

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	N/A	1	17

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

**STRUCTURE
SUBSURFACE INVESTIGATION**

COUNTY JACKSON
PROJECT DESCRIPTION INVESTIGATION FOR
EMBANKMENT FAILURE US 441 S COWEE
MOUNTAIN NEAR PUMPKIN TOWN RD
SITE DESCRIPTION 35°16'18.1"N 83°17'31.3"W

REFERENCE: N/A

PROJECT: 15614

CONTENTS

<u>SHEET NO.</u>	<u>DESCRIPTION</u>
1	TITLE SHEET
2, 2A	LEGEND (SOIL & ROCK)
2B, 2C	SUPPLEMENTAL LEGEND (GSI)
3	SITE PLAN
4-17	BORE LOGS

PERSONNEL
F. WOODARD

INVESTIGATED BY C. TAYLOR
DRAWN BY T. LYNN
CHECKED BY J. CRENSHAW
SUBMITTED BY HDR
DATE APRIL 2019



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 - 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.



SIGNATURE DATE

**DOCUMENT NOT CONSIDERED FINAL
UNLESS ALL SIGNATURES COMPLETED**

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

**SUBSURFACE INVESTIGATION
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS
(PAGE 1 OF 2)**

SOIL DESCRIPTION										GRADATION									
SOIL IS CONSIDERED 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 THE STANDARD PENETRATION TEST (AASHTO T 206, ASTM D1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY INCLUDE THE FOLLOWING: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. FOR EXAMPLE, VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6										WELL GRADED - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE. UNIFORMLY GRADED - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLE SIZES OF TWO OR MORE SIZES.									
SOIL LEGEND AND AASHTO CLASSIFICATION										ANGULARITY OF GRAINS									
GENERAL CLASS. GRANULAR MATERIALS (<= 35% PASSING #200) SILT-CLAY MATERIALS (> 35% PASSING #200) ORGANIC MATERIALS										MINERALOGICAL COMPOSITION									
GROUP CLASS. A-1, A-3, A-2, A-4, A-5, A-6, A-7, A-1-A-2, A-4, A-5, A-6, A-7										MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.									
SYMBOL										COMPRESSIBILITY									
% PASSING #10, #40, #200										SLIGHTLY COMPRESSIBLE, MODERATELY COMPRESSIBLE, HIGHLY COMPRESSIBLE									
MATERIAL PASSING #40 LL, PI										PERCENTAGE OF MATERIAL									
GROUP INDEX										ORGANIC MATERIAL, GRANULAR SOILS, SILT-CLAY SOILS, OTHER MATERIAL									
USUAL TYPES OF MAJOR MATERIALS										GROUND WATER									
GEN. RATING AS SUBGRADE										WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING, STATIC WATER LEVEL AFTER 24 HOURS, PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA, SPRING OR SEEP									
CONSISTENCY OR DENSENESS										MISCELLANEOUS SYMBOLS									
PRIMARY SOIL TYPE, COMPACTNESS OR CONSISTENCY, RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE), RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT ²)										ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION, SOIL SYMBOL, ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT, INFERRED SOIL BOUNDARY, INFERRED ROCK LINE, ALLUVIAL SOIL BOUNDARY, DIP & DIP DIRECTION OF ROCK STRUCTURES, TEST BORING, AUGER BORING, CORE BORING, MONITORING WELL, PIEZOMETER INSTALLATION, SLOPE INDICATOR INSTALLATION, CONE PENETROMETER TEST, SOUNDING ROD, TEST BORING WITH CORE, SPT N-VALUE									
TEXTURE OR GRAIN SIZE										RECOMMENDATION SYMBOLS									
U.S. STD. SIEVE SIZE OPENING (MM), BOULDER (BLDR.), COBBLE (COB.), GRAVEL (GR.), COARSE SAND (CSE. SD.), FINE SAND (F SD.), SILT (SL.), CLAY (CL.)										UNDERCUT, UNCLASSIFIED EXCAVATION - UNSUITABLE WASTE, UNCLASSIFIED EXCAVATION - ACCEPTABLE DEGRADABLE ROCK, UNCLASSIFIED EXCAVATION - ACCEPTABLE, BUT NOT TO BE USED IN THE TOP 3 FEET OF EMBANKMENT OR BACKFILL									
GRAIN SIZE										ABBREVIATIONS									
SOIL MOISTURE - CORRELATION OF TERMS										AR - AUGER REFUSAL, BT - BORING TERMINATED, CL - CLAY, CPT - CONE PENETRATION TEST, CSE. - COARSE, DMT - DILATOMETER TEST, DPT - DYNAMIC PENETRATION TEST, e - VOID RATIO, F - FINE, FOSS. - FOSSILIFEROUS, FRAC. - FRACTURED, FRACTURES, FRAGS. - FRAGMENTS, HI. - HIGHLY, MED. - MEDIUM, MICA - MICACEOUS, MOD. - MODERATELY, NP - NON PLASTIC, ORG. - ORGANIC, PMT - PRESSUREMETER TEST, SAP. - SAPROLITIC, SD. - SAND, SANDY, SL. - SILT, SILTY, SLI. - SLIGHTLY, TCR - TRICONE REFUSAL, w - MOISTURE CONTENT, v - VERY, VST - VANE SHEAR TEST, WEA. - WEATHERED, ? - UNIT WEIGHT, ? - DRY UNIT WEIGHT, SAMPLE ABBREVIATIONS: S - BULK, SS - SPLIT SPOON, ST - SHELBY TUBE, RS - ROCK, RT - RECOMPACTED TRIAXIAL, CBR - CALIFORNIA BEARING RATIO									
PLASTICITY										EQUIPMENT USED ON SUBJECT PROJECT									
PLASTICITY INDEX (PI), DRY STRENGTH										DRILL UNITS: CME-45C, CME-55, CME-550, VANE SHEAR TEST, PORTABLE HOIST, ADVANCING TOOLS: CLAY BITS, 6' CONTINUOUS FLIGHT AUGER, 8" HOLLOW AUGERS, HARD FACED FINGER BITS, TUNG-CARBIDE INSERTS, CASING w/ ADVANCER, TRICONE STEEL TEETH, TRICONE TUNG-CARB., CORE BIT, HAMMER TYPE: AUTOMATIC, MANUAL, CORE SIZE: B, H, N, HAND TOOLS: POST HOLE DIGGER, HAND AUGER, SOUNDING ROD, VANE SHEAR TEST									
COLOR										DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-GRAY). MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.									





