

REVISED

GEOTECHNICAL BASE LINE REPORT

Route S-30-34 Replacement Bridge over Millers Fork Creek
Laurens 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: P038301

F&ME Project #: G6100.05.05

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-30-34 Bridge over Millers Fork Creek
Laurens County, South Carolina
SCDOT Project ID: P038301
F&ME Project No.: G6100.050.05

Dear Mr. Harris:

Submitted herein is F&ME Consultants, Inc. (FME) revised Geotechnical Base Line Report (GBLR) for the Route S-30-34 Replacement Bridge over Millers Fork 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



TABLE OF CONTENTS

1.0	INTRODUCTION	3
2.0	FIELD EXPLORATION SUMMARY	3
2.1	Soil Test Borings (STB's).....	3
2.2	Groundwater	4
3.0	LABORATORY TESTING.....	4
4.0	SUBSURFACE STRATIGRAPHY	5
5.0	CONCEPTUAL GEOTECHNICAL ASSESSMENT.....	5

APPENDIX

SECTION 1	Site Location Plan – Figure 1
SECTION 2	Test Boring Location Plan – Figure 2
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

1.0 INTRODUCTION

FME performed geotechnical soil test borings and laboratory testing for the Route S-30-34 Replacement Bridge over Millers Fork Creek located in Laurens 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 June 30, 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-501	Paved Roadway	31.0	9.9	40.9	34.514716	-82.809363	579.5
B-502	Paved Roadway	37.3	9.4	46.7	34.514985	-82.110841	579.3
Totals	-	68.3	19.3	87.6			

2.2 Groundwater

Groundwater depths were recorded at the time of boring (TOB) for soil test boring B-501 with the recorded measurement noted on the individual Soil Test Boring Logs in Section 4 of the Appendix to this report. In test boring B-502 groundwater measurement was made at 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, as applicable.

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-501	5/30/2019	12.0	Backfilled
B-502	5/30/2019	Not Recorded	12.5

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	6	AASHTO T88
Grain Size Analyses with Wash 200	3	AASHTO T11
Atterberg Limits	5	AASHTO T89/T90
Natural Moisture Content	7	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	438	0	SM	3	-
Alluvium	432	6	SP, SP-SM, SM, ML	3	-
Residuum	410	28	SP	14	-
PWR	405	33	SM	100+	-
Bed Rock	404	34	N/A	N/A	Gneiss

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 will 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 sufficient to resist the assumed lateral loading conditions, and drilled pile will not be likely. We anticipate that the piles will be driven to a practical refusal pile driving condition on weathered rock or sound bedrock. To avoid excessive pile driving stresses, we anticipate that pile driving termination criteria will be based on encountering a pile driving practical refusal condition. Shallow foundation concepts are likely not feasible due to the estimated bearing depth and the presence of groundwater 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 may or may not be feasible based on the soil thickness above rock to resist the lateral loads. We anticipate that drilled shafts will be the most feasible foundation type for 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 on the order from 9,200 psi to 18,000 psi.

S-30-34 Replacement Bridge over Millers Fork 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

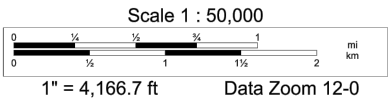
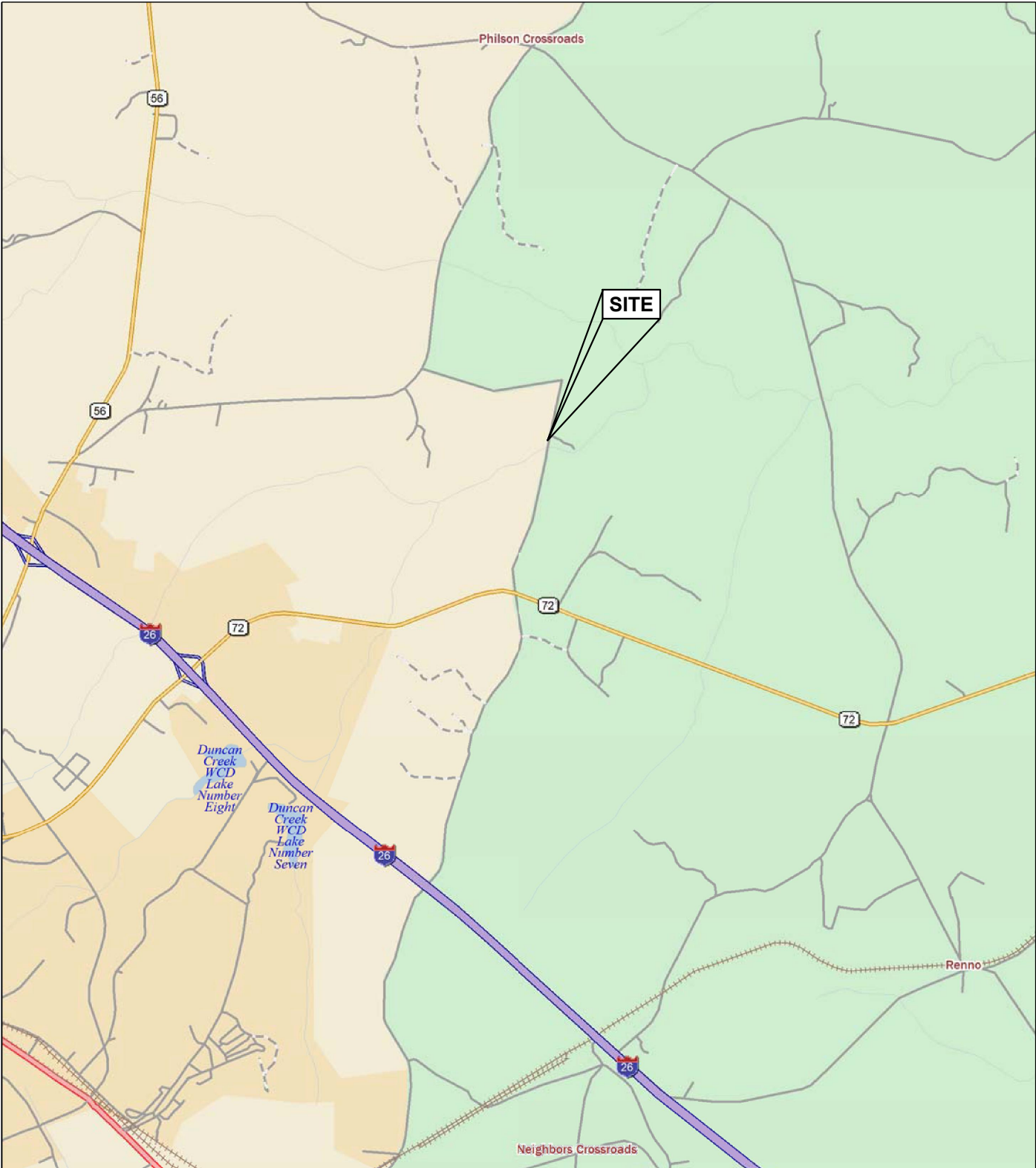
S-30-34 Replacement Bridge over Millers Fork Creek

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	LAURENS	P038301	S-30-34	



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	

MILLERS FORK CREEK
LAURENS COUNTY, SOUTH CAROLINA

SITE LOCATION PLAN

F&ME JOB NO. G6100.050

SCALE: AS NOTED

FIGURE 1

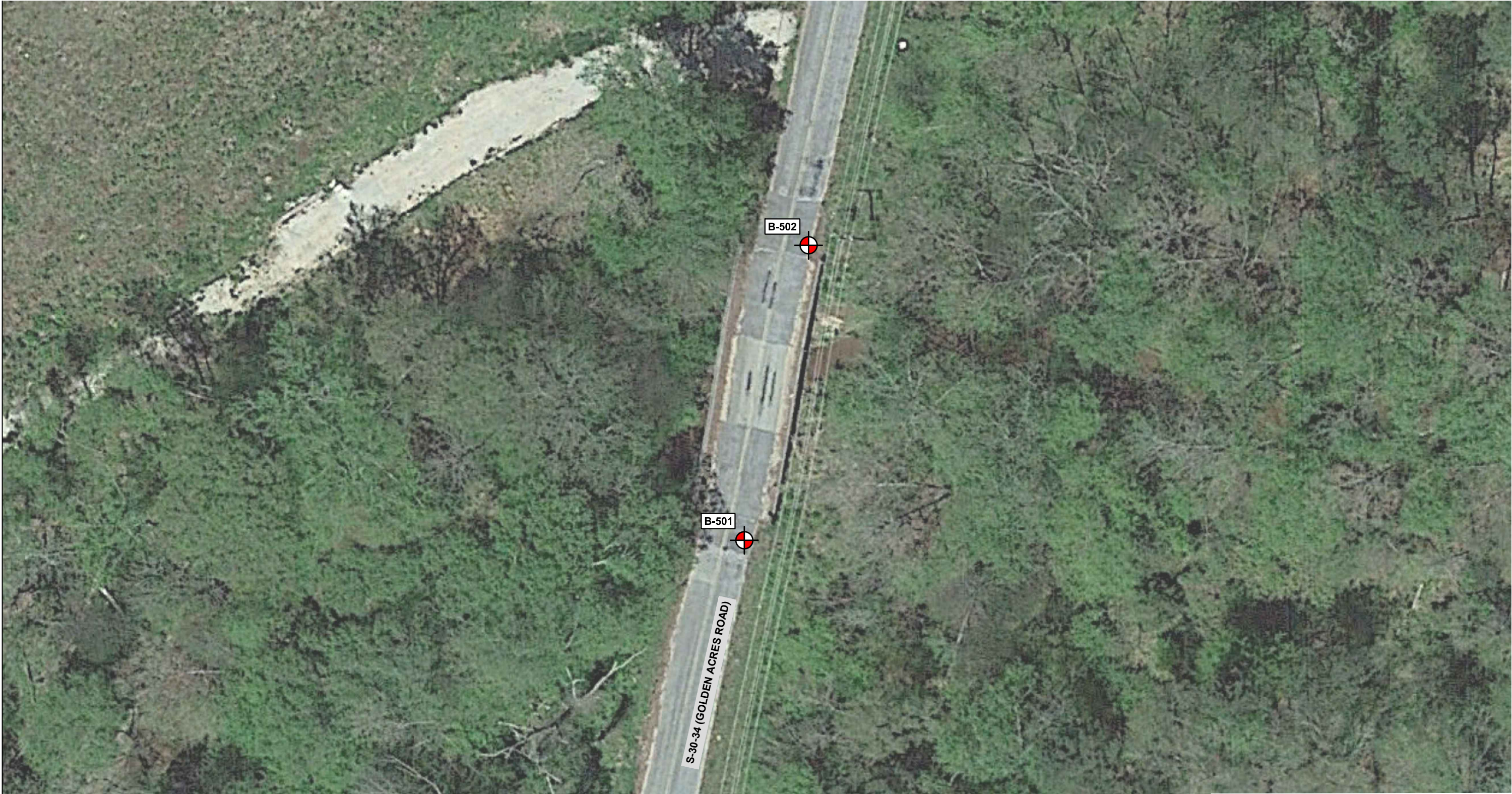
S-30-34 Replacement Bridge over Millers Fork Creek

