ECS Southwest, LLP

Geotechnical Engineering Report

Coweta Trails Phase II

11954 S 273rd E Avenue
Coweta, Oklahoma

ECS Project Number 58:1518

August 26, 2022

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Mr. Dean L. Carlson, P.E.
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ECS Project No. 58:1518

Reference: Geotechnical Engineering Report
Coweta Trails Phase II
11954 S 273rd E Avenue
Coweta, Oklahoma

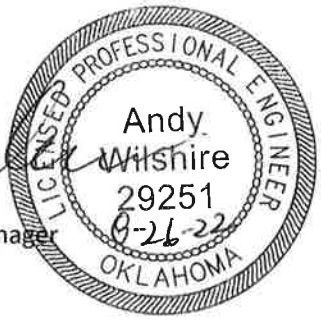
Dear Mr. Carlson:

ECS Southwest (ECS) has completed the subsurface exploration, laboratory testing, and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our agreed to scope of work. This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted, and our design and construction recommendations.

It has been our pleasure to be of service to Carlson Consulting Engineers, Inc. during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and we would like to provide our services during construction phase operations as well to verify subsurface conditions assumed for this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Southwest, LLP



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EXECUTIVE SUMMARY

This Executive Summary is intended as a very brief overview of the primary geotechnical conditions that are expected to affect design and construction. The following summarizes the main findings of the exploration, particularly those that may have a cost impact on the planned development. Further, our principal foundation recommendations are summarized. Information gleaned from the executive summary should not be utilized in lieu of reading the entire geotechnical report.

- The planned project is understood to be a three-story senior living apartment with a building footprint of approximately 19,146 square feet and is assumed to consist of structural steel/masonry and/or wood frame construction. Anticipated maximum structural loads are assumed to be column and wall loading of 100 kips and 6 kips/foot, respectively. We have also assumed the structure will have a finished floor elevation at or near existing grade.

- The planned structure may be supported on a shallow foundation system consisting of spread footings with conventional slab on grade, provided the subgrade is improved and prepared as outlined in this report. A reinforced slab with grade beams (monolithic slab/BRAB) or post-tensioned slab on grade may also be used.

- Should a conventional slab on grade be used, subgrade improvements of the highly plastic clay soils are necessary below the planned structure to reduce the potential for vertical movements. Specific details on addressing these highly plastic clay soils are presented in the body of the report.

- Pavements should be supported directly on stabilized subgrades or a layer of aggregate base upon subgrades that are evaluated and prepared as outlined in this report.

- It is recommended that ECS conduct a geotechnical review of the project plans (prior to issuance for construction) to check to see that ECS' geotechnical recommendations have been properly interpreted and implemented.

- To prevent misinterpretation of ECS recommendations, ECS should be retained to perform quality control testing and documentation during construction of the earthwork and foundations for the project.

1.0 INTRODUCTION

The purpose of this study was to provide geotechnical information for the design and construction of the foundations, floor slabs, and pavements for the planned Coweta Trails Phase II project located at 11954 S 273rd E Avenue in Coweta, Oklahoma. The recommendations developed for this report are based on project information provided by the client.

Our services were provided in accordance with our Proposal No. 58:2082-GP, dated July 8, 2022, authorized by the client by providing the signed contract on July 21, 2022, which includes our agreed to terms and conditions.

This report contains the procedures and results of our subsurface exploration and laboratory testing programs, review of existing site conditions, engineering analyses, and recommendations for the design and construction of the project.

The report includes the following items.

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

2.0 PROJECT INFORMATION

2.1 PROJECT LOCATION/CURRENT SITE USE

The project is located at 11954 S 273rd E Avenue in Coweta, Oklahoma. The location is depicted in Figure 2.1.1 as shown below.

Figure 2.1.1. Site Location

ECS reviewed aerial photographs of the subject site dated 1995 to 2022. Since February 1995, the site appears to have been a vacant, grassed property. At some time between May and September 2020 it appears construction of the existing Coweta Trails facility adjacent to the south had commenced and this site was used for a construction staging area. At some time between February 2021 and June 2022, it appears the construction of the existing Coweta Trails facility was completed. Since that time, the site has remained relatively unchanged.

Currently the site is a vacant, grassed property with what appears to be a drainage channel along the northeast perimeter. The topography of the site generally slopes down from west to east with maximum and minimum boring elevations of approximately EL 665 feet and EL 662 feet, respectively. The ground surface elevations noted in this report were obtained from Google Earth and have been rounded to the nearest foot.

2.2 Proposed Construction

The following information explains our understanding of the planned development including the proposed buildings and related infrastructure.

SUBJECT	DESIGN INFORMATION / ASSUMPTIONS
Building Footprint	Approximately 19,146 square feet in plan view
# of Stories	Three-story, above grade
Usage	Senior Apartments
Framing (assumed)	Structural steel/masonry and/or wood frame
Column Loads (assumed)	100 kips (Full Dead and Live Load) maximum
Wall Loads (assumed)	6 kips per linear foot (klf) maximum

SUBJECT	DESIGN INFORMATION / ASSUMPTIONS
Lowest Finish Floor Elevation	Unknown, assumed no more than 2 feet below or above existing grades

We also understand that associated parking/drive areas will be constructed. *If ECS' understanding of the project is* not *correct, especially if the structural loads are different, please contact ECS so that we may review these changes and revise our recommendations, as appropriate.*

3.0 FIELD EXPLORATION AND LABORATORY TESTING

Our exploration procedures are explained in greater detail in Appendix B including the insert titled Subsurface Exploration Procedures. Our scope of work included drilling nine (9) borings. The boring locations were selected by ECS based on information provided by the client and identified in the field by the private utility locator using boring GPS coordinates generated by ECS. The approximate as-drilled boring locations are shown on the Boring Location Diagram in Appendix A.

3.1 Subsurface Characterization

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

Approximate Depth of Bottom of Strata Below Grade	Elevation[(1)] (ft)	Stratum	Material Description	Consistency / Density
6 inches	---	Cover	Topsoil	--
16 to 17 feet	Elevation 647 to 645	I	(CL) LEAN CLAY and LEAN CLAY WITH SAND, various shades of brown, orange, gray, and black	Firm to Hard
18.5[(2)] feet	Elevation 644	II[(3)]	(WR) WEATHERED LIMESTONE, light brown	Very Hard

Notes:

(1) Elevations are approximate.
(2) Depth to deepest boring termination depth.
(3) Auger refusal was encountered in/on Stratum II in the building borings only at depth of approximately 16 to 18.5 feet.

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

3.2 Groundwater Observations

Water levels were measured in our boring logs in Appendix B. Groundwater was not observed in the borings at the time of our exploration and is indicated on the boring logs as "dry".

Variations in the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors.

3.3 Laboratory Testing

The laboratory testing consisted of selected tests performed on samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples. Testing performed include moisture content, Atterberg Limits, percent passing the No. 200 sieve.

Samples were visually classified on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) and including USCS classification symbols, and ASTM D2487 Standard Practice for Classification for Engineering Purposes (Unified Soil Classification System (USCS). After classification, the samples were grouped in the major zones noted on the boring logs in Appendix B. The group symbols for each soil type are indicated in parentheses along with the soil descriptions. The stratification lines between strata on the logs are approximate; in situ, the transitions may be gradual.

4.0 DESIGN RECOMMENDATIONS

4.1 Potential Vertical Movements

The intent of recommendations contained in this report are provided in order to reduce the potential risk associated with the shrink/swell tendencies of the on-site expansive soil, should a conventional slab on grade be used.

The majority of clay soils encountered in the borings have a high expansion potential. Based on our Atterberg limits laboratory test results and experience with similar soils, we estimate potential vertical soil movements (PVM) of the highly expansive soils encountered in the borings of up to about 3 inches, based on dry moisture conditions. These potential movements reflect moisture changes in the soil that can occur over the life of the structure and after construction is complete. The actual movements could be greater if poor drainage, ponded water, and/or other unusual sources of moisture are allowed to saturate the soils beneath the structure after construction.

4.2 Subgrade Improvements

In order to reduce the risk associated with future movements of a conventional slab on grade, we recommend the following general building pad subgrade improvements to reduce the PVM to approximately 1 inch. Please note, these recommendations are the minimum requirements to reduce potential movements below the floor slab due to expansion potential. If a monolithic slab/BRAB or post-tensioned slab is used, subgrade improvements are not required.

Options	Depth of Select Fill (feet)	Depth of Moisture Conditioning (feet)	Total Depth of Improved Zone (feet)	Estimated PVM (inch)
Option 1	2.5	---	2.5	1
Option 2	2	2	4	1
Option 3	---	5	5	1

The subgrade improvements should extend at least 5 feet beyond the edge of the building pads and include any flatwork sensitive to movements such as sidewalks or pavements. Exterior perimeter footing/grade beam backfill should consist of moisture conditioned clay soil. Please refer to the "Material Specifications" section of this report for more details.

These design parameters assume that positive drainage will be provided away from the structures and with moderate irrigation of surrounding lawn and planter areas with no excessive wetting or drying of soils adjacent to the foundations. Greater potential movements could occur with extreme wetting or drying of the soils due to ponding of water, plumbing leaks or lack of irrigation. Recommendations for earthwork operations are found in the "Site Construction Recommendations" portion of this report.