**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
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SUBSURFACE INVESTIGATION

SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS (PAGE 2 OF 2)

ROCK DESCRIPTION

HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT REFUSAL IF TESTED, 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:

WEATHERED ROCK (WR)		NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.
CRYSTALLINE ROCK (CR)		FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.
NON-CRYSTALLINE ROCK (NCR)		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.
COASTAL PLAIN SEDIMENTARY ROCK (CP)		COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.

WEATHERING

FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.
VERY SLIGHT (V SL.)	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.
SLIGHT (SL.)	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.
MODERATE (MOD.)	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.
MODERATELY SEVERE (MOD. SEV.)	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>
SEVERE (SEV.)	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>
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE THAT ONLY MINOR VESTIGES OF ORIGINAL ROCK FABRIC REMAIN. <u>IF TESTED, WOULD YIELD SPT N VALUES < 100 BPF</u>
COMPLETE	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.

ROCK HARDNESS

VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.
MODERATELY HARD	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.
MEDIUM HARD	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.
SOFT	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.
VERY SOFT	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 FINGERNAIL.

FRACTURE SPACING

BEDDING

TERM	SPACING	TERM	THICKNESS
VERY WIDE	MORE THAN 10 FEET	VERY THICKLY BEDDED	4 FEET
WIDE	3 TO 10 FEET	THICKLY BEDDED	1.5 - 4 FEET
MODERATELY CLOSE	1 TO 3 FEET	THINLY BEDDED	0.16 - 1.5 FEET
CLOSE	0.16 TO 1 FOOT	VERY THINLY BEDDED	0.03 - 0.16 FEET
VERY CLOSE	LESS THAN 0.16 FEET	THICKLY LAMINATED	0.008 - 0.03 FEET
		THINLY LAMINATED	< 0.008 FEET

INDURATION

FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.	
FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.

TERMS AND DEFINITIONS

ALLUVIUM (ALLUV.) - 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, SUCH 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 DISLODGED 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 (ROD) - 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 (SROD) - 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.

BENCH MARK: TP-2 SPIKE BEHIND GUARDRAIL

ELEVATION: 2618.03 FEET

NOTES:

FIAD - FILLED IMMEDIATELY AFTER DRILLING

**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
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SUBSURFACE INVESTIGATION

**SUPPLEMENTAL LEGEND, GEOLOGICAL STRENGTH INDEX (GSI) TABLES
FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (PAGE 1 OF 2)**

AASHTO LRFD Figure 10.4.6.4-1 — Determination of GSI for Jointed Rock Mass (Marinos and Hoek, 2000)

**GEOLOGICAL STRENGTH INDEX (GSI) FOR
JOINTED ROCKS (Hoek and Marinos, 2000)**

From the lithology, structure and surface conditions of the discontinuities, estimate the average value of GSI. Do not try to be too precise. Quoting a range from 33 to 37 is more realistic than stating that GSI = 35. Note that the table does not apply to structurally controlled failures. Where weak planar structural planes are present in an unfavorable orientation with respect to the excavation face, these will dominate the rock mass behaviour. The shear strength of surfaces in rocks that are prone to deterioration as a result of changes in moisture content will be reduced if water is present. When working with rocks in the fair to very poor categories, a shift to the right may be made for wet conditions. Water pressure is dealt with by effective stress analysis.