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	LAURENS	P038301	S-30-34	



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

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

S-30-34 Replacement Bridge over Millers Fork Creek

Geotechnical Base Line Report

APPENDIX

SECTION 3 DRILL RIG PHOTOS

Drill Rig Setup Photographs

B-501



Drill Rig Setup Photographs

B-502



S-30-34 Replacement Bridge over Millers Fork Creek

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
				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			GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
		CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
FINE GRAINED SOILS	SILTS AND CLAYS	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
				ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	SILTS AND CLAYS			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
				MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
HIGHLY ORGANIC SOILS	SILTS AND CLAYS			CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
				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:	P038301	County:	Laurens	Boring No.:	B-501
Site Description:	S-30-34 Replacement Bridge over Millers Fork Creek			Route:	S-30-34
Eng./Geo.:	R. Wessinger	Boring Location:	N/A	Offset:	N/A
Elev.:	438.1 ft	Latitude:	34.514716	Longitude:	-81.809363
Total Depth:	40.9 ft	Soil Depth:	31 ft	Core Depth:	9.9 ft
Date Started:	5/30/2019				
Date Completed:	5/30/2019				
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	12 ft	24HR
					Backfilled

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	● SPT N VALUE ●	PL MC LL	▲ FINES CONTENT (%)
	0.0	ASPHALT (11.5-in)											
	1.0	FILL		1.0									
	2.0	Very Loose, Moist, Reddish Brown/Red, Non-Plastic, Silty Fine to Medium SAND (SM), Micaceous, Munsell= 5YR 4/4 & 2.5YR 4/6		2.0	SS-1	1	2						
	3.0			3.0									
	4.0			4.0	SS-2	1	1	2	2	3	●		
433.1	5.0			5.0									
	6.0			6.0	SS-3	2	1	1	2	2	●		
	7.0	ALLUVIUM		7.0									
	8.0	Very Loose, Moist to Wet, Reddish Brown, Non-Plastic, Silty Fine to Medium SAND (SM/A-2-4), Micaceous, Munsell= 5YR 4/4		8.0	SS-4	1	1	1	2	2	●		
	9.0	@SS-5: LL=NP, PL=NP, PI=NP, NMC=13.9%, %200=19.0		9.0									
	10.0	@8-ft.: Yellowish Red, Fine Sands, Munsell= 5YR 5/8		10.0	SS-5	2	1	2	1	3	●	○	▲
428.1	11.0			11.0									
	12.0			12.0									
	13.5	Very Loose, Moist to Wet, Grayish Brown, Fine SAND (SP-SM) with Silt, Munsell= 10YR 5/2		13.5	SS-6	1	2	1		3	●	▲	
423.1	14.5	@SS-6: %200=9.7		14.5									
	15.5			15.5									
	16.5			16.5									
	17.5			17.5									
	18.5	Very Loose, Wet, Dark Grayish Brown, Non-Plastic, Silty Fine to Medium SAND (SM), Micaceous, with Trace of Thin Clay Seams, Munsell=10YR 4/2		18.5	SS-7	4	2	2		4	●	○	▲
418.1	19.5	@SS-7 NMC=26.3%, %200=35.1		19.5									
	20.5			20.5									
	21.5			21.5									
	22.5			22.5									
	23.5			23.5									

LEGEND

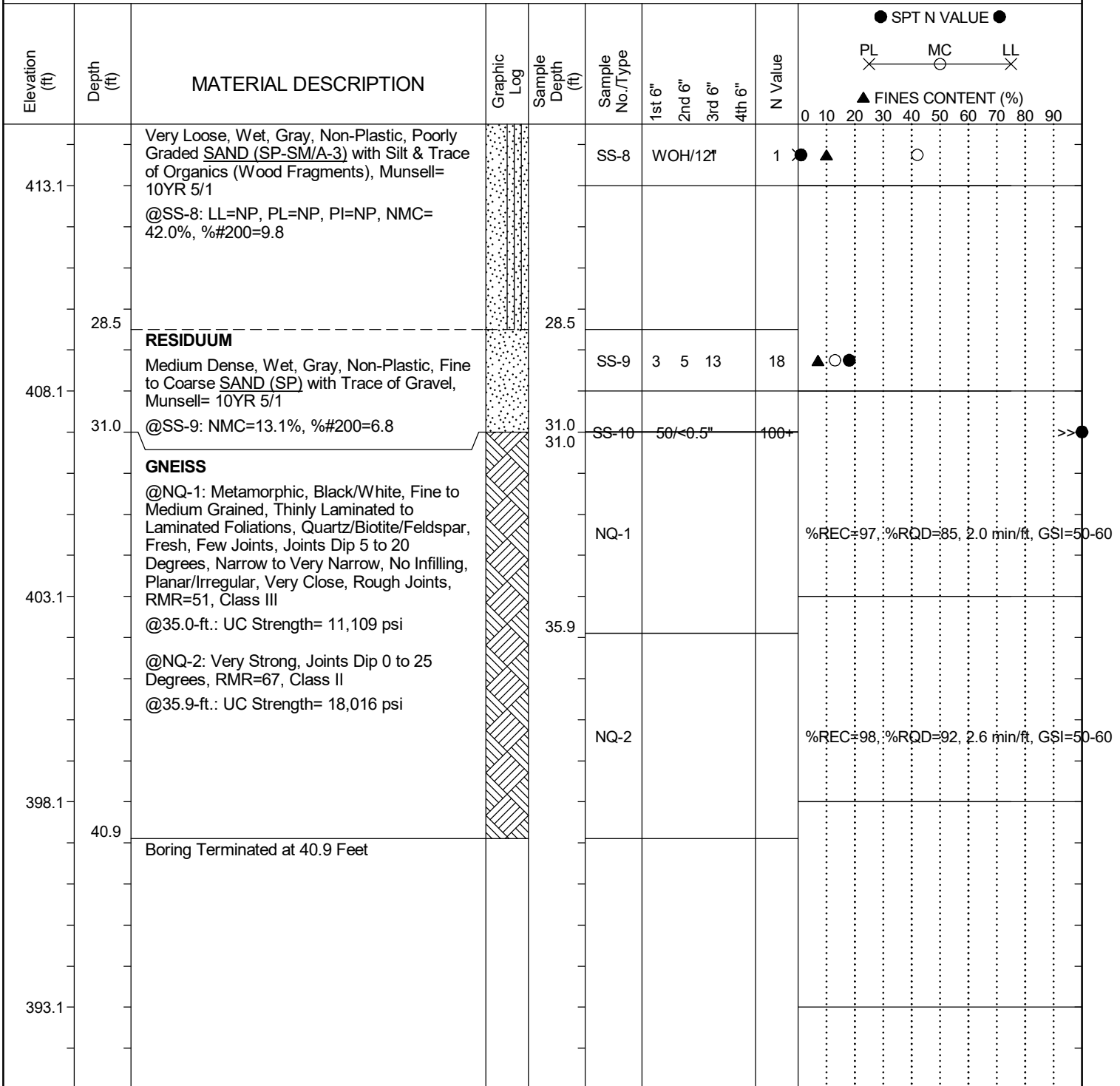
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SAMPLER TYPE	
SS - Split Spoon	NQ - Rock Core, 1-7/8"
UD - Undisturbed Sample	CU - Cuttings
AWG - Rock Core, 1-1/8"	CT - Continuous Tube

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:	P038301	County:	Laurens	Boring No.:	B-501
Site Description:	S-30-34 Replacement Bridge over Millers Fork Creek			Route:	S-30-34
Eng./Geo.:	R. Wessinger	Boring Location:	N/A	Offset:	N/A
Elev.:	438.1 ft	Latitude:	34.514716	Longitude:	-81.809363
Date Started:	5/30/2019				
Total Depth:	40.9 ft	Soil Depth:	31 ft	Core Depth:	9.9 ft
Date Completed:	5/30/2019				
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	12 ft	24HR
					Backfilled



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:	P038301	County:	Laurens	Boring No.:	B-502
Site Description:	S-30-34 Replacement Bridge over Millers Fork Creek			Route:	S-30-34
Eng./Geo.:	R. Wessinger	Boring Location:	N/A	Offset:	N/A
Elev.:	438.0 ft	Latitude:	34.514985	Longitude:	-81.809295
Date Started:	5/30/2019				
Total Depth:	46.6 ft	Soil Depth:	37.3 ft	Core Depth:	9.4 ft
Date Completed:	5/30/2019				
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 NR	24HR	12.5 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	● SPT N VALUE ●	PL X MC X LL X	▲ FINES CONTENT (%)
	0.0	ASPHALT (12.5-in)											
	1.0	FILL											
	2.0	Loose to Very Loose, Moist, Red, Non-Plastic, Silty Fine to Medium SAND (SM), Micaceous, Munsell= 2.5YR 4/8			SS-1	7	2						
	4.0				SS-2	1	2	3	3	5	●		
433.0	6.0				SS-3	2	1	2	2	3	●		
	8.0	ALLUVIUM											
	8.0	Very Loose, Moist to Wet, Yellowish Red, Medium Plasticity, Silty Fine to Medium SAND (SM/A-7-5(1)), Munsell=5YR 4/6			SS-4	1	1	2	3	3	●	○ X ▲	
		@SS-4: LL= 44, PL=32, PI=12, NMC=26.0%, %200=39.5			SS-5	1	1	1	2	3	●		
428.0		Very Loose, Moist, Yellowish Red, Non-Plastic, Fine to Medium SAND (SP-SM) with Silt, Micaceous, Munsell=5YR 4/6											
	13.5	@13.5-ft.: Wet, Light Grayish Brown, Fine to Coarse Sands, Munsell=10YR 6/2			SS-6	1	2	2		4	● ▲		
423.0		@SS-6: %200=9.8											
	18.5												
418.0		Very Loose, Greenish Gray, Non-Plastic, Silty Fine to Coarse SAND (SM/A-2-4), Munsell=10GY 5/1			SS-7	2	1	1		2	●	○ ▲	
		@SS-7: LL=NP, PL=NP, PI=NP, NMC=23.3%, %200=34.4											
	23.5												
413.0		Very Loose, Moist to Wet, Greenish Gray, Low Plasticity, Sandy SILT (ML/A-4(1)), Micaceous, with Trace of Thin Clay Seams, Munsell=10GY 5/1			SS-8	VOH/12"	3			3	●	○ X	▲
		@SS-8: NMC=30.3%, %200=60.4											
28.5													