4.3 FOUNDATIONS

Provided the subgrades are improved and structural fills are prepared as recommended in this report, the proposed structures can be supported by conventional shallow foundations including column footings and continuous wall footings. We recommend the foundation design use the following parameters:

Design Parameter	Column Footing	Wall Footing
Net Allowable Bearing Pressure(1)	3,000 psf	3,000 psf
Acceptable Bearing Soil Material	Natural Soil or Compacted Fill	Natural Soil or Compacted Fill
Minimum Width	24 inches	18 inches
Minimum Footing Embedment Depth (below slab or finished grade) (2)	24 inches	24 inches
Estimated Total Settlement (3)	Less than 1- inch	Less than 1- inch
Estimated Differential Settlement (4)	Less than ¾ inches between columns	Less than ¾ inches per 30 linear feet

Notes:

(1) Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
(2) For bearing considerations and frost penetration requirements.
(3) Based on our assumed structural loads. If final loads are different, ECS must be contacted to update foundation recommendations and settlement calculations.
(4) Based on maximum loads and variability in borings. Differential settlement can be re-evaluated once the foundation plans are more complete.

Monolithic Slab/BRAB: Should improving the subgrade in order to use conventional shallow foundations and slab on grade be cost prohibitive, foundations consisting of a reinforced slab with grade beams (monolithic slab/BRAB) under load bearing walls could also be used to support the proposed structures.

The reinforced slab may be designed using a soil modulus of subgrade reaction of 125 pci and the grade beams or spread footings may be design for a net allowable soil bearing pressure of 3,000

psf bearing on newly placed and compacted select fill or natural soils that were encountered in the borings.

If a monolithic slab is used this system may be designed with conventional reinforcing. The slab should be designed in accordance with WRI/CRSI "Design Slab-On-Ground Foundations". The structure can be supported on a monolithic/waffle slab and grade beam foundation system designed in accordance with the following information:

Design Parameter	BRAB/WRI Slab
Allowable Bearing Pressure	3,000 psf
Design PI	30
Climatic Rating (Cw)	20
Soil-Climate Support Index (1-C)	0.15

Post-Tensioned Slab: In lieu of a BRAB/WRI slab, a post-tensioned slab on grade could be used. The following design parameters are recommended for the Post-Tensioning Institute's slab-on-grade design method (3rd Edition) should that method be chosen:

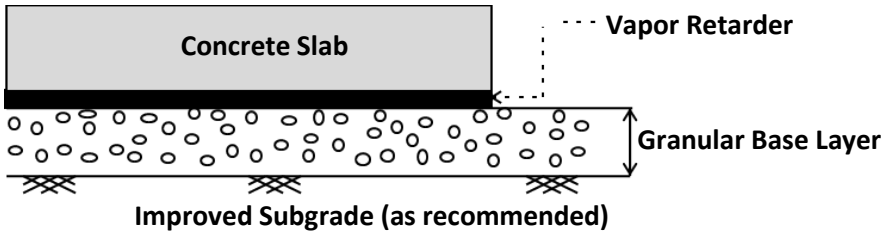
Center Lift		Edge Lift	
e_m (feet)	Y_m (inches)	e_m (feet)	Y_m (inches)
6.5	0.5	3.5	0.8

Potential Undercuts: DCP testing of the bearing soils by ECS representatives should be incorporated during construction to verify their suitability for supporting shallow foundations. If soft or inadequate soils are observed at the footing bearing elevations, these soils should be undercut and removed. Any undercut should be backfilled with lean concrete ($f'_c \geq 1{,}000$ psi at 28 days) up to the original design bottom of footing elevation; the original footing shall be constructed on top of the hardened lean concrete.

4.4 Conventional Slab on Grade

A conventional slab on grade may be used provided it is supported on subgrades improved as presented in this report.

The following graphic depicts our soil-supported slab recommendations:



1. Concrete Slab Thickness: 4 inches minimum
2. Concrete Slab Strength: 3,000 psi minimum
3. Drainage Layer Thickness: 4 inches minimum
4. Drainage Layer Material: GRAVEL (GP, GW)
5. Subgrade compacted per the earthwork recommendations provided.

Subgrade Modulus: Provided subgrades are improved and prepared as discussed herein, the slab may be designed assuming a modulus of subgrade reaction, k_1 of 125 pci (lbs/cu. inch).

Vapor Retarder: Before the placement of concrete, a vapor retarder may be placed on top of the granular drainage layer to provide additional protection against moisture penetration through the floor slab. When a vapor retarder is used, special attention should be given to surface curing of the slab to reduce the potential for uneven drying, curling and/or cracking of the slab. Depending on proposed flooring material types, the structural engineer and/or the architect may choose to eliminate the vapor retarder.

Slab Isolation: Soil-supported slabs should be isolated from the foundations and foundation-supported elements of the structure so that differential movement between the foundations and slab will not induce excessive shear and bending stresses in the floor slab. Where the structural configuration prevents the use of a free-floating slab such as in a drop-down footing/monolithic slab configuration, the slab should be designed with suitable reinforcement and load transfer devices to preclude overstressing of the slab.

4.5 Building Perimeter Conditions

Soils placed along the exterior of the foundations should consist of fine-grained soils encountered on site, placed and compacted in accordance with this report. The purpose of this clay backfill is to reduce the opportunity for surface or subsurface water infiltration beneath the structure. Additionally, where lateral penetrations (for utilities) into or below the structure occur, a clay plug (or suitable synthetic alternative) should be placed at the building line to reduce the opportunity for infiltrating water, regardless of the backfill material. A clay plug detail is included in Appendix A.

Positive drainage away from the structure should also be provided. Additionally, irrigation of lawn and landscaped areas should be moderate, with no excessive wetting or drying of soils around the perimeter of the structures allowed. Trees and bushes/shrubs planted near the perimeter of the structures can withdraw large amounts of water from the soils and should be planted at least their anticipated mature height away from the building.

Where flatwork is placed against or near the structure, a positive seal must be installed and adequately maintained to limit water intrusion. Down spouts and gutters should be used to collect and distribute water at least 10 feet away from the structure.

Routine maintenance of the building perimeter condition is necessary so that the recommendations contained in this report are followed and maintained. Greater potential vertical movements could occur with extreme wetting or drying of the soils due to poor drainage, ponding of water, plumbing leaks, lack of irrigation, and/or lack of routine maintenance, etc.

4.6 Seismic Design Considerations

Seismic Site Classification: The International Building Code (IBC) 2015/2018 requires site classification for seismic design based on the upper 100 feet of a soil profile. At least two methods are utilized in classifying sites, namely the shear wave velocity (v_s) method and the Standard Penetration Resistance (N-value) method. The Standard Penetration Resistance (N-value) method was used in classifying this site.

SEISMIC SITE CLASSIFICATION			
Site Class	**Soil Profile Name**	**Shear Wave Velocity, Vs, (ft./s)**	**N value (bpf)**
A	Hard Rock	Vs > 5,000 fps	N/A
B	Rock	2,500 < Vs ≤ 5,000 fps	N/A
C	Very dense soil and soft rock	1,200 < Vs ≤ 2,500 fps	>50
D	Stiff Soil Profile	600 ≤ Vs ≤ 1,200 fps	15 to 60
E	Soft Soil Profile	Vs < 600 fps	<15

Based upon our interpretation of the subsurface conditions, the appropriate Seismic Site Classification is "C" as shown in the preceding table.

Ground Motion Parameters: In addition to the seismic site classification, ECS has determined the design spectral response acceleration parameters following the IBC methodology. The Mapped Reponses were estimated from the U.S. Seismic Design Maps website https://seismicmaps.org/. The design responses for the short (0.2 sec, S_{DS}) and 1-second period (S_{D1}) are noted in bold at the far right end of the following table.

GROUND MOTION PARAMETERS [IBC 2015 Method]								
Period (sec)	**Mapped Spectral Response Accelerations (g)**		**Values of Site Coefficient for Site Class**		**Maximum Spectral Response Acceleration Adjusted for Site Class (g)**		**Design Spectral Response Acceleration (g)**	
Reference	Figures 1613.3.1 (1) & (2)		Tables 1613.3.3 (1) & (2)		Eqs. 16-37 & 16-38		Eqs. 16-39 & 16-40	
0.2	S_S	0.138	F_a	1.2	$S_{MS}=F_aS_s$	0.166	$S_{DS}=2/3\ S_{MS}$	0.11
1.0	S_1	0.072	F_v	1.7	$S_{M1}=F_vS_1$	0.122	$S_{D1}=2/3\ S_{M1}$	0.082

The Site Class definition should not be confused with the Seismic Design Category designation which the Structural Engineer typically assesses. If a higher site classification is beneficial to the project, we can provide additional testing methods that may yield more favorable results.

4.7 PAVEMENTS

Subgrade Characteristics: Based on the results of our borings, it appears that the pavement subgrades will consist of existing high plasticity soils. The subgrade should be prepared in accordance with the recommendations in the "Site Construction Recommendations" section of this report.

Design Traffic Loading: We were not provided traffic loading information so we have assumed heavy duty pavements will experience a maximum traffic loading of 380,000 ESALs.

The preliminary pavement sections below are guidelines that may or may not comply with local jurisdictional minimums.