SURFACE CONDITIONS

VERY GOOD
Very rough, fresh unweathered surfaces

GOOD
Rough, slightly weathered, iron stained surfaces

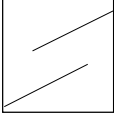
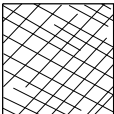
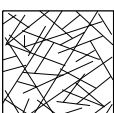

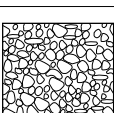
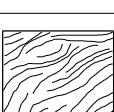
FAIR
Smooth, moderately weathered and altered surfaces

POOR
Slackensided, highly weathered surfaces with compact coatings or fillings or angular fragments

VERY POOR
Slackensided, highly weathered surfaces with soft clay coatings or fillings

DECREASING SURFACE QUALITY →

STRUCTURE

	INTACT OR MASSIVE - intact rock specimens or massive in situ rock with few widely spaced discontinuities
	BLOCKY - well interlocked undisturbed rock mass consisting of cubical blocks formed by three intersecting discontinuity sets
	VERY BLOCKY - interlocked, partially disturbed mass with multi-faceted angular blocks formed by 4 or more joint sets
	BLOCKY/DISTURBED/SEAMY - folded with angular blocks formed by many intersecting discontinuity sets. Persistence of bedding planes or schistosity
	DISINTEGRATED - poorly interlocked, heavily broken rock mass with mixture of angular and rounded rock pieces
	LAMINATED/SHEARED - Lack of blockiness due to close spacing of weak schistosity or shear planes

DECREASING INTERLOCKING OF ROCK PIECES

90				N/A	N/A
80					
	70				
		60			
			50		
				40	
					30
					20
					10
N/A					
	N/A				

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SUBSURFACE INVESTIGATION

**SUPPLEMENTAL LEGEND, GEOLOGICAL STRENGTH INDEX (GSI) TABLES
 FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (PAGE 2 OF 2)**

AASHTO LRFD Figure 10.4.6.4-2 — Determination of GSI for Tectonically Deformed Heterogeneous Rock Masses (Marinos and Hoek, 2000)

GSI FOR HETEROGENEOUS ROCK MASSES SUCH AS FLYSCH (Marinos, P and Hoek E., 2000)

From a description of the lithology, structure and surface conditions (particularly of the bedding planes), choose a box in the chart. Locate the position in the box that corresponds to the condition of the discontinuities and estimate the average value of GSI from the contours. Do not attempt to be too precise. Quoting a range from 33 to 37 is more realistic than giving GSI = 35. Note that the Hoek-Brown criterion does not apply to structurally controlled failures. Where unfavourably oriented continuous weak planar discontinuities are present, these will dominate the behaviour of the rock mass. The strength of some rock masses is reduced by the presence of groundwater and this can be allowed for by a slight shift to the right in the columns for fair, poor and very poor conditions. Water pressure does not change the value of GSI and it is dealt with by using effective stress analysis.

SURFACE CONDITIONS OF DISCONTINUITIES (Predominantly bedding planes)

VERY GOOD - Very Rough, fresh unweathered surfaces

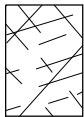
GOOD - Rough, slightly weathered surfaces

FAIR - Smooth, moderately weathered and altered surfaces

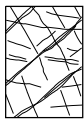
POOR - Very smooth, occasionally slickensided surfaces with compact coatings or fillings with angular fragments

VERY POOR - Very smooth, slickensided or highly weathered surfaces with soft clay coatings or fillings

COMPOSITION AND STRUCTURE



A. Thick bedded, very blocky sandstone. The effect of pelitic coatings on the bedding planes is minimized by the confinement of the rock mass. In shallow tunnels or slopes these bedding planes may cause structurally controlled instability.



B. Sandstone with thin inter-layers of siltstone



C. Sandstone and siltstone in similar amounts



D. Siltstone or silty shale with sandstone layers



E. Weak siltstone or clayey shale with sandstone layers

C, D, E, and **G** - may be more or less folded than illustrated but this does not change the strength. Tectonic deformation, faulting and loss of continuity moves these categories to **F** and **H**.



