

REVISED

GEOTECHNICAL BASE LINE REPORT

Route S-41-211 Replacement Bridge over Richland Creek
Saluda County, South Carolina



PREPARED FOR

SCDOT

955 Park Street

Columbia, South Carolina 29201

PREPARED BY

F&ME Consultants, Inc.

1825 Blanding Street

Columbia, South Carolina 29201

SCDOT Project ID: P038305

F&ME Project #: G6100.05.13

October 23, 2019

October 23, 2019

Trapp Harris, P.E.
Design-Build Group Geotechnical Engineer
South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29201

Re: Closed and Load-Restricted Bridge Package 2020-1
REVISED Geotechnical Base Line Report
Route S-41-211 Bridge over Richland Creek
Saluda County, South Carolina
SCDOT Project ID: P038305
F&ME Project No.: G6100.050.13

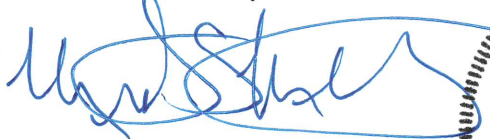
Dear Mr. Harris:

Submitted herein is F&ME Consultants, Inc. (FME) revised Geotechnical Base Line Report (GBLR) for the Route S-41-211 Replacement Bridge over Richland Creek. Revisions to our previously submitted report include the corrosion series laboratory test results. This report contains findings from our subsurface field exploration, results from the laboratory testing program, and conceptual geotechnical assessment of embankments and bridge foundation systems.

It has been a pleasure working with you on this project and we appreciate the opportunity to be of service. Please notify us if there are any questions or if we may be of further assistance.

Sincerely,

F&ME Consultants, Inc.

A handwritten signature in blue ink, appearing to read 'Michael S. Miller', written over a circular professional engineer seal.

Michael S. Miller, P.E.
Senior Geotechnical Engineer



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1.0 INTRODUCTION

FME performed geotechnical soil test borings and laboratory testing for the Route S-41-211 Replacement Bridge over Richland Creek located in Saluda County, South Carolina. A Site Location Plan is presented as Figure 1 in Section 1 in the Appendix of this report. The South Carolina Department of Transportation (SCDOT) Scope of Services Work Request for the geotechnical subsurface exploration and laboratory testing was issued on March 1, 2019.

The field investigation consisted of performing soil test borings (STB's) with associated Standard Penetration Testing (SPT) and rock core sampling. Laboratory testing was performed on selected soil and rock core samples collected from the test borings. The exploration methods and laboratory procedures were conducted in general accordance with the current American Association of State Highway and Transportation Officials (AASHTO), American Society of Testing and Materials (ASTM) Standards, and the SCDOT Geotechnical Design Manual (GDM). This Geotechnical Base Line Report was prepared in general accordance with the 2019 SCDOT Geotechnical Design Manual (GDM), Version 2.0. along with PCDM-11 Supplemental Design Criteria for Low Volume Bridge Replacement Projects.

2.0 FIELD EXPLORATION SUMMARY

On July 9 and 10, 2019, F&ME performed two (2) soil test borings (STB's). The test boring locations were performed in proximity to the existing bridge end bent locations. The intent of the subsurface investigation was to provide a broad indication of the subsurface conditions at the site.

The STB's were advanced using a CME 45B trailer mounted drill rig with an automatic standard penetration test (SPT) hammer system. Rotary wash drilling techniques were used during drilling to maintain a stable borehole. Standard split-spoon sampling was performed continuously over the first ten (10) feet of the boring depth and at five (5) foot intervals thereafter. Soil test borings were advanced to a drilling refusal condition and subsequently advanced into rock using NQ rock coring techniques. Details of each STB are included on the individual Soil Test Boring Logs in Section 4 in the Appendix of this report.

2.1 Soil Test Borings (STB's)

The following table is a summary of the STB designations, exploration depths, locations, and ground surface elevations of the test boring locations.

Table 1 – Soil Test Boring Summary Table

SOIL TEST BORINGS (STB)							
Test Hole No.	Surface Condition	Soil Depth (ft.)	Rock Core Depth (ft.)	Total Boring Depth (ft.)	Latitude	Longitude	Elev. (ft.-MSL)
B-1301	Paved Roadway	18.5	10.5	29.0	33.950049	-81.706330	467.3
B-1302	Roadway Shoulder	13.5	12.8	26.3	33.950044	-81.706512	468.9
Totals	-	32.0	23.3	55.3			

2.2 Groundwater

Groundwater depths were recorded at the time of boring (TOB) for soil test borings B-1301 and B-1302, with the recorded measurements noted on the individual Soil Test Boring Logs in Section 4 of the Appendix to this report. Groundwater measurements were also made twenty-four (24) hours following boring completion. The following table is a summary of the groundwater measurements for the soil test borings at time of boring and at twenty-four (24) hours following boring completion.

Table 2 – Groundwater Depth Summary Table

GROUNDWATER DEPTH			
Boring No.	Date of TOB Groundwater Measurement	TOB Groundwater Depth (ft.)	24-hr. Groundwater Depth (ft.)
B-1301	7/9/2019	8.3	10.2
B-1302	7/10/2019	8.1	10.1

3.0 LABORATORY TESTING

Following completion of F&ME's field investigation, select split-spoon samples were tested in FME's AASHTO accredited laboratory to determine applicable physical and engineering properties. Four (4) rock core specimens were sent to Geotechnical Testing Services, Inc. and tested for unconfined compressive strength testing and Young's Modulus determinations. One (1) split-spoon sample was sent to an off-site AASHTO accredited laboratory for corrosion series testing. All laboratory testing was performed in general accordance with procedures set forth in the most current AASHTO and ASTM standards.

The laboratory testing performed for the split-spoon samples and rock cores are detailed in the table below. Data sheets containing the results of the laboratory testing program are provided in Section 7 of the Appendix.

Table 3 – Laboratory Testing Summary Table

LABORATORY SOIL AND ROCK TESTING		
Type of Test	Quantity	Procedure
Grain Size Analysis with Hydrometer	4	AASHTO T88
Grain Size Analyses with Wash 200	1	AASHTO T11
Atterberg Limits	1	AASHTO T89/T90
Natural Moisture Content	5	ASTM D2216
pH	1	AASHTO T289
Resistivity	1	AASHTO T288
Chloride Content	1	AASHTO T291
Sulfate Content	1	AASHTO T290
Rock Core Compressive Strength and Young's Modulus	4	ASTM D7012 Methods C and D

4.0 SUBSURFACE STRATIGRAPHY

The following table summarizes the soil and rock stratigraphy based on conditions as encountered in the soil test borings performed during this geotechnical subsurface investigation.

Table 4 – Stratigraphy Summary Table

SOIL AND ROCK STRATIGRAPHY					
Strata	Elevation of Top Layer (ft-MSL)	Depth to Top of Layer (ft.)	USCS Soil Type	Avg. SPT N Value (bpf)	Comments
Fill	480	0	SM, ML, CL	8	-
Alluvium	472	8	SC	3	-
Residuum	472	8	SM	29	-
PWR	469	11	ML	100+	-
Bed Rock	464	16	N/A	N/A	Meta-Tuff

5.0 CONCEPTUAL GEOTECHNICAL ASSESSMENT

Relative to the SCDOT's Supplemental Design Criteria for Low Volume Bridge Replacement Projects, the soil subgrade below the new embankment areas are anticipated to be adequate for embankment construction.

We anticipate that pile foundations may be preferred for support of the bridge abutments. The Strength Case axial loadings will likely govern the geotechnical pile design. We anticipate that the soil thickness above rock is insufficient to resist the assumed lateral loading conditions and drilled piles may be likely at one or both bridge abutments. Due to relatively shallow depth to PWR as indicated by boring B-1302 location, shallow foundation concepts may be feasible at this abutment location due to the estimated bearing depth and given groundwater conditions at that depth.

If a multi-span concept is pursued, the selection of the interior bent foundation type will be predicated on the scour depth relative to the bent location(s). For an assumed scour depth and channel geometry, FME anticipates that driven pile concepts will not be feasible based on an insufficient soil thickness above rock to resist the lateral loads. As such, we anticipate that drilled shafts will be utilized at the interior bent(s). The drilled shafts will consist of construction casing and rock sockets below the casing tip elevation. We expect the Strength Case axial loadings will govern the drilled shaft design. Based on the performed borings, the rock strengths range from 1,160 psi to 4,520 psi.

S-41-211 Replacement Bridge over Richland Creek

Geotechnical Base Line Report

APPENDIX

SECTION 1	SITE LOCATION PLAN
SECTION 2	BORING LOCATION PLAN
SECTION 3	DRILL RIG PHOTOS
SECTION 4	TEST BORING LOGS
SECTION 5	GENERALIZED SUBSURFACE PROFILE
SECTION 6	ROCK CORE PHOTOS
SECTION 7	LABORATORY TEST RESULTS

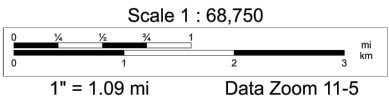
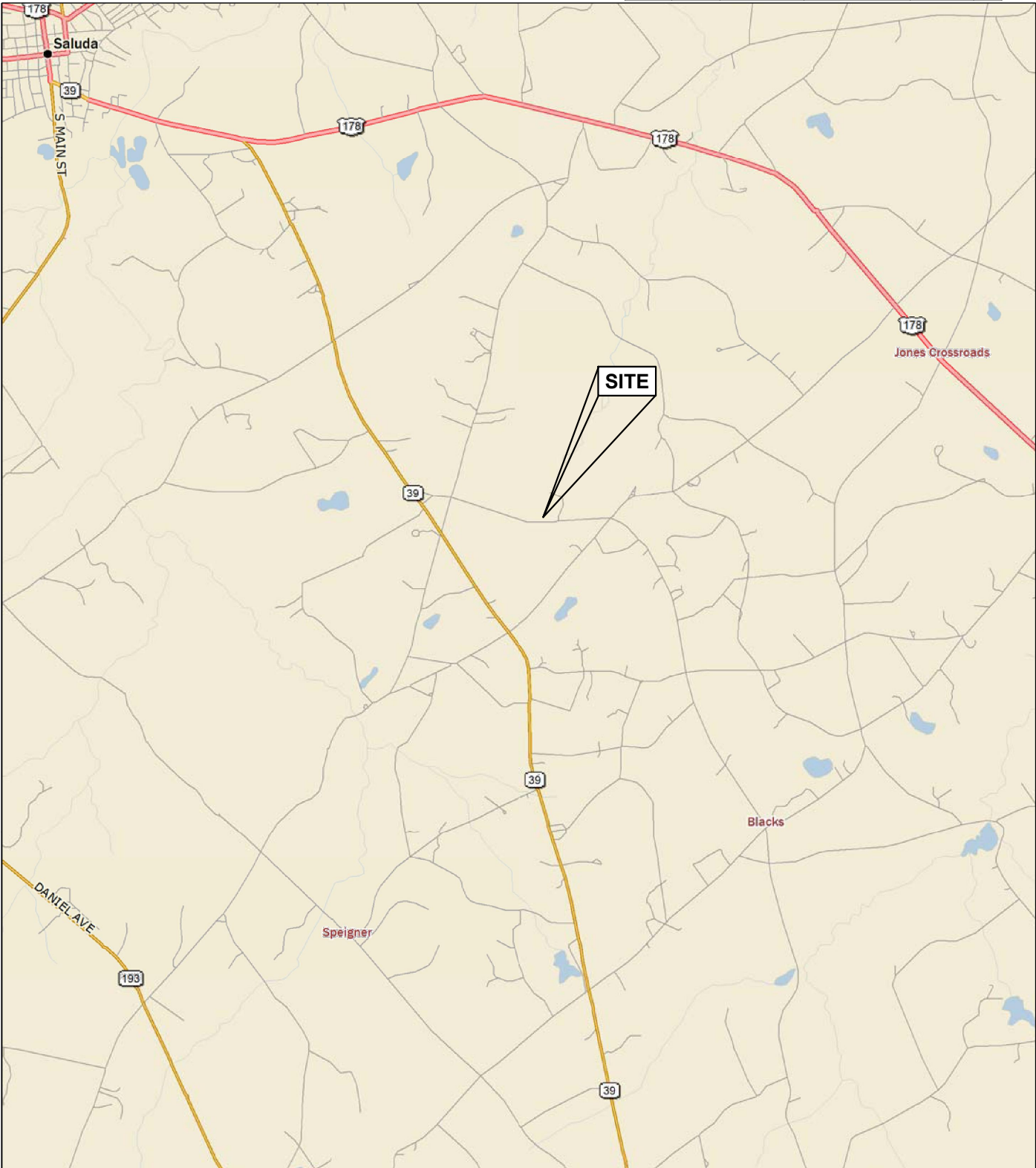
S-41-211 Replacement Bridge over Richland Creek

