

S-20-20 (Camp Welfare Road) Bridge Replacement over Hogfork Branch

Fairfield County, SC

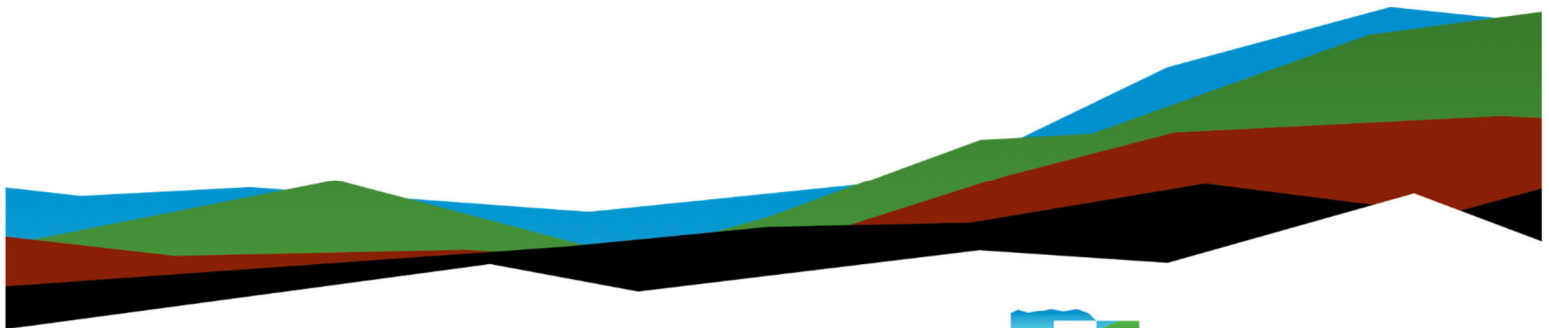
Geotechnical Subsurface Data Report

August 21, 2023 (rev1) | SCDOT Project ID: P041958

Terracon Project No.: EN23P100

Prepared for:

HNTB Corporation
343 E. Six Forks Road, Suite 200
Raleigh, NC 27609



Nationwide
Terracon.com

- Facilities
- Environmental
- Geotechnical
- Materials



1800 Reynolds Avenue
North Charleston, SC 29405
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Terracon.com

August 21, 2023 (rev1)

HNTB Corporation
343 E. Forks Road, Suite 200
Raleigh, NC 27609

Attn: Mr. Spencer Franklin, PE, Senior Vice President
P: 919-546-8997

Re: Geotechnical Subsurface Data Report
S-20-20 Bridge Replacement over Hogfork Branch
Fairfield County, South Carolina
SCDOT Project ID.: P041958
Terracon Project No.: EN23P100

Dear Mr. Franklin:

Terracon Consultants Inc. (Terracon) has completed the exploration and testing services for the above referenced project. The services were conducted in general accordance with our Task Order Number 001 (dated May 25, 2023).

Introduction

HNTB Corporation (HNTB) has contracted Terracon to perform subsurface exploration, and laboratory testing for the S-20-20 Bridge Replacement over Hogfork Branch in Fairfield County, South Carolina. The proposed bridge intends to replace the existing bridge over Hogfork Branch. This GSDR was prepared in general accordance with the 2022 SCDOT Geotechnical Design Manual (GDM) and Preconstruction Design Memorandum (PCDM) 11 - Supplemental Design Criteria for Low Volume Bridge Replacement Projects.

Project Description

The project site is located at the S-20-20 (Welfare Camp Road) crossing over Hogfork Branch in Fairfield County, South Carolina. Site location and exploration plans are presented in Appendix A of this report. Based on the conceptual plans by HNTB dated 6/13/2023, the replacement bridge will be constructed on essentially the same alignment as the current bridge. The existing bridge is a multi-span structure supported by deep foundations. The

conceptual plans show that the replacement bridge will also be a single-span structure supported by deep foundations.

Geotechnical Testing

The geotechnical exploration for this project was performed between June 16 and June 23, 2023. The results of our field work and our associated laboratory testing are included in Appendices A and B.

Field Exploration

Our field exploration consisted of the following:

- Two (2) Standard Penetration Test (SPT) Borings (S-20-20-1 and S-20-20-2), including rock coring
- One (1) Offset Boring (S-20-20-1A) for bulk sample collection

The tests were performed at the approximate locations as approved by SCDOT. A description of our testing methods and graphical logs outlining the soil conditions at each test location are presented in Appendix A. The test locations were established in the field by Terracon and surveyed by Construction Support Services, LLC after completion.

Laboratory Testing

The following laboratory tests were performed on the soil samples collected at the site.

- Eleven (11) Natural Moisture Content Tests
- Five (5) Atterberg Limits Tests
- Six (6) Grain Size Tests
- Six (6) Grain Size Tests with Hydrometer
- One (1) Remolded, Consolidated-Undrained (CU) Triaxial Compression Test with Pore Pressure Readings
- One (1) Standard Proctor Test
- One (1) Corrosivity Suite Tests (pH, chloride content, sulfate content, and resistivity tests)
- Four (4) Compressive Strength of Rock Core Tests

The scope of the laboratory testing frequency was determined by the SCDOT. The laboratory testing assignment was performed by our engineers. The laboratory procedures and results of the laboratory tests are presented in Appendix B.

Closure

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Abdul Q. Fekrat, PhD, P.E.
Project Engineer
SC Registration No. 38531



Phillip A. Morrison, P.E.
Geotechnical Department Manager
SC Registration No. 17275

Reviewed by Terracon's Authorized Project Reviewer David J. Corley, P.E.

Appendix A

Field Exploration

- Exhibit A-1 – Site Location Map
- Exhibit A-2 – Exploration Plan
- Exhibit A-3 – Summary of Boring Data
- Exhibit A-4 – GeoScoping Form (2 Pages)
- Exhibit A-5 – Field Exploration Description (2 Pages)
- Exhibit A-6 – Soil/Rock Description Terms (2 Pages)
- Exhibit A-7 – Soil/Rock Symbols
- Exhibit A-8 – Boring Logs (4 Pages)
- Exhibit A-9 – Grout Logs (3 Pages)
- Exhibit A-10 – Rock Core Photograph Log

Note: All exhibits are one page unless noted above.

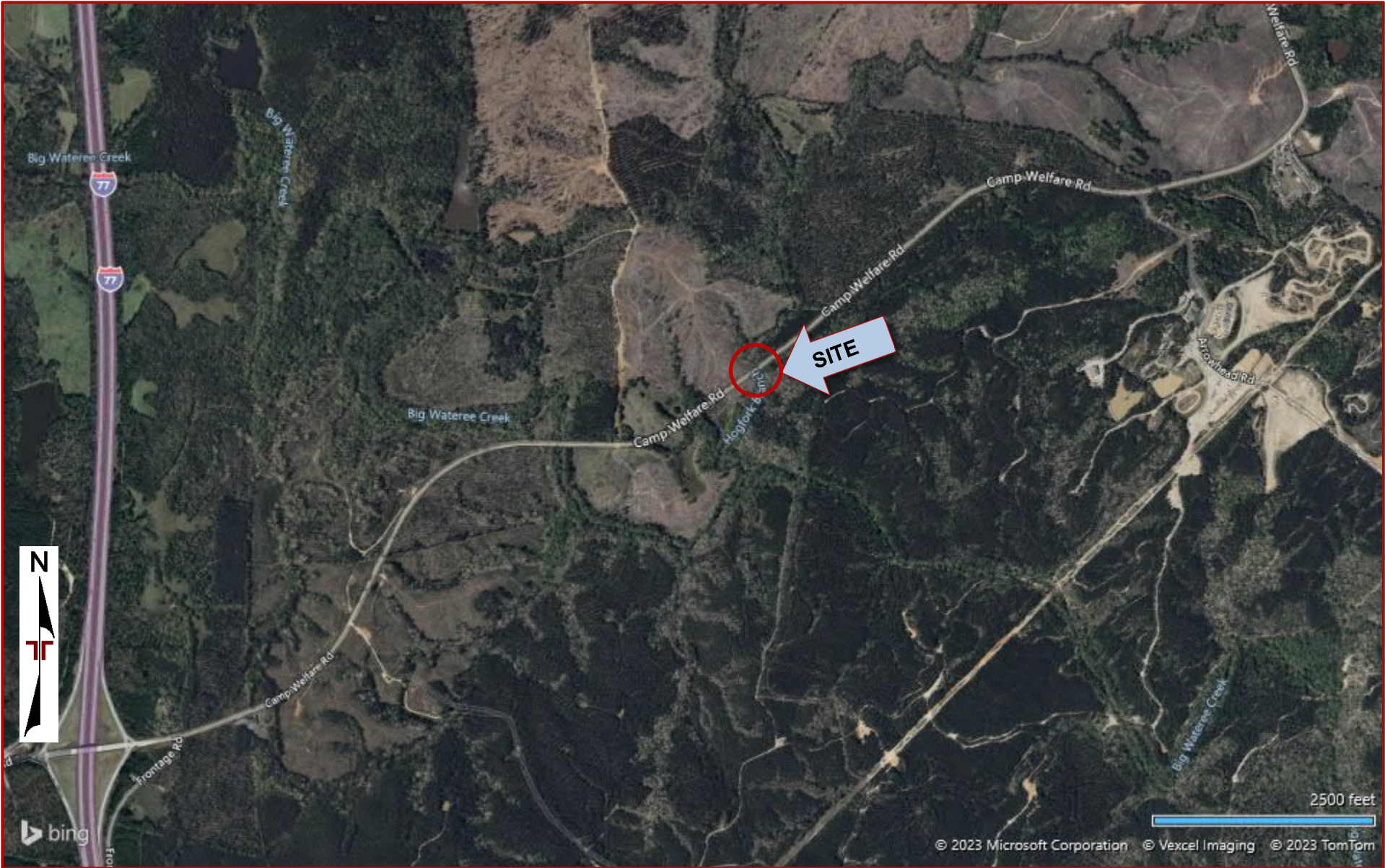


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT
INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: HORNSBORO, SC (1/1/1983) and MT CROGHAN, NC
(1/1/1983).



DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT
INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY
MICROSOFT BING MAPS

Summary of Boring Data

Boring No.	Ground Elevation ft.	Test Depth ft.	Northing	Easting	Latitude	Longitude	Station	Offset
S-20-20-1	265.6	34.0	964,455.84	2,008,636.61	34.484094	-80.971339	210+15.79	L 4.77
S-20-20-2	264.7	31.5	964,498.42	2,008,716.80	34.484211	-80.971073	211+05.80	R 7.19

Note: Additionally, a bulk sample was collected near S-20-20-1.

GeoScoping Form

PROJECT INFORMATION	
Project ID: 7323P100	Date of Trip: 6/16/2023
County: FAIRFIELD	Location: LATINNSBORG, SC
Rd/Route: CAMP WELFARE ROAD	Local Name: HOGFORK BRANCH
Attendees: A. BEATY, S. TRUSEDALE, D. SUTTON	

EXISTING BRIDGE INFORMATION	
Bridge Length:	Bridge Width:
Superstructure Type:	Substructure Type:
Begin Bridge Sta.:	End Bridge Sta.:
Begin Bridge Embankment Sta. ¹ :	End Bridge Embankment Sta. ¹ :
Structure Number: S-20-20	Posted Weight Limit: 8 TONS
Crossing: HOG FORK BRANCH	Skew:
Latitude:	Longitude:
Existing Fill Height:	Approximate Existing Slope Angle:

¹Begin and End Bridge Embankment 100 feet down station or up station from bridge, respectively

EXISTING ROADWAY EMBANKMENT INFORMATION	
Begin Project Sta.:	Begin Bridge Embankment Sta. ¹ :
Accessibility Issues: NONE	
Ground Cover: ASPHALT	
Existing Fill Height:	Approximate Existing Slope Angle:
Local Development (undeveloped, developed residential, developed commercial, developed industrial, etc.):	
Topography (level, flat, rolling, steep, hillside, valley, swamp, gully, etc.):	
Traffic Control Necessary (Y/N): N	
Surface Soil:	
Exposed Rock (Y/N): N	Muck (Y/N):
In Stream Bed (Y/N):	In Banks (Y/N): Y
Wetlands On-Site (Y/N):	Wetlands Adjacent (Y/N):
Depth FG to Water:	Water Depth:
Depth to Existing Ground:	
Scour Condition at EB:	Scour Condition at IB:
End Bridge Embankment Sta. ¹ :	End Project Sta.:
Accessibility Issues: BRIDGE CLOSURE	
Ground Cover: ASPHALT	
Existing Fill Height: 18.5 FEET	Approximate Existing Slope Angle:
Local Development (undeveloped, developed residential, developed commercial, developed industrial, etc.):	
Topography (level, flat, rolling, steep, hillside, valley, swamp, gully, etc.):	
Traffic Control Necessary (Y/N): N	
Surface Soil: CLAYS & SANDS	
Exposed Rock (Y/N): N	Muck (Y/N): N
In Stream Bed (Y/N): N	In Banks (Y/N): Y
Wetlands On-Site (Y/N):	Wetlands Adjacent (Y/N):
Depth FG to Water:	Water Depth:
Depth to Existing Ground:	
Scour Condition at EB:	Scour Condition at IB:

GeoScoping Form

UTILITIES INFORMATION	
Attached:	
Above Ground/ Overhead:	
Underground:	FIBER
COMMENTS	

Instructions:

1. Attach boring location plan for bridge and roadway.
2. Attach all photographs taken, photographs to be labeled as to direction looking in and what is being depicted.
3. Fill out GeoScoping Form as completely as possible, using additional sheets as necessary to describe site conditions.
4. If representative of GEC on site during GeoScoping, include GEC representative's name and contact number in Attendees block.

Exhibit A-6 - Field Exploration Description

Overview

The testing locations were proposed to and approved by SCDOT and located in the field by Terracon using measurements from existing structures shown on the provided drawings. The borings were surveyed by Construction Support Services, LLC after testing and drilling was complete. The locations as shown in the Exploration Plan are shown to the scale indicated.

A field log of each test location was prepared by our engineer. The final boring logs included with this report represent the engineer's description of the encountered conditions modified as necessary based on laboratory test results of the individual samples.

Soil Test Borings (STB)

All boring and sampling operations were conducted in general accordance with the following procedures:

- SCDOT Geotechnical Design Manual 2022
- Preconstruction Design Memorandum (PCDM) 11 - Supplemental Design Criteria for Low Volume Bridge Replacement Projects
- ASTM D5783, "Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geo-environmental Exploration"
- ASTM D6151, "Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling"
- ASTM D1586 "Test Method for Penetration Test and Split-Barrel Sampling of Soils"
- ASTM D4220 "Standard Practices for Preserving and Transporting Soil"
- ASTM D2113 "Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration"
- ASTM D5079 "Standard Practices for Preserving and Transporting Rock Core Samples"

Each soil test boring was advanced using rotary wash drilling techniques. Bulk samples were collected using a hollow stem auger. The initial sampling program is summarized in the following table:

Test ID	Total Depth	Interval of Continuous Sampling
S-20-20-1	100 feet or 10 feet rock coring	0 to 10 feet
S-20-20-2	100 feet or 10 feet rock coring	0 to 10 feet

Additionally, a bulk sample was collected near S-20-20-1.

Soil samples were obtained with a standard 1.4-inch I.D., 2-inch O.D., split-barrel sampler, also known as a standard split-spoon. The sampler is advanced into the soil a total of 18 to 24 inches by striking the drill rod using a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler for each of three to four, 6-inch

increments is recorded. The sum of the number of blows for the second and third increments is called the "Standard Penetration Value", or N-value (N_{meas} , blows per foot). The N-value, when properly evaluated, is an index to the soil strength.

Soil classification provides a general guide to the engineering properties of various soil types and enables the engineer to apply his experience to current situations. In our exploration, samples obtained during drilling operations are examined and visually classified by a geotechnical engineer using the procedures outlined in ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System). Laboratory testing was also performed on select split-spoon samples to evaluate index properties for further classification. The soils are described according to color, texture, and relative density or consistency (based on standard penetration resistance). The designations shown on the logs are described in the 2022 SCDOT Geotechnical Design Manual, Chapter 6.

The borings were advanced either to the planned drilling depth at which they were terminated, or to refusal of the drilling equipment. Select borings were continued below this depth using diamond bit rock coring techniques. NQ2 sized cores were recovered from the borehole. The rock recovery ratios (REC, percentage of the total core run), Rock Quality Designation (RQD, percentage of the total core run of pieces greater than 4 inches) were recorded along with a description of the rock. An explanation of the rock descriptions shown on the logs is provided in the SCDOT GDM, Chapter 6. Photos of the recovered rock core specimens are provided in the Rock Core Photograph Log.

As practical, groundwater readings were collected from each of the soil test borings after 24 hours. These water levels are indicated on the boring logs. The borings were advanced using mud rotary drilling techniques. As the drilling method introduces water into the borehole, time-of-drilling water levels may not be reliable.

At the conclusion of the work, the boreholes were backfilled with the drill cuttings and clean sand. The upper 20 feet of the boreholes were grouted with a cement bentonite grout and capped with cold-patch asphalt.