F. Tectonically deformed, intensively folded/faulted, sheared clayey shale or siltstone with broken and deformed sandstone layers forming an almost chaotic structure

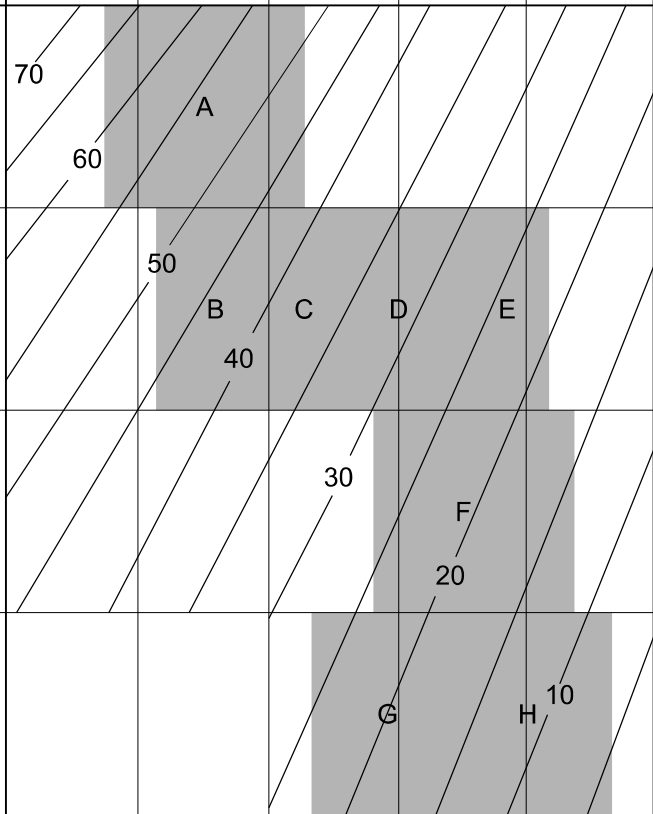


G. Undisturbed silty or clayey shale with or without a few very thin sandstone layers

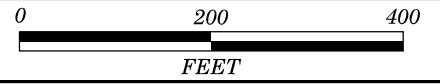


H. Tectonically deformed silty or clayey shale forming a chaotic structure with pockets of clay. Thin layers of sandstone are transformed into small rock pieces.

➤ Means deformation after tectonic disturbance



SITE PLAN



GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.											
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)										
BORING NO. CMS-1		STATION N/A		OFFSET N/A		ALIGNMENT -L-	0 HR. N/A										
COLLAR ELEV. 2,643.0 ft		TOTAL DEPTH 68.5 ft		NORTHING 580,865		EASTING 718,903	24 HR. FIAD										
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic											
DRILLER Woodward, F.		START DATE 04/13/19		COMP. DATE 04/14/19		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)		
2645																	
	2,643.0	0.0	2	3	3										2,643.0	0.0	GROUND SURFACE
	2,641.5	1.5	3	3	3										2,641.5	1.5	ROADWAY EMBANKMENT Loose, gray, dark gray and brown, silty SAND, with gravel, non-plastic (A-2-5). Soft to very stiff, brown and red, clayey SILT, with gravel, slightly plastic (A-5).
2640	2,640.0	3.0	2	2	2												
	2,638.5	4.5	2	12	11												
	2,637.0	6.0	5	4	3												
2635	2,635.5	7.5	2	3	3												
	2,634.0	9.0	2	2	3												
	2,632.5	10.5	4	5	5												
2630	2,631.0	12.0	2	4	6												
	2,629.5	13.5	3	4	6												
2625	2,624.5	18.5	4	6	8										2,626.2	16.8	RESIDUAL Medium dense, gray and brown, clayey, fine to coarse SAND, saprolitic, slightly plastic (A-2-5).
2620	2,619.5	23.5	5	6	8												
	2,618.0	25.0	4	6	9												
2615	2,614.5	28.5	2	2	3										2,615.5	27.5	Medium stiff, brown, slightly sandy, clayey SILT, saprolitic, slightly plastic (A-5).
2610	2,609.5	33.5	5	14	18												
															2,608.6	34.4	Dense, brown, orange, white, silty, fine to coarse SAND, saprolitic, non-plastic (A-2-4).
2605															2,606.2	36.8	

