Revised Report of Subsurface Exploration and Geotechnical Evaluation

Cooper Academy Addition

Clayton, North Carolina

Building & Earth Project No.: **RD230492(R01)**

Prepared For:

Johnston County Public Schools

February 20, 2024

BUILDING & EARTH

Geotechnical, Environmental, and Materials Engineers

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February 20, 2024

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Attention: Mr. Brooks Moore, PE

Subject: REVISED Report of Subsurface Exploration and Geotechnical Evaluation
Cooper Academy Addition
849 N Mial Street
Clayton, North Carolina 27577
Building & Earth Project No: RD230492R01

Mr. Brooks:

Building & Earth Sciences, LLP (Building & Earth) has completed an authorized subsurface exploration and geotechnical engineering evaluation in support of additions to Cooper Academy located in Clayton, North Carolina.

The purpose of this work has been to assess general subsurface conditions at the site and to provide geotechnical engineering recommendations for use in project design and construction. Geotechnical recommendations in this report are based on a physical reconnaissance of the site and observation and classification of subsurface samples recovered from 20 engineering test borings drilled at the site. Confirmation of subsurface conditions reported herein, during construction, is an essential part of the geotechnical service.

Building & Earth appreciates the opportunity to provide consultation services in support of this project. If there are any questions regarding information in this report, or if additional information is required, please call.

Respectfully submitted,

BUILDING & EARTH SCIENCES, LLP
North Carolina Engineering Firm F-1081

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1.0 PROJECT & SITE DESCRIPTION

Proposed for construction are building additions and civil improvements to the Cooper Academy located at 849 N. Mial St., Clayton, North Carolina. Building additions will extend in a northeasterly direction from an existing one-story school building situated in the rear (southeastern portion) of the Academy Campus. A one-story addition will be constructed adjacent to the existing building, and a two-story building will be constructed beyond the one-story addition. The one-story addition will be separated from the existing one-story school building by a 9′-4″ covered walkway, as will the one-story and two-story additions.

The one-story addition will be the same width (80 feet) as the existing building and will have a footprint covering about 117 feet by 80 feet. The finished floor elevation (FFE) of this addition will be the same as the existing structure, 316.64 feet.

Situated northeast of the one-story addition, the two-story addition with overall dimensions of about 80 feet by 202.7 feet will be constructed. This addition will be constructed with the long dimension perpendicular to the one-story addition, with a ground FFE at 301.3-ft. and a first-floor elevation at 316.64-ft. Northeast and southeast building walls will be exposed to about the first floor FFE, and the northwest wall will be partially exposed. The southwest wall, adjacent to the one-story addition, will be completely below grade.

In addition to the buildings, new roadways and parking areas are planned, and a stormwater management structure is planned for an area southeast of the two building additions. Additional project information is tabulated below:

Development Item	Detail	Description
General Site	Size (Ac.)	Approx. 13 acres (site boundaries on Google Earth)
	Existing Development	Cooper Academy (elementary school) with playgrounds and parking lots around perimeter of buildings and trailers
	Vegetation	Low grass around buildings and mature trees to the ESE of property
	Slopes	Yes
	Retaining Walls	Yes, two-story addition basement walls only.
	Drainage	Well drained
	Cuts & Fills	Cuts and fills up to about 10 to 12-ft.
Proposed Buildings	No. of Bldgs	2
	Square Ft.	102,170 S.F.
	Stories	1 and 2
	Construction	Structural Steel & Masonry (assumed)
	Column Loads	100 kips (provided)
	Wall Loads	9 kips per lineal foot (provided)
	Preferred Foundation	Conventional shallow spread
	Preferred Slab	First level: Concrete Slab-on-grade Second level: slab-on-deck
Pavements	Traffic	At grade asphalt parking lot with bus drop off loop
	Standard Duty	Yes - Flexible
	Heavy Duty	Yes - Flexible

Table 1: Project and Site Description

References:
1. Undated untitled drawing showing existing campus with topographic contours.
2. Undated drawing titled “Grading Plan” Project 09.01.2023 prepared by Boomerang Design.
3. Undated unlabeled drawing showing civil boring positions.
4. Undated unlabeled drawing showing structural boring positions.
5. Drawings A101 and A102 respectively labeled “First Floor Plan” and “Ground Floor Plan / Mech. Yard Plan” both date 06.09.2023.

Notes:

1. ***If actual loading conditions exceed those listed above, Building & Earth should review our geotechnical recommendations to assess any effects on our recommendations for foundation design.***
2. ***As grading plans become finalized, Building & Earth should be allowed to review the plans and assess any effects on our recommendations.***

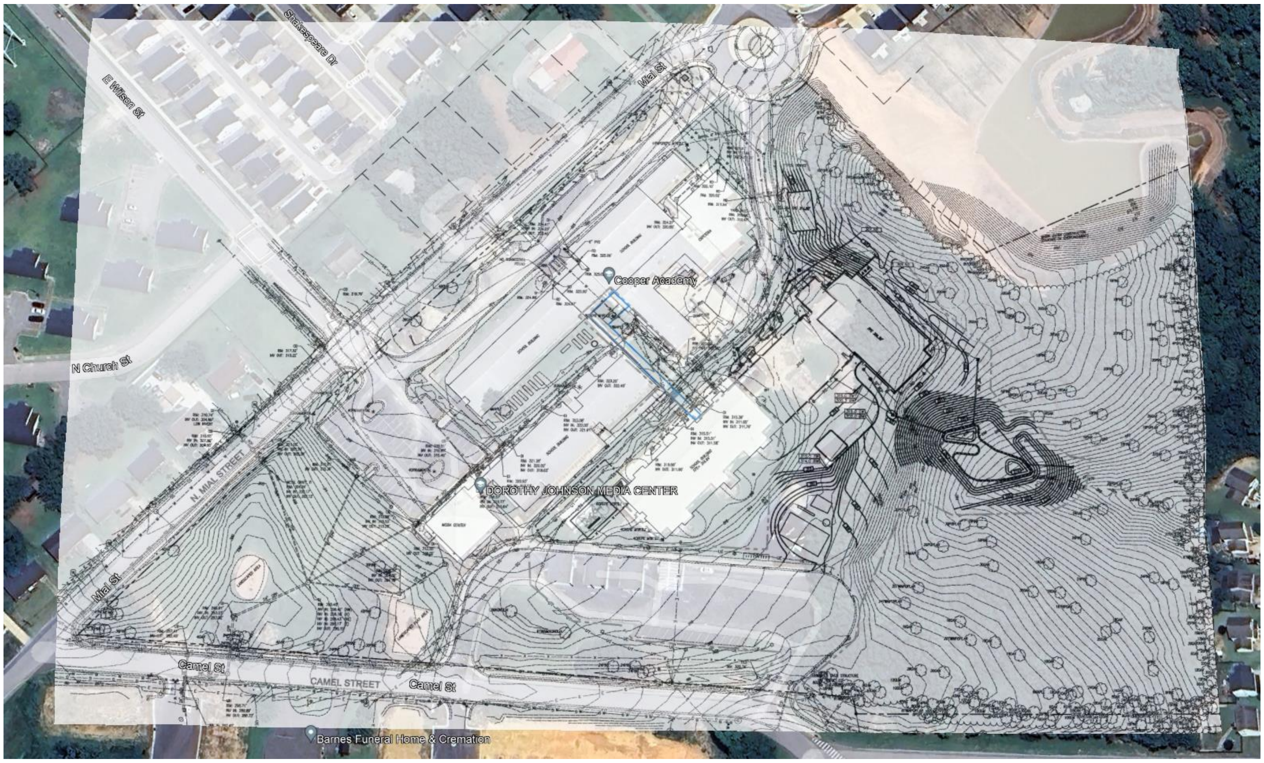


Figure 1: Aerial Imagery with Site Overlay (Google Earth)

Figure 2: View from B-05, Center of proposed building addition

Figure 3: Woods, Infiltration boring location

2.0 SCOPE OF SERVICES

Subsurface exploration was performed during the period October 11-13 and on October 16, 2023 in general conformance with our proposal RD25273, dated July 27, 2023. Notice-to-proceed was provided by Shelly Johnson of Boomerang Design. Occasionally some modification to work scopes appearing in our proposals is required to provide for proper evaluation of encountered subsurface conditions. One boring, B-11, was omitted due to its location inside a playground and one boring, B-20, was hand augured due to the possibility of buried utility lines at the boring site. Only one tri-axial shear test was performed (2 proposed) and one soil unconfined compressive strength test was performed (none proposed). Six classification tests (Atterberg limits and grain size analyses) were performed (4 proposed). Because no new pavement areas are planned, but rather mill and repave, bulk samples were not retrieved from the pavement areas to prevent additional damage to the existing pavement structure. The alternative laboratory testing program reflects actual subsurface conditions.

The purpose of the geotechnical exploration has been to characterize general subsurface conditions at the boring sites and to gather data on which to base a geotechnical evaluation with respect to the project. Subsurface exploration consisted of 20 soil test borings. The site was drilled using a Diedrich D-25 drill rig equipped with an automatic hammer for performing Standard Penetration Tests (SPT's) to evaluate relative soil strength.

Soil boring sites were field located using a layout plan provide by Boomerang Design and measuring from existing site features. Some boring positions were moved to avoid existing site features. As such boring positions appearing on the appended Boring Location Plan should be considered approximate.

Soil samples recovered from the test borings were visually classified and specific samples were selected by the project engineer for laboratory analysis. The laboratory analyses consisted of:

Test	ASTM	No. of Tests
Natural Moisture Content	D2216	22
Atterberg Limits	D4318	6
Material Finer Than No. 200 Sieve by Washing	D1140	6
Unconfined Compression Test on Soil Samples	D2166	1
Triaxial Shear Test (Consolidated-Undrained)	D4767	1
Standard Proctor Compaction Test	D698	1
Particle Size Distribution of Soils (Gradation)	D6913	6

Table 2: Scope of Laboratory Tests

Results of the laboratory analyses are presented on boring logs and in tabular form, both in the report Appendix. Descriptions of laboratory tests that were performed for this work also appear in the Appendix.

Information gathered from the exploration was used to prepare building foundation recommendations, to provide geotechnical recommendations for use in project design and construction, and to aid in identifying geotechnical matters that may be encountered during site earthworks operations. Results of the work presented herein provide or address the following:

- Summary of existing surface conditions.
- A description of the subsurface conditions encountered at boring locations.
- Site preparation considerations including material types to be expected during grading as well as recommendations regarding handling and treatment of unsuitable soils, if encountered.
- Compaction requirements and recommended criteria to establish suitable surfaces for structural backfill.
- Boring logs detailing the materials encountered with soil classifications, penetration values, and groundwater levels (if measured).
- Presentation of laboratory test results.
- Recommendations for foundation and floor slab support of new additions.
- Recommendations for lateral earth pressure
- Presentation of the estimated total and differential settlement.
- Recommendations for medium and light-duty asphalt sections.

- Plans and maps showing the location of the project and our onsite work.

3.0 GEOTECHNICAL SITE CHARACTERIZATION

The following paragraphs are intended to provide a general characterization of the site from a geotechnical engineering perspective. It is not the intention of this report to address every potential geotechnical matter that may arise, nor to provide every possible interpretation of conditions encountered. The following condition descriptions and subsequent geotechnical recommendations are based, in part, on the assumption significant changes in subsurface conditions do not occur between boreholes. However, anomalous conditions can occur due to variations in existing fill that may be present at the site, or due to natural geologic variation. It is therefore necessary to confirm that conditions reported herein during earthworks operations and during foundations installation.

3.1 Geology

Clayton North Carolina is situated in the eastern Piedmont region. Soils in the piedmont are typically weathered from underlying igneous and metamorphic rock of the Cenozoic (66 million years to present) era. Rock underlying the Cooper Academy is mapped (USGS map titled *Preliminary Bedrock Geologic Map of the Raleigh 30' X 60' Quadrangle, North Carolina* dated 2004) as gneiss and schist, locally influence by a diabase dike. Soils in the area are weathered from this and adjacent bedrock and may have been transported by erosional forces. Conditions encountered in test borings drilled for this study generally correlate to published geologic information. No potentially adverse geologic conditions were noted on maps reviewed for this study.

3.2 Seismic Site Evaluation

ReMi testing was performed to determine the Seismic Site Classification of the building area. The ReMi array run consisted of 12 geophone receivers and was approximately 289 feet in length. The location of the array run appears on the Boring Location Plan. Results of ReMi testing are presented below.

Basis of Evaluation	Site Classification
2015 International Building Code (IBC) and ASCE 7-16, Chapter 20	D – Stiff Soil
The Geogiga Surface Plus refraction microtremor (ReMi) method was used to determine the Seismic Site Class of the building area. Geogiga Seismic Surface Plus ReMi Vs9.3 software uses data from conventional seismograph and S-wave geophones to estimate average shear wave velocities and one and two-dimensional shear wave profiles to a depth of 100 feet below existing grades. These velocities are used to classify a building site with the Site Class A through E designation. The average shear wave velocity (V_s) in the upper 100 feet was 1,015 feet per second (ft/s). The results of the shear wave velocity analysis are attached.	

Table 3: Seismic Site Classification

The ASCE 7 Hazard Tool (https://asce7hazardtool.online/) was used to determine the mapped Risk-targeted Maximum Considered Earthquake (MCE_R) ground motion parameters for 0.2-second (S_S) and 1-second (S_1) spectral response acceleration, 5% damped; the short-period (F_a) and long-period (F_v) site coefficients; the 0.2-second (S_{MS}) and 1-second (S_{M1}) spectral response acceleration, adjusted for site class; the design parameters for 0.2-second (S_{DS}) and 1-second (S_{D1}) spectral response acceleration; and the Seismic Design Category.

Using coordinates from the approximate center of the run: latitude 35°39'17.49"N, longitude 78°27'4.03"W and assuming a Risk Category **III**, the results of the evaluation using the ASCE 7 Hazard Tool are tabulated below. If actual Risk Category is different, Building & Earth Sciences should be notified to review the effects on our evaluation.

Parameter	Value	Parameter	Value
S_S:	0.116	**S_1:**	0.059
F_a:	1.6	**F_v:**	2.4
S_{MS}:	0.186	**S_{M1}:**	0.141
S_{DS}:	0.124	**S_{D1}:**	0.094
Seismic Design Category:		B	

Table 4: Seismic Parameters

A report provided by the ASCE 7 Hazard Tool is included in the Appendix.

3.3 Existing Surface Conditions

At the time of our field exploration, the site was developed as an educational campus with several buildings, roadways, and parking areas. Two small buildings, a fenced mechanical equipment area and basketball courts lie within the building additions footprints. Vegetation consisted of low grass and mature trees in a wooded area directly to the east of the building site; it appears a portion of the two-story structure will encroach on the wooded area. Based upon review of historical imagery, site conditions have not been significantly unaltered since at least 1985.

3.4 Subsurface Conditions

A generalized stratification, summarized below, has been prepared using data from the soil test borings. This general stratification depicts general soil conditions and strata types encountered during our field investigation.

Stratum No.	Typical Thickness	Description	Consistency
1	3 inches	Topsoil	N/A
2	1-4 ft.	Silty and Clayey Sand, Various Fill	Loose to Dense
3	3-6 ft.	Sandy Lean to Fat Clay (CL or CH)	Soft to Very Stiff
4	20 ft. +	Silt with Sand and Sandy Silt (ML)	Medium Stiff to Hard

Table 5: Stratification Summary

Subsurface soil profiles, presented in the Appendix, have been prepared using the test boring data. For specific information obtained from the soil borings, please refer to the appended Boring Logs. Ground surface elevations at the boring sites have been estimated using Google Earth imagery and should be considered approximate.

3.4.1 Surface Cover: Topsoil

Except for test boring locations B-16, B-17, B-19, and B-21, topsoil was encountered at the ground surface. Topsoil depths generally were about 3 inches thick. No testing has been performed to verify this material meets general characteristics (organic material content) of "topsoil". Topsoil depths reported should only be considered an estimate as topsoil thickness may vary in unexplored portions of the site.

3.4.2 SURFACE COVER: EXISTING PAVEMENT

Test borings B-16, B-17, B-19, and B-21 were performed in existing pavement areas. According to Google Earth the bus parking lot appears in the 1999 aerial photograph but was not present before this date. The remainder of the pavement area appear to be present in all photographs back to 1993. It is not clear if the pavement has been repaired or replaced since the initial construction. The existing pavements consist of 2.25 to 4 inches of asphalt over 3 to 8 inches of aggregate base course stone. Significant areas of the pavement have alligator cracking, and do not appear to be a good candidate for overlay.

3.4.3 SILTY TO CLAYEY SAND, FILL

Soils and fill materials described variously as light brown, damp, silty and clayey sand (SC and SM) were observed in all test borings but B-9. In addition to the sandy materials, asphalt and gravel road base materials were observed in several of the borings. This material extends to depths up to 4-ft. below the surface and exhibits N-values in the range 4 to 29 bpf. N-values in the range 4 to 14 bpf are considered representative.

Wash 200 grain size and Atterberg limit tests were performed on one (1) sample of the sandy material. The clay fraction exhibits a liquid limit of 37, a plasticity index of 18, and 35 percent of the material passes a standard #200 sieve.

3.4.4 SANDY LEAN CLAY (CL) OCCASIONALLY SANDY FAT CLAY (CH)

Soils generally described as brown, damp, Sandy Lean Clay (CL) were encountered in most of the test borings extending below the silty clay sand and fill material to depths approximately 4 to 7 feet below the surface. This material is visually classified Sandy Fat Clay (CH) and Clayey Sand (SC) in some borings. Classification testing was not performed on representative samples collected from this stratum.

3.4.5 SILT (ML), SILT WITH SAND (ML) AND ELASTIC SILT (MH)

Below the upper strata and extending below the boring termination depths, soils described as Sandy Silt and Silt with Sand (ML), brown, moist and medium stiff were encountered. Standard penetration test values in this material range from 5 to 24 blows per foot, with values in the range 10 to 13 blows per foot considered representative for design.

Wash 200 grain size and Atterberg limit tests were performed on 3 samples recovered from this stratum yielded liquid limit values from 36 to 43 and plasticity indices from 6 to 14. Wash 200 testing yielded a range of 54 to 62 percent passing the #200 sieve. This material is classified as ML in accordance with the USCS classification system. The elastic silt (MH) materials are isolated thin layers in boring B-09, B-12, and B-19.

3.5 Auger Refusal

Auger refusal is the drilling depth at which a borehole can no longer be advanced using soil drilling procedures. Auger refusal can occur on hard soil, boulders, buried debris or bedrock. Coring is required to sample materials below auger refusal. Auger refusal did not occur in test borings drilled for this study. All borings were extended to their planned termination depth.

3.6 Groundwater

Groundwater measurements were made in all the test borings during drilling, and in borings B-01 and B-15 about 24-hrs. after drilling completion via stand-pipe piezometers. Groundwater observations are tabulated below. Water levels reported are accurate only for the time and date of their measurements. Long term (seasonal) ground-water monitoring was not included as part of the subsurface exploration. Except for B-01 and B-15, the test borings were backfilled upon their completion and stand-pipe piezometers were removed following the (approximate) 24-hour readings.

Boring No.	Depth (ft)	Elevation (ft.)	Depth (ft) at 24-hr	Elevation @ 24-hr.
B-01	18.6	288.4	17.4	289.6
B-15	28.6	250.4	19.7	259.3

Table 6: Groundwater Depths and Elevations

3.7 Seasonal High Water Table & Infiltration Testing

Evidence of seasonal high water table (SHWT) was not encountered within the upper 12 feet of the soil profile at soil boring location B-15. Based on the topographic information provided, the bottom of the basin will be at an elevation of 279 feet which is at or near the existing grade at the bore location. As such, the existing surface soils as well as the newly constructed berms will likely control the infiltration of stormwater.

To determine the parameters that the Civil Designer will need to design the basins, Compact Constand Head Permeability testing was performed at a depth of 24 inches below the ground surface to get below any organic root material that could affect the drainage rate of the near surface soils. The results of our testing are summarized below.

Test Position	Elevation
Ground Surface Elevation (ft)	279
Bottom of Basin Elevation (ft)	279
Depth to Observed SHWT (in)	NE
SHWT Elevation (ft)	NE
Depth to Groundwater (ft)	28.6
Groundwater Elevation (ft)	250.4
CCHP Elevation (ft)	277
Ksat (in/hour)	<0.05

* NE – Not Encountered

Table 7: Seasonal High Water Data (Boring B-15)

The flow of the near surface soils has been approximated using the concepts presented in Bernoulli's Equation for steady state flow and Darcy's Law for fluid flow through a porous media. Additionally, our Ksat values were calculated using the Glover solution which is dependent on soil saturation, the geometry of the bore hole, and the hydraulic head. To develop our recommendations, Building & Earth has measured/calculated the saturated flow rate (Ksat) for the soils at the site using accepted test methods and equipment. Ultimately, the drainage of the basins will be a function of the saturated flow rate of the soils, the surface area of the basin geometry, and the pressure differential (hydraulic head) induced by the storm water levels in the drainage structure. To determine the appropriate Ksat for the soils in each basin, a small diameter bore hole was advanced to a pre-determined depth of interest. At this depth, a constant head (pressure) was established and maintained. Once our measurements approached a stabilized flow rate, our test was terminated.

