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REFERENCE: U-5818

PROJECT: 44390

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

STRUCTURE  
SUBSURFACE INVESTIGATION

COUNTY MCDOWELL  
PROJECT DESCRIPTION SR 1001 (SUGAR HILL RD.)  
FROM I-40 WB RAMPS TO 0.3 MI. WEST OF I-40  
EB RAMPS  
SITE DESCRIPTION BRIDGE NO. 128 ON SR 1001 (-L-)  
OVER I-40 (-Y-)

CONTENTS

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	LEGEND (SOIL & ROCK)
2A	SUPPLEMENTAL LEGEND (GSI)
3	SITE PLAN
4	PROFILE
5-7	CROSS SECTION(S)
8-13	BORE LOG(S)
14	SOIL TEST RESULTS
15-20	ROCK TEST RESULTS
21-23	CORE PHOTOS
24	SITE PHOTOGRAPH

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	U-5818	1	25

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. THE SUBSURFACE PLANS AND REPORTS, FIELD BORING LOGS, ROCK CORES AND SOIL TEST DATA ARE NOT 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 THE 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.

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

PERSONNEL

L. BUTLER

M. STEPHENSON

R. KRAL

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INVESTIGATED BY S&ME, Inc.

DRAWN BY J.R. SWARTLEY

CHECKED BY R. KRAL

SUBMITTED BY S. LANEY

DATE JULY 2018



3201 SPRING FOREST ROAD  
RALEIGH, NC 27616  
(919) 872-2660



DocuSigned by:  
Stewart Laney 07/23/2018

75BB4AB1AB2B4CB SIGNATURE DATE

DOCUMENT NOT CONSIDERED FINAL  
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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
**GEOTECHNICAL ENGINEERING UNIT**  
**SUBSURFACE INVESTIGATION**  
SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION										GRADATION										ROCK DESCRIPTION										TERMS AND DEFINITIONS																																																																									
<p>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</p>										<p>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.</p>										<p>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:</p>										<p>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.</p>																																																																									
SOIL LEGEND AND AASHTO CLASSIFICATION										ANGULARITY OF GRAINS										WEATHERED ROCK (WR)										NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.																																																																									
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<p>MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.</p>										<p>SLIGHTLY COMPRESSIBLE LL &lt; 31 MODERATELY COMPRESSIBLE LL = 31 - 50 HIGHLY COMPRESSIBLE LL &gt; 50</p>										<p>FRESH - ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.</p>										<p>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.</p>																																																																									
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	4.75	2.00	0.42	0.25	0.075	0.053																																																																																																	
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>SOIL MOISTURE SCALE (ATTERBERG LIMITS)</th> <th>FIELD MOISTURE DESCRIPTION</th> <th>GUIDE FOR FIELD MOISTURE DESCRIPTION</th> </tr> <tr> <td>LL - LIQUID LIMIT</td> <td>- SATURATED - (SAT.)</td> <td>USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE</td> </tr> <tr> <td>PL - PLASTIC LIMIT</td> <td>- WET - (W)</td> <td>SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE</td> </tr> <tr> <td>OM - OPTIMUM MOISTURE SHRINKAGE LIMIT</td> <td>- MOIST - (M)</td> <td>SOLID; AT OR NEAR OPTIMUM MOISTURE</td> </tr> <tr> <td>SL - SHRINKAGE LIMIT</td> <td>- DRY - (D)</td> <td>REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE</td> </tr> </table>										SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION	LL - LIQUID LIMIT	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE	PL - PLASTIC LIMIT	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE	OM - OPTIMUM MOISTURE SHRINKAGE LIMIT	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE	SL - SHRINKAGE LIMIT	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE	<p>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</p> <p>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</p> <p>VST - VANE SHEAR TEST WEA. - WEATHERED W - UNIT WEIGHT W<sub>d</sub> - DRY UNIT WEIGHT</p> <p>SAMPLE ABBREVIATIONS S - BULK SS - SPLIT SPOON ST - SHELBY TUBE RS - ROCK RT - RECOMPACTED TRIAXIAL CBR - CALIFORNIA BEARING RATIO</p>										<p>VERY HARD - CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.</p>										<p>HARD - CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.</p>																																																										
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>NON PLASTIC</th> <th colspan="2">PLASTICITY INDEX (PI)</th> <th>DRY STRENGTH</th> </tr> <tr> <td>SLIGHTLY PLASTIC</td> <td>0-5</td> <td></td> <td>VERY LOW</td> </tr> <tr> <td>MODERATELY PLASTIC</td> <td>6-15</td> <td></td> <td>SLIGHT</td> </tr> <tr> <td>HIGHLY PLASTIC</td> <td>16-25</td> <td></td> <td>MEDIUM</td> </tr> <tr> <td></td> <td>26 OR MORE</td> <td></td> <td>HIGH</td> </tr> </table>										NON PLASTIC	PLASTICITY INDEX (PI)		DRY STRENGTH	SLIGHTLY PLASTIC	0-5		VERY LOW	MODERATELY PLASTIC	6-15		SLIGHT	HIGHLY PLASTIC	16-25		MEDIUM		26 OR MORE		HIGH	<p>DRILL UNITS:</p> <p>CME-45C</p> <p>CME-55</p> <p>CME-550</p> <p>VANE SHEAR TEST</p> <p>PORTABLE HOIST</p> <p>CME-550X</p> <p>DIEDRICH D-50</p> <p>ADVANCING TOOLS:</p> <p>CLAY BITS</p> <p>6" CONTINUOUS FLIGHT AUGER</p> <p>8" HOLLOW AUGERS</p> <p>HARD FACED FINGER BITS</p> <p>TUNG-CARBIDE INSERTS</p> <p>CASING w/ ADVANCER</p> <p>TRICONE 2 1/16" STEEL TEETH</p> <p>TRICONE TUNG-CARB.</p> <p>CORE BIT</p> <p>HAMMER TYPE:</p> <p>AUTOMATIC</p> <p>MANUAL</p> <p>CORE SIZE:</p> <p>B</p> <p>H</p> <p>N O</p> <p>HAND TOOLS:</p> <p>POST HOLE DIGGER</p> <p>HAND AUGER</p> <p>SOUNDING ROD</p> <p>VANE SHEAR TEST</p>										<p>FRAC. SPACING</p> <p>VERY WIDE MORE THAN 10 FEET</p> <p>WIDE 3 TO 10 FEET</p> <p>MODERATELY CLOSE 1 TO 3 FEET</p> <p>CLOSE 0.16 TO 1 FOOT</p> <p>VERY CLOSE LESS THAN 0.16 FEET</p>										<p>BEDDING</p> <p>VERY THICKLY BEDDED 4 FEET</p> <p>THICKLY BEDDED 1.5 - 4 FEET</p> <p>THINLY BEDDED 0.16 - 1.5 FEET</p> <p>VERY THINLY BEDDED 0.03 - 0.16 FEET</p> <p>THICKLY LAMINATED 0.008 - 0.03 FEET</p> <p>THINLY LAMINATED &lt; 0.008 FEET</p>																																																					
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COLOR										INDURATION										VERY HARD										HARD																																																																									
<p>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.</p>										<p>FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.</p> <p>FRIABLE - RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.</p> <p>MODERATELY INDURATED - GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.</p> <p>INDURATED - GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.</p> <p>EXTREMELY INDURATED - SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.</p>										<p>BENCH MARK: BM#2 N: 703619 E: 1098038</p> <p style="text-align: right;">ELEVATION: 1394.48 FEET</p>										<p>NOTES:</p> <p>FIAD = FILLED IN AFTER DRILLING</p>																																																																									

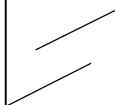
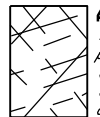
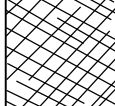

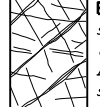



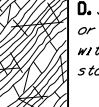

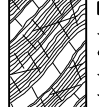

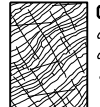

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
GEOTECHNICAL ENGINEERING UNIT