SOIL DESCRIPTION TERMS

Relative Density/Consistency Terms

<u>Relative Density</u> ¹			<u>Consistency</u> ²		
Descriptive Term	Relative Density	SPT Blow Count	Descriptive Term	Unconfined Compression Strength (q _u) (tsf)	SPT Blow Count
Very Loose	0 to 15%	4 and less	Very Soft	0.25 and less	2 and less
Loose	16 to 35%	5 to 10	Soft	0.26 to 0.50	3 to 4
Medium Dense	36 to 65%	11 to 30	Firm	0.51 to 1.00	5 to 8
Dense	66 to 85%	31 to 50	Stiff	1.01 to 2.00	9 to 15
Very Dense	86 to 100%	51 and more	Very Stiff	2.01 to 4.00	16 to 30
			Hard	4.01 and more	31 and more

Moisture Condition

<u>Descriptive Term</u>	<u>Criteria</u>
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually in coarse-grained soils below the water table

Color

Describe the sample color while sample is still moist.

Angularity¹

<u>Descriptive Term</u>	<u>Criteria</u>
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

HCl Reaction³

<u>Descriptive Term</u>	<u>Criteria</u>
None Reactive	No visible reaction
Weakly Reactive	Some reaction, with bubbles forming slowly
Strongly Reactive	Violent reaction, with bubbles forming immediately

Cementation³

<u>Descriptive Term</u>	<u>Criteria</u>
Weakly Cemented	Crumbles or breaks with handling or little finger pressure Moderately
Cemented	Crumbles or breaks with considerable finger pressure
Strongly Cemented	Will not crumble or break with finger pressure

Particle-Size Range¹

<u>Gravel</u>	Diameter, mm	Sieve Size	<u>Sand</u>	Diameter, mm	Sieve Size
Fine	4.76 to 19.1	#4 to ¾ inch	Fine	0.074 to 0.42	#200 to #40
Coarse	19.1 to 76.2	¾ inch to 3 inch	Medium	0.42 to 2.00	#40 to #10
			Coarse	4.00 to 4.76	#10 to #4

Primary Soil Type^{1, 2}

The primary soil type will be shown in all capital letters.

USCS Soil Designation

Indicate USCS soil designation as defined in ASTM D-2487 and D-2488

AASHTO Soil Designation

Indicate AASHTO soil designation as defined in AASHTO M-145 and ASTM D-3282

¹Applies to coarse-grained soils (major portion retained on No. 200 sieve)

²Applies to fine-grained soils (major portion passing No. 200 sieve)

³Use as required

DESCRIPTION OF ROCK PROPERTIES

WEATHERING

Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately Severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)

Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock^a

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

^aSpacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designation (RQD)^a

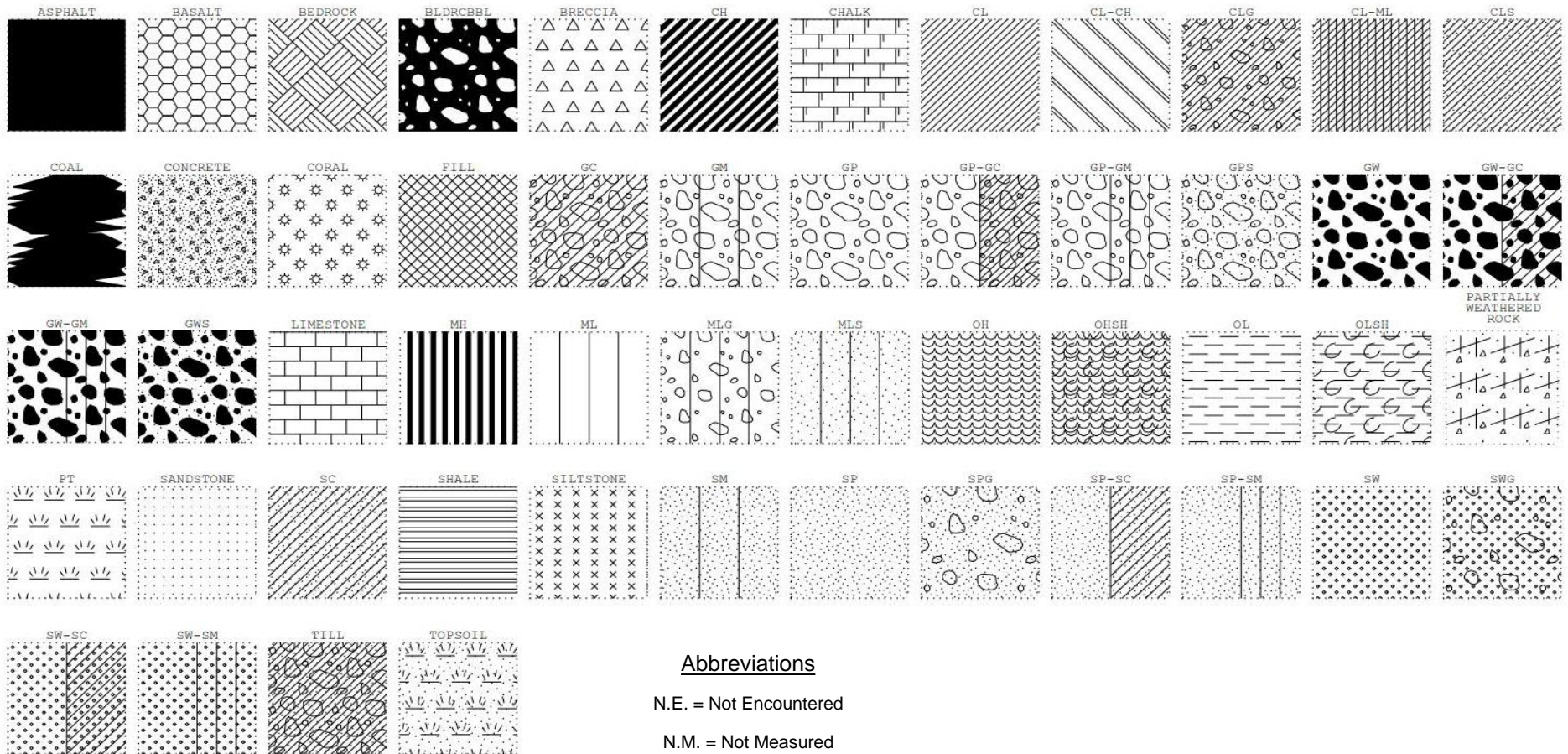
RQD, as a percentage	Diagnostic Description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

^aRQD (given as a percentage) = length of core in pieces 4 in. and longer/length of run.

Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly open
1/32 to 3/8 in.	Moderately open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately wide
Greater than 0.1 ft.	Wide

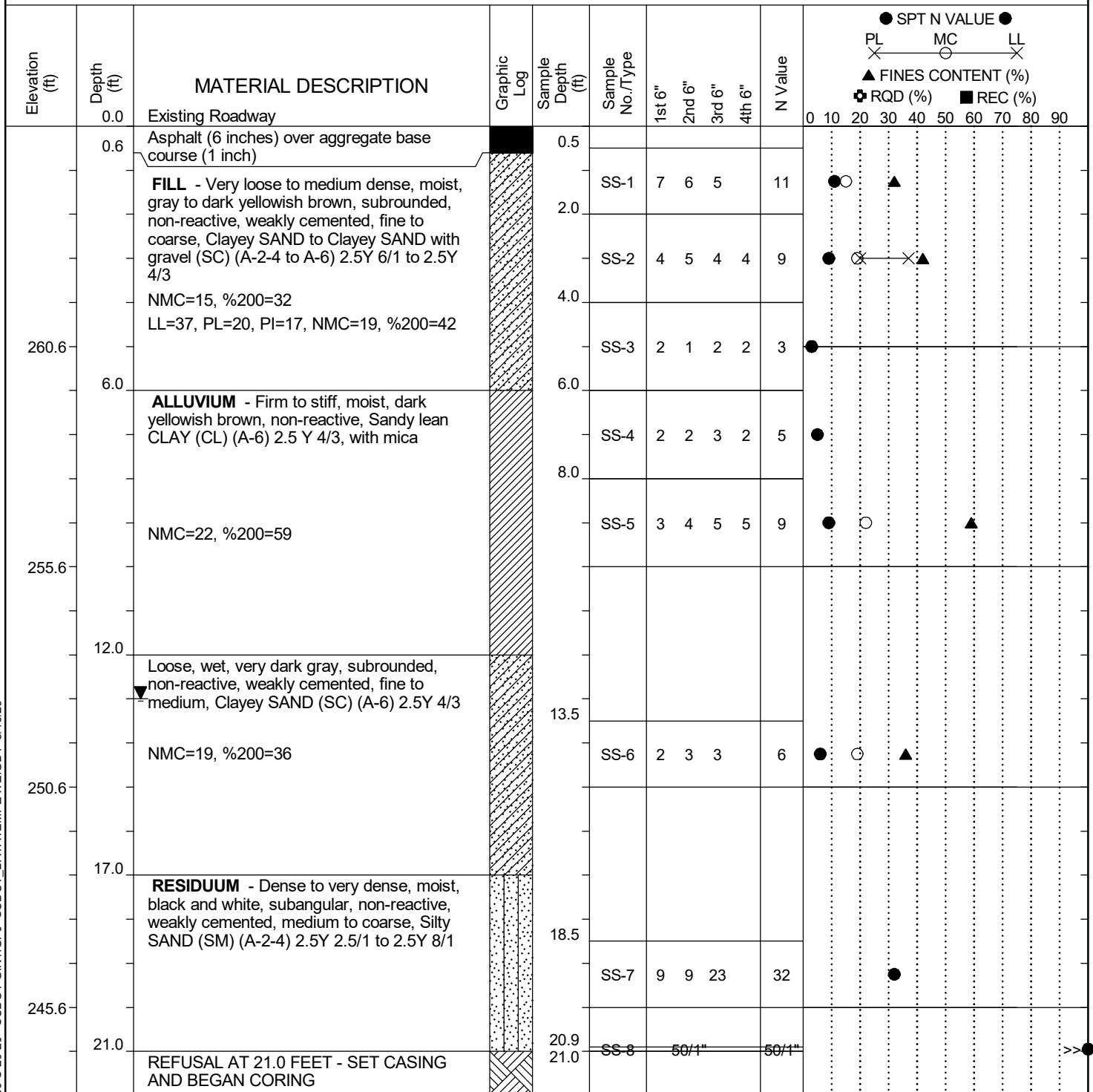
References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.



Project Manager:	AQF	Project No.	EN23P100	 <p>1800 Reynolds Ave North Charleston, SC 29405 PH. (843) 884-1234 FAX. (843) 884-9234</p>	<h2>SOIL/ROCK SYMBOLS</h2>	<h2>Exhibit A-7</h2>
Drawn by:	KJZ	Scale:	N.T.S.			
Checked by:	AQF	File Name:	Soil – Rock – Log			
Approved by:	DJC	Date:	Jul 2023			

SCDOT Soil Test Log

Project ID:	P041958	County:	Fairfield	Boring No.:	S-20-20-1
Site Description:	S-20-20 Bridge Replacement over Hogfork Branch			Route:	S-20-20
Eng./Geo.:	A. Beaty	Boring Location:	210+15.79	Offset:	L 4.77
Elev.:	265.6 ft	Latitude:	34.484094	Longitude:	-80.971339
Total Depth:	34 ft	Soil Depth:	21 ft	Date Started:	6/21/2023
Core Depth:	13 ft	Date Completed:	6/23/2023		
Bore Hole Diameter (in):	3	Sampler Configuration		Liner Required:	Y (N)
Drill Machine:	DR#1109	Drill Method:	RW / RC	Hammer Type:	Automatic
Core Size:	NQ2	Driller:	S. Truesdale	Energy Ratio:	93.9%
		Groundwater:	TOB N.M.	24HR	13 ft



LEGEND

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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: P041958				County: Fairfield		Boring No.: S-20-20-1		
Site Description:		S-20-20 Bridge Replacement over Hogfork Branch					Route: S-20-20	
Eng./Geo.: A. Beaty		Boring Location: 210+15.79		Offset: L 4.77		Alignment: Existing		
Elev.: 265.6 ft		Latitude: 34.484094		Longitude: -80.971339		Date Started: 6/21/2023		
Total Depth: 34 ft		Soil Depth: 21 ft		Core Depth: 13 ft		Date Completed: 6/23/2023		
Bore Hole Diameter (in): 3		Sampler Configuration		Liner Required: Y (N)		Liner Used: Y (N)		
Drill Machine: DR#1109		Drill Method: RW / RC		Hammer Type: Automatic		Energy Ratio: 93.9%		
Core Size: NQ2		Driller: S. Truesdale		Groundwater: TOB N.M.		24HR 13 ft		

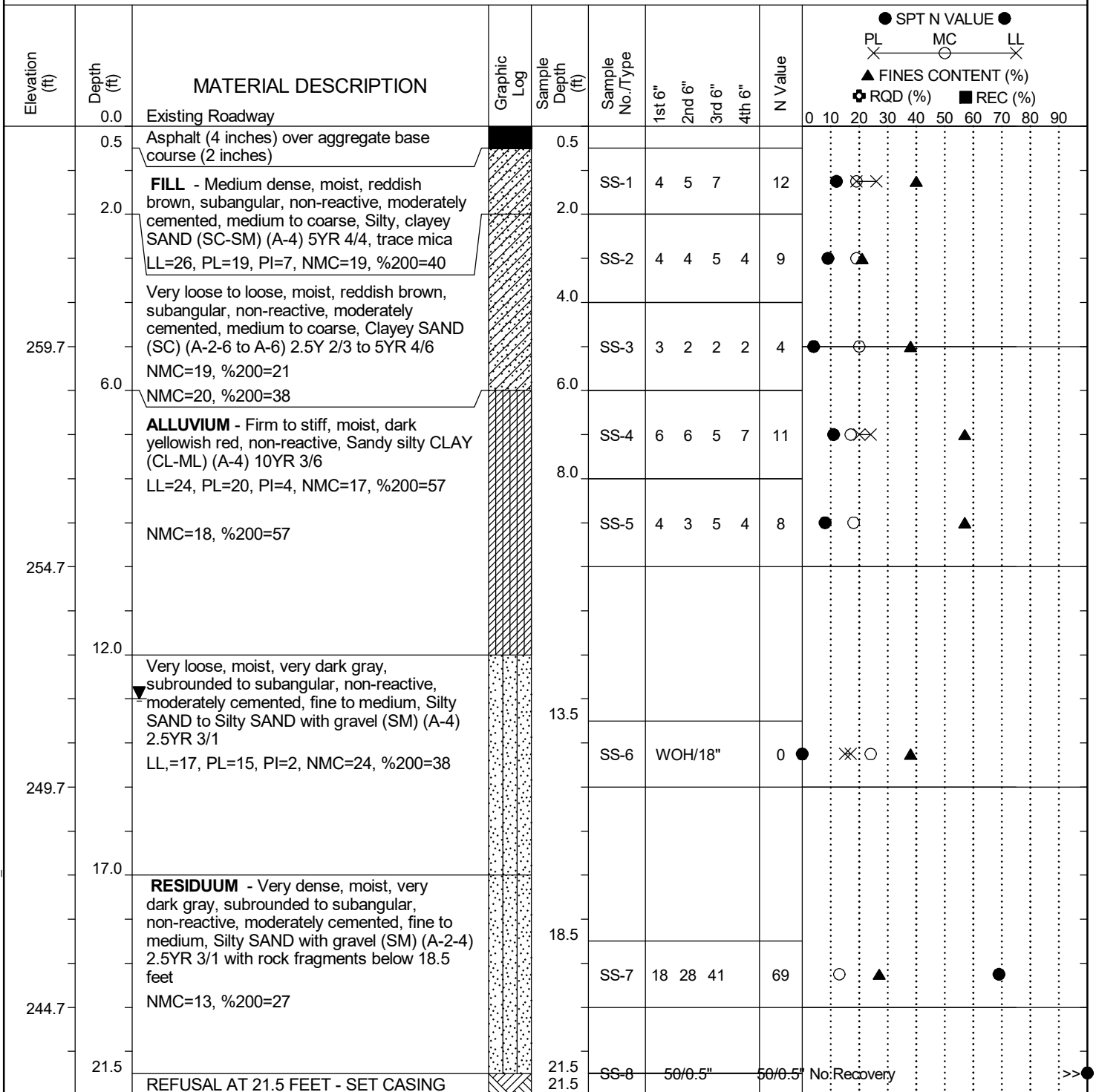
Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	<div> ● SPT N VALUE ● PL X MC O LL X ▲ FINES CONTENT (%) ⊕ RQD (%) ■ REC (%) </div>
240.6		METAGRANODIORITE - Black and white, fine grained, residual soil to moderately weathered, extremely weak to strong rock, 0-90°, J, N, No, No, Ir, VC, R to SR, NQ-1: %REC=28, RQD=0, GSI=20, 2.1 min/ft			NQ-1						<div> ⊕ 20 </div>
		NQ-2: %REC=38, RQD=0, GSI=40, 1.9 min/ft		26.0							
235.6					NQ-2						<div> ⊕ 40 </div>
		NQ-3: %REC=81, RQD=14, GSI=60, RMR=27, 2.7 min/ft, qu=11,995 psi		31.0							
					NQ-3						<div> ⊕ 70 </div>
34.0		BORING TERMINATED AT 34 FEET									
230.6											
225.6											