4.0 SITE DEVELOPMENT CONSIDERATIONS

An undated drawing titled "Grading Plan" Project 09.01.2023 prepared by Boomerang Design was provided for use in this report preparation. The grading plan suggests significant cut and fill depths will be required as part of the work. Estimates of cut and fill depths are tabulated below:

Building Area	Est. Max. Cut (ft.)	Est. Max. Fill (ft.)
One-Story Addition	1	7
Two Story Addition	12	3
General Civil Grading	8 to 10	6 to 8

Table 8: Estimated Maximum Cut and Fill Depths

Subsurface information and estimated foundation loads indicate foundation support using a conventional shallow spread foundation system is appropriate for the project. Site development recommendations have been prepared under the assumption this foundation system type will be employed. ***If a different type of foundation system is preferred, Building & Earth should be requested to review the site development recommendations to verify that they are appropriate for the preferred foundation system.***

Primary geotechnical concerns affecting this this project are:

- The presence of variable fill material, including buried pavement materials.
- Installation of a basement retaining wall beneath the two-story addition approximately adjacent to the one-story addition.
- Primarily silty soils likely to ravel and slough on embankment slopes.
- Primarily silty site soils that may be difficult to place as structural fill. Difficulties may include moisture sensitivity, and difficulty in embankment construction.
- Mass Earthworks likely requiring placement and compaction of relatively silty soil materials.

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

4.1 Initial Site Preparation

Initial site preparation should include removal of all existing structures, playground equipment, trees, roots, topsoil and any otherwise deleterious materials for all areas to receive structural fill or building components. Approximately 3-inches of topsoil is recorded on test boring logs drilled within the building areas with up to 4 feet of fill below; this condition is recorded as prevalent in all test borings. Building & Earth recommends the project geotechnical engineer or a qualified agent of the engineer observe stripping and grubbing operations to confirm all unsuitable materials are removed from proposed development areas.

Due to past use, buried structures such as foundations, utility lines, septic tanks, etc. may be encountered during mass grading and foundation installation operations. If encountered, these should be removed and the resulting excavations should be backfilled in accordance with recommendations appearing in the *Structural Fill* section of this report.

Materials disturbed during clearing operations should be stabilized in place or, if necessary, undercut to undisturbed materials and backfilled with properly compacted, approved structural fill.

During site preparation the contractor should identify borrow source materials that will be used as structural fill and provide samples to the testing laboratory so that conformance to structural fill recommendations (provided below) can be confirmed, and so that laboratory moisture-density (Proctor) testing can be completed prior to earthworks commencement.

4.2 SUBGRADE EVALUATION

We recommend the project geotechnical engineer or a qualified agent of the engineer evaluate subgrades after fill and building areas are stripped as some unsuitable or unstable areas may be present in unexplored areas of the site. All areas that will require fill or that will support structures should be carefully proof-rolled with a heavy (40,000 # minimum), rubber-tired vehicle at the following times.

- After an area has been stripped, and undercut if required, prior to the placement of any fill.
- After grading an area to the finished subgrade elevation in a building or pavement area.
- After areas have been exposed to any precipitation, and/or have been exposed for more than 48 hours.

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

4.3 Moisture Sensitive Soils

Moisture sensitive sandy silt and silt with sand (ML), clayey sand (SC) and variously classified fill materials were encountered across the site during the subsurface exploration. These soils will degrade if allowed to become saturated. Therefore, not allowing water to pond by maintaining positive drainage and temporary dewatering methods (if required) will be important to help avoid degradation and softening of the soils.

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

4.4 Undercutting of Low Consistency Soils

Low consistency soils (N≤8 as measured using an automatic SPT hammer) were encountered in the upper 1 to 2-ft. in some of the test borings, and may be present in unexplored areas of the site. Where encountered, low consistency soils should be undercut to a stable, suitable subgrade. The undercutting should extend laterally 5 feet outside building footprints.

In areas to receive pavement, low consistency soils removal should extend laterally 3 feet beyond pavement edges. It may be possible to stabilize the soft soils in the pavement areas in place. Typical stabilization methods vary widely and include modification of the soft soils with the addition of shot rock or No. 2 stone, as well as utilization of geogrids and graded aggregates. The design of a specific stabilization method is beyond the scope of this investigation but can be provided by Building & Earth as an additional service if desired. Any undercutting or stabilization performed in pavement areas should be conducted under the observation of the geotechnical engineer or his representative.

Some unsuitable or unstable areas may be present in unexplored areas of the site. Once the known undercut is complete, the areas planned for construction should be proofrolled in order to identify any additional soft soils requiring removal.

Undercut soils should be replaced with structural fill. Clean, non-organic, non-saturated soils taken from the undercut area can be re-used as structural fill. The placement procedure, compaction and composition of the structural fill must meet the requirements of the Structural Fill section of this report.

4.5 Undercutting of Highly Plastic Soils

Laboratory testing suggests moderately plastic soils (elastic silt with sand (MH) are present on the site. Where this material occurs beneath building foundation and floor slabs, we recommend it be undercut so that it lies at least 2-ft. below foundations and floor slabs. The undercutting should extend at least 5 feet horizontally beyond building footprints.

In parking and drive areas the highly plastic clays should be undercut to 1-ft. below planned subgrades (bottom of the base layer). The undercut material should be replaced with structural fill meeting the recommendations appearing in the Structural Fill section of this report.

The undercutting should be conducted under the observation of the geotechnical engineer or a qualified representative of the engineer. *Weather conditions at the time of construction will affect the undercutting depths and quantities.* Some instability may exist during construction, depending on climatic and other factors immediately preceding and during construction.

4.6 Structural Fill

Structural fill material recommendations follow:

Soil Type	USCS Classification	Property Recommendations	Placement Location
Sand and Gravel	GW, GP, GM, SW, SP, SM or combinations	Maximum 2" particle size	All areas where fill material is confined against raveling. Not recommended in areas subject to foundation or utility trenching.
Clay	CL, SC, GC	LL<50, PI<25, γ_d>100 pcf	All areas.
Clay	CH	LL>55, PI>25, γ_d>100 pcf	Not recommended for use.
Elastic Silt	MH	LL>50, PI>22, γ_d>100 pcf	Not recommended for use.
On-site soils	Silt with Sand (ML) Sandy Silt (ML) Clayey Sand (SC)	As listed above	All areas, Compaction of ML materials will likely be highly moisture sensitive.

Table 9: Structural Fill Recommendations

Notes:

1. LL indicates the soil Liquid Limit; PI indicates the soil Plasticity Index; γ_d indicates the maximum dry density as defined by the density standard outlined in the table below.
2. Laboratory testing of the soils proposed for fill should be performed to verify their conformance with the above recommendations.

3. Any fill to be placed at the site should be reviewed by the geotechnical engineer.
4. Placement of material described as sandy silt or silty sand on embankment slopes may be subject to sloughing until the slopes are stabilized with vegetation. This condition is expected to worsen on slopes steeper than about 3.0 to 1.0V.

Structural fill placement recommendations follow:

Specification	Recommendation
Lift Thickness	8-in. maximum loose, 6-in. maximum compacted
Density	98% as determined by ASTM D698 (standard Proctor)
Moisture	+/- 2% of optimum as determined by ASTM D698 (standard Proctor) ML soils may require a more restrictive compaction moisture tolerance.
Density Testing Frequency	1 test per 10,000 sq. ft. of material placed in each lift, minimum 2 tests per lift.

Table 10: Structural Fill Placement Recommendations

4.7 Excavation Considerations

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

4.8 Groundwater

Groundwater was encountered in borings B-01 and B-15 at the depths tabulated above. Groundwater could be encountered at higher elevations during construction, particularly during undercutting operations. It should be noted that fluctuations in groundwater levels could occur due to seasonal variations in rainfall. The contractor should be prepared to remove groundwater seepage from excavations if encountered during construction. Excavations extending below groundwater levels will likely require dewatering systems (such as well points, sump pumps or trench drains). The contractor should evaluate the most economical and practical dewatering method.

4.9 Cut Slopes

Provided grading information suggests cut slopes up to about 10 to 15 feet in height are expected. Due to the relatively low strength of the site soils, Building & Earth recommends cut slopes not exceed 3(H):1(V). Due to the types of soils encountered at the site, we recommend that stability analysis be performed for all cut slopes greater than 15 feet. It is noted the stability of cut slopes can be affected by minor discontinuities that may not be detected in the borings. Therefore, careful inspection of the excavation process and the cut slope by Building & Earth engineering personnel during construction is critical.

Proposed cut slopes are expected to expose silt with significant sand content. Therefore, the face of cut slopes will likely be susceptible to erosion. Additionally, the likelihood of surficial slides, sloughing, and shallow failures is greatly increased in excavations where shallow groundwater is present. Water should not be allowed to pond at the toe or crest of the cuts. Nor should water be allowed to flow over the face of the slope. Interceptor ditches should be constructed at proper locations to promote the collection and removal of excess water. Recommended locations for interceptor and collection channels include the crest and the toe of the slopes and at benches within the slope, as applicable.

Permanent drains will be required in areas exhibiting continual seepage such as at the toe of cut slopes. The drain will serve to collect and remove water that continues to seep into the area and reduce the potential of water infiltrating the adjacent subgrade soils.

4.10 FILL SLOPES

Provided grading information suggests fill embankments up to about 15 feet in height are expected to be constructed at the site. Building & Earth recommends a maximum plan inclination of fill embankments at 3(H):1(V). Due to the types of soils available on site for fill construction, we recommend that stability analysis be performed for all fill slopes greater than 15 feet in height. It is important to note that fill embankments are a structural element requiring proper construction techniques and suitable materials to perform as designed.

Even if properly constructed, fill embankments tend to "creep" over time. Creep is the gradual, downward movement of soils near the slope face. The movement can lead to distress in structures supported on the fill. Therefore, pavements and buildings should be set back a minimum distance of 5 and 15 feet from the crest of fill embankments, respectively, or greater if a greater offset distance is required by the International Building Code (IBC).

The long-term stability of fill embankments is dependent on a stable subgrade. Embankments constructed over low-consistency material are susceptible to settlement and slope failure. Therefore, low-strength soils should be removed from beneath the embankment and a minimum of 10 feet beyond the toe of the embankment. Excavations should be backfilled with compacted and tested engineered fill. Building & Earth should verify that the underlying, subgrade soils within the area of influence of the slope exhibit a high consistency prior to embankment construction. All material used to construct the fill embankment should conform to the project requirements for engineered fill. Unsuitable materials (organics, debris, wet or soft soil) should not be placed in embankments. On-site soils must be carefully monitored during construction to ensure only high strength engineered fill is used to construct embankments.

Fill should be placed in thin, horizontal lifts and compacted and tested in accordance with the project requirements. Due to the difficulty in compacting soils on the face of the slope, fill embankments should be overbuilt and cut back to the desired configuration upon completion. In no case should the slope be constructed or reconfigured by pushing soil over the top edge of the slope. Careful control by the contractor during construction is important to ensure that no part of the slope exceeds the design inclination. The fill should be benched into the natural soils to prevent the formation of weak zones.

4.11 Existing Slopes

Existing slopes are present within the development area. Minimum slope setback requirements are identified in the International Building Code (IBC) Section 1808.7.1. The setbacks should be followed to assure building foundations have adequate vertical and lateral support, and that foundations are installed a minimum safe distance from the top of the slopes.

4.12 Utility Trench Backfill

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

4.13 Landscaping and Drainage Considerations

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

4.14 Wet Weather Construction

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

During rainy periods, additional effort will be required to properly prepare the site and establish/maintain an acceptable subgrade. The difficulty will increase in areas where clay or silty soils are exposed at the subgrade elevation. Grading contractors typically postpone grading operations during wet weather to wait for conditions that are more favorable. Contractors can typically disk or aerate the upper soils to promote drying during intermittent periods of favorable weather. When deadlines restrict postponement of grading operations, additional measures such as undercutting and replacing saturated soils or stabilization can be utilized to facilitate placement of additional fill material.

5.0 FOUNDATION RECOMMENDATIONS

Actual foundation loading was provided by Mr. Victor Torres, PE with Lynch Mykins Structural Engineers, PC. We understand that individual column loads will be less than 100 kips and wall loads will be less than 9 kips per linear foot. ***If this foundation loading is incorrect, our office should be contacted, such that our recommendations can be reviewed and revised accordingly.***

6.0 SHALLOW FOUNDATIONS

Provided field conditions reported herein are confirmed and after our site preparation and grading recommendations are implemented, Building & Earth recommends the proposed structure be supported on conventional shallow spread foundations designed using a 3,000 psf allowable soil bearing capacity.

Even though computed footing dimensions may be less, column footings should be at least 24 inches wide and strip footings should be at least 18 inches wide. These dimensions facilitate hand cleaning of foundation bearing surfaces that may have been disturbed during excavation and reinforcing steel placement. They also reduce the potential for localized punching shear failure. ***All exterior footings should bear at least 24 inches below the adjacent exterior grades for frost protection and to enhance bearing capacity.*** Total settlement of footings designed and constructed as recommended above should be 1 inch or less, with differential settlement up to about ½-inch or less.

7.0 BASEMENT RETAINING WALL CONSTRUCTION

Where basements are constructed, Building & Earth recommends basement retaining walls be designed as braced against lateral deflection, with earth pressures against the walls computed for the "at rest" (K_o) condition. It is recommended the walls be braced at the top prior to backfilling the space between the wall exteriors and the adjacent, retained earth. We further recommend a minimum 12-inch thick layer of freely draining stone be placed as a drainage blanket between retaining walls and retained earth, and that a "socked" perforated pipe be placed at the base of this drainage blanket to provide a removal pathway for any water that may build up in the retained materials. A non-woven filter fabric should separate the stone blanket from the retained soils and a water barrier should be applied to the retaining walls prior to backfilling. Drainage piping should be run either to daylight or to a sump that will preclude standing water from building up behind the walls.

Lateral loading against basement retaining walls should be computed as an equivalent fluid pressure based upon the material retained. Where backfill is installed following wall bracing, the "at rest" soil condition is recommended. Where backfill is placed prior to bracing or where unbraced cantilever walls are used, the walls should be expected to move laterally and the active case condition should be used to compute loading.

Two backfill material conditions should be considered in design. These are: 1) Use of soil materials native to the site; and 2) Use of well graded clean gravel or gravel sand mixes. If soil is used, a freely draining stone material (described above) should be placed against the walls. If stone is used as a backfill material, it is recommended the stone be installed in a trench sloped at a minimum 1H:1V extending away from the wall foundations to the surface. A non-woven filter fabric should be placed between the stone and the native soils. The ground surface above and surrounding the retaining walls should be graded to promote rapid and efficient drainage away from the walls. If stone is used as the backfill material, it should be covered with a non-woven filter fabric and, where exposed to precipitation, at least 18-inches of low permeability soil should be placed over the stone. Recommended equivalent fluid pressure values for the four loading conditions are tabulated below:

Backfill Material	Active Case (pcf)	At Rest Case (pcf)
Native, Local Soil	85	100
Clean Gravel or Gravel-Sand Mixture	35	60

Table 11: Equivalent Fluid Pressures for Retaining Wall Design

Fill material placed behind retaining walls should be placed in lifts as described above and compacted using hand operated compaction equipment. Heavy equipment should not be used to place and compact the retained materials as the vehicle loads may damage the retaining walls.

8.0 FLOOR SLABS

We recommend floor slabs for the proposed additions be supported on a minimum four-inch layer of ½-inch up to 1½-inch, free-draining, gap-graded gravel, such as AASHTO No. 57 stone, with no more than 5 percent passing the ASTM No. 200 sieve. The purpose of this layer is to help distribute concentrated loads and to act as a capillary break for moisture migration through the subgrade soil. This gravel material should be consolidated in-place with vibratory equipment. The surface of the base material should be choked with finer material. A clean fine-graded material with at least 10 to 30 % of particles passing a No. 100 sieve but not contaminated with clay, silt or organic material is recommended. With the gravel material, such as AASHTO No. 57 stone, a modulus of subgrade reaction of 150 pci can be used in the design of a grade-supported building floor slab.

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

9.0 PAVEMENT CONSIDERATIONS

Provided site preparation recommendations are followed, soil conditions encountered at the boring sites support pavement design using a California Bearing Ratio (CBR) of five (5). Note that no CBR or plate load testing was completed to develop these recommendations.

For pavement design purposes, we have assumed two levels of traffic shown on the table below. From discussions with Heather Rhymes, PLA with CLH design, pa we understand that a heavy-duty, asphalt roadway will be constructed to access the new storm drain basin. Additionally, the current bus parking lot will be demolished, and a new student drop off loop will be constructed. The student drop off area will have limited spaced for faculty parking, but will not be used for trash pick-up or school supply deliveries. The drop off loop will be designed as an emergency access point as well. Specific traffic information was provided by Ms. Rhymes and includes the following daily traffic volume:

Type	Automobiles (per weekday)	Fire Truck (3-Axle/10-Tire) (per month)	Maintenance Trucks (2-Axle/6-Tire) (per day)	Trash Trucks (per week)	ESAL
Standard Duty	1,100	2	--	--	3.3 X E+4
Heavy Duty	10	2	1	--	2.9 X E+4

Table 12: Provided Traffic Volume

The volumes shown above are an example of vehicle types and daily traffic that would result in the total equivalent 18-kip single-axle load (ESAL) shown. If this traffic loading is not correct, please contact our office so we can re-evaluate our design recommendations.

It has been our experience that parking lots experience a certain level of wear and stress greater than roadways designed for similar traffic volumes. Therefore, parking lots are typically designed using the AASHTO method and adjusted based on experience. Alternative traffic volume estimates may result in alternate section recommendations. In addition to the estimated CBR value, we have assumed the following design parameters:

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

Table 13: Assumed Design Parameters

Note: All subgrade, base and pavement construction operations should meet minimum requirements appearing in the North Carolina Standard Specification for Road and Bridge Construction.

9.1 Flexible Pavement

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

Material	Structural No.
Asphalt Concrete	0.44
Crushed Stone Base	0.14

Table 14: Structural Equivalent Coefficient

The following flexible pavement sections are based on the design parameters presented above:

Minimum Recommended Thickness (in)		Material
Standard Duty	**Heavy Duty**	
2.0	2.0	Surface Course (S9.5B)
--	--	Binder Course (I19.0C)
8.0	8.0	ABC Stone

Table 15: Asphalt Pavement Recommendations

9.2 Rigid Pavement

The following rigid pavement sections are based on the design parameters presented above. We assume an effective modulus of subgrade reaction (k) of 140 pci. We have assumed concrete elastic modulus (E_c) of 3.6 X 10^6 psi, and a concrete modulus of rupture (S'_c) of 650 psi.

Minimum Recommended Thickness (in)		Material
Standard Duty	**Heavy Duty**	
N/A	**4.0**	Portland Cement Concrete, f'_c=**4,000** psi
N/A	**6.0**	**ABC Stone**

Table 16: Rigid Pavement Recommendations

The concrete should be protected against moisture loss, rapid temperature fluctuations, and construction traffic for several days after placement. All pavements should be sloped for positive drainage. We recommended that the pavements be reinforced to hold any cracks that might develop tightly together and restrain their growth.

All pavement construction, including subgrade and base course preparation, should meet minimum requirements of the NCDOT.

10.0 SUBGRADE REHABILITATION

Subgrade soils often become disturbed during the period between initial site grading and construction of surface improvements. The amount and depth of disturbance will vary with soil type, weather conditions, construction traffic, and drainage.

The engineer should evaluate subgrade soils during final grading to verify the subgrade is suitable to receive pavement and/or concrete slab base materials. The final evaluation may include proofrolling or density tests.

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

11.0 CONSTRUCTION MONITORING

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

- During stripping and clearing to confirm subgrade conditions adequate for fill placement.
- During mass excavation to confirm soil types in-situ and soil types selected for embankment construction.
- Earthworks embankment construction.
- During retaining wall construction and backfill operations.
- During foundation installation.
- To address all special inspection requirements appearing in applicable building codes.

12.0 CLOSING AND LIMITATIONS

This report was prepared for Johnson County Public Schools, for specific application to the additions planned for Cooper Academy located in Clayton, North Carolina. The information in this report is not transferable. This report should not be used for a different development on the same property without first being evaluated by the engineer.

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

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

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

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

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

Appendix Table of Contents

GEOTECHNICAL INVESTIGATION METHODOLOGIES

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

DRILLING PROCEDURES – STANDARD PENETRATION TEST (ASTM D1586)

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

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

The SPT testing was performed using a drill rig equipped with a manual hammer. Manual hammers are dropped using a manually operated rope and cathead system. The N-values discussed or mentioned in this report and shown on the boring logs are recorded field values.

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

HAND AUGER BORINGS AND DYNAMIC CONE PENETRATION TESTING

Hand auger borings were drilled with a 3-inch diameter auger to advance the hole below the existing grade. A Building & Earth representative collected samples of the subsurface soils at regular depth intervals and at depths where a change in lithology occurred.

