **COMPLETED** 6/9/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft					
		LEAN CLAY, With Sand & Gravel, Red to Brown, Stiff, Moist (CL) 3.0 ft	SPT 1		3-3-12 (15)	0	
3		CLAYEY GRAVEL, With Sand, Red to Brown, Very Dense, Moist (GC) 5.0 ft	SPT 2		20-31-43 (74)	2	
5		Bottom of borehole at 5.0 feet.					



BORING LOG - PPI - PPI STD TEMPLATE.GDT - 6/24/22 09:36 - S:_MASTER PROJECT FILE\2022\OK\C\CHILDERS ARCHITECT-281188-WW HASTINGS SURFACE PARKING-SUB\BORING LOGS\281188 - GINT.GPJ

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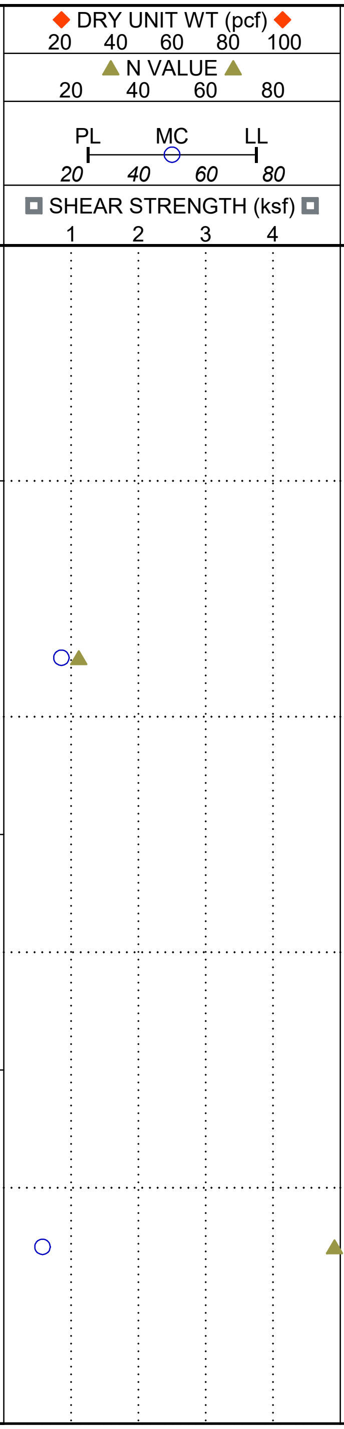
GEOTECHNICAL BORING LOG

BORING NUMBER P4

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/10/22 **COMPLETED** 6/10/22
SURFACE ELEVATION ______ **BENCHMARK EL.** ______
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING ______
NOTES ______

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft					
		CLAYEY GRAVEL, With Sand, Red, Medium Dense, Moist (GC)					
1			SPT 1		3-9-13 (22)	1.75	
2							
3		- Very Dense Below 3.5'					
4			SPT 2		25-38-60 (98)	2	
5		5.0 ft					



Bottom of borehole at 5.0 feet.

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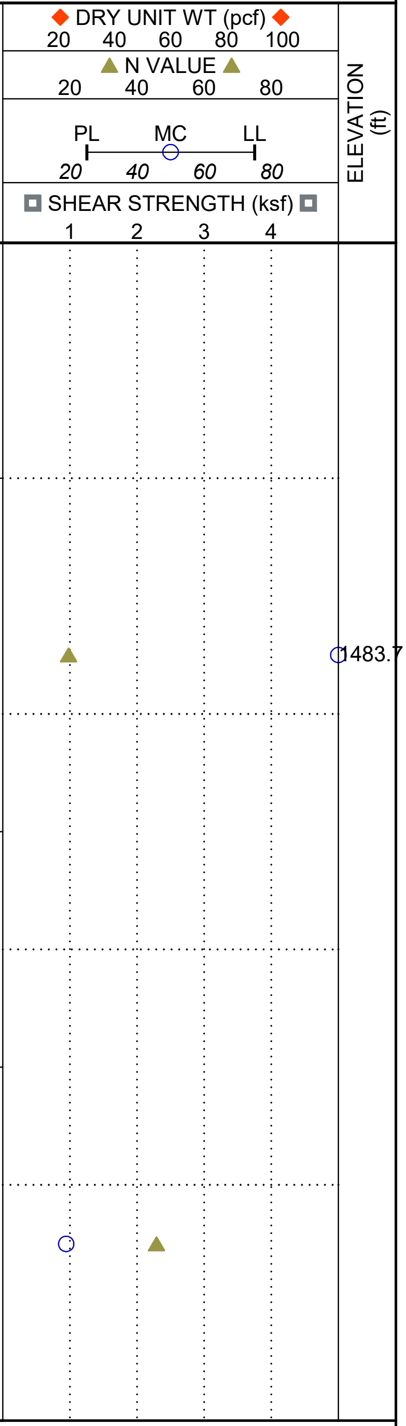
GEOTECHNICAL BORING LOG

BORING NUMBER P5

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/10/22
COMPLETED 6/10/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft					
		GRAVELLY LEAN CLAY, Red to Brown, Very Stiff, Moist (CL)					
1							
			SPT 1		1-3-17 (20)	1.25	
2							
3		- Hard Below 3.5'					
4			SPT 2		24-30-16 (46)	2.25	
		5.0 ft					
5		Bottom of borehole at 5.0 feet.					