LEGEND

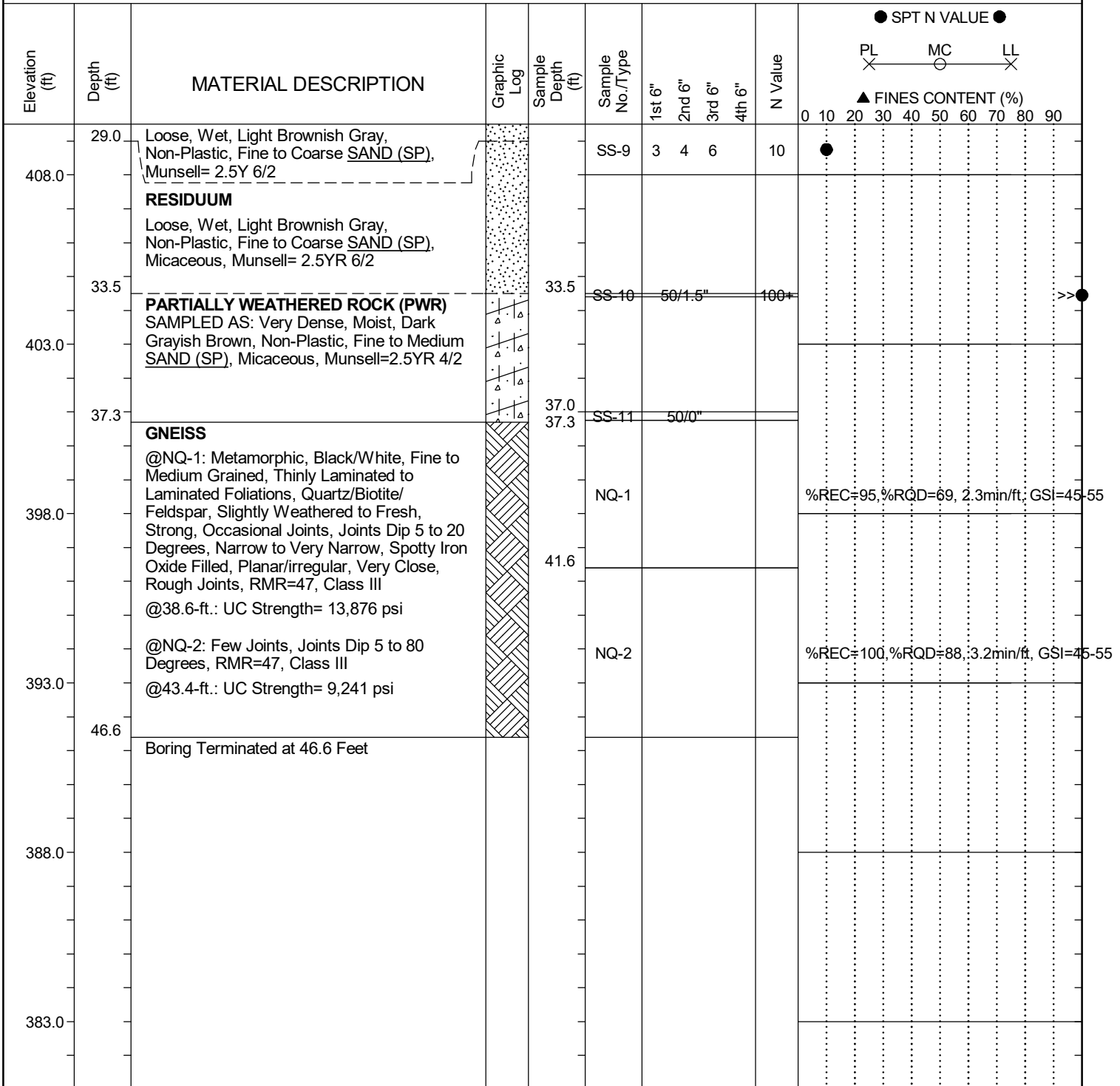
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SAMPLER TYPE	
SS - Split Spoon	NQ - Rock Core, 1-7/8"
UD - Undisturbed Sample	CU - Cuttings
AWG - Rock Core, 1-1/8"	CT - Continuous Tube

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:	P038301	County:	Laurens	Boring No.:	B-502
Site Description:	S-30-34 Replacement Bridge over Millers Fork Creek			Route:	S-30-34
Eng./Geo.:	R. Wessinger	Boring Location:	N/A	Offset:	N/A
Elev.:	438.0 ft	Latitude:	34.514985	Longitude:	-81.809295
Date Started:	5/30/2019				
Total Depth:	46.6 ft	Soil Depth:	37.3 ft	Core Depth:	9.4 ft
Date Completed:	5/30/2019				
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 NR
24HR	12.5 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-30-34 Replacement Bridge over Millers Fork Creek

Geotechnical Base Line Report

















APPENDIX

SECTION 5 GENERALIZED SUBSURFACE PROFILE

KEY TO SYMBOLS

PROJECT NAME	Closed and Load-Restricted Bridge Package 2020-1 (S-30-34 Bridge Replacement over Millers Fork Creek)
PROJECT COUNTY	Laurens

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

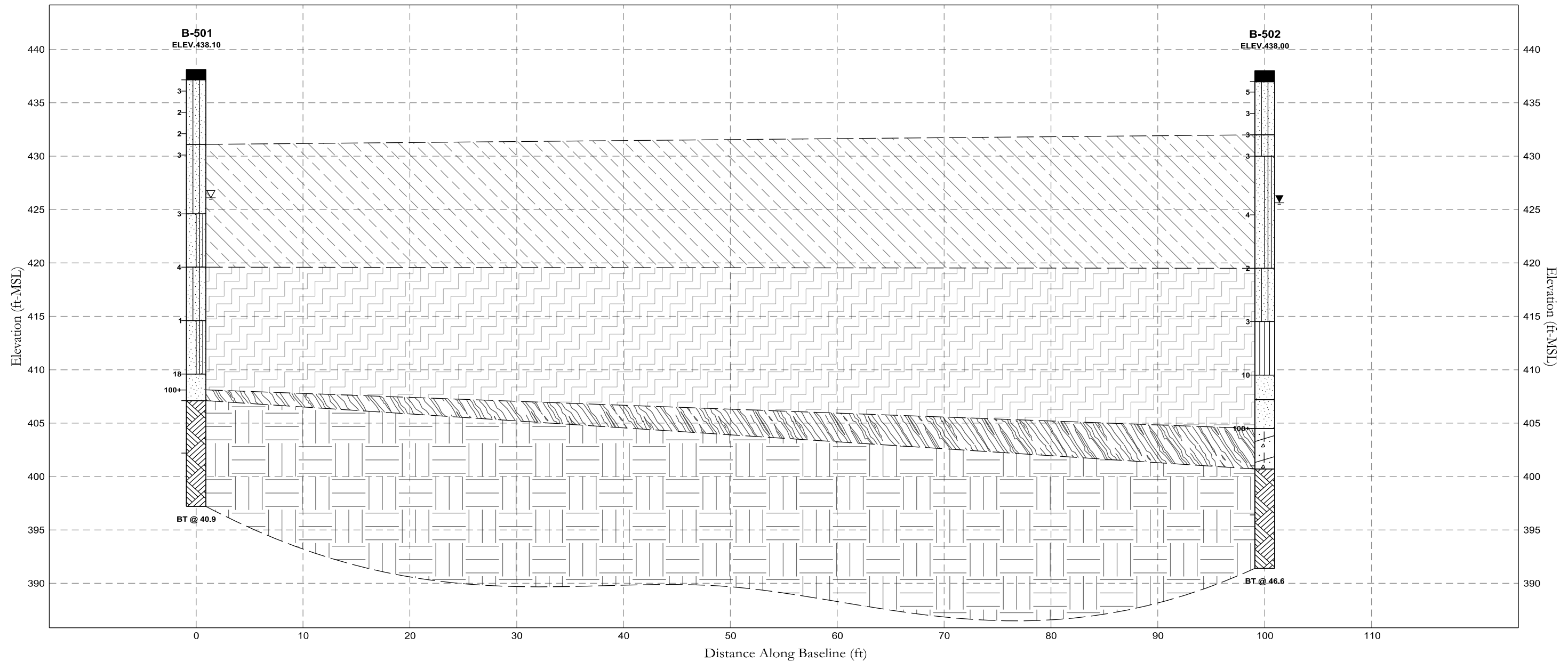
ABBREVIATIONS

- 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

- 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

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.

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



**S-30-34 BRIDGE REPLACEMENT
OVER MILLERS FORK CREEK**

GENERALIZED SUBSURFACE PROFILE

HRZ SCALE = NTS

VRT SCALE = NTS

S-30-34 Replacement Bridge over Millers Fork Creek

Geotechnical Base Line Report

APPENDIX

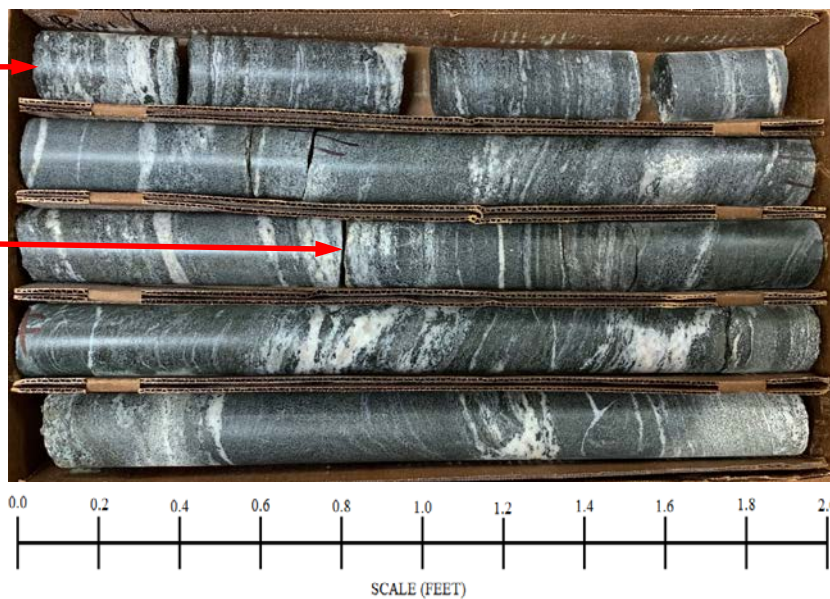
SECTION 6 ROCK CORE PHOTOS

S-30-34 RBO Millers Fork Creek

Boring B-501

Begin Run 1
31.0 feet

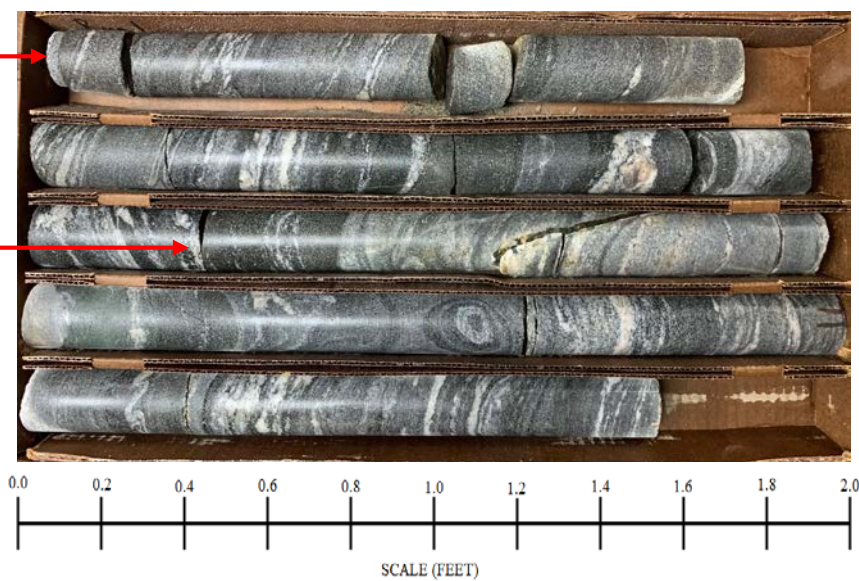
Begin Run 2
35.9 feet



Boring B-502

Begin Run 1
37.3 feet

Begin Run 2
41.6 feet



S-30-34 Replacement Bridge over Millers Fork Creek

Geotechnical Base Line Report

APPENDIX

SECTION 7 LABORATORY TEST RESULTS



SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens

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-501	10.0	NP	NP	NP	4.76	19	SM	13.9			
B-501	15.0				4.76	10					
B-501	20.0				4.76	35		26.3			
B-501	25.0	NP	NP	NP	19	10	SP-SM	42.0			
B-501	30.0				19	7		13.1			
B-502	8.0	44	32	12	4.76	39	SM	26.0			
B-502	15.0				4.76	10					
B-502	20.0	NP	NP	NP	4.76	34	SM	23.3			
B-502	25.0	28	23	5	9.51	60	ML	30.3			