Dynamic Cone Penetration (DCP) testing was performed in the hand auger borings to evaluate the consistency of the subgrade soils. The DCP apparatus consists of a steel, cylindrical shaft with a conical tip at the end. The conical tip measures 1.5-inches in diameter, with a 45° tip angle. A 15-pound sliding ring weight is mounted to the shaft. When dropped from a height of 20 inches, the ring weight strikes a steel anvil, driving the point into the soil. After seating the point into the soil 2 inches, the weight is dropped until the shaft travels an interval of 1.75 inches. The number of blows necessary to drive the tip each 1.75-inch increment is recorded. Given the material type and certain soil properties, this number can then be correlated to the Standard Penetration Test (ASTM D1586) N-values. The DCP test results are shown under the "Remarks" column on the boring logs.

BULK SAMPLING

Bulk sample are obtained for the evaluation of the compaction characteristics of the site soils and for determination of the California Bearing Ratio (CBR). The bulk samples are obtained from manual excavations, backhoe test pits, or from auger cutting. Similar soils are normally combined to provide samples of adequate size for compaction or CBR testing.

UNDISTURBED SAMPLING

Soil samples are obtained using Shelby tube samplers. The Shelby tube is a three (3) inch diameter, thin walled sampling tube that allows for relatively undisturbed sampling of soil. The undisturbed or thin-walled tube sampling is conducted in general accordance with ASTM D1587.

The sampling procedure consists of augering to the sample depth, then cleaning out the open borehole and continuously pushing the thin-walled, metal Shelby tube into the soil. The Shelby tubes are carefully withdrawn from the borehole to reduce the possibility of disturbing the sample. The ends of the Shelby tube are sealed in the field and the tubes are transported to the laboratory for testing.

BORING LOG DESCRIPTION

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

DEPTH AND ELEVATION

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

SAMPLE TYPE

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

SAMPLE NUMBER

Each sample collected is numbered sequentially.

BLOWS PER INCREMENT, REC%, RQD%

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

SOIL DATA

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

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

SOIL DESCRIPTION

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

GRAPHIC

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

REMARKS

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

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

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

SOIL CLASSIFICATION METHODOLOGY

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

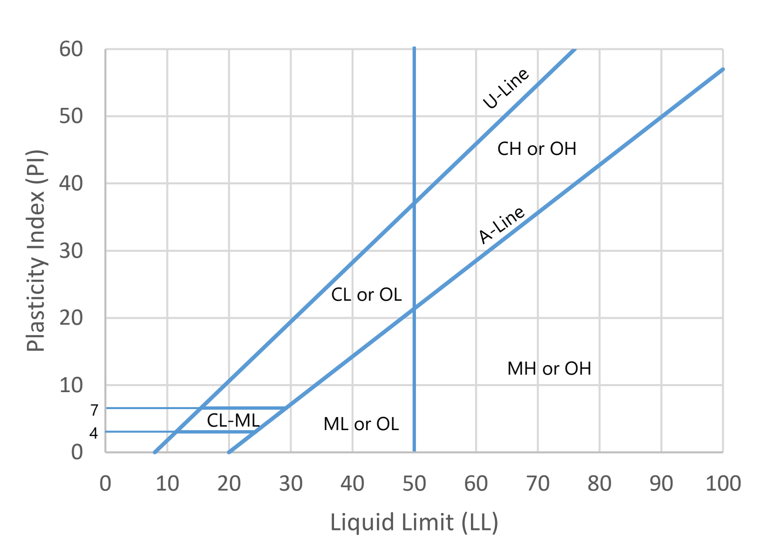


Figure 1: Plasticity Chart (based on ASTM D2487)

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

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

* - Modified based on 80% hammer efficiency

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

Table 1: Symbol Legend

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

Table 2: Standard Sieve Sizes

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

Table 3: Soil Data

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

Table 4: Soil Drilling Methods

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

Table 5: Descriptors

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

Table 6: Sampling Methods

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

Table 7: Plasticity

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

Table 8: Moisture Condition

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

Table 9: Structure

BUILDING & EARTH

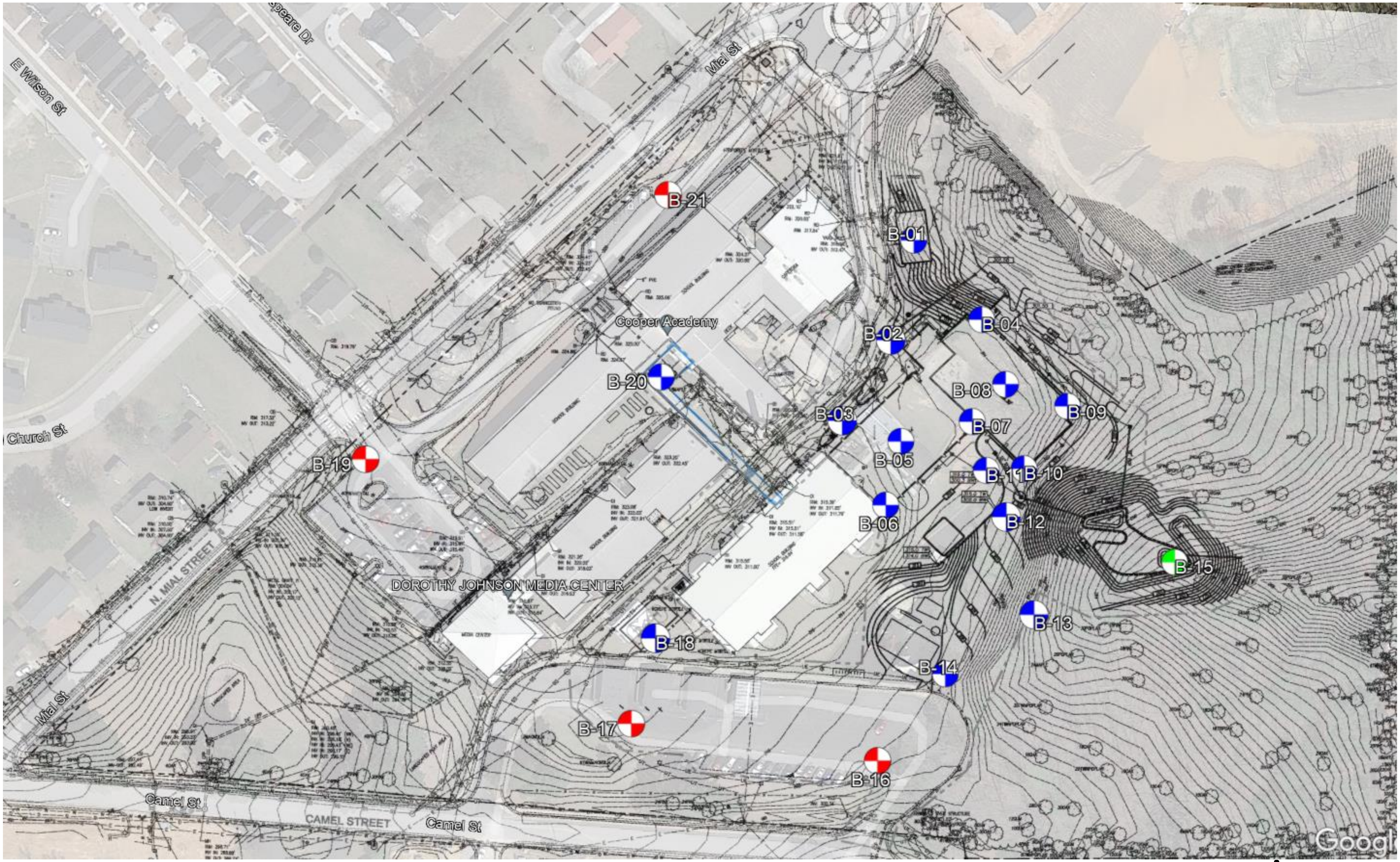
Geotechnical, Environmental, and Materials Engineers

KEY TO HATCHES

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

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

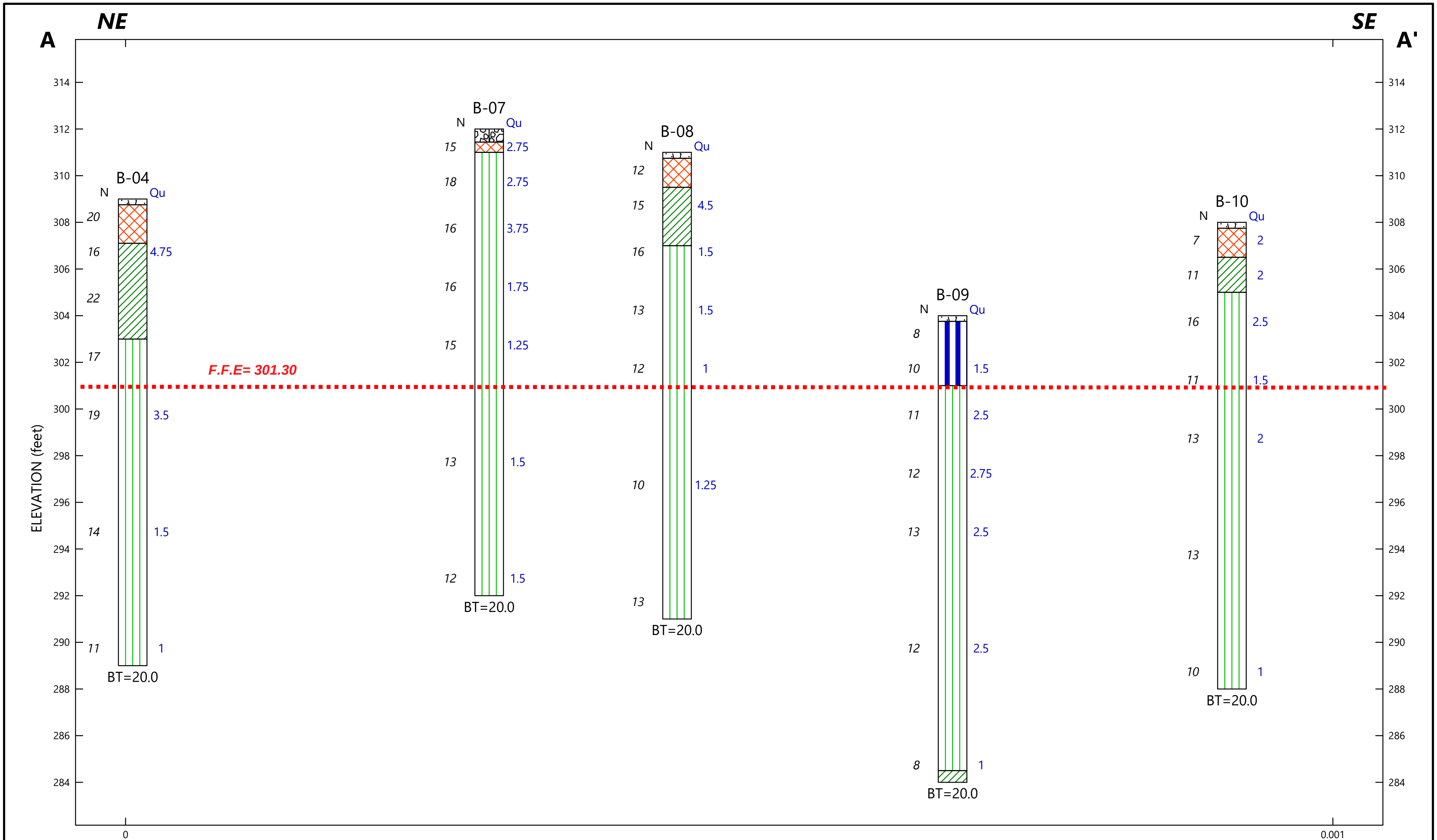
BORING LOCATION PLAN

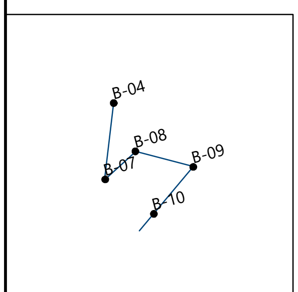


Building Boring Location **Pavement Boring Location** **Infiltration Boring Location** N

Boring Location Map				
BUILDING & EARTH	**BES Project #:**	RD230492	**Address:**	849 N Mial St
	Drawing Source:	Boomerang Design (10/4/2023), Google Earth	**City:**	Clayton, NC
	Client:	Johnston County Public Schools	**Figure 1**	
	Project:	Cooper Academy Addition		

SUBSURFACE SOIL PROFILES





Site Map Scale 1 inch equals 0 feet

Key to Hatches

- Topsoil
- Fill
- USCS Low Plasticity Clay
- USCS Silt
- Aggregate Base Material
- USCS Elastic Silt

Legend

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

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

0 0

Horizontal Scale (feet)
Vertical Exaggeration: 0x

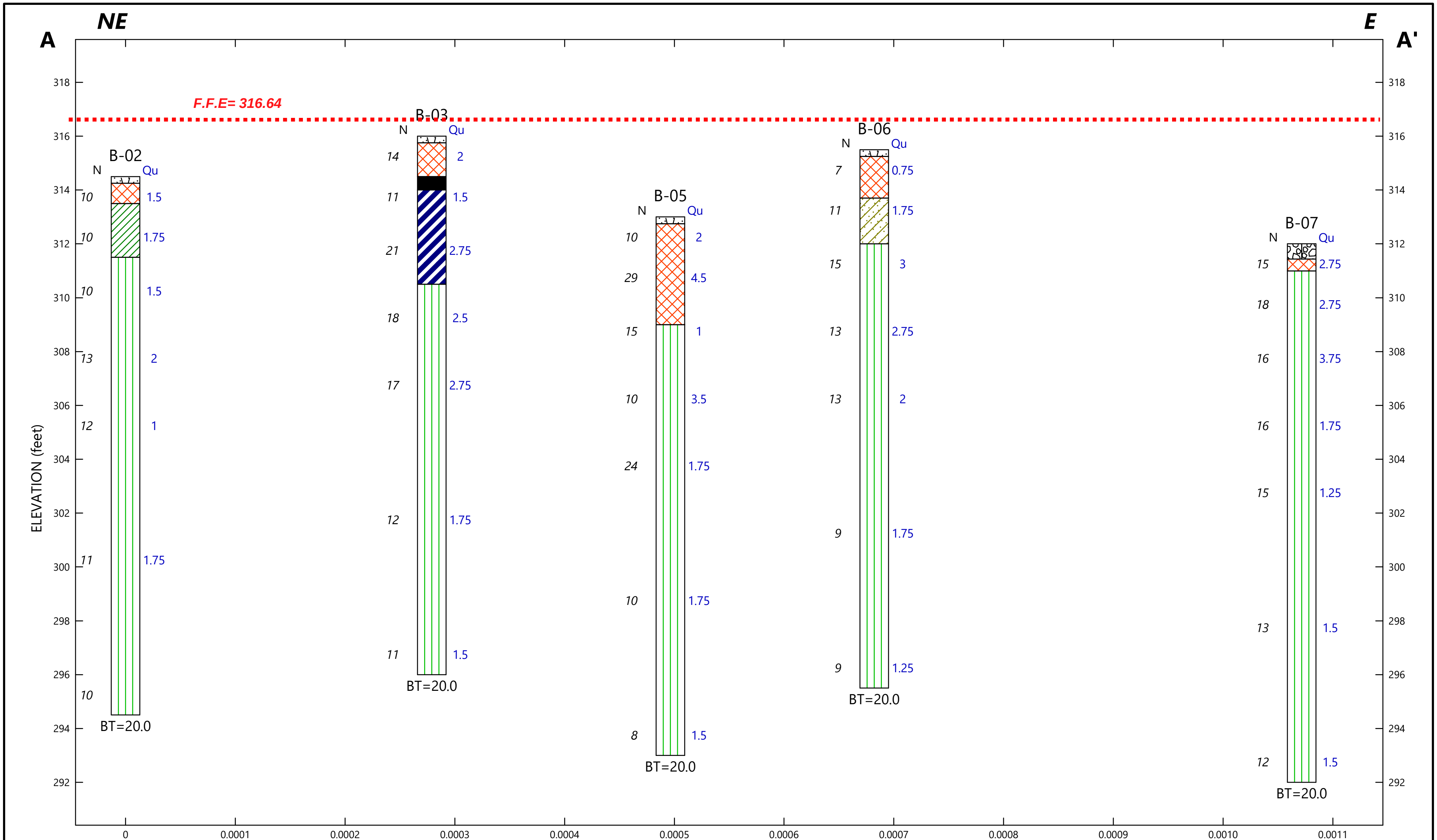
Building & Earth Sciences, Inc.
610 Spring Branch Road, Dunn, NC 28334

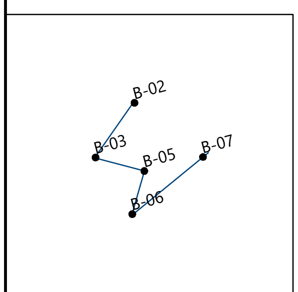
Cooper Academy Addition
Clayton, NC

Subsurface Profile 1

PROJECT NO: RD230492	PLATE NO: A-1	DATE: 11/16/23

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers





Site Map Scale 1 inch equals 0 feet

Key to Hatches

- Topsoil
- Fill
- USCS Low Plasticity Clay
- USCS Silt
- Asphalt
- USCS High Plasticity Clay
- USCS Clayey Sand
- Aggregate Base Material

Legend

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

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

0 0

Horizontal Scale (feet)
Vertical Exaggeration: 0x

Building & Earth Sciences, Inc.
610 Spring Branch Road, Dunn, NC 28334

Cooper Academy Addition
Clayton, NC

Subsurface Profile 2

PROJECT NO: RD230492	PLATE NO: A-1	DATE: 11/16/23

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BORING LOGS

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

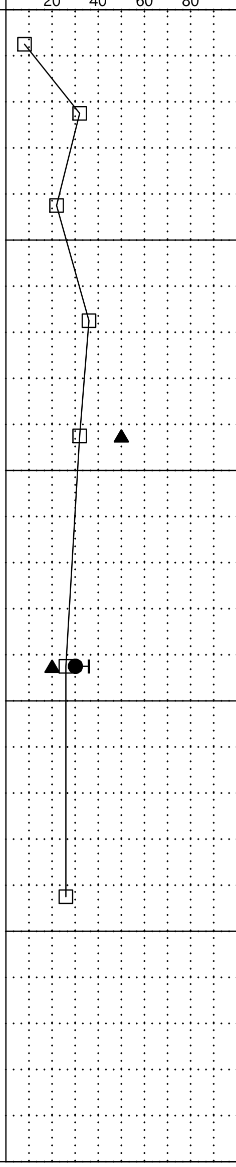
Designation: B-01

Sheet 1 of 1

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/11/23
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	307
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Equipment Pad	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
		Split Spoon	S-1	3 2 2	
	305	Split Spoon	S-2	4 6 10	
5		Split Spoon	S-3	3 3 8	
	300	Split Spoon	S-4	4 7 11	
10		Split Spoon	S-5	4 7 9	
	295				
15		Split Spoon	S-6	6 7 6	Sample S-6 LL: 36 PL: 30 PI: 6 M: 30.1% F: 61%
	290				
20		Split Spoon	S-7	4 6 7	
	285				



Depth	SOIL DESCRIPTION	Elevation	REMARKS
0.3	TOPSOIL: approx. 3 inches	306.8	
1.9	CLAYEY SAND (SC): loose, brown, fine to medium grained, moist, existing fill; with fine gravel	305.1	
6.5	SANDY LEAN CLAY (CL): very stiff, reddish yellow, fine to medium grained, moist, with fine gravel wet stiff	300.5	
20.0	SANDY SILT (ML): very stiff, red, tan, fine to medium grained, moist, with fine gravel light brown, red streaks	287.0	Boring cave-in at 14 feet Groundwater encountered at 18.6 feet (EL 288.4) at time of drilling and stabilized at 17.4 feet (EL 289.6).
	Boring Terminated at 20 feet.		Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

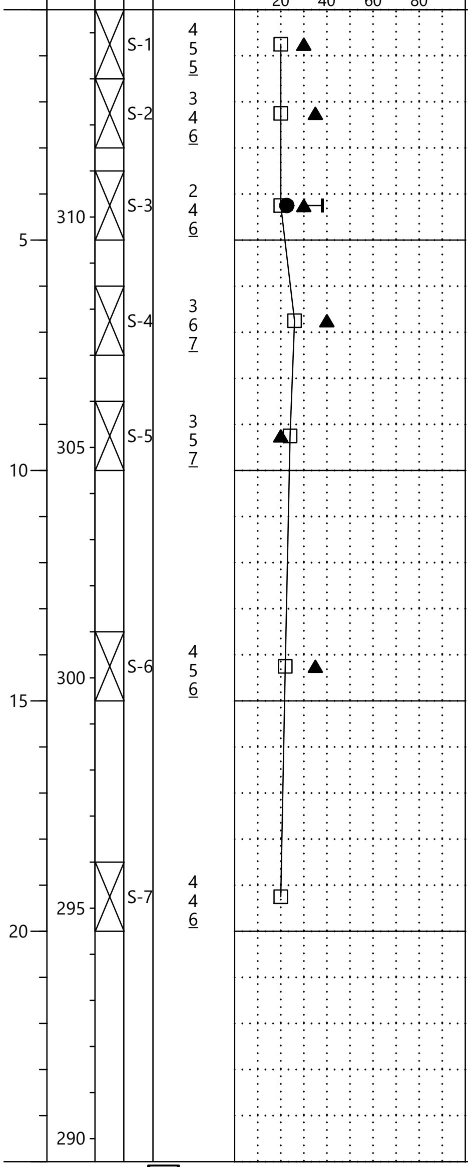
LOG OF BORING

Designation: B-02

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/12/23
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Rainy, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	314.5
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Retaining wall	LOGGED BY:	G.Gonzalez

SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
Split Spoon	S-1	4 5 5	
Split Spoon	S-2	3 4 6	
Split Spoon	S-3	2 4 6	Sample S-3 LL: 38 PL: 30 PI: 8 M: 22.6% F: 61.1%
Split Spoon	S-4	3 6 7	
Split Spoon	S-5	3 5 7	
Split Spoon	S-6	4 5 6	
Split Spoon	S-7	4 4 6	



Depth (ft)	SOIL DESCRIPTION	Elevation	REMARKS
0.3	TOPSOIL: approx. 3 inches	314.3	
1.0	CLAYEY SAND (SC): medium dense, brown, fine to medium grained, dry, existing fill; with fine gravel	313.5	
3.0	SANDY LEAN CLAY (CL): stiff, reddish yellow, fine to medium grained, moist	311.5	
	SANDY SILT (ML): stiff, reddish yellow, fine to medium grained, moist		
	very stiff		
	tan		
	stiff		
20.0		294.5	Boring cave-in at 19.6 feet
	Boring Terminated at 20 feet.		