**SUBSURFACE INVESTIGATION**

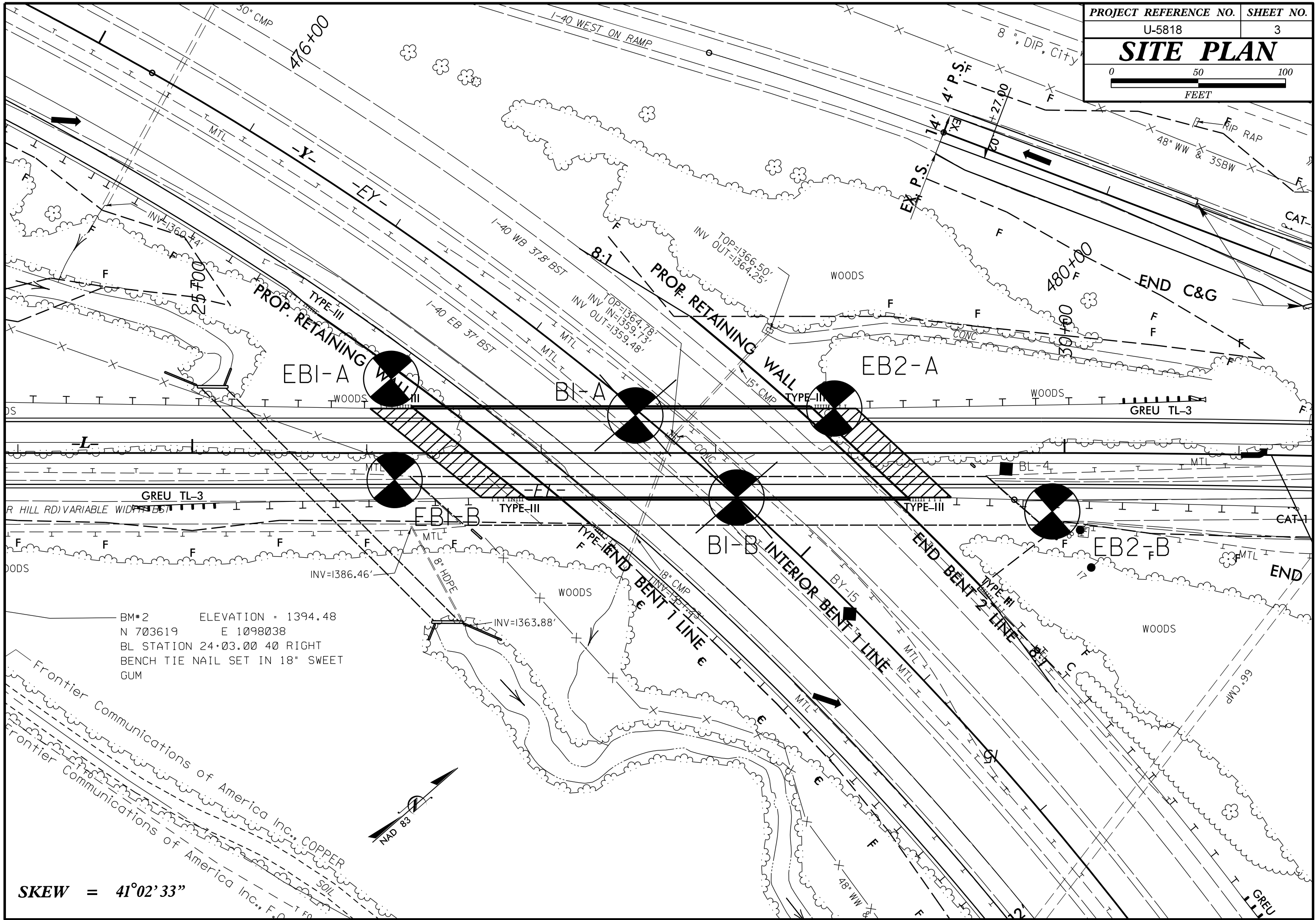
SUPPLEMENTAL LEGEND, GEOLOGICAL STRENGTH INDEX (GSI) TABLES  
FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

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

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

GEOLOGICAL STRENGTH INDEX (GSI) FOR JOINTED ROCKS (Hoek and Marinos, 2000)		SURFACE CONDITIONS					GSI FOR HETEROGENEOUS ROCK MASSES SUCH AS FLYSCH (Marinos, P and Hoek E., 2000)		SURFACE CONDITIONS OF DISCONTINUITIES (Predominantly bedding planes)					
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.		VERY GOOD	GOOD	FAIR	POOR	VERY POOR	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.		VERY GOOD	GOOD	FAIR	POOR	VERY POOR	
STRUCTURE		DECREASING SURFACE QUALITY →					COMPOSITION AND STRUCTURE							
	INTACT OR MASSIVE - intact rock specimens or massive in situ rock with few widely spaced discontinuities	90			N/A	N/A		70						
	BLOCKY - well interlocked undisturbed rock mass consisting of cubical blocks formed by three intersecting discontinuity sets	80					<i>A. Thick bedded, very blocky sandstone</i> 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.	60						
	VERY BLOCKY - interlocked, partially disturbed mass with multi-faceted angular blocks formed by 4 or more joint sets		70						50					
	BLOCKY/DISTURBED/SEAMY - folded with angular blocks formed by many intersecting discontinuity sets. Persistence of bedding planes or schistosity		60							40				
	DISINTEGRATED - poorly interlocked, heavily broken rock mass with mixture of angular and rounded rock pieces			50							30			
	LAMINATED/SHEARED - Lack of blockiness due to close spacing of weak schistosity or shear planes				40							20		
					30		<i>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.</i>						10	
					20									
					10									
		N/A	N/A											
							<i>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.</i>							

→ Means deformation after tectonic disturbance

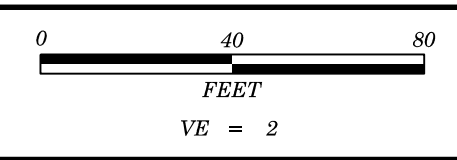


BM\*2 ELEVATION = 1394.48  
 N 703619 E 1098038  
 BL STATION 24+03.00 40 RIGHT  
 BENCH TIE NAIL SET IN 18" SWEET  
 GUM

**SKEW = 41°02'33"**

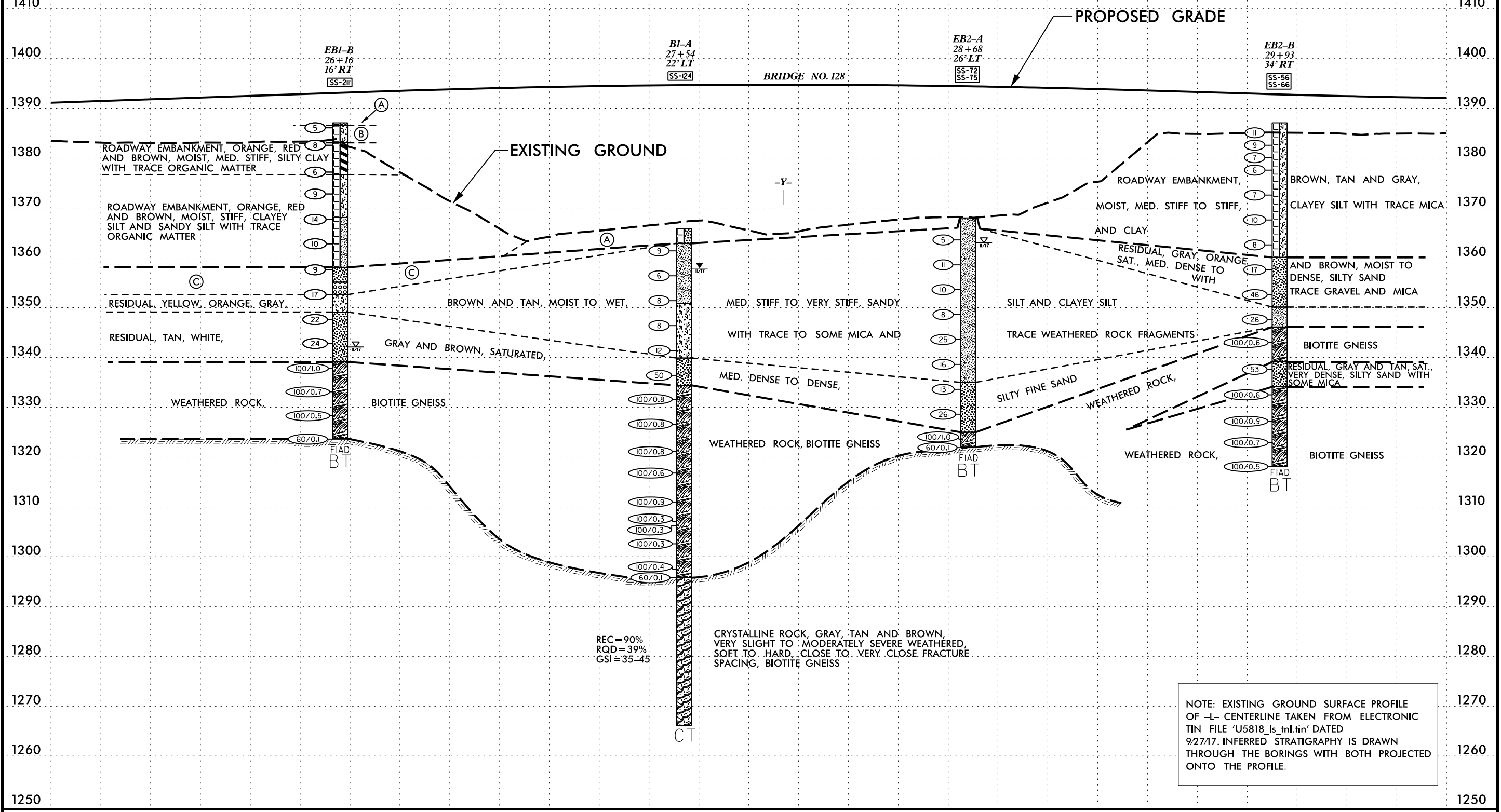
Frontier Communications of America Inc., COPPER  
 Frontier Communications of America Inc., F.O.

5/14/99



<b>PROJECT REFERENCE NO.</b>	<b>SHEET NO.</b>
U-5818	4
<b>PROFILE PROJECTED ALONG -L-</b>	

- (A) ROADWAY EMBANKMENT, GRAY, BROWN AND ORANGE, MOIST, LOOSE, SILTY SAND AND FINE TO COARSE SAND WITH TRACE GRAVEL
- (B) ROADWAY EMBANKMENT, BROWN AND ORANGE, MOIST, MED. STIFF, CLAYEY SILT
- (C) ALLUVIAL, GRAY, GREEN AND BROWN, SILTY FINE SAND AND COARSE SAND WITH TRACE MICA AND SOME GRAVEL



NOTE: EXISTING GROUND SURFACE PROFILE OF -L- CENTERLINE TAKEN FROM ELECTRONIC TIN FILE 'U5818\_ls.tin' DATED 9/27/17. INFERRED STRATIGRAPHY IS DRAWN THROUGH THE BORINGS WITH BOTH PROJECTED ONTO THE PROFILE.