Rock Coring Summary

Project ID: P038301

Project Name: S-30-34 RBO Millers Fork Creek

Project County: Laurens

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-501	NQ-1	31.0	97	85	11,109	0.29	3.30E+03	170	51
									50-60
	NQ-2	35.9	98	92	18,016	0.36	5.40E+03	173	67
									50-60
B-502	NQ-1	37.3	95	69	13,876	0.44	4.20E+03	167	47
									45-55
	NQ-2	41.6	100	88	9,241	0.60	4.50E+03	177	47
									45-55

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

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	<u>S-30-34 Replacement Bridge over Millers Fork Creek</u>	PROJECT NO.:	<u>P038301</u>
SAMPLE NUMBER:	<u>19-1595</u>	DATE SAMPLE RECEIVED:	<u>6/18/2019</u>
DESCRIPTION OF SOIL:	<u>VARIOUS</u>		
TESTED BY:	<u>AMC</u>	DATE OF TESTING:	<u>8/7/2019</u>
WEIGHED BY:	<u>AMC</u>	DATE OF WEIGHING:	<u>8/8/2019</u>

BORING NO.	B-501	B-501	B-501	B-501	
SAMPLE NO.	SS-5	SS-7	SS-8	SS-9	
SAMPLE DEPTH	8-10'	18.5-20'	23.5-25'	28.5-30'	
WATER CONTENT, W%	13.9	26.3	42.0	13.1	

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%					

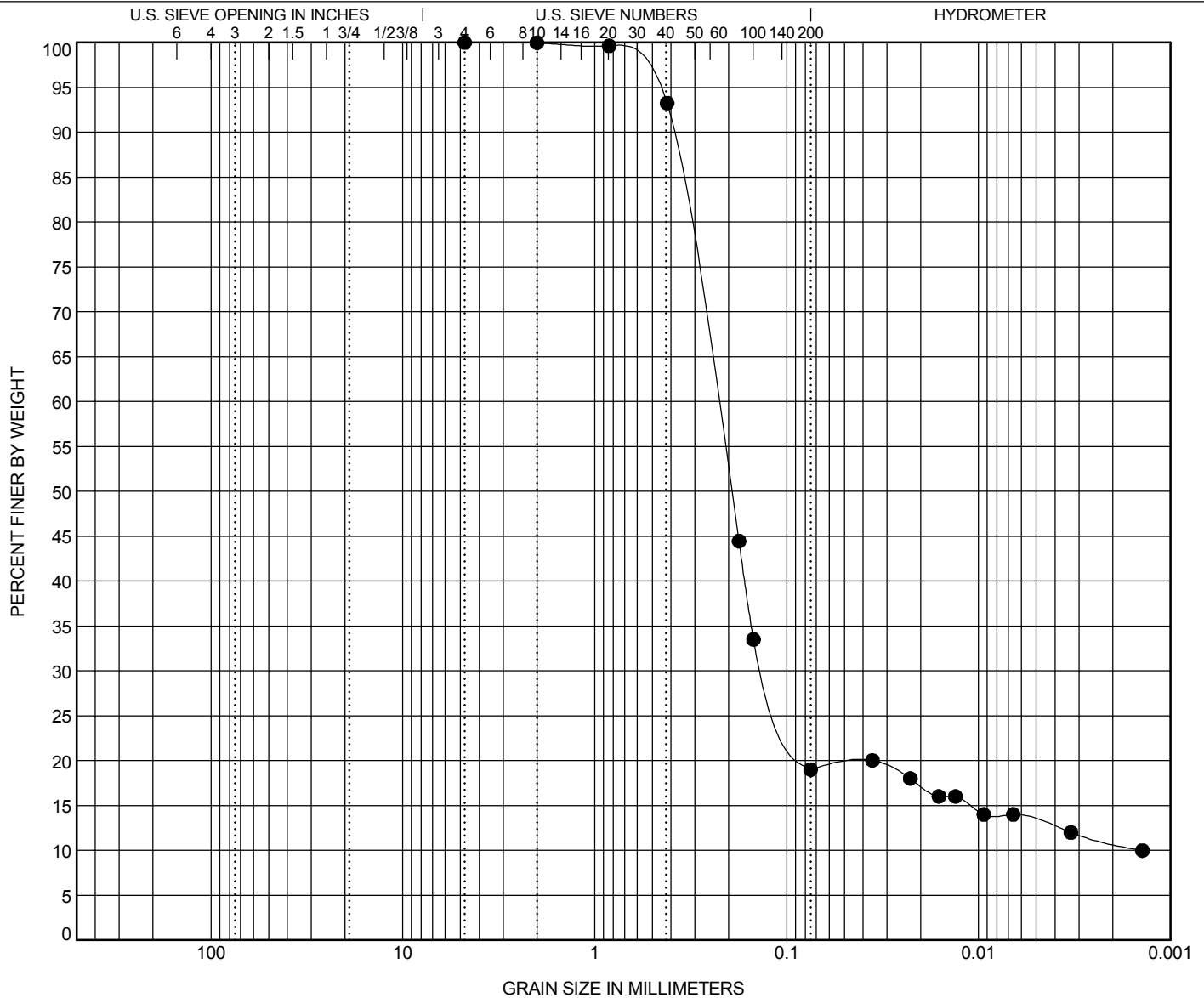


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-501	10.0	Silty SAND (SM/A-2-4)					NP	NP	NP	32.18	165.88
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay		
● B-501	10.0	4.76	0.507	0.195	0.001	0.0	81.0	5.8	13.2		

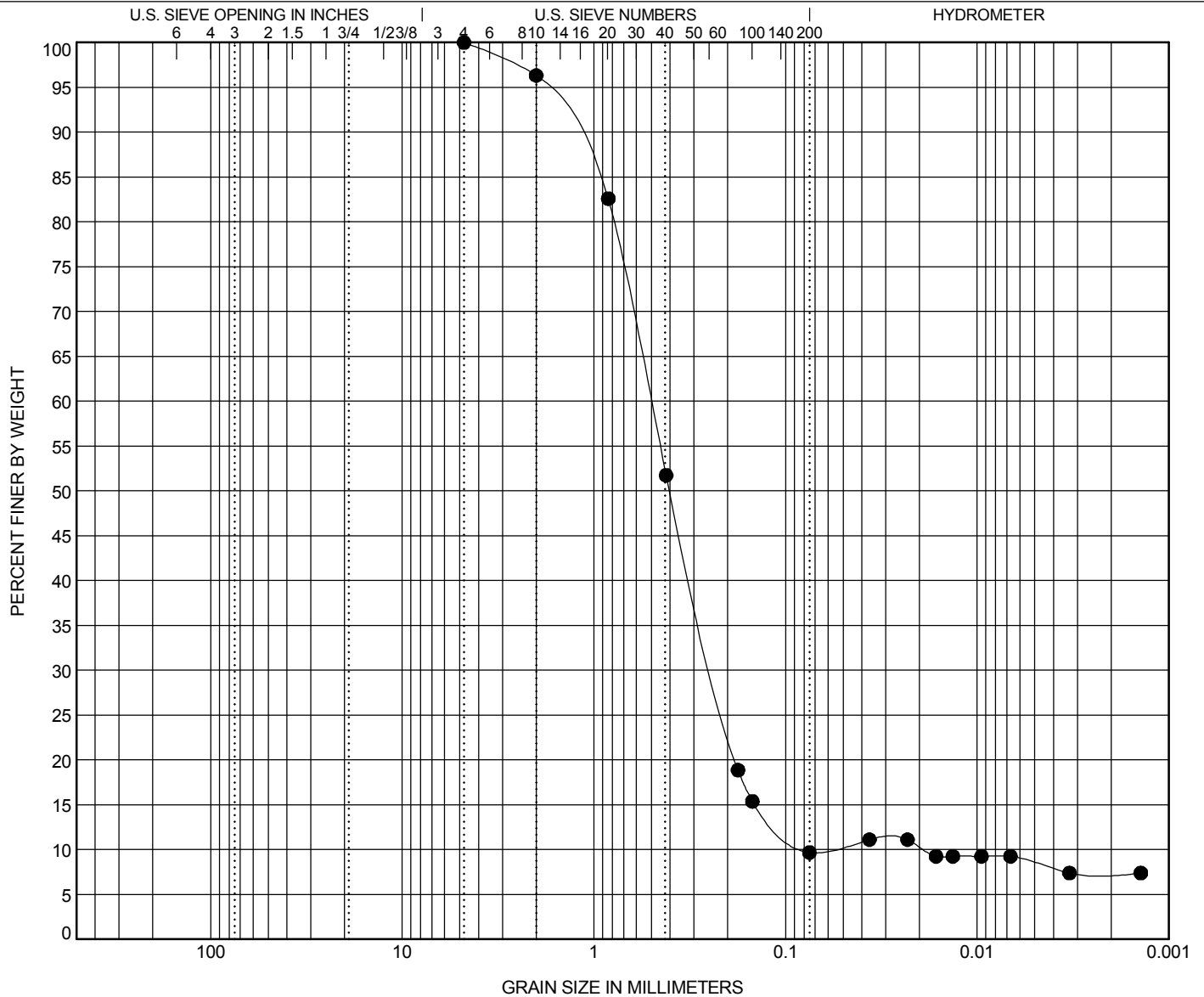


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-501	15.0	SAND (SP-SM) with Silt								1.92	8.73
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay		
● B-501	15.0	4.76	1.839	0.401	0.058	0.0	90.3	1.2	8.5		

