

SUBSURFACE INVESTIGATION AND FOUNDATION DESIGN REPORT

**For Replacement of Culvert No. 430359
Schnabel Engineering Project No. 12821004.00**

State Project Reference No.: 17BP.14.R.53

County: Haywood

*Description: Culvert No.430359 over Jones Cove Creek on SR 1531
(Lee Road)*

May 16, 2012





May 16, 2012

Mr. Dean Hatfield, PE
The Louis Berger Group, Inc.
1001 Wade Avenue, Suite 400
Raleigh, North Carolina 27605

State Project Number: 17BP.14.R.53
County: Haywood
Description: Culvert No. 430359 over Jones Cove Creek on SR 1531 (Lee Road)

Subject: Subsurface Investigation and Foundation Design for Replacement of Culvert No. 430359, Schnabel Engineering Project No. 12821004.00

Dear Mr. Hatfield:

SCHNABEL ENGINEERING SOUTH, PC (Schnabel) is pleased to submit our geotechnical engineering report for this project. This document includes attached figures, tables and appendices with relevant data collected for this study. This study was performed in accordance with our agreement dated February 15, 2012. Our services include development of foundation recommendations based on subsurface exploration.

SUBSURFACE INVESTIGATION

The North Carolina Department of Transportation (NCDOT) prepared the bridge inspection report dated February, 2011. We performed four hand auger borings on March 12, 2012. Appendix A includes the Subsurface Investigation Data. The hand auger boring logs are referenced to a benchmark elevation of 2563.56 ft, which the legend indicates is located on a railroad spike in a tree found approximately 20 feet east of the existing bridge.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

We reviewed the Bridge Inspection Report, geological maps and information in our files. Based on our review, the geologic stratigraphy consists of residual materials derived from the weathering of an intrusive granitic gneiss formation from the Cambrian Age. At the existing bridge, the roadway is founded on a 6 to 8 foot tall fill embankment. In the immediate vicinity of the creek, some of the residual soils have been eroded and been replaced with alluvial deposits.

The existing roadway surface elevation at the existing bridge is approximately EL 2565. The hand auger borings were performed on and adjacent to the roadway embankment at ground surface elevations between 2556 ft and 2558 ft. The hand auger borings showed existing embankment fill soils consisting of Sandy Silt and Silty Sand to depths between 1.0 and 3.2 feet below the existing ground surface. AASHTO classifications included A-2 and A-4. Auger refusal was encountered in all of the hand auger borings between depths of 1.0 to 3.2 feet below the existing ground surface (EL 2555 ft to EL 2556 ft). The bottom of the stream is at about EL 2555 ft.

Groundwater was not encountered in the hand augers borings at the time of field exploration.

GEOTECHNICAL RECOMMENDATIONS

We based our geotechnical engineering analysis on the information developed from the subsurface exploration and design directives provided by NCDOT and the loadings and hydraulic data provided by The Louis Berger Group. We understand that the existing bridge will be replaced by a four-sided double box culvert approximately 45-feet long with two 8-ft by 8-ft clear openings and 8-inch thick walls. The factored bearing pressures expected at the bottom of the culvert are 2 ksf and 3 ksf for the service and strength limit case, respectively. We understand the invert of the culvert will be near EL 2555 ft.

Culvert Foundation

We expect that the four-sided culvert will be supported on foundation conditioning material. Therefore, we have provided a modulus of subgrade reaction (k) to design the foundation. We also evaluated the factored bearing resistance and analyzed the settlement of the system considering the factored service loads.

Based on the hand auger borings, we expect that the majority of the culvert foundation will be founded on silty sand. We recommend that the entire subgrade (rock and soil) be over-excavated a minimum of one (1) foot and backfilled with foundation conditioning material as described in Standards Section 414-4. The foundation conditioning material should consist of Class VI Select Material as described in Standards Section 1016. The contractor should place the conditioning material in accordance with Standards Section 235-4. The layer of conditioning material will protect the soil subgrade from disturbance during construction and will provide a layer of high-strength bearing material to reduce differential settlements.

Where the culvert mat foundation is founded on the alluvial soils and properly placed conditioning material, we recommend that a modulus of subgrade reaction (k) of 80 tcf be used to design the slab of the bottom of the culvert. The recommended modulus values provided are for a 1-ft square plate and consider the 1-ft thick layer of conditioning material placed over the subgrade.