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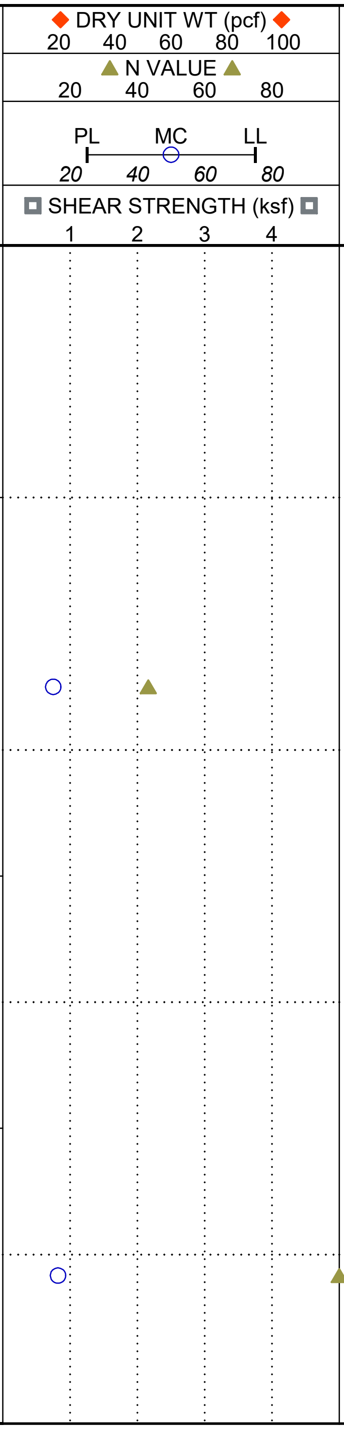
GEOTECHNICAL BORING LOG

BORING NUMBER P6

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/10/22
COMPLETED 6/10/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft					
		CLAYEY GRAVEL, Wtih Sand, Red to Brown, Dense, Moist (GC)					
1			SPT 1		7-8-35 (43)	1	
2							
3		- Red, Very Dense Below 3.5'					
4		4.7 ft	SPT 2		33-55-66/2"	1.5	



Refusal at 4.7 feet.
Bottom of borehole at 4.7 feet.

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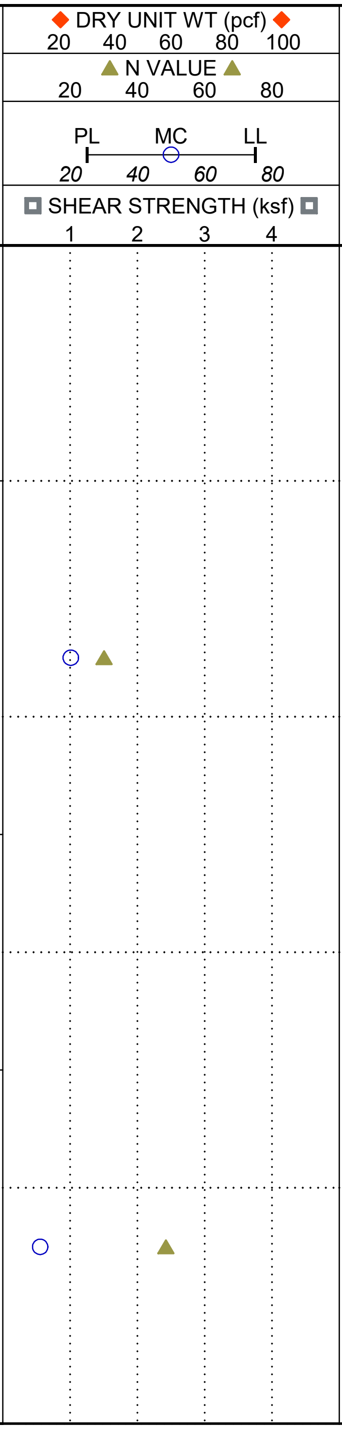
GEOTECHNICAL BORING LOG

BORING NUMBER P7

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/10/22 **COMPLETED** 6/10/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") — 0.4 ft					
0.4			GRAVELLY LEAN CLAY, Red to Brown, Very Stiff, Moist (CL)					
1				SPT 1		4-13-17 (30)	1	
2			— 3.0 ft					
3			CLAYEY GRAVEL, With Sand, Red to Brown, Dense, Moist (GC)					
4				SPT 2		20-22-26 (48)	1.25	
5			— 5.0 ft					



Bottom of borehole at 5.0 feet.

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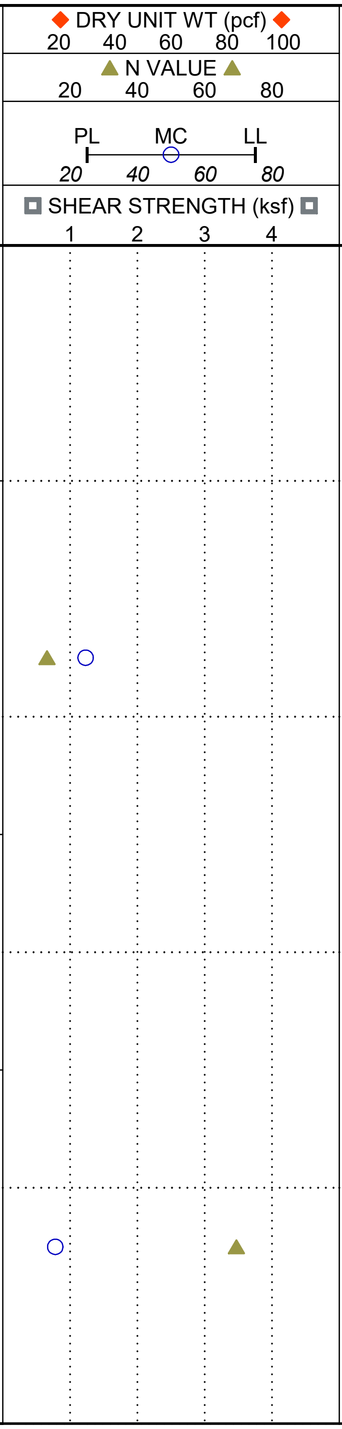
GEOTECHNICAL BORING LOG

BORING NUMBER P8

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/8/22 **COMPLETED** 6/8/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
			LEAN CLAY, Trace Sand & Gravel, Red to Gray, Stiff, Moist (CL) 3.0 ft	SPT 1		3-5-8 (13)	1	
			CLAYEY GRAVEL, With Sand, Red to Brown, Very Dense, Moist (GC) 5.0 ft	SPT 2		20-34-35 (69)	3.5	
5			Bottom of borehole at 5.0 feet.					