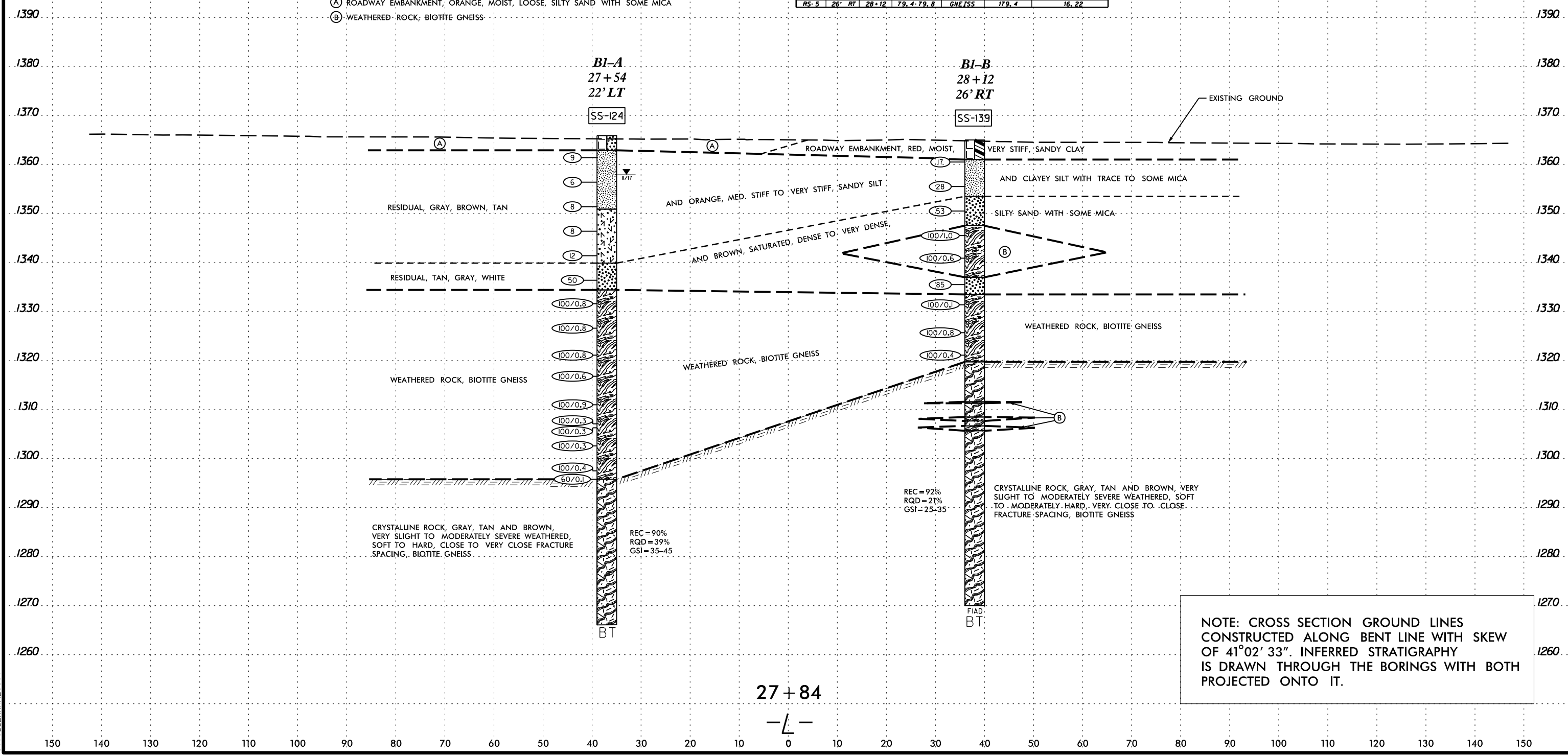


150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

CL

ROCK TEST RESULTS						
SAMPLE NO.	OFFSET	STATION	DEPTH INTERVAL	ROCK TYPE	UNIT WT. LB/FT	UNCONFINED COMP. STRENGTH, KSI
RS-1	22' LT	27+54	80.1-80.5	GNEISS	166.8	9.46
RS-2	22' LT	27+54	88.3-88.7	GNEISS	166.1	25.65
RS-3	26' RT	28+12	51.9-60.3	GNEISS	170.6	4.90
RS-4	26' RT	28+12	67.5-67.9	GNEISS	166.2	5.08
RS-5	26' RT	28+12	79.4-79.8	GNEISS	179.4	16.22

- (A) ROADWAY EMBANKMENT, ORANGE, MOIST, LOOSE, SILTY SAND WITH SOME MICA
- (B) WEATHERED ROCK, BIOTITE GNEISS



NOTE: CROSS SECTION GROUND LINES CONSTRUCTED ALONG BENT LINE WITH SKEW OF 41°02' 33". INFERRED STRATIGRAPHY IS DRAWN THROUGH THE BORINGS WITH BOTH PROJECTED ONTO IT.

27+84  
-L-

150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

6/23/16  
 150  
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 140  
 150





# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 44390.1.1		TIP U-5818		COUNTY McDOWELL		GEOLOGIST Butler, L.										
SITE DESCRIPTION BRIDGE NO. 128 ON SR 1001 (-L-) OVER I-40 (-Y-)							GROUND WTR (ft)									
BORING NO. EB1-A		STATION 26+14		OFFSET 43 ft LT		ALIGNMENT -L-										
COLLAR ELEV. 1,368.1 ft		TOTAL DEPTH 36.8 ft		NORTHING 703,906		EASTING 1,098,123										
DRILL RIG/HAMMER EFF./DATE SME4323 CME-550X 73% 11/16/2017			DRILL METHOD H.S. Augers		HAMMER TYPE Automatic											
DRILLER Contract Driller		START DATE 11/22/17		COMP. DATE 11/22/17		SURFACE WATER DEPTH N/A										
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
1370																
	1,367.1	1.0	2	3	4											
1365	1,364.2	3.9	3	3	5											
	1,362.1	6.0	4	5	6											
1360	1,359.6	8.5	4	4	6											
	1,354.6	13.5	1	1	2											
1355	1,349.5	18.6	53	47/0.3												
1345	1,344.4	23.7	WOH	29	47											
1340	1,339.5	28.6	3	6	9											
1335	1,334.5	33.6	100/0.3													
	1,331.4	36.7	60/0.1													

WBS 44390.1.1		TIP U-5818		COUNTY McDOWELL		GEOLOGIST Butler, L.										
SITE DESCRIPTION BRIDGE NO. 128 ON SR 1001 (-L-) OVER I-40 (-Y-)							GROUND WTR (ft)									
BORING NO. EB1-B		STATION 26+16		OFFSET 16 ft RT		ALIGNMENT -L-										
COLLAR ELEV. 1,387.1 ft		TOTAL DEPTH 63.5 ft		NORTHING 703,869		EASTING 1,098,168										
DRILL RIG/HAMMER EFF./DATE SME4323 CME-550X 73% 11/16/2017			DRILL METHOD H.S. Augers		HAMMER TYPE Automatic											
DRILLER Contract Driller		START DATE 11/14/17		COMP. DATE 11/14/17		SURFACE WATER DEPTH N/A										
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
1390																
	1,387.1	0.0	7	2	3											
1385	1,383.6	3.5	3	3	5											
	1,378.2	8.9	3	2	4											
1380	1,373.8	13.3	2	4	5											
	1,368.7	18.4	3	7	7											
1375	1,363.8	23.3	3	5	5											
1370	1,358.6	28.5	6	4	5											
	1,353.6	33.5	9	12	5											
1365	1,348.6	38.5	8	11	11											
	1,343.8	43.3	5	10	14											
1360	1,338.8	48.3	12	23	77											
	1,333.8	53.3	51	48/0.2												
1355	1,328.8	58.3	100/0.5													
	1,323.7	63.4	60/0.1													

NCDOT BORE DOUBLE 623517016\_GEO\_U5818.GPJ NC\_DOT\_GDT 7/20/18



# GEOTECHNICAL BORING REPORT CORE LOG

<b>WBS</b> 44390.1.1		<b>TIP</b> U-5818		<b>COUNTY</b> McDOWELL		<b>GEOLOGIST</b> Stephenson, M.						
<b>SITE DESCRIPTION</b> BRIDGE NO. 128 ON SR 1001 (-L-) OVER I-40 (-Y-)							<b>GROUND WTR (ft)</b>					
<b>BORING NO.</b> B1-A		<b>STATION</b> 27+54		<b>OFFSET</b> 22 ft LT		<b>ALIGNMENT</b> -L-						
<b>COLLAR ELEV.</b> 1,365.9 ft		<b>TOTAL DEPTH</b> 99.8 ft		<b>NORTHING</b> 703,997		<b>EASTING</b> 1,098,231						
<b>DRILL RIG/HAMMER EFF./DATE</b> SME267 DIEDRICH D-50 74% 10/20/2017				<b>DRILL METHOD</b> H.S. Augers		<b>HAMMER TYPE</b> Automatic						
<b>DRILLER</b> Contract Driller		<b>START DATE</b> 11/27/17		<b>COMP. DATE</b> 11/28/17		<b>SURFACE WATER DEPTH</b> N/A						
<b>CORE SIZE</b> NQ2		<b>TOTAL RUN</b> 29.7 ft										
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN		STRATA		LOG	DESCRIPTION AND REMARKS	DEPTH (ft)	
					REC. (ft) %	RQD (ft) %	REC. (ft) %	RQD (ft) %				
1295.8	1,295.8	70.1	5.0		(2.6) 52%	(0.4) 8%	(26.8) 90%	(11.7) 39%		Begin Coring @ 70.1 ft	70.1	
1290	1,290.8	75.1	5.0		(5.0) 100%	(1.7) 34%				CRYSTALLINE ROCK		
1285	1,285.8	80.1	5.0		(4.7) 94%	(1.1) 22%				Crystalline Rock - Biotite Gneiss: gray, tan and brown, very slight to moderately severe weathered, hard to soft, close to very close fracture spacing, with following joints: 8 at 10°, 24 at 20°, 30 at 30°, 15 at 45°, 7 at 60°, 3 at 70°, and 3 at 80°. GSI = 35 to 45.		
1280	1,280.8	85.1	4.7		(4.7) 100%	(2.2) 47%						
1275	1,276.1	89.8	5.0		(5.0) 100%	(3.3) 66%				RS-1		
1270	1,271.1	94.8	5.0		(4.8) 96%	(3.0) 60%				RS-2		
	1,266.1	99.8									Boring Terminated at Elevation 1,266.1 ft in Crystalline Rock (BIOTITE GNEISS)	99.8
											1. Auger refusal encountered at 59.3 feet below existing grades. Drilling method switched to wash rotary with a casing advancer. 2. Drill rates were not recorded.	