The factored bearing resistance of the foundation considering shear failure of the entire culvert exceeds the maximum factored strength limit load of 3000 psf. Considering a service load of 2000 psf, we estimate settlements will be less than ½ inch in the alluvial and residual soils.

Lateral Earth Pressures, Backfill, and Drainage

We have assumed that the proposed exterior culvert walls will be designed as non-yielding walls. Therefore, the wall design should consider the at-rest condition. We expect that most of the available on-site soils will be wet. Therefore we recommend that the culvert excavation be backfilled with Class II Select Material, as described in Standards Section 1016. Soil parameters for the backfill and subgrade are shown in the table below and may be used in the design of the culvert.

Soil Description	Use	Phi (deg)	Cohesion (psf)	Soil Unit Weight (pcf)			At-Rest Earth Pressure Coefficient
				Moist	Saturated	Submerged	
Class II Select Material	Wall Backfill	30	0	115	125	63	0.5
Class IV Select Material	Subgrade Conditioning	32	0	120	125	63	N/A

Where applicable, the design should consider surcharge loads using a rectangular earth pressure distribution. The surcharge pressure ordinate should be obtained by multiplying the surface surcharge pressure, q, by 0.5. These design parameters do not consider hydrostatic pressure. If adequate drainage is not provided, hydrostatic pressures must be included.

The contractor should place backfill material in accordance with Standards Sections 235-4 and 414-7. The backfill should be placed in maximum 10-inch thick loose lifts for the full width of the cross section, and compact each lift to at least 95 percent of maximum dry density per AASTO T99, Standard Proctor. Only light hand-operated equipment should be used to compact backfill against walls. The Structural Engineer of Record should approve the size of the compaction equipment.

The design should provide subdrainage (weep holes) through the exterior culvert walls. The weep holes should be constructed and installed in accordance with Standards Section 410-9 which requires a filter consisting of coarse and fine aggregate be placed around each weep hole to limit soil intrusion into the culvert. Where the culvert walls cannot be drained, the wall must be designed to resist the hydrostatic pressure. The hydrostatic pressure should be added to the equivalent fluid pressure and surcharge pressure provided above.

Seismic Site Classification

We have evaluated the Seismic Site Class for this project according to the AASHTO 2010 LRFD Code. We recommend Site Class D be used for seismic design on this project. This Site Class was evaluated based on subsurface information and extrapolation of the soil parameters to 100 feet. It is likely that a Site Class C could be obtained through additional testing; however, we expect that the additional testing cost would outweigh the potential culvert savings. Based on the recommended site class and project location, the following seismic design parameters were calculated:

Period	Site Coefficient	Mapped Maximum Considered Spectral Response Acceleration	Design Response Spectrum
Peak	1.4	PGA = 0.14	A _s = 0.20
Short (0.2 sec)	1.6	S _s = 0.24	S _{DS} = 0.38
1 Second	2.4	S ₁ = 0.06	S _{D1} = 0.14

Pavement Subgrades

NCDOT requires that all exposed pavement subgrades be compacted to a minimum of 100% AASHTO T99 prior to replacement of roadway base and asphalt. If the minimum level of compaction cannot be achieved, we recommend that the material be removed and replaced with Class II Select Material or other material approved by the Engineer, in accordance with NCDOT Standards. After compaction the final subgrade should be proofrolled in accordance with NCDOT Standards.

CONSTRUCTION RECOMMENDATIONS

Earthwork

The test boring data does not indicate the presence of topsoil, however the contractor should expect to encounter topsoil and other deleterious surface material during construction. The depth of stripping necessary to provide a suitable base for placement and compaction of earthwork or for pavement subgrade preparation may include topsoil and other soft or loose surficial layers with or without organic matter.

Based on the preliminary project plans, most of the existing roadway fill embankment will remain in place and will be unavailable for reuse. We expect the on-site soils in the vicinity of the creek are wet and will be difficult to compact, and will be easily disturbed. Drying and reworking of the soils will be difficult except during warm, dry periods. Therefore, we expect that the contractor will import soil for backfilling and embankment construction. The contractor may need crushed stone and stabilization geotextile to create working platforms to provide a base on which to place compacted structural fill.

Foundation Construction

The contractor should exercise care during excavation for the foundation so that as little disturbance as possible occurs at the foundation level. Dewatering will be necessary. The contractor should carefully clean loose or soft soils from the bottom of the excavation before placing the conditioning material. The subgrades should be observed during construction to evaluate whether subgrade soils meet the requirements as recommended in this report.