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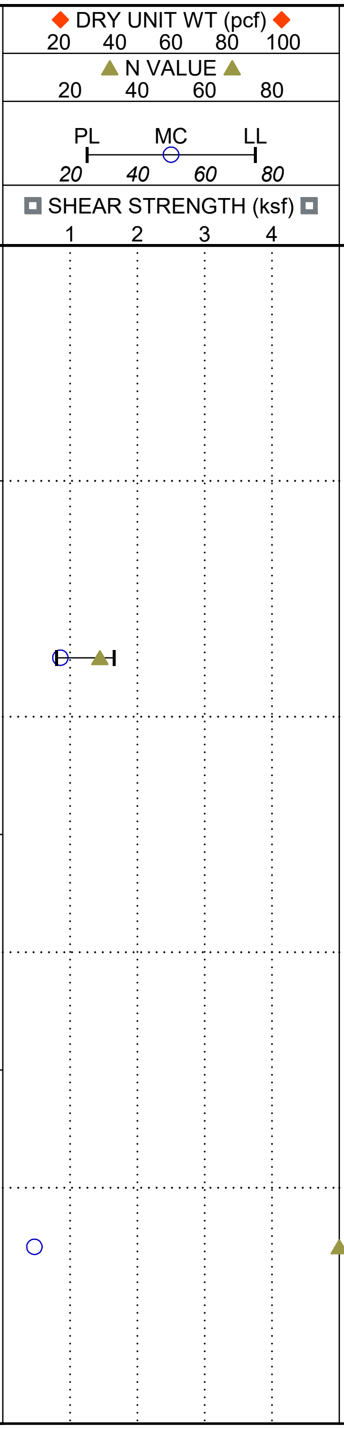
GEOTECHNICAL BORING LOG

BORING NUMBER P9

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/9/22 **COMPLETED** 6/9/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
			LEAN CLAY, With Sand & Gravel, Red to Brown, Very Stiff, Moist (CL)					
1				SPT 1		3-7-22 (29)	3	
2								
3			3.0 ft					
			CLAYEY GRAVEL, With Sand, Red to Brown, Very Dense, Moist (GC)					
4				SPT 2		35-66-55 (121)	0	
5			5.0 ft					



Bottom of borehole at 5.0 feet.

BORING LOG - PPI - PPI STD TEMPLATE.GDT - 6/24/22 09:36 - S:_MASTER PROJECT FILE\2022\OK\C\CHILDERS ARCHITECT-281188-WW HASTINGS SURFACE PARKING-SUB\BORING LOGS\281188 - GINT.GPJ

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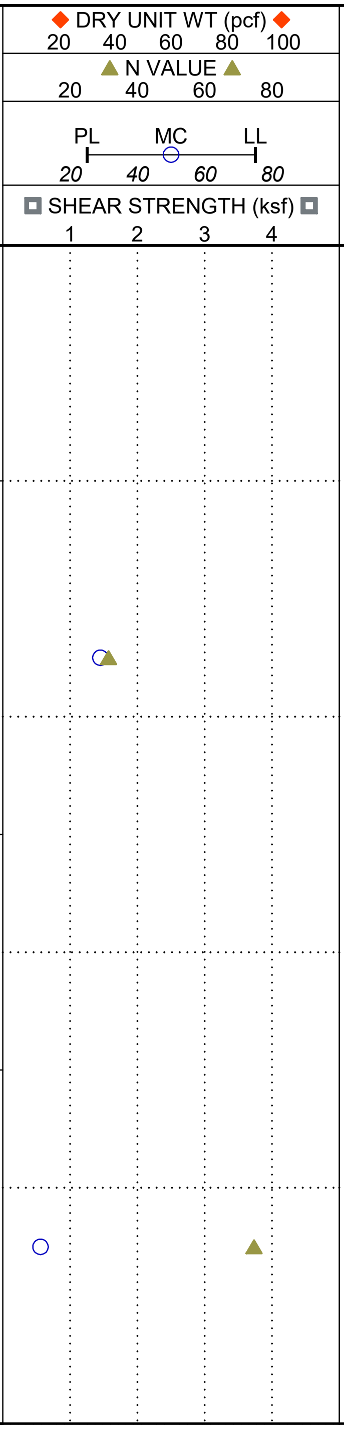
GEOTECHNICAL BORING LOG

BORING NUMBER P10

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/8/22 **COMPLETED** 6/8/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5")					
0.4 ft			LEAN CLAY, With Sand, Trace Gravel, Red to Brown, Hard, Moist (CL)					
1				SPT 1		3-4-28 (32)	1.25	
3.0 ft			CLAYEY GRAVEL, With Sand, Red to Brown, Very Dense, Moist (GC)					
4				SPT 2		22-35-39 (74)	2	
5.0 ft			Bottom of borehole at 5.0 feet.					