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

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

Designation: B-03

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/12/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Rainy, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	316
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Building corner	LOGGED BY:	G.Gonzalez

Chart legend: □ N-Value □ (10, 20, 30, 40); ▲ Qu (tsf) ▲ (1, 2, 3, 4); I Atterberg Limits I (20, 40, 60, 80); ● % Moisture ● (20, 40, 60, 80)

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT
	315	Split Spoon	S-1	5 6 8
		Split Spoon	S-2	5 5 6
5		Split Spoon	S-3	4 8 13
	310	Split Spoon	S-4	5 7 11
10		Split Spoon	S-5	5 7 10
	305			
15		Split Spoon	S-6	3 5 7
	300			
20		Split Spoon	S-7	4 4 7
	295			

Depth	SOIL DESCRIPTION	Elevation	REMARKS
0.3	TOPSOIL: approx. 3 inches	315.8	
1.5	CLAYEY SAND (SC): medium dense, brown, fine to medium grained, moist, existing fill	314.5	
2.0	ASPHALT	314.0	
5.5	SANDY FAT CLAY (CH): very stiff, brown, tan, fine to medium grained, moist, 2" seam of asphalt @ 3.5 feet	310.5	
	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist		
	tan		
20.0	stiff	296.0	Boring cave in at 18.4 feet
	Boring Terminated at 20 feet.		Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

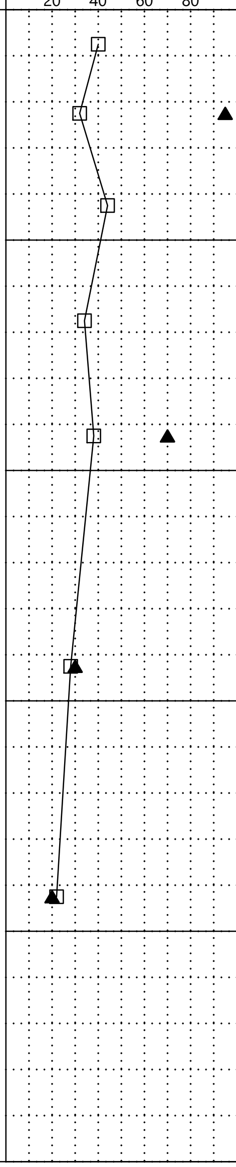
LOG OF BORING

Designation: B-04

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/11/23
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	309
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Building corner	LOGGED BY:	G.Gonzalez

Chart legend: □ N-Value □ (10, 20, 30, 40); ▲ Qu (tsf) ▲ (1, 2, 3, 4); I Atterberg Limits I (20, 40, 60, 80); ● % Moisture ● (20, 40, 60, 80)



SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT
Split Spoon	S-1	6 10 10
Split Spoon	S-2	4 6 10
Split Spoon	S-3	6 9 13
Split Spoon	S-4	3 6 11
Split Spoon	S-5	5 8 11
Split Spoon	S-6	5 7 7
Split Spoon	S-7	3 5 6

DEPTH (ft): 5, 10, 15, 20
ELEVATION (ft): 305, 300, 295, 290, 285

DEPTH	SOIL DESCRIPTION	ELEVATION
0.3	TOPSOIL: approx. 3 inches	308.8
1.9	CLAYEY SAND (SC): medium dense, brown, reddish yellow, fine to medium grained, moist, existing fill; with fine gravel	307.1
6.0	SANDY LEAN CLAY (CL): very stiff, red, fine to medium grained, moist	303.0
20.0	SANDY SILT (ML): very stiff, red, fine to medium grained, moist stiff, reddish yellow	289.0
	Boring Terminated at 20 feet.	

REMARKS:

Shelby tube at 8.5-10.5 feet

Boring cave in at 13.4 feet
Artificially high blow count due to auger stem partially blocked- resampled

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

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

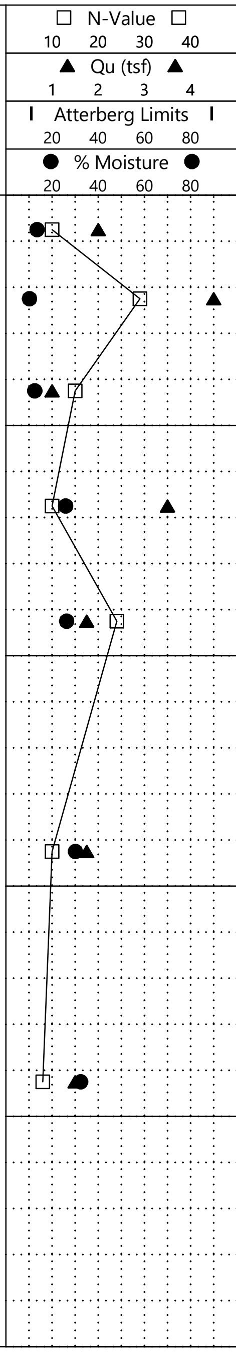
LOG OF BORING

Designation: B-05

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/11/23
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	313
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Center of building	LOGGED BY:	G.Gonzalez

SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
Split Spoon	S-1	2, 4, 6	Sample S-1 M: 13.5%
Split Spoon	S-2	4, 13, 16	Sample S-2 M: 10.2%
Split Spoon	S-3	8, 8, 7	Sample S-3 M: 12.5%
Split Spoon	S-4	5, 4, 6	Sample S-4 M: 25.9%
Split Spoon	S-5	6, 12, 12	Sample S-5 M: 26.3%
Split Spoon	S-6	3, 4, 6	Sample S-6 M: 30.1%
Split Spoon	S-7	2, 3, 5	Sample S-7 M: 32.4%



DEPTH (ft)	ELEVATION (ft)	SOIL DESCRIPTION	REMARKS
0.3	312.8	TOPSOIL: approx. 3 inches	
4.0	309.0	CLAYEY SAND (SC): medium dense, brown, fine to medium grained, moist, existing fill dense	boring offset 5 feet east
20.0	293.0	SANDY SILT (ML): very stiff, light brown, reddish yellow, fine to medium grained, moist, with fine gravel stiff, reddish yellow hard stiff	Boring cave in at 14.2 feet
		Boring Terminated at 20 feet.	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

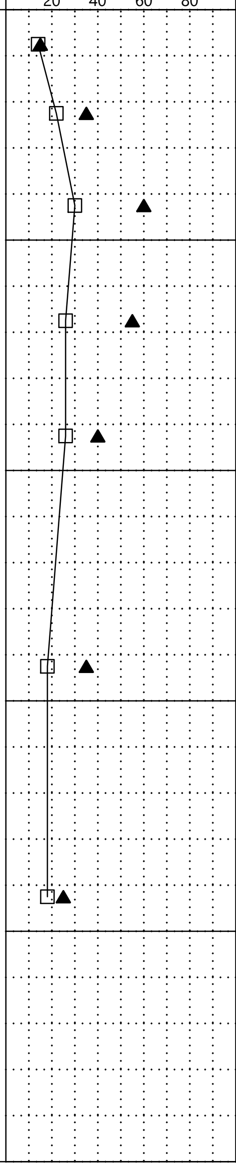
LOG OF BORING

Designation: B-06

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/11/23
DRILLING METHOD:	Hollow Stem Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	315.5
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Building corner	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.3	315.3					TOPSOIL: approx. 3 inches	
1.8	313.7	Split Spoon	S-1	2-3-4		CLAYEY SAND (SC): loose, brown, fine to medium grained, moist, existing fill	
3.5	312.0	Split Spoon	S-2	2-4-7		CLAYEY SAND (SC): medium dense, yellowish brown, fine to medium grained, moist	
		Split Spoon	S-3	4-6-9		SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist	
		Split Spoon	S-4	3-5-8			
		Split Spoon	S-5	3-6-7			
						tan	
		Split Spoon	S-6	3-4-5		stiff	
							Boring cave in at 15.4 feet
20.0	295.5	Split Spoon	S-7	4-4-5			
						Boring Terminated at 20 feet.	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.



Depth scale: 5, 10, 15, 20. Elevation scale: 315, 310, 305, 300, 295.

SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

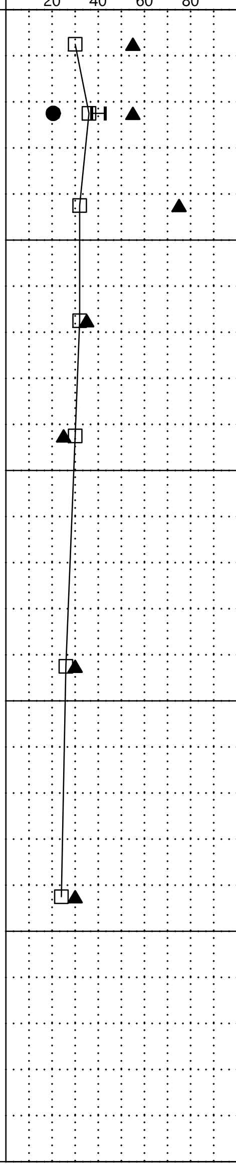
610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

LOG OF BORING

Designation: B-07

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/13/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 70s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	312
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Retaining wall	LOGGED BY:	G.Gonzalez

Column headings: DEPTH (ft) | ELEVATION (ft) | SAMPLE TYPE | SAMPLE NO. | BLOWS PER INCREMENT | □ N-Value □ (10, 20, 30, 40); ▲ Qu (tsf) ▲ (1, 2, 3, 4); I Atterberg Limits I (20, 40, 60, 80); ● % Moisture ● (20, 40, 60, 80) | LAB DATA | SOIL DESCRIPTION | GRAPHIC | REMARKS



Depth (ft)	Elevation (ft)	Sample No.	Blows per Increment
0–1.5		S-1	4, 6, 9
2–3.5	310	S-2	3, 8, 10
4–5.5		S-3	4, 7, 9
6.5–8	305	S-4	4, 7, 9
9–10.5		S-5	4, 6, 9
14–15.5		S-6	4, 6, 7
19–20.5		S-7	4, 5, 7

Depth scale: 5, 10, 15, 20. Elevation scale: 310, 305, 300, 295, 290.

Lab Data:
Sample S-2
LL: 43
PL: 37
PI: 6
M: 20.5%
F: 61.6%

Depth	Soil Description	Elevation
0.6	AGGREGATE BASE	311.4
1.0	CLAYEY SAND (SC): medium dense, reddish brown, fine to medium grained, moist, existing fill; with fine gravel	311.0
	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist, with fine gravel	
	reddish gray	
20.0	Boring Terminated at 20 feet.	292.0

Remarks:
Pavement: approx. 6.75 inches of ABC
Boring cave in at 19.5 feet
Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

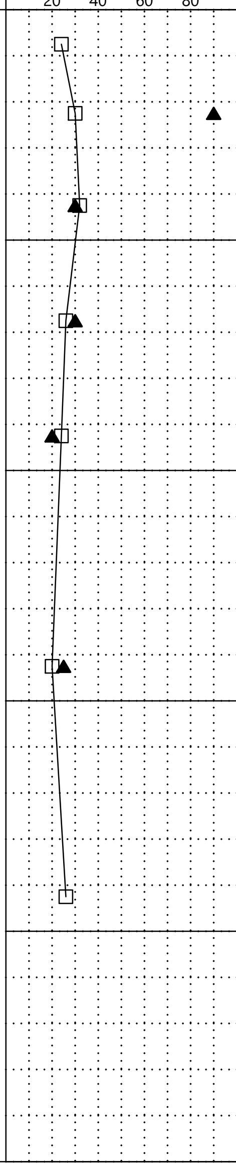
Designation: B-08

Building & Earth — Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/12/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Rainy, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	311
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Center of building	LOGGED BY:	G.Gonzalez

SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT
Split Spoon	S-1	5, 6, 6
Split Spoon	S-2	6, 6, 9
Split Spoon	S-3	4, 7, 9
Split Spoon	S-4	4, 5, 8
Split Spoon	S-5	4, 5, 7
Split Spoon	S-6	3, 5, 5
Split Spoon	S-7	3, 5, 8



DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)	REMARKS
0.3	TOPSOIL: approx. 3 inches	310.8	
1.5	CLAYEY SAND (SC): medium dense, light brown, fine to medium grained, moist, existing fill; with fine gravel	309.5	
4.0	SANDY LEAN CLAY (CL): very stiff, reddish yellow, fine to medium grained, moist	307.0	
20.0	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist red stiff very stiff, brownish yellow, with fine gravel	291.0	Boring cave in at 19.8 feet
	Boring Terminated at 20 feet.		Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

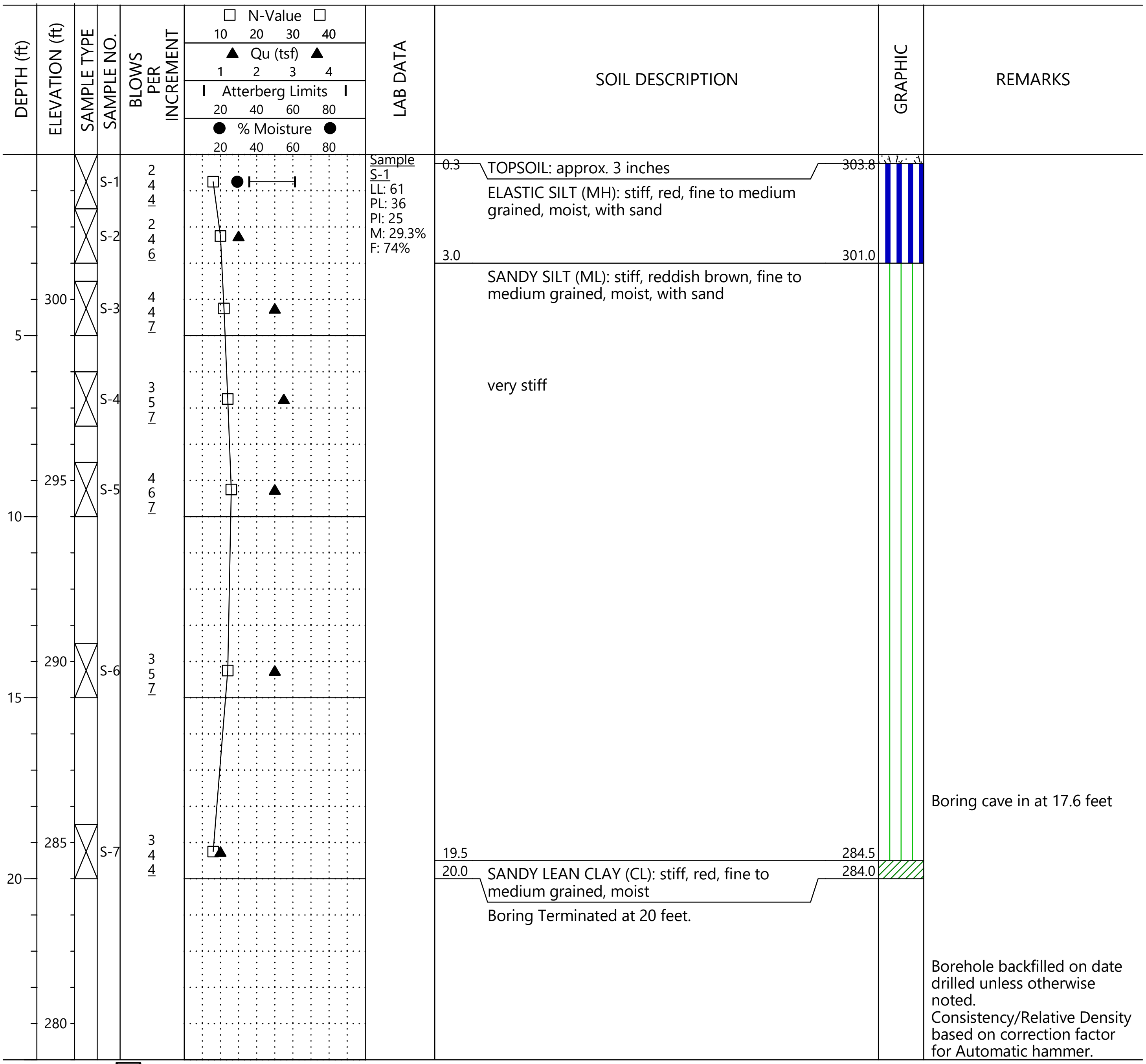
LOG OF BORING

Designation: B-09

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/16/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	304
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Building corner	LOGGED BY:	G.Gonzalez



SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

Designation: B-10

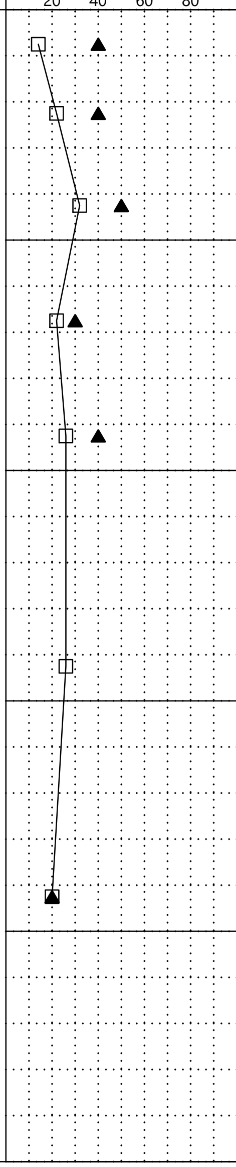
Sheet 1 of 1

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/16/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	308
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Building corner	LOGGED BY:	G.Gonzalez

SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT
Split Spoon	S-1	3 3 4
Split Spoon	S-2	4 4 7
Split Spoon	S-3	4 7 9
Split Spoon	S-4	4 5 6
Split Spoon	S-5	4 6 7
Split Spoon	S-6	4 6 7
Split Spoon	S-7	3 4 6



DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)	REMARKS
0.3	TOPSOIL: approx. 3 inches	307.8	
1.5	CLAYEY SAND (SC): loose, dark brown, fine to medium grained, moist	306.5	
3.0	SANDY LEAN CLAY (CL): stiff, red, fine to medium grained, moist, with fine gravel	305.0	
	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist		
	stiff		
	very stiff, yellow, black streaks		
	stiff		Boring cave in at 19.1 feet
20.0		288.0	
	Boring Terminated at 20 feet.		Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

Depth scale: 5, 10, 15, 20. Elevation scale: 305, 300, 295, 290, 285.

SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

BUILDING & EARTH

Geotechnical, Environmental, and Materials Engineers

Designation: B-11

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/16/23
DRILLING METHOD:		WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	310
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Playground	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	□ N-Value □ 10 20 30 40 / ▲ Qu (tsf) ▲ 1 2 3 4 / I Atterberg Limits I 20 40 60 80 / ● % Moisture ● 20 40 60 80	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
	310								Drilling not performed due to located in playground area
5	305								
10	300								
15	295								
20	290								Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.
	285								

SAMPLE TYPE

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

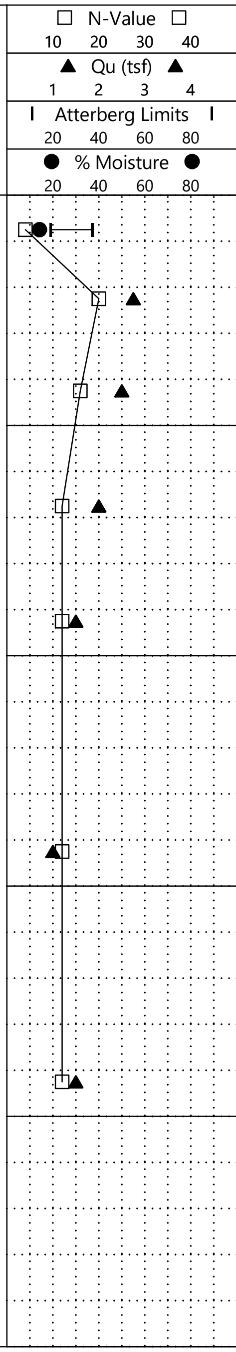
LOG OF BORING

Designation: B-12

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/16/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	308
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Woods	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.3	307.8					TOPSOIL: approx. 3 inches	
1.5	306.5	Split Spoon	S-1	2 2 2	Sample S-1 LL: 37 PL: 19 PI: 18 M: 14.2% F: 35%	CLAYEY SAND (SC): loose, brown, fine to medium grained, moist, with fine gravel	
3.0	305.0	Split Spoon	S-2	6 9 11		ELASTIC SILT (MH): very stiff, gray, yellow, fine to medium grained, moist, with fine gravel	
		Split Spoon	S-3	7 7 9		SANDY SILT (ML): very stiff, yellowish brown, fine to medium grained, moist	
		Split Spoon	S-4	3 5 7		reddish yellow	
		Split Spoon	S-5	4 5 7			
		Split Spoon	S-6	4 5 7			
20.0	288.0	Split Spoon	S-7	4 5 7			Boring cave in at 18.3 feet
						Boring Terminated at 20 feet.	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.



SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

Designation: B-13

Sheet 1 of 1

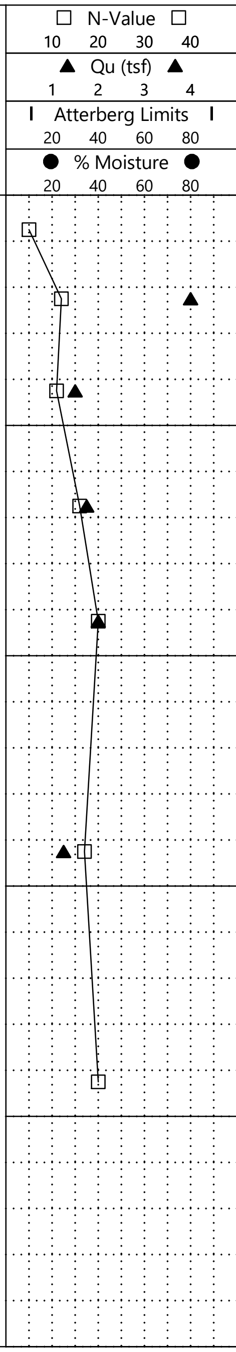
BUILDING & EARTH

Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/16/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	294
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Woods	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.3 / 293.8						TOPSOIL: approx. 3 inches		
1.0 / 293.0		Split Spoon	S-1	2 2 3		CLAYEY SAND (SC): loose, brown, fine to medium grained, moist, existing fill; with roots and gravel		
		Split Spoon	S-2	4 6 6		SANDY SILT (ML): stiff, brown, tan, fine to medium grained, moist		
	290	Split Spoon	S-3	3 6 5		very stiff, yellow, tan, fine to medium grained, moist		
5		Split Spoon	S-4	4 8 8		stiff		
	285	Split Spoon	S-5	6 10 10		yellow, gray		
10								
	280	Split Spoon	S-6	6 8 9				
15								Boring cave in at 17.5 feet
	275	Split Spoon	S-7	6 7 13		red, tan		
20.0 / 274.0						Boring Terminated at 20 feet.		
	270							Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.



SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

Designation: B-14

Sheet 1 of 1

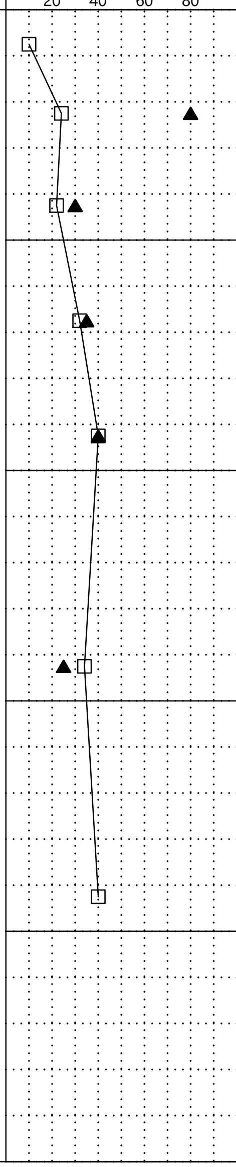
BUILDING & EARTH

Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/16/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	308
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Woods	LOGGED BY:	G.Gonzalez

DEPTH (ft) | ELEVATION (ft) | SAMPLE TYPE | SAMPLE NO. | BLOWS PER INCREMENT | □ N-Value □ (10, 20, 30, 40) / ▲ Qu (tsf) ▲ (1, 2, 3, 4) / I Atterberg Limits I (20, 40, 60, 80) / ● % Moisture ● (20, 40, 60, 80) | LAB DATA | SOIL DESCRIPTION | GRAPHIC | REMARKS



Sample No.	Blows per Increment
S-1	2, 2, 3
S-2	4, 6, 6
S-3	3, 6, 5
S-4	4, 8, 8
S-5	6, 10, 10
S-6	6, 8, 9
S-7	6, 7, 13

Depth (ft)	Soil Description	Elevation (ft)
0.3	TOPSOIL: approx. 3 inches	307.8
2.0	CLAYEY SAND (SC): medium dense, brown, fine to medium grained, moist, existing fill	306.0
5.5	SANDY LEAN CLAY (CL): very stiff, red, fine to medium grained, moist	302.5
20.0	SANDY SILT (ML): stiff, reddish yellow, fine to medium grained, moist; yellow, black streaks; very stiff	288.0
	Boring Terminated at 20 feet.	

REMARKS:

Boring cave in at 20 feet

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

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

Designation: B-15

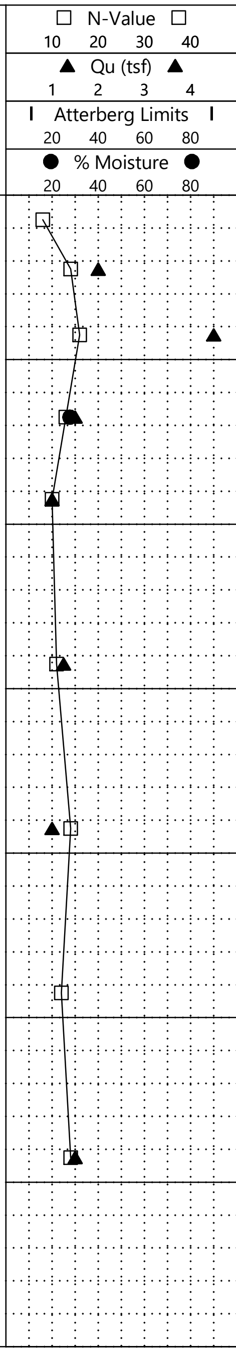
Sheet 1 of 1

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME: Cooper Academy Addition
PROJECT NUMBER: RD230492
DRILLING METHOD: Hollow Stem Auger
EQUIPMENT USED: Diedrich D25
HAMMER TYPE: Automatic
BORING LOCATION: Infiltration/SHWT

LOCATION: Clayton, NC
DATE DRILLED: 10/16/23
WEATHER: Clear, 60s
ELEVATION: 279
DRILL CREW: DR50
LOGGED BY: G.Gonzalez



DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.3	278.8	Split Spoon	S-1	2 2 6		TOPSOIL: approx. 3 inches	
1.0	278.0	Split Spoon	S-2	5 6 8		CLAYEY SAND (SC): medium dense, brown, fine to medium grained, moist, with fine gravel	
3.8	275.2	Split Spoon	S-3	4 6 10		SANDY LEAN CLAY (CL): very stiff, red, fine to medium grained, moist, with fine gravel	
		Split Spoon	S-4	4 6 7	Sample S-4 M: 27.7%	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist	
		Split Spoon	S-5	2 4 6		stiff	
		Split Spoon	S-6	3 5 6			Boring cave-in at 14.5 feet
		Split Spoon	S-7	4 6 8		very stiff	Groundwater encountered at 28.6 feet (EL 250.4) at time of drilling and stabilized at 19.7 feet (EL 259.3).
		Split Spoon	S-8	4 6 6		light brown, saturated	
30.0	249.0	Split Spoon	S-9	4 6 8		saturated	
						Boring Terminated at 30 feet.	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

Depth scale (ft): 5, 10, 15, 20, 25, 30
Elevation scale (ft): 275, 270, 265, 260, 255, 250, 245

SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

LOG OF BORING

Designation: B-16

Sheet 1 of 1

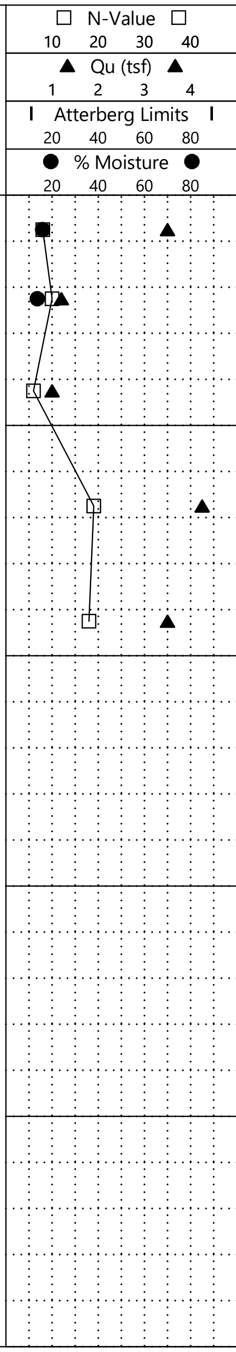
BUILDING & EARTH

Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/12/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	307
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Parking lot (south)	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
		Split Spoon	S-1	2 3 5	Sample S-1 M: 15.9%
	305	Split Spoon	S-2	2 5 5	Sample S-2 M: 13.6%
		Split Spoon	S-3	2 3 3	
5					
	300	Split Spoon	S-4	5 8 11	
		Split Spoon	S-5	4 8 10	
10					
	295				
15					
	290				
20					
	285				



Depth	SOIL DESCRIPTION	Elevation	REMARKS
0.3	ASPHALT	306.7	Pavemnt: approx. 3.5 inches of asphalt and 2.25 inches of ABC
0.5	AGGREGATE BASE	306.5	
2.5	CLAYEY SAND (SC): loose, reddish brown, fine to medium grained, moist, existing fill; with fine gravel	304.5	
4.0	SILTY SAND (SM): medium dense, light brown, fine to medium grained, moist, existing fill; with fine gravel loose	303.0	
5.5	SANDY LEAN CLAY (CL): medium stiff, brownish yellow, fine to medium grained, moist	301.5	
10.0	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist	297.0	Boring cave in at 9 feet
	Boring Terminated at 10 feet.		

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

SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

LOG OF BORING

Designation: B-17

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/12/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	313
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Parking lot (south)	LOGGED BY:	G.Gonzalez

N-Value: 10, 20, 30, 40; Qu (tsf): 1, 2, 3, 4; Atterberg Limits: 20, 40, 60, 80; % Moisture: 20, 40, 60, 80

SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
Split Spoon	S-1	2 4 6	Sample S-1 M: 30.8%
Split Spoon	S-2	3 8 11	Sample S-2 M: 36.5%
Split Spoon	S-3	4 9 12	
Split Spoon	S-4	4 5 7	
Split Spoon	S-5	3 5 6	

DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)	REMARKS
0.3	ASPHALT	312.8	
0.9	AGGREGATE BASE	312.1	Pavement: approx. 3 inches of asphalt and 7.5 inches of ABC
1.0	CLAYEY SAND (SC): medium dense, brown, fine to medium grained, moist, existing fill	312.0	
	SANDY LEAN CLAY (CL): very stiff, red, fine to medium grained, moist		
6.5	CLAYEY SAND (SC): medium dense, brown, fine to medium grained, moist, with fine gravel	306.5	
6.8	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist, with fine gravel stiff	306.2	
10.0	Boring Terminated at 10 feet.	303.0	Boring cave in at 9.4 feet

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

SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

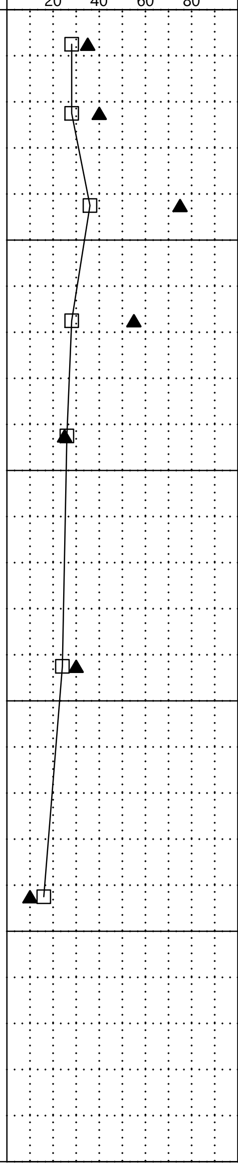
LOG OF BORING

Designation: B-18

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/12/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	316
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Building walkway	LOGGED BY:	G.Gonzalez

SAMPLE NO.	SAMPLE TYPE	BLOWS PER INCREMENT
S-1	Split Spoon	5 8 6
S-2	Split Spoon	3 8 6
S-3	Split Spoon	5 8 10
S-4	Split Spoon	4 6 8
S-5	Split Spoon	3 8 5
S-6	Split Spoon	3 5 7
S-7	Split Spoon	2 4 4

DEPTH (ft): 5, 10, 15, 20
ELEVATION (ft): 315, 310, 305, 300, 295



LAB DATA

Depth	SOIL DESCRIPTION	Elevation	REMARKS
0.3	TOPSOIL: approx. 3 inches	315.8	
0.8	CLAYEY SAND (SC): medium dense, brown, fine to medium grained, moist, with fine gravel	315.2	
2.5	SANDY LEAN CLAY (CL): very stiff, reddish yellow, fine to medium grained, moist, with fine gravel	313.5	
	SANDY SILT (ML): very stiff, reddish yellow, fine to medium grained, moist		
	stiff		Boring cave in at 17.6 feet
20.0	Boring Terminated at 20 feet.	296.0	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

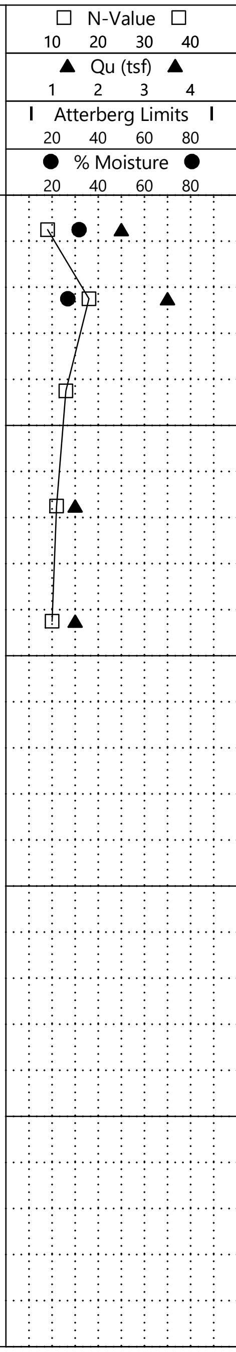
LOG OF BORING

Designation: B-19

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/13/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	321
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Parking lot (north)	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.3	320.7					ASPHALT	
1.0	320.0	Split Spoon	S-1	3, 4, 5	Sample S-1 M: 31.7%	AGGREGATE BASE	Pavement: approx. 4 inches of asphalt and 8 inches of ABC
3.0	318.0	Split Spoon	S-2	5, 8, 10	Sample S-2 M: 26.8%	ELASTIC SILT (MH): stiff, red, tan, fine to medium grained, moist very stiff	
4.3	316.7	Split Spoon	S-3	6, 6, 7		SANDY LEAN CLAY (CL): very stiff, brown, fine to medium grained, moist, with fine gravel	
10.0	311.0	Split Spoon	S-4	3, 4, 7		SANDY SILT (ML): stiff, reddish yellow, fine to medium grained, moist	
		Split Spoon	S-5	3, 4, 6			Boring cave in at 9.7 feet
						Boring Terminated at 10 feet.	



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

SAMPLE TYPE: Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

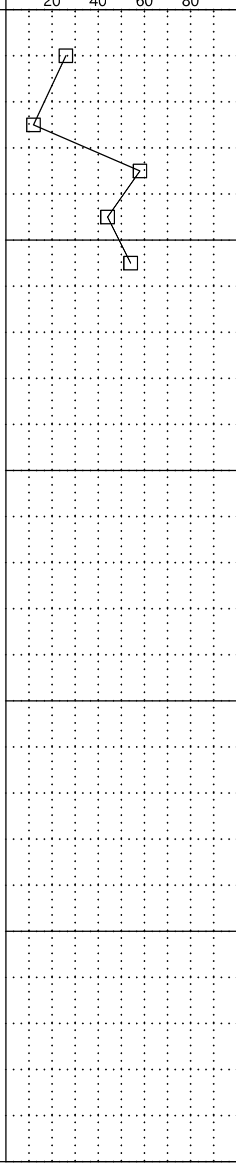
610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

LOG OF BORING

Designation: B-20

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/16/23
DRILLING METHOD:	Hand Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Hang Auger/DCP	ELEVATION:	323
HAMMER TYPE:	Manual	DRILL CREW:	DR50
BORING LOCATION:	Building walkway	LOGGED BY:	G.Gonzalez

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value (10 20 30 40) / Qu (tsf) (1 2 3 4) / Atterberg Limits (20 40 60 80) / % Moisture (20 40 60 80)	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.3	322.8						TOPSOIL: brown, approx. 3 inches		DCP
		Grab	S-1	5 7 6			SILTY SAND (SM): medium dense, light brown, fine to medium grained, moist		
2.0	321.0	Grab	S-2	4 3 3			SANDY LEAN CLAY (CL): medium stiff, yellow, tan, fine to medium grained, moist		
	320	Grab		7 11 18			very stiff		
		Grab		7 10 12			very stiff		
5.0	318.0	Grab		6 8 19			very stiff		
							Boring Terminated at 5 feet.		



Depth scale: 5, 10, 15, 20. Elevation scale: 320, 315, 310, 305, 300.

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

SAMPLE TYPE: Grab Sample

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-21

610 Spring Branch Road
Dunn, NC 28334
Office: 9102922085

PROJECT NAME:	Cooper Academy Addition	LOCATION:	Clayton, NC
PROJECT NUMBER:	RD230492	DATE DRILLED:	10/13/23
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Clear, 60s
EQUIPMENT USED:	Diedrich D25	ELEVATION:	325.5
HAMMER TYPE:	Automatic	DRILL CREW:	DR50
BORING LOCATION:	Parking lot (north)	LOGGED BY:	G.Gonzalez

SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
Split Spoon	S-1	3, 5, 8	Sample S-1 M: 15.2%
Split Spoon	S-2	4, 9, 12	Sample S-2 M: 14.2%
Split Spoon	S-3	4, 8, 11	
Split Spoon	S-4	5, 10, 13	
Split Spoon	S-5	8, 10, 11	

Chart axes: □ N-Value □ (10, 20, 30, 40); ▲ Qu (tsf) ▲ (1, 2, 3, 4); I Atterberg Limits I (20, 40, 60, 80); ● % Moisture ● (20, 40, 60, 80)

Depth (ft): 5, 10, 15, 20. Elevation (ft): 325, 320, 315, 310, 305.

DEPTH (ft)	SOIL DESCRIPTION	ELEVATION (ft)
0.3	ASPHALT	325.2
1.0	AGGREGATE BASE	324.5
1.3	CLAYEY SAND (SC): medium dense, dark brown, fine to medium grained, moist, with fine gravel	324.3
2.0	SANDY FAT CLAY (CH): very stiff, brown, tan, fine to medium grained, moist	323.5
	SANDY SILT (ML): very stiff, brown, tan, fine to medium grained, moist	
	hard	
	very stiff	
10.0		315.5
	Boring Terminated at 10 feet.	