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:	P041958				County:	Fairfield		Boring No.:	S-20-20-2		
Site Description:	S-20-20 Bridge Replacement over Hogfork Branch							Route:	S-20-20		
Eng./Geo.:	A. Beaty		Boring Location:	211+05.80		Offset:	R 7.19		Alignment:	Existing	
Elev.:	264.7 ft		Latitude:	34.484211		Longitude:	-80.971073		Date Started:	6/16/2023	
Total Depth:	31.5 ft		Soil Depth:	21.5 ft		Core Depth:	10 ft		Date Completed:	6/23/2023	
Bore Hole Diameter (in):	3		Sampler Configuration			Liner Required:	Y (N)		Liner Used:	Y (N)	
Drill Machine:	DR#1109		Drill Method:	RW / RC		Hammer Type:	Automatic		Energy Ratio:	93.9%	
Core Size:	NQ2		Driller:	S. Truesdale		Groundwater:	TOB N.M.			24HR	13 ft



LEGEND

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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:	P041958	County:	Fairfield	Boring No.:	S-20-20-2
Site Description:	S-20-20 Bridge Replacement over Hogfork Branch			Route:	S-20-20
Eng./Geo.:	A. Beaty	Boring Location:	211+05.80	Offset:	R 7.19
Elev.:	264.7 ft	Latitude:	34.484211	Longitude:	-80.971073
Total Depth:	31.5 ft	Soil Depth:	21.5 ft	Core Depth:	10 ft
Date Started:	6/16/2023				
Date Completed:	6/23/2023				
Bore Hole Diameter (in):	3	Sampler Configuration	Liner Required: Y (N)		Liner Used: Y (N)
Drill Machine:	DR#1109	Drill Method:	RW / RC	Hammer Type:	Automatic
Energy Ratio:	93.9%				
Core Size:	NQ2	Driller:	S. Truesdale	Groundwater:	TOB N.M.
24HR	13 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 — LL X ▲ FINES CONTENT (%) + RQD (%) ■ REC (%)
239.7		AND BEGAN CORING									
		METAGRANODIORITE - Dark gray, very fine grained, slightly weathered, strong to extremely strong rock, 0-90°, J, N, No, No, Ir, VC, SR, 2.5Y 3/1 to 7.5YR 4/6									
		NQ-1: %REC=56, RQD=22, GSI=60, RMR=41, 2.8 min/ft, qu=33,861 psi		25.5	NQ-1						
		NQ-2: %REC=100, RQD=53, GSI=70, RMR=43, 4.5 min/ft, qu=11,328 psi			NQ-2						
234.7				30.5	NQ-3						
	31.5	NQ-3: %REC=100, RQD=0, GSI=70 RMR=30, 2.9 min/ft, qu=7,302 psi									
		BORING TERMINATED AT 31.5 FEET									
229.7											
224.7											

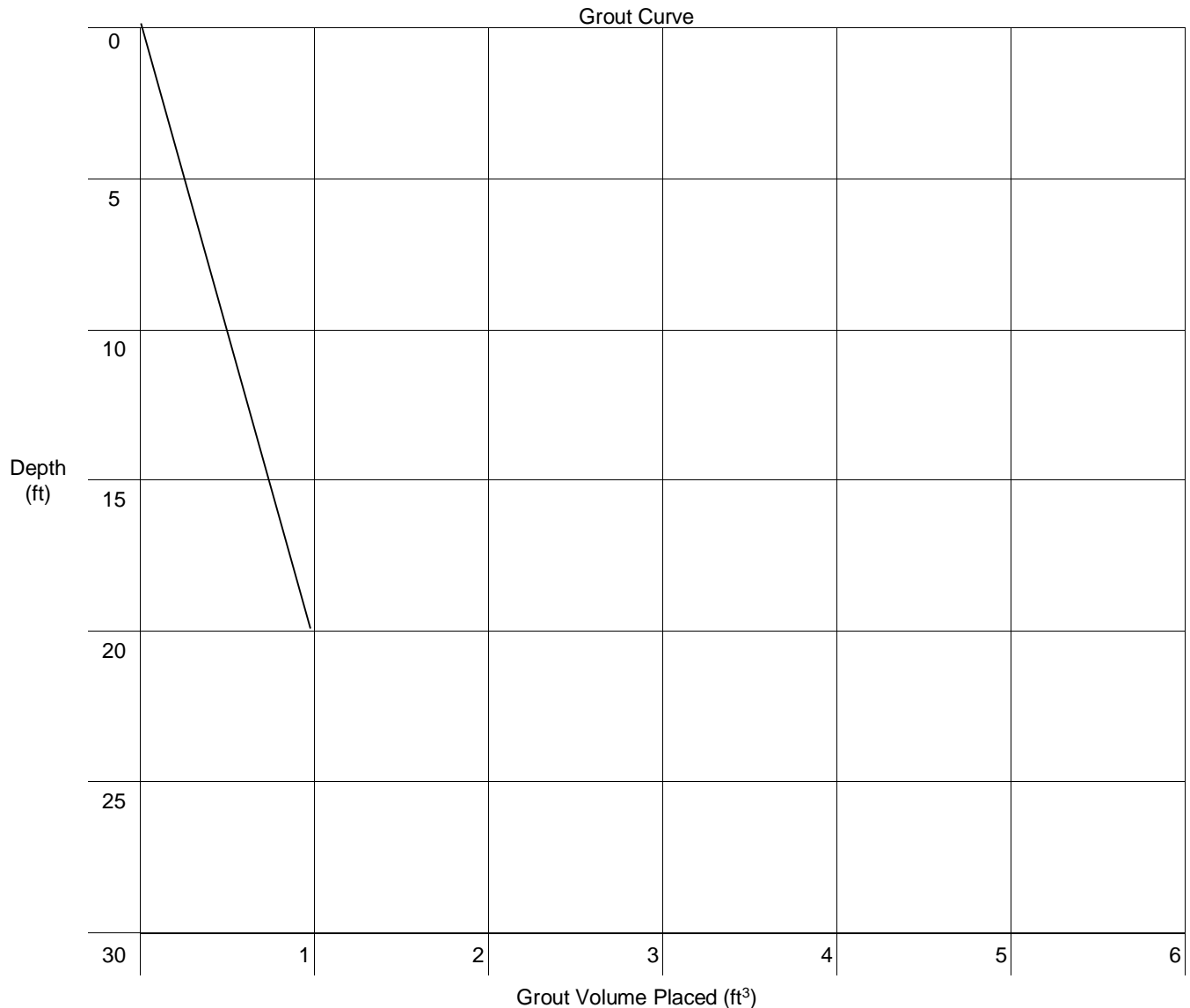
LEGEND

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	



GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL (REV 03-23-16)

Project Name:	S-20-20 BRO Hogfork Branch				
Project ID:	P041958		Test Hole No.:	S-20-20-1	
Consultant Firm:	Terracon Consultants, Inc.		Station:	210+15.79	
Grouted By (Driller's Name):	Truesdale	Date	6/23/2023	Offset:	L 4.77
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water				

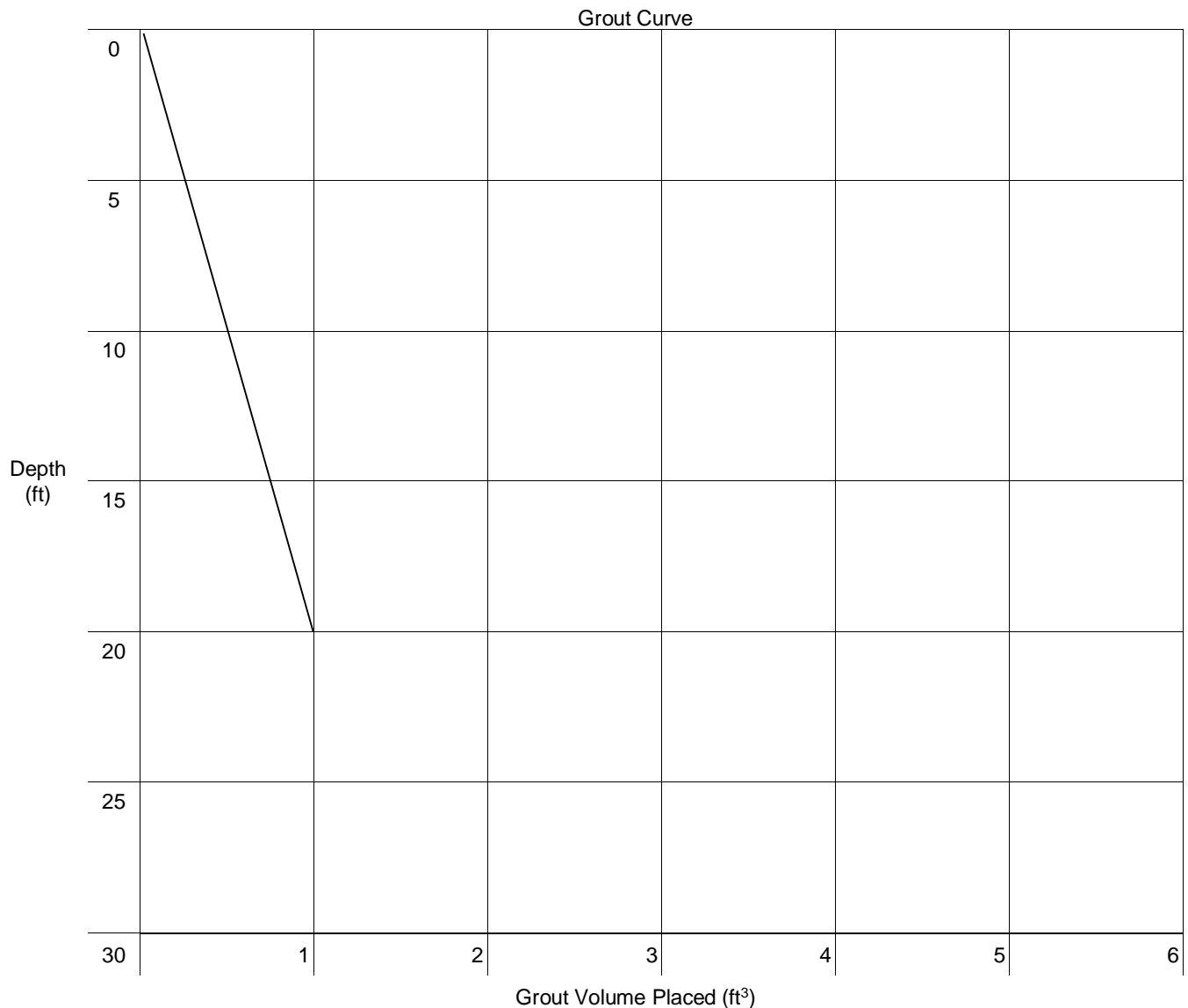


Number of Bags On-Site	1	ea
Depth of Test Hole Grouted	20	ft
Diameter of Test Hole	0.25	ft
Area of Test Hole	0.05	ft ²
Volume of Test Hole	1.0	ft ³
Volume of Casing (If applicable)	N/A	ft ³
Theoretical Volume of Test Hole	1.0	ft ³
Number of Bags Used	1/2	ea
Volume Placed	1.0	ft ³



GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL (REV 03-23-16)

Project Name:	S-20-20 BRO Hogfork Branch		Test Hole No.:	S-20-20-2
Project ID:	P041958		Station:	211+05.80
Consultant Firm:	Terracon Consultants, Inc.		Offset:	R 7.19
Grouted By (Driller's Name):	Truesdale	Date	6/23/2023	
Notes:	Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water			



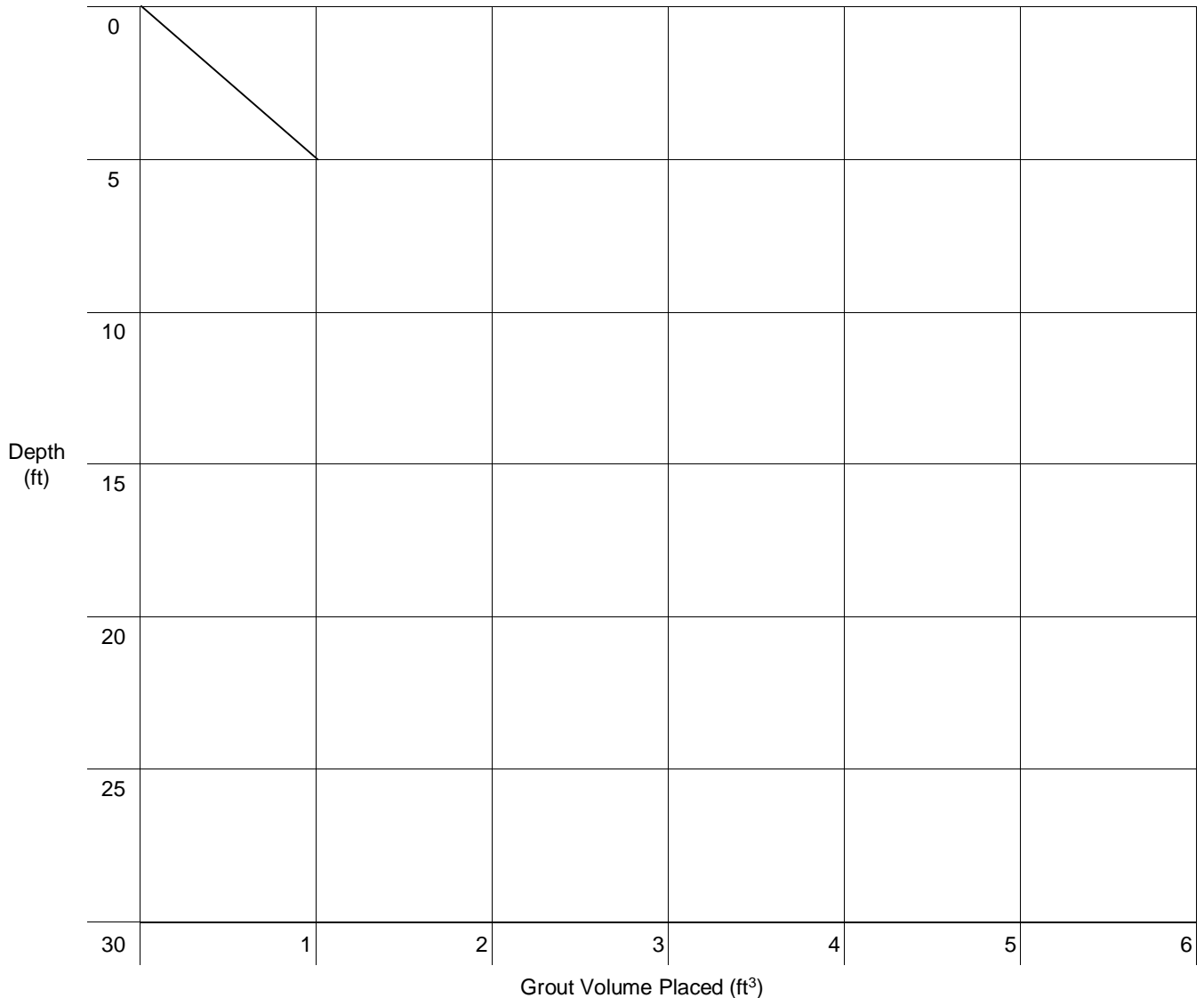
Number of Bags On-Site	_____	ea
Depth of Test Hole Grouted	20	ft
Diameter of Test Hole	0.25	ft
Area of Test Hole	0.05	ft²
Volume of Test Hole	1.0	ft³
Volume of Casing (If applicable)	N/A	ft³
Theoretical Volume of Test Hole	1.0	ft³
Number of Bags Used	½	ea
Volume Placed	1.0	ft³



GROUT LOG OF TEST HOLES FOR GEOTECHNICAL ON-CALL (REV 03-23-16)

Project Name: S-20-20 BRO Hogfork Branch
Project ID: P041958 Test Hole No.: S-20-20-1A
Consultant Firm: Terracon Consultants, Inc. Station: _____
Grouted By (Driller's Name): Truesdale Date 6/23/2023 Offset: _____
Notes: Mix design: 1 pound cement, 1 pound bentonite, 6 pounds water

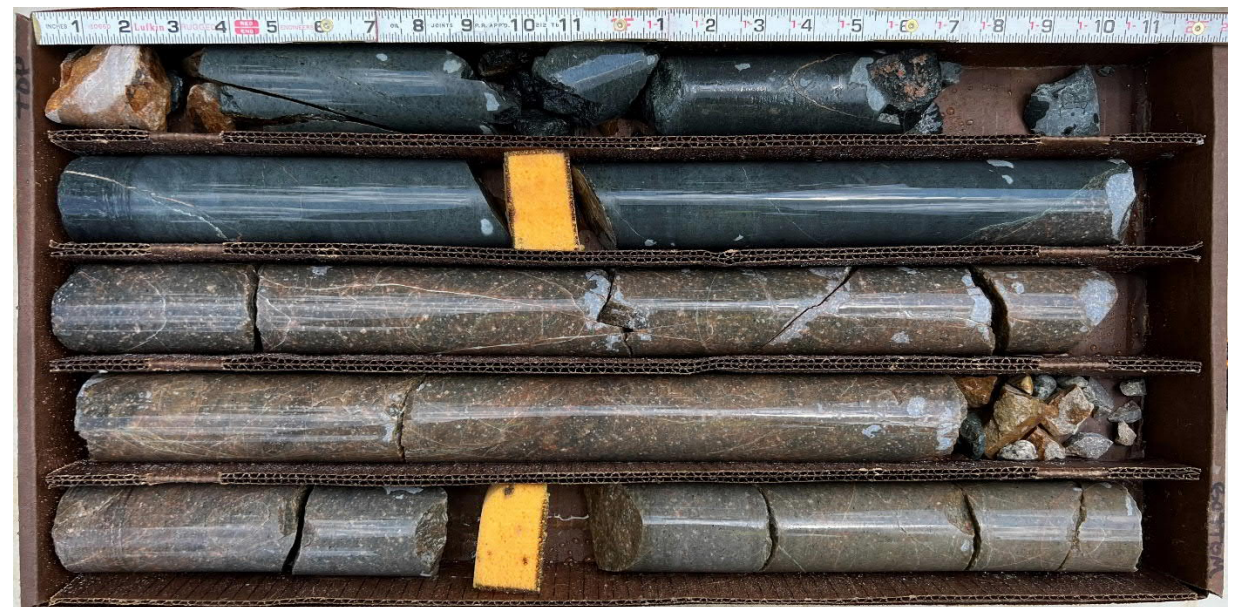
Grout Curve



Number of Bags On-Site	_____	ea
Depth of Test Hole Grouted	5	ft
Diameter of Test Hole	0.5	ft
Area of Test Hole	0.20	ft ²
Volume of Test Hole	1.0	ft ³
Volume of Casing (If applicable)	N/A	ft ³
Theoretical Volume of Test Hole	1.0	ft ³
Number of Bags Used	2	ea
Volume Placed	1.0	ft ³



S-20-20-1: NQ-1 (21.0-26.0'), NQ-2 (26.0-31.0'), NQ-3 (31.0-34.5')



S-20-20-2: NQ-1 (21.5-25.5'), NQ-2 (25.5-30.5'), NQ-3 (30.5-31.5')

Appendix B

Laboratory Testing

Exhibit B-1 – Laboratory Testing Description
Summary of Laboratory Data
Laboratory Data Sheets (20 Pages)

Note: All exhibits are one page unless noted above.