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GEOTECHNICAL BORING LOG

BORING NUMBER P11

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/9/22 **COMPLETED** 6/9/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	▲ N VALUE ▲	PL MC LL	ELEVATION (ft)
0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft							
		GRAVELLY LEAN CLAY, Red to Brown, Hard, Moist (CL)							
1			SPT 1		1-12-28 (40)	2	40	MC ≈ 20	
2		3.0 ft							
3		CLAYEY GRAVEL, With Sand, Red, Very Dense, Moist (GC) 3.8 ft	SPT 2		66/4"	1.25	>80	MC ≈ 10	

Refusal at 3.8 feet.
Bottom of borehole at 3.8 feet.

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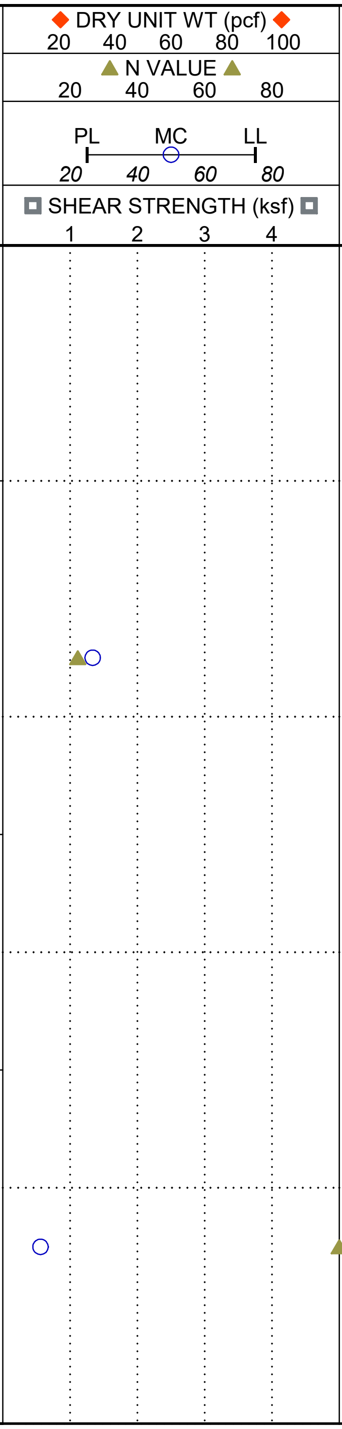
GEOTECHNICAL BORING LOG

BORING NUMBER P12

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/8/22 **COMPLETED** 6/8/22
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER SP **DRILL RIG** Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV **CHECKED BY** CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft					
		LEAN CLAY, With Sand & Gravel, Red to Brown, Very Stiff, Moist (CL) 3.0 ft					
1			SPT 1		3-5-17 (22)	1	
2							
3		CLAYEY SAND, With Gravel, Red to Tan, Very Dense, Moist (SC) 5.0 ft					
4			SPT 2		31-48-62 (110)	3.5	
5		Bottom of borehole at 5.0 feet.					



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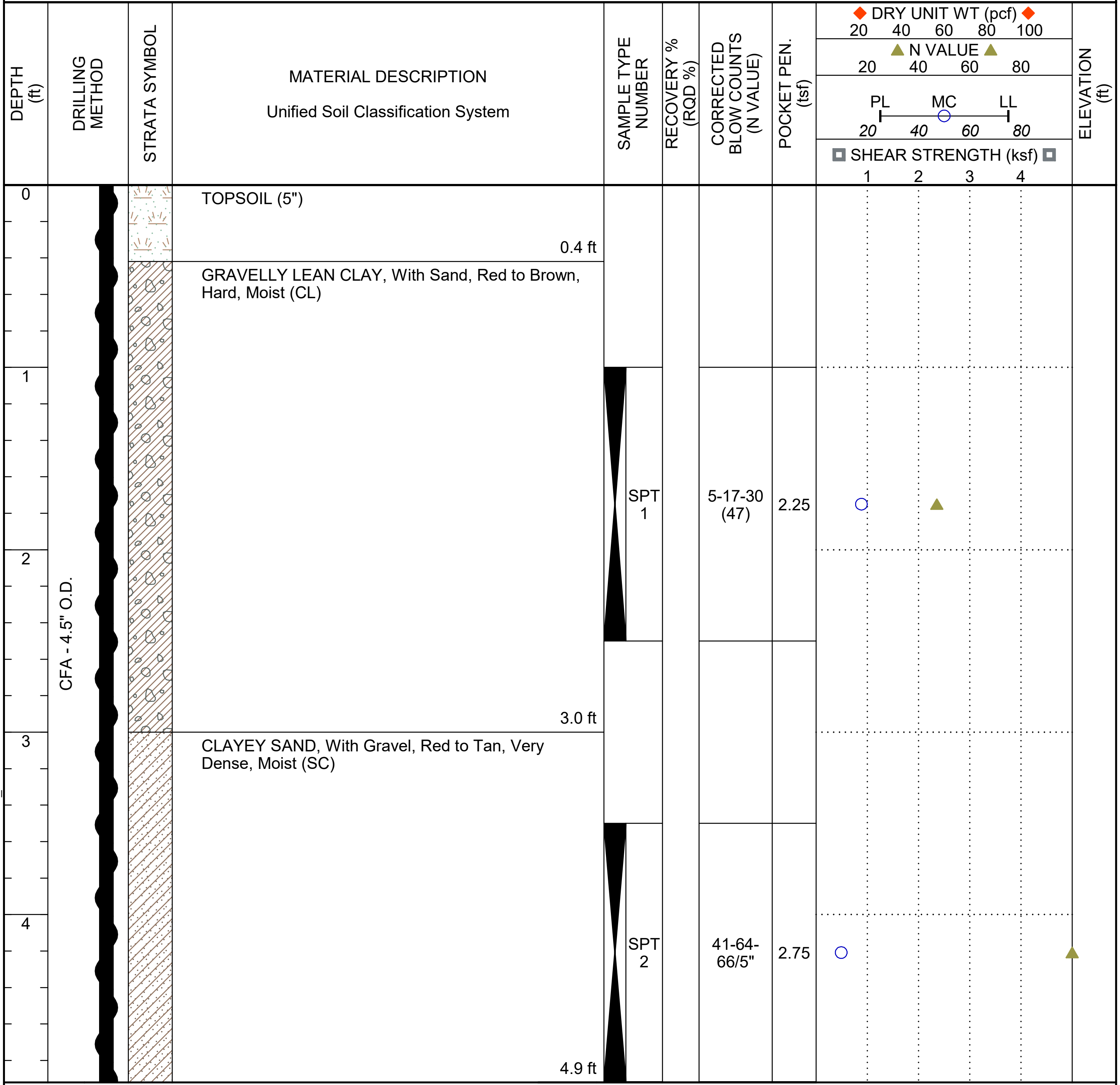
GEOTECHNICAL BORING LOG