Geotechnical Base Line Report

APPENDIX

SECTION 1 SITE LOCATION PLAN

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	SALUDA	P038305	S-41-211	



F&ME CONSULTANTS, INC.
COLUMBIA, SC

4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 6.3.19	GROUP - -
R/W		DATE	

RICHLAND CREEK
SALUDA COUNTY, SOUTH CAROLINA

SITE LOCATION PLAN

F&ME JOB NO. G6100.050

SCALE: AS NOTED

FIGURE 1

S-41-211 Replacement Bridge over Richland Creek

Geotechnical Base Line Report

APPENDIX

SECTION 2 BORING LOCATION PLAN

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD/ROUTE NO.	SHEET NO.
3	SC	SALUDA	P038305	S-41-211	



LEGEND:

SOIL TEST BORING LOCATION

4			
3			
2			
1			
REV.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	CTC	DATE 6.3.19	GROUP -- --
R/W		DATE	

F&ME CONSULTANTS, INC.

COLUMBIA, SC

RICHLAND CREEK SALUDA COUNTY, SOUTH CAROLINA	
BORING LOCATION PLAN	
F&ME JOB NO. G6100.050	
SCALE: 1"=30'	FIGURE 2

S-41-211 Replacement Bridge over Richland Creek

Geotechnical Base Line Report

APPENDIX

SECTION 3 DRILL RIG PHOTOS

Drill Rig Setup Photographs

B-1301



Drill Rig Setup Photographs

B-1302



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Geotechnical Base Line Report

APPENDIX

SECTION 4 TEST BORING LOGS

Soil Test Boring Log Descriptors

Correlation of Penetration Resistance with Relative Density and Consistency














Coarse Grained Soils (Sands/Gravel)		Fine Grained Soils (Silt/Clay)	
SPT Blow Count	Relative Density	SPT Blow Count	Consistency
≤ 4	Very Loose	≤ 2	Very Soft
5 – 10	Loose	3 – 4	Spft
11 – 30	Medium Dense	5 – 8	Firm
31 – 50	Dense	9 – 15	Stiff
≥ 51	Very Dense	16 – 30	Very Stiff
		≥ 31	Hard

Particle Size Identification
















Gravel	Sieve Size
Fine	#4 to ¾ inch
Coarse	¾ inch to 3 inch

Sand	Sieve Size
Fine	#200 to #40
Medium	#40 to #10
Coarse	#10 to #4

Gravel	Sieve Size
Fines Content	< #200

SYMBOL	PRINT CODE*	TYPICAL DESCRIPTION
	SCCT	CONCRETE
	SCAT	ASPHALT
	SCTS	TOPSOIL/PEAT
	SCSAND	SAND
	SCSTSAND	SILTY SAND/SANDY SILT
	SCCLSAND	CLAYEY SAND/SANDY CLAY
	SCCLAY	CLAY
	SCSILT	SILT
	SCSTCLAY	SILTY CLAY/CLAYEY SILT
	SCSAP	SAPROLITE
	SCLS	LIMESTONE
	SCBR	GRANITE (BEDROCK)
	SCMARL	MARL

SOIL CLASSIFICATION CHART

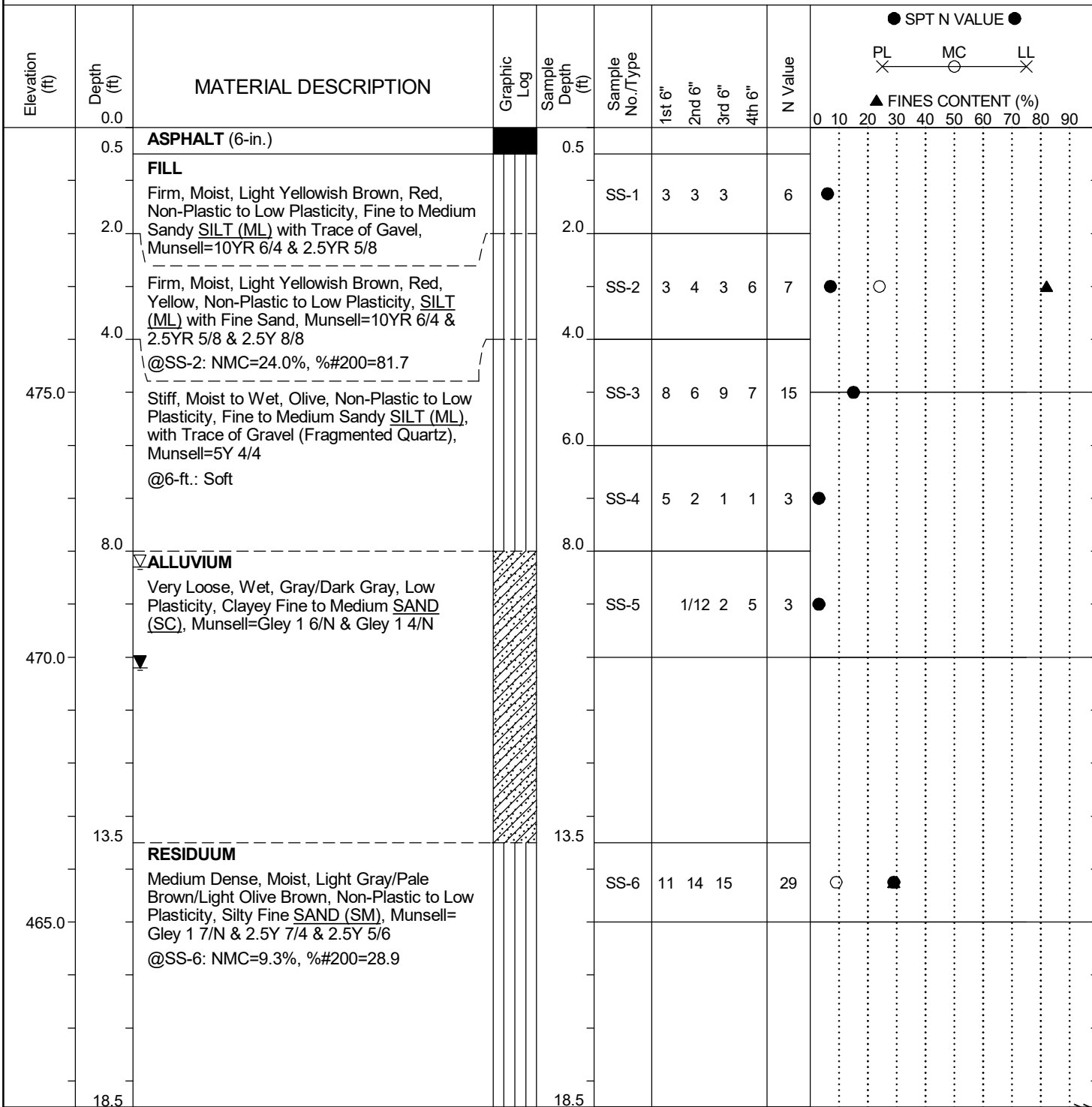
MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
		CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
FINE GRAINED SOILS	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		LIQUID LIMIT LESS THAN 50		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
		LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
HIGHLY ORGANIC SOILS	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		CH	INORGANIC CLAYS OF HIGH PLASTICITY
		LIQUID LIMIT GREATER THAN 50		OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
		LIQUID LIMIT GREATER THAN 50		PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS



SCDOT Soil Test Log

Project ID:	P038305	County:	Saluda	Boring No.:	B-1301
Site Description:	S-41-211 Replacement Bridge over Richland Creek			Route:	S-41-211
Eng./Geo.:	M. Touchberry	Boring Location:	N/A	Offset:	N/A
Elev.:	480.0 ft	Latitude:	33.950049	Longitude:	-81.70633
Date Started:	7/9/2019				
Total Depth:	29 ft	Soil Depth:	18.5 ft	Core Depth:	10.5 ft
Date Completed:	7/9/2019				
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)	Drill Machine:	CME 45B	Drill Method:	RW/RC
Hammer Type:	Automatic	Energy Ratio:	92%	Core Size:	NQ/8
Driller:	L. Guempel	Groundwater:	TOB	8.3 ft	24HR
					10.2 ft



LEGEND

Continued Next Page

SAMPLER TYPE	
SS - Split Spoon	NQ - Rock Core, 1-7/8"
UD - Undisturbed Sample	CU - Cuttings
AWG - Rock Core, 1-1/8"	CT - Continuous Tube

DRILLING METHOD	
HSA - Hollow Stem Auger	RW - Rotary Wash
CFA - Continuous Flight Augers	RC - Rock Core
DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P038305	County:	Saluda	Boring No.:	B-1301
Site Description:	S-41-211 Replacement Bridge over Richland Creek			Route:	S-41-211
Eng./Geo.:	M. Touchberry	Boring Location:	N/A	Offset:	N/A
Elev.:	480.0 ft	Latitude:	33.950049	Longitude:	-81.70633
Date Started:	7/9/2019				
Total Depth:	29 ft	Soil Depth:	18.5 ft	Core Depth:	10.5 ft
Date Completed:	7/9/2019				
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)	Drill Machine:	CME 45B	Drill Method:	RW/RC
Hammer Type:	Automatic	Energy Ratio:	92%	Core Size:	NQ/8
Driller:	L. Guempel	Groundwater:	TOB	8.3 ft	24HR
					10.2 ft