NCDOT CORE DOUBLE 623517016\_GEO\_U5818.GPJ NC\_DOT\_GDT 7/5/18

# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 44390.1.1		TIP U-5818		COUNTY McDOWELL		GEOLOGIST Stephenson, M.	
SITE DESCRIPTION BRIDGE NO. 128 ON SR 1001 (-L-) OVER I-40 (-Y-)							GROUND WTR (ft)
BORING NO. B1-B		STATION 28+12		OFFSET 26 ft RT		ALIGNMENT -L-	
COLLAR ELEV. 1,365.0 ft		TOTAL DEPTH 95.0 ft		NORTHING 704,010		EASTING 1,098,304	
DRILL RIG/HAMMER EFF./DATE SME267 DIEDRICH D-50 74% 10/20/2017			DRILL METHOD H.S. Augers		HAMMER TYPE Automatic		
DRILLER Contract Driller		START DATE 11/29/17		COMP. DATE 12/05/17		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)		
1365															1,365.0	0.0	GROUND SURFACE
																	ROADWAY EMBANKMENT RED, SANDY CLAY (A-6)
1360	1,361.5	3.5	6	7	10												RESIDUAL TAN, SANDY SILT (A-4) WITH TRACE MICA
1355	1,356.5	8.5	6	9	19												BROWN-GRAY, SILTY SAND (A-2-4) WITH SOME MICA
1350	1,351.5	13.5	18	22	31												WEATHERED ROCK GRAY-TAN, BIOTITE GNEISS
1345	1,346.5	18.5	26	74/0.5													RESIDUAL BROWN-GRAY, SILTY SAND (A-2-4) WITH SOME MICA
1340	1,341.5	23.5	75	25/0.1													WEATHERED ROCK BROWN-GRAY-WHITE, BIOTITE GNEISS
1335	1,336.5	28.5	11	27	58												CRYSTALLINE ROCK GRAY, BIOTITE GNEISS
1330	1,331.5	33.5	100/0.1														WEATHERED ROCK GRAY, BIOTITE GNEISS
1325	1,326.5	38.5	65	35/0.3													CRYSTALLINE ROCK GRAY, BIOTITE GNEISS
1320	1,321.5	43.5	100/0.4														WEATHERED ROCK GRAY, BIOTITE GNEISS
1315																	CRYSTALLINE ROCK GRAY, BIOTITE GNEISS
1310																	WEATHERED ROCK GRAY, BIOTITE GNEISS
1305																	CRYSTALLINE ROCK GRAY-BROWN, BIOTITE GNEISS
1300																	WEATHERED ROCK GRAY-BROWN, BIOTITE GNEISS
1295																	CRYSTALLINE ROCK GRAY-BROWN-TAN, BIOTITE GNEISS
1290																	
1285																	

WBS 44390.1.1		TIP U-5818		COUNTY McDOWELL		GEOLOGIST Stephenson, M.	
SITE DESCRIPTION BRIDGE NO. 128 ON SR 1001 (-L-) OVER I-40 (-Y-)							GROUND WTR (ft)
BORING NO. B1-B		STATION 28+12		OFFSET 26 ft RT		ALIGNMENT -L-	
COLLAR ELEV. 1,365.0 ft		TOTAL DEPTH 95.0 ft		NORTHING 704,010		EASTING 1,098,304	
DRILL RIG/HAMMER EFF./DATE SME267 DIEDRICH D-50 74% 10/20/2017			DRILL METHOD H.S. Augers		HAMMER TYPE Automatic		
DRILLER Contract Driller		START DATE 11/29/17		COMP. DATE 12/05/17		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)		
1285																	Match Line
1280																	CRYSTALLINE ROCK GRAY-BROWN-TAN, BIOTITE GNEISS <i>(continued)</i>
1275																	
1270																	Boring Terminated at Elevation 1,270.0 ft in Crystalline Rock (BIOTITE GNEISS)  1. Drill rates were not recorded

NCDOT BORE DOUBLE 623517016\_GEO\_U5818.GPJ\_NC\_DOT\_GDT 7/20/18

# GEOTECHNICAL BORING REPORT CORE LOG

<b>WBS</b> 44390.1.1		<b>TIP</b> U-5818		<b>COUNTY</b> McDOWELL		<b>GEOLOGIST</b> Stephenson, M.					
<b>SITE DESCRIPTION</b> BRIDGE NO. 128 ON SR 1001 (-L-) OVER I-40 (-Y-)							<b>GROUND WTR (ft)</b>				
<b>BORING NO.</b> B1-B		<b>STATION</b> 28+12		<b>OFFSET</b> 26 ft RT		<b>ALIGNMENT</b> -L-					
<b>COLLAR ELEV.</b> 1,365.0 ft		<b>TOTAL DEPTH</b> 95.0 ft		<b>NORTHING</b> 704,010		<b>EASTING</b> 1,098,304					
<b>DRILL RIG/HAMMER EFF./DATE</b> SME267 DIEDRICH D-50 74% 10/20/2017				<b>DRILL METHOD</b> H.S. Augers		<b>HAMMER TYPE</b> Automatic					
<b>DRILLER</b> Contract Driller		<b>START DATE</b> 11/29/17		<b>COMP. DATE</b> 12/05/17		<b>SURFACE WATER DEPTH</b> N/A					
<b>CORE SIZE</b> NQ2		<b>TOTAL RUN</b> 49.7 ft									
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN		STRATA		LOG	DESCRIPTION AND REMARKS	DEPTH (ft)
					REC. (ft) %	RQD (ft) %	REC. (ft) %	RQD (ft) %			
1319.7	1,319.7	45.3	4.7		(4.4) 94%	(0.3) 6%	(7.8) 96%	(0.9) 11%		Begin Coring @ 45.3 ft	45.3
1315	1,315.0	50.0	5.0		(4.5) 90%	(1.1) 22%				Crystalline Rock - Biotite Gneiss: gray, very slight to moderately severe weathered, moderately hard to soft, close to very close fracture, with following joints: 8 at 10°, 13 at 20°, 13 at 30°, 3 at 45°, 2 at 60°, 1 at 70°, and 1 at 80°. GSI = 30 - 35.	
1310	1,310.0	55.0	5.0		(4.5) 90%	(0.3) 6%	(2.4) 86%	(0.5) 18%	RS-3	WEATHERED ROCK Gray, Biotite Gneiss	53.4
1305	1,305.0	60.0	5.0		(4.5) 90%	(0.3) 6%	(1.0) 100%	(0.3) 30%		CRYSTALLINE ROCK Crystalline Rock - Biotite Gneiss: gray, slight to moderately severe weathered, moderately hard to soft, close to very close fracture spacing, with following joints: 2 at 10°, 8 at 20°, 2 at 30°, 2 at 45°, 1 at 70°. GSI = 25 - 35.	56.5
1300	1,300.0	65.0	5.0		(2.3) 46%	(0.0) 0%	(32.7) 92%	(8.1) 23%		WEATHERED ROCK Gray, Biotite Gneiss	57.3
1295	1,295.0	70.0	5.0		(4.8) 96%	(1.5) 30%			RS-4	CRYSTALLINE ROCK Crystalline Rock - Biotite Gneiss: brown and gray, moderately to moderately severe weathered, moderately hard to medium hard, close to very close fracture spacing, with following joints: 1 at 10°, 1 at 20°, 2 at 30°, 1 at 70°, and 1 at 80°. GSI = 20 - 30.	58.3
1290	1,290.0	75.0	5.0		(4.9) 98%	(1.1) 22%				WEATHERED ROCK Gray-Brown, Biotite Gneiss	59.3
1285	1,285.0	80.0	5.0		(5.0) 100%	(2.3) 46%			RS-5	CRYSTALLINE ROCK Crystalline Rock - Biotite Gneiss: gray, tan and brown, moderately hard to soft, very slight to moderately severe weathered, close to very close fracture spacing, with following joints: 54 at 10°, 80 at 20°, 36 at 30°, 19 at 45°, 8 at 60°, 5 at 70°, and 8 at 80°. GSI = 25 to 35.	
1280	1,280.0	85.0	5.0		(5.0) 100%	(0.8) 16%					
1275	1,275.0	90.0	5.0		(5.0) 100%	(0.4) 8%					
1270	1,270.0	95.0	5.0		(5.0) 100%	(2.0) 40%					
Boring Terminated at Elevation 1,270.0 ft in Crystalline Rock (BIOTITE GNEISS)											95.0
1. Drill rates were not recorded											

NCDOT CORE DOUBLE 623517016\_GEO\_U5818.GPJ NC\_DOT\_GDT 7/20/18









**UNCONFINED COMPRESSION  
(ASTM D7012 Method C)**

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project Name: Sugar Hill Road  
Project Number: 6235-17-016, Phase 01

Report Date: January 23, 2018  
Reviewed By: Jason B. Burgess

Sample No.	Sample Id	Depth (ft)	Dimensions, in.		Shape (See Key)	Area (in <sup>2</sup> )	Unit Weight (lbs/ft <sup>3</sup> )	Loading Rate (psi/sec)	Maximum Load (lbs)	Strength (psi)	Moisture (%)
			Length	Diameter							
RS-1	B1-A	80.1	4.38	1.97	A	3.05	166.8	48	28,840	9,456	0.2
RS-2	B1-A	88.3	4.38	1.98	A	3.08	166.1	87	79,010	25,653	0.1
RS-3	B1-B	53.9	4.20	1.97	D	3.05	170.6	62	14,948	4,901	0.2
RS-4	B1-B	67.5	4.39	1.97	C	3.05	166.2	39	15,495	5,080	0.2
RS-5	B1-B	79.4	4.46	1.98	E	3.08	179.4	88	49,950	16,218	0.1

NOTES: Effective (as received) unit weight as determined by RTH 109-93.  
Loading rates were selected to target reaching failure between 2 and 15 minutes.  
Test results for specimens not meeting the requirements of ASTM D4543 may differ from a test specimen that meets the requirements of ASTM D4543.