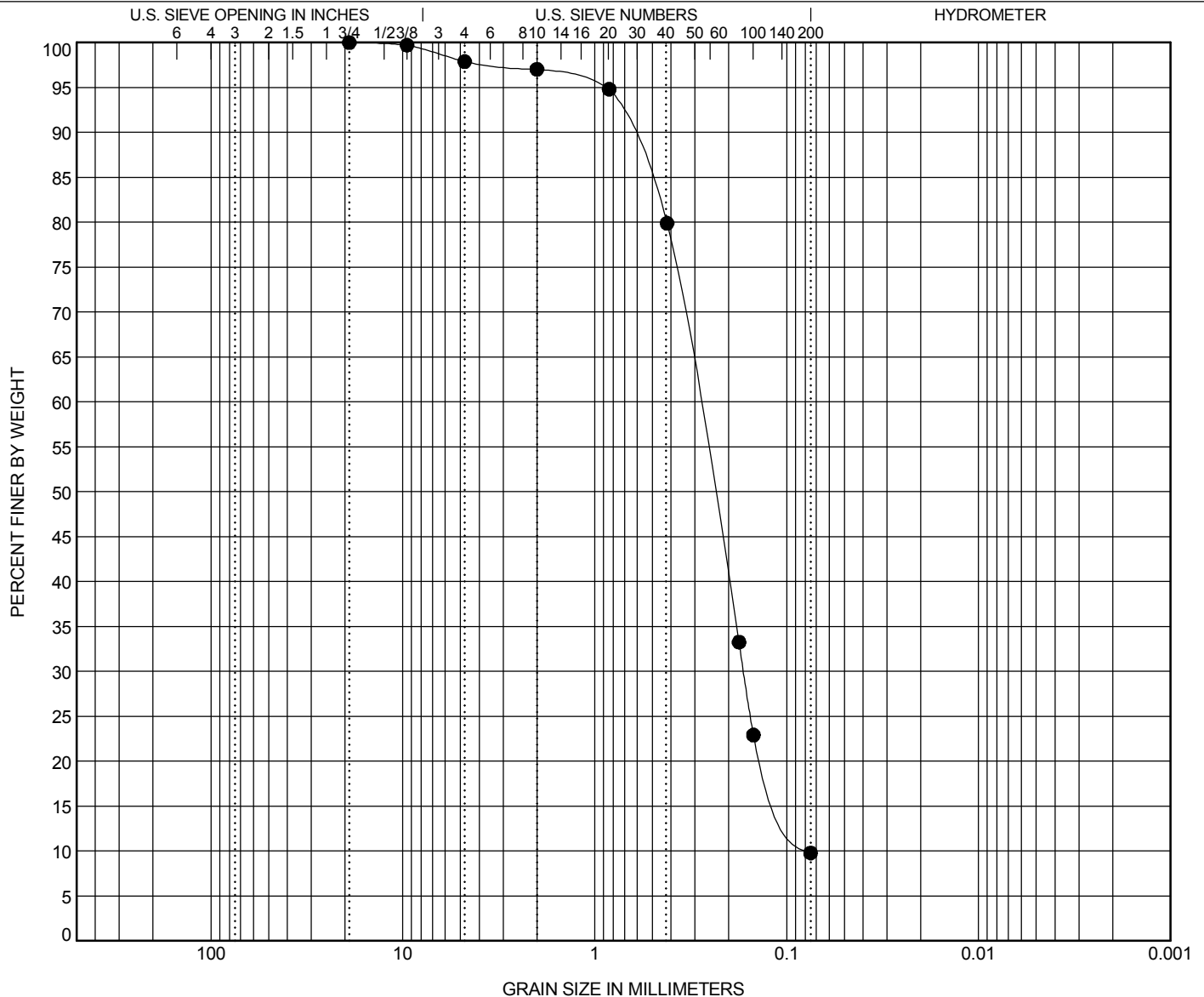


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens



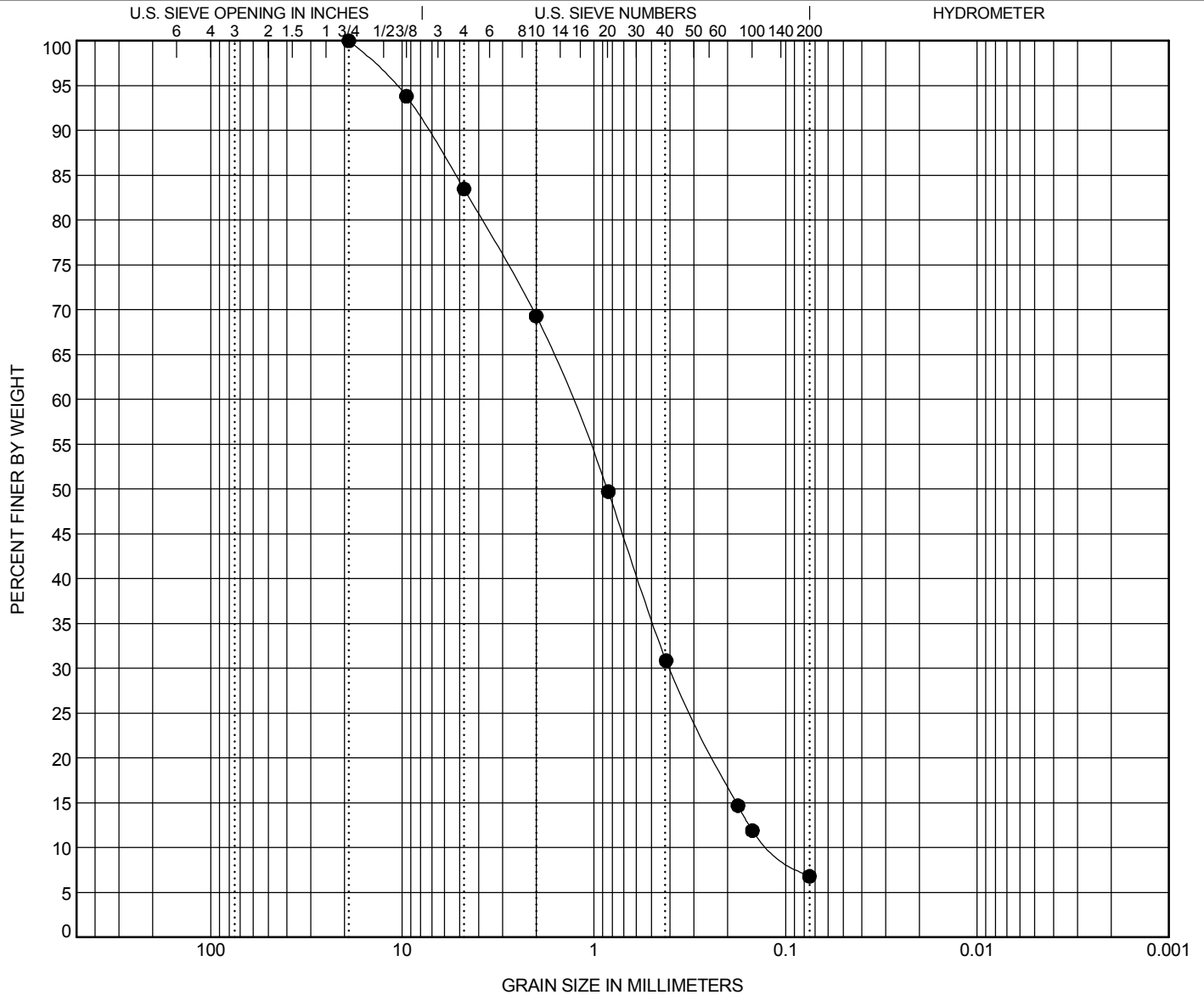


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens

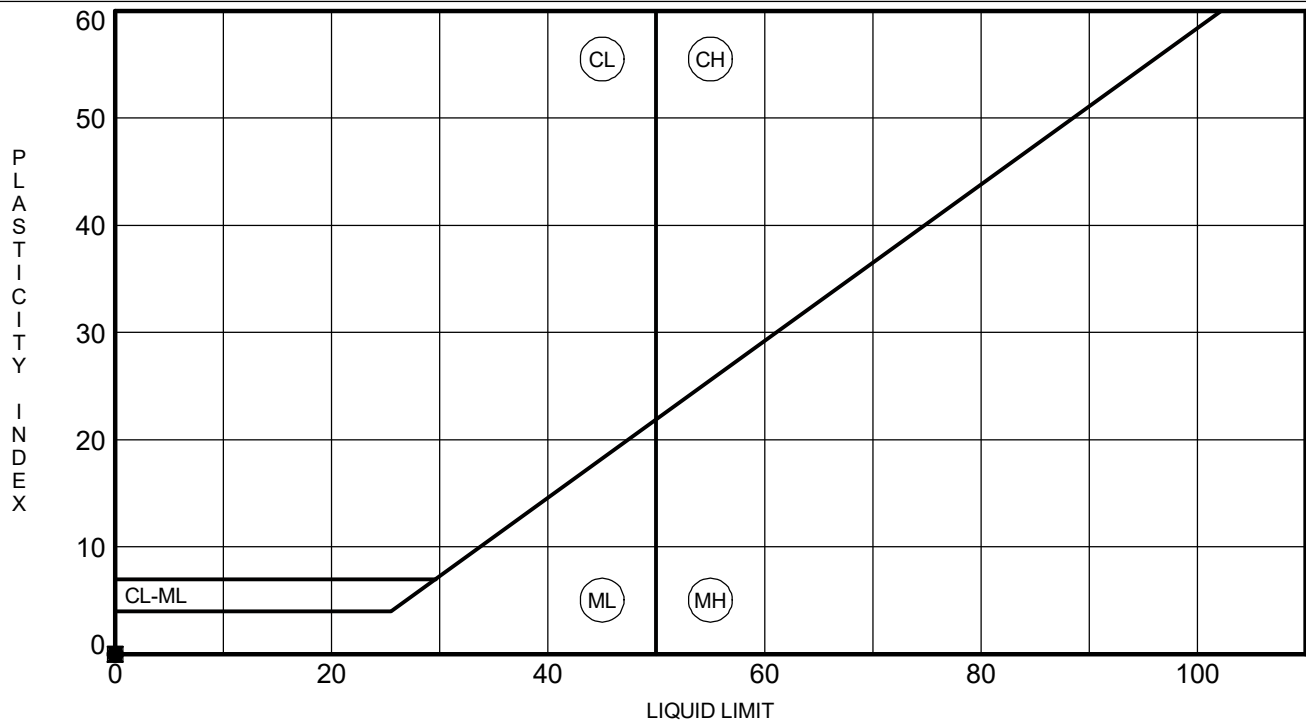


ATTERBERG LIMITS' RESULTS

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens

[illegible]

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

Client F&ME Consultants
 Client Project G6100.050 - Load Restricted Bridge Projects
 Project Number 42140

Boring G6100.050.00005 - Millers Fork Creek
 Depth 35.0' - 35.3'
 Sample RC-501.1
 Lab ID number 42140017

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

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

Axial Strain	Diametric Strain	Axial Stress psi
1.55E-03	-3.92E-04	5526
6.86E-04	-1.44E-04	2716

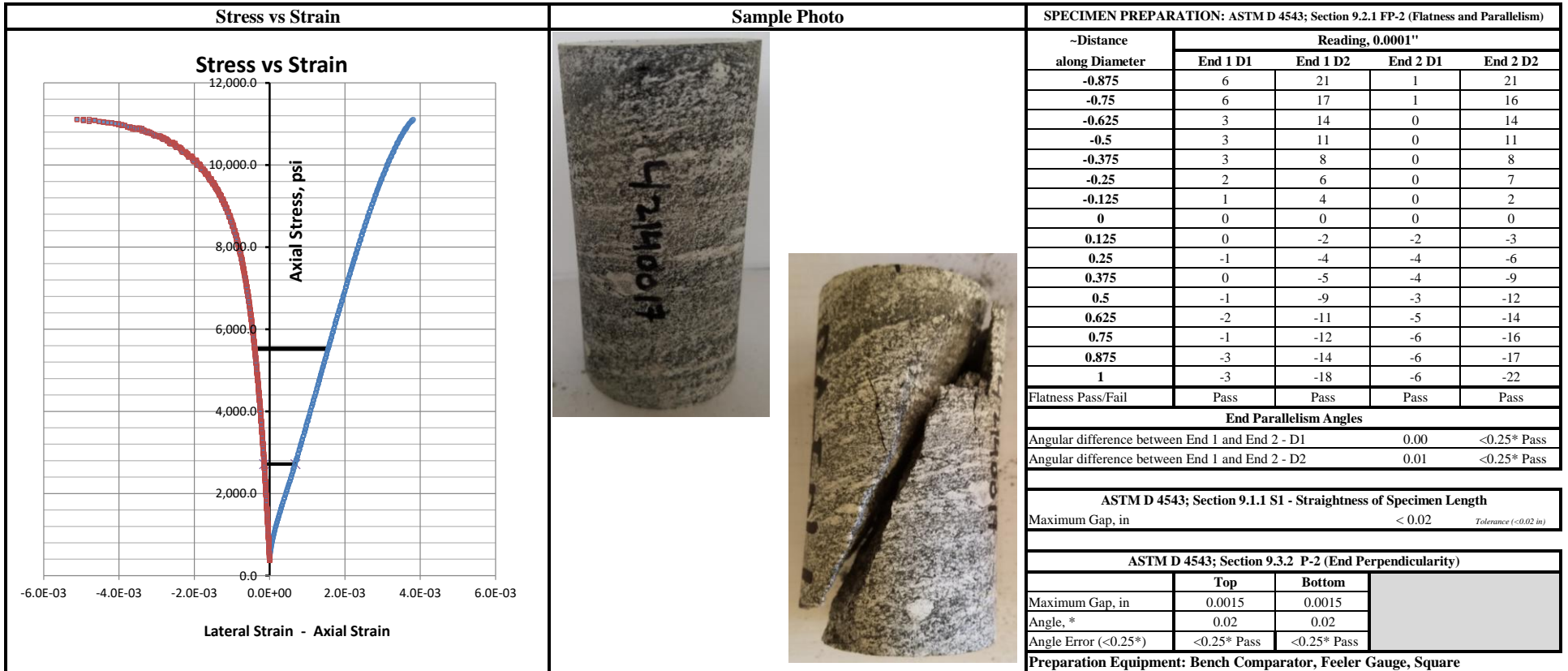
ASTM D 4543; Section 4.2 & 5.6	
Length, in	3.997
Mid Height Diameter #1, in	1.862
Mid Height Diameter #2, in	1.864
Average Mid. Height Diameter, in.	1.86
Sample Area, in ²	2.73
L/D Ratio (2.0-2.5)	2.15