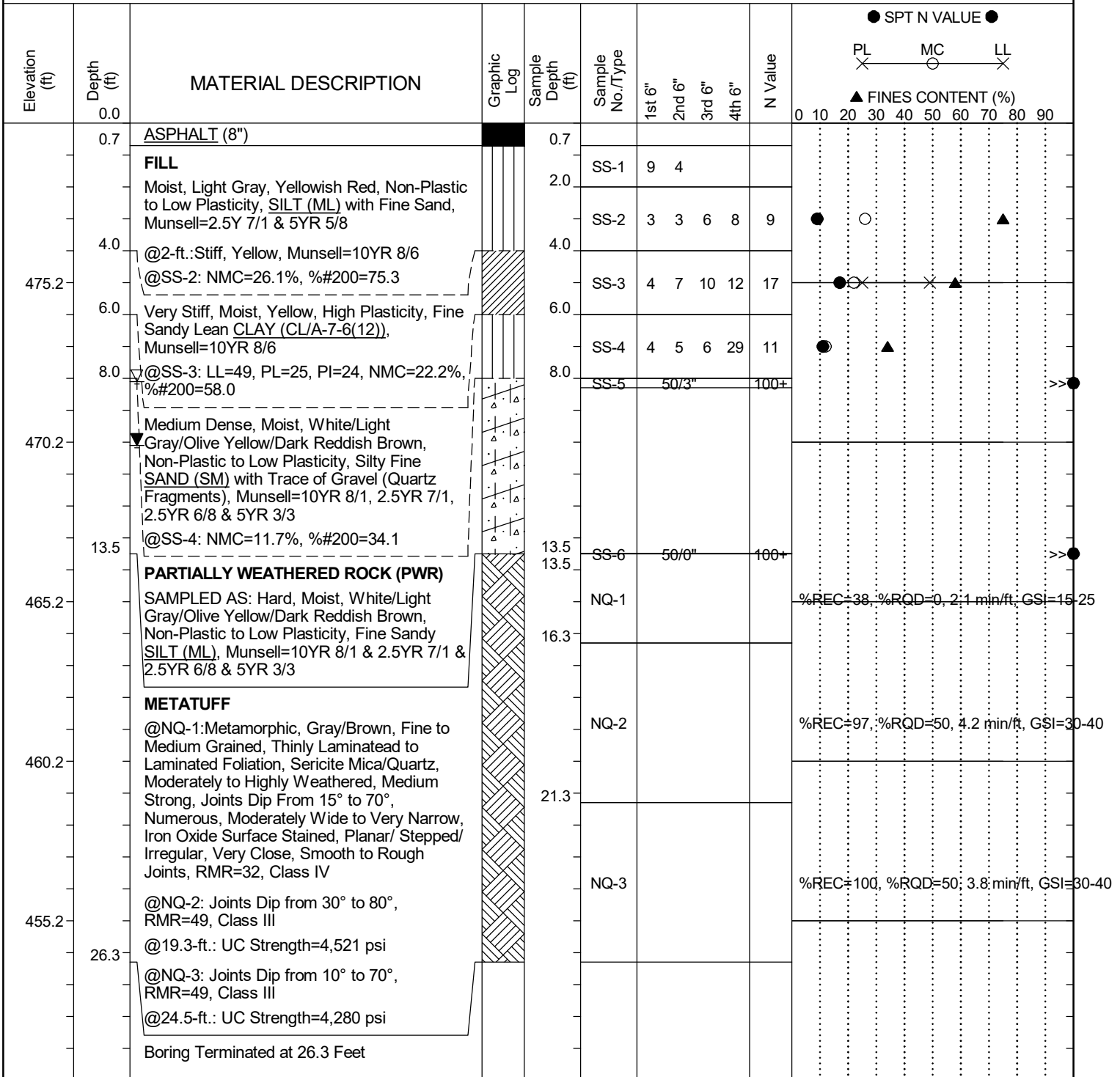
Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	<div> <div>● SPT N VALUE ●</div> <div> <div>PL</div> <div>MC</div> <div>LL</div> </div> <div> <div>×</div> <div>○</div> <div>×</div> </div> <div>▲ FINES CONTENT (%)</div> <div>0 10 20 30 40 50 60 70 80 90</div> </div>
460.0	18.5	METATUFF @NQ-1: Metamorphic, Gray/Bluish Gray, Fine to Medium Grained, Thinly Laminated to Laminated Foliation, Sericite Mica/ Quartz, Highly to Moderately Weathered, Weak, Joints Dip from 25° to 75°, Numerous, Moderately Wide to Narrow, Iron Oxide Surface Stained, Planar/ Stepped/ Irregular, Very Close, Smooth to Slightly Rough Joints, RMR=41, Class III @19.3-ft.: UC Strength = 1,162 psi @20.5-ft.: RMR=42, Class III, UC Strength=2,368 psi @NQ-2: Joints Dip from 10° to 75°, RMR=37, Class IV @NQ-3: Joints Dip from 30° to 85°, No Staining, RMR=44, Class III		18.5	SS-7	50	0.25			100+	%REC=97, %RQD=48, 1.5 min/ft, GSI=35-45
455.0	21.1			21.1	NQ-1						
450.0	26.1			26.1	NQ-2						%REC=82, %RQD=10, 2 min/ft, GSI=20-30
445.0	29.0			29.0	NQ-3						%REC=100, %RQD=34, 2.8 min/ft, GSI=35-45
	29.0	Boring Terminated at 29.0 Feet									

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P038305	County:	Saluda	Boring No.:	B-1302
Site Description:	S-41-211 Replacement Bridge over Richland Creek			Route:	S-41-211
Eng./Geo.:	M. Touchberry	Boring Location:	N/A	Offset:	N/A
Elev.:	480.2 ft	Latitude:	33.950044	Longitude:	-81.706512
Date Started:	7/9/2019				
Total Depth:	26.3 ft	Soil Depth:	13.5 ft	Core Depth:	12.8 ft
Date Completed:	7/10/2019				
Bore Hole Diameter (in):	4	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)	Drill Machine:	CME 45B	Drill Method:	RW/RC
Hammer Type:	Automatic	Energy Ratio:	92%	Core Size:	NQ/8
Driller:	L. Guempel	Groundwater:	TOB	8.1 ft	24HR
					10.1 ft



LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

S-41-211 Replacement Bridge over Richland Creek

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APPENDIX


SECTION 5 GENERALIZED SUBSURFACE PROFILE


KEY TO SYMBOLS


PROJECT NAME Closed and Load-Restricted Bridge Package 2020-1
(S-41-211 Bridge Replacement over Richland Creek)


PROJECT COUNTY Saluda


LITHOLOGIC SYMBOLS
(Unified Soil Classification System)


 ASPHALT


 GABC (Graded Aggregate Base Course)


 PWR: Partially Weathered Rock


 BEDROCK: Bedrock


 CH: USCS High Plasticity Clay


 CL: USCS Low Plasticity Clay


 CL-ML: USCS Low Plasticity Silty Clay


 MH: USCS Elastic Silt


 ML: USCS Silt


 SP: USCS Poorly Graded Sand


 SM: USCS Silty Sand

 SC: USCS Clayey Sand

 SP-SM: USCS Poorly Graded Sand w/ Silt

 SC-SM: USCS Silty, Clayey Sand



 SP-SC: USCS Poorly Graded Sand w/ Clay

 No Recovery

SOIL TEST ID'S

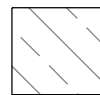
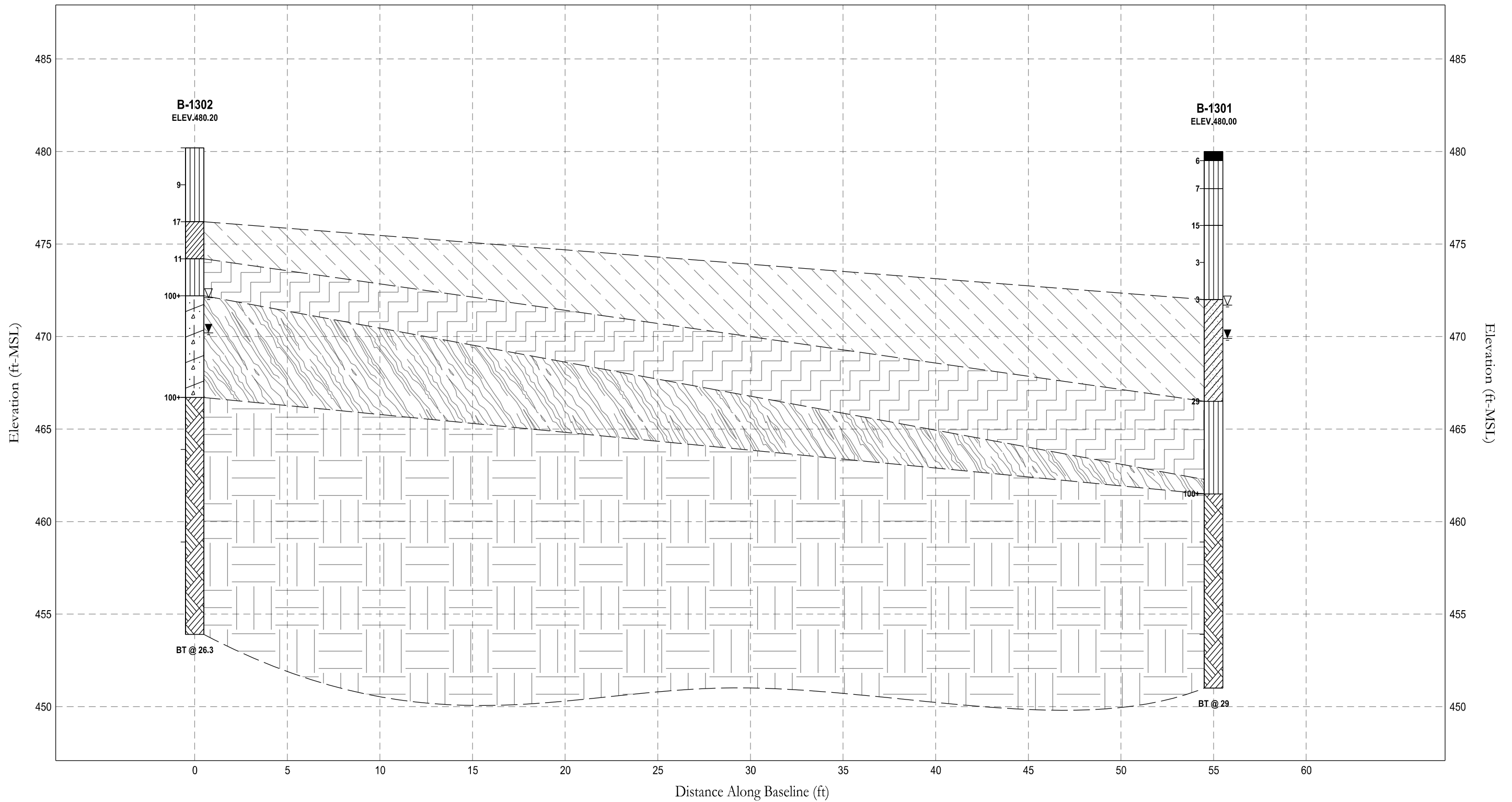
B-# SOIL TEST BORING

ABBREVIATIONS

- LL - LIQUID LIMIT (%)
 - PL - PLASTIC LIMIT (%)
 - PI - PLASTIC INDEX (%)
 - NMC - MOISTURE CONTENT (%)
 - NP - NON PLASTIC
 - %#200 - PERCENT PASSING NO. 200 SIEVE
-  Water Level at Time
Drilling, or as Shown
-  Water Level at End of
Drilling, or as Shown

NOTES

1. THE GENERALIZED SUBSURFACE PROFILES ARE PROVIDED ONLY FOR ILLUSTRATIVE PURPOSES. THE INTENT OF THESE DRAWINGS IS TO PROVIDE THE READER WITH VERY GENERAL INFORMATION ON SUBSURFACE CONDITIONS AT THE TIME OF THE INVESTIGATION. VARIATIONS IN THE INDICATED SUBSURFACE CONDITIONS WILL BECOME EVIDENT ONCE ADDITIONAL BORINGS ARE PERFORMED. THE INDICATED STRATIGRAPHY BETWEEN TESTING LOCATIONS WAS GENERATED USING STRAIGHT-LINE LINEAR INTERPOLATION, AND DOES NOT REPRESENT THE TRUE STRATIGRAPHY.