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT_GDT 4/30/19

GEOTECHNICAL BORING REPORT BORE LOG

WBS 15614.1050013	TIP N/A	COUNTY JACKSON	GEOLOGIST Taylor, C.
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road			GROUND WTR (ft)
BORING NO. CMS-1	STATION N/A	OFFSET N/A	ALIGNMENT -L-
COLLAR ELEV. 2,643.0 ft	TOTAL DEPTH 68.5 ft	NORTHING 580,865	EASTING 718,903
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019		DRILL METHOD NW Casing w/ SPT	HAMMER TYPE Automatic
DRILLER Woodard, F.	START DATE 04/13/19	COMP. DATE 04/14/19	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	DEPTH (ft)
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
2605	2,604.5	38.5	1	6	5	Match Line								Medium stiff to hard, brown, orange and white, fine to coarse, sandy SILT, saprolitic, non-plastic (A-4). (continued)	
2600	2,599.5	43.5	2	4	3										
2595	2,594.5	48.5	2	3	4										
2590	2,589.5	53.5	2	6	12										
2585	2,584.5	58.5	18	31	59										
2580	2,579.5	63.5	9	9	14										
2575	2,574.5	68.5	60/0.0			60/0.0									68.5
													Boring Terminated with Standard Penetration Test Refusal at Elevation 2,574.5 ft on Crystalline Rock (Schist). No water return at 3.0 ft. depth. Set 4" casing to 12.0 ft depth.		

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT.GDT 4/30/19

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.											
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)										
BORING NO. CMS-2		STATION N/A		OFFSET N/A		ALIGNMENT -L-	0 HR. N/A										
COLLAR ELEV. 2,617.2 ft		TOTAL DEPTH 90.0 ft		NORTHING 581,138		EASTING 719,150	24 HR. FIAD										
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic											
DRILLER Woodward, F.		START DATE 04/15/19		COMP. DATE 04/15/19		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)		
2620																	
	2,617.2	0.0	5	8	6										2,617.2	0.0	GROUND SURFACE
	2,615.7	1.5	5	5	5								M		2,615.7	1.5	ROADWAY EMBANKMENT Medium dense, dark brown and gray, silty SAND, with gravel, non-plastic (A-2-5).
2615																	
	2,614.2	3.0	2	2	4								M				Medium stiff to very stiff, brown, orange and red, slightly sandy, clayey SILT, with gravel, quartz fragments, saprolitic, non to slightly plastic (A-5).
	2,612.7	4.5	4	6	7								M				
	2,611.2	6.0	2	6	7								M				
2610																	
	2,609.7	7.5	7	8	9								M				
	2,608.2	9.0	3	4	5								M				
	2,606.7	10.5	4	7	9								M				
2605																	
	2,605.2	12.0	2	4	3								M				
	2,603.7	13.5	4	6	9								M				
2600																	
	2,598.7	18.5	4	6	9								M		2,600.4	16.8	RESIDUAL Medium stiff to very stiff, gray, brown, red, tan, and white, clayey SILT, with few rock fragments, non to slightly plastic (A-5).
2595																	
	2,593.7	23.5	2	4	5								M				
2590																	
	2,588.7	28.5	3	9	11								M				
2585																	
	2,583.7	33.5	2	4	4								M				
2580																	

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT_GDT 4/30/19

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.											
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)										
BORING NO. CMS-2		STATION N/A		OFFSET N/A		ALIGNMENT -L-	0 HR. N/A										
COLLAR ELEV. 2,617.2 ft		TOTAL DEPTH 90.0 ft		NORTHING 581,138		EASTING 719,150	24 HR. FIAD										
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic											
DRILLER Woodard, F.		START DATE 04/15/19		COMP. DATE 04/15/19		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)		
2580						Match Line											
	2,578.7	38.5	4	7	4									M		<p style="text-align: center;">RESIDUAL</p> <p>Medium stiff to very stiff, gray, brown, red, tan, and white, clayey SILT, with few rock fragments, non to slightly plastic (A-5). <i>(continued)</i></p>	
2575														M			
	2,573.7	43.5	2	4	9									M			
2570														M			
	2,568.7	48.5	WOH	5	9									M			
2565														M			
	2,563.7	53.5	4	7	5									M			
2560														M			
	2,558.7	58.5	2	2	5									M			
2555														M			
	2,553.7	63.5	1	2	4									M			
2550														W			
	2,548.7	68.5	1	2	4									M			
2545														M			
	2,543.7	73.5	2	5	10									M			
2540																	
															2,540.4	76.8	

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT_GDT 4/30/19

GEOTECHNICAL BORING REPORT BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.									
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)								
BORING NO. CMS-2		STATION N/A		OFFSET N/A		ALIGNMENT -L-									
COLLAR ELEV. 2,617.2 ft		TOTAL DEPTH 90.0 ft		NORTHING 581,138		EASTING 719,150									
DRILL RIG/HAMMER EFF/DATE HDR9935 CME-55 85%03/18/2019				DRILL METHOD NW Casing w SPT		HAMMER TYPE Automatic									
DRILLER Woodard, F.		START DATE 04/15/19		COMP. DATE 04/15/19		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	DEPTH (ft)
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
2540	2,538.7	78.5	7	9	13	Match Line								Very stiff, brown, dark gray, orange, and white, fine to coarse, sandy SILT, with rock fragments, saprolitic, non-plastic (A-4). (continued)	
2535	2,533.7	83.5	4	10	10										
2530	2,528.7	88.5	22	31	34									Very dense, brown, white, and orange, silty, fine to coarse SAND, saprolitic, non-plastic (A-2-4).	86.8
														Boring Terminated at Elevation 2,527.2 ft in Residual Soil.	90.0
														No water return at 53.5 ft. depth.	