Foundation subgrades needing undercut should be backfilled to the original design subgrade elevation with the foundation conditioning material described above. The conditioning material should extend at least 12 inches laterally beyond the limits of the culvert in all directions. Placement of the conditioning material should take place the same day as excavation of the foundation.

Rock Excavation

Test boring data do not indicate that bedrock will be encountered during excavation. However, weathered rock or rock could be encountered during excavation. Actual conditions during excavation may be different as some variation is common, even over relatively short distances.

Dewatering

The foundation will extend below groundwater. Dewatering will likely be required to install the foundation. Temporary steel sheet piling may be needed to seal out groundwater and provide temporary excavation support. Proper dewatering is essential to prevent deterioration of the subgrades and to maintain a dry subgrade. The contract documents should require that the contractor lower the ground water to a minimum of 3 feet below the subgrade during foundation and culvert installation.

Dewatering at the site should be completed by a competent dewatering contractor with at least 5 years of experience in the region. Groundwater levels should be maintained at least 3 feet below the lowest footing subgrade elevation. Sufficient time must be allowed in the construction schedule for the dewatering contractor to install wells, begin well operation, and pump wells to lower ground water levels to the required elevation.

LIMITATIONS

We based the analyses and recommendations submitted in this report on limited subsurface information. We attempted to provide for normal contingencies, but the possibility remains that unexpected conditions may be encountered during construction.

We prepared this report to aid in the evaluation of this site and to assist in the design of the project. We intend it for use concerning this specific project. We based our recommendations on information on the site and proposed construction as described in this report. Substantial changes in loads, locations, or grades should be brought to our attention so we can modify our recommendations as needed. We would appreciate an opportunity to review the plans and specifications as they pertain to the recommendations contained in this report, and to submit our comments to you based on this review.


We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report, or any other instrument of service.


The Louis Berger Group, Inc.
Foundation Design For Culvert No. 430359

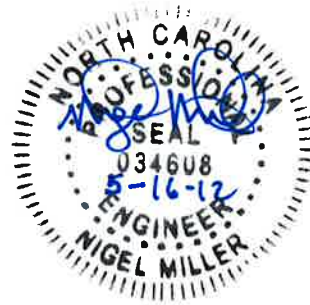
We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING SOUTH, PC


for Pamela Oree
Senior Staff Engineer


Nigel Miller, PE
Associate



Appendix A: Structure Subsurface Investigation Drawings

APPENDIX A

STRUCTURE SUBSURFACE INVESTIGATION DRAWINGS

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	17BP.14.R.53	1	7

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

STRUCTURE
SUBSURFACE INVESTIGATION

PROJ. REFERENCE NO. 17BP.14.R.53 F.A. PROJ. N/A
COUNTY HAYWOOD
PROJECT DESCRIPTION CULVERT NO. 359 ON SR1531
OVER JONES COVE CREEK

SITE DESCRIPTION _____

CONTENTS

<u>SHEET</u>	<u>DESCRIPTION</u>
1	TITLE SHEET
2-2A	LEGEND
3	SITE PLAN
4-7	HAND AUGER REPORTS

PERSONNEL

P. OREE
S. BUCHANAN
N. MILLER
SOIL DRILLING
SERVICES, INC.

INVESTIGATED BY P. OREE
CHECKED BY S. BUCHANAN
SUBMITTED BY N. MILLER
DATE APRIL 2012

CAUTION NOTICE

THE SUBSURFACE INFORMATION AND THE SUBSURFACE INVESTIGATION ON WHICH IT IS BASED WERE MADE FOR THE PURPOSE OF STUDY, PLANNING, AND DESIGN, AND NOT FOR CONSTRUCTION OR PAY PURPOSES. THE VARIOUS FIELD BORING LOGS, ROCK CORES, AND SOIL TEST DATA AVAILABLE MAY BE REVIEWED OR INSPECTED IN RALEIGH BY CONTACTING THE N. C. DEPARTMENT OF TRANSPORTATION, GEOTECHNICAL ENGINEERING UNIT AT (919) 707-6850. NEITHER THE SUBSURFACE PLANS AND REPORTS, NOR THE FIELD BORING LOGS, ROCK CORES, OR SOIL TEST DATA ARE PART OF THE CONTRACT.