ALLUVIUM



RESIDUUM



PWR



BEDROCK



S-41-211 BRIDGE REPLACEMENT
OVER RICHLAND CREEK

GENERALIZED SUBSURFACE PROFILE

HRZ SCALE = NTS

VRT SCALE = NTS

The generalized subsurface profile is provided for illustrative purposes. The intent of this drawing is to provide the reader with very general information on soil stratigraphy at the bridge site. Variations in the indicated subsurface conditions will become evident once additional borings are performed.

4			
3			
2			
1			
REV. NO.	BY	DATE	DESCRIPTION OF REVISION
TOPO.		DATE	
DWG.	JFH	DATE 8.27.19	GROUP - -
R/W		DATE	

S-41-211 Replacement Bridge over Richland Creek

Geotechnical Base Line Report

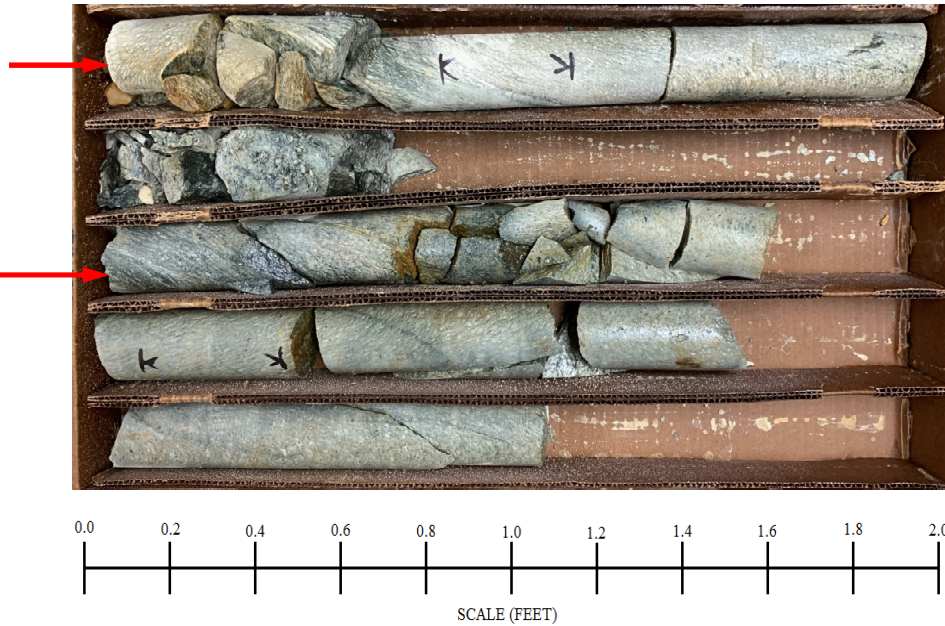
APPENDIX

SECTION 6 ROCK CORE PHOTOS

S-41-211 RBO Richland Creek
Boring B-1301



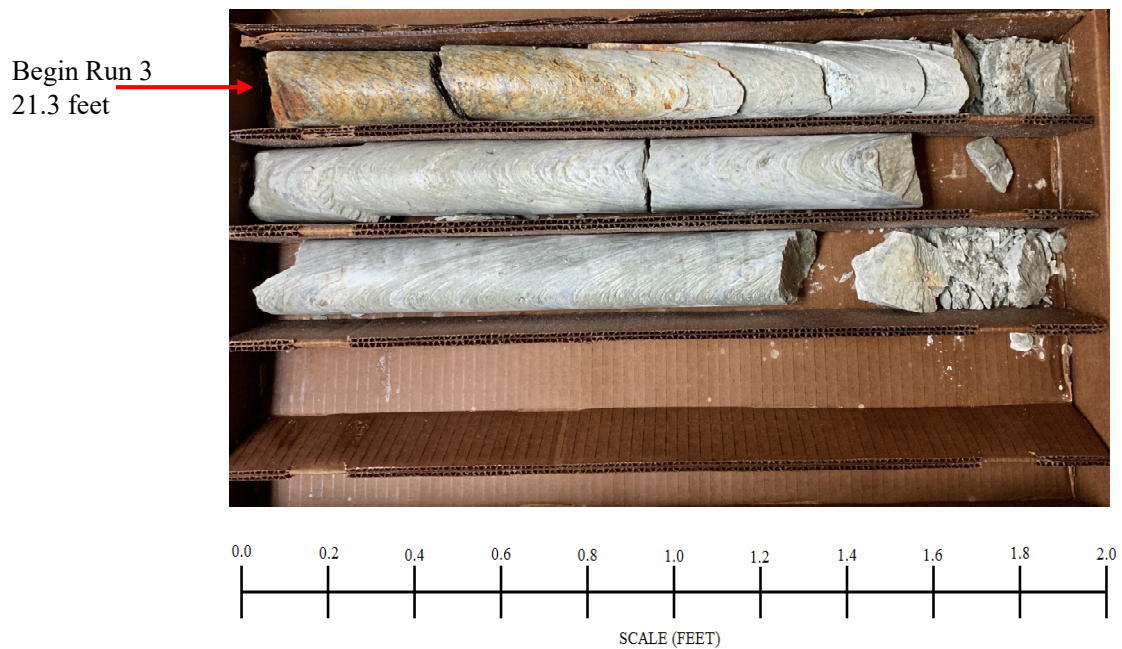
Begin Run 1
18.5 feet



Begin Run 3
26.1 feet



S-41-211 RBO Richland Creek
Boring B-1302



S-41-211 Replacement Bridge over Richland Creek

Geotechnical Base Line Report

APPENDIX

SECTION 7 LABORATORY TEST RESULTS



SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

PROJECT ID P038305

PROJECT NAME S-41-211 Replacement Bridge over Richland Creek

PROJECT COUNTY Saluda

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1301	4.0				19	82		24.0			
B-1301	15.0				4.76	29		9.3			
B-1302	4.0				4.76	75		26.1			
B-1302	6.0	49	25	24	4.76	58	CL	22.2			
B-1302	8.0				4.76	34		11.7			



Rock Coring Summary

Project ID: P038305

Project Name: S-41-211 RBO Richland Creek

Project County: Saluda

Borehole	Core Run Number	Core Run Top Depth (ft)	REC (%)	RQD (%)	q _u (psi)	Poisson's Ratio	Elastic Modulus (ksi)	Unit Weight (pcf)	RMR
									GSI
B-1301	NQ-1	18.5	97	48	1,162	0.55	6.03E+02	161	41
					2,368	0.33	3.30E+03	166	35-45
	NQ-2	21.1	82	10	N/A	N/A	N/A	N/A	42
									20-30
	NQ-3	26.1	100	34	N/A	N/A	N/A	N/A	44
									35-45
B-1302	NQ-1	13.5	38	0	N/A	N/A	N/A	N/A	32
									15-25
	NQ-2	16.3	97	50	4,521	0.36	8.30E+03	167	49
									30-40
	NQ-3	21.3	100	50	4,280	0.18	5.40E+03	164	49
									30-40

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	<u>S-41-211 Replacement Bridge over Richland Creek</u>	PROJECT NO.:	<u>P038305</u>
SAMPLE NUMBER:	<u>19-1834</u>	DATE SAMPLE RECEIVED:	<u>7/22/2019</u>
DESCRIPTION OF SOIL:	<u>VARIOUS</u>		
TESTED BY:	<u>JH</u>	DATE OF TESTING:	<u>8/6/2019</u>
WEIGHED	<u>JH</u>	DATE OF WEIGHING:	<u>8/7/2019</u>
RY:			

BORING NO.	B-1301	B-1301			
SAMPLE NO.	SS-2	SS-6			
SAMPLE DEPTH	2-4'	13.5-15'			
WATER CONTENT, W%	24.0	9.3			

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

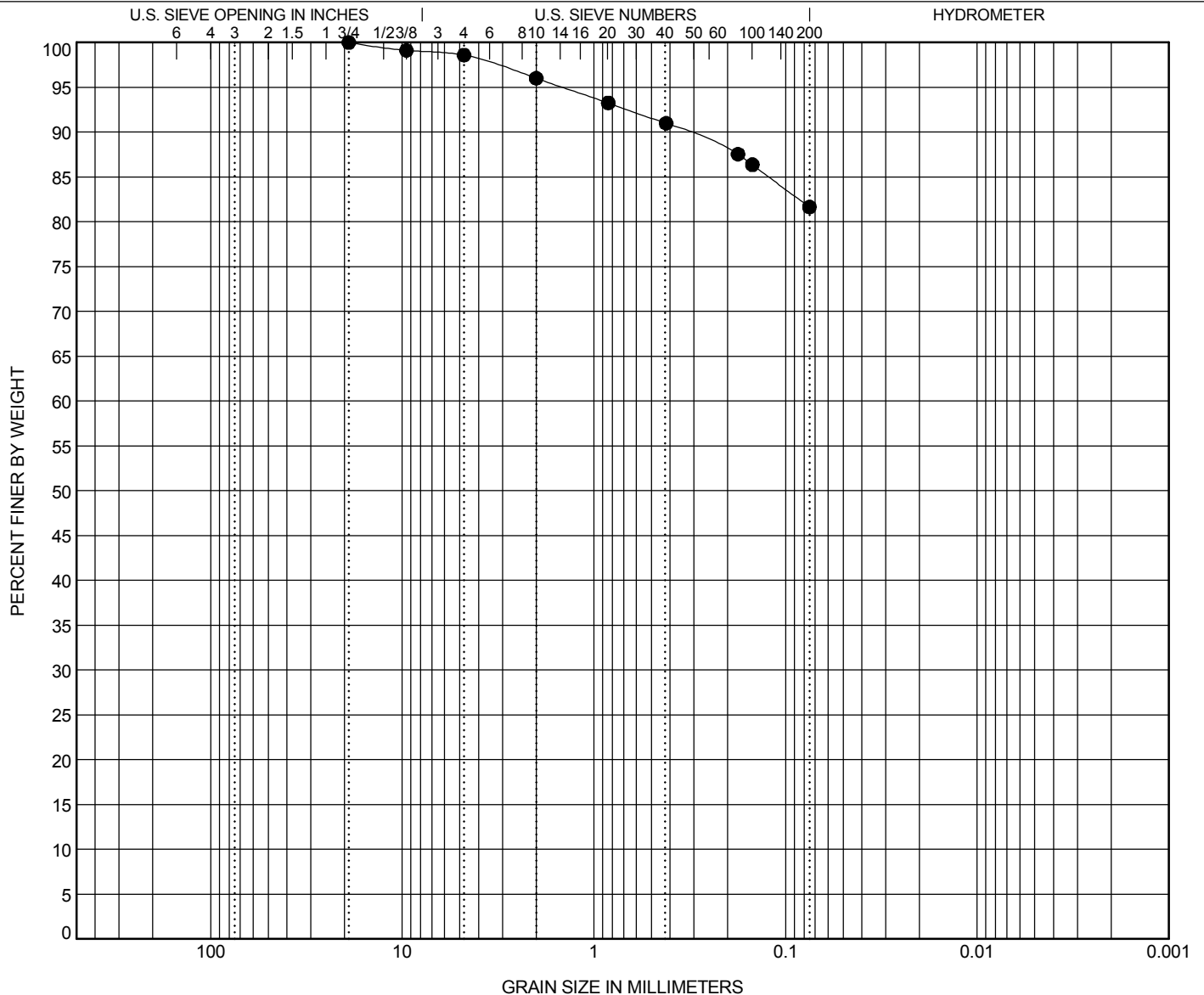


GRAIN SIZE DISTRIBUTION

PROJECT ID P038305

PROJECT NAME S-41-211 Replacement Bridge over Richland Creek

PROJECT COUNTY Saluda



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-1301	4.0	SILT (ML) with Sand									
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt		%Clay	
● B-1301	4.0	19	1.451			1.4	16.9	81.7			