BORING NUMBER P13

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/9/22
COMPLETED 6/9/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES



DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.	TOPSOIL (5") 0.4 ft					
		GRAVELLY LEAN CLAY, With Sand, Red to Brown, Hard, Moist (CL) 3.0 ft	SPT 1		5-17-30 (47)	2.25	
		CLAYEY SAND, With Gravel, Red to Tan, Very Dense, Moist (SC) 4.9 ft	SPT 2		41-64-66/5"	2.75	

Refusal at 4.9 feet.
Bottom of borehole at 4.9 feet.

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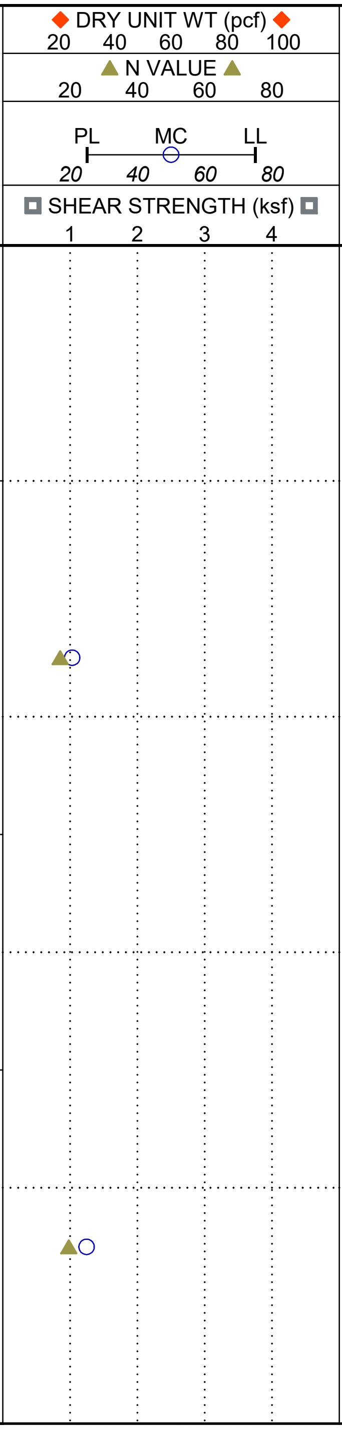
GEOTECHNICAL BORING LOG

BORING NUMBER P14

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/8/22
COMPLETED 6/8/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
			LEAN CLAY, With Sand & Gravel, Red to Brown, Very Stiff, Moist (CL)					
1				SPT 1		1-5-12 (17)	1.25	
2								
3			3.0 ft					
			GRAVELLY LEAN CLAY, With Sand, Red, Very Stiff, Moist (CL)					
4				SPT 2		9-8-12 (20)	3.25	
5			5.0 ft					



Bottom of borehole at 5.0 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER P15

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME WW Hastings Surface Parking

PROJECT NO. 281188

PROJECT LOCATION Tahlequah, OK

DATE STARTED 6/8/22 **COMPLETED** 6/8/22

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER SP **DRILL RIG** Dietrich D-50

GROUND WATER LEVELS

HAMMER TYPE Auto

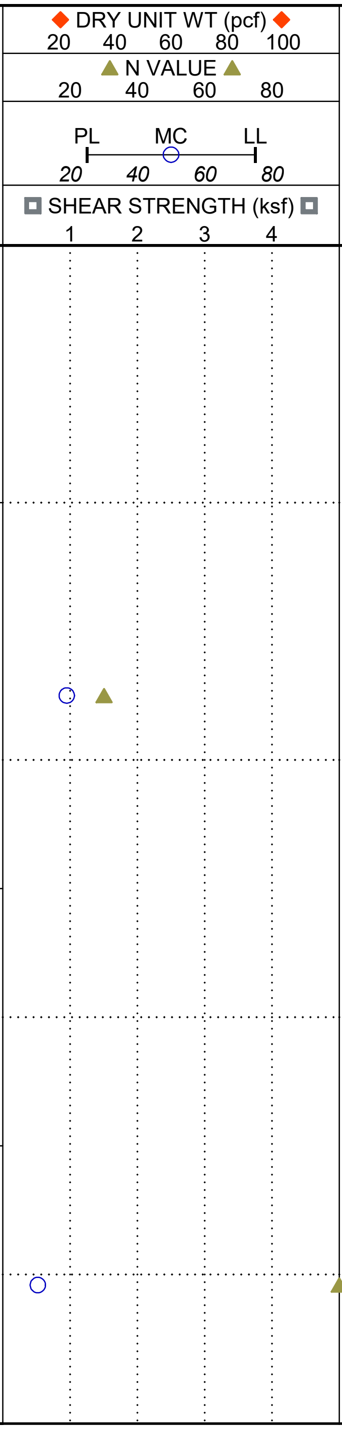
AT TIME OF DRILLING None

LOGGED BY MV **CHECKED BY** CL

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft					
1			GRAVELLY LEAN CLAY, With Sand, Red to Brown, Very Stiff, Moist (CL)					
2				SPT 1		3-10-20 (30)	1.25	
			3.0 ft					
3			CLAYEY GRAVEL, Wtih Sand, Red, Very Dense, Moist (GC)					
4			4.6 ft	SPT 2		43-66-66/1"	0.75	



Refusal at 4.6 feet.
Bottom of borehole at 4.6 feet.