REMARKS

Pavement: approx 4 inches of asphalt and 8 inches of ABC

Boring cave in at 8.5 feet

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

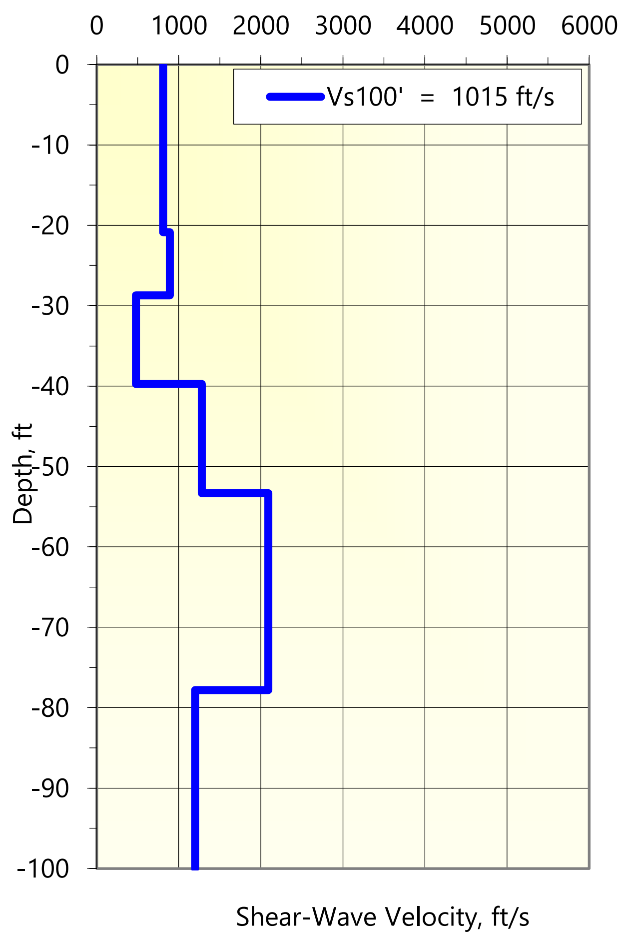
SAMPLE TYPE ⊠ Split Spoon

LL: LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
PL: PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
PI: PLASTICITY INDEX
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGT

SEISMIC SITE CLASS

Geogiga Surface Plus 9.3 ReMi Survey Results

Depth (ft)	Shear Wave Velocity Vs (ft/sec)
0.00	808.50
-20.87	808.50
-20.87	890.70
-28.72	890.70
-28.72	477.70
-39.75	477.70
-39.75	1282.70
-53.32	1282.70
-53.32	2092.00
-77.82	2092.00
-77.82	1197.60
-100.00	1197.60



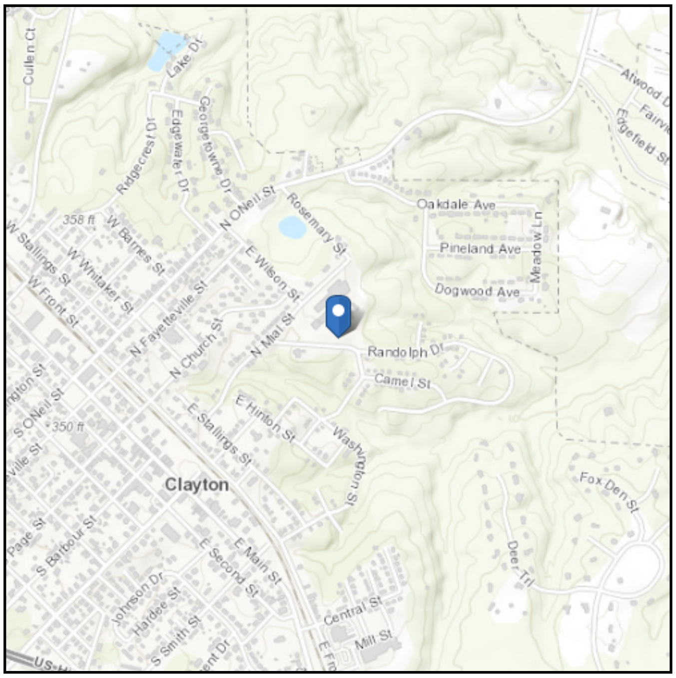
BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

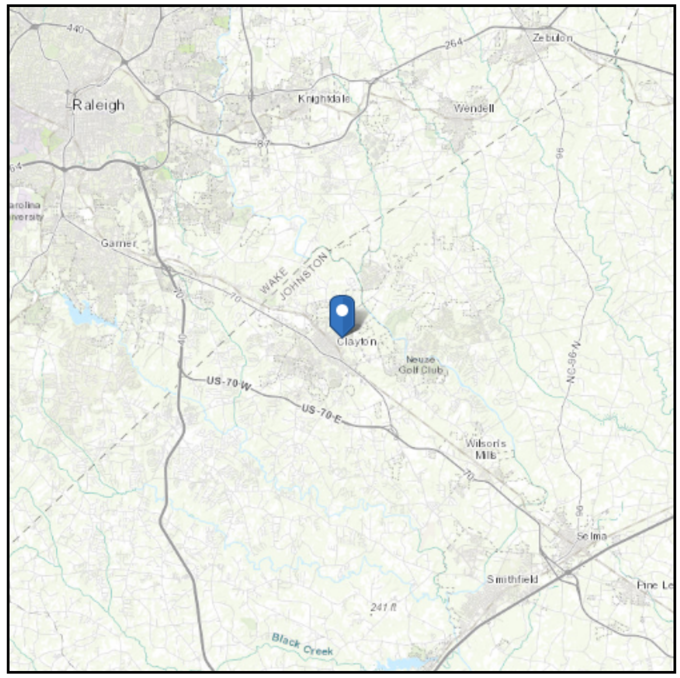
ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: III
Soil Class: D - Stiff Soil

Latitude: 35.654858
Longitude: -78.451119
Elevation: 310.0864129148909 ft (NAVD 88)





Seismic

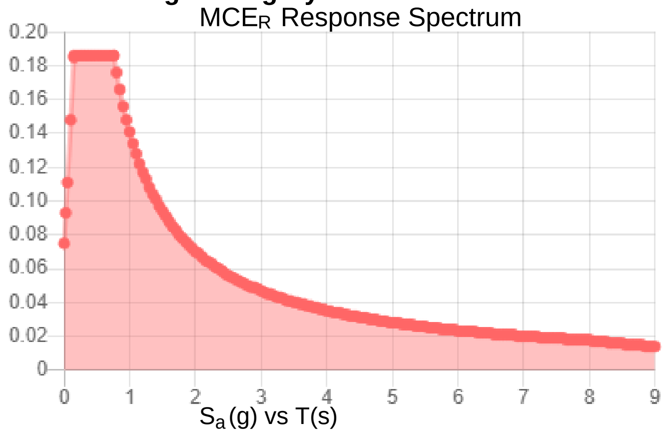
D - Stiff Soil

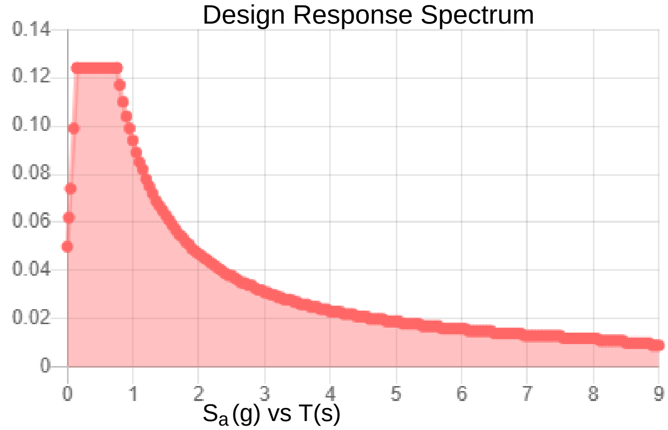
Site Soil Class:

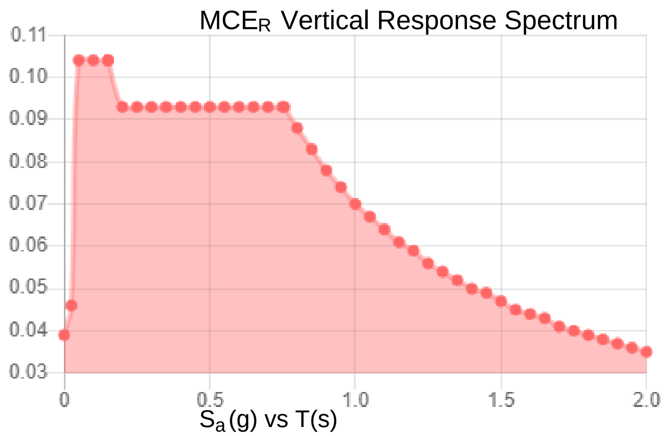
Results:

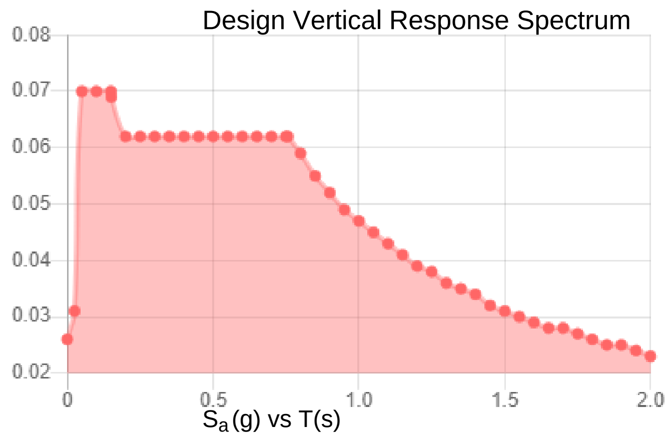
S_S :	0.116	S_{D1} :	0.094
S_1 :	0.059	T_L :	8
F_a :	1.6	PGA :	0.056
F_v :	2.4	PGA_M :	0.089
S_{MS} :	0.186	F_{PGA} :	1.6
S_{M1} :	0.141	I_e :	1.25
S_{DS} :	0.124	C_v :	0.7

Seismic Design Category: B









Data Accessed: **Thu Dec 07 2023**

Date Source:

USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

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LABORATORY TEST PROCEDURES

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

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

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

POCKET PENETROMETER

Pocket Penetrometer tests were performed on cohesive soil samples. The pocket penetrometer provides a consistency classification, and an indication of the soils unconfined compressive strength (Qu).

NATURAL MOISTURE CONTENT (ASTM D2216)

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

ATTERBERG LIMITS (ASTM D4318)

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

GRAIN-SIZE DISTRIBUTION (ASTM D6913)

Soil grain-size distribution includes determining percentages of material sizes for the soils sample. The wash determines the amount of material finer than the openings on the No. 200 sieve (0.075 mm) by washing soil over it. After drying in the oven, the soils retained on the No. 200 sieve are separated into specified grain sizes by running through sieves with consecutively smaller openings. The result is a distribution of particle sized that make up the bulk sample. Results are presented on the boring logs and Laboratory Results section included in this report.

STANDARD PROCTOR COMPACTION TEST (ASTM D698)

Standard Proctor compaction tests were performed to determine the maximum dry density and optimum moisture content for the soil, for use as a comparative basis during fill placement. The Standard Proctor test consists of the compaction of soil with known moisture content into a steel mold of fixed height and diameter. The soil is compacted in the mold in three lifts of equal volume using a 5.5 lb. manual hammer with a 12-inch free fall, to produce a consistent compactive effort. The test procedure is repeated on samples at several different moisture contents until a curve showing the relationship between moisture content and dry density of the soil is established. From this curve, the maximum dry density (peak density value) and optimum moisture content (moisture content correlating to the maximum dry density) are obtained.

LABORATORY CALIFORNIA BEARING RATIO (ASTM D1883)

The California Bearing Ratio, usually abbreviated CBR, is a punching shear test. The CBR value is a semi-empirical index of the soil's strength and deflection characteristics and has been correlated with pavement performance to establish design curves for pavement thickness. The tests were performed on six-inch diameter, five-inch thick disks of compacted soil, confined in steel cylinders. The specimens were soaked for at least 96 hours prior to testing. A piston, approximately two inches in diameter, was forced into the soaked soil at a standard rate to determine the soil's resistance to penetration. The CBR value is the ratio, expressed as a percentage, of the actual load required to produce a 0.1-inch deflection to that required for the same deflection in a certain standard crushed stone.

TRIAXIAL SHEAR TEST (CONSOLIATED-UNDRAINED) (ASTM D4767)

Triaxial Shear tests are used to determine the shear strength of soil samples under various loading conditions. A consolidated-undrained triaxial shear test was completed on a relatively undisturbed sample extruded from a Shelby tube. The data from this test was used in analyzing the shear strength parameters of the soil. Portions of the samples were placed in six (6) inch long tube molds and then subjected to deviator stresses at different confining pressures. The various confining pressures help determine the shear strength of the soil at different depths.

LABORATORY TEST RESULTS

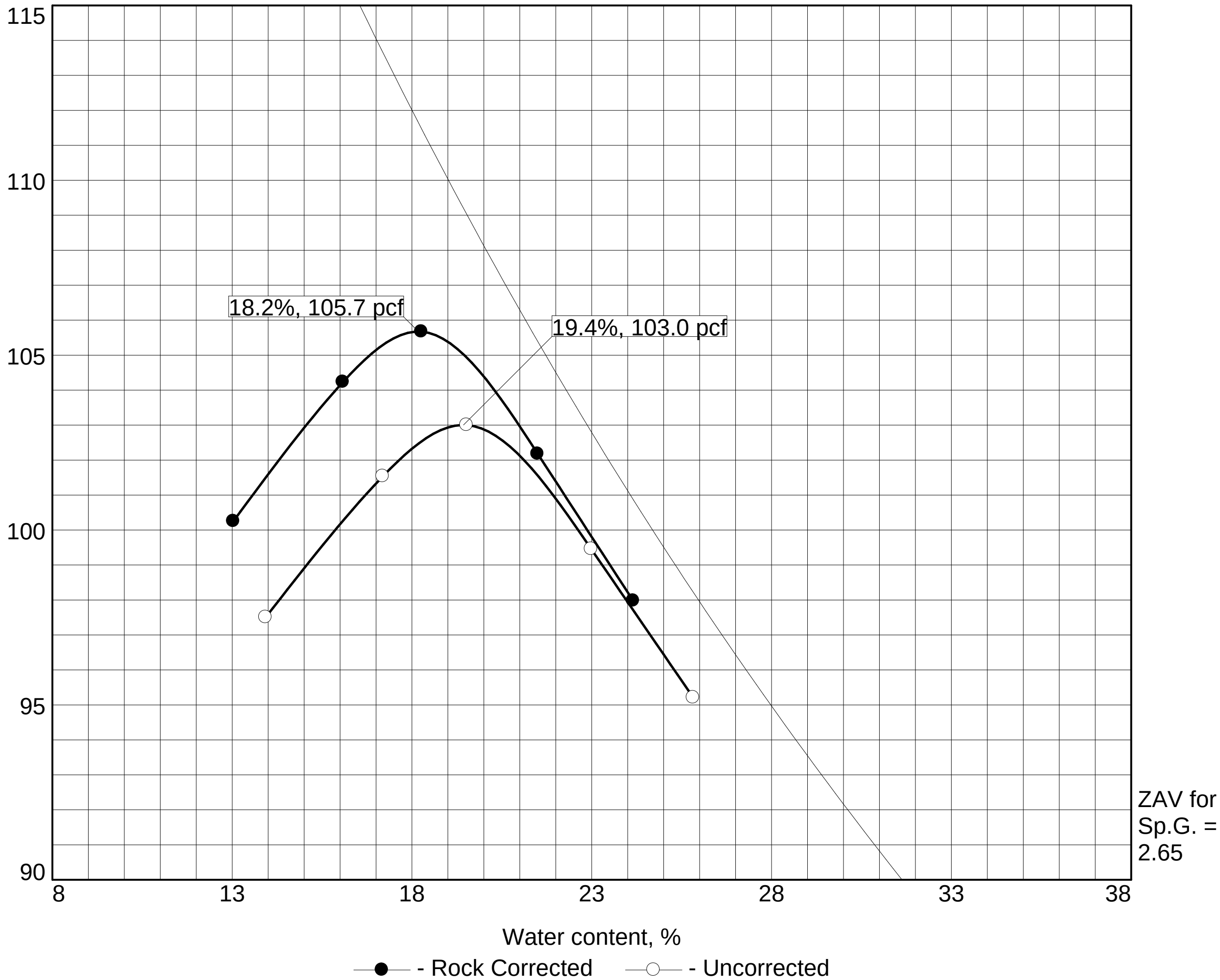
The results of the laboratory testing are presented in the following tables.

Boring or Test Pit Location	Sample Depth (ft)	LL	PL	PI	% Passing #200 Sieve	Moisture Content (%)
B-07/B-08	(bulk)	43	29	14	54	15.1
B-01	13.5-15	36	30	6	61	30.1
B-02	3.5-5	38	30	8	61.1	22.6
B-05	0-1.5	--	--	--	--	10.2
B-05	1.5-3	--	--	--	--	10.2
B-05	3.5-5	--	--	--	--	12.5
B-05	6-7.5	--	--	--	--	25.9
B-05	8.5-10	--	--	--	--	26.3
B-05	13.5-15	--	--	--	--	30.1
B-05	18.5-20	--	--	--	--	32.4
B-07	1.5-5	43	37	6	61.6	20.5
B-09	0-3	61	36	25	74	29.3
B-12	0-1.5	37	19	18	35	14.2
B-15	6-7.5	--	--	--	--	27.7
B-16	1.5-3	--	--	--	--	15.9
B-16	1.5-3	--	--	--	--	13.6
B-17	0-1.5	--	--	--	--	30.8
B-17	1.5-3	--	--	--	--	36.5
B-19	0-1.5	--	--	--	--	31.7
B-19	1.5-3	--	--	--	--	26.8
B-21	15.2	--	--	--	--	15.2
B-21	14.2	--	--	--	--	14.2

Table A-1: General Soil Classification Test Results

Soils with a Liquid Limit (LL) greater than 50 and Plasticity Index (PI) greater than 25 usually exhibit significant volume change with varying moisture content and are considered to be highly plastic. Soils with a LOI value greater than 3 percent are usually not suitable for supporting building and pavement sections.

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method A Standard
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
3.5-5'	ML	A-7-6(6)	15.1		43	14	6.5	53.9

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 105.7 pcf	103.0 pcf	Light brown red sandy silt
Optimum moisture = 18.2 %	19.4 %	

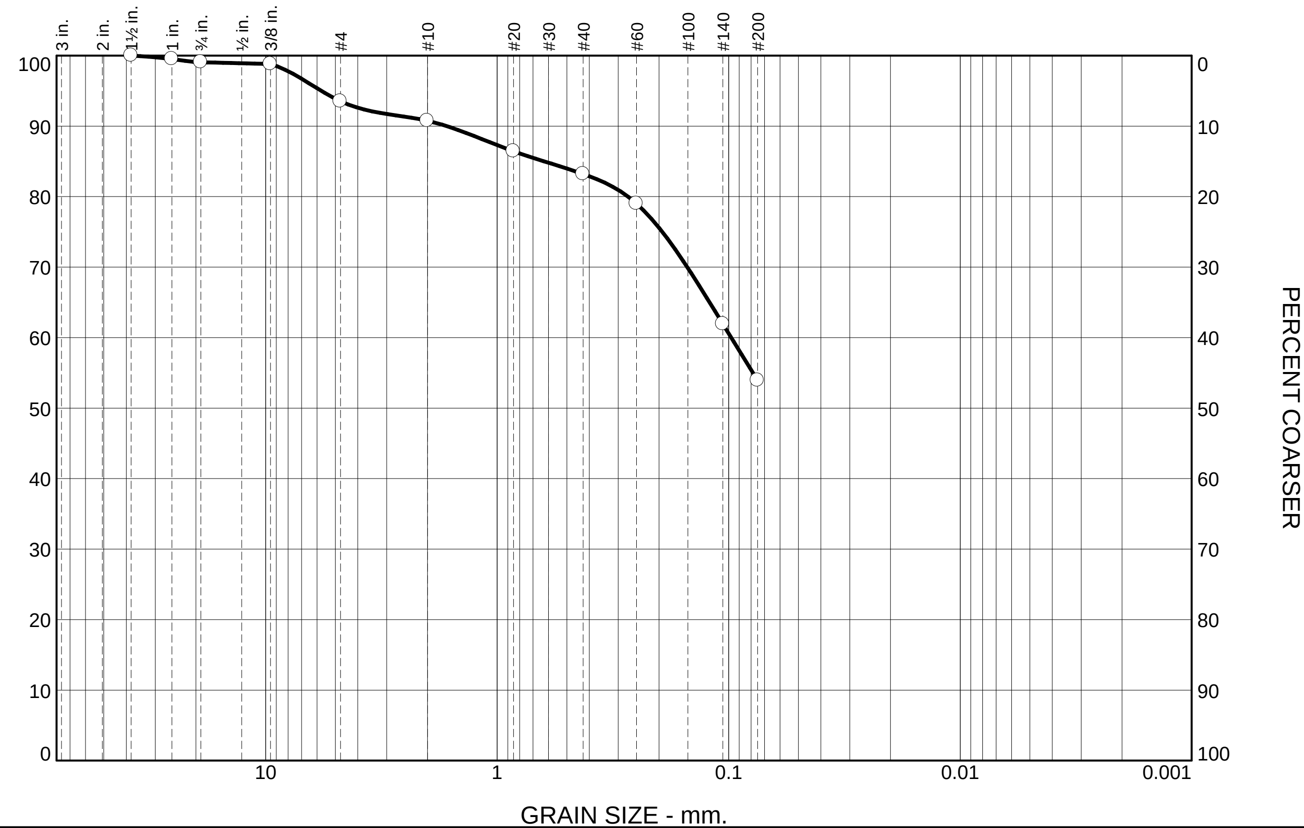
Project No. RD230492 **Client:** Johnston County Schools
Project: Cooper Academy Additions (GEO) Clayton, NC
Date: 10-23-23
Location: Bulk sample **Sample Number:** 23-0184-01

Remarks:

BUILDING & EARTH

Checked By: John Dailly

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	1	5	3	8	29	54	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100		
1	100		
.75	99		
.375	99		
#4	94		
#10	91		
#20	86		
#40	83		
#60	79		
#140	62		
#200	54		

* (no specification provided)

Material Description

Light brown red sandy silt

Atterberg Limits

PL= 29 LL= 43 PI= 14

Coefficients

D_{90}= 1.6542 D_{85}= 0.6270 D_{60}= 0.0975
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-7-6(6)