GENERAL SOIL AND ROCK STRATA DESCRIPTIONS AND INDICATED BOUNDARIES ARE BASED ON A GEOTECHNICAL INTERPRETATION OF ALL AVAILABLE SUBSURFACE DATA AND MAY NOT NECESSARILY REFLECT THE ACTUAL SUBSURFACE CONDITIONS BETWEEN BORINGS OR BETWEEN SAMPLED STRATA WITHIN THE BOREHOLE. THE LABORATORY SAMPLE DATA AND THE IN SITU (IN-PLACE) TEST DATA CAN BE RELIED ON ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE STANDARD TEST METHOD. THE OBSERVED WATER LEVELS OR SOIL MOISTURE CONDITIONS INDICATED IN THE SUBSURFACE INVESTIGATIONS ARE AS RECORDED AT THE TIME OF THE INVESTIGATION. THESE WATER LEVELS OR SOIL MOISTURE CONDITIONS MAY VARY CONSIDERABLY WITH TIME ACCORDING TO CLIMATIC CONDITIONS INCLUDING TEMPERATURES, PRECIPITATION, AND WIND, AS WELL AS OTHER NON-CLIMATIC FACTORS.

THE BIDDER OR CONTRACTOR IS CAUTIONED THAT DETAILS SHOWN ON THE SUBSURFACE PLANS ARE PRELIMINARY ONLY AND IN MANY CASES THE FINAL DESIGN DETAILS ARE DIFFERENT. FOR BIDDING AND CONSTRUCTION PURPOSES, REFER TO THE CONSTRUCTION PLANS AND DOCUMENTS FOR FINAL DESIGN INFORMATION ON THIS PROJECT. THE DEPARTMENT DOES NOT WARRANT OR GUARANTEE THE SUFFICIENCY OR ACCURACY OF THE INVESTIGATION MADE, NOR THE INTERPRETATIONS MADE, OR OPINION OF THE DEPARTMENT AS TO THE TYPE OF MATERIALS AND CONDITIONS TO BE ENCOUNTERED. THE BIDDER OR CONTRACTOR IS CAUTIONED TO MAKE SUCH INDEPENDENT SUBSURFACE INVESTIGATIONS AS HE DEEMS NECESSARY TO SATISFY HIMSELF AS TO CONDITIONS TO BE ENCOUNTERED ON THIS PROJECT. THE CONTRACTOR SHALL HAVE NO CLAIM FOR ADDITIONAL COMPENSATION OR FOR AN EXTENSION OF TIME FOR ANY REASON RESULTING FROM THE ACTUAL CONDITIONS ENCOUNTERED AT THE SITE DIFFERING FROM THOSE INDICATED IN THE SUBSURFACE INFORMATION.

NOTE - THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N. C. DEPARTMENT OF TRANSPORTATION AS BEING ACCURATE NOR IS IT CONSIDERED TO BE PART OF THE PLANS, SPECIFICATIONS, OR CONTRACT FOR THE PROJECT.

NOTE - BY HAVING REQUESTED THIS INFORMATION THE CONTRACTOR SPECIFICALLY WAIVES ANY CLAIMS FOR INCREASED COMPENSATION OR EXTENSION OF TIME BASED ON DIFFERENCES BETWEEN THE CONDITIONS INDICATED HEREIN AND THE ACTUAL CONDITIONS AT THE PROJECT SITE.

DRAWN BY: S. KITTS



**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS**

SOIL DESCRIPTION										GRADATION																																																																																																																																														
SOIL IS CONSIDERED TO BE THE UNCONSOLIDATED, SEMI-CONSOLIDATED, OR WEATHERED EARTH MATERIALS THAT CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER, AND YIELD LESS THAN 100 BLOWS PER FOOT ACCORDING TO STANDARD PENETRATION TEST (AASHTO T206, ASTM D-1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY SHALL INCLUDE: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. EXAMPLE: VERY STIFF, GRAY, SILTY CLAY, MOST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-G										WELL GRADED - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE. UNIFORM - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. (ALSO POORLY GRADED) GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLES OF TWO OR MORE SIZES.																																																																																																																																														
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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