Laboratory Testing Description

The samples collected during the field exploration were taken to our laboratory for additional testing. The laboratory testing scope was developed by the SCDOT and laboratory assignment was performed by Terracon. The laboratory tests were conducted on selected soil samples from the borings and the bulk samples locations. The test results are presented in this appendix.


The laboratory test results were used to confirm the soil descriptions presented on the boring logs in Appendix A. Laboratory tests were performed in general accordance with the applicable ASTM, AASHTO, SCDOT or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

■	Moisture Content	AASHTO T265/(ASTM D2216)
■	Atterberg Limits	AASHTO T89/T90(ASTM D4318)
■	Wash 200	AASHTO T11/(ASTM D1140)
■	Triaxial Shear CU w/ PP	AASHTO T297/(ASTM D4767)
■	Grain Size Distribution	ASTM D6913
■	Hydrometer	ASTM D7928
■	Corrosion Series	AASHTO D422
		AASHTO T289/ASTM G51
		AASHTO T290/ASTM C1580
		AASHTO T291

SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

BORING ID	Depth (Ft.)	Soil Classification USCS & AASHTO	Water Content (%)	% Fines	Liquid Limit	Plastic Limit	Plasticity Index
S-20-20-1	0-5	CLAYEY SAND(SC) / A-4 (1)	12.1	45.0	26	17	9
S-20-20-1	0.5-2	CLAYEY SAND WITH GRAVEL (SC) / A-2-4	15.0	31.5			
S-20-20-1	2-4	CLAYEY SAND(SC) / A-6 (3)	19.4	42.0	37	20	17
S-20-20-1	8-10	SANDY LEAN CLAY(CL) / A-6	22.4	58.9			
S-20-20-1	13.5-15	CLAYEY SAND(SC) / A-6	18.9	36.3			
S-20-20-2	0.5-2	SILTY, CLAYEY SAND(SC-SM) / A-4 (0)	18.6	39.5	26	19	7
S-20-20-2	2-4	CLAYEY SAND(SC) / A-2-6	19.3	21.2			
S-20-20-2	4-6	CLAYEY SAND(SC) / A-6	19.5	38.4			
S-20-20-2	6-8	SANDY SILTY CLAY(CL-ML) / A-4 (0)	16.8	56.9	24	20	4
S-20-20-2	8-10	SANDY SILTY CLAY(CL-ML) / A-4	18.2	57.0			
S-20-20-2	13.5-15	SILTY SAND(SM) / A-4 (0)	23.8	38.1	17	15	2
S-20-20-2	18.5-20	SILTY SAND WITH GRAVEL(SM) / A-2-4	13.1	27.3			
PROJECT: S-20-20 Bridge Replacement Over Hogfork Branch							
SITE: Fairfield County , South Carolina		 1800 Reynolds Ave North Charleston, SC			PROJECT NUMBER: P041958		
		PH. 843-884-1234 FAX. 843-884-9234			CLIENT: HNTB North Carolina PC Raleigh, NC		
					EXHIBIT: B-1		