Remarks

As-received water content=15.1%

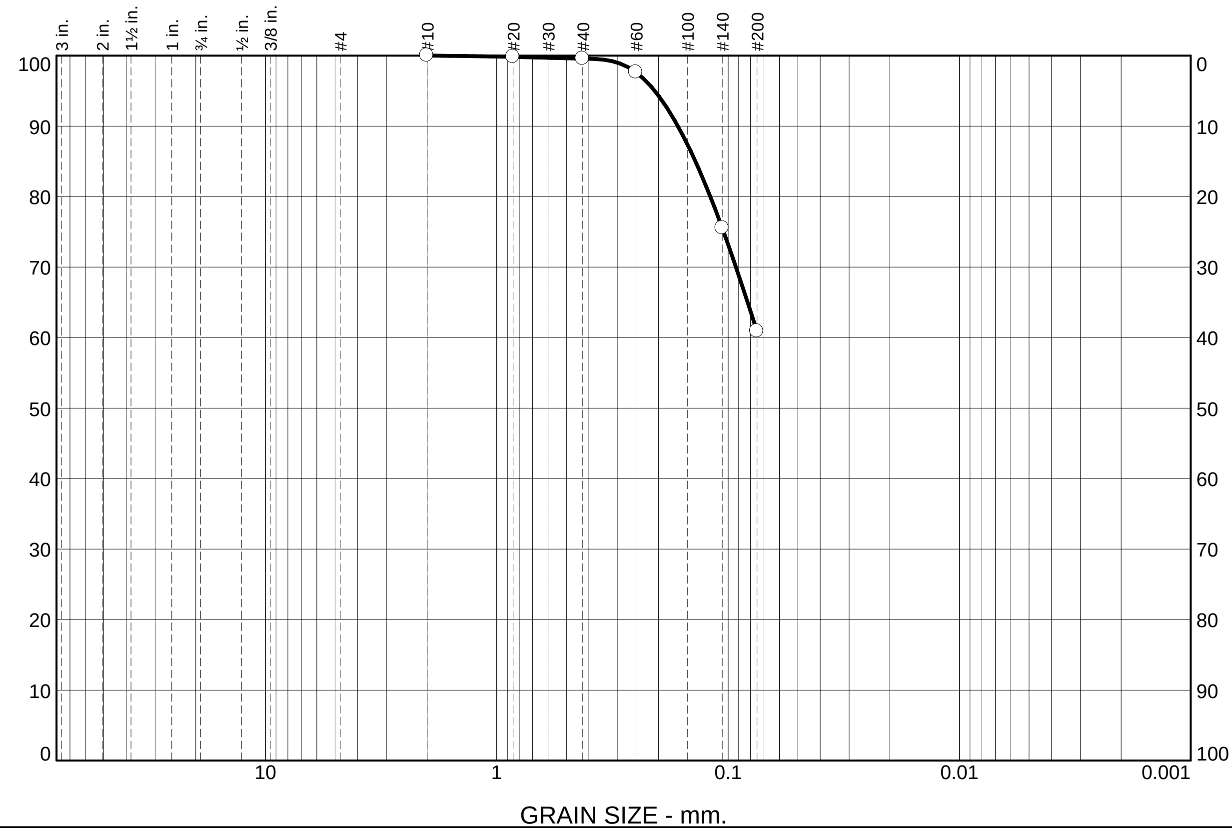
Location: Bulk sample
Sample Number: 23-0184-01 **Depth:** 3.5-5' **Date:** 10-23-23

BUILDING & EARTH

Client: Johnston County Schools
Project: Cooper Academy Additions (GEO) Clayton, NC
Project No: RD230492

Checked By: John Dailly

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	0	39	61	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100		
#20	100		
#40	100		
#60	98		
#140	76		
#200	61		

* (no specification provided)

Material Description

sandy silt

Atterberg Limits

PL= 30 LL= 36 PI= 6

Coefficients

D_{90}= 0.1649 D_{85}= 0.1385 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(3)

Remarks

As-received water content=30.1%

Location: B-01, S-06
Sample Number: 23-0184-02 **Depth:** 13.5-15' **Date:** 10-23-23

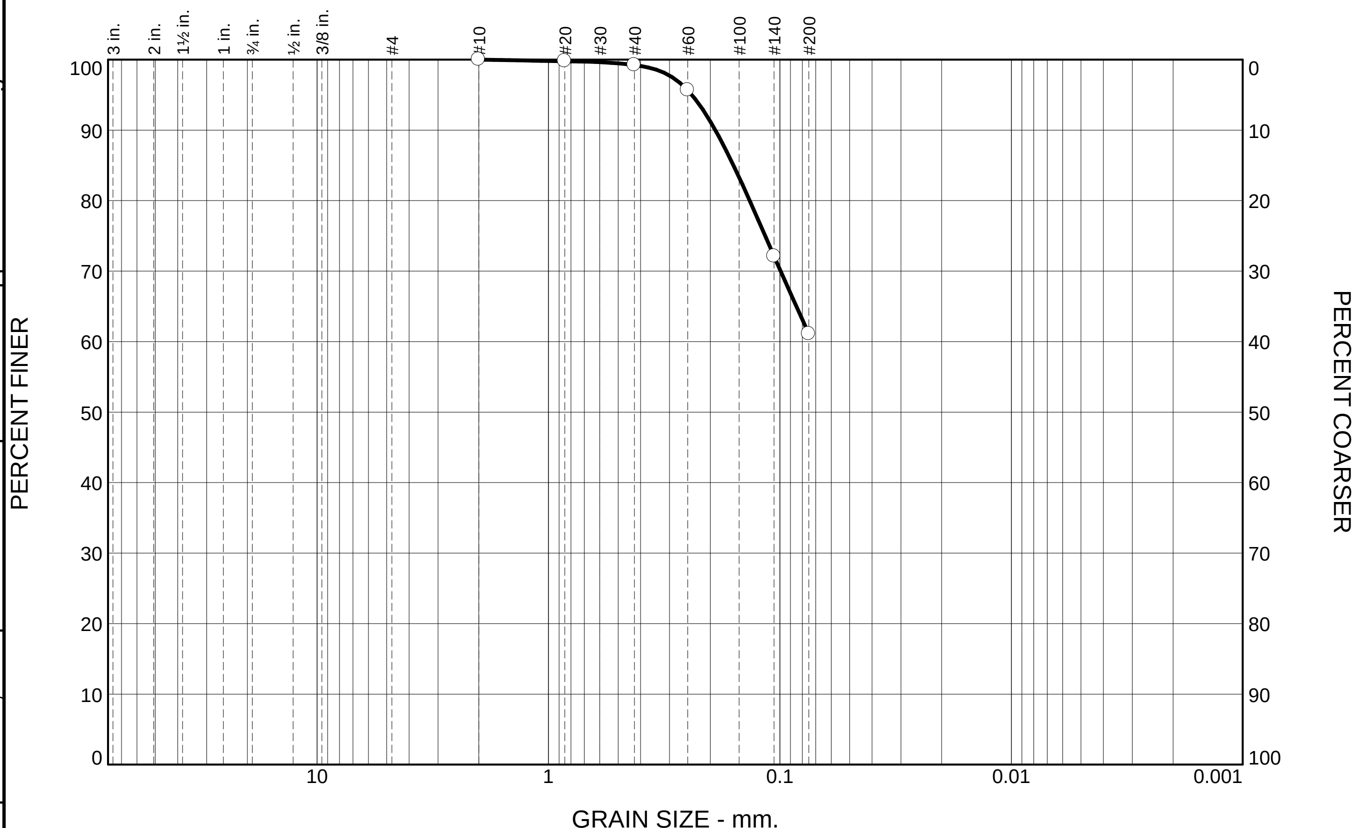
BUILDING & EARTH

Client: Johnston County Schools
Project: Cooper Academy Additions (GEO) Clayton, NC

Project No: RD230492

Checked By: John Dailly

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.8	38.1	61.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	99.2		
#60	95.7		
#140	72.1		
#200	61.1		

* (no specification provided)

Material Description

sandy silt

Atterberg Limits

PL= 30 LL= 38 PI= 8

Coefficients

D_{90}= 0.1902 D_{85}= 0.1588 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(4)

Remarks

As-received water content=22.6%

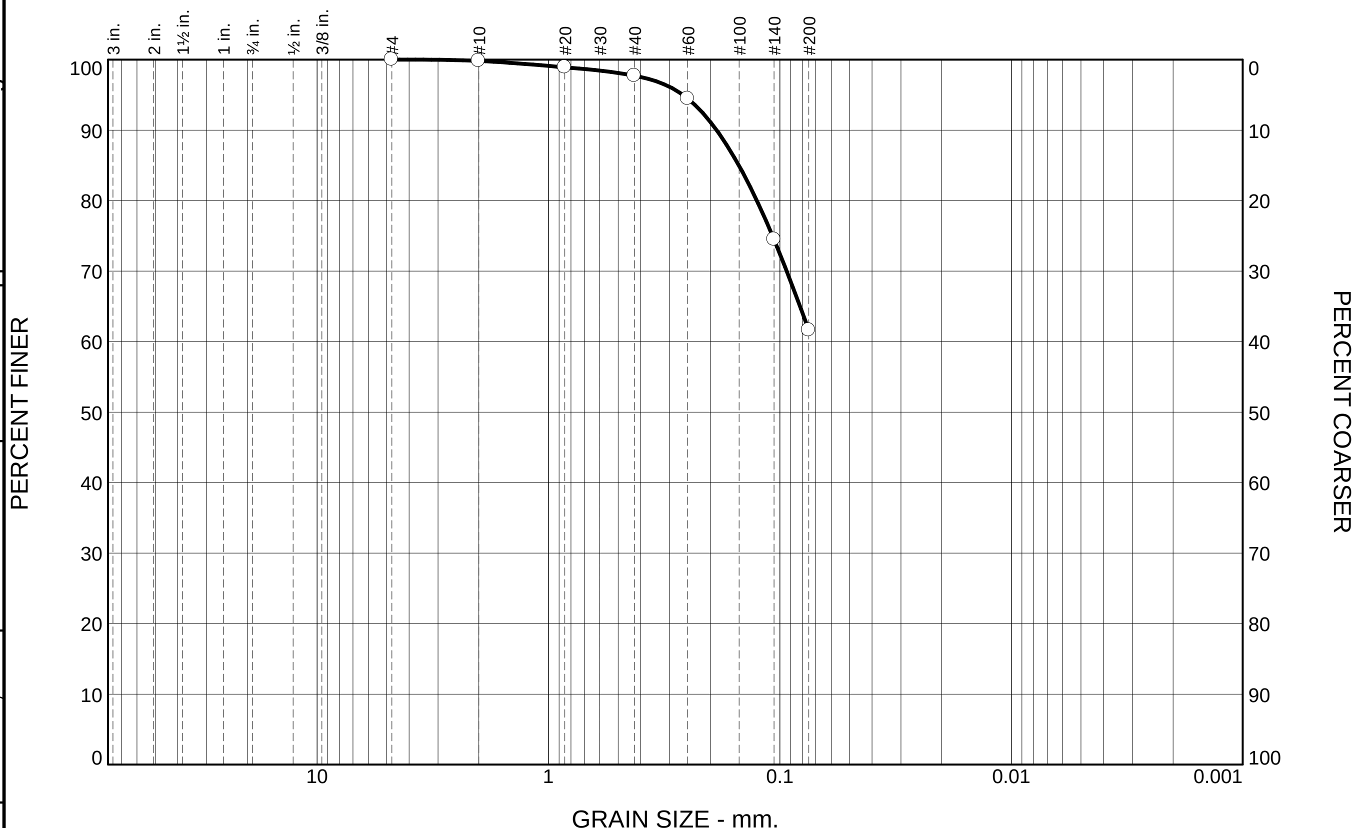
Location: B-02, S-03
Sample Number: 23-0184-03 **Depth:** 3.5-5' **Date:** 10-23-23

BUILDING & EARTH

Client: Johnston County Schools
Project: Cooper Academy Additions (GEO) Clayton, NC
Project No: RD230492

Checked By: John Dailly

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	2.1	36.1	61.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	98.9		
#40	97.7		
#60	94.5		
#140	74.5		
#200	61.6		

* (no specification provided)

Material Description

sandy silt

Atterberg Limits

PL= 37 LL= 43 PI= 6

Coefficients

D_{90}= 0.1878 D_{85}= 0.1505 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-5(4)

Remarks

As-received water content=20.5%

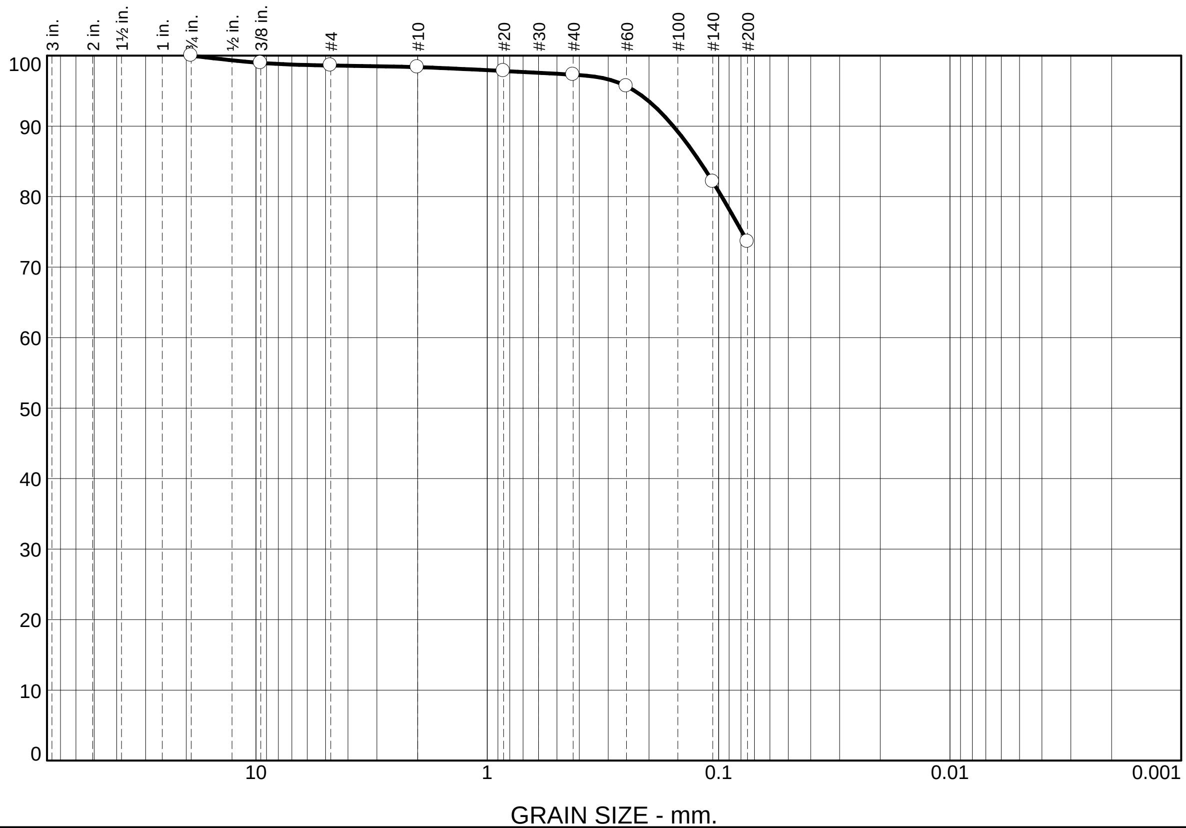
Location: B-07, S-02 & S-03 composite
Sample Number: 23-0184-11 **Depth:** 1.5-5 **Date:** 10-23-23

BUILDING & EARTH

Client: Johnston County Schools
Project: Cooper Academy Additions (GEO) Clayton, NC
Project No: RD230492

Checked By: John Dailly

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	1	1	1	23	74	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.750	100		
.375	99		
#4	99		
#10	98		
#20	98		
#40	97		
#60	96		
#140	82		
#200	74		

* (no specification provided)

Material Description

elastic silt with sand

Atterberg Limits

PL= 36 LL= 61 PI= 25

Coefficients

D_{90}= 0.1571 D_{85}= 0.1208 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= MH AASHTO= A-7-5(21)

Remarks

As-received water content=29.3%

Location: B-09, S-01 & S-02 composite
Sample Number: 23-0184-12 **Depth:** 0-3' **Date:** 10-23-23

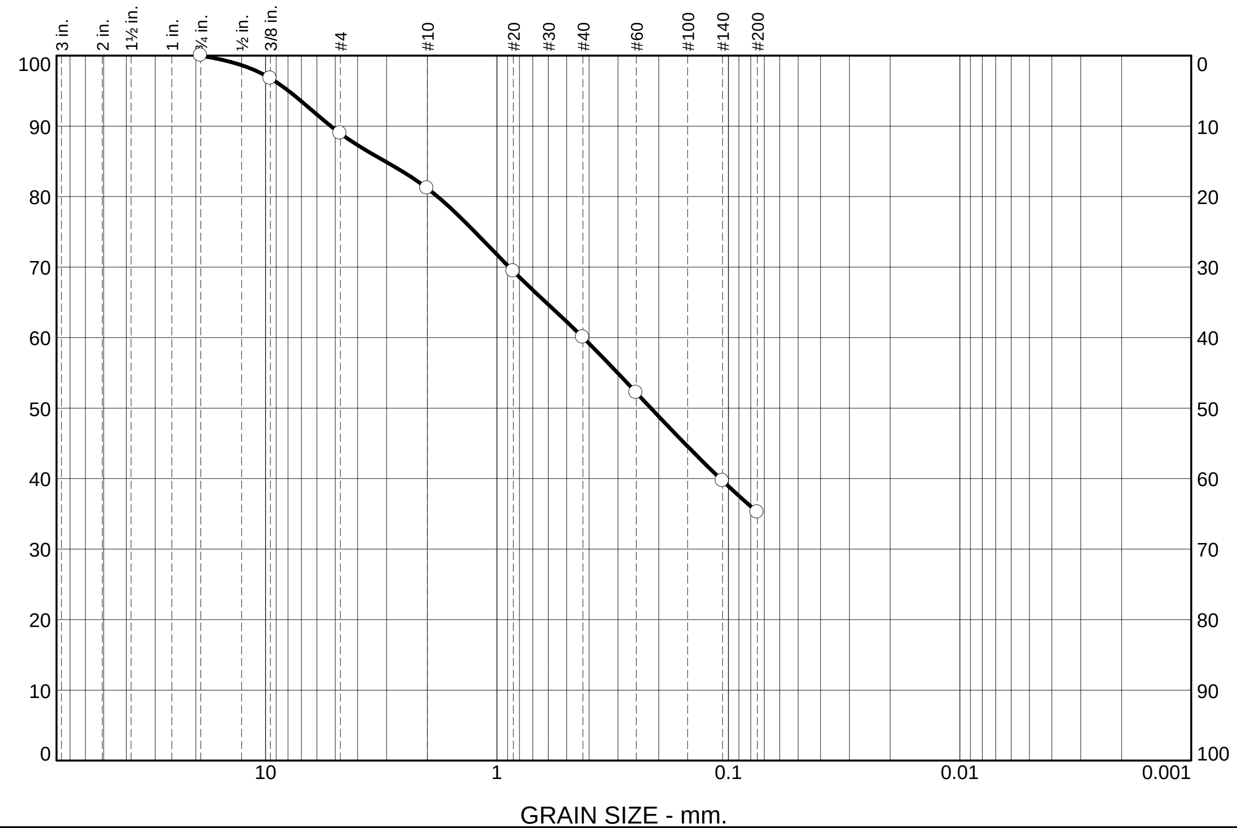
BUILDING & EARTH

Client: Johnston County Schools
Project: Cooper Academy Additions (GEO) Clayton, NC

Project No: RD230492

Checked By: John Dailly

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	11	8	21	25	35	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.750	100		
.375	97		
#4	89		
#10	81		
#20	69		
#40	60		
#60	52		
#140	40		
#200	35		

* (no specification provided)

Material Description

clayey sand

Atterberg Limits

PL= 19 LL= 37 PI= 18

Coefficients

D_{90}= 5.2195 D_{85}= 3.0418 D_{60}= 0.4244
D_{50}= 0.2163 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(2)

Remarks

As-received water content=14.2%

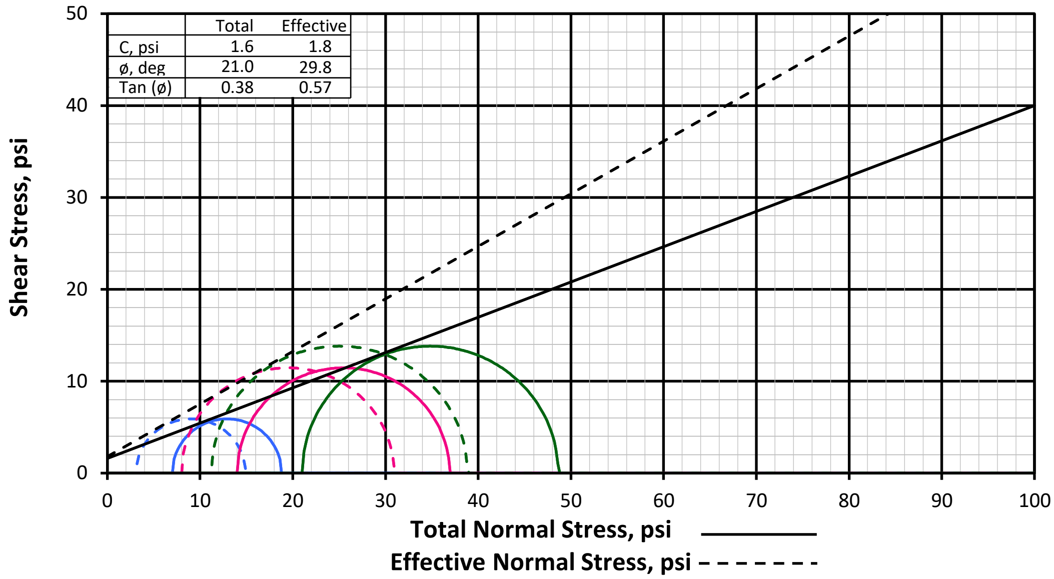
Location: B-12, S-01
Sample Number: 23-0184-13 **Depth:** 0-1.5 **Date:** 10-23-23