NCDOT BORE SINGLE COWEE MOUNTAIN US 441S GPJ NC_DOT.GDT 4/30/19

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.										
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)									
BORING NO. CMS-3		STATION N/A		OFFSET N/A		ALIGNMENT -L-										
COLLAR ELEV. 2,590.8 ft		TOTAL DEPTH 88.5 ft		NORTHING 581,452		EASTING 719,382										
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic										
DRILLER Woodward, F.		START DATE 04/15/19		COMP. DATE 04/16/19		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)	
2595																
	2,590.8	0.0	2	8	4										2,590.8	0.0
2590	2,589.3	1.5	4	7	8								M		2,589.3	1.5
	2,587.8	3.0	3	3	4								M			
	2,586.3	4.5	4	3	3								M			
2585	2,584.8	6.0	WOH	1	1								M			
	2,583.3	7.5	2	1	3								M			
	2,581.8	9.0	2	2	3								M			
2580	2,580.3	10.5	3	6	7								M		2,580.3	10.5
	2,578.8	12.0	4	3	3								M			
	2,577.3	13.5	3	5	6								M			
2575																
	2,572.3	18.5	6	8	12								M			
2570																
	2,567.3	23.5	3	4	7								M			
2565																
	2,562.3	28.5	3	4	8								M			
2560																
	2,557.3	33.5	1	4	6								M			
2555																

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT.GDT 4/30/19

GROUND SURFACE
ELEV. (ft) 2,590.8 DEPTH (ft) 0.0

ROADWAY EMBANKMENT
Medium dense, dark gray, SILT, and gravel, non-plastic (A-2-5).
Very soft to stiff, red, brown and white, clayey SILT, with rock fragments, non to slightly plastic (A-5).

RESIDUAL
Medium stiff to hard, brown, orange, black, red and white, SILT, with trace sands, saprolitic, non to slightly plastic (A-4).

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.										
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)									
BORING NO. CMS-3		STATION N/A		OFFSET N/A		ALIGNMENT -L-	0 HR. N/A									
COLLAR ELEV. 2,590.8 ft		TOTAL DEPTH 88.5 ft		NORTHING 581,452		EASTING 719,382	24 HR. FIAD									
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w SPT		HAMMER TYPE Automatic										
DRILLER Woodard, F.		START DATE 04/15/19		COMP. DATE 04/16/19		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)	
2515						Match Line								WEATHERED ROCK Tan and brown, SCHIST (continued)		
	2,512.3	78.5	33	67/0.4						100/0.9						
2510																
	2,507.3	83.5	43	57/0.3						100/0.8						
2505																
	2,502.3	88.5	60/0.0							60/0.0				2,502.3	88.5	Boring Terminated with Standard Penetration Test Refusal at Elevation 2,502.3 ft on Crystalline Rock (Schist).

NCDOT BORE SINGLE COWEE MOUNTAIN US 441S.GPJ NC_DOT.GDT 4/30/19

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.												
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)											
BORING NO. CMS-4		STATION N/A		OFFSET N/A		ALIGNMENT -L-	0 HR. N/A											
COLLAR ELEV. 2,609.6 ft		TOTAL DEPTH 89.1 ft		NORTHING 581,238		EASTING 719,125	24 HR. FIAD											
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic												
DRILLER Woodard, F.		START DATE 04/23/19		COMP. DATE 04/23/19		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)			
2610	2,609.6	0.0	2	4	4										2,609.6	0.0	GROUND SURFACE	
	2,608.1	1.5	1	2	2	3							M				ROADWAY EMBANKMENT Soft to stiff, brown, black, dark brown and tan, SILT, with sand and rock fragments, non to slightly plastic (A-4).	
	2,606.6	3.0	2	4	3	4							M					
2605	2,605.1	4.5	3	3	3	7							M					
	2,603.6	6.0	2	2	1	6							M					
	2,602.1	7.5	11	7	3	3							M					
2600	2,600.6	9.0	2	1	1	10							W					
	2,599.1	10.5	1	1	2	2												
	2,597.6	12.0	2	3	2	3									2,597.6	12.0		RESIDUAL
	2,596.1	13.5	4	4	5	5							M					Medium stiff to stiff, brown, dark brown and tan, SILT, with fine to coarse sand, saprolitic, non-plastic (A-4).
2595						9							M					
	2,592.6														2,592.6	17.0	Very soft to soft, brown, clayey SILT, with trace coarse sand, saprolitic, non to slightly plastic (A-5).	
2590	2,590.6	19.0	2	2	2								M					
	2,585.6	24.0	WOH	WOH	WOH								W					
2585																		
	2,582.3														2,582.3	27.3	Loose, brown, dark gray and white, SAND, with trace silt, saprolitic, non-plastic (A-2-4).	
2580	2,580.6	29.0	4	2	2								W					
	2,577.3														2,577.3	32.3	Medium stiff to hard, brown, white, gray and orange, fine to coarse sandy SILT, with rock fragments, saprolitic, non-plastic (A-4).	
2575	2,575.6	34.0	4	6	11								M					
	2,570.6	39.0	2	3	4	17												
2570																		