Test Parameters		
Test Temperature	Room	
Moisture Condition	As-Received	
Sample Weight, gms	486.16	
Sample Volume, cc	179	
Wet Density, pcf	170	

Test Results	
Overall Loading Rate, psi/sec	40
Peak Load, lbs	30282
Unconfined Compressive Strength, psi	11,109
Youngs Modulus, E psi	3.3 E+06
Slope of Lateral Curve, psi	-11.3 E+06
Poisson's Ratio	0.29

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By: ALO

Date Tested: 7/25/2019

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

Client F&ME Consultants
 Client Project G6100.050 - Load Restricted Bridge Projects
 Project Number 42140
 Description: Gray Granite
 As-Received Condition: Useable L/D > 2
 Sample Preparation: Diamond saw blade cut, surface ground flat

Boring G6100.050.00005 - Millers Fork Creek
 Depth 35.9' - 36.2'
 Sample RC-501.2
 Lab ID number 42140018

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
1.61E-03	-4.93E-04	8997
7.81E-04	-1.96E-04	4513

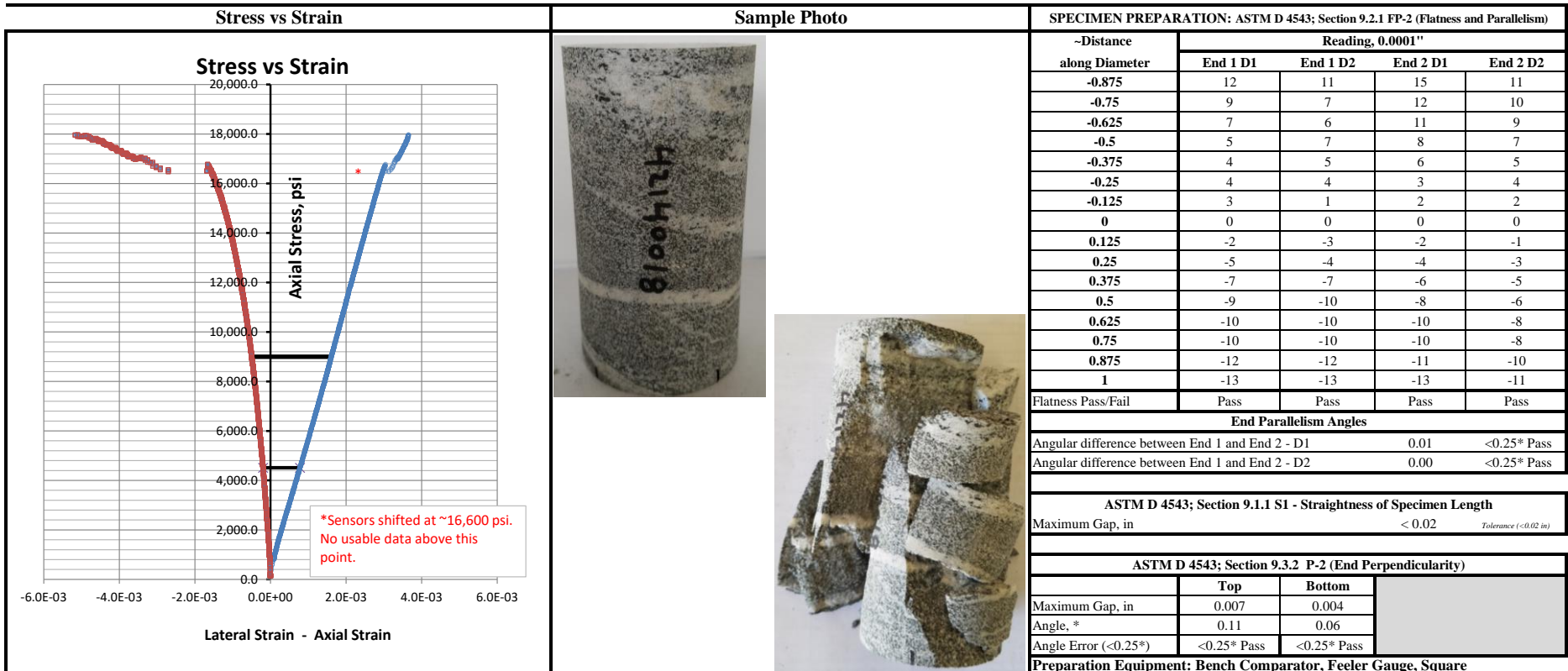
ASTM D 4543; Section 4.2 & 5.6	
Length, in	3.79
Mid Height Diameter #1, in	1.863
Mid Height Diameter #2, in	1.864
Average Mid. Height Diameter, in.	1.86
Sample Area, in^2	2.73
L/D Ratio (2.0-2.5)	2.03

Test Parameters		
	Test Temperature	Room
	Moisture Condition	As-Received
	Sample Weight, gms	469.15
	Sample Volume, cc	169
	Wet Density, pcf	173

Test Results	
Overall Loading Rate, psi/sec	40
Peak Load, lbs	49136
Unconfined Compressive Strength, psi	18,016
Youngs Modulus, E psi	5.4 E+06
Slope of Lateral Curve, psi	-15.1 E+06
Poisson's Ratio	0.36

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By:

Date Tested:

7/25/2019

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

MOISTURE CONTENT DETERMINATION
(AASHTO T265)

PROJECT:	S-30-34 Replacement Bridge over Millers Fork Creek	PROJECT NO.:	P9038301
SAMPLE NUMBER:	19-1597	DATE SAMPLE RECEIVED:	6/18/2019
DESCRIPTION OF SOIL:	VARIOUS		
TESTED BY:	AMC	DATE OF TESTING:	8/7/2019
WEIGHED BY:	AMC	DATE OF WEIGHING:	8/8/2019

BORING NO.	B-502	B-502	B-502		
SAMPLE NO.	SS-4	SS-7	SS-8		
SAMPLE DEPTH	6-8'	18.5-20'	23.5-25'		
WATER CONTENT, W%	26.0	23.3	30.3		