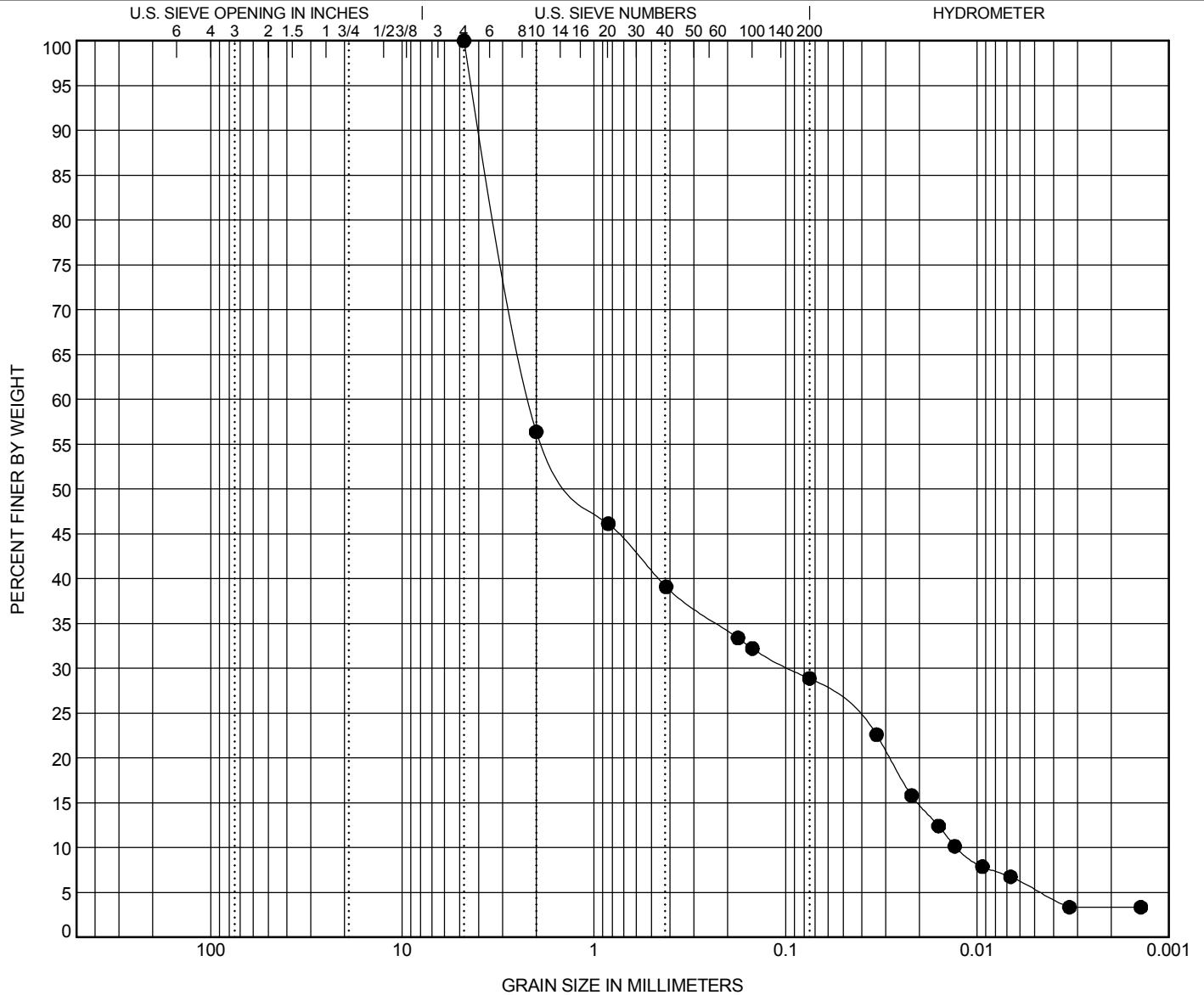


GRAIN SIZE DISTRIBUTION

PROJECT ID P038305

PROJECT NAME S-41-211 Replacement Bridge over Richland Creek

PROJECT COUNTY Saluda



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-1301	15.0	Silty SAND (SM)								0.32	167.91
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay		
● B-1301	15.0	4.76	4.31	1.165	0.013	0.1	71.0	23.5	5.4		

Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression
ASTM D7012-14e1 (D) / D4543-08e1

Method of Calculating Young's Modulus from Axial Stress-Strain Curve

Average Modulus - Linear Portion of Axial Stress Strain Curve

Manually selected by lab at 50% and 75% of the total Compressive strength (psi) - other values possible

Client	F&ME Consultants	Boring	G6100.050.00013 - Richland Creek
Client Project	G6100.050 Load Restricted Bridge Package	Depth	19.3' - 19.6'
Project Number	42301	Sample	RC-1301.1
		Lab ID number	42301001

Description: Green Phyllite
 As-Received Condition: Useable L/D > 2
 Sample Preparation: Diamond saw blade cut, surface ground flat

Axial Strain	Diametric Strain	Axial Stress psi
7.53E-04	-3.37E-04	882
2.73E-04	-7.23E-05	592

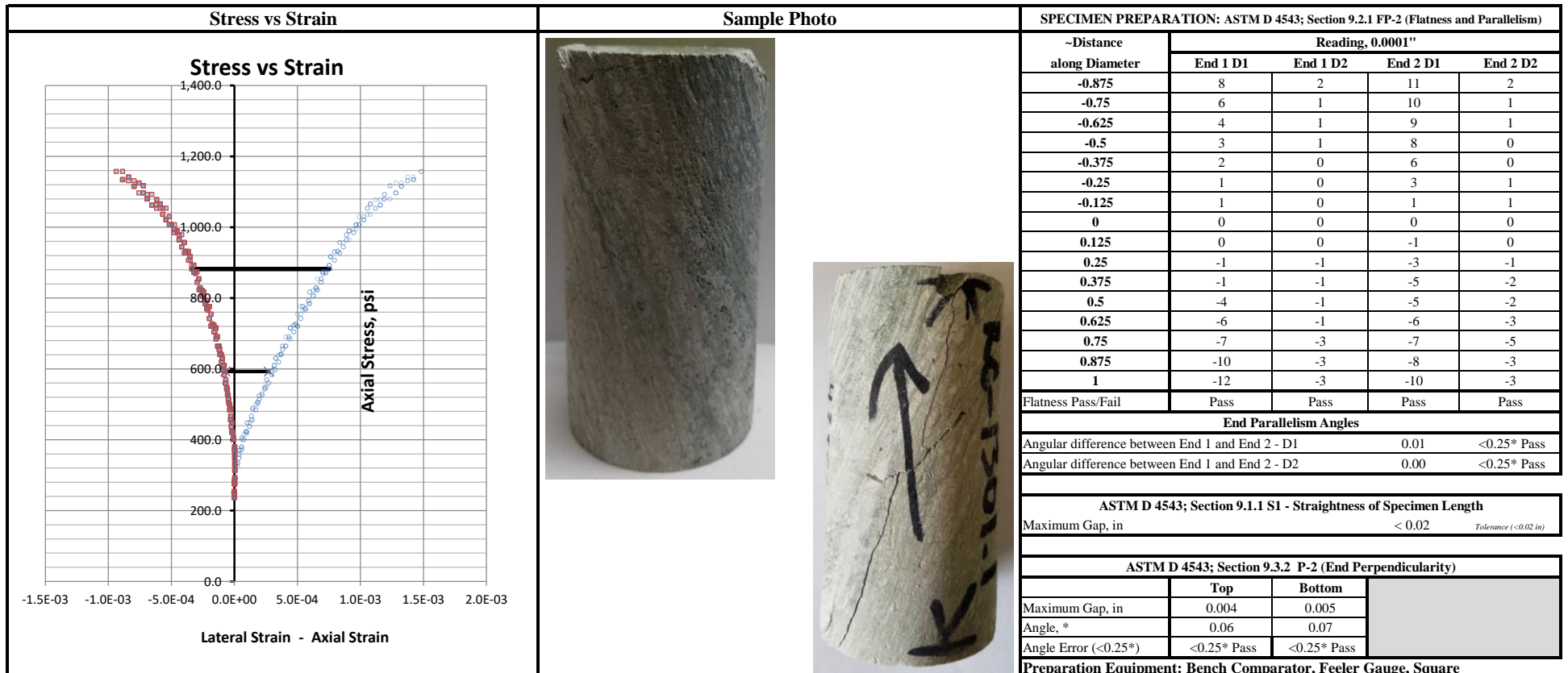
ASTM D 4543; Section 4.2 & 5.6	
Length, in	3.982
Mid Height Diameter #1, in	1.863
Mid Height Diameter #2, in	1.862
Average Mid. Height Diameter, in.	1.86
Sample Area, in^2	2.72
L/D Ratio (2.0-2.5)	2.14

Test Parameters		
Test Temperature	Room	
Moisture Condition	As-Received	
Sample Weight, gms	457.79	
Sample Volume, cc	178	
Wet Density, pcf	161	

Test Results	
Overall Loading Rate, psi/sec	32
Peak Load, lbs	3165
Unconfined Compressive Strength, psi	1,162
Youngs Modulus, E psi	603.3 E+03
Slope of Lateral Curve, psi	-1.1 E+06
Poisson's Ratio	0.55

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By: ALO

Date Tested: 8/28/2019

Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression
ASTM D7012-14e1 (D) / D4543-08e1

Client	F&ME Consultants	Boring	G6100.050.00013 - Richland Creek
Client Project	G6100.050 Load Restricted Bridge Package	Depth	20.5' - 20.8'
Project Number	42301	Sample	RC-1301.2
		Lab ID number	42301002

Description: Green Phyllite
 As-Received Condition: Useable L/D > 2
 Sample Preparation: Diamond saw blade cut, surface ground flat

Method of Calculating Young's Modulus from Axial Stress-Strain Curve

Average Modulus - Linear Portion of Axial Stress Strain Curve

Manually selected by lab at 50% and 75% of the total Compressive strength (psi) - other values possible

Axial Strain	Diametric Strain	Axial Stress psi
4.20E-04	-9.83E-05	2375
7.75E-04	-2.15E-04	3535