PROPOSED PAVEMENT SECTIONS				
MATERIAL	FLEXIBLE PAVEMENT		RIGID PAVEMENT	
	Heavy Duty	Light Duty	Heavy Duty	Light Duty
Portland Cement Concrete(1)	-	-	6 in.	5 in.
Asphaltic Concrete Surface Course	2 in.	2 in.	-	-
Asphaltic Concrete Binder Course(2)	4 ½ in	3 in.	-	-
Stabilized Subgrades(3,4)	8 in.	8 in.	8 in.	8 in.

Notes:

(1) Due to the excessive surface wear and subsequent deterioration of asphalt pavement caused by turning truck traffic, we recommend that any areas where trucks will be turning or backing up be constructed of Portland cement concrete only.
(2) ODOT Type A aggregate base material may be substituted for the asphalt binder using a substitute ratio of three inches of aggregate base for each inch of asphalt binder.
(3) Based on experience with similar soils, we estimate 5 percent lime will be required to stabilize the near surface soils at this site. The final amount and type of stabilizing agent should be determined at the time of construction based on the type(s) of material(s) at final grade.
(4) In lieu of stabilized subgrades, 6 inches of ODOT Type A aggregate base material may be used.

ECS should be allowed to review these recommendations and make appropriate revisions based upon the formulation of the final traffic design criteria for the project. It is important to note that the design sections do not account for construction traffic loading. It should also be noted that these design recommendations may not satisfy the local jurisdictional traffic guidelines. Any roadways constructed for public use and to be dedicated to the local or state jurisdiction for repair and maintenance must be designed in accordance with those jurisdictional requirements.

In general, heavy duty sections are areas that will be subjected to trucks, buses, or other similar vehicles including main drive lanes of the development. Light duty sections are appropriate for vehicular traffic and parking areas.

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

Large, front loading trash dumpsters frequently impose concentrated front wheel loads on pavements during loading. This type of loading typically results in rutting of asphalt pavement and ultimately pavement failures. For preliminary design purposes, we recommend that the pavement in trash pickup areas consist of an 8 inch thick Portland Cement Concrete (PCC) pavement section. Appropriate jointing should also be incorporated into the design of the PCC pavement. When traffic loading becomes available ECS or the Civil Engineer can design the pavements.

Pavements should be specified, constructed and tested to meet the ODOT Standard Specifications for Highway Construction and the following requirements:

1. Reinforcing steel may consist of #3 reinforcing steel bars placed at 18 inches on center each way.

2. Hot Mix Asphaltic Concrete: In accordance with Oklahoma Department of Transportation (ODOT) Standard Specifications.

3. Portland Cement Concrete: Minimum compressive strength of 3,500 psi (28 Days). Concrete should be designed with 3 to 6 percent entrained air.

Crushed Limestone Base Material: ODOT Type A Aggregate Base. The material should be compacted to a minimum 95 percent of Standard Proctor maximum dry density (ASTM D 698) and within three percentage points of the material's optimum moisture.

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 SUBGRADE PREPARATION

In a dry and undisturbed state, the upper 1-foot of the majority of the soil at the site should provide good subgrade support for fill placement and construction operations. However, when wet, this soil will degrade quickly with disturbance from contractor operations. Therefore, good site drainage should be maintained during earthwork operations, which should help maintain the integrity of the soil.

The surface of the site should be kept properly graded in order to enhance drainage of the surface water away from the proposed structures during the construction phase. We recommend that an attempt be made to enhance the natural drainage without interrupting its pattern, where possible.

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

5.1.1 Stripping and Grubbing

The subgrade preparation should consist of removing all existing foundations, utilities, and pavements, and stripping all vegetation, topsoil, loose, poorly compacted or deleterious existing soils, existing fill (as defined in this report), and any soft or yielding materials from the 5-foot expanded building area, and any areas receiving new fill. Deeper topsoil or organic laden soils may be present in wet, low-lying, and poorly drained areas. ECS should be retained to verify that topsoil

and yielding surficial materials have been removed prior to the placement of structural fill or construction of structures.

5.1.2 Proofrolling

Prior to fill placement or other construction on subgrades, the subgrades should be evaluated by an ECS field technician. The exposed subgrade should be thoroughly proofrolled with construction equipment having a minimum axle load of 10 tons [e.g. fully loaded tandem-axle dump truck]. Proofrolling should be traversed in two perpendicular directions with overlapping passes of the vehicle under the observation of an ECS technician. This procedure is intended to assist in identifying any localized yielding materials.

Where proofrolling identifies areas that are yielding or "pumping" subgrade those areas should be repaired prior to the placement of any subsequent Structural Fill or other construction materials. Methods of stabilization include undercutting, moisture conditioning, or chemical stabilization. The situation should be discussed with ECS to determine the appropriate procedure. Test pits may be excavated to explore the shallow subsurface materials to help in determining the cause of the observed yielding materials, and to assist in the evaluation of appropriate remedial actions to repair the subgrade.

5.2 Earthwork Operations

The following sections describe the requirements for fill placement and earthwork testing.

5.2.1 Fill Placement

Prior to placement of any new fill or other construction material, subgrades should be scarified to a minimum depth of 8 inches, moisture conditioned to a workable moisture content at or above the optimum value and compacted to at least 95% of Maximum Dry Density as obtained by the Standard Proctor Method (ASTM D-698).

Fill material in the building pad areas should consist of select fill. Details regarding select fill are presented in the "Materials Specifications" section of this report. Fill material should be moisture conditioned at or above the optimum moisture content and compacted to at least 95% of the Maximum Dry Density as obtained by the Standard Proctor Method (ASTM D-698).

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

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

5.2.2 Earthwork Testing

Field density and moisture tests should be performed by ECS on each lift as necessary to verify that adequate compaction is achieved. One test per 2,500 square feet per lift is recommended in the future building and pavement areas (two tests minimum per lift). Utility trench backfill should be

tested at a rate of one test per lift per each 150 linear feet of trench (two tests minimum per lift). Certain jurisdictional requirements may require testing in addition to that noted previously. Therefore, these recommendations should be reviewed and the more stringent specifications should be followed.

5.3 MATERIAL SPECIFICATIONS

The recommendations provided in the "Subgrade Improvements" portion of this report outline the subgrade improvement options required in order to achieve the desired PVM. This section is intended to outline the material requirements of those recommendations.

5.3.1 Select Fill

For the purposes of this report, select fill may consist of imported material that is free of debris and organic matter, has a Plasticity Index (PI) between 8 and 15, no less than 60% passing the No. 200 sieve and a maximum particle size of 2 inches. The PI and gradation of this material should be evaluated by ECS at the time of construction.

This material should be placed and compacted at workable moisture contents at or above the optimum moisture content and compacted to at least 95% of the Maximum Dry Density as obtained using the Standard Proctor Method (ASTM D-698).

5.3.2 Moisture Conditioning

Within the planned pads and flatwork sensitive to movements, moisture conditioning should be performed as outlined in this report. Reworking of the existing clays, and new clayey fill, is performed to increase the moisture of the clays to a level that reduces their ability to absorb additional water that could result in post-construction heave in these soils.

The moisture conditioning should consist of undercutting, scarifying and/or reworking, as required to achieve the required subgrade improvement. During this process, the clay should receive adequate amounts of water to attain an even moisture content of at least +2% or higher above the optimum moisture content. During the addition of water, the soils should be adequately mixed, and re-mixed, to achieve an even distribution of the moisture throughout the soil mass. Once appropriately mixed, the material should be compacted to at least 95% of the Maximum Dry Density as obtained using the Standard Proctor Method (ASTM D-698).

Outside of the moisture conditioned zone and where clay is used to establish site grades, we recommend that this material be placed and compacted to at least 95% of the Maximum Dry Density as obtained using the Standard Proctor Method (ASTM D-698). These soils should be free of deleterious materials, and be reworked to achieve an even distribution of water in order to achieve a moisture content of ±2% of the material optimum moisture content.

Care should be taken to verify and preserve the specified moisture levels in the reworked clays prior to placement of non-expansive fill.

5.3.3 Lime Stabilized On Site Clay

In lieu of importing select fill, as defined above, the on-site clay soils may be lime stabilized. The advantage of lime stabilization over untreated material is that the nature of the stabilized soil is such that, once placed, it limits water infiltration into the subgrade and promotes surface drainage.

A preliminary lime application rate of 5% hydrated lime by dry weight of clay should be used for budgeting purposes. The lime stabilized clay should be thoroughly mixed and appropriately mellowed for at least 48 hours and tested for gradation and lime reactivity (pH) prior to final placement and compaction.

Once appropriately mixed and mellowed, this material may then be placed and compacted at workable moisture contents at least +3% above the optimum moisture content and compacted to at least 95% of the Maximum Dry Density as obtain using the Standard Proctor Method (ASTM D-698).

5.4 Foundation and Slab Observations

Protection of Foundation Excavations: Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, a 1 to 3-inch thick "mud mat" of "lean" concrete should be placed on the bearing soils before the placement of reinforcing steel.

Footing Subgrade Observations: Most of the soils at the foundation bearing elevation are anticipated to be suitable for support of the proposed structure. It is important to have ECS observe the foundation subgrade prior to placing foundation concrete, to confirm the bearing soils are what was anticipated.