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%					

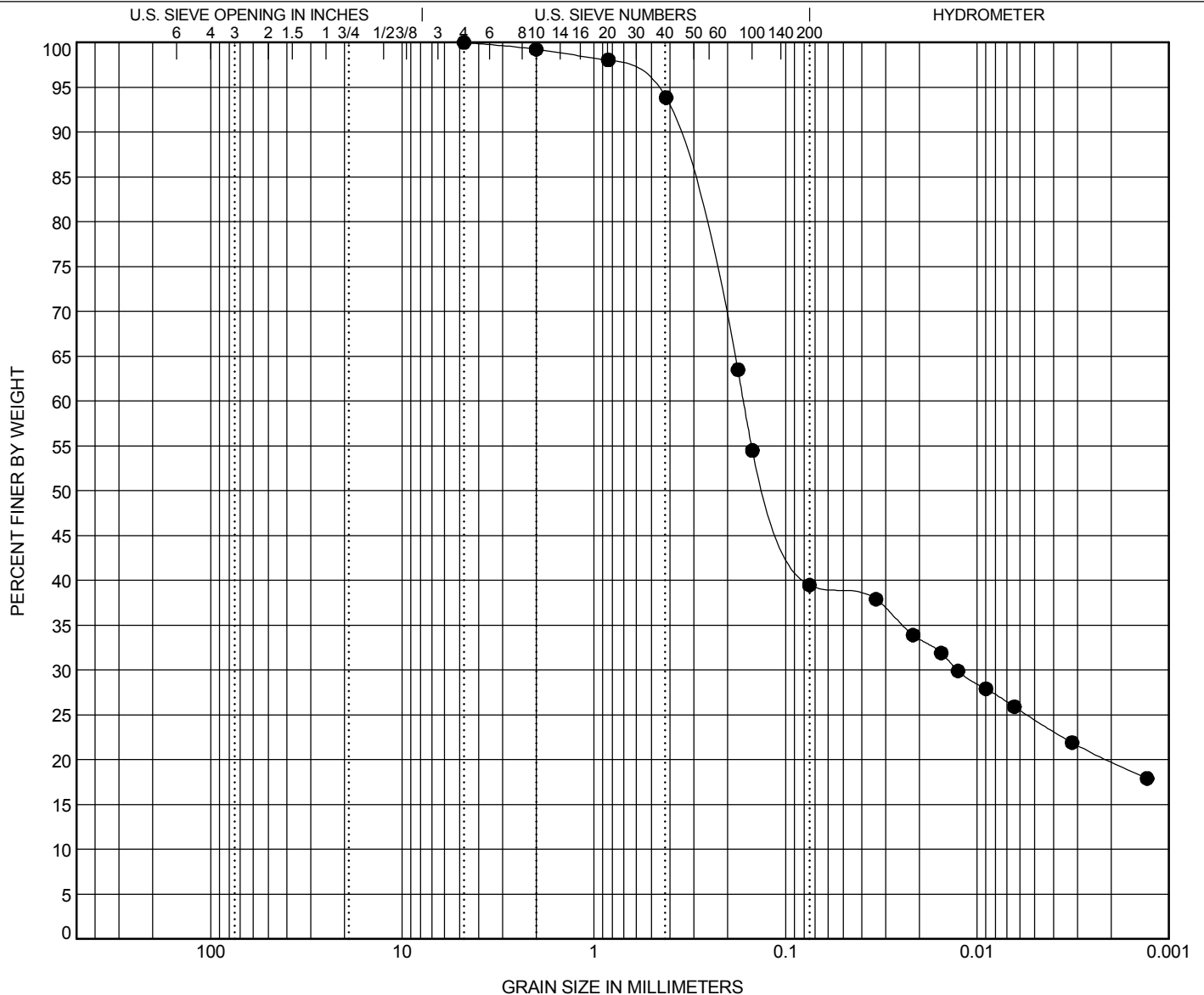


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens



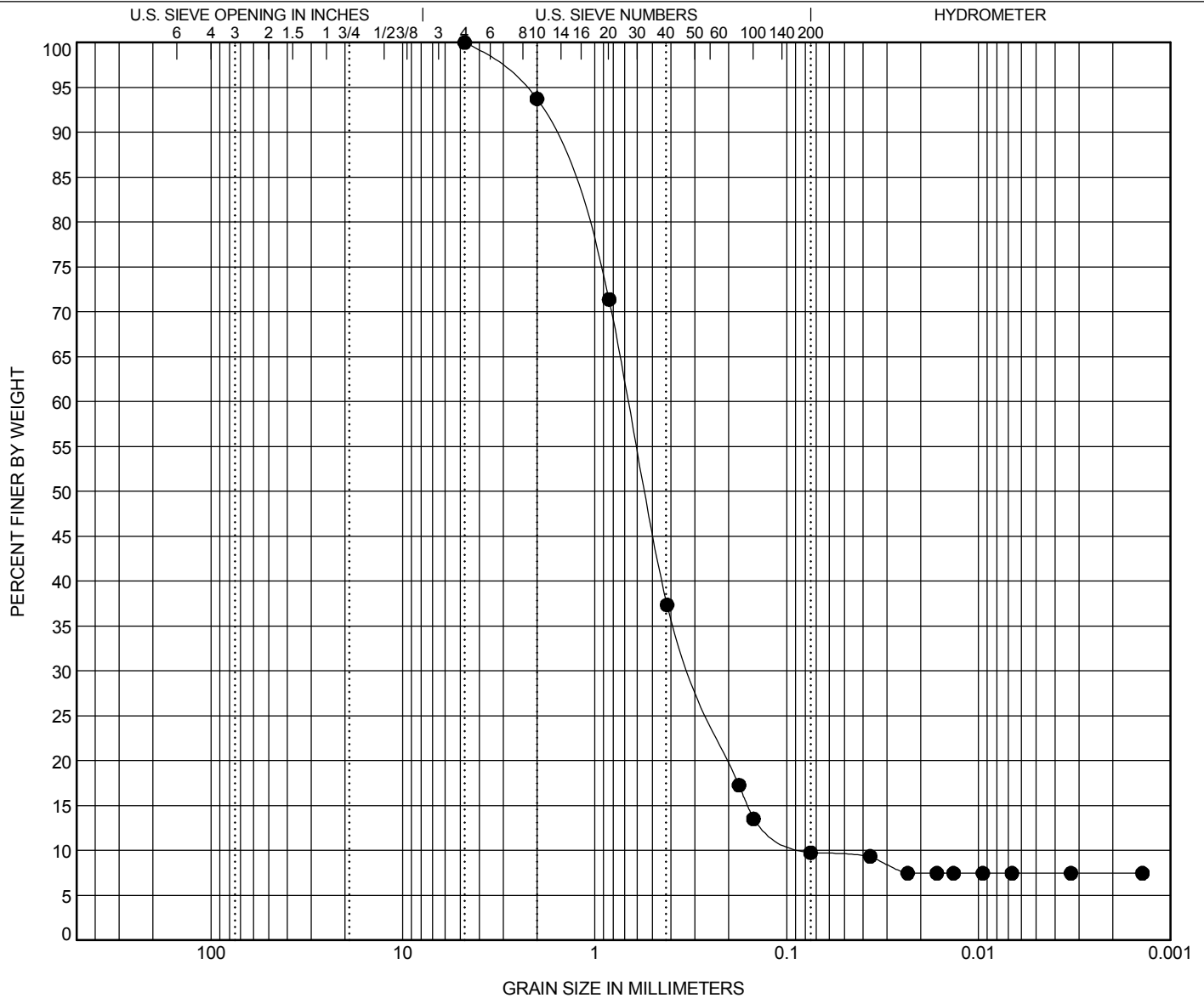


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-502	15.0	SAND (SP-SM) with Silt								1.79	8.50
BOREHOLE	DEPTH	D100	D95	D50	D10	%Gravel	%Sand	%Silt	%Clay		
● B-502	15.0	4.76	2.382	0.544	0.078	0.0	90.2	2.3	7.5		