SHAPE KEY

ASTM D4543-08 *Standard Practice for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerance* Section 1.2 - "Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content and chemistry, and other natural geologic processes. As such, it is not always possible to obtain or prepare rock core specimens that satisfy the desirable tolerances given in this practice. Most commonly, this situation presents itself with weaker, more porous, and poorly cemented rock types and rock types containing significant or weak (or both) structural features. For these and other rock types which are difficult to prepare, all reasonable efforts shall be made to prepare a specimen in accordance with this practice and for the intended test procedure. However, when it has been determined by trial that this is not possible, prepare the rock specimen to the closest tolerances practicable and consider this to be the best effort and report it as such and if allowable or necessary for the intended test, capping the ends of the specimen as discussed in this practice is permitted."

- A Test specimen measurements met the desired shape tolerances of ASTM D4543-08 (side straightness, end flatness & parallelism, and end perpendicularity to axis)
- B Test specimen measurements met the desired shape tolerances of ASTM D4543-08 for end flatness & parallelism, and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness. Specimen prepared to closest tolerances practicable.
- C Test specimen measurements met the desired shape tolerances of ASTM D4543-08 for end flatness & parallelism. Specimen did not meet the desired tolerances for side straightness and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.
- D Test specimen measurements met the desired shape tolerances of ASTM D4543-08 for end flatness. Specimen did not meet the desired tolerances for side straightness, parallelism and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.
- E Test specimen measurements met the desired shape tolerances of ASTM D4543-08 for end flatness and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness and parallelism. Specimen prepared to closest tolerances practicable.

UNCONFINED COMPRESSION WITH YOUNG'S MODULUS AND POISSON'S RATIO  
(ASTM D7012 Method C and D)



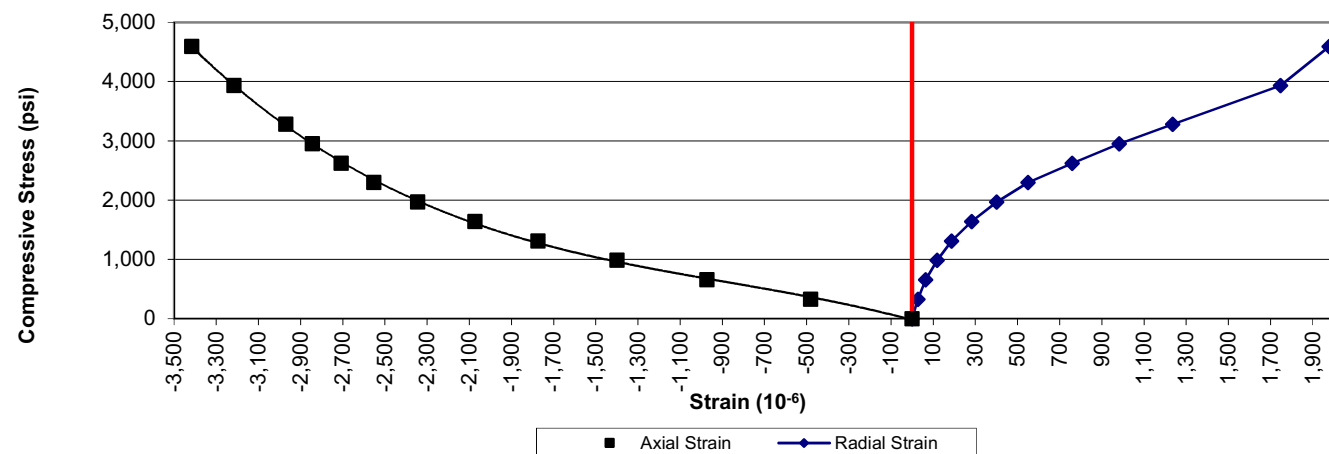
1413 Topside Road, Louisville, TN 37777

Project:	Sugar Hill Road	Diameter, in.:	1.97	Date:	1/22/2018
Project No.:	6235-17-016, Phase 01	Length, in.:	4.39	Tested by:	BKP / RCR
Boring Id:	B1-B	Unit Weight, pcf:	166.2	Reviewed by:	JBB
Sample No:	N/A	Moisture Content, %:	0.2		
Depth (ft):	67.5	Load Rate, psi/sec:	39		

Data Point	Strain (10 <sup>-6</sup> )		Load (lb)	Compressive Stress (psi)	Secant Modulus x 10 <sup>6</sup> (psi)	Poisson's Ratio	Remarks Failure
	axial	radial					
1	0	0	0	0	0.00	0.00	
2	-480	27	1,000	328	0.68	0.06	
3	-973	64	2,000	656	0.67	0.07	
4	-1,399	119	3,000	984	0.70	0.09	
5	-1,774	187	4,000	1,311	0.74	0.11	
6	-2,073	283	5,000	1,639	0.79	0.14	
7	-2,344	401	6,000	1,967	0.84	0.17	
8	-2,552	550	7,000	2,295	0.90	0.22	
9	-2,707	759	8,000	2,623	0.97	0.28	
10	-2,843	983	9,000	2,951	1.04	0.35	
11	-2,969	1,235	10,000	3,279	1.10	0.42	
12	-3,215	1,747	12,000	3,934	1.22	0.54	
13	-3,415	1,978	14,000	4,590	1.34	0.58	
14			15,495	5,080			Failure

Comments: Loading rate was selected to target reaching failure between 2 and 15 minutes. Test specimen measurements met the desired shape tolerances of ASTM D4543-08 for end flatness & parallelism. Specimen did not meet the desired tolerances for side straightness and end perpendicularity to axis. Specimen prepared to closest tolerances practicable. Test results for specimens not meeting the requirements of ASTM D4543 may differ from a test specimen that meets the requirements of ASTM D4543.

Stress vs. Strain



UNCONFINED COMPRESSION WITH YOUNG'S MODULUS AND POISSON'S RATIO  
(ASTM D7012 Method C and D)



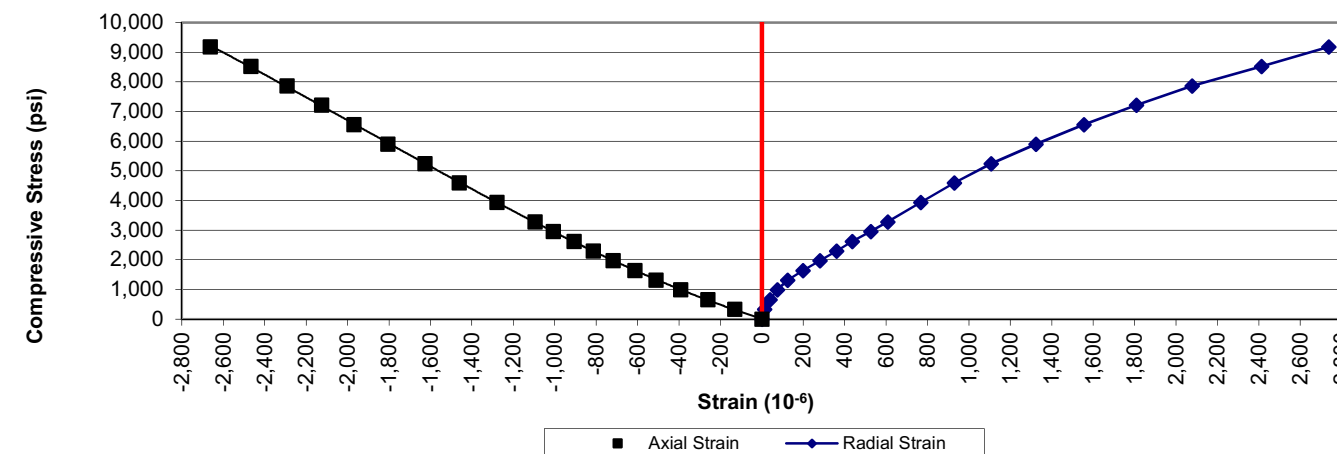
1413 Topside Road, Louisville, TN 37777

Project:	Sugar Hill Road	Diameter, in.:	1.97	Date:	1/22/2018
Project No.:	6235-17-016, Phase 01	Length, in.:	4.38	Tested by:	BKP / RCR
Boring Id:	B1-A	Unit Weight, pcf:	166.8	Reviewed by:	JBB
Sample No:	N/A	Moisture Content, %:	0.2		
Depth (ft):	80.1	Load Rate, psi/sec:	48		

Data Point	Strain (10 <sup>-6</sup> )		Load (lb)	Compressive Stress (psi)	Secant Modulus x 10 <sup>6</sup> (psi)	Poisson's Ratio	Remarks Failure
	axial	radial					
1	0	0	0	0	0.00	0.00	
2	-130	13	1,000	328	2.52	0.10	
3	-260	39	2,000	656	2.52	0.15	
4	-392	75	3,000	984	2.51	0.19	
5	-511	125	4,000	1,311	2.57	0.24	
6	-613	198	5,000	1,639	2.67	0.32	
7	-717	280	6,000	1,967	2.74	0.39	
8	-813	361	7,000	2,295	2.82	0.44	
9	-906	437	8,000	2,623	2.90	0.48	
10	-1,006	526	9,000	2,951	2.93	0.52	
11	-1,095	608	10,000	3,279	2.99	0.56	
12	-1,278	767	12,000	3,934	3.08	0.60	
13	-1,461	930	14,000	4,590	3.14	0.64	
14	-1,626	1,107	16,000	5,246	3.23	0.68	
15	-1,806	1,323	18,000	5,902	3.27	0.73	
16	-1,970	1,555	20,000	6,557	3.33	0.79	
17	-2,126	1,808	22,000	7,213	3.39	0.85	
18	-2,292	2,077	24,000	7,869	3.43	0.91	
19	-2,467	2,413	26,000	8,525	3.46	0.98	
20	-2,663	2,737	28,000	9,180	3.45	1.03	
21			28,840	9,456			Failure

Comments: Loading rate was selected to target reaching failure between 2 and 15 minutes.