INDEX PROPERTIES VERSUS DEPTH

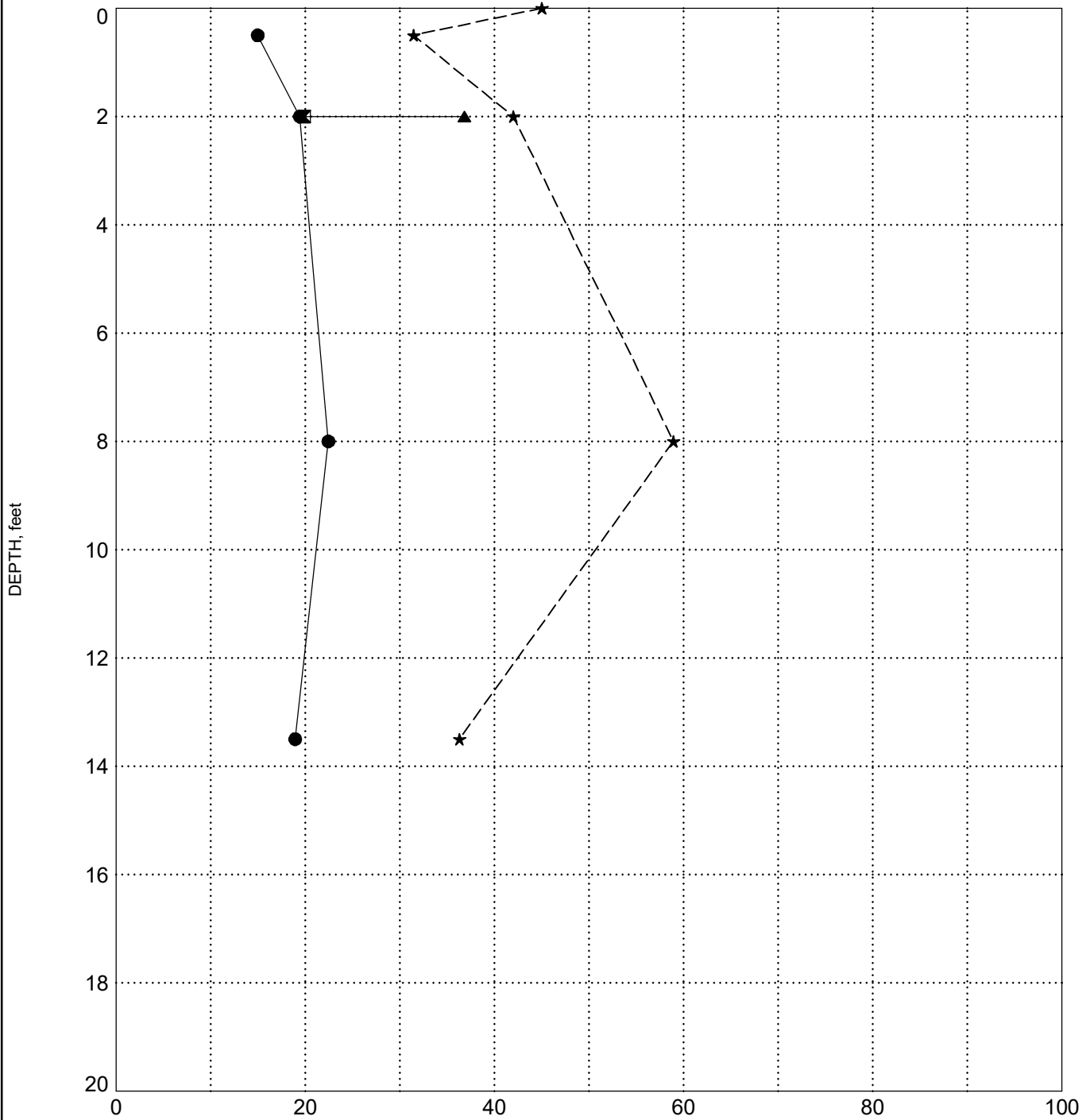
PROJECT ID P041958

PROJECT NAME S-20-20 Bridge Replacement over Hogfork Branch

PROJECT COUNTY Fairfield

SURFACE ELEVATION: 265.6

BORING S-20-20-1



LEGEND	
●	Water Content
✕	Plastic Limit
▲	Liquid Limit
★	Fines

INDEX PROPERTIES VERSUS DEPTH

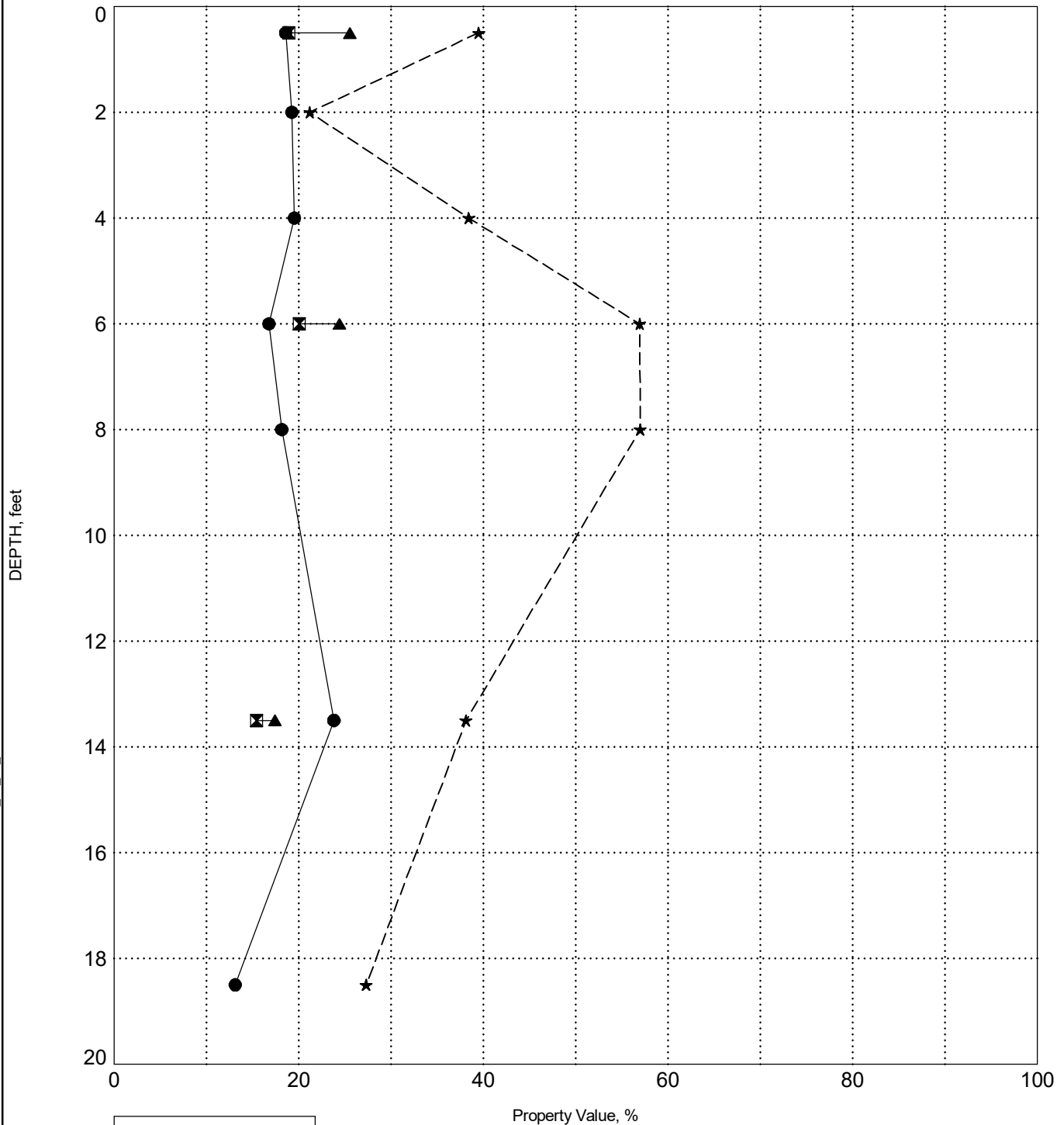
PROJECT ID P041958

PROJECT NAME S-20-20 Bridge Replacement over Hogfork Branch

PROJECT COUNTY Fairfield

SURFACE ELEVATION: 264.7

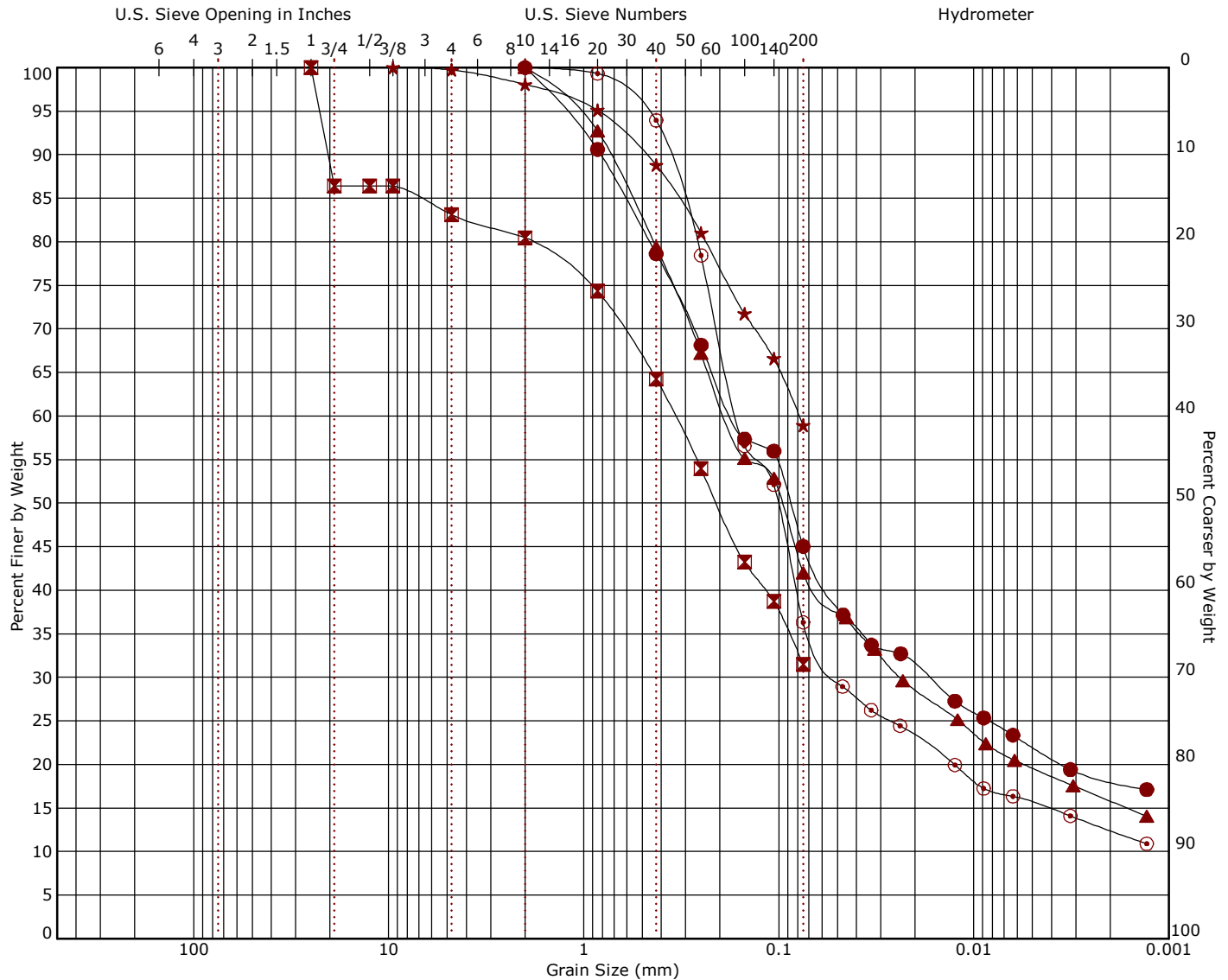
BORING S-20-20-2



LEGEND	
●	Water Content
☒	Plastic Limit
▲	Liquid Limit
★	Fines

Grain Size Distribution

ASTM D422 / ASTM D6913



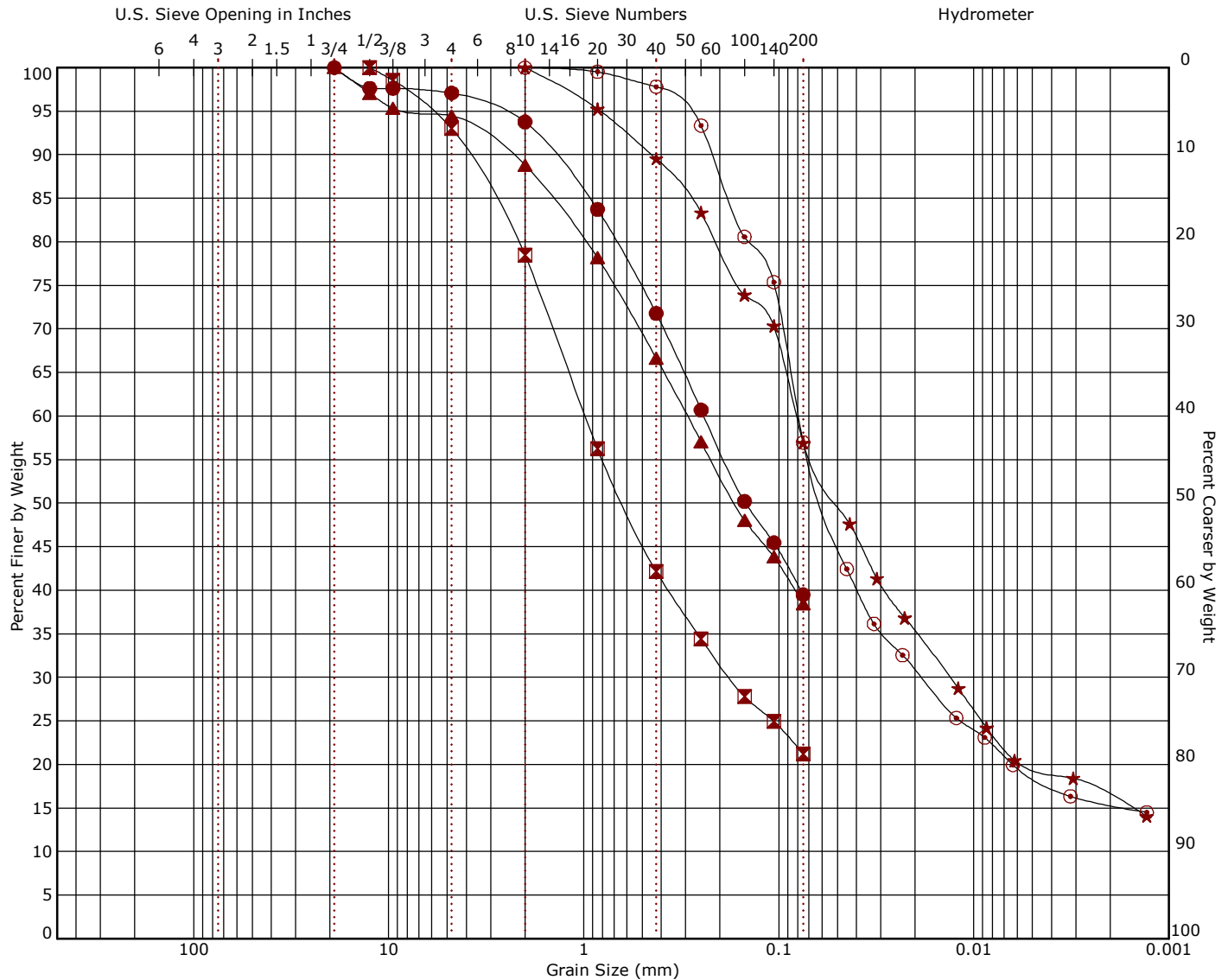
Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID	Depth (Ft)	USCS Classification	USCS	AASHTO	LL	PL	PI	Cc	Cu
● S-20-20-1A	0 - 5	CLAYEY SAND	SC	A-4 (1)	26	17	9		
⊠ S-20-20-1	0.5 - 2	CLAYEY SAND WITH GRAVEL	SC						
▲ S-20-20-1	2 - 4	CLAYEY SAND	SC	A-6 (3)	37	20	17		
★ S-20-20-1	8 - 10								
⊙ S-20-20-1	13.5								

Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● S-20-20-1	0 - 5	2	0.17	0.017		0.0	0.0	55.0		23.0	22.0
⊠ S-20-20-1	0.5 - 2	25	0.341			0.0	16.9	51.6	31.5		
▲ S-20-20-1	2 - 4	2	0.184	0.024		0.0	0.0	58.0		22.4	19.6
★ S-20-20-1	8 - 10	9.5	0.079			0.0	0.3	40.8	58.9		
⊙ S-20-20-1	13.5	2	0.162	0.05		0.0	0.0	63.7		20.7	15.6

Grain Size Distribution

ASTM D422 / ASTM D6913



Cobbles

Gravel

coarse

fine

Sand

coarse

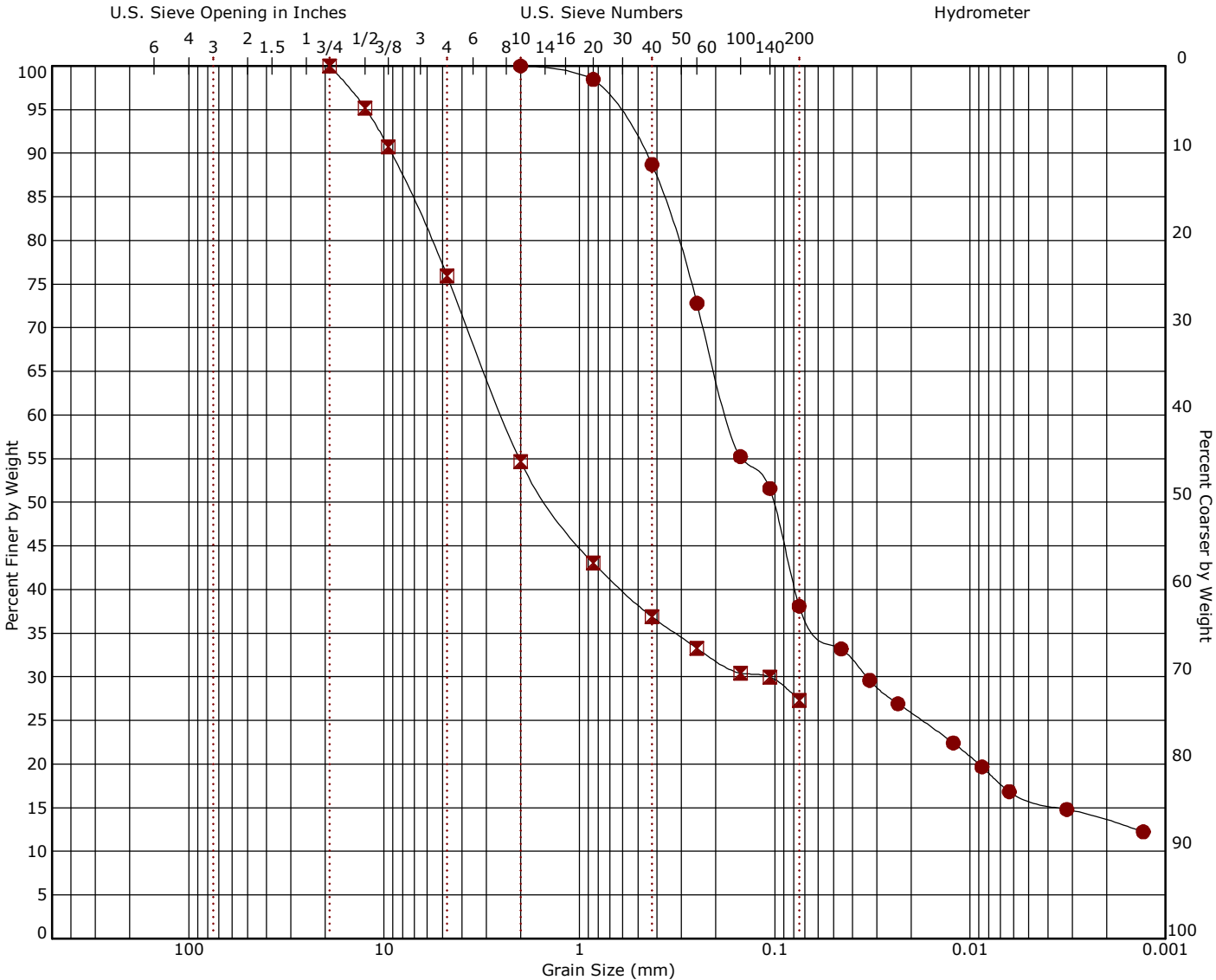
medium

fine

Silt or Clay

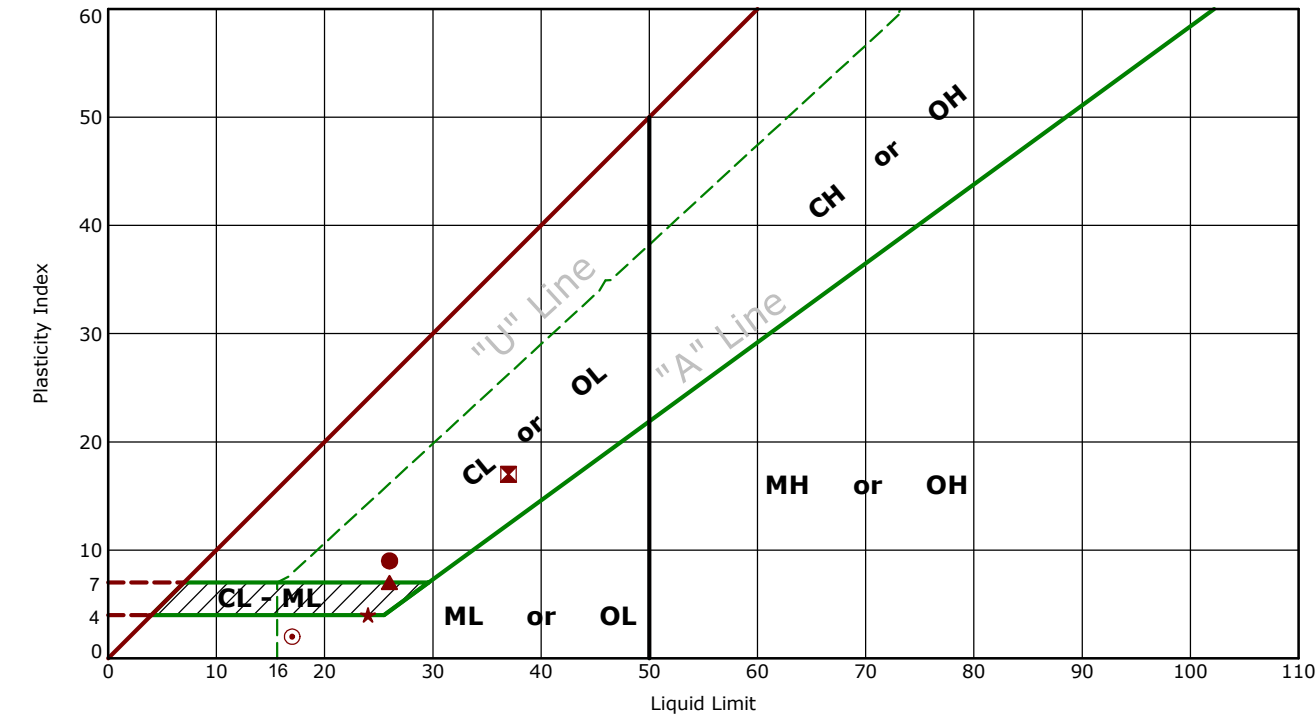
Boring ID	Depth (Ft)	USCS Classification				USCS	AASHTO	LL	PL	PI	Cc	Cu
● S-20-20-2	0.5 - 2	SILTY, CLAYEY SAND				SC-SM	A-4 (0)	26	19	7		
☒ S-20-20-2	2 - 4	CLAYEY SAND				SC						
▲ S-20-20-2	4 - 6	CLAYEY SAND				SC						
★ S-20-20-2	6 - 8	SANDY SILTY CLAY				CL-ML	A-4 (0)	24	20	4		
⊗ S-20-20-2	8 - 10											
Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay	
● S-20-20-2	0.5 - 2	19	0.242			0.0	2.9	57.6	39.5			
☒ S-20-20-2	2 - 4	12.5	0.982	0.178		0.0	7.0	71.8	21.2			
▲ S-20-20-2	4 - 6	19	0.294			0.0	5.5	56.1	38.4			
★ S-20-20-2	6 - 8	2	0.081	0.013		0.0	0.0	43.1		37.1	19.8	
⊗ S-20-20-2	8 - 10	2	0.079	0.019		0.0	0.0	43.0		38.3	18.7	

Grain Size Distribution
ASTM D422 / ASTM D6913



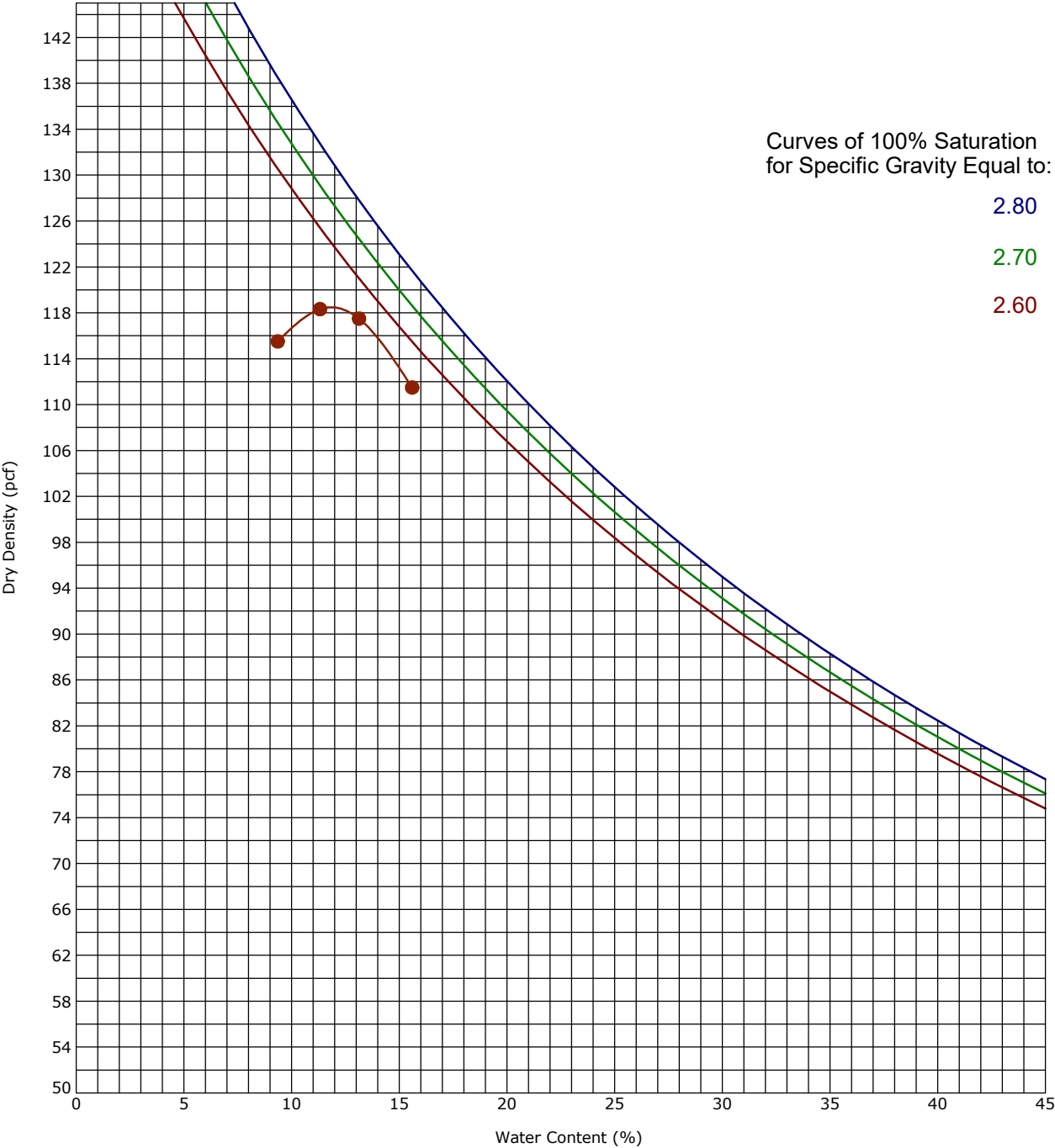
Cobbles		Gravel		Sand			Silt or Clay				
		coarse	fine	coarse	medium	fine					
Boring ID	Depth (Ft)	USCS Classification			USCS	AASHTO	LL	PL	PI	Cc	Cu
● S-20-20-2	13.5 - 15	SILTY SAND			SM	A-4 (0)	17	15	2		
▣ S-20-20-2	18.5 - 20	SILTY SAND WITH GRAVEL			SM						
Boring ID	Depth (Ft)	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● S-20-20-2	13.5 - 15	2	0.172	0.034		0.0	0.0	61.9		21.9	16.1
▣ S-20-20-2	18.5 - 20	19	2.485	0.107		0.0	24.1	48.6	27.3		

Atterberg Limit Results
ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	S-20-20-1A	0 - 5	26	17	9	45.0	SC	CLAYEY SAND
■	S-20-20-1	2 - 4	37	20	17	42.0	SC	CLAYEY SAND
▲	S-20-20-2	0.5 - 2	26	19	7	39.5	SC-SM	SILTY, CLAYEY SAND
★	S-20-20-2	6 - 8	24	20	4	56.9	CL-ML	SANDY SILTY CLAY
⊙	S-20-20-2	13.5 - 15	17	15	2	38.1	SM	SILTY SAND with gravel