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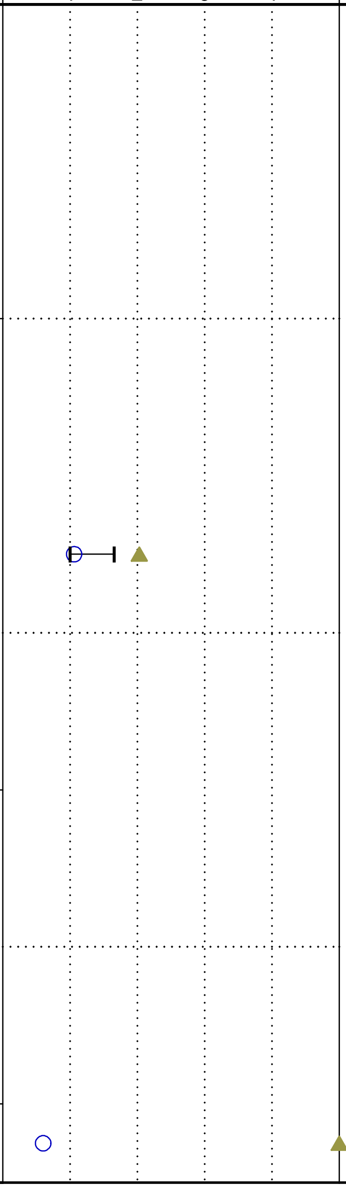
GEOTECHNICAL BORING LOG

BORING NUMBER P16

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK
DATE STARTED 6/8/22
COMPLETED 6/8/22
SURFACE ELEVATION
BENCHMARK EL.
DRILLER SP
DRILL RIG Dietrich D-50
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY MV
CHECKED BY CL
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	◆ DRY UNIT WT (pcf) ◆ 20 40 60 80 100 ▲ N VALUE ▲ 20 40 60 80 PL MC LL 20 40 60 80 ▣ SHEAR STRENGTH (ksf) ▣ 1 2 3 4	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (5") 0.4 ft						
			GRAVELLY LEAN CLAY, With Sand, Red to Brown, Hard, Moist (CL)						
1									
				SPT 1		3-13-28 (41)	2		
2									
3									
			- Red, Very Hard Below 3.5' 3.8 ft	SPT 2		66/3"	0.5		



Refusal at 3.8 feet.
Bottom of borehole at 3.8 feet.

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KEY TO SYMBOLS

CLIENT Childers Architect
PROJECT NAME WW Hastings Surface Parking
PROJECT NO. 281188
PROJECT LOCATION Tahlequah, OK

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

▨ CHERT: Chert
▨ CL: USCS Low Plasticity Clay
▨ CLG: USCS Low Plasticity Gravelly Clay
▨ GC: USCS Clayey Gravel
▨ SC: USCS Clayey Sand
▨ TOPSOIL: Topsoil

SAMPLER SYMBOLS

⧗ Standard Penetration Test

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
∇ Water Level at Time Drilling, or as Shown
▼ Water Level at End of Drilling, or as Shown
▼ Water Level After 24 Hours, or as Shown

APPENDIX II

GENERAL NOTES

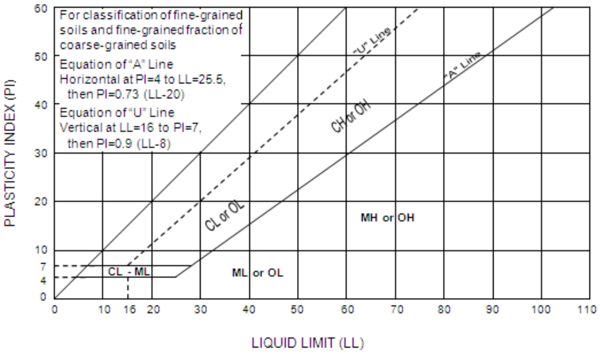
PALMERTON & PARRISH, INC.

GENERAL NOTES

SOIL PROPERTIES & DESCRIPTIONS

COHESIVE SOILS

Consistency	Unconfined Compressive Strength (Qu)	Pocket Penetrometer Strength	N-Value
	(psf)	(tsf)	(blows/ft)
Very Soft	<500	<0.25	0-1
Soft	500-1000	0.25-0.50	2-4
Medium Stiff	1001-2000	0.50-1.00	5-8
Stiff	2001-4000	1.00-2.00	9-15
Very Stiff	4001-8000	2.00-4.00	16-30
Hard	>8000	>4.00	31-60
Very Hard			>60



Group Symbol	Group Name
CL –	Lean Clay
ML –	Silt
OL –	Organic Clay or Silt
CH –	Fat Clay
MH –	Elastic Silt
OH –	Organic Clay or Silt
PT –	Peat
CL-CH –	Lean to Fat Clay

Plasticity		Moisture	
Description	Liquid Limit (LL)	Descriptive Term	Guide
Lean	<45%	Dry	No indication of water
Lean to Fat	45-49%	Moist	Indication of water
Fat	≥50%	Wet	Visible water

Fine Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms: SILT, LEAN CLAY, FAT CLAY, ELASTIC SILT	PRIMARY CONSTITUENT
Sandy,gravelly, abundant cobbles, abundant boulders	>30-50]
with sand, with gravel, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered sand, scattered gravel, scattered cobbles, scattered boulders	5-15]
a trace sand, a trace gravel, a few cobbles, a few boulders	<5]
The relationship of clay and silt constituents is based on plasticity and normally determined by performing index tests. Refined classifications are based on Atterberg Limits tests and the Plasticity Chart.	