Stress vs. Strain



PREPARING ROCK CORES AS CYLINDRICAL TEST SPECIMENS AND VERIFY CONFORMANCE OF DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)



1413 Topside Road, Louisville, TN 37777

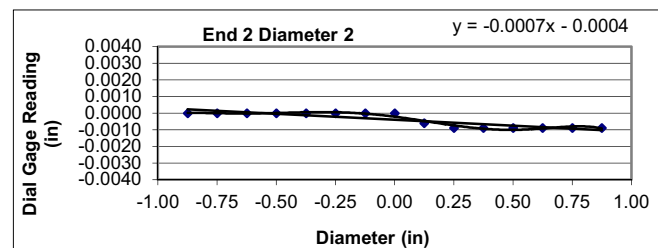
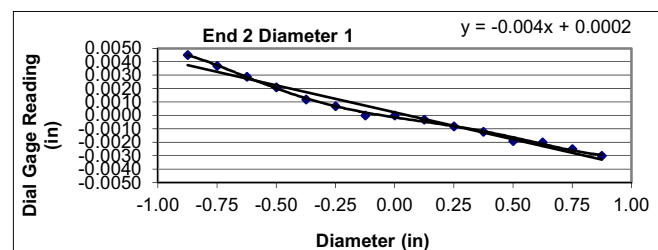
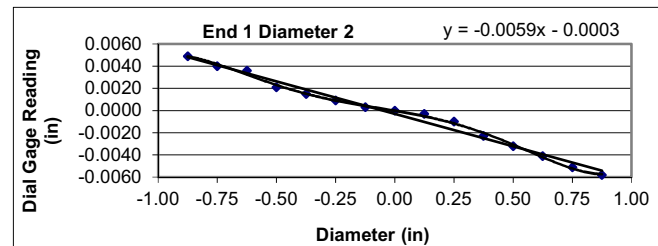
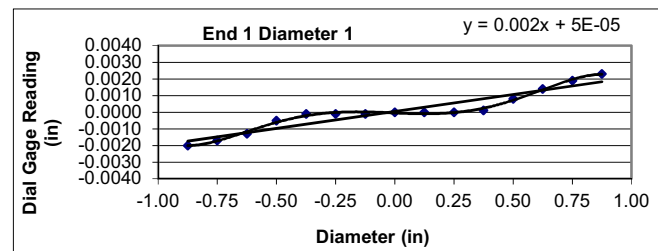
<b>Project:</b> Sugar Hill Road	<b>Diameter (in):</b> 1.97	<b>Date:</b> 1/18/2018
<b>Project No.:</b> 6235-17-016, Phase 01	<b>Length (in):</b> 4.20	<b>Tested by:</b> BKP
<b>Boring Id:</b> B1-B	<b>Unit Weight (pcf):</b> 170.6	<b>Reviewed by:</b> JBB
<b>Sample No.:</b> N/A	<b>Moisture Content (%):</b> 0.2	
<b>Depth (ft):</b> 53.9		

Deviation From Straightness (Procedure S1)

Is the maximum gap  $\leq 0.02$  in.? NO Straightness Tolerance Met? NO

End Flatness and Parallelism Readings (Procedure FP1)

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	-0.0020	0.0049	0.0045	0.0000
- 6/8	-0.0017	0.0040	0.0037	0.0000
- 5/8	-0.0013	0.0036	0.0029	0.0000
- 4/8	-0.0005	0.0021	0.0021	0.0000
- 3/8	-0.0001	0.0015	0.0012	0.0000
- 2/8	-0.0001	0.0009	0.0007	0.0000
- 1/8	-0.0001	0.0003	0.0000	0.0000
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	-0.0003	-0.0003	-0.0006
2/8	0.0000	-0.0010	-0.0008	-0.0009
3/8	0.0001	-0.0023	-0.0012	-0.0009
4/8	0.0008	-0.0032	-0.0019	-0.0009
5/8	0.0014	-0.0041	-0.0020	-0.0009
6/8	0.0019	-0.0051	-0.0025	-0.0009
7/8	0.0023	-0.0058	-0.0030	-0.0009



Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is  $\leq 0.001$  in.

Flatness Tolerance Met? YES

Parallelism is met when the angular difference between best fit lines on opposing ends is  $\leq 0.25^\circ$ .

Parallelism Diameter 1

End 1:	Slope of Best Fit Line:	0.00204
	Angle of Best Fit Line:	0.11672
End 2:	Slope of Best Fit Line:	-0.00402
	Angle of Best Fit Line:	-0.23033
	Max Angular Difference:	<b>0.35</b>

Parallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00586
	Angle of Best Fit Line:	-0.33559
End 2:	Slope of Best Fit Line:	-0.00071
	Angle of Best Fit Line:	-0.04076
	Max Angular Difference:	<b>-0.29</b>

Parallelism Tolerance Met? NO

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is  $\leq 0.0043$ .

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0043	0.0022	<b>YES</b>
End 1 Diam 2	0.0107	0.0054	<b>NO</b>
End 2 Diam 1	0.0075	0.0038	<b>YES</b>
End 2 Diam 2	0.0009	0.0005	<b>YES</b>

Perpendicularity Tolerance Met? NO

PREPARING ROCK CORES AS CYLINDRICAL TEST SPECIMENS AND VERIFY CONFORMANCE OF DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)



1413 Topside Road, Louisville, TN 37777

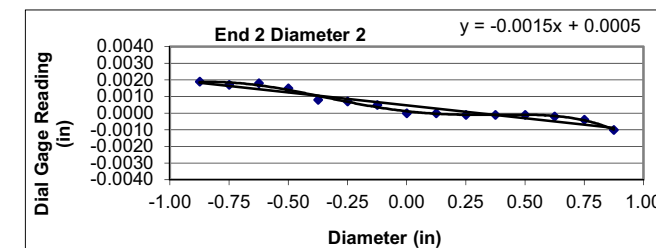
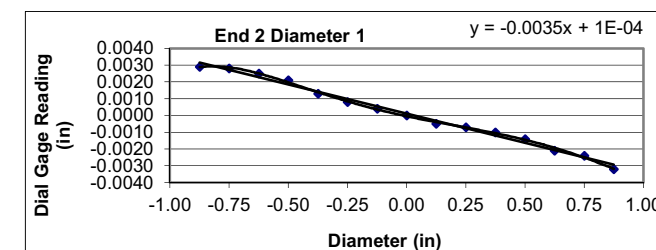
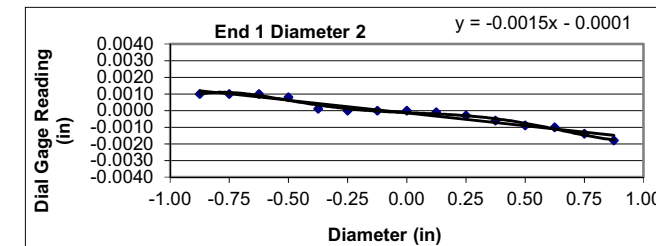
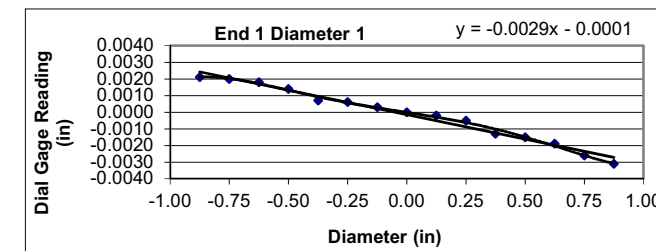
<b>Project:</b> Sugar Hill Road	<b>Diameter (in):</b> 1.98	<b>Date:</b> 1/18/2018
<b>Project No.:</b> 6235-17-016, Phase 01	<b>Length (in):</b> 4.38	<b>Tested by:</b> BKP
<b>Boring Id:</b> B1-A	<b>Unit Weight (pcf):</b> 166.1	<b>Reviewed by:</b> JBB
<b>Sample No.:</b> N/A	<b>Moisture Content (%):</b> 0.1	
<b>Depth (ft):</b> 88.3		

Deviation From Straightness (Procedure S1)

Is the maximum gap  $\leq 0.02$  in.? YES Straightness Tolerance Met? YES

End Flatness and Parallelism Readings (Procedure FP1)

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0021	0.0010	0.0029	0.0019
- 6/8	0.0020	0.0010	0.0028	0.0017
- 5/8	0.0018	0.0010	0.0025	0.0018
- 4/8	0.0014	0.0008	0.0021	0.0015
- 3/8	0.0007	0.0001	0.0013	0.0008
- 2/8	0.0006	0.0000	0.0008	0.0007
- 1/8	0.0003	0.0000	0.0004	0.0005
0	0.0000	0.0000	0.0000	0.0000
1/8	-0.0002	-0.0001	-0.0005	0.0000
2/8	-0.0005	-0.0003	-0.0007	-0.0001
3/8	-0.0013	-0.0006	-0.0010	-0.0001
4/8	-0.0015	-0.0009	-0.0014	-0.0001
5/8	-0.0019	-0.0010	-0.0021	-0.0002
6/8	-0.0026	-0.0014	-0.0024	-0.0004
7/8	-0.0031	-0.0018	-0.0032	-0.0010



Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is  $\leq 0.001$  in.

Flatness Tolerance Met? YES

Parallelism is met when the angular difference between best fit lines on opposing ends is  $\leq 0.25^\circ$ .

Parallelism Diameter 1

End 1:	Slope of Best Fit Line:	-0.00294
	Angle of Best Fit Line:	-0.16829
End 2:	Slope of Best Fit Line:	-0.00348
	Angle of Best Fit Line:	-0.19923
	Max Angular Difference:	<b>0.03</b>

Parallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00153
	Angle of Best Fit Line:	-0.08774
End 2:	Slope of Best Fit Line:	-0.00155
	Angle of Best Fit Line:	-0.08856
	Max Angular Difference:	<b>0.00</b>

Parallelism Tolerance Met? YES

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is  $\leq 0.0043$ .