Slab Subgrade Verification: Prior to placement of a granular base/drainage layer, the subgrade should be improved/prepared in accordance with recommendations provided in this report.

5.5 Utility Installations

Utility Subgrades: The soils encountered in our exploration are expected to be generally suitable for support of utility pipes. The pipe subgrades should be observed and probed for stability by ECS. Utility cuts should not be left open for more than 24 hours or during times when precipitation is anticipated and should be properly backfilled. Any loose or unsuitable materials encountered should be removed and replaced with suitable compacted fill, or pipe stone bedding material.

Utility Backfilling: Backfilling should be accomplished with properly compacted on-site soils, rather than granular materials. If granular materials are used, a utility trench cut-off at the building line is recommended to help prevent water from migrating through the utility trench backfill to beneath the proposed structure. If used, the granular bedding material (often AASHTO #57 stone) should be at least 4 inches thick, but not less than that specified by the civil engineer's project drawings and specifications. We recommend that the bedding materials be placed up to the springline of the pipe. Fill placed for support of the utilities, as well as backfill over the utilities, should satisfy the requirements for fill placement provided in this report.

Excavation Safety: All excavations and slopes should be constructed and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing, constructing, and maintaining stable temporary excavations and slopes. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the

excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

6.0 CLOSING

ECS has prepared this report of findings, evaluations, and recommendations to guide geotechnical-related design and construction aspects of the project. In fulfilling our obligations and responsibilities, as listed in the proposal, we performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation, expressed or implied, and no warranty or guarantee is included or intended in this report. ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

The description of the proposed project is based on information provided to ECS by the project design team. If any of this information is inaccurate, either due to our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted so that we can review the report in light of the changes and provide additional or alternate recommendations as may be required.

We recommend that ECS review the project's plans and specifications so that we may evaluate those plans/specifications with the intent of the geotechnical report.

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of and integral to the geotechnical design recommendations. We recommend that the Owner retain ECS throughout construction.

ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

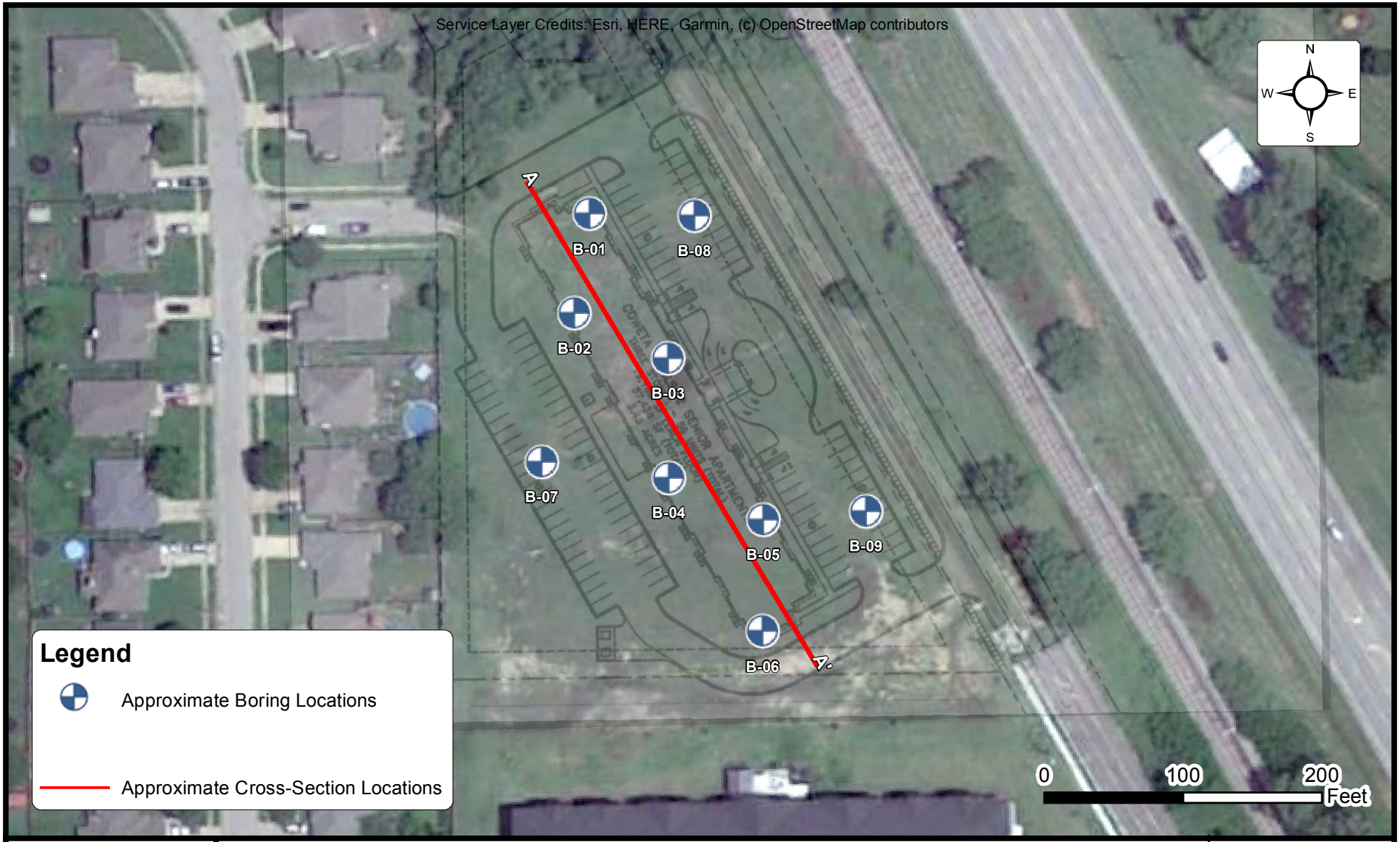
APPENDIX A – Drawings & Reports

Site Location Diagram
Boring Location Diagram
Generalized Subsurface Soil Profile A-A’
Clay Plug Detail at Trench

SITE LOCATION DIAGRAM
COWETA TRAILS PHASE II

11954 S 273RD E AVENUE, COWETA, OKLAHOMA
CARLSON CONSULTING ENGINEERS, INC.

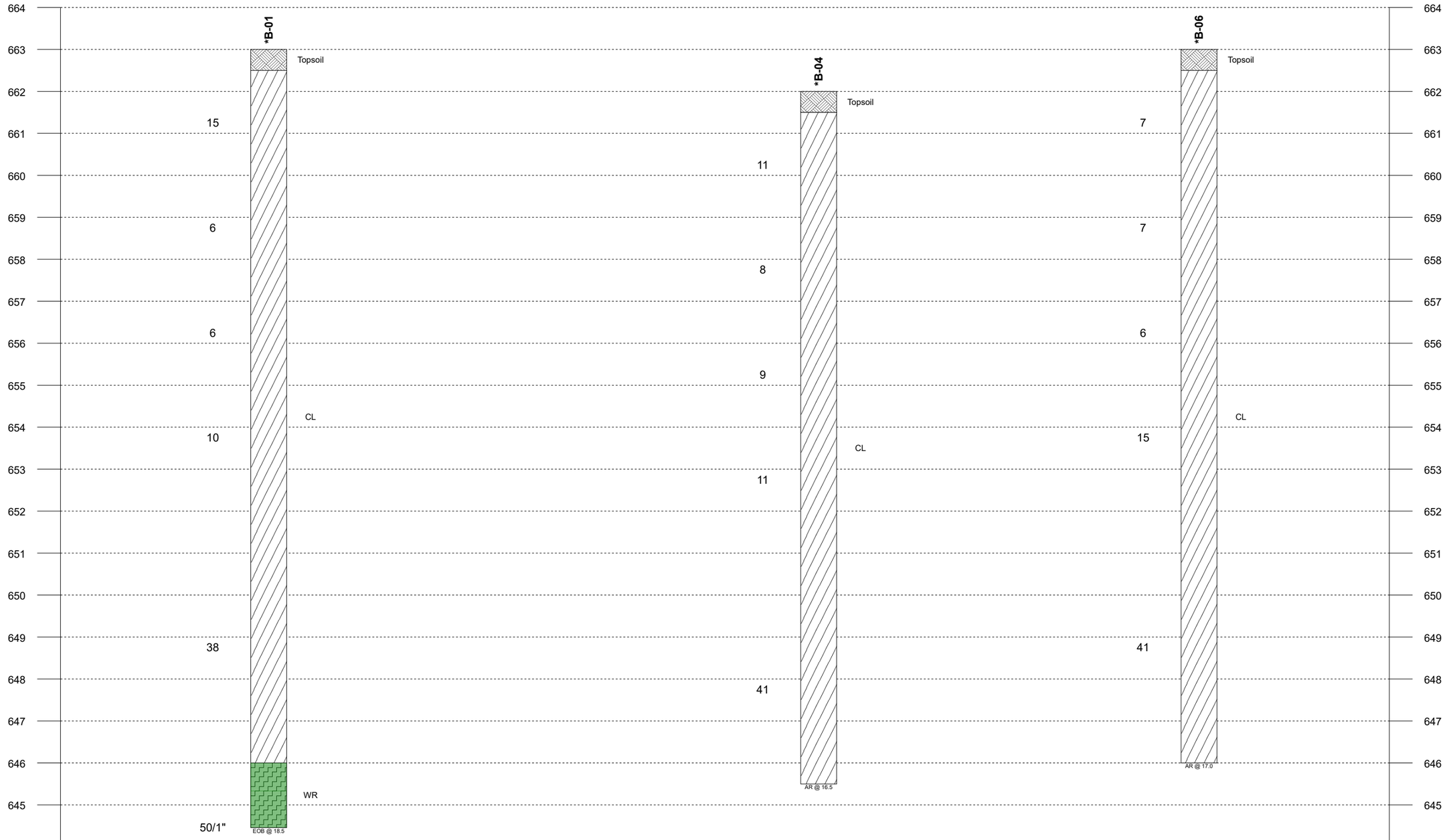
ENGINEER	AW
SCALE	AS NOTED
PROJECT NO.	58:1518
FIGURE	1 OF 1
DATE	8/26/2022