NCDOT BORE SINGLE COWEE MOUNTAIN US 441S.GPJ NC_DOT.GDT 4/30/19

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.										
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)									
BORING NO. CMS-4		STATION N/A		OFFSET N/A		ALIGNMENT -L-	0 HR. N/A									
COLLAR ELEV. 2,609.6 ft		TOTAL DEPTH 89.1 ft		NORTHING 581,238		EASTING 719,125	24 HR. FIAD									
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic										
DRILLER Woodard, F.		START DATE 04/23/19		COMP. DATE 04/23/19		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)	
2570						Match Line								Medium stiff to hard, brown, white, gray and orange, fine to coarse sandy SILT, with rock fragments, saprolitic, non-plastic (A-4). (continued)		
2565	2,565.6	44.0	2	4	5											
2560	2,560.6	49.0	8	7	10											
2555	2,555.6	54.0	2	4	7											
2550	2,550.6	59.0	3	7	9											
2545	2,545.6	64.0	5	8	12											
2540	2,540.6	69.0	6	9	14											
2535	2,535.6	74.0	12	21	24											
2530	2,530.6	79.0	14	19	30											

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT.GDT 4/30/19

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013	TIP N/A	COUNTY JACKSON	GEOLOGIST Taylor, C.												
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)								
BORING NO. CMS-4	STATION N/A	OFFSET N/A	ALIGNMENT -L-				0 HR.	N/A							
COLLAR ELEV. 2,609.6 ft	TOTAL DEPTH 89.1 ft	NORTHING 581,238	EASTING 719,125				24 HR.	FIAD							
DRILL RIG/HAMMER EFF./DATE HDR9935 CVE-55 85% 03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic									
DRILLER Woodard, F.	START DATE 04/23/19	COMP. DATE 04/23/19	SURFACE WATER DEPTH N/A												
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	L O G	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					ELEV. (ft)
2530													Medium stiff to hard, brown, white, gray and orange, fine to coarse sandy SILT , with rock fragments, saprolitic, non-plastic (A-4). (continued)		
	2,525.6	84.0	24	33	49										
2525															
	2,520.6	89.0													
			60/0.1										CRISTALLINE ROCK Brown, SCHIST		
													Boring Terminated with Standard Penetration Test Refusal at Elevation 2,520.5 ft in Crystalline Rock (Schist).		
													No water return at 3.0 ft. depth.		

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT.GDT 4/30/19

GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON		GEOLOGIST Taylor, C.										
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road							GROUND WTR (ft)									
BORING NO. CMS-5		STATION N/A		OFFSET N/A		ALIGNMENT -L-										
COLLAR ELEV. 2,589.7 ft		TOTAL DEPTH 89.1 ft		NORTHING 581,482		EASTING 719,297										
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%/03/18/2019				DRILL METHOD NW Casing w/ SPT		HAMMER TYPE Automatic										
DRILLER Woodard, F.		START DATE 04/24/19		COMP. DATE 04/24/19		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						
2590	2,589.7	0.0	3	3	3										2,589.7	0.0
	2,588.2	1.5	2	3	2										2,589.0	0.7
	2,586.7	3.0	3	3	3											
2585	2,585.2	4.5	3	4	8										2,585.2	4.5
	2,583.7	6.0	5	3	5											
	2,582.2	7.5	3	7	8										2,582.2	7.5
2580	2,580.7	9.0	8	13	17											
	2,579.2	10.5	8	15	16											
	2,577.7	12.0	7	9	8											
	2,576.2	13.5	9	11	14											
2575																
	2,570.7	19.0	6	8	14										2,572.7	17.0
2570																
	2,567.4	22.3													2,567.4	22.3
2565	2,565.7	24.0	3	7	9											
	2,560.7	29.0	4	5	10											
2560																
	2,555.7	34.0	2	4	4											
2555																
	2,550.7	39.0	1	3	4											
2550																