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0052	0.0026	<b>YES</b>
End 1 Diam 2	0.0028	0.0014	<b>YES</b>
End 2 Diam 1	0.0061	0.0031	<b>YES</b>
End 2 Diam 2	0.0029	0.0015	<b>YES</b>

Perpendicularity Tolerance Met? YES

**PREPARING ROCK CORES AS CYLINDRICAL TEST SPECIMENS AND VERIFY CONFORMANCE OF DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)**



1413 Topside Road, Louisville, TN 37777

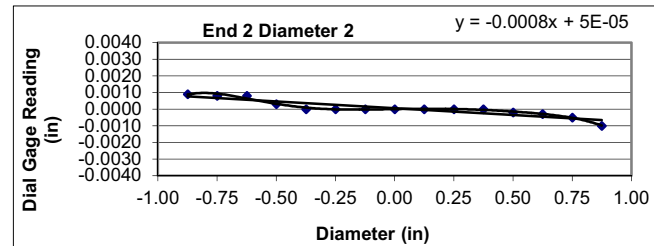
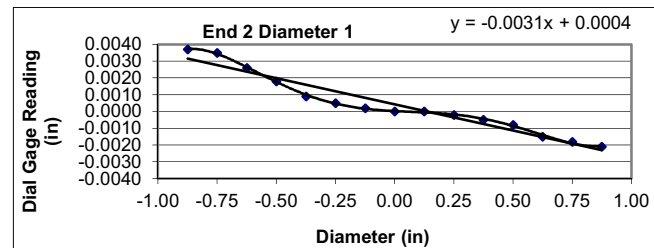
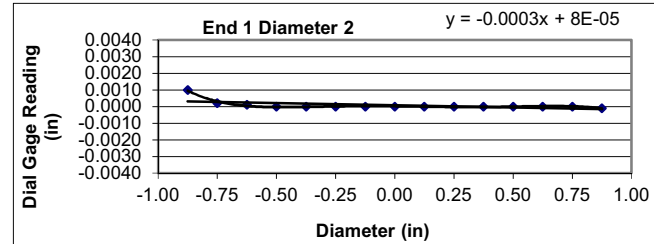
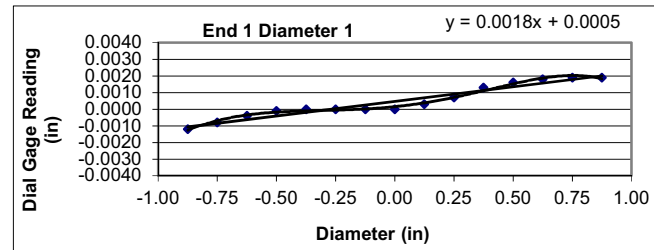
<b>Project:</b> Sugar Hill Road	<b>Diameter (in):</b> 1.98	<b>Date:</b> 1/18/2018
<b>Project No.:</b> 6235-17-016, Phase 01	<b>Length (in):</b> 4.46	<b>Tested by:</b> BKP
<b>Boring Id:</b> B1-B	<b>Unit Weight (pcf):</b> 179.4	<b>Reviewed by:</b> JBB
<b>Sample No.:</b> N/A	<b>Moisture Content (%):</b> 0.1	
<b>Depth (ft):</b> 79.4		

**Deviation From Straightness (Procedure S1)**

Is the maximum gap  $\leq 0.02$  in.? NO Straightness Tolerance Met? NO

**End Flatness and Parallelism Readings (Procedure FP1)**

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	-0.0012	0.0010	0.0037	0.0009
- 6/8	-0.0008	0.0002	0.0035	0.0008
- 5/8	-0.0004	0.0001	0.0026	0.0008
- 4/8	-0.0001	0.0000	0.0018	0.0003
- 3/8	0.0000	0.0000	0.0009	0.0000
- 2/8	0.0000	0.0000	0.0005	0.0000
- 1/8	0.0000	0.0000	0.0002	0.0000
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0003	0.0000	0.0000	0.0000
2/8	0.0007	0.0000	-0.0002	0.0000
3/8	0.0013	0.0000	-0.0005	0.0000
4/8	0.0016	0.0000	-0.0008	-0.0002
5/8	0.0018	0.0000	-0.0015	-0.0003
6/8	0.0019	0.0000	-0.0018	-0.0005
7/8	0.0019	-0.0001	-0.0021	-0.0010



Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is  $\leq 0.001$  in.

Flatness Tolerance Met? YES

Parallelism is met when the angular difference between best fit lines on opposing ends is  $\leq 0.25^\circ$ .

**Parallelism Diameter 1**

End 1:	Slope of Best Fit Line:	0.00175
	Angle of Best Fit Line:	0.10035
End 2:	Slope of Best Fit Line:	-0.00312
	Angle of Best Fit Line:	-0.17860
	Max Angular Difference:	<b>0.28</b>

**Parallelism Diameter 2**

End 1:	Slope of Best Fit Line:	-0.00027
	Angle of Best Fit Line:	-0.01539
End 2:	Slope of Best Fit Line:	-0.00082
	Angle of Best Fit Line:	-0.04682
	Max Angular Difference:	<b>0.03</b>

Parallelism Tolerance Met? NO

**Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is  $\leq 0.0043$ .**

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0031	0.0016	<b>YES</b>
End 1 Diam 2	0.0011	0.0006	<b>YES</b>
End 2 Diam 1	0.0058	0.0029	<b>YES</b>
End 2 Diam 2	0.0019	0.0010	<b>YES</b>

Perpendicularity Tolerance Met? YES

**PREPARING ROCK CORES AS CYLINDRICAL TEST SPECIMENS AND VERIFY CONFORMANCE OF DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)**



1413 Topside Road, Louisville, TN 37777

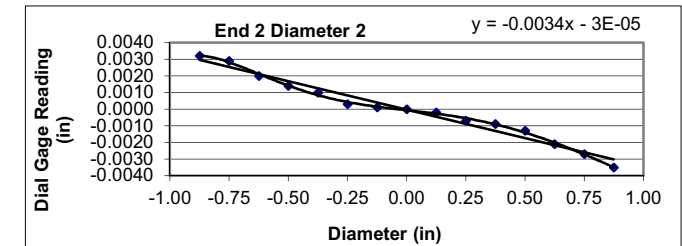
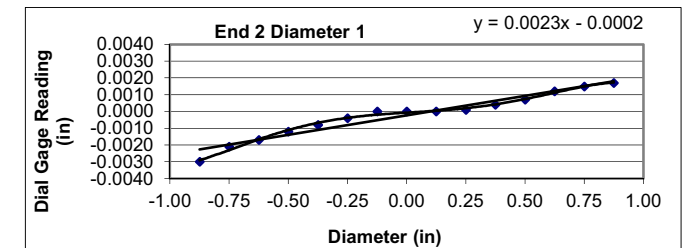
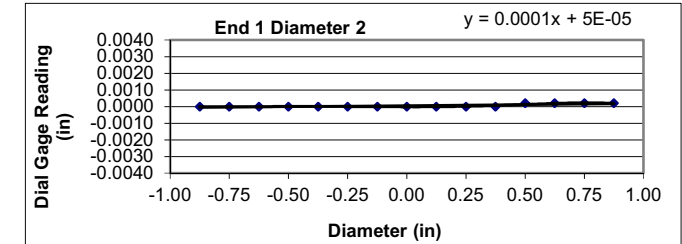
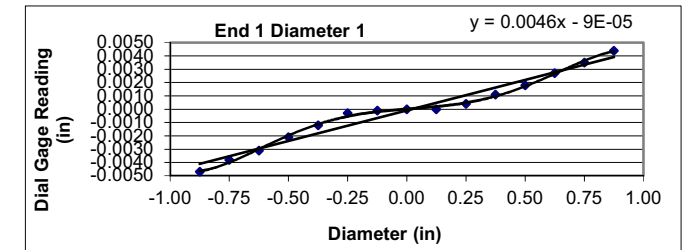
<b>Project:</b> Sugar Hill Road	<b>Diameter (in):</b> 1.97	<b>Date:</b> 1/18/2018
<b>Project No.:</b> 6235-17-016, Phase 01	<b>Length (in):</b> 4.39	<b>Tested by:</b> BKP
<b>Boring Id:</b> B1-B	<b>Unit Weight (pcf):</b> 166.2	<b>Reviewed by:</b> JBB
<b>Sample No.:</b> N/A	<b>Moisture Content (%):</b> 0.2	
<b>Depth (ft):</b> 67.5		

**Deviation From Straightness (Procedure S1)**

Is the maximum gap  $\leq 0.02$  in.? NO Straightness Tolerance Met? NO

**End Flatness and Parallelism Readings (Procedure FP1)**

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	-0.0047	0.0000	-0.0030	0.0032
- 6/8	-0.0038	0.0000	-0.0021	0.0029
- 5/8	-0.0031	0.0000	-0.0017	0.0020
- 4/8	-0.0021	0.0000	-0.0012	0.0014
- 3/8	-0.0012	0.0000	-0.0008	0.0010
- 2/8	-0.0003	0.0000	-0.0004	0.0003
- 1/8	-0.0001	0.0000	0.0000	0.0001
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	0.0000	0.0000	-0.0002
2/8	0.0004	0.0000	0.0001	-0.0007
3/8	0.0011	0.0000	0.0004	-0.0009
4/8	0.0018	0.0002	0.0007	-0.0013
5/8	0.0027	0.0002	0.0012	-0.0021
6/8	0.0035	0.0002	0.0015	-0.0027
7/8	0.0044	0.0002	0.0017	-0.0035



Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is  $\leq 0.001$  in.

Flatness Tolerance Met? YES

Parallelism is met when the angular difference between best fit lines on opposing ends is  $\leq 0.25^\circ$ .