BORING LOCATION DIAGRAM
COWETA TRAILS PHASE II

11954 S 273RD E AVENUE, COWETA, OKLAHOMA
CARLSON CONSULTING ENGINEERS, INC.

ENGINEER	AW
SCALE	AS NOTED
PROJECT NO.	58:1518
FIGURE	1 OF 1
DATE	8/26/2022



Legend Key

- Topsoil
- Lean CLAY
- Weathered Rock

Notes:

1- EOB: END OF BORING AR: AUGER REFUSAL SR: SAMPLER REFUSAL.
2- SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL INFORMATION.
3- STANDARD PENETRATION TEST RESISTANCE (LEFT OF BORING) IN BLOWS PER FOOT (ASTM D1586).

Plastic Limit Water Content Liquid Limit X—●—△	WL (First Encountered)		Fill
[FINES CONTENT %]	WL (Completion)		Possible Fill
BOTTOM OF CASING	WL (Estimated Seasonal High Water)		Probable Fill
100% LOSS OF CIRCULATION	WL (Stabilized)		Rock

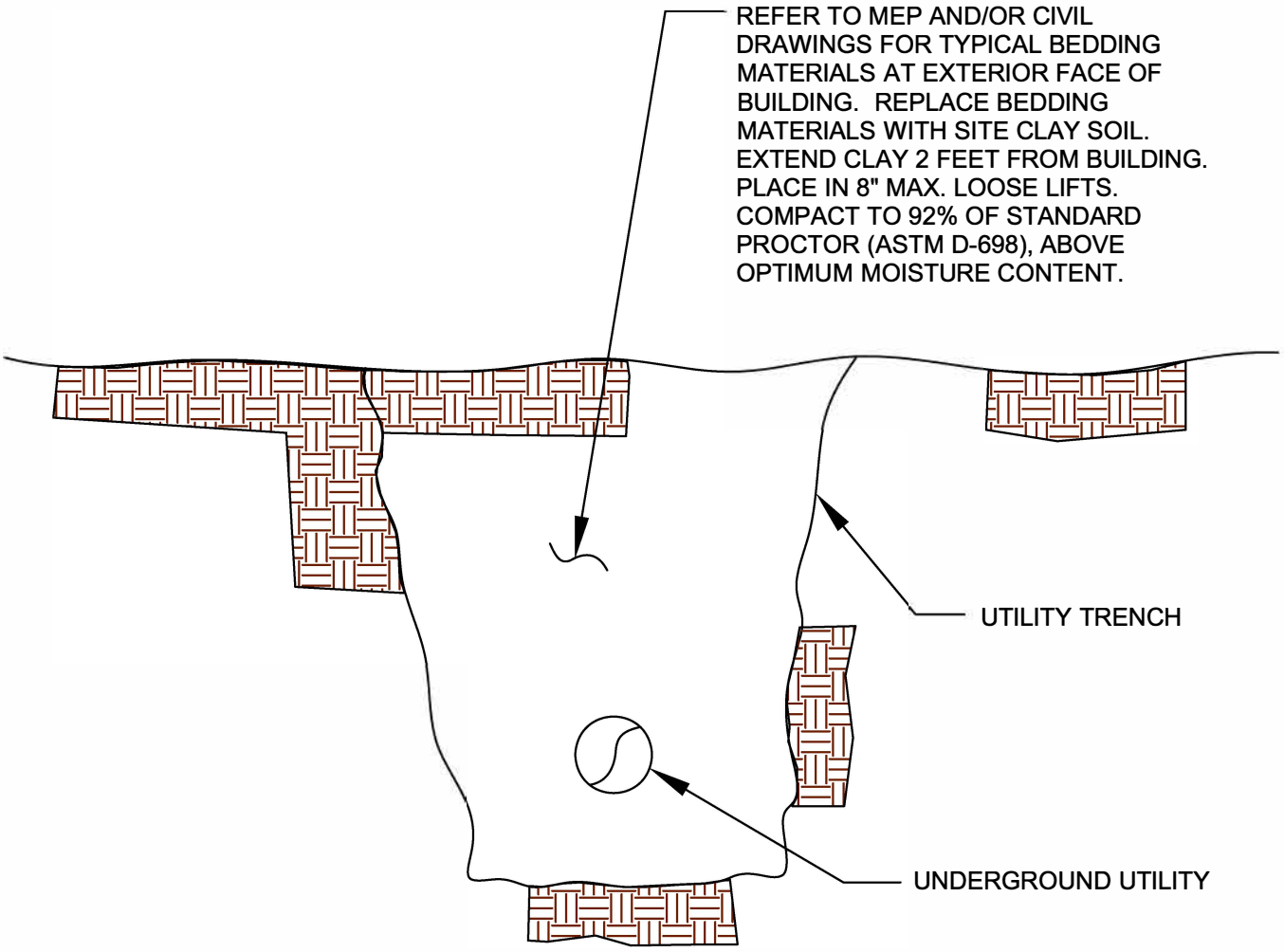
GENERALIZED SUBSURFACE SOIL PROFILE **Section line A-A'**

Coweta Trails Phase II

Carlson Consulting Engineers, Inc.

11954 S 273rd E Avenue, Coweta, Oklahoma 74429

Project No:	58:1518	Date:	08/26/2022



TYPICAL DETAIL DIAGRAM

ECS

CLAY PLUG AT UTILITY TRENCH

ENGINEER	SCALE NTS
DRAFTSMAN CLL	PROJECT NO.
REVISIONS	SHEET 1 OF 1
	DATE 11/7/08

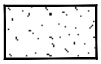
APPENDIX B – Field Operations

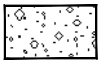
Reference Notes for Boring Logs
Subsurface Exploration Procedure: Standard Penetration Testing (SPT)
Boring Logs B-01 to B-09

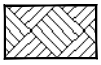
REFERENCE NOTES FOR BORING LOGS

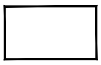
MATERIAL[1,2]

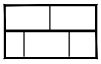

ASPHALT


CONCRETE


GRAVEL

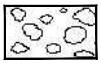

TOPSOIL

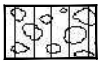

VOID


BRICK

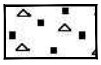

AGGREGATE BASE COURSE

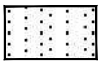

GW **WELL-GRADED GRAVEL**
gravel-sand mixtures, little or no fines

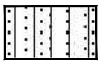

GP **POORLY-GRADED GRAVEL**
gravel-sand mixtures, little or no fines


GM **SILTY GRAVEL**
gravel-sand-silt mixtures

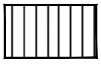

GC **CLAYEY GRAVEL**
gravel-sand-clay mixtures

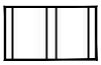

SW **WELL-GRADED SAND**
gravelly sand, little or no fines

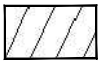

SP **POORLY-GRADED SAND**
gravelly sand, little or no fines


SM **SILTY SAND**
sand-silt mixtures

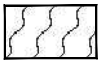

SC **CLAYEY SAND**
sand-clay mixtures

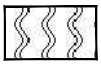

ML **SILT**
non-plastic to medium plasticity

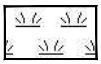

MH **ELASTIC SILT**
high plasticity


CL **LEAN CLAY**
low to medium plasticity


CH **FAT CLAY**
high plasticity


OL **ORGANIC SILT or CLAY**
non-plastic to low plasticity


OH **ORGANIC SILT or CLAY**
high plasticity


PT **PEAT**
highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS

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

PARTICLE SIZE IDENTIFICATION

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

COHESIVE SILTS & CLAYS

UNCONFINED COMPRESSIVE STRENGTH, Q_P[4]	SPT[5] (BPF)	CONSISTENCY[7] (COHESIVE)
<0.25	<2	Very Soft
0.25 - <0.50	2 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

GRAVELS, SANDS & NON-COHESIVE SILTS

SPT[5]	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

RELATIVE AMOUNT[7]	COARSE GRAINED (%)[8]	FINE GRAINED (%)[8]
Trace	≤5	≤5
With	10 - 20	10 - 25
Adjective *(ex: "Silty")*	25 - 45	30 - 45

WATER LEVELS[6]

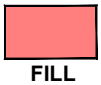

WL (First Encountered)


WL (Completion)


WL (Seasonal High Water)


WL (Stabilized)

FILL AND ROCK


FILL


POSSIBLE FILL


PROBABLE FILL


ROCK

[1]Classifications and symbols per ASTM D 2488-17 (Visual-Manual Procedure) unless noted otherwise.