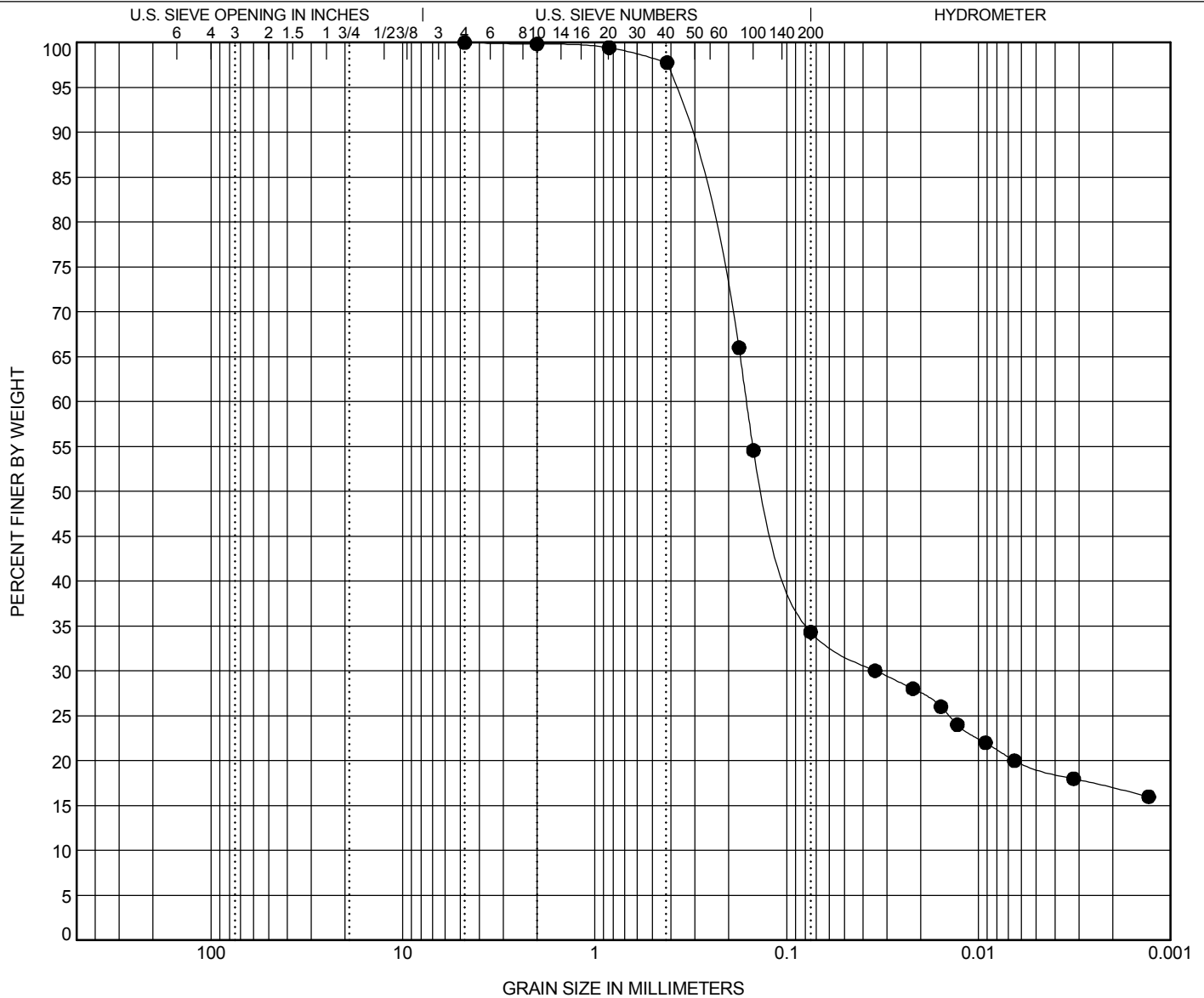


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens



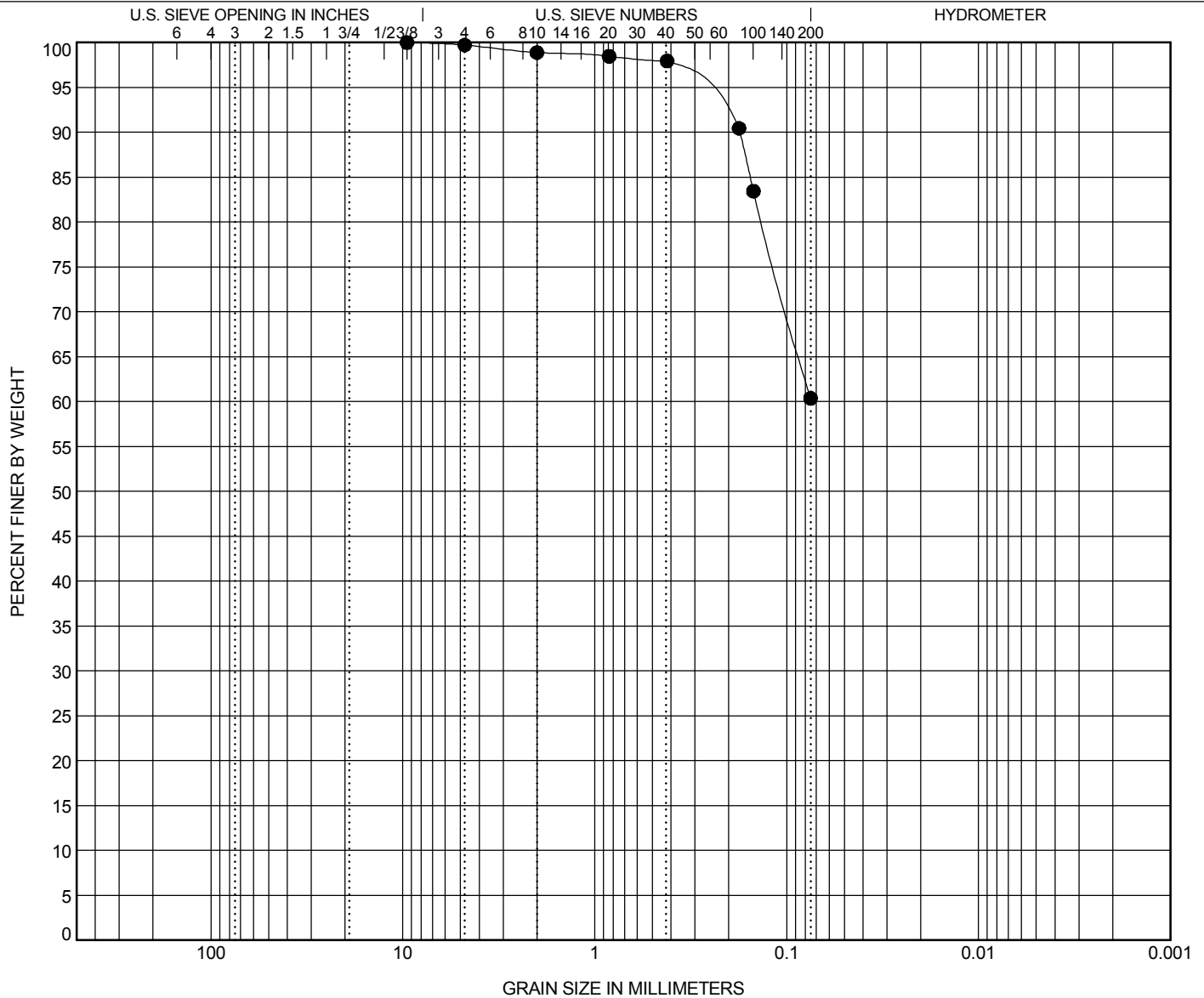


GRAIN SIZE DISTRIBUTION

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens

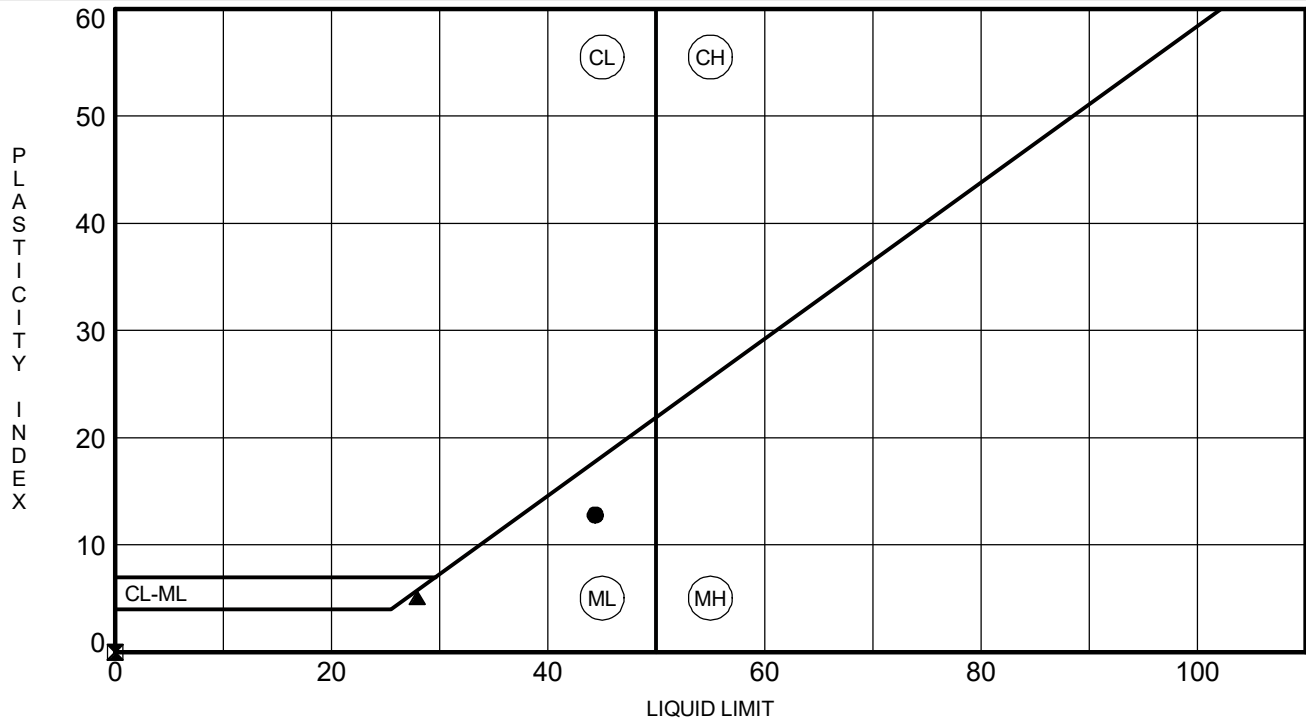


ATTERBERG LIMITS' RESULTS

PROJECT ID P038301

PROJECT NAME S-30-34 Replacement Bridge over Millers Fork Creek

PROJECT COUNTY Laurens

[illegible]

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

Client F&ME Consultants
 Client Project G6100.050 - Load Restricted Bridge Projects
 Project Number 42140

Boring G6100.050.00005 - Millers Fork Creek
 Depth 38.6' - 38.9'
 Sample RC-502.3
 Lab ID number 42140019

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

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

Axial Strain	Diametric Strain	Axial Stress psi
1.67E-03	-5.45E-04	6932
8.66E-04	-1.89E-04	3531

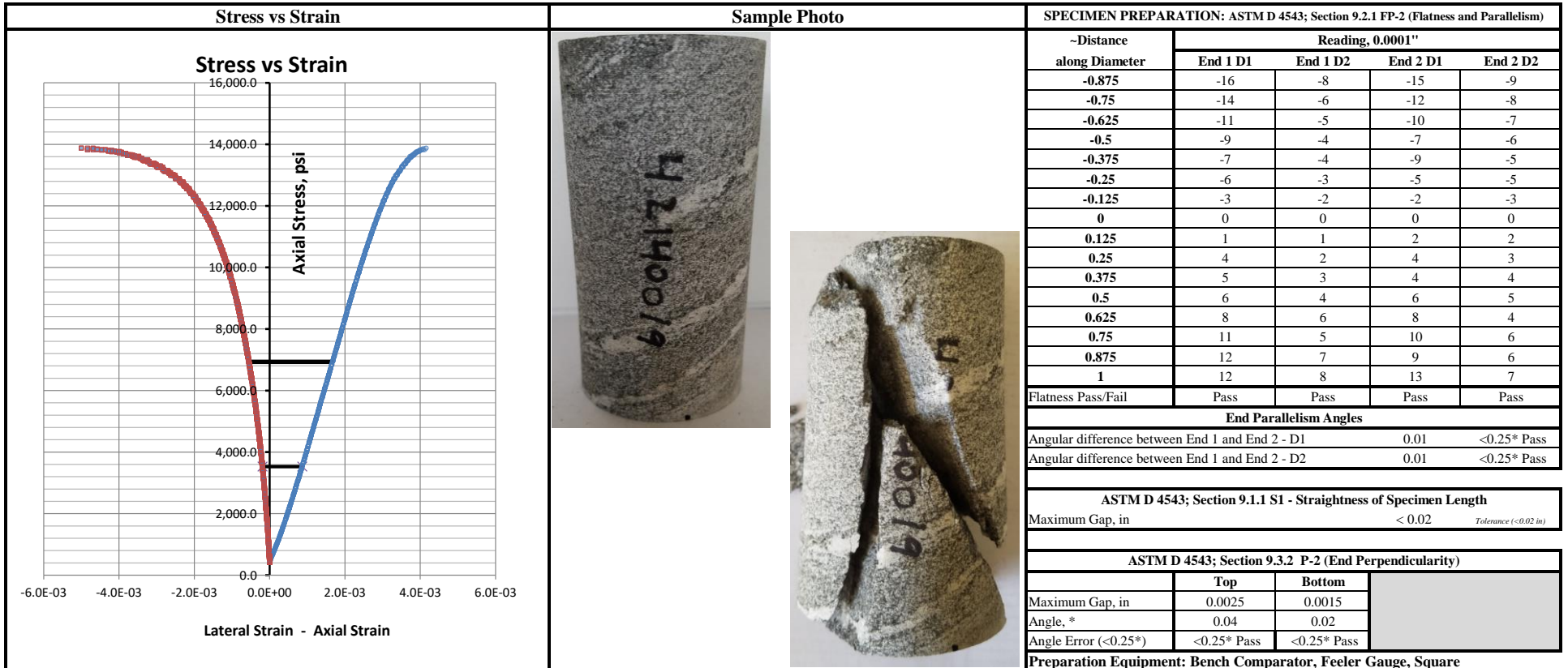
ASTM D 4543; Section 4.2 & 5.6	
Length, in	3.84
Mid Height Diameter #1, in	1.872
Mid Height Diameter #2, in	1.869
Average Mid. Height Diameter, in.	1.87
Sample Area, in ²	2.75
L/D Ratio (2.0-2.5)	2.05

Test Parameters		
Test Temperature	Room	
Moisture Condition	As-Received	
Sample Weight, gms	462.43	
Sample Volume, cc	173	
Wet Density, pcf	167	

Test Results	
Overall Loading Rate, psi/sec	40
Peak Load, lbs	38130
Unconfined Compressive Strength, psi	13,876
Youngs Modulus, E psi	4.2 E+06
Slope of Lateral Curve, psi	-9.5 E+06
Poisson's Ratio	0.44

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By: ALO

Date Tested: 7/25/2019

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

Client F&ME Consultants
 Client Project G6100.050 - Load Restricted Bridge Projects
 Project Number 42140

Boring G6100.050.00005 - Millers Fork Creek
 Depth 43.4' - 43.7'
 Sample RC-502.4
 Lab ID number 42140020

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

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

Axial Strain	Diametric Strain	Axial Stress psi
8.69E-04	-4.63E-04	4606
3.65E-04	-1.63E-04	2338

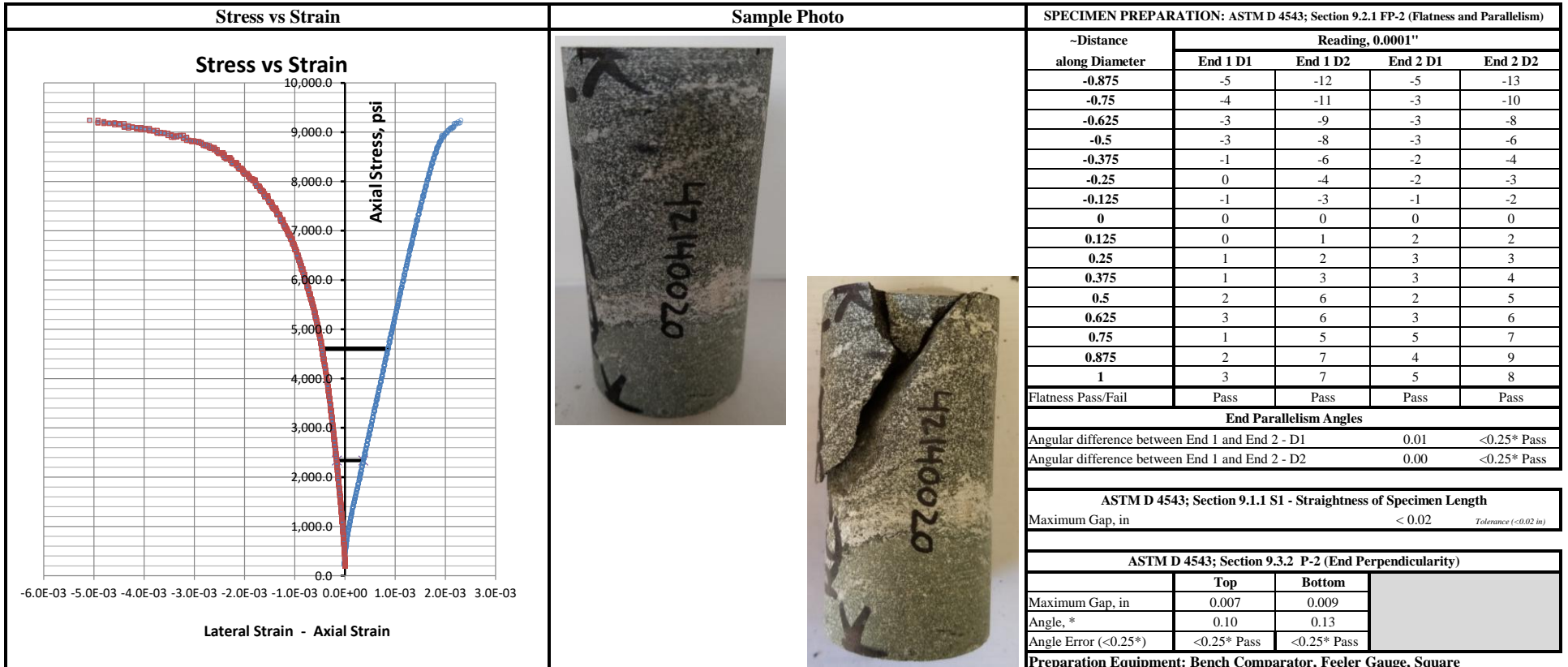
ASTM D 4543; Section 4.2 & 5.6	
Length, in	3.992
Mid Height Diameter #1, in	1.868
Mid Height Diameter #2, in	1.872
Average Mid. Height Diameter, in.	1.87
Sample Area, in ²	2.75
L/D Ratio (2.0-2.5)	2.13

Test Parameters		
Test Temperature	Room	
Moisture Condition	As-Received	
Sample Weight, gms	509.36	
Sample Volume, cc	180	
Wet Density, pcf	177	

Test Results	
Overall Loading Rate, psi/sec	40
Peak Load, lbs	25380
Unconfined Compressive Strength, psi	9,241
Youngs Modulus, E psi	4.5 E+06
Slope of Lateral Curve, psi	-7.5 E+06
Poisson's Ratio	0.60

Load Application in Relation to Lithology:

Angle



Performed By: MAK

Input Validation: MAK

Reviewed By: ALO

Date Tested: 7/25/2019

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