**Parallelism Diameter 1**

End 1:	Slope of Best Fit Line:	0.00459
	Angle of Best Fit Line:	0.26274
End 2:	Slope of Best Fit Line:	0.00232
	Angle of Best Fit Line:	0.13293
	Max Angular Difference:	<b>0.13</b>

**Parallelism Diameter 2**

End 1:	Slope of Best Fit Line:	0.00013
	Angle of Best Fit Line:	0.00720
End 2:	Slope of Best Fit Line:	-0.00342
	Angle of Best Fit Line:	-0.19612
	Max Angular Difference:	<b>0.20</b>

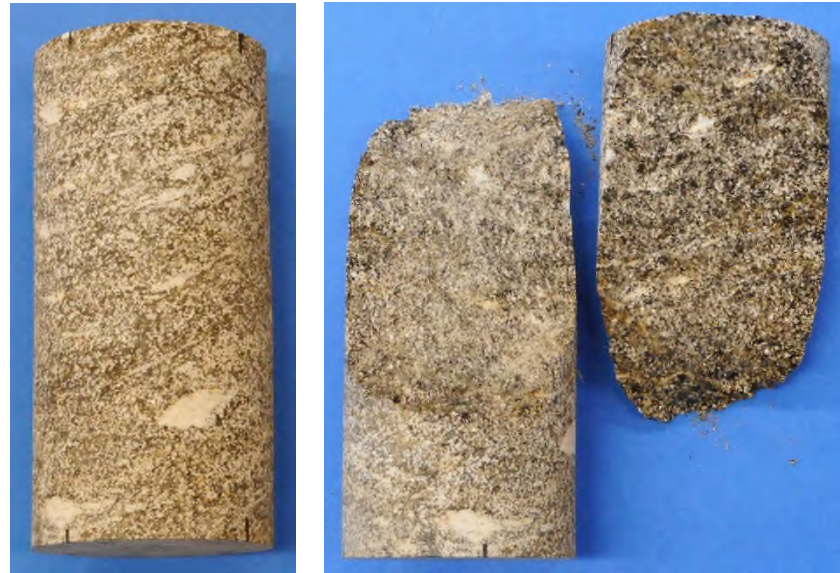
Parallelism Tolerance Met? YES

**Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is  $\leq 0.0043$ .**

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0091	0.0046	<b>NO</b>
End 1 Diam 2	0.0002	0.0001	<b>YES</b>
End 2 Diam 1	0.0047	0.0024	<b>YES</b>
End 2 Diam 2	0.0067	0.0034	<b>YES</b>

Perpendicularity Tolerance Met? NO

<b>3</b>	<b>Location / Orientation</b>	B1-B (53.9')
	<b>Remarks</b>	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)



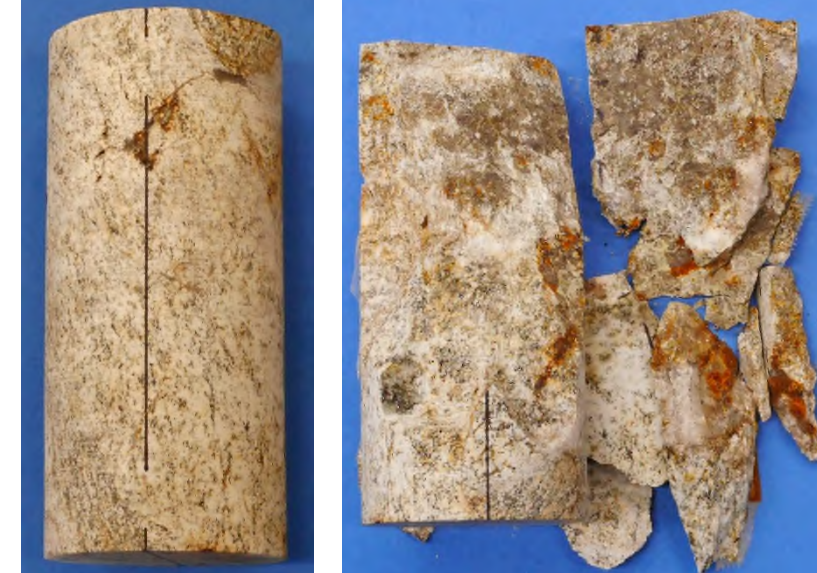
Date: 1/22/2018  
Photographer: Ben Painter

<b>4</b>	<b>Location / Orientation</b>	B1-B (67.5')
	<b>Remarks</b>	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)



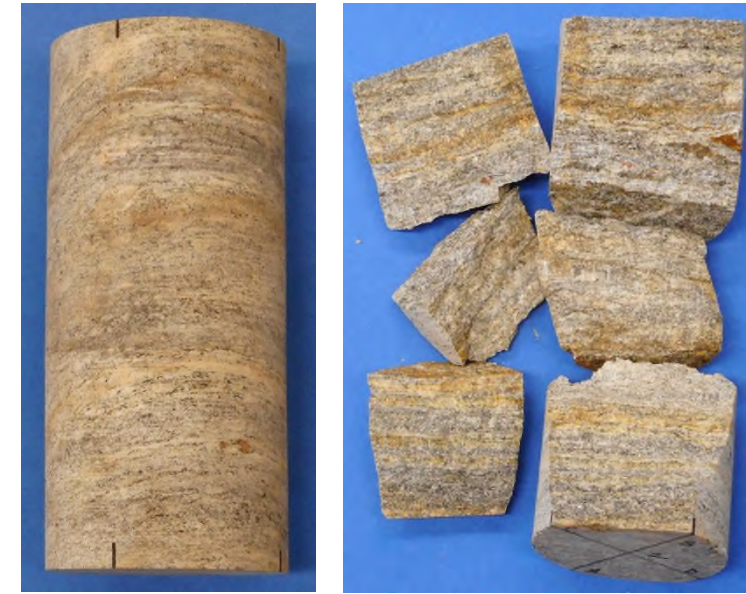
Date: 1/22/2018  
Photographer: Ben Painter

<b>1</b>	<b>Location / Orientation</b>	B1-A (80.1')
	<b>Remarks</b>	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)



Date: 1/22/2018  
Photographer: Ben Painter

<b>2</b>	<b>Location / Orientation</b>	B1-A (88.3')
	<b>Remarks</b>	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)



Date: 1/22/2018  
Photographer: Ben Painter

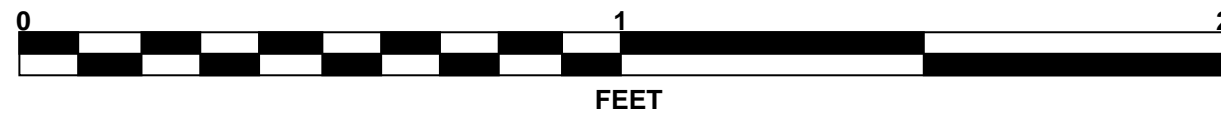


<b>5</b>	<b>Location / Orientation</b>	B1-B (79.4')	Photographer: Ben Painter	Date: 1/22/2018
	<b>Remarks</b>	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)		

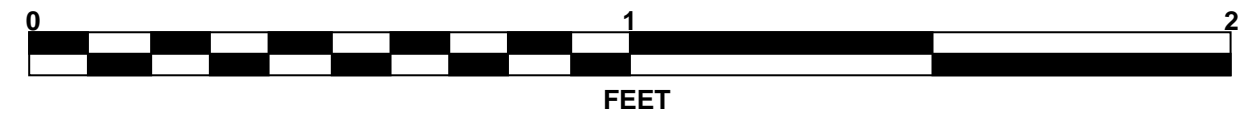


# CORE PHOTOGRAPHS

**B1-A**  
BOXES 1 & 2: 70.1 - 89.8 FEET



**B1-A**  
BOXES 3 & 4: 89.8 - 99.8 FEET

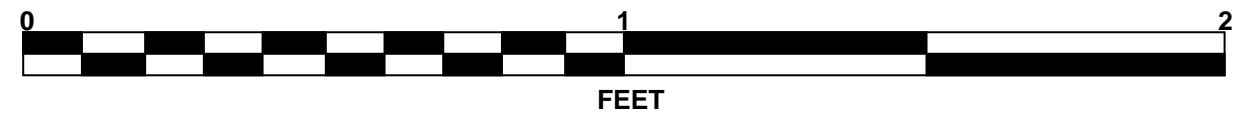
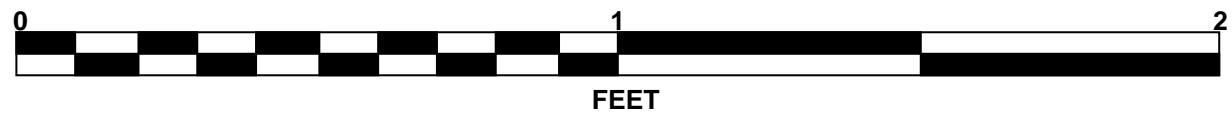


# CORE PHOTOGRAPHS

**B1-B**  
BOXES 1 & 2: 45.3 - 65.0 FEET



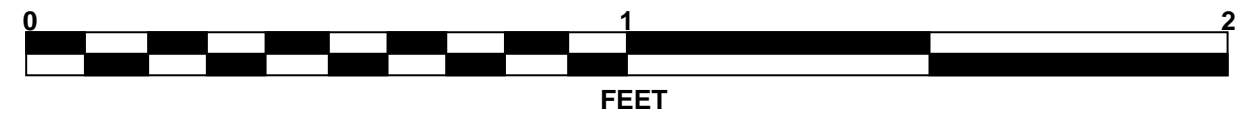
**B1-B**  
BOXES 3 & 4: 65.0 - 83.0 FEET





# CORE PHOTOGRAPHS

**B1-B**  
BOXES 5 & 6: 83.0 - 95.0 FEET



# SITE PHOTOGRAPH

Bridge No. 128 on -L- (SR 1001) over -Y- (I-95)



Looking Northeast towards End Bent 2