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	N-VALUE
Very Loose	0-4
Loose	5-10
Medium Dense	11-24
Dense	25-50
Very Dense	≥51

MOISTURE CONDITION	
Descriptive Term	Guide
Dry	No indication of water
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table.

**GRAIN SIZE IDENTIFICATION		
Name	Size Limits	Familiar Example
Boulder	12 in. or more	Larger than basketball
Cobbles	3 in. to 12 in.	Grapefruit
Coarse Gravel	¾-in. to 3 in.	Orange or lemon
Fine Gravel	No. 4 sieve to ¾-in.	Grape or pea
Coarse Sand	No. 10 sieve to No. 4 sieve	Rock salt
Medium Sand	No. 40 sieve to No. 10 sieve	Sugar, table salt
Fine Sand*	No. 200 sieve to No. 40 sieve	Powdered sugar
Fines	Less than No. 200 sieve	
*Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8 in.		

Coarse Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms: GRAVEL, SAND, COBBLES, BOULDERS	PRIMARY CONSTITUENT
Sandy,gravelly, abundant cobbles, abundant boulders	>30-50]
with gravel, with sand, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered gravel, scattered sand, scattered cobbles, scattered boulders	5-15]
a trace gravel, a trace sand, a few cobbles, a few boulders	<5]
Silty (MH & ML)*, clayey (CL & CH)*	<15]
(with silt, with clay)*	5-15] – secondary fine grained constituents
(trace silt, trace clay)*	<5]
*Index tests and/or plasticity tests are performed to determine whether the term "silt" or "clay" is used.	

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987

GENERAL NOTES

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD)

Description of Rock Quality	*RQD (%)
Very Poor	< 25
Poor	25-50
Fair	50-75
Good	75-90
Excellent	90-100

*RQD is defined as the total length of sound core pieces 4 in. or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

SCALE OF RELATIVE ROCK HARDNESS

Term	Field Identification	Approx. Unconfined Compressive Strength (tsf)
Extremely Soft	Can be indented by thumbnail	2.6-10
Very Soft	Can be peeled by pocket knife	10-50
Soft	Can be peeled with difficulty by pocket knife	50-260
Medium Hard	Can be grooved 2 mm deep by firm pressure of knife	260-520
Moderately Hard	Requires one hammer blow to fracture	520-1040
Hard	Can be scratched with knife or pick only with difficulty	1040-2610
Very Hard	Cannot be scratched by knife or sharp pick	>2610

DEGREE OF WEATHERING

Slightly Weathered	Rock generally fresh, joints stained and discoloration extends into rock up to 25mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered	Rock mass is decomposed 50% or less, significant portions of rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
Highly Weathered	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

GRAIN SIZE (TYPICALLY FOR SEDIMENTARY ROCKS)

Description	Diameter (mm)	Field Identification
Very Coarse Grained	>4.76	
Coarse Grained	2.0-4.76	Individual grains can easily be distinguished by eye.
Medium Grained	0.42-2.0	Individual grains can be distinguished by eye.
Fine Grained	0.074-0.42	Individual grains can be distinguished by eye with difficulty.
Very Fine Grained	<0.074	Individual grains cannot be distinguished by unaided eye.

VOIDS

Pit	Voids barely seen with naked eye to 6mm (¼-in)
Vug	Voids 6 to 50mm (¼ to 2 in) in diameter
Cavity	50 to 6000mm (2 to 24 in) in diameter
Cave	>600mm

BEDDING THICKNESS

Very Thick Bedded	> 3’ thick
Thick Bedded	1’ to 3’ thick
Medium Bedded	4” to 1’ thick
Thin Bedded	1¼” to 4” thick
Very Thin Bedded	½” to 1¼” thick
Thickly Laminated	⅛” to ½” thick
Thinly Laminated	⅛” or less (paper thin)

DRILLING NOTES

Drilling and Sampling Symbols

NQ – Rock Core (2-in. diameter)
HQ – Rock Core (3 in. diameter)
HSA – Hollow Stem Auger
CFA – Continuous Flight (Solid Stem) Auger
SS – Split Spoon Sampler
ST – Shelby Tube
WB – Wash Bore or Mud Rotary
TP – Test-Pit
HA – Hand Auger

Soil Sample Types

Shelby Tube Samples: Relatively undisturbed soil samples were obtained from the borings using thin wall (Shelby) tube samplers pushed hydraulically into the soil in advance of drilling. This sampling, which is considered to be undisturbed, was performed in accordance with the requirements of ASTM D 1587. This type of sample is considered best for the testing of "in-situ" soil properties such as natural density and strength characteristics. The use of this sampling method is basically restricted to soil containing little to no chert fragments and to softer shale deposits.

Split Spoon Samples: The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The “N” value corresponds to the number of blows required to drive the last 1 foot of an 18-in. long, 2-in. O.D. split-barrel sampler with a 140 lb. hammer falling a distance of 30 in. The Standard Penetration Test is carried out according to ASTM D-1586.

Water Level Measurements

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, shallow groundwater may indicate a perched condition. Caution is merited when interpreting short-term water level readings from open bore holes. Accurate water levels are best determined from piezometers.