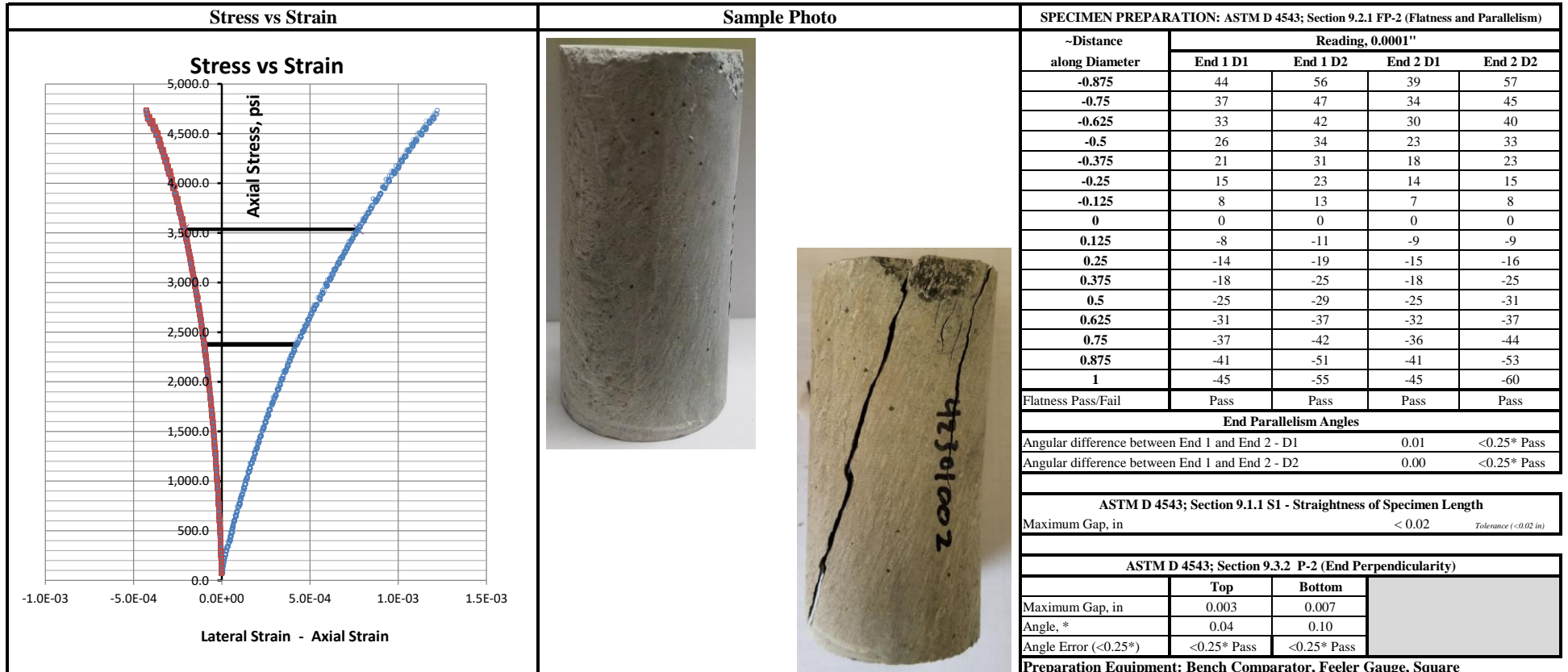
ASTM D 4543; Section 4.2 & 5.6	
Length, in	4.213
Mid Height Diameter #1, in	1.859
Mid Height Diameter #2, in	1.86
Average Mid. Height Diameter, in.	1.86
Sample Area, in^2	2.72
L/D Ratio (2.0-2.5)	2.27

Test Parameters		
Test Temperature	Room	
Moisture Condition	As-Received	
Sample Weight, gms	497.87	
Sample Volume, cc	187	
Wet Density, pcf	166	

Test Results	
Overall Loading Rate, psi/sec	20
Peak Load, lbs	12853
Unconfined Compressive Strength, psi	2,368
Youngs Modulus, E psi	3.3 E+06
Slope of Lateral Curve, psi	-10.0 E+06
Poisson's Ratio	0.33

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By: ALO

Date Tested: 8/28/2019

F&ME CONSULTANTS
3112 Devine Street
Columbia, South Carolina 29205

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	S-41-211 Replacement Bridge over Richland Creek	PROJECT NO.:	P038305
SAMPLE NUMBER:	19-1836	DATE SAMPLE RECEIVED:	7/22/2019
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	JH	DATE OF TESTING:	8/6/2019
WEIGHED	JH	DATE OF WEIGHING:	8/7/2019
RY:			

BORING NO.	B-1302	B-1302	B-1302		
SAMPLE NO.	SS-2	SS-3	SS-4		
SAMPLE DEPTH	2-4'	4-6'	6-8'		
WATER CONTENT, W%	26.1	22.2	11.7		

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

BORING NO.					
SAMPLE NO.					
SAMPLE DEPTH					
WATER CONTENT, W%					

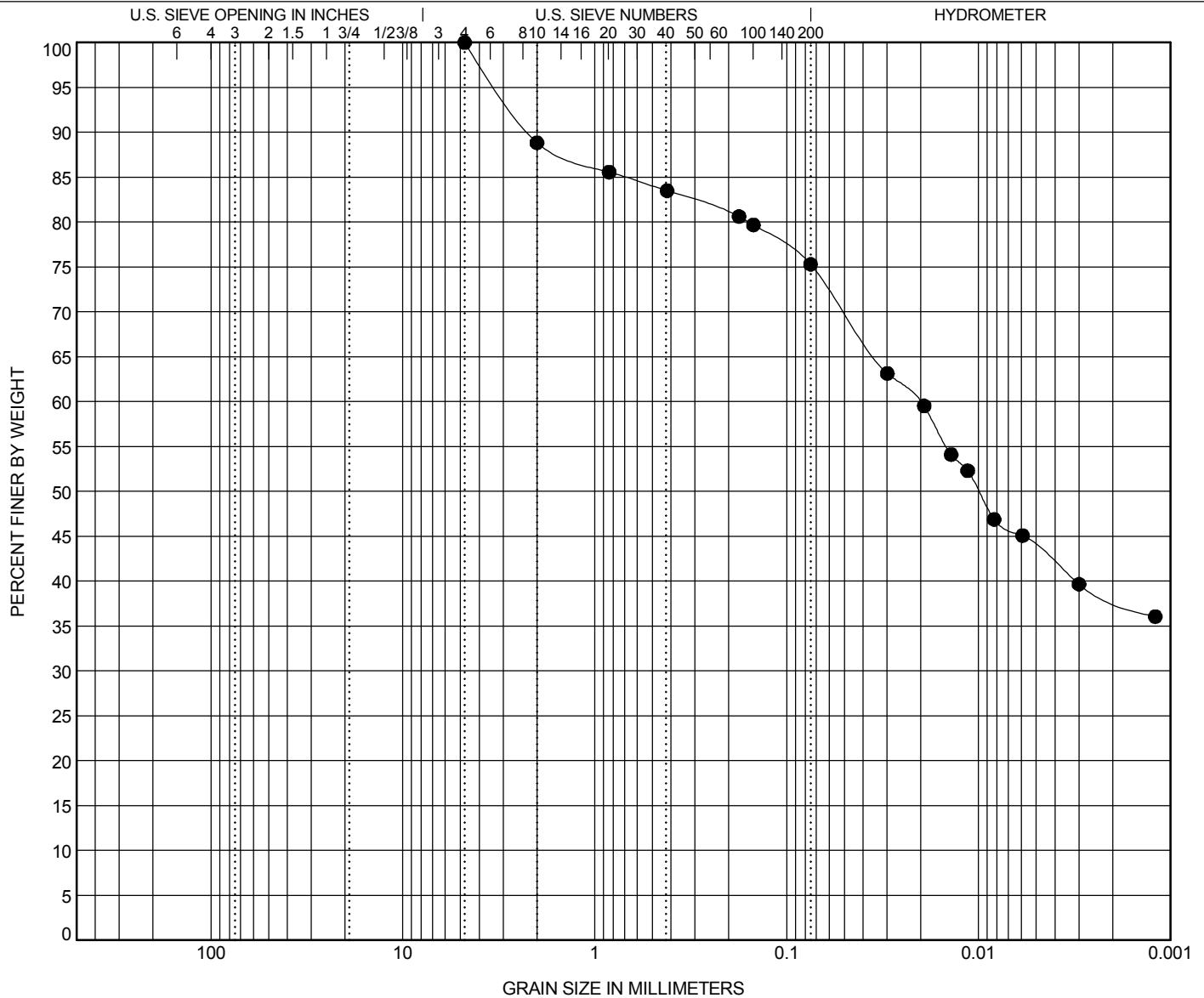


GRAIN SIZE DISTRIBUTION

PROJECT ID P038305

PROJECT NAME S-41-211 Replacement Bridge over Richland Creek

PROJECT COUNTY Saluda



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-1302	4.0	SILT (ML) with Sand									
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt		%Clay	
● B-1302	4.0	4.76	3.227	0.01		0.0	24.7	31.5		43.8	

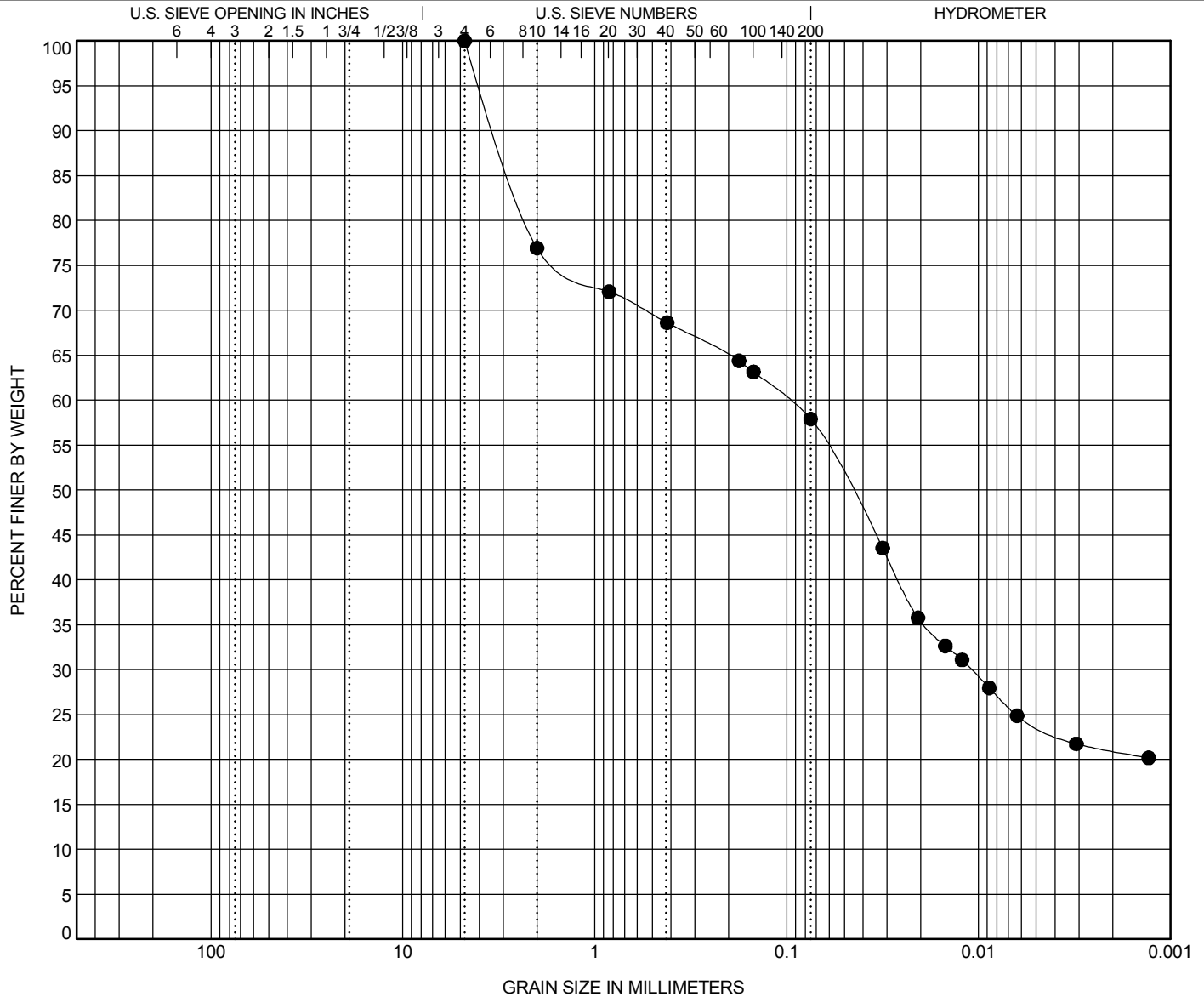


GRAIN SIZE DISTRIBUTION

PROJECT ID P038305

PROJECT NAME S-41-211 Replacement Bridge over Richland Creek

PROJECT COUNTY Saluda



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-1302	6.0	Sandy Lean CLAY (CL/A-7-6(12))					49	25	24		
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay		
● B-1302	6.0	4.76	3.944	0.047		0.1	42.0	34.1	23.9		