ROCK DESCRIPTION		TERMS AND DEFINITIONS	
<p>HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT IF TESTED, WOULD YIELD SPT REFUSAL, AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS. IN NON-COASTAL PLAIN MATERIAL, THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK. ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:</p>		<p>ALLUVIUM (ALLOY.) - SOILS THAT HAVE BEEN TRANSPORTED BY WATER. AQUIFER - A WATER BEARING FORMATION OR STRATA. ARENACEOUS - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND. ARGILLACEOUS - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, AS SHALE, SLATE, ETC. ARTESIAN - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IT IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE. CALCAREOUS (CALC.) - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE. COLLUVIUM - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE. CORE RECOVERY (REC.) - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE. DIKE - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK. DIP - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL. DIP DIRECTION (DIP AZIMUTH) - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH. FAULT - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE. FISSILE - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES. FLOAT - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLOGGED FROM PARENT MATERIAL. FLOOD PLAIN (FP) - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM. FORMATION (FM) - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD. JOINT - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED. LEDGE - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT. LENS - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS. MOTTLED (MOT.) - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS, MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE. PERCHED WATER - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM. RESIDUAL (RES.) SOIL - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK. ROCK QUALITY DESIGNATION (RQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE. SAPROLITE (SAP) - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK. SILL - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, THAT HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRUDED ROCKS. SLICKENSIDE - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE. STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT) - NUMBER OF BLOWS (N OR BPF) OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO PRODUCE A PENETRATION OF 1 FOOT INTO SOIL WITH A 2 INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER. SPT REFUSAL IS PENETRATION EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS. STRATA CORE RECOVERY (SREC.) - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE. STRATA ROCK QUALITY DESIGNATION (SRQD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS WITHIN A STRATUM EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF STRATA AND EXPRESSED AS A PERCENTAGE. TOPSOIL (TS) - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.</p>	
<p>WEATHERED ROCK (WR)</p> 	<p>NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.</p>		
<p>CRYSTALLINE ROCK (CR)</p> 	<p>FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.</p>		
<p>NON-CRYSTALLINE ROCK (NCR)</p> 	<p>FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.</p>		
<p>COASTAL PLAIN SEDIMENTARY ROCK (CP)</p> 	<p>COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.</p>		
WEATHERING			
<p>FRESH</p>	<p>ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING, ROCK RINGS UNDER HAMMER IF CRYSTALLINE.</p>		
<p>VERY SLIGHT (V SLI.)</p>	<p>ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN, CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY, ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.</p>		
<p>SLIGHT (SLI.)</p>	<p>ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH, OPEN JOINTS MAY CONTAIN CLAY, IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED, CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.</p>		
<p>MODERATE (MOD.)</p>	<p>SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS, IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.</p>		
<p>MODERATELY SEVERE (MOD. SEV.)</p>	<p>ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED, IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION, ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK, ROCK GIVES "CLUNK" SOUND WHEN STRUCK. <u>IF TESTED, WOULD YIELD SPT REFUSAL</u></p>		
<p>SEVERE (SEV.)</p>	<p>ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED, ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL, IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT, SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. <u>IF TESTED, WOULD YIELD SPT N VALUES > 100 BPF</u></p>		
<p>VERY SEVERE (V SEV.)</p>	<p>ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED, ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT THE MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING, SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE SUCH THAT ONLY MINOR VESTIGES OF THE ORIGINAL ROCK FABRIC REMAIN. <u>IF TESTED, WOULD YIELD SPT N VALUES < 100 BPF</u></p>		
<p>COMPLETE</p>	<p>ROCK REDUCED TO SOIL, ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS, QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS, SAPROLITE IS ALSO AN EXAMPLE.</p>		
ROCK HARDNESS			
<p>VERY HARD</p>	<p>CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK, BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.</p>		
<p>HARD</p>	<p>CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY, HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.</p>		
<p>MODERATELY HARD</p>	<p>CAN BE SCRATCHED BY KNIFE OR PICK, GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK, HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.</p>		
<p>MEDIUM HARD</p>	<p>CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT, CAN BE EXCAVATED IN SMALL CHIPS TO PIECES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.</p>		
<p>SOFT</p>	<p>CAN BE GROOVED OR GOUGED READILY BY KNIFE OR PICK, CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT, SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.</p>		
<p>VERY SOFT</p>	<p>CAN BE CARVED WITH KNIFE, CAN BE EXCAVATED READILY WITH POINT OF PICK, PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE, CAN BE SCRATCHED READILY BY FINGER NAIL.</p>		
FRACTURE SPACING		BEDDING	
<p>TERM</p>	<p>SPACING</p>	<p>TERM</p>	<p>THICKNESS</p>
<p>VERY WIDE</p>	<p>MORE THAN 10 FEET</p>	<p>VERY THICKLY BEDDED</p>	<p>> 4 FEET</p>
<p>WIDE</p>	<p>3 TO 10 FEET</p>	<p>THICKLY BEDDED</p>	<p>1.5 - 4 FEET</p>
<p>MODERATELY CLOSE</p>	<p>1 TO 3 FEET</p>	<p>THINLY BEDDED</p>	<p>0.16 - 1.5 FEET</p>
<p>CLOSE</p>	<p>0.16 TO 1 FEET</p>	<p>VERY THINLY BEDDED</p>	<p>0.03 - 0.16 FEET</p>
<p>VERY CLOSE</p>	<p>LESS THAN 0.16 FEET</p>	<p>THICKLY LAMINATED</p>	<p>0.008 - 0.03 FEET</p>
		<p>THINLY LAMINATED</p>	<p>< 0.008 FEET</p>
INDURATION			
<p>FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF THE MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.</p>			
<p>FRIABLE</p>	<p>RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.</p>		
<p>MODERATELY INDURATED</p>	<p>GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.</p>		
<p>INDURATED</p>	<p>GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.</p>		
<p>EXTREMELY INDURATED</p>	<p>SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.</p>		
<p>BENCH MARK: BM#1-BL- STA 8+34.89, 9.64' LT</p>		<p>ELEVATION: 2563.56 FT.</p>	
<p>NOTES:</p>			