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

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

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

[5]Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf). SPT correlations per 7.4.2 Method B and need to be corrected if using an auto hammer.

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

[7]Minor deviation from ASTM D 2488-17 Note 14.

[8]Percentages are estimated to the nearest 5% per ASTM D 2488-17.

SUBSURFACE EXPLORATION PROCEDURE: STANDARD PENETRATION TESTING (SPT) ASTM D 1586 Split-Barrel Sampling

Standard Penetration Testing, or **SPT**, is the most frequently used subsurface exploration test performed worldwide. This test provides samples for identification purposes, as well as a measure of penetration resistance, or N-value. The N-Value, or blow counts, when corrected and correlated, can approximate engineering properties of soils used for geotechnical design and engineering purposes.

SPT Procedure:

- Involves driving a hollow tube (split-spoon) into the ground by dropping a 140-lb hammer a height of 30-inches at desired depth
- Recording the number of hammer blows required to drive split-spoon a distance of 12 inches (in 3 or 4 Increments of 6 inches each)

- Auger is advanced* and an additional SPT is performed
- One SPT test is typically performed for every two to five feet

- Obtain two-inch diameter soil sample

**Drilling Methods May Vary—* The predominant drilling methods used for SPT are open hole fluid rotary drilling and hollow-stem auger drilling.

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-01**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Coweta Trails Phase II	**Drilling Services of Oklahoma**

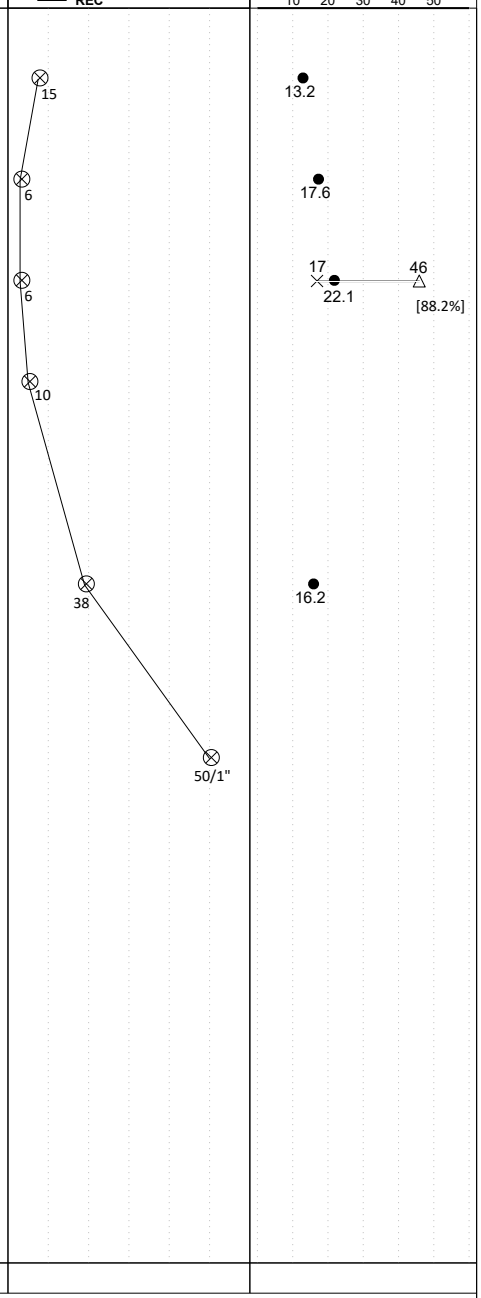
SITE LOCATION: **11954 S 273rd E Avenue, Coweta, Oklahoma 74429**

LOSS OF CIRCULATION

NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:
975317.6	**2656580.9**		**663.00**

BOTTOM OF CASING

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness[6"]			
	S-1	SS	18	18	(CL) LEAN CLAY, dark brown and orange to light brown and black, moist, stiff to firm to stiff to hard			11-7-8 (15)
	S-2	SS	18	18				3-3-3 (6)
5							658	
	S-3	SS	18	18				2-3-3 (6)
	S-4	SS	18	18				3-5-5 (10)
10							653	
	S-5	SS	18	18				15-17-21 (38)
15							648	
	S-6	SS	1	0	(WR) WEATHERED LIMESTONE, light brown, very hard **AUGER REFUSAL AT 18.5 FT**			50/1" (50/1")
20							643	
25							638	
30							633	



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

▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 08 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 08 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-02**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Coweta Trails Phase II	**Drilling Services of Oklahoma**

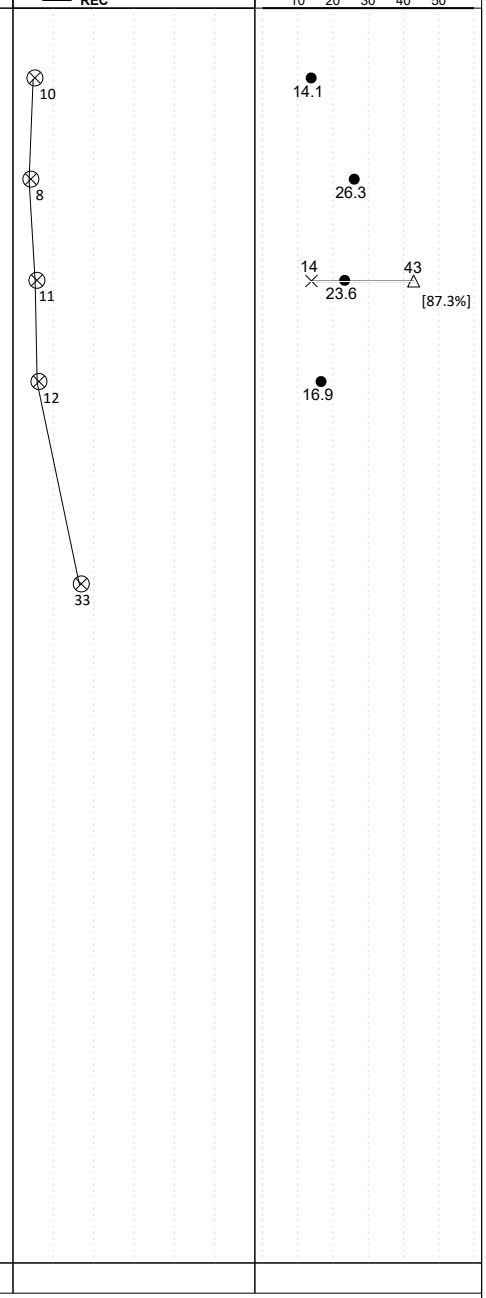
SITE LOCATION: **11954 S 273rd E Avenue, Coweta, Oklahoma 74429**

LOSS OF CIRCULATION

NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:	BOTTOM OF CASING
975256.9	**2656573.1**		**663.00**	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness[6"]			
	S-1	SS	18	18	(CL) LEAN CLAY, brown to black and brown to orangish brown and black to brown and dark gray, moist, stiff to firm to stiff to hard, auger refusal at approximately 17 feet on presumed Weathered Limestone			6-5-5 (10)
	S-2	SS	18	18				3-4-4 (8)
5	S-3	SS	18	18			658	4-5-6 (11)
	S-4	SS	18	18				3-5-7 (12)
10							653	
	S-5	SS	18	18				9-11-22 (33)
15							648	
					AUGER REFUSAL AT 17.0 FT			
20							643	
25							638	
30							633	

STANDARD PENETRATION BLOWS/FT (20 40 60 80 100)
ROCK QUALITY DESIGNATION & RECOVERY — RQD — REC
LIQUID LIMIT △ PLASTIC LIMIT ×
CALIBRATED PENETROMETER TSF (1 2 3 4 5)
WATER CONTENT % ● [FINES CONTENT] % (10 20 30 40 50)



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

▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-03**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Coweta Trails Phase II	**Drilling Services of Oklahoma**

SITE LOCATION: **11954 S 273rd E Avenue, Coweta, Oklahoma 74429**

LOSS OF CIRCULATION

NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:
975218.4	**2656639.4**		**662.00**

BOTTOM OF CASING

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness[6"]			
	S-1	SS	18	18	(CL) LEAN CLAY, dark brown to black and brown to orangish brown and black to orangish brown and gray, moist, stiff to hard, auger refusal at approximately 17 feet on presumed Weathered Limestone			7-5-4 (9)
	S-2	SS	18	18				4-4-5 (9)
5							657	
	S-3	SS	18	18				3-4-6 (10)
	S-4	SS	18	18				3-7-8 (15)
10							652	
	S-5	SS	18	18				13-14-20 (34)
15							647	
					AUGER REFUSAL AT 17.0 FT			
20							642	
25							637	
30							632	