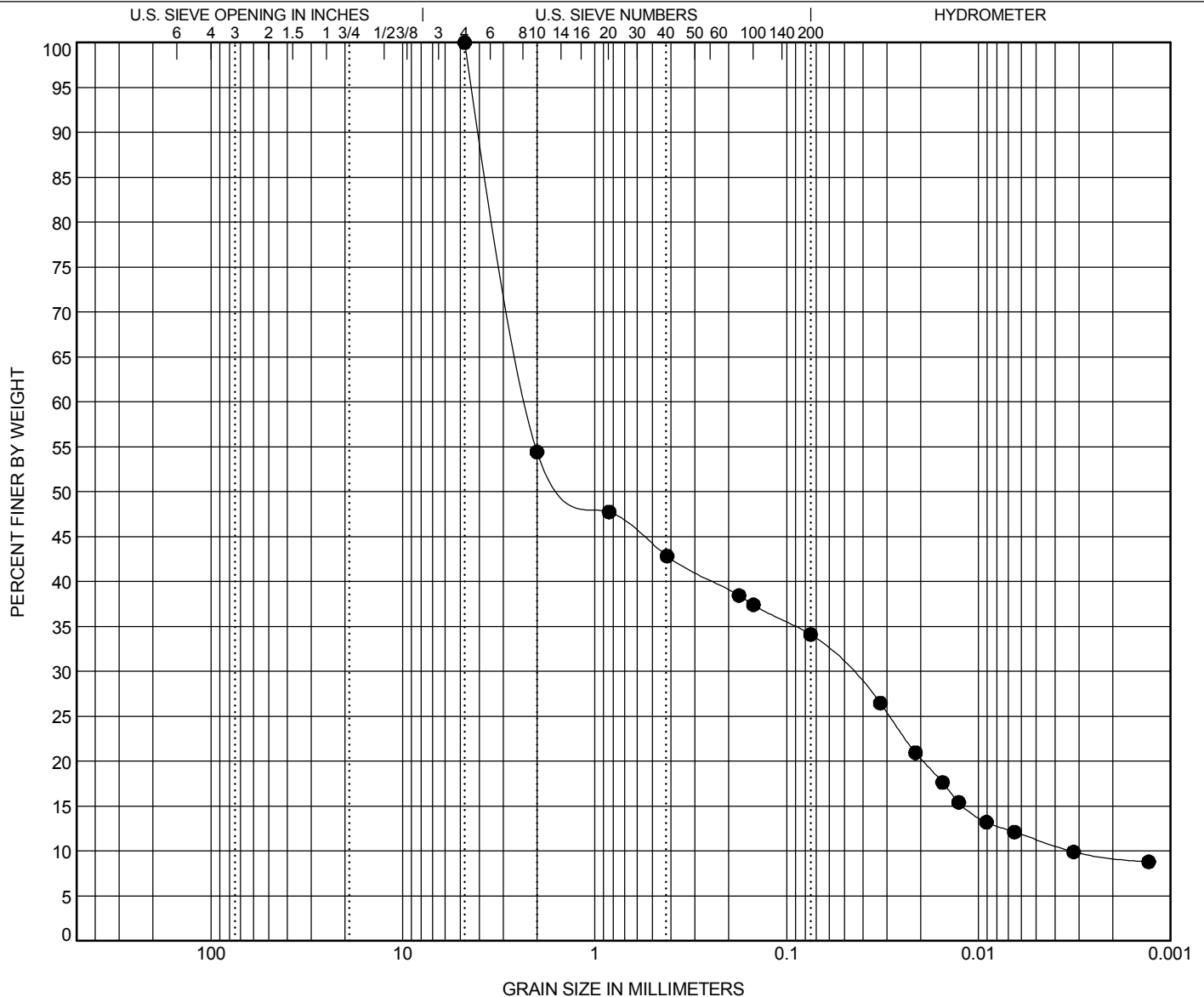


GRAIN SIZE DISTRIBUTION

PROJECT ID P038305

PROJECT NAME S-41-211 Replacement Bridge over Richland Creek

PROJECT COUNTY Saluda



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

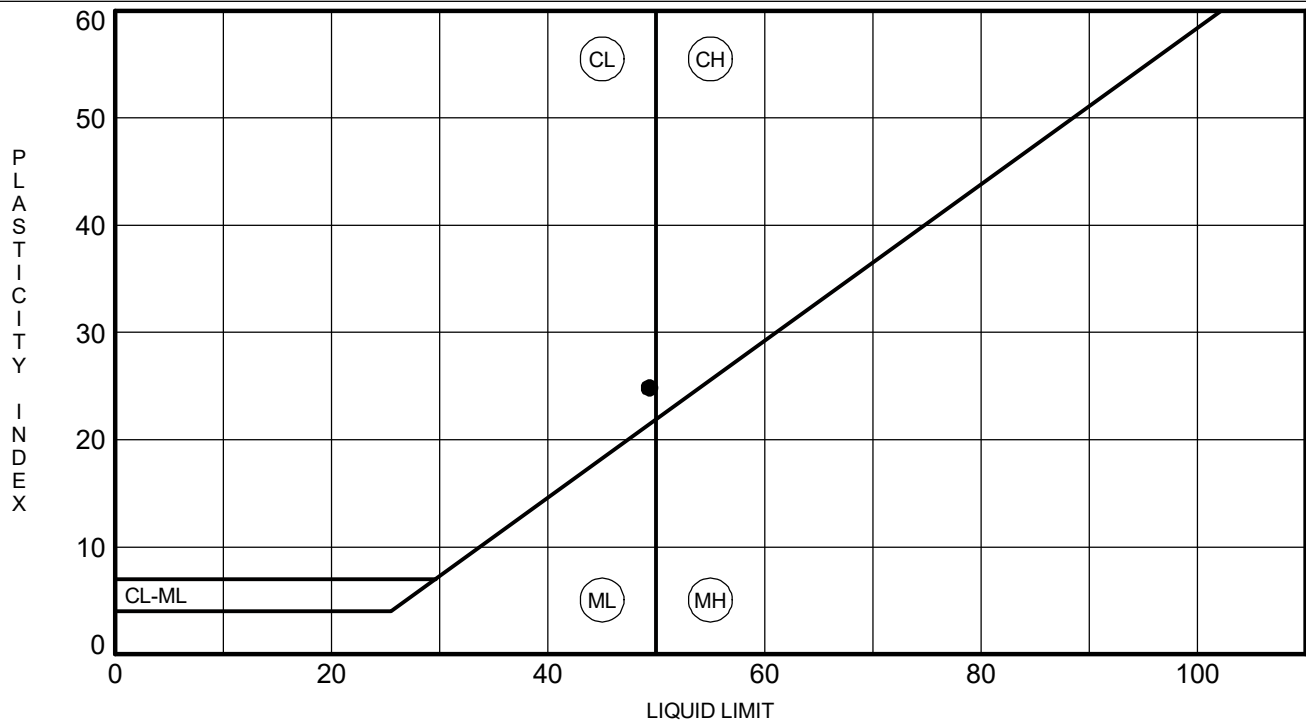
BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-1302	8.0	Silty SAND (SM)								0.31	675.32
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay		
● B-1302	8.0	4.76	4.328	1.126	0.003	0.1	65.8	22.8	11.3		

ATTERBERG LIMITS' RESULTS

PROJECT ID P038305

PROJECT NAME S-41-211 Replacement Bridge over Richland Creek

PROJECT COUNTY Saluda

[illegible]

Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression
ASTM D7012-14e1 (D) / D4543-08e1

Client	F&ME Consultants	Boring	G6100.050.00013 - Richland Creek
Client Project	G6100.050 Load Restricted Bridge Package	Depth	19.3' - 19.6'
Project Number	42301	Sample	RC-1302.3
		Lab ID number	42301003

Description: Green Phyllite
 As-Received Condition: Useable L/D > 2
 Sample Preparation: Diamond saw blade cut, surface ground flat

Method of Calculating Young's Modulus from Axial Stress-Strain Curve

Average Modulus - Linear Portion of Axial Stress Strain Curve

Manually selected by lab at 25% and 50% of the total Compressive strength (psi) - other values possible

Axial Strain	Diametric Strain	Axial Stress psi
1.69E-04	-6.08E-05	2229
3.03E-04	-1.09E-04	3343

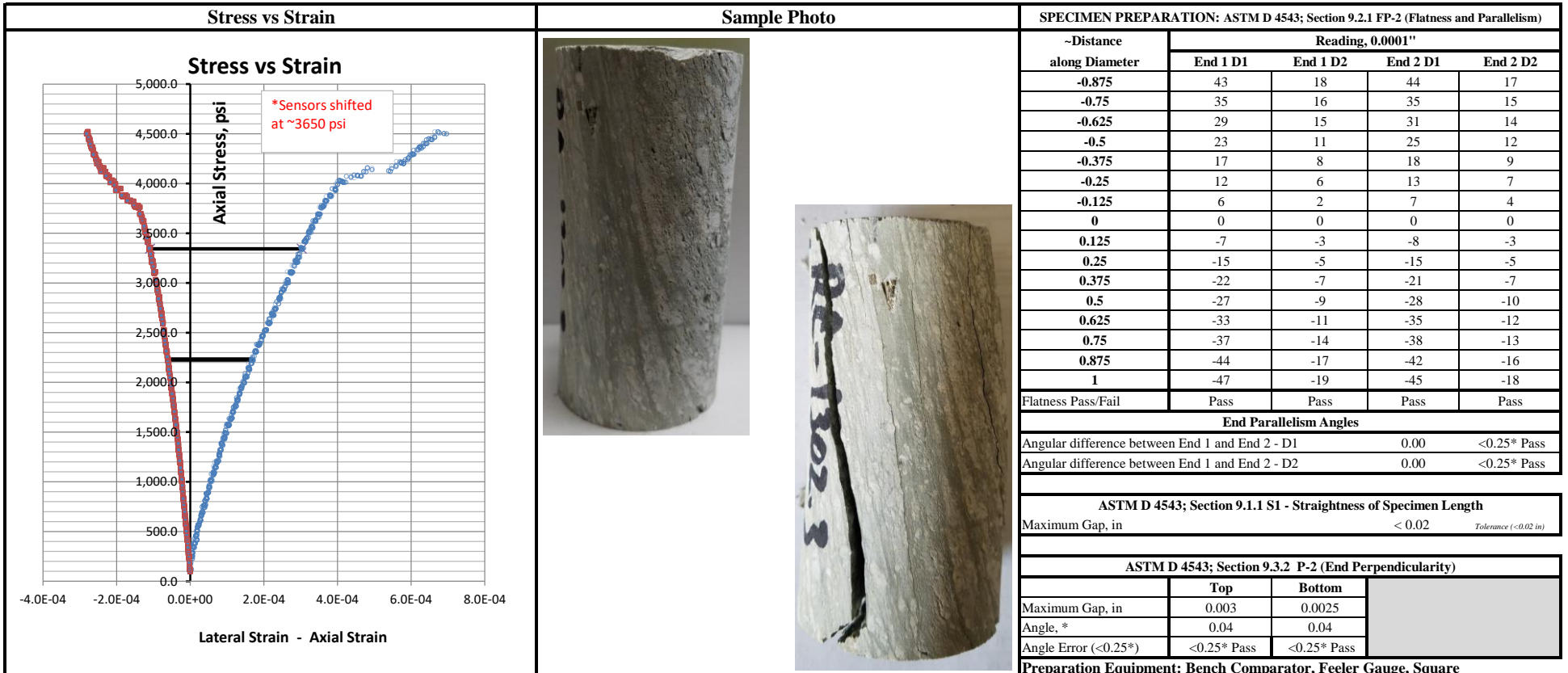
ASTM D 4543; Section 4.2 & 5.6	
Length, in	4.088
Mid Height Diameter #1, in	1.857
Mid Height Diameter #2, in	1.854
Average Mid. Height Diameter, in.	1.86
Sample Area, in^2	2.70
L/D Ratio (2.0-2.5)	2.20