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	17BP.14.R.53	3	7

EXPLANATION:



HAND AUGER BORING
(03/2012, SCHNABEL ENGINEERING)

DRAWING SOURCE:
430359_RDY_DSN.DWG



JONES COVE CREEK



PROPOSED WINGWALLS
SHOWN AT CLIENT REQUEST.

BM #1
-BL- STA 8+34.89
9.64' LT
ELEV = 2563.56'

TO 14+00

BL-2

SR 1531
(LEE ROAD)

HA1-A

HA2-A

HA1-B

HA2-B

13+00

SCALE: 1" = 20'

0 20 40



FEET



CULVERT NO. 430359
HAYWOOD COUNTY, NORTH CAROLINA
NC DEPARTMENT OF TRANSPORTATION
SCHNABEL PROJECT NO. 12821004.00

SITE PLAN



NCDOT GEOTECHNICAL ENGINEERING UNIT

BORELOG REPORT

WBS N/A		TIP 17BP.14.R.53		COUNTY HAYWOOD		GEOLOGIST Oree, P.												
SITE DESCRIPTION Culvert No. 359 on SR 1531 (Lee Road) over Jones Cove Creek							GROUND WTR (ft)											
BORING NO. HA1-A		STATION 13+08		OFFSET 17 ft LT		ALIGNMENT -L-												
COLLAR ELEV. 2,558.0 ft		TOTAL DEPTH 3.2 ft		NORTHING 671,830		EASTING 830,905												
DRILL RIG/HAMMER EFF./DATE N/A		DRILL METHOD Hand Auger		HAMMER TYPE N/A														
DRILLER Cassell, R.		START DATE 03/12/12		COMP. DATE 03/12/12		SURFACE WATER DEPTH N/A												
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT					BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100	ELEV. (ft)	DEPTH (ft)						
2560																	GROUND SURFACE	0.0
																M	ALLUVIAL	1.5
																M	BROWN, FINE TO COARSE GRAINED SANDY SILT, SLIGHTLY MICACEOUS.	1.9
2555																M	BROWN, FINE TO COARSE GRAINED SAND, WITH SOME FINE TO MEDIUM GRAVEL.	3.2
																	RESIDUAL	
																	GRAY, SILTY FINE TO COARSE GRAINED SAND.	
																	Boring Terminated at Elevation 2,554.8 ft in Silty Sand	