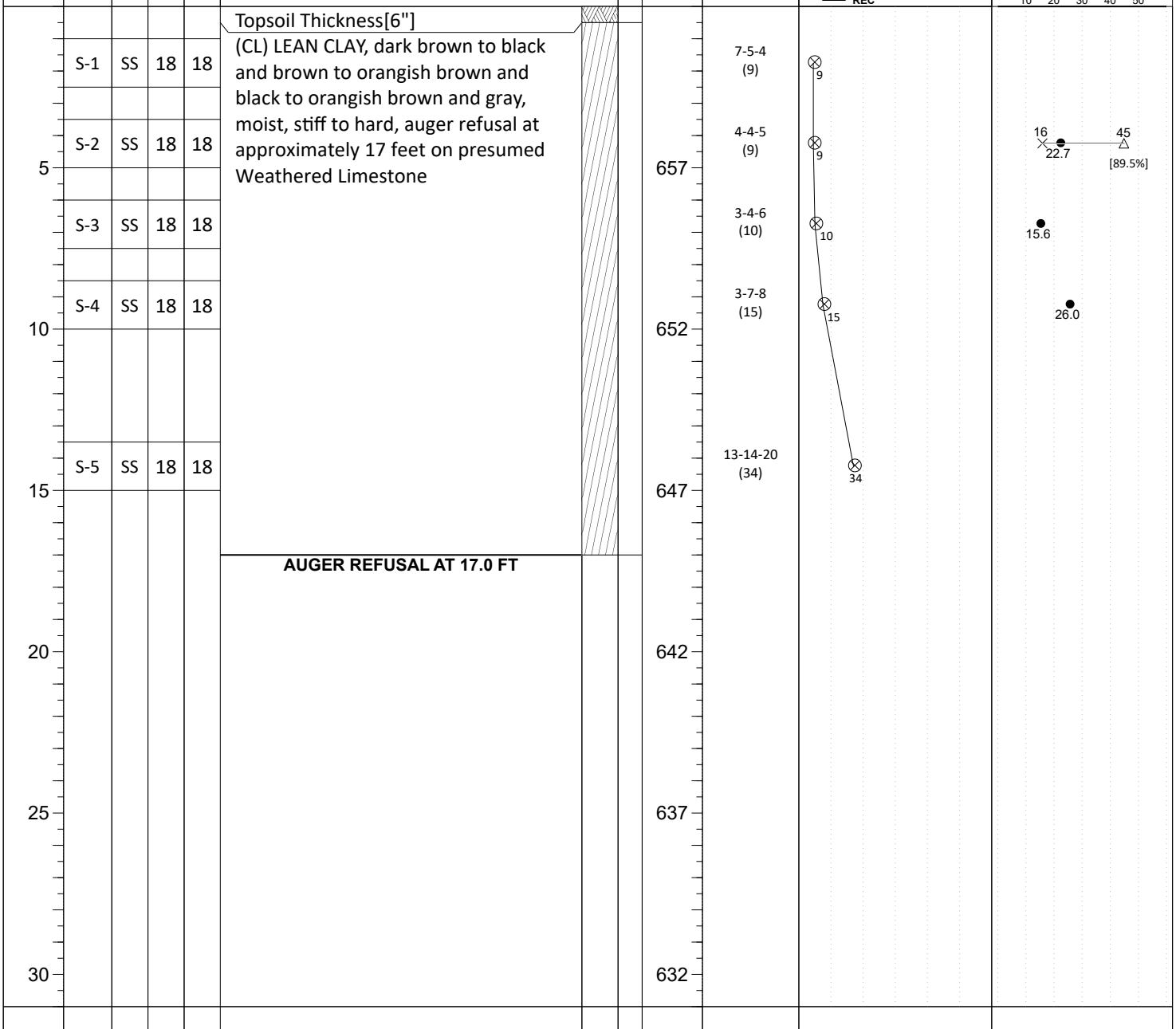
STANDARD PENETRATION BLOWS/FT (20 40 60 80 100)

ROCK QUALITY DESIGNATION & RECOVERY — RQD — REC

LIQUID LIMIT △ PLASTIC LIMIT ×

CALIBRATED PENETROMETER TSF ○ (1 2 3 4 5)

WATER CONTENT % ● [FINES CONTENT] % (10 20 30 40 50)



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

▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-04**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Coweta Trails Phase II	**Drilling Services of Oklahoma**

SITE LOCATION: **11954 S 273rd E Avenue, Coweta, Oklahoma 74429**

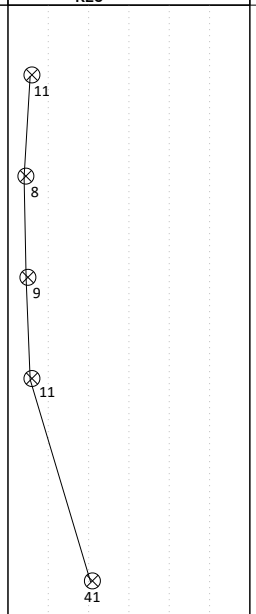
LOSS OF CIRCULATION

NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:	BOTTOM OF CASING
975135.0	**2656641.6**		**662.00**	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness[6"]			
	S-1	SS	18	18	(CL) LEAN CLAY, brown to brown and black to orangish brown and gray, moist, stiff to firm to stiff to hard, auger refusal at approximately 16.5 feet on presumed Weathered Limestone			9-6-5 (11)
	S-2	SS	18	18				4-4-4 (8)
5	S-3	SS	18	18			657	3-4-5 (9)
	S-4	SS	18	18				4-5-6 (11)
10							652	
	S-5	SS	18	18				12-18-23 (41)
15					**AUGER REFUSAL AT 16.5 FT**		647	
20							642	
25							637	
30							632	

STANDARD PENETRATION BLOWS/FT (20 40 60 80 100)

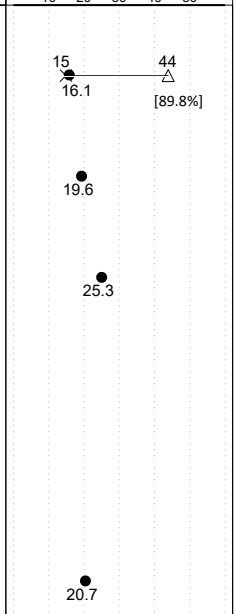
ROCK QUALITY DESIGNATION & RECOVERY — RQD — REC



LIQUID LIMIT △ PLASTIC LIMIT ×

CALIBRATED PENETROMETER TSF (1 2 3 4 5)

WATER CONTENT % ● [FINES CONTENT] % (10 20 30 40 50)



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

▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-05**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Coweta Trails Phase II	**Drilling Services of Oklahoma**

SITE LOCATION: **11954 S 273rd E Avenue, Coweta, Oklahoma 74429**

LOSS OF CIRCULATION

NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:	BOTTOM OF CASING
975099.8	**2656709.3**		**663.00**	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness[6"]			
	S-1	SS	18	18	(CL) LEAN CLAY, brown to orangish brown and black to light brown, orangish brown, and gray, moist, firm to stiff to hard, auger refusal at approximately 16 feet on presumed Weathered Limestone			5-3-3 (6)
	S-2	SS	18	18				3-4-5 (9)
5	S-3	SS	18	18			658	5-5-5 (10)
	S-4	SS	18	18				4-5-6 (11)
10							653	
	S-5	SS	18	18				13-12-19 (31)
15							648	
					AUGER REFUSAL AT 16.0 FT			
20							643	
25							638	
30							633	

STANDARD PENETRATION BLOWS/FT (20 40 60 80 100)

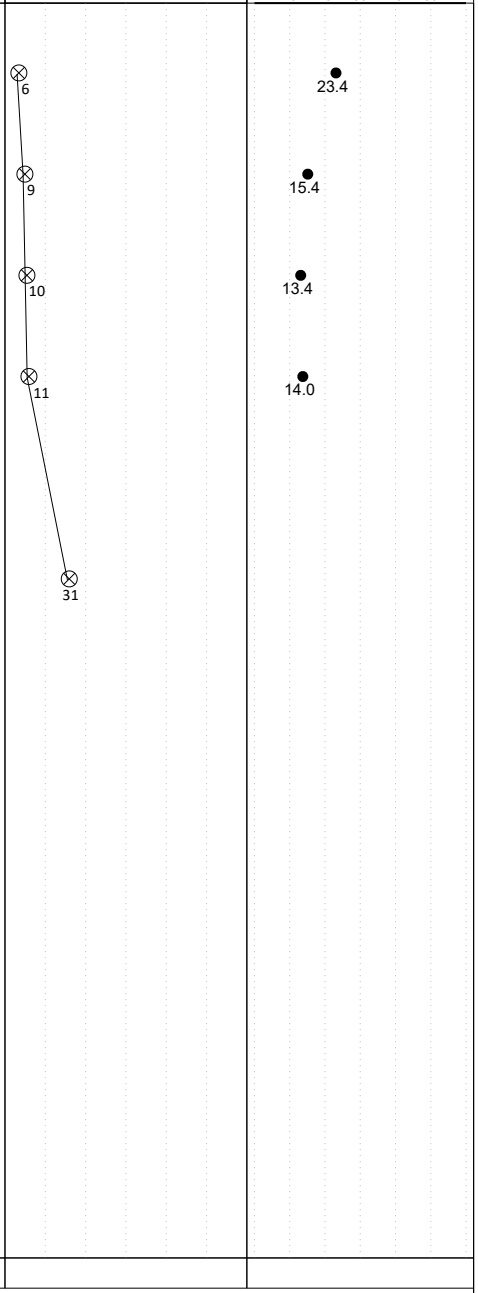
ROCK QUALITY DESIGNATION & RECOVERY — RQD — REC