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT.GDT 4/30/19

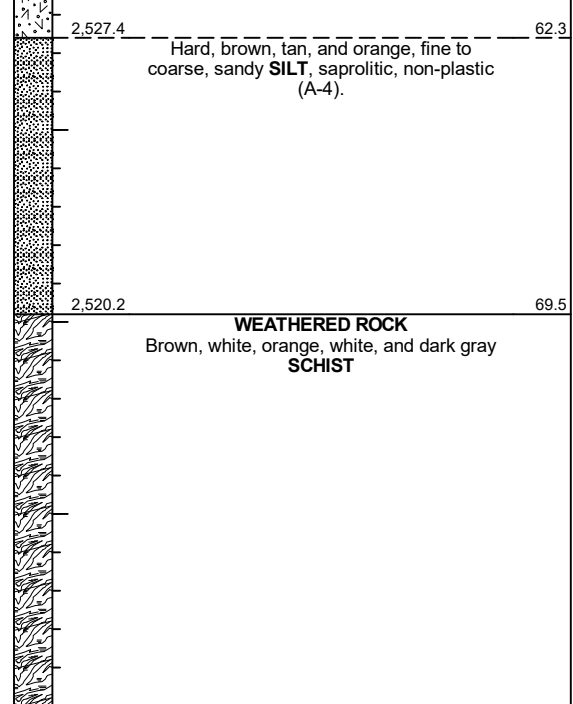
GEOTECHNICAL BORING REPORT

BORE LOG

WBS 15614.1050013	TIP N/A	COUNTY JACKSON	GEOLOGIST Taylor, C.
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road			GROUND WTR (ft)
BORING NO. CMS-5	STATION N/A	OFFSET N/A	ALIGNMENT -L-
COLLAR ELEV. 2,589.7 ft	TOTAL DEPTH 89.1 ft	NORTHING 581,482	EASTING 719,297
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019		DRILL METHOD NW Casing w/ SPT	HAMMER TYPE Automatic
DRILLER Woodard, F.	START DATE 04/24/19	COMP. DATE 04/24/19	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)	
2550						Match Line										
	2,545.7	44.0	2	2	5											Stiff to very stiff, white, tan, brown, black, and orange, clayey SILT, with quartz fragments and fine sand, saprolitic, non to slightly plastic (A-5). (continued)
2545																
	2,540.7	49.0	4	5	10											
2540																
	2,535.7	54.0	5	5	8											
2535																
	2,530.7	59.0	5	10	15											
2530																
	2,525.7	64.0	10	24	24											
2525																
	2,520.7	69.0	5	25	75/0.3											
2520																
	2,515.7	74.0	37	63/0.3						100/0.8						
2515																
	2,510.7	79.0														
2510																

NCDOT BORE SINGLE COWEE MOUNTAIN US 441S.GPJ NC_DOT.GDT 4/30/19



GEOTECHNICAL BORING REPORT BORE LOG

WBS 15614.1050013		TIP N/A		COUNTY JACKSON			GEOLOGIST Taylor, C.									
SITE DESCRIPTION Embankment Failure US 441 S Cowee Mountain Near Pumpkin Town Road									GROUND WTR (ft)							
BORING NO. CMS-5		STATION N/A		OFFSET N/A		ALIGNMENT -L-			0 HR. N/A							
COLLAR ELEV. 2,589.7 ft		TOTAL DEPTH 89.1 ft		NORTHING 581,482		EASTING 719,297			24 HR. FIAD							
DRILL RIG/HAMMER EFF/DATE HDR9935 CVE-55 85%03/18/2019				DRILL METHOD NW Casing w/ SPT			HAMMER TYPE Automatic									
DRILLER Woodward, F.		START DATE 04/24/19		COMP. DATE 04/24/19		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)	
2510			Match Line													
	2,505.7	84.0													WEATHERED ROCK	
	Brown, white, orange, white, and dark gray SCHIST (continued)															
2505			100/0.2						100/0.2							
	2,500.7	89.0													CRYSTALLINE ROCK	
	Brown, dark gray, and white, SCHIST															
	Boring Terminated with Standard Penetration Test Refusal at Elevation 2,500.6 ft in Crystalline Rock (Schist).															
			60/0.1						60/0.1					2,500.7	89.0	
														2,500.6	89.1	

NCDOT BORE SINGLE COWEE MOUNTAIN US 441 S. GPJ NC_DOT.GDT 4/30/19