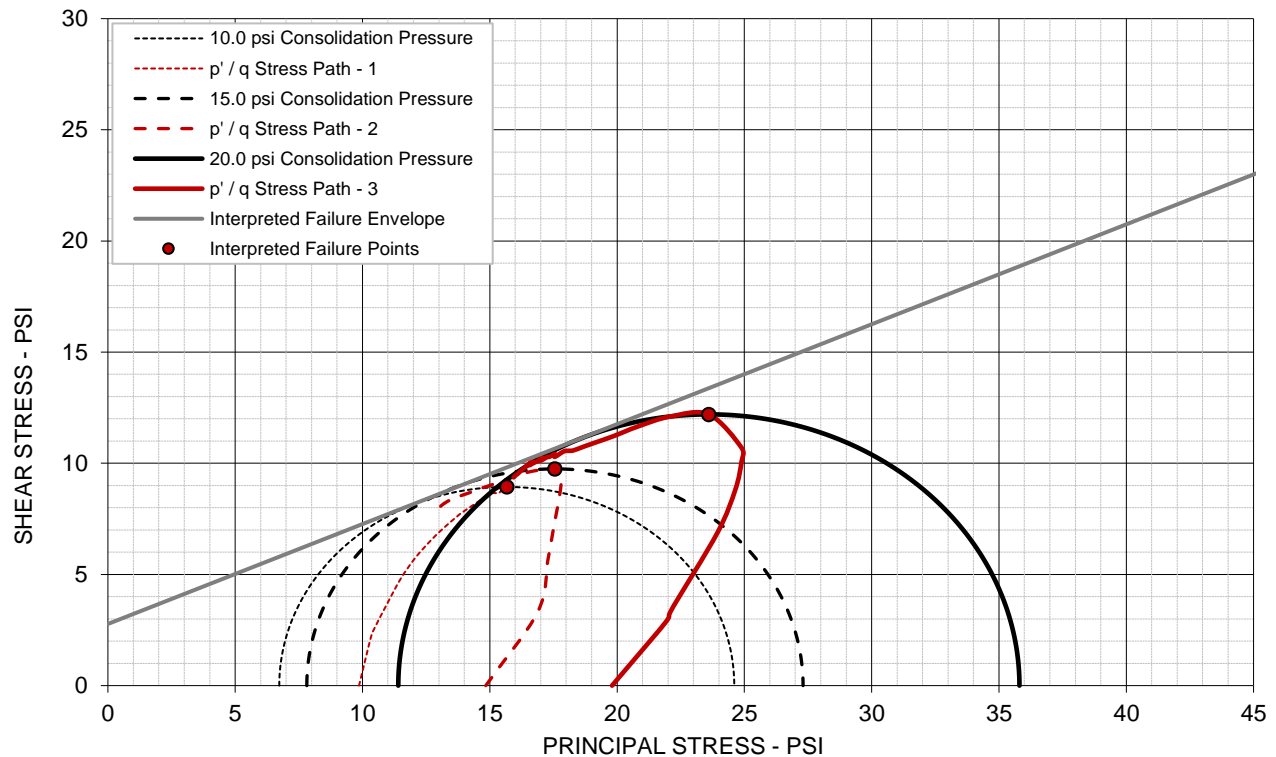
Moisture-Density Relationship
ASTM D698-Method B



Boring ID		Depth (Ft)		Description of Materials				
S-20-20-1A		0 - 5		CLAYEY SAND(SC)				
Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)	
45	0.0	26	17	9	ASTM D698-Method B	118.5	11.8	

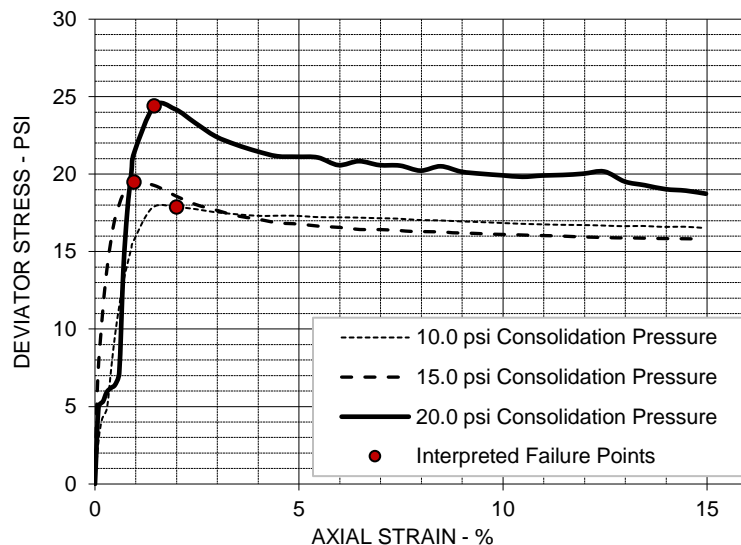
ICU TRIAXIAL COMPRESSION TEST ASTM D4767 / AASHTO T297

Failure Criteria: Max Deviator Stress



EFFECTIVE STRESS PARAMETERS

$\phi' = 24.2$ deg $c' = 2.8$ psi



SPECIMEN NO.

1 2 3

INITIAL

Moisture Content - %	11.8	11.8	11.8
Dry Density - pcf	112.6	112.6	112.6
Diameter - inches	2.85	2.85	2.85
Height - inches	6.00	6.00	6.00

AT TEST

Final Moisture - %			
Dry Density - pcf	113.3	113.7	113.9
Calculated Diameter (in.)	2.85	2.84	2.85
Height - inches	5.99	5.97	5.99
Effect. Consol. Stress - psi	10.0	15.0	20.0
Failure Stress - psi	17.87	19.49	24.40
Total Pore Pressure - psi	53.3	57.2	58.6
Strain Rate - %/min.	0.0332	0.0300	0.0299
Failure Strain - %	2.0	1.0	1.5
σ_1' Failure - psi	24.60	27.31	35.80
σ_3' Failure - psi	6.73	7.81	11.41

TEST DESCRIPTION

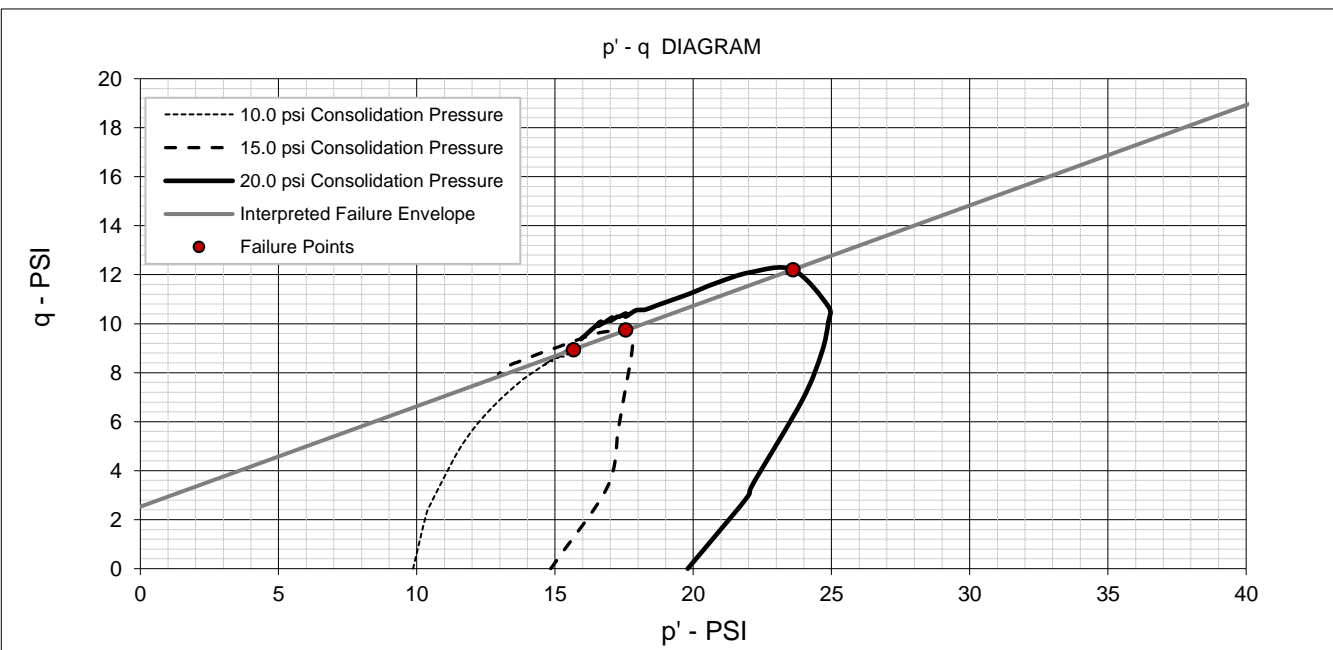
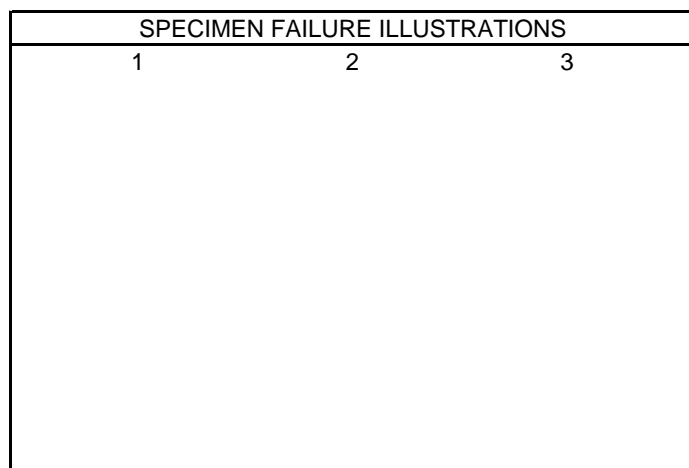
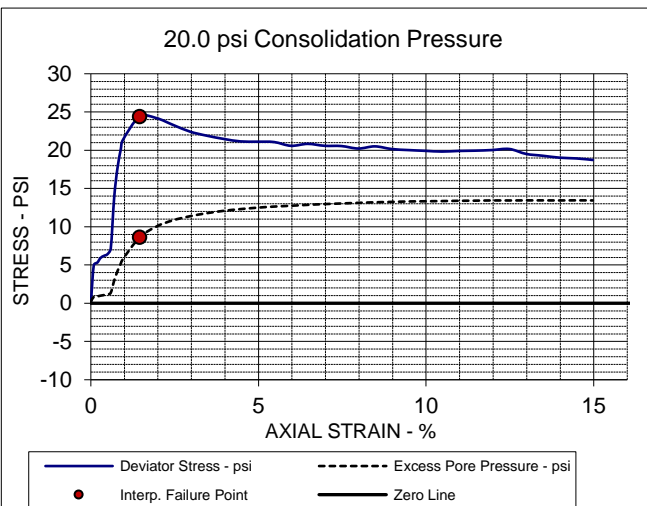
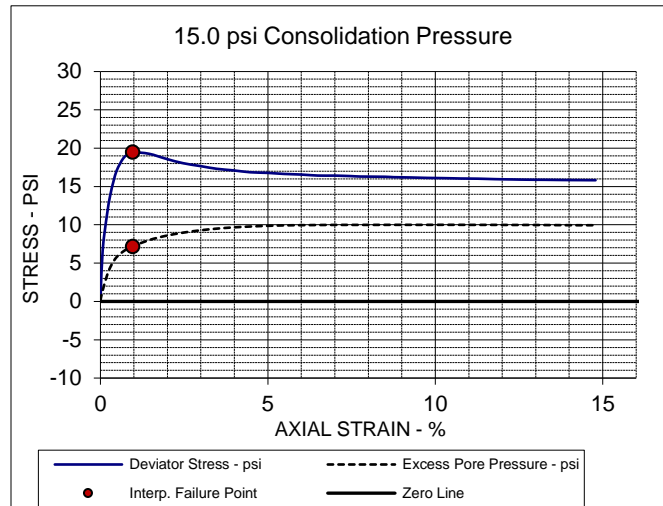
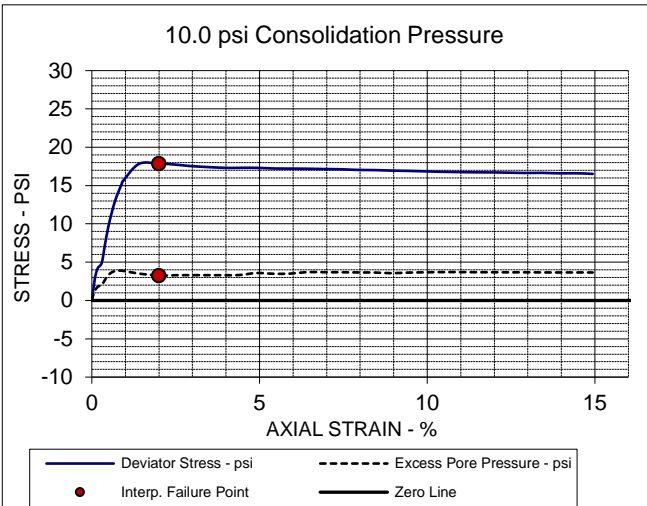
ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION
 SAMPLE TYPE: Remolded
 DESCRIPTION: Clayey Sand
 SAMPLE ID: S-20-20-1, Bulk, 0.0-5.0 ft
 SPECIFIC GRAVITY: 2.65
 LL: 26 PL: 17 PI: 9 Percent -200: 45.0
 Remarks: Remolded to 95% of the Standard Proctor


PROJECT INFORMATION

PROJECT: S-20-20 BRO Hogfork Branch
 LOCATION: Fairfield County
 PROJECT #: EN23P100
 CLIENT: HNTB North Carolina PC
 DATE: 07/10/23

1800 Reynolds Avenue
 Charleston, SC

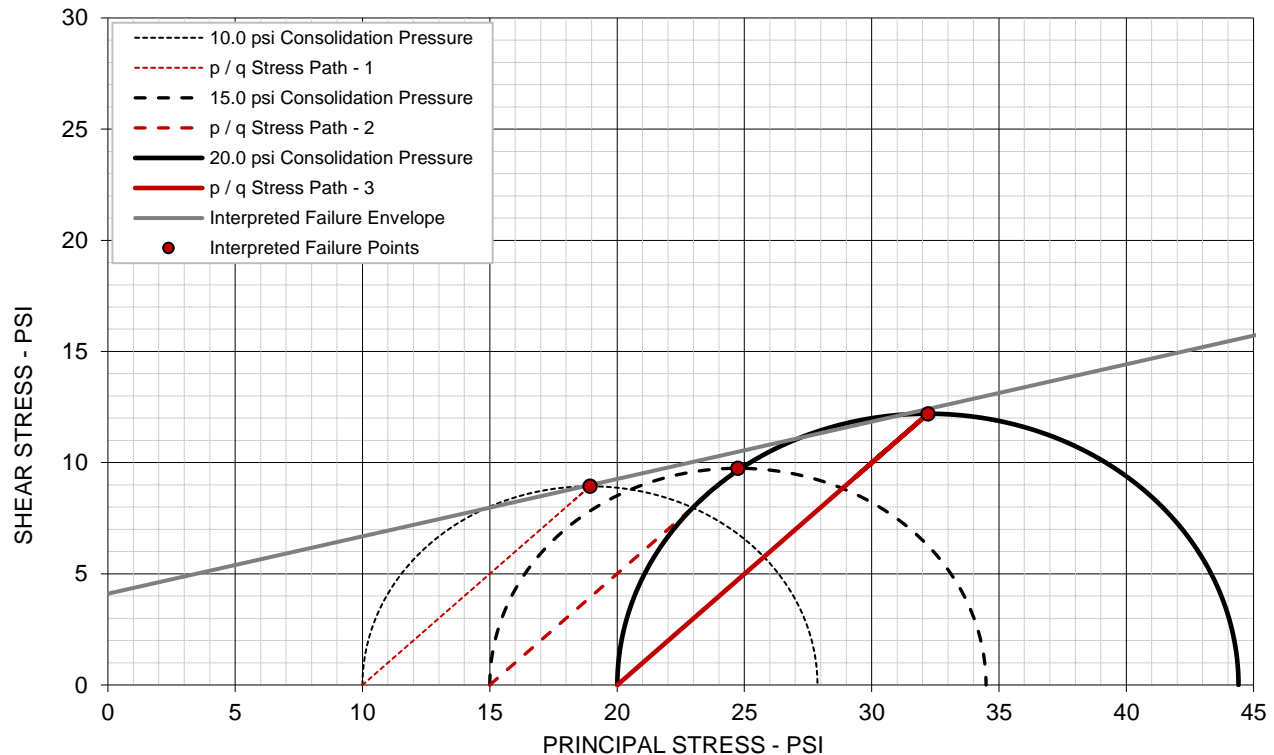




EFFECTIVE STRESS PARAMETERS		R ² = 1.00	α = 22.3 deg	a = 2.5 psi
PROJECT: S-20-20 BRO Hogfork Branch			ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION TEST	
LOCATION: Fairfield County			CLIENT: HNTB North Carolina PC	
SAMPLE ID: S-20-20-1, Bulk, 0.0-5.0 ft			<div>1800 Reynolds Avenue Charleston, SC</div> <div></div>	
DESCRIPTION: Clayey Sand				

ICU TRIAXIAL COMPRESSION TEST ASTM D4767 / AASHTO T297

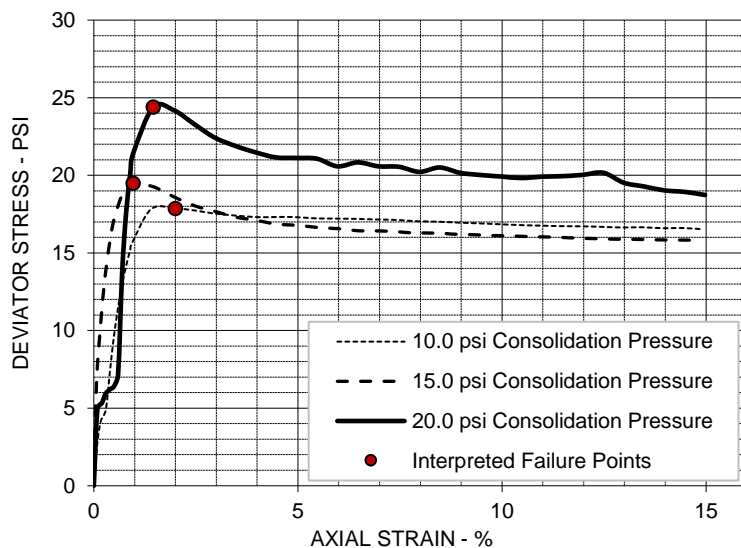
Failure Criteria: Max Deviator Stress



TOTAL STRESS PARAMETERS

$\phi = 14.5$ deg

$c = 4.1$ psi



SPECIMEN NO.