LIQUID LIMIT

PLASTIC LIMIT

CALIBRATED PENETROMETER TSF (1 2 3 4 5)

WATER CONTENT % [FINES CONTENT] % (10 20 30 40 50)



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

▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-06**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Coweta Trails Phase II	**Drilling Services of Oklahoma**

SITE LOCATION: **11954 S 273rd E Avenue, Coweta, Oklahoma 74429**

LOSS OF CIRCULATION

NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:	BOTTOM OF CASING
975024.0	**2656708.7**		**663.00**	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness[6"]			
	S-1	SS	18	18	(CL) LEAN CLAY, orangish brown to brown, black, and light gray to brown and black to brown, orangish brown and gray, moist, firm to stiff to hard, auger refusal at approximately 17 feet on presumed Weathered Limestone			4-3-4 (7)
	S-2	SS	18	18				3-3-4 (7)
5	S-3	SS	18	18			658	3-3-3 (6)
	S-4	SS	18	18				5-7-8 (15)
10							653	
	S-5	SS	18	18				12-16-25 (41)
15					**AUGER REFUSAL AT 17.0 FT**		648	
20							643	
25							638	
30							633	

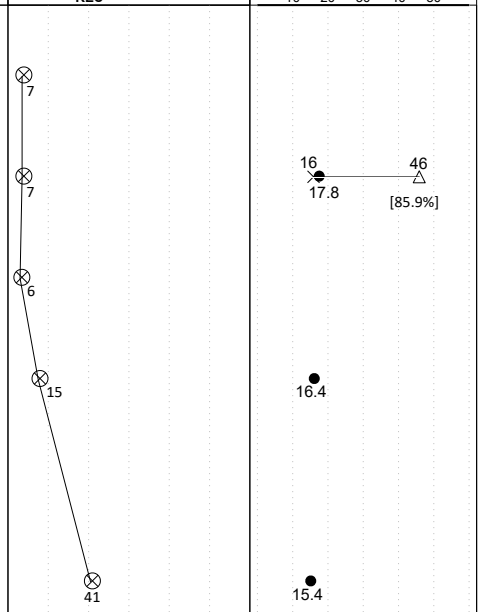
STANDARD PENETRATION BLOWS/FT (20 40 60 80 100)

ROCK QUALITY DESIGNATION & RECOVERY — RQD — REC

LIQUID LIMIT △ PLASTIC LIMIT ×

CALIBRATED PENETROMETER TSF (1 2 3 4 5)

WATER CONTENT % ● [FINES CONTENT] % (10 20 30 40 50)



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

▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-07**	**1 of 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Coweta Trails Phase II	**Drilling Services of Oklahoma**

SITE LOCATION: **11954 S 273rd E Avenue, Coweta, Oklahoma 74429**

LOSS OF CIRCULATION

NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:	BOTTOM OF CASING
975150.1	**2656553.4**		**665.00**	

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT (20 40 60 80 100) / ROCK QUALITY DESIGNATION & RECOVERY (RQD, REC)	LIQUID LIMIT / PLASTIC LIMIT / CALIBRATED PENETROMETER TSF (1 2 3 4 5) / WATER CONTENT % [FINES CONTENT] % (10 20 30 40 50)
0					Topsoil Thickness[6"]		665			
	S-1	SS	18	18	(CL) LEAN CLAY, brown, moist, firm			4-4-3 (7)	7	15.4
	S-2	SS	18	18				3-4-4 (8)	8	25.0
5					**END OF BORING AT 5.0 FT**		660			
10							655			
15							650			
20							645			
25							640			
30							635			

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

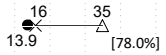
▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-08**	**1 of 1**
PROJECT NAME:	DRILLER/CONTRACTOR:		
Coweta Trails Phase II	**Drilling Services of Oklahoma**		
SITE LOCATION:			LOSS OF CIRCULATION
11954 S 273rd E Avenue, Coweta, Oklahoma 74429			
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:
975323.0	**2656658.6**		**662.00**

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					Topsoil Thickness[6"]			
	S-1	SS	18	18	(CL) LEAN CLAY WITH SAND, brown, orangish brown, gray, and black, moist, firm			7-4-3 (7)
	S-2	SS	18	18				4-4-4 (8)
5					**END OF BORING AT 5.0 FT**		657	
10							652	
15							647	
20							642	
25							637	
30							632	

STANDARD PENETRATION BLOWS/FT: 20 40 60 80 100
ROCK QUALITY DESIGNATION & RECOVERY: RQD, REC
LIQUID LIMIT / PLASTIC LIMIT
CALIBRATED PENETROMETER TSF: 1 2 3 4 5
WATER CONTENT % [FINES CONTENT] %: 10 20 30 40 50



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

WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Carlson Consulting Engineers, Inc.	**58:1518**	**B-09**	**1 of 1**
PROJECT NAME:	DRILLER/CONTRACTOR:		
Coweta Trails Phase II	**Drilling Services of Oklahoma**		
SITE LOCATION:			LOSS OF CIRCULATION
11954 S 273rd E Avenue, Coweta, Oklahoma 74429			
NORTHING:	EASTING:	STATION:	SURFACE ELEVATION:
975114.2	**2656780.3**		**662.00**

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT (20 40 60 80 100) / ROCK QUALITY DESIGNATION & RECOVERY (RQD, REC)	LIQUID LIMIT / PLASTIC LIMIT / CALIBRATED PENETROMETER TSF (1 2 3 4 5) / WATER CONTENT % [FINES CONTENT] % (10 20 30 40 50)
					Topsoil Thickness[6"]					
	S-1	SS	18	18	(CL) LEAN CLAY WITH SAND, brown and black, moist, firm			3-4-4 (8)	8	13 31 18.3 [82.8%]
	S-2	SS	18	18				3-3-4 (7)	7	
5					**END OF BORING AT 5.0 FT**		657			
10							652			
15							647			
20							642			
25							637			
30							632			

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

▽ WL (First Encountered) **Dry**	BORING STARTED: **Aug 09 2022**		CAVE IN DEPTH:
▼ WL (Completion)	BORING COMPLETED: **Aug 09 2022**		HAMMER TYPE:
▼ WL (Seasonal High Water)	EQUIPMENT: **Truck #1**	LOGGED BY: **MOY**	DRILLING METHOD: **Solid Stem Auger**
▽ WL (Stabilized)			

GEOTECHNICAL BOREHOLE LOG

APPENDIX C – Laboratory Testing

Laboratory Testing Summary

Laboratory Testing Summary

Sample Source	Sample Number	Start Depth (feet)	End Depth (feet)	Sample Distance (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Organic Content
							LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-01	S-1	1.0	2.5	1.5	13.2									
B-01	S-2	3.5	5.0	1.5	17.6									
B-01	S-3	6.0	7.5	1.5	22.1	CL	46	17	29	88.2				
B-01	S-5	13.5	15.0	1.5	16.2									
B-02	S-1	1.0	2.5	1.5	14.1									
B-02	S-2	3.5	5.0	1.5	26.3									
B-02	S-3	6.0	7.5	1.5	23.6	CL	43	14	29	87.3				
B-02	S-4	8.5	10.0	1.5	16.9									
B-03	S-2	3.5	5.0	1.5	22.7	CL	45	16	29	89.5				
B-03	S-3	6.0	7.5	1.5	15.6									
B-03	S-4	8.5	10.0	1.5	26.0									
B-04	S-1	1.0	2.5	1.5	16.1	CL	44	15	29	89.8				
B-04	S-2	3.5	5.0	1.5	19.6									
B-04	S-3	6.0	7.5	1.5	25.3									
B-04	S-5	13.5	15.0	1.5	20.7									
B-05	S-1	1.0	2.5	1.5	23.4									
B-05	S-2	3.5	5.0	1.5	15.4									
B-05	S-3	6.0	7.5	1.5	13.4									

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

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

Project No. 58:1518
Project Name: Coweta Trails Phase II
PM: Ethan Pollard
PE: Andrew Wilshire
Printed On: August 26, 2022

ECS Southwest, LLP - Oklahoma City
7801 N Robinson Ave, Suite D-8,
Oklahoma City, OK 73116
Phone: 405-265-5501

Laboratory Testing Summary

Sample Source	Sample Number	Start Depth (feet)	End Depth (feet)	Sample Distance (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Organic Content
							LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-05	S-4	8.5	10.0	1.5	14.0									
B-06	S-2	3.5	5.0	1.5	17.8	CL	46	16	30	85.9				
B-06	S-4	8.5	10.0	1.5	16.4									
B-06	S-5	13.5	15.0	1.5	15.4									
B-07	S-1	1.0	2.5	1.5	15.4									
B-07	S-2	3.5	5.0	1.5	25.0									
B-08	S-1	1.0	2.5	1.5	13.9	CL	35	16	19	78.0				
B-09	S-1	1.0	2.5	1.5	18.3	CL	31	13	18	82.8				

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

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

Project No. 58:1518
Project Name: Coweta Trails Phase II
PM: Ethan Pollard
PE: Andrew Wilshire
Printed On: August 26, 2022

ECS Southwest, LLP - Oklahoma City
7801 N Robinson Ave, Suite D-8,
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Phone: 405-265-5501