Automatic Hammer

Palmerton and Parrish’s CME’s are equipped with automatic hammers. The conventional method used to obtain disturbed soil samples used a safety hammer operated by company personnel with a cat head and rope. However, use of an automatic hammer allows a greater mechanical efficiency to be achieved in the field while performing a Standard Penetration resistance test based upon automatic hammer efficiencies calibrated using dynamic testing techniques.

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987

APPENDIX III

GRAIN SIZE ANALYSIS RESULTS

4168 W Kearney St.
Springfield, MO 65803
Telephone: 417-864-6000

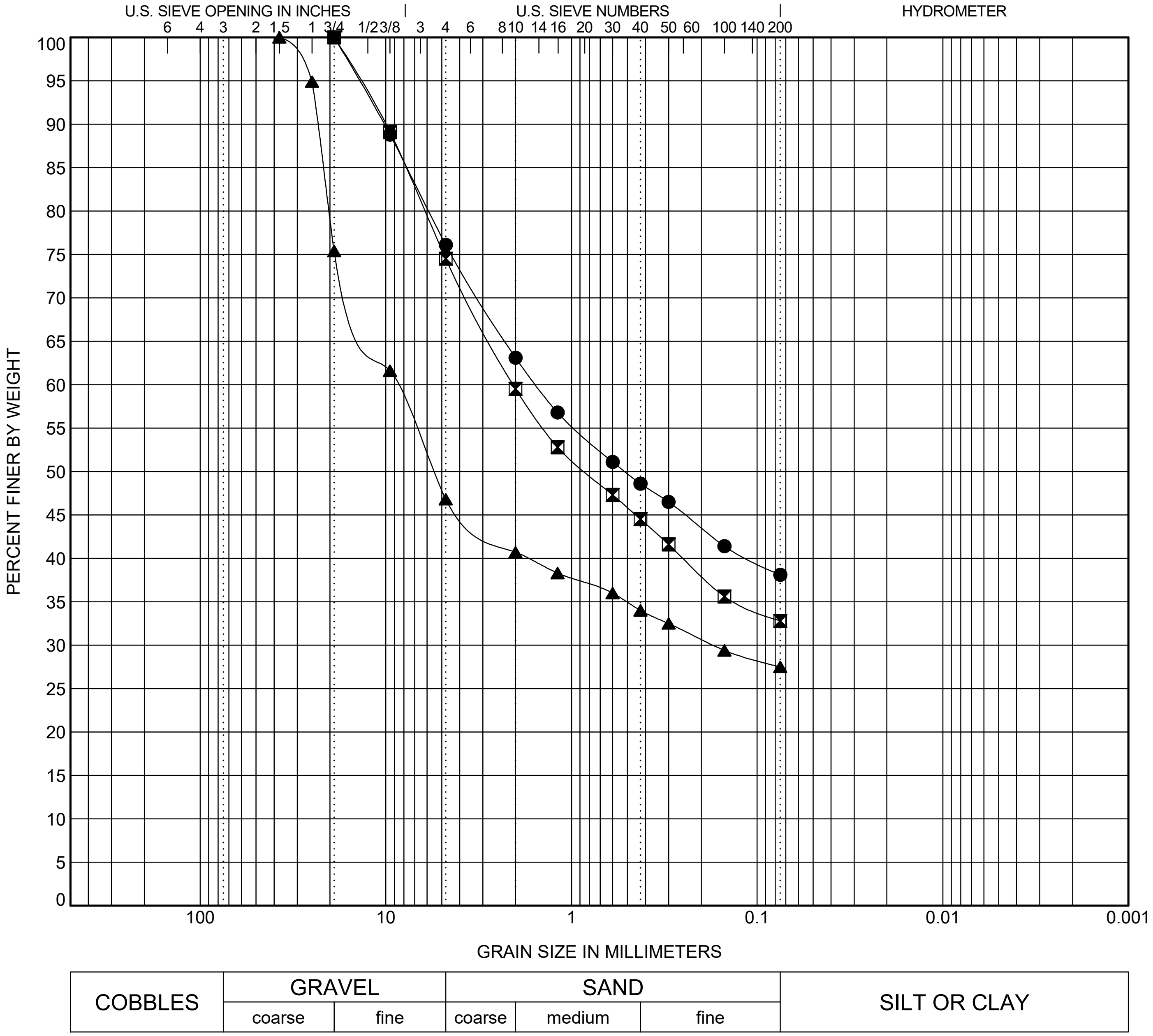
GRAIN SIZE DISTRIBUTION

CLIENT Childers Architect

PROJECT NAME WW Hastings Surface Parking

PROJECT NO. 281188

PROJECT LOCATION Tahlequah, OK



BOREHOLE		DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**DB3**	**6.0**	**CLAYEY SAND with GRAVEL(SC)**					
☒	**EP5**	**6.0**	**CLAYEY SAND with GRAVEL(SC)**					
▲	**P3**	**3.5**	**CLAYEY GRAVEL with SAND(GC)**					

BOREHOLE		DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**DB3**	**6.0**	**19**	**1.548**			**23.9**	**38.0**	**38.1**	
☒	**EP5**	**6.0**	**19**	**2.059**			**25.5**	**41.7**	**32.8**	
▲	**P3**	**3.5**	**37.5**	**8.814**	**0.172**		**53.2**	**19.3**	**27.5**	

GRAIN SIZE - PPI STD TEMPLATE.GDT - 6/22/22 15:37 - S:_MASTER PROJECT FILE\2022\OK\C\CHILDERS ARCHITECT-281188-WW HASTINGS SURFACE PARKING-SUB\BORING LOGS\281188 - GINT.GPJ

APPENDIX IV

IMPORTANT INFORMATION REGARDING YOUR GEOTECHNICAL REPORT

Important Information about This

Geotechnical-Engineering Report

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

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

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

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

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

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

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL
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