1 2 3

INITIAL

Moisture Content - %	11.8	11.8	11.8
Dry Density - pcf	112.6	112.6	112.6
Diameter - inches	2.85	2.85	2.85
Height - inches	6.00	6.00	6.00

AT TEST

Final Moisture - %			
Dry Density - pcf	113.3	113.7	113.9
Calculated Diameter (in.)	2.85	2.84	2.85
Height - inches	5.99	5.97	5.99
Effect. Consol. Stress - psi	10.0	15.0	20.0
Failure Stress - psi	17.87	19.49	24.40
Total Pore Pressure - psi	53.3	57.2	58.6
Strain Rate - %/min.	0.0332	0.0300	0.0299
Failure Strain - %	2.0	1.0	1.5
σ_1 Failure - psi	27.87	34.49	44.41
σ_3 Failure - psi	10.00	15.00	20.01

TEST DESCRIPTION

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL COMPRESSION
SAMPLE TYPE: Remolded
DESCRIPTION: Clayey Sand
SAMPLE ID: S-20-20-1, Bulk, 0.0-5.0 ft
SPECIFIC GRAVITY: 2.65
LL: 26 PL: 17 PI: 9 Percent -200: 45.0
Remarks: Remolded to 95% of the Standard Proctor

PROJECT INFORMATION

PROJECT: S-20-20 BRO Hogfork Branch
LOCATION: Fairfield County
PROJECT #: EN23P100
CLIENT: HNTB North Carolina PC
DATE: 07/10/23

1800 Reynolds Avenue
Charleston, SC



Client

HNTB North Carolina PC
Raleigh, NC

Project

S-20-20 BRO Hogfork Branch
EN23P100

Date Received: 6/27/2023

Results from Corrosion Testing

Sample Location	S-20-20-1
Sample Depth (ft.)	0'-10'

pH Analysis, ASTM G 51	6.60
Water Soluble Sulfate (SO ₄), ASTM D516-07 (mg/kg)	73
Chlorides, APHA 4500-Cl ⁻ E, (mg/kg)	37
Resistivity (Saturated), ASTM G 57, (ohm-cm)	2500

Analyzed By: Kyle Lemcke
Laboratory Manager

The tests were performed in general accordance with applicable ASTM and AWWA test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

Summary of Core Data

Boring No.	Core Run No.	Top Depth, ft.	RR (%)	RQD (%)	q _u (psi)	Poisson's Ratio	Secant Modulus ksi	Unit Wt. (pcf)	GSI /RMR
S-20-20-1	NQ-1	21.0	28	0	--	--	--	--	20/--
S-20-20-1	NQ-2	26.0	38	0	--	--	--	--	40/--
S-20-20-1	NQ-3	31.0	81	14	11,995	0.073	1,063	174	60/27
S-20-20-2	NQ-1	21.5	56	22	33,861	0.412	1,662	180	60/41
S-20-20-2	NQ-2	25.5	100	53	11,328	0.069	1,099	173	70/43
S-20-20-2	NQ-3	30.5	100	0	7,302	0.187	1,107	164	70/30

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

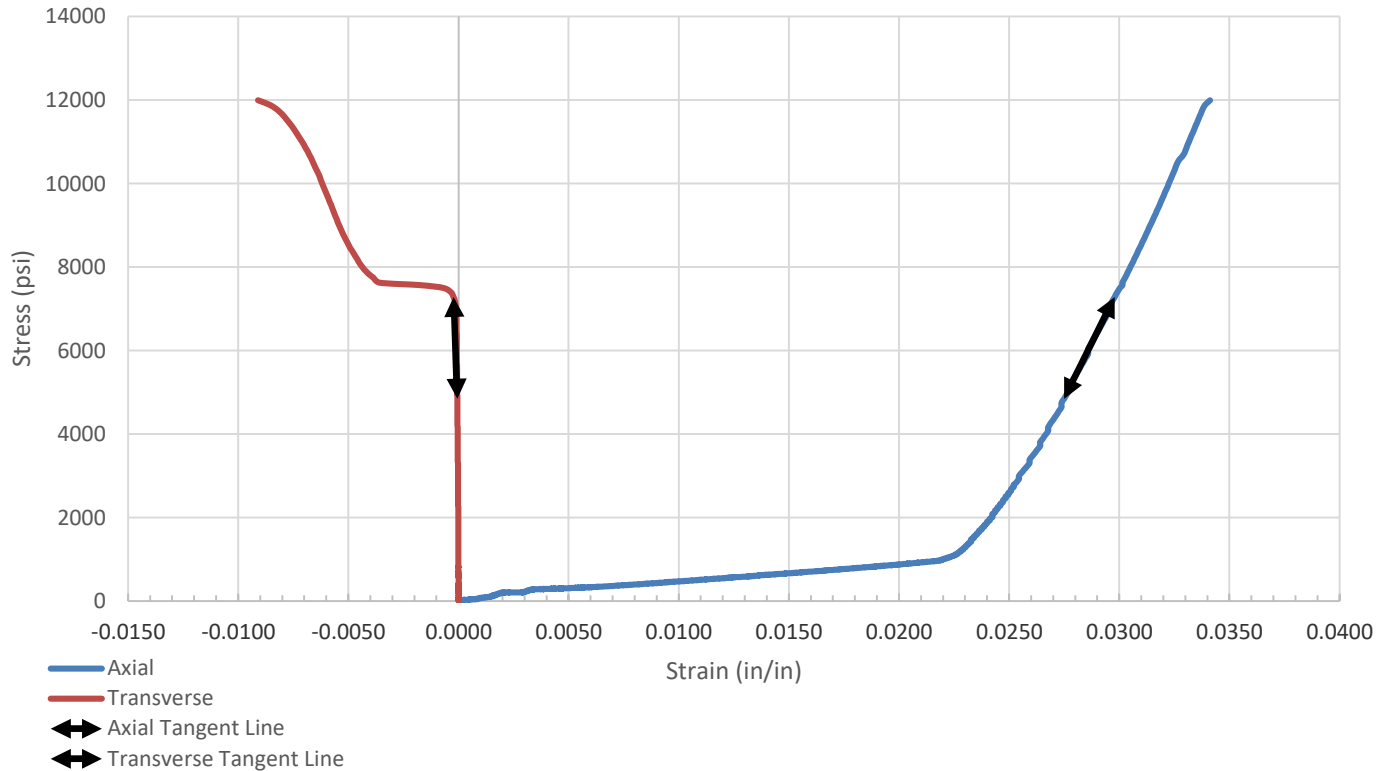
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-20-20 BRO Hogfork Branch		
Rock Type:	Metagranodiorite		
Boring:	S-20-20-1	Depth (feet):	31.0

SPECIMEN INFORMATION

Sample No.:	NQ -3	Mass (g):	624.46
Length (in.):	4.168	Diameter (in.):	2.04
L/D Ratio:	2.0	Density (pcf):	174.282

TEST RESULTS

Failure Load (lbs):	39283
Failure Strain (%):	3.74
Unconfined Compressive Strength (psi):	11,995
Elastic Modulus, E, (ksi):	1063
Poisson's Ratio, u:	0.073
Time of Failure (min):	03:59
Rate of Loading (psi/sec):	50.147
Moisture Content Post-break:	0.1%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0100
Perpendicularity Deviation:	
Diameter 1a:	0.0091
Diameter 1b:	0.0127
Diameter 2a:	0.0069
Diameter 2b:	0.0126
Max Deviation from Flatness:	0.0122
Parallelism Deviation:	
Diameter a:	0.12
Diameter b:	1.30

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in accordance with ASTM D4543 and D7012.

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

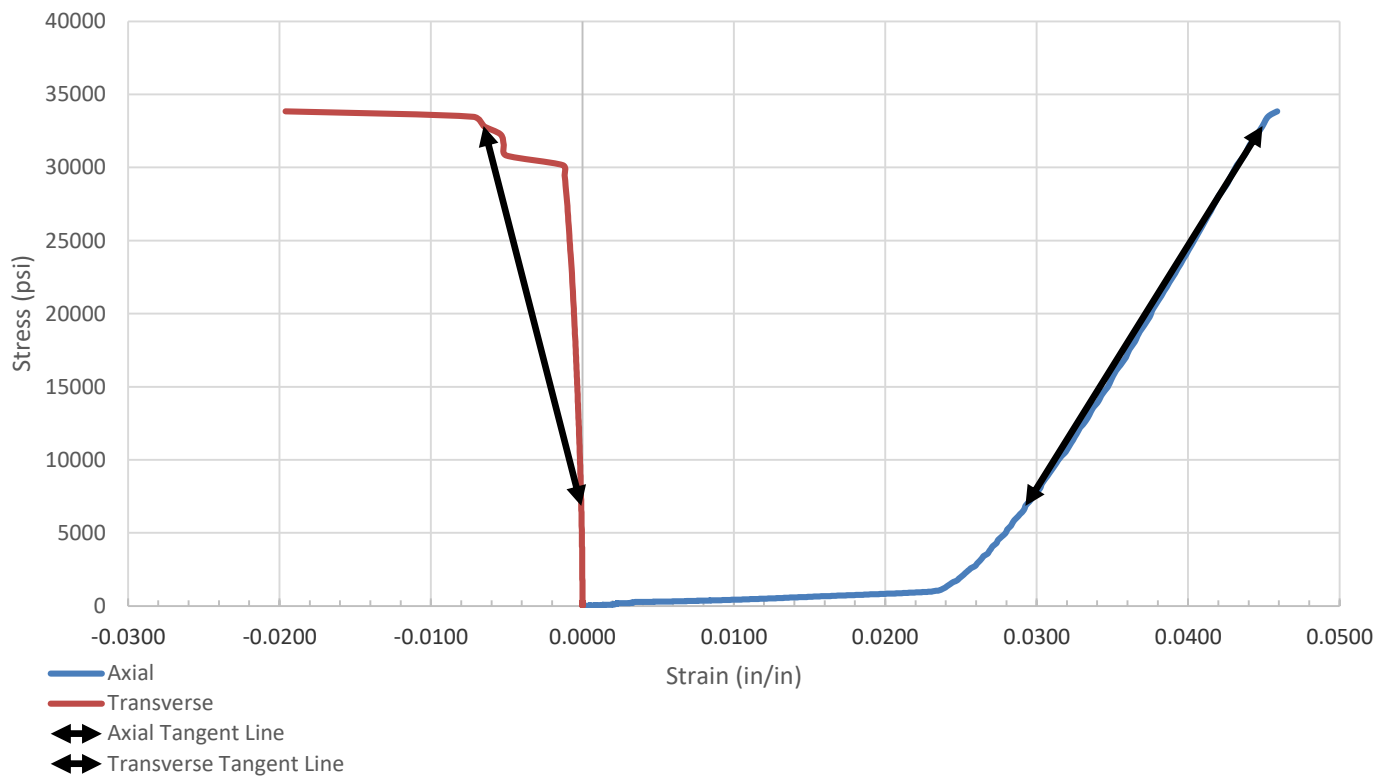
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-20-20 BRO Hogfork Branch		
Rock Type:	Metagranodiorite		
Boring:	S-20-20-2	Depth (feet):	21.5

SPECIMEN INFORMATION

Sample No.:	NQ -1	Mass (g):	607.53
Length (in.):	4.174	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	179.720

TEST RESULTS

Failure Load (lbs):	104470
Failure Strain (%):	4.59
Unconfined Compressive Strength (psi):	33,861
Elastic Modulus, E, (ksi):	1662
Poisson's Ratio, u:	0.412
Time of Failure (min):	03:10
Rate of Loading (psi/sec):	178.215
Moisture Content Post-break:	0.1%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0104
Perpendicularity Deviation:	
Diameter 1a:	0.0070
Diameter 1b:	0.0014
Diameter 2a:	0.0117
Diameter 2b:	0.0039
Max Deviation from Flatness:	0.0054
Parallelism Deviation:	
Diameter a:	0.08
Diameter b:	0.11

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in general accordance with ASTM D4543 and D7012.

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

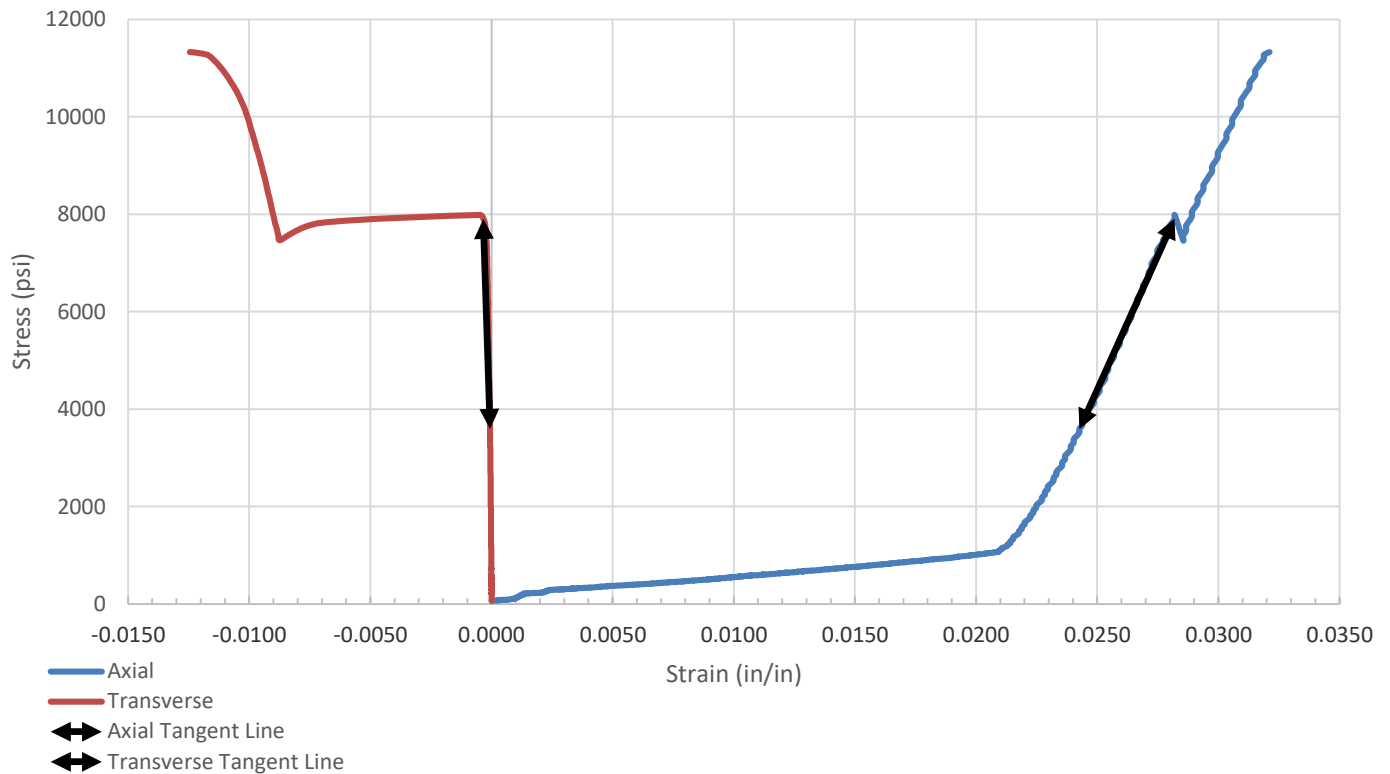
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-20-20 BRO Hogfork Branch		
Rock Type:	Metagranodiorite		
Boring:	S-20-20-2	Depth (feet):	25.5

SPECIMEN INFORMATION

Sample No.:	NQ-2	Mass (g):	589.89
Length (in.):	4.2255	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	172.898

TEST RESULTS

Failure Load (lbs):	34846
Failure Strain (%):	3.28
Unconfined Compressive Strength (psi):	11,328
Elastic Modulus, E, (ksi):	1099
Poisson's Ratio, ν :	0.069
Time of Failure (min):	02:09
Rate of Loading (psi/sec):	87.546
Moisture Content Post-break:	0.6%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0153
Perpendicularity Deviation:	
Diameter 1a:	0.0135
Diameter 1b:	0.0024
Diameter 2a:	0.0140
Diameter 2b:	0.0098
Max Deviation from Flatness:	0.0023
Parallelism Deviation:	
Diameter a:	0.02
Diameter b:	0.76

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in general accordance with ASTM D4543 and D7012.