NCDOT BORE SINGLE CULVERT 359.GPJ NC_DOT.GDT 4/19/12



NCDOT GEOTECHNICAL ENGINEERING UNIT

BORELOG REPORT

WBS N/A		TIP 17BP.14.R.53		COUNTY HAYWOOD		GEOLOGIST Oree, P.	
SITE DESCRIPTION Culvert No. 359 on SR 1531 (Lee Road) over Jones Cove Creek							GROUND WTR (ft)
BORING NO. HA1-B		STATION 12+94		OFFSET 20 ft RT		ALIGNMENT -L-	
COLLAR ELEV. 2,556.5 ft		TOTAL DEPTH 1.0 ft		NORTHING 671,790		EASTING 830,899	
0 HR. Dry		24 HR. FIAD		DRILL RIG/HAMMER EFF./DATE N/A		DRILL METHOD Hand Auger	
HAMMER TYPE N/A		DRILLER Cassell, R.		START DATE 03/12/12		COMP. DATE 03/12/12	
SURFACE WATER DEPTH N/A		ELEV (ft)		DRIVE ELEV (ft)		DEPTH (ft)	
BLOW COUNT		BLOWS PER FOOT		SAMP. NO.		L O G	
0.5ft 0.5ft 0.5ft		0 25 50 75 100		MOI		SOIL AND ROCK DESCRIPTION	
2560						ELEV. (ft) DEPTH (ft)	
						2,556.5 GROUND SURFACE 0.0	
						2,555.5 ALLUVIAL 1.0	
						BROWN, FINE TO COARSE GRAINED SANDY SILT, SLIGHTLY MICACEOUS.	
						Boring Terminated at Elevation 2,555.5 ft on Gravel	

NCDOT BORE SINGLE CULVERT 359.GPJ NC_DOT.GDT 4/19/12



NCDOT GEOTECHNICAL ENGINEERING UNIT

BORELOG REPORT

WBS N/A		TIP 17BP.14.R.53		COUNTY HAYWOOD		GEOLOGIST Oree, P.											
SITE DESCRIPTION Culvert No. 359 on SR 1531 (Lee Road) over Jones Cove Creek							GROUND WTR (ft)										
BORING NO. HA2-A		STATION 13+25		OFFSET 18 ft LT		ALIGNMENT -L-											
COLLAR ELEV. 2,558.1 ft		TOTAL DEPTH 2.2 ft		NORTHING 671,834		EASTING 830,921											
DRILL RIG/HAMMER EFF./DATE N/A		DRILL METHOD Hand Auger		HAMMER TYPE N/A													
DRILLER Cassell, R.		START DATE 03/12/12		COMP. DATE 03/12/12		SURFACE WATER DEPTH N/A											
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION			
			0.5ft	0.5ft	0.5ft	0	25	50	75	100				ELEV. (ft)	DEPTH (ft)		
2560																	
															2,558.1	GROUND SURFACE	0.0
															2,556.3	ALLUVIAL	1.8
															2,555.9	BROWN, FINE TO COARSE GRAINED SANDY SILT, SLIGHTLY MICACEOUS.	2.2
																RESIDUAL	
																GRAY, SILTY FINE TO COARSE GRAINED SAND.	
																Boring Terminated at Elevation 2,555.9 ft in Silty Sand	

NCDOT BORE SINGLE CULVERT 359.GPJ NC_DOT.GDT 4/19/12



NCDOT GEOTECHNICAL ENGINEERING UNIT

BORELOG REPORT

WBS N/A		TIP 17BP.14.R.53		COUNTY HAYWOOD		GEOLOGIST Oree, P.											
SITE DESCRIPTION Culvert No. 359 on SR 1531 (Lee Road) over Jones Cove Creek							GROUND WTR (ft)										
BORING NO. HA2-B		STATION 13+07		OFFSET 19 ft RT		ALIGNMENT -L-	0 HR. Dry										
COLLAR ELEV. 2,556.0 ft		TOTAL DEPTH 1.5 ft		NORTHING 671,794		EASTING 830,911	24 HR. FIAD										
DRILL RIG/HAMMER EFF./DATE N/A				DRILL METHOD Hand Auger		HAMMER TYPE N/A											
DRILLER Cassell, R.		START DATE 03/12/12		COMP. DATE 03/12/12		SURFACE WATER DEPTH N/A											
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	ELEV. (ft)	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100							
2560																	
2555															2,556.0	0.0	
															2,554.5	1.5	
<p style="text-align: center;">GROUND SURFACE</p> <p style="text-align: center;">ARTIFICIAL FILL</p> <p style="text-align: center;">BROWN, FINE TO MEDIUM GRAINED SANDY SILT.</p> <p style="text-align: center;">Boring Terminated at Elevation 2,554.5 ft in Sandy Silt</p>																	

NCDOT BORE SINGLE CULVERT 359.GPJ NC_DOT.GDT 4/19/12