Test Parameters		
Test Temperature	Room	
Moisture Condition	As-Received	
Sample Weight, gms	484.85	
Sample Volume, cc	181	
Wet Density, pcf	167	

Test Results	
Overall Loading Rate, psi/sec	20
Peak Load, lbs	12224
Unconfined Compressive Strength, psi	4,521
Youngs Modulus, E psi	8.3 E+06
Slope of Lateral Curve, psi	-23.0 E+06
Poisson's Ratio	0.36

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By: ALO

Date Tested: 8/28/2019

Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression
ASTM D7012-14e1 (D) / D4543-08e1

Client	F&ME Consultants	Boring	G6100.050.00013 - Richland Creek
Client Project	G6100.050 Load Restricted Bridge Package	Depth	24.5' - 24.8'
Project Number	42301	Sample	RC-1302.4
		Lab ID number	42301004

Description: Green Phyllite
 As-Received Condition: Useable L/D > 2
 Sample Preparation: Diamond saw blade cut, surface ground flat

Method of Calculating Young's Modulus from Axial Stress-Strain Curve

Average Modulus - Linear Portion of Axial Stress Strain Curve

Manually selected by lab at 25% and 50% of the total Compressive strength (psi) - other values possible

Axial Strain	Diametric Strain	Axial Stress psi
3.34E-04	-3.82E-05	2133
5.39E-04	-7.48E-05	3238

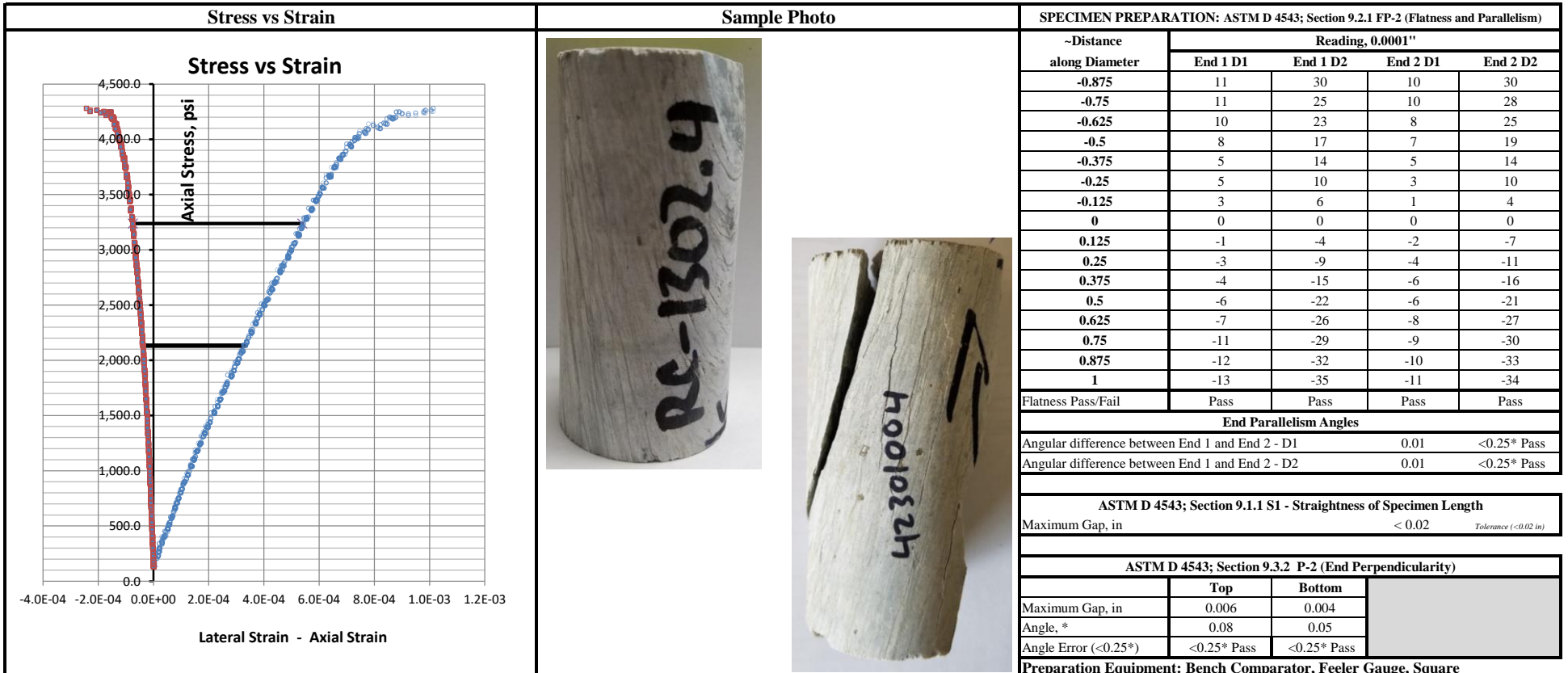
ASTM D 4543; Section 4.2 & 5.6	
Length, in	4.19
Mid Height Diameter #1, in	1.864
Mid Height Diameter #2, in	1.862
Average Mid. Height Diameter, in.	1.86
Sample Area, in ²	2.73
L/D Ratio (2.0-2.5)	2.25

Test Parameters		
Test Temperature	Room	
Moisture Condition	As-Received	
Sample Weight, gms	490.88	
Sample Volume, cc	187	
Wet Density, pcf	164	

Test Results	
Overall Loading Rate, psi/sec	20
Peak Load, lbs	11667
Unconfined Compressive Strength, psi	4,280
Youngs Modulus, E psi	5.4 E+06
Slope of Lateral Curve, psi	-30.2 E+06
Poisson's Ratio	0.18

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By: ALO

Date Tested: 8/28/2019

Corrosivity Testing

Client F&ME Consultants
 Client Project G6100.050 Load Restricted Bridge Package 2020-1
 Project No. 42301

Lab Sample ID	Boring	Depth	Sample	Matrix	pH AASHTO T289			Chloride AASHTO T291 (Method B)			Sulfate AASHTO T290 (Method B)			Min. Soil Resistivity AASHTO T288		
					Result	Date Tested	Tested By	Result mg/kg (ppm)	Date Tested	Tested By	Result mg/kg (ppm)	Date Tested	Tested By	Result, Ohm-cm	Date Tested	Tested By
42301013	G6100.050.00001	B-901	0.0' - 10.0'	Soil	5.3	8/27/2019	AMP	75	8/29/2019	AMP	<30	8/28/2019	AMP	16,500	8/27/2019	AMP
42301014	G6100.050.00002	B-802	0.0' - 10.0'	Soil	5.4	8/27/2019	AMP	47	8/29/2019	AMP	<30	8/28/2019	AMP	9,850	8/27/2019	AMP
42301015	G6100.050.00003	B-1001	0.0' - 10.0'	Soil	5.7	8/27/2019	AMP	<10	8/29/2019	AMP	<30	8/28/2019	AMP	16,500	8/27/2019	AMP
42301016	G6100.050.00004	B-602	0.0' - 10.0'	Soil	5.6	8/27/2019	AMP	<10	8/29/2019	AMP	<30	8/28/2019	AMP	15,500	8/27/2019	AMP
42301017	G6100.050.00005	B-501	0.0' - 10.0'	Soil	6.0	8/27/2019	AMP	75	8/29/2019	AMP	<30	8/28/2019	AMP	4,900	8/27/2019	AMP
42301018	G6100.050.00006	B-701	0.0' - 10.0'	Soil	5.2	8/27/2019	AMP	<10	8/29/2019	AMP	<30	8/28/2019	AMP	18,000	8/27/2019	AMP
42301019	G6100.050.00007	B-1202	0.0' - 10.0'	Soil	5.5	8/27/2019	AMP	38	8/29/2019	AMP	88	8/28/2019	AMP	1,700	8/27/2019	AMP
42301020	G6100.050.00008	B-1602	0.0' - 10.0'	Soil	6.1	8/27/2019	AMP	136	8/29/2019	AMP	<30	8/28/2019	AMP	3,500	8/27/2019	AMP
42301021	G6100.050.00009	B-402	0.0' - 10.0'	Soil	5.9	8/27/2019	AMP	<10	8/29/2019	AMP	<30	8/28/2019	AMP	10,500	8/29/2019	AMP
42301022	G6100.050.00010	B-301	0.0' - 10.0'	Soil	7.5	8/27/2019	AMP	40	8/29/2019	AMP	28	8/28/2019	AMP	2,200	8/29/2019	AMP
42301023	G6100.050.00011	B-202	0.0' - 10.0'	Soil	5.9	8/27/2019	AMP	<10	8/29/2019	AMP	36	8/28/2019	AMP	7,200	8/29/2019	AMP
42301024	G6100.050.00012	B-101	0.0' - 10.0'	Soil	6.2	8/27/2019	AMP	<10	8/29/2019	AMP	<30	8/28/2019	AMP	6,000	8/29/2019	AMP
42301025	G6100.050.00013	B-1302	0.0' - 10.0'	Soil	4.9	8/27/2019	AMP	40	8/29/2019	AMP	<30	8/28/2019	AMP	8,500	8/28/2019	AMP
42301026	G6100.050.00014	B-1402	0.0' - 10.0'	Soil	5.2	8/27/2019	AMP	<10	8/29/2019	AMP	<30	8/28/2019	AMP	11,000	8/28/2019	AMP
42301027	G6100.050.00015	B-1501	0.0' - 10.0'	Soil	5.8	8/27/2019	AMP	<10	8/29/2019	AMP	<30	8/28/2019	AMP	11,000	8/28/2019	AMP
42301028	G6100.050.00016	B-1102	0.0' - 10.0'	Soil	5.7	8/27/2019	AMP	78	8/29/2019	AMP	<30	8/28/2019	AMP	5,200	8/28/2019	AMP

Input Validation: AMP

Reviewed By: ALO