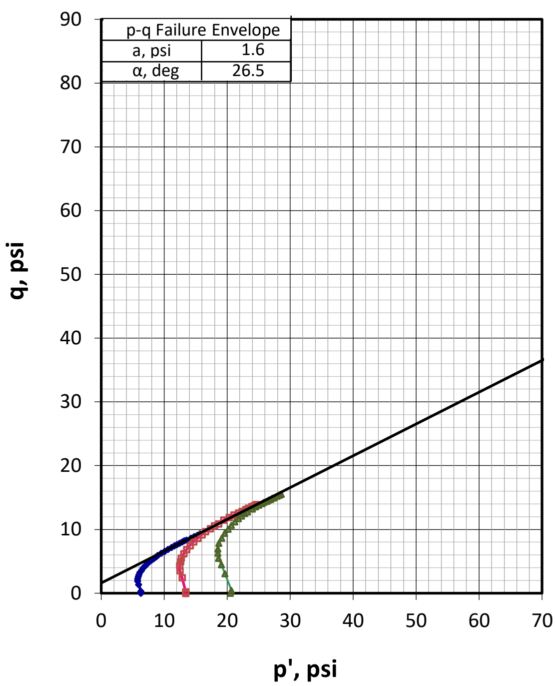
BUILDING & EARTH

Client: Johnston County Schools
Project: Cooper Academy Additions (GEO) Clayton, NC

Project No: RD230492

Checked By: John Dailly





Sample No.		1	2	3
Initial	Water Content, %	20.5	20.4	19.9
	Dry Density, pcf	98.4	97.5	97.6
	Saturation, %	78	75.8	74.0
	Void Ratio	0.7115	0.7273	0.7257
	Diameter, in.	2.85	2.85	2.85
	Height, in.	6.00	6.05	6.10
At Test	Water Content, %	28.2	27.8	26.9
	Dry Density, pcf	95.7	96.3	97.6
	Saturation, %	100	100	100
	Void Ratio	0.7606	0.7503	0.7264
	Diameter, in.	2.90	2.08	2.87
	Height, in.	5.96	6.00	6.03
Strain rate, in./min.		0.004	0.004	0.004
Back Pressure, psi		68.0	68.0	68
Cell Pressure, psi		75.0	82.0	89
Failure Total Stress, psi		18.8	36.9	48.6
	Total Pore Pr., psi	72.2	75.1	77.8
Failure Dev. Stress, psi		11.8	22.9	27.6
Failure Stress Ratio		4.81	3.86	3.47
$\overline{\sigma_1}$ Failure, psi		14.9	30.9	38.8
$\overline{\sigma_3}$ Failure, psi		3.1	8.0	11.2

Type of Test: CU with Pore Pressures
Sample Type: Undisturbed
Description: Red Brown Sandy Silty Clay (CL-ML)

Specific Gravity = 2.7
Remarks:

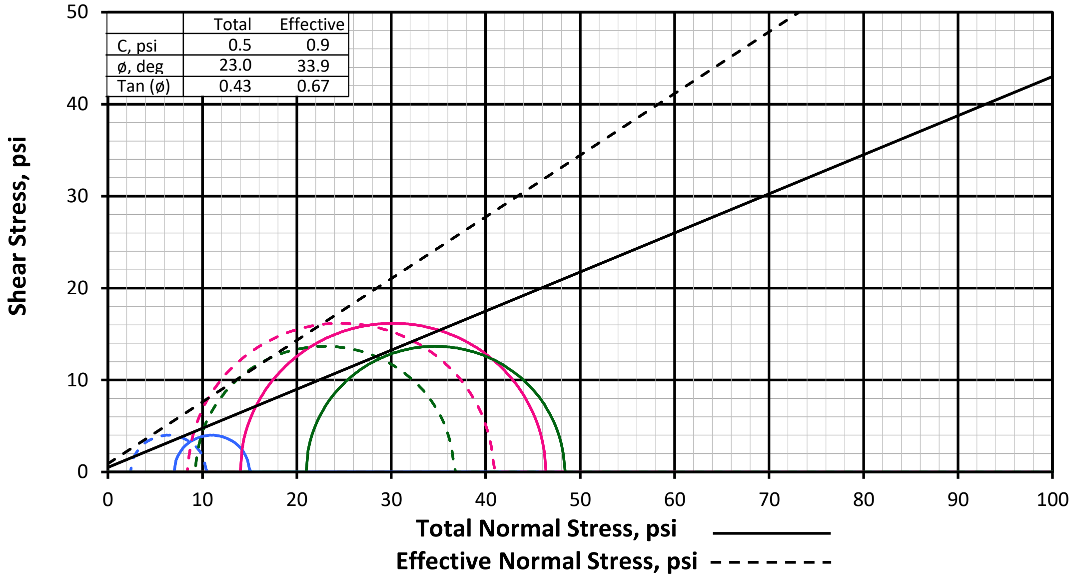
Client:

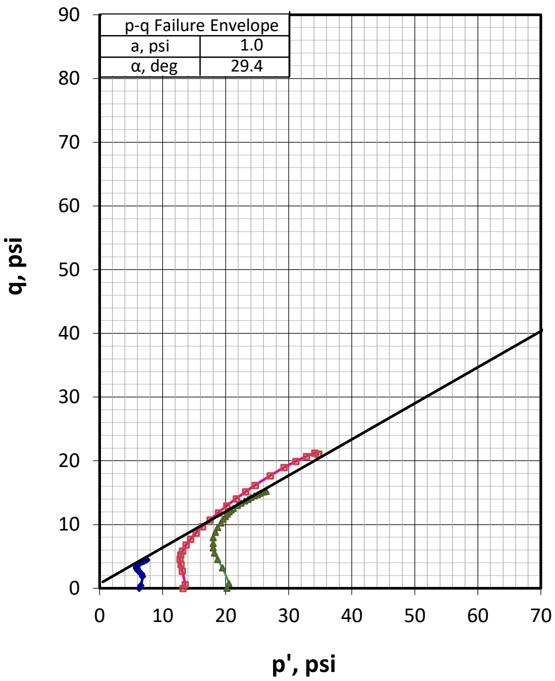
Project: Midland

Location: 0
Sample No: 0 **Depth:** 3-5'
Project No: RD230492 **Date:** 11/13/2023

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

TRIAXIAL SHEAR TEST REPORT





	Sample No.	1	2	3
Initial	Water Content, %	27.1	23.0	23.7
	Dry Density, pcf	79.4	87.0	86.5
	Saturation, %	65	66.5	67.6
	Void Ratio	1.1215	0.9357	0.9478
	Diameter, in.	2.85	2.85	2.85
	Height, in.	5.15	5.79	5.80
At Test	Water Content, %	37.4	29.2	33.0
	Dry Density, pcf	83.9	94.3	89.1
	Saturation, %	100	100	100
	Void Ratio	1.0083	0.7866	0.8904
	Diameter, in.	2.78	2.07	2.83
	Height, in.	5.11	5.71	5.70
	Strain rate, in./min.	0.0064	0.0064	0.0064
	Back Pressure, psi	68.0	68.0	68
	Cell Pressure, psi	75.0	82.0	89
	Failure Total Stress, psi	15.0	46.3	48.3
	Total Pore Pr., psi	72	75.1	79.7
	Failure Dev. Stress, psi	8.0	32.3	27.3
	Failure Stress Ratio	4.34	4.80	3.94
	$\overline{\sigma_1}$ Failure, psi	10.4	40.8	36.6
	$\overline{\sigma_3}$ Failure, psi	2.4	8.5	9.3

Type of Test: CU with Pore Pressures
Sample Type: Compacted
Description: Red Yellow Silty, Clayey Sand (SC-SM)

Specific Gravity = 2.7
Remarks:

Client: Johnston County Public Schools

Project: Cooper Academy Addition (GEO) Clayton, NC

Location: B-04
Sample No: 5 **Depth:** 8.5-10'
Project No: RD230492 **Date:** 10/25/2023

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

TRIAXIAL SHEAR TEST REPORT

0.0
0.0

R

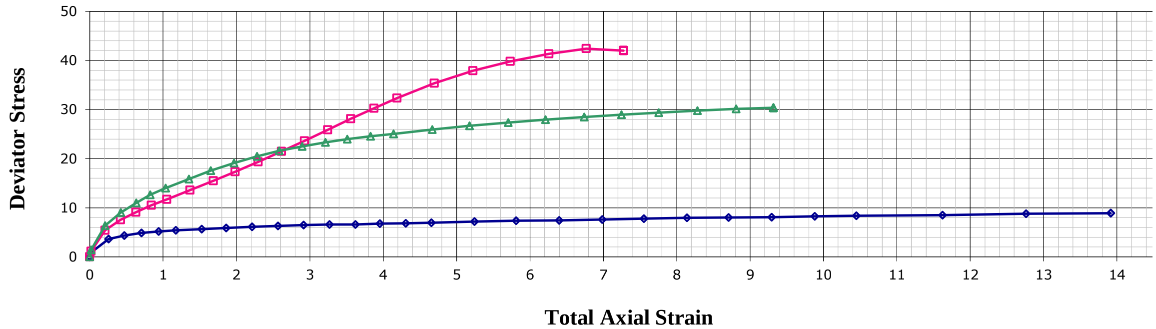
Consolidated-Undrained Triaxial Compression Test

ASTM

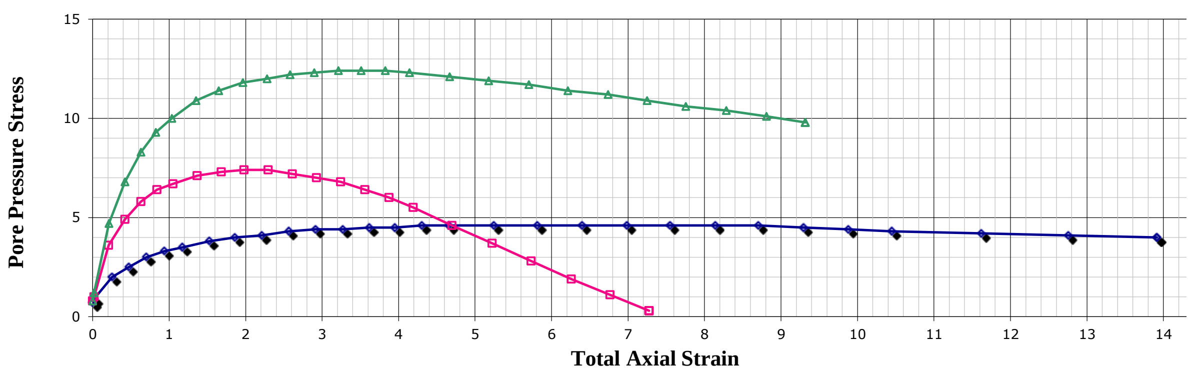
Octo

Boring #B-04 @ 8.5 - 10.5'

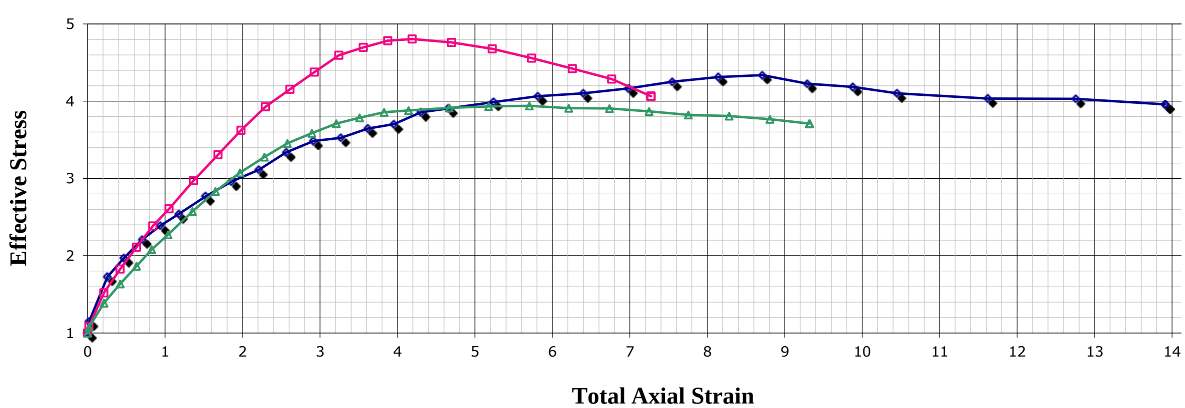
Deviator Stress vs. Total Axial Strain



Pore Pressure vs. Total Axial Strain



Effective Stress vs. Total Axial Strain



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Consolidated-Undrained Triaxial Compression Test

ASTM

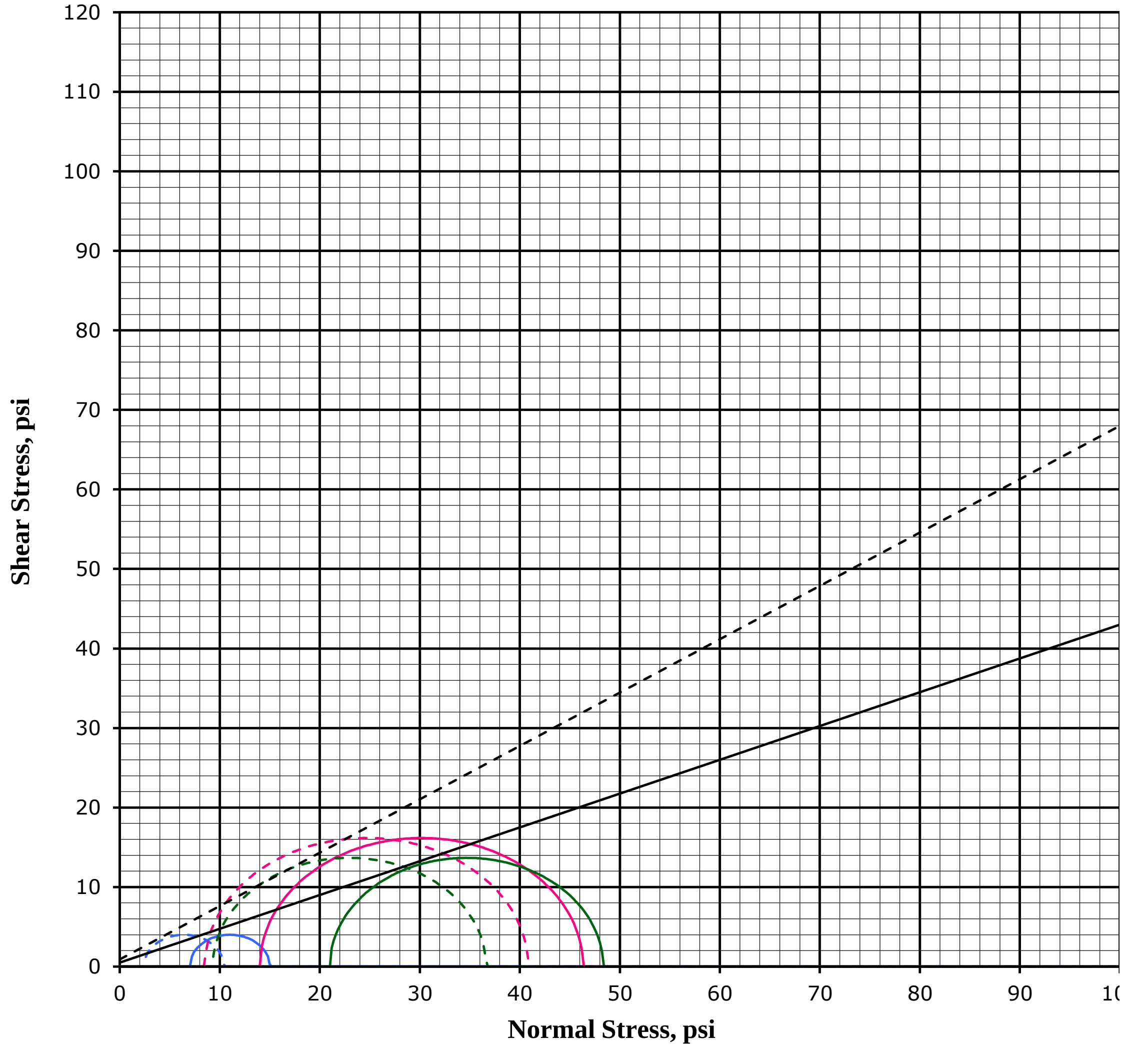
Octo

Boring #B-04 @ 8.5 - 10.5'
Red Yellow Silty, Clayey Sand (SC-SM)
Sample Type: Compacted

Strength Parameters

	ϕ	C
Effective	33.9°	0.9 psi
Total	23.0°	0.5 psi

Total and Effective Mohr's Circles



	Stg. 1	Stg. 2	Stg. 3
Effective Consolidation Stress, psi	7.0	14.0	21.0
Deviator Stress at Failure, psi	8.0	32.3	27.3
Effective Minor Pricipal Stress at Failure, psi	2.4	8.5	9.3
Effective Major Pricipal Stress at Failure, psi	10.4	40.8	36.6
Axial Strain at Failure, psi	8.71	4.19	5.70

0.0 R
0.0

Consolidated-Undrained Triaxial Compression Test

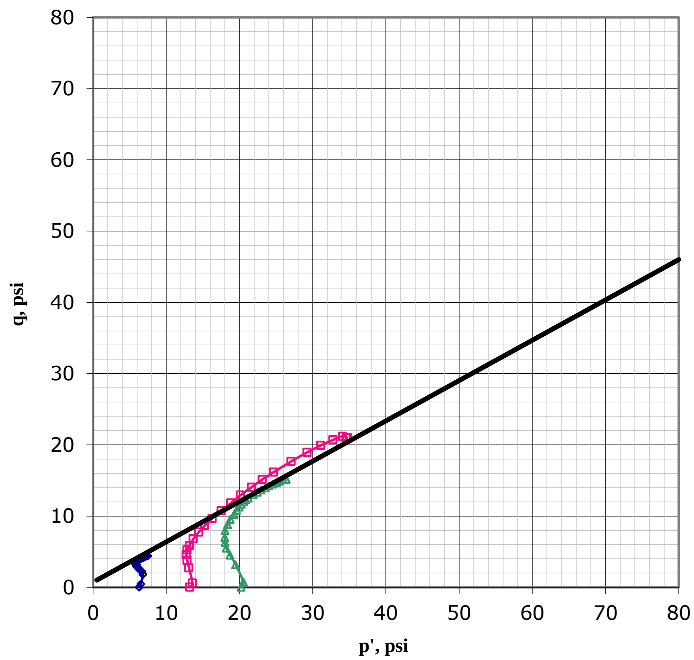
ASTM

Octo

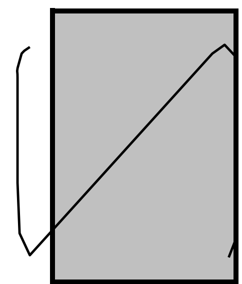
Boring #B-04 @ 8.5 - 10.5'
Red Yellow Silty, Clayey Sand (SC-SM)
Sample Type: Compacted

Parameters
α = 29.4°
a = 1.0 psi

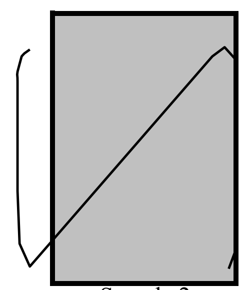
p' vs q Chart



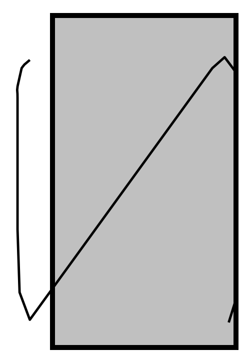
Failure Sketche



Sample 1



Sample 2



Sample 3

Method followed for sample saturation: Wet
Failure criterion used: Max. Eff. Stress Ratio (σ'1 / σ'3)
Specific Gravity: 2.70 (ASTM D 854)
Method for cross-sectional determination after consolidation: B
Method for soil classification: ASTM D 2488 (visual-manual procedure)

Remarks

Important Information about This

Geotechnical-Engineering Report

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

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

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

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

Read the Full Report

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

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

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are Not Final

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

A Geotechnical-Engineering Report Is Subject to Misinterpretation

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

Do Not Redraw the Engineer's Logs

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

Environmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

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

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

GBC GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

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