Report Number: 7323P100
Service Date: 06/02/23
Report Date: 07/10/23



Client

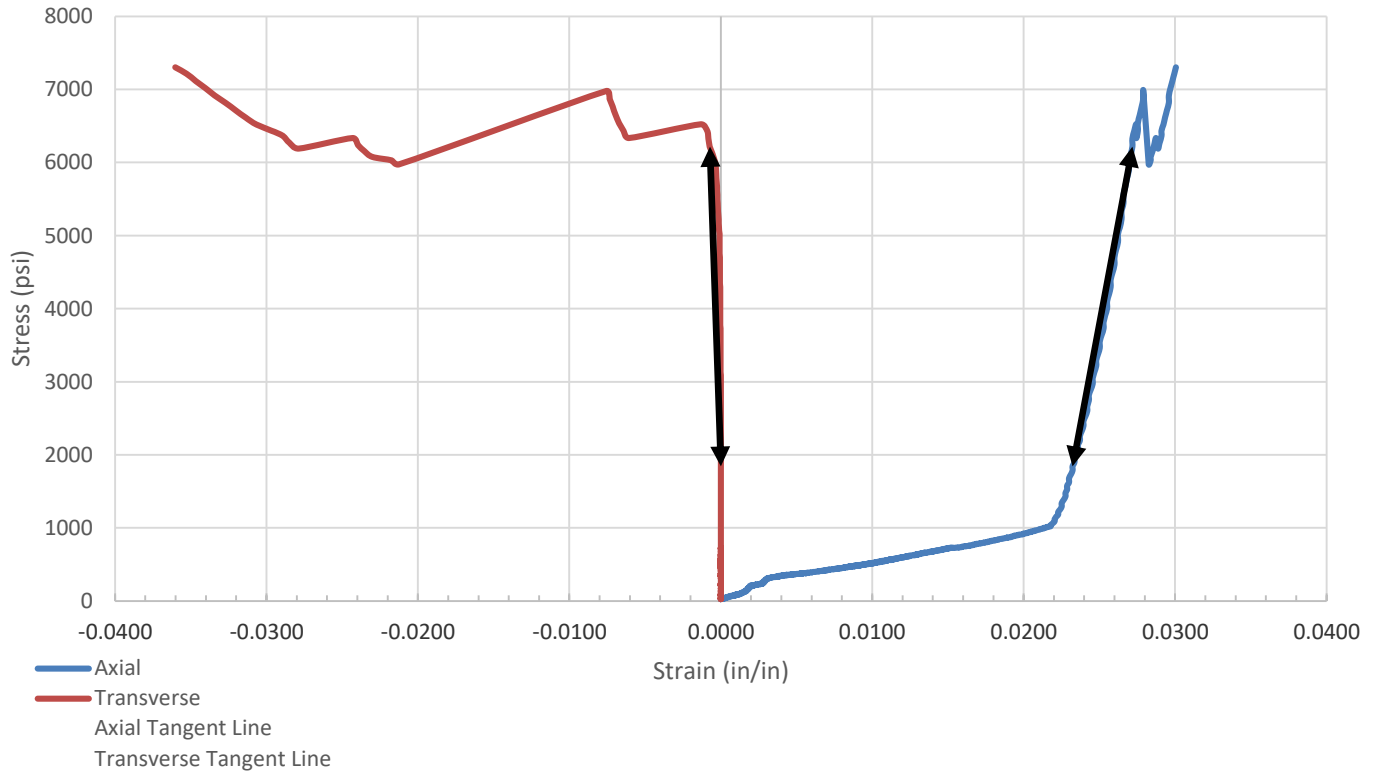
HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D7012 Stress/ Strain Curve



SAMPLE LOCATION

Site:	S-20-20 BRO Hogfork Branch		
Rock Type:	Metagranodiorite		
Boring:	S-20-20-2	Depth (feet):	30.5

SPECIMEN INFORMATION

Sample No.:	NQ-3	Mass (g):	557.49
Length (in.):	4.197	Diameter (in.):	1.98
L/D Ratio:	2.1	Density (pcf):	163.848

TEST RESULTS

Failure Load (lbs):	22553
Failure Strain (%):	3.01
Unconfined Compressive Strength (psi):	7,302
Elastic Modulus, E, (ksi):	1107
Poisson's Ratio, ν :	0.187
Time of Failure (min):	04:11
Rate of Loading (psi/sec):	29.117
Moisture Content Post-break:	0.1%

Report Number: 7323P100

Service Date: 06/02/23

Report Date: 07/10/23

Client

HNTB North Carolina PC
Attn: Spencer Franklin
343 E Six Forks Rd Ste 200
Raleigh, NC 27609

Project

S-20-20 BRO Hogfork Branch

Project No. 7323P100

ASTM D4543 Test Results:

<u>Parameter</u>	<u>Data</u>
Side Straightness:	0.0028
Perpendicularity Deviation:	
Diameter 1a:	0.0199
Diameter 1b:	0.0070
Diameter 2a:	0.0233
Diameter 2b:	0.0107
Max Deviation from Flatness:	0.0053
Parallelism Deviation:	
Diameter a:	0.13
Diameter b:	1.11

Equipment:

	TICCS ID:
Calipers:	W-44049
Scale:	B-71466
Dial Indicator:	C-70608
Compression (spherically seated):	C-48999

Samples were prepared and tested in general accordance with ASTM D4543 and D7012.

Appendix C
Supporting Documents

Rig Calibration Report (5 Pages)

SPT Automatic Hammer Energy Measurement Report

Drill Rig Model: Diedrich D-50
 Drill Rig Serial Number: D50-479
 Asset Number: DR#1109

July 3, 2023

July 03, 2023

Terracon Consultants Inc.
 521 Clemson Rd.
 Columbia, SC 29229

Attn: Chris Costner
 E: chris.costner@terracon.com

Re: SPT Automatic Hammer Energy Measurement Report
 Rig Serial Number: D50-479 Terracon Project Number: DUXX0500

Dear Mr. Costner:

This report provides the Energy Transfer Ratio (ETR) for the Standard Penetration Testing (SPT) automatic hammer as summarized below:

Table 1: Hammer Efficiency Summary

Drill Rig Make/Model	Drill Rig Serial Number	Drill Rig Year	Asset Number	Energy Transfer Ratio (ETR)	Hammer Efficiency Correction (Ce)
Diedrich D50	D50-479	2021	DR#1109	93.9% ± 2.3%	1.57

If you have any questions concerning this summary, or if we may be of further service, please contact us.

James P. Smith

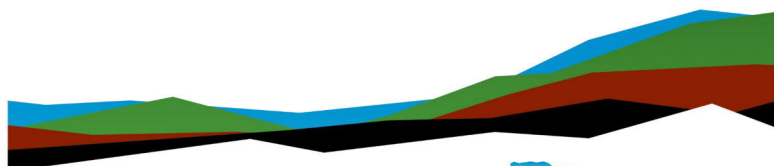
James P. Smith
 National Manager of Equipment & Training

Rob Kramer

Rob Kramer
 Geophysical Services Manager, COG

Attachments:

- Exhibit A: PDA SPT Analyzer Results
- Exhibit B: PDA Equipment Calibration



Prepared for:

Terracon Consultants, Inc.
 Columbia, South Carolina



Facilities | Environmental | **Geotechnical** | Materials |

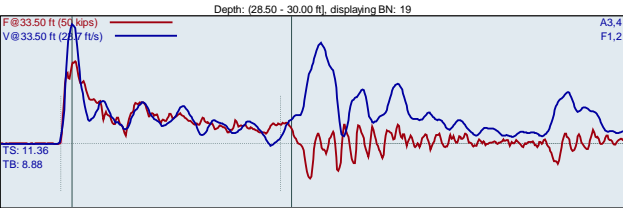


MEASUREMENT SUMMARY

ITEM	DESCRIPTION
Drill Rig Owner	Terracon Consultant, Inc. - Columbia, SC
Drill Rig Operator	Shiver Truesdale; Terracon Exploration
Testing Date	07/03/2023
Testing Location	Columbia, SC
Boring Identification	B-1
Hammer Type	140 pounds (automatic)
Boring Method	Rotary Wash
Drill Rods	<ul style="list-style-type: none"> AWJ 1-3/4" outside diameter 3/16" wall thickness
Calibration Testing Equipment	<ul style="list-style-type: none"> 2-foot AWJ rod instrumented w/ two strain gauges and two accelerometers Model SPT Analyzer™ (PDA)
ASTM Methods Used	<p>ASTM D1586, Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils</p> <p>ASTM D4633-16, Standard Method for Energy Measurement for Dynamic Penetrometers</p>
SPT Calibration Personnel	Micah Hatch- Department Manager, Terracon Consultants, Inc.

Exhibit A

PDA SPT Analyzer Results



F1 : [512AWJ] 207.75 PDICAL (1) FF1
F2 : [512AWJ2] 208.76 PDICAL (1) FF1

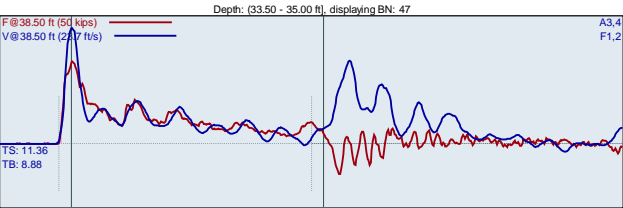
A3 (PR): [K5998] 403.535 mw/6.4v5000g (1) VF1
A4 (PR): [K10453] 411.89 mw/6.4v5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
3	6	32	23.8	48.1	315	89.9
4	6	34	23.8	47.8	319	91.3
5	6	32	23.5	48.4	316	90.4
6	6	32	23.3	47.8	324	92.5
7	6	32	23.0	48.3	325	92.8
8	6	32	22.2	48.2	316	90.4
9	6	32	22.0	47.7	324	92.7
10	6	32	22.7	48.5	324	92.7
11	6	32	21.6	47.9	326	93.3
12	6	31	21.3	48.4	326	93.1
13	9	32	21.7	47.7	323	94.1
14	9	32	22.1	48.0	326	93.3
15	9	32	21.8	47.9	331	94.7
16	9	31	21.7	48.2	329	93.9
17	9	32	21.8	48.1	334	95.4
18	9	33	22.2	47.5	338	96.5
19	9	32	22.1	48.4	340	97.1
20	9	32	22.2	48.1	326	93.2
21	9	32	22.7	47.8	332	94.8
Average		32	22.1	48.1	329	93.9
Std Dev		0	0.4	0.3	6	1.6
Maximum		33	23.0	48.5	340	97.1
Minimum		31	21.3	47.5	316	90.4
N-value: 15						

Sample Interval Time: 22.48 seconds.



F1 : [512AWJ] 207.75 PDICAL (1) FF1
F2 : [512AWJ2] 208.76 PDICAL (1) FF1

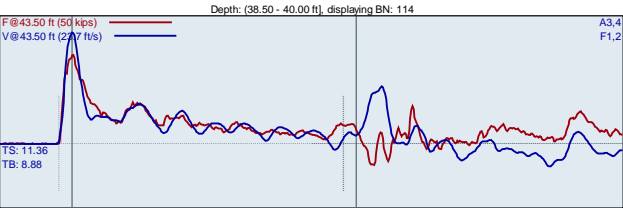
A3 (PR): [K5998] 403.535 mw/6.4v5000g (1) VF1
A4 (PR): [K10453] 411.89 mw/6.4v5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
23	7	32	19.5	48.3	314	89.7
24	7	31	19.4	48.4	305	87.0
25	7	31	19.9	48.1	311	88.9
26	7	31	19.4	48.2	310	88.6
27	7	31	19.5	48.0	311	88.8
28	7	31	19.9	48.1	310	88.7
29	9	31	19.6	48.0	314	89.8
30	9	32	19.8	48.3	314	89.7
31	9	30	19.2	48.0	309	88.3
32	9	31	19.7	48.2	313	89.5
33	9	31	19.6	47.9	313	89.5
34	9	30	19.3	48.0	310	88.7
35	9	32	21.2	48.3	319	91.2
36	9	32	21.3	48.3	321	91.7
37	9	33	22.0	48.1	327	93.5
38	12	32	20.4	48.2	302	86.2
39	12	32	21.6	47.9	319	91.2
40	12	32	21.1	47.9	321	91.7
41	12	31	20.4	48.0	311	88.9
42	12	31	20.9	48.1	324	92.6
43	12	32	21.8	48.0	322	92.1
44	12	32	22.3	48.1	323	92.3
45	12	32	21.4	48.1	317	90.6
46	12	32	21.8	48.2	323	92.4
47	12	32	21.5	48.2	322	92.0
48	12	33	22.0	48.2	320	91.4
49	12	32	21.8	47.7	322	92.1

Sample Interval Time: 32.40 seconds.



F1 : [512AWJ] 207.75 PDICAL (1) FF1
F2 : [512AWJ2] 208.76 PDICAL (1) FF1

A3 (PR): [K5998] 403.535 mw/6.4v5000g (1) VF1
A4 (PR): [K10453] 411.89 mw/6.4v5000g (1) VF1

FMX: Maximum Force
VMX: Maximum Velocity
BPM: Blows/Minute

EFV: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BL#	BC /6"	FMX kips	VMX ft/s	BPM bpm	EFV ft-lb	ETR %
51	17	35	21.7	47.4	339	96.8
52	17	35	21.7	48.4	336	96.0
53	17	35	21.7	48.2	336	96.1
54	17	34	21.7	48.2	337	96.3
55	17	34	21.7	48.1	339	96.9
56	17	34	21.2	48.1	337	96.2
57	17	34	21.2	48.3	336	95.9
58	17	33	21.2	48.4	322	92.1
59	17	35	22.2	48.1	343	98.0
60	17	33	21.2	48.0	324	92.6
61	17	34	21.8	48.3	337	96.3
62	17	34	21.7	48.0	331	94.5
63	17	33	21.3	48.2	335	95.6
64	17	34	21.8	48.2	336	95.9
65	17	34	22.1	48.0	329	94.0
66	17	33	21.4	48.3	336	96.1
67	19	34	21.7	48.5	331	94.7
68	19	33	21.3	47.8	336	95.9
69	19	33	21.2	48.2	334	95.3
70	19	35	22.9	47.8	344	98.4
71	19	34	22.1	48.1	339	96.9
72	19	33	20.9	48.3	333	95.0
73	19	33	20.8	48.1	331	94.4
74	19	34	20.7	47.9	329	94.1
75	19	34	20.9	48.2	331	94.6
76	19	34	21.1	47.7	343	97.9
77	19	35	20.9	48.3	332	94.9
78	19	35	21.1	48.3	336	96.1
79	19	34	20.5	48.1	338	96.5
80	19	34	20.6	48.4	338	96.7
81	19	34	20.4	48.3	326	93.2

82	19	33	20.2	48.0	336	96.0
83	19	34	20.3	48.3	333	95.1
84	19	33	20.1	47.7	325	92.8
85	19	33	19.9	48.4	330	94.4
86	31	35	20.5	47.9	332	94.9
87	31	34	20.5	48.1	330	94.3
88	31	33	20.3	47.8	324	92.5
89	31	33	20.8	48.3	336	95.9
90	31	33	20.6	48.0	331	94.6
91	31	34	20.4	48.4	338	96.7
92	31	33	20.2	48.5	329	94.0
93	31	34	20.6	48.0	336	96.1
94	31	34	20.7	48.6	334	95.3
95	31	34	20.5	48.6	334	95.4
96	31	34	20.3	48.5	331	94.5
97	31	33	20.3	48.4	331	94.6
98	31	34	20.3	48.5	332	94.9
99	31	33	20.5	48.4	333	95.2
100	31	33	20.0	48.0	338	96.5
101	31	34	21.1	48.3	332	94.8
102	31	33	20.0	48.1	334	95.4
103	31	34	20.2	48.8	329	93.9
104	31	33	20.0	48.3	331	94.4
105	31	33	20.1	48.1	330	94.3
106	31	35	20.4	47.9	334	95.5
107	31	34	20.2	48.3	331	94.5
108	31	34	20.1	48.0	335	95.7
109	31	34	20.0	48.3	327	93.3
110	31	34	20.0	47.9	330	94.2
111	31	34	20.3	47.6	331	94.6
112	31	34	20.5	47.2	333	95.1
113	31	35	20.4	47.6	336	95.9
114	31	35	20.6	47.7	335	95.7
115	31	34	20.6	47.2	335	95.7
116	31	34	20.6	47.2	339	96.7
Average			34	20.6	48.1	333
Std Dev			1	0.6	0.4	4
Maximum			35	22.9	48.8	344
Minimum			33	19.9	47.2	324
N-value: 50						

Sample Interval Time: 81.06 seconds.

Summary of SPT Test Results

Project: Dietrich D50 (SN 479), Test Date: 7/3/2023						EFV: Maximum Energy ETR: Energy Transfer Ratio - Rated				
FMX: Maximum Force VMX: Maximum Velocity BPM: Blows/Minute										
Test Length ft		Blows Applied /ft	N Value	N50 Value	Average FMX kips	Average VMX ft/s	Average BPM bpm	Average EFV ft-lb	Average ETR %	
33.50		6-6-9	15	23	32	22.1	48.1	329	93.9	
38.50		7-9-12	21	32	32	20.9	48.1	318	90.7	
43.50		17-19-31	50	78	34	20.6	48.1	333	95.2	
Overall Average Values:						33	20.9	48.1	328	93.9
Standard Deviation:						1	0.9	0.3	8	2.3
Overall Maximum Value:						35	23.0	48.8	344	98.4
Overall Minimum Value:						30	19.2	47.2	302	86.2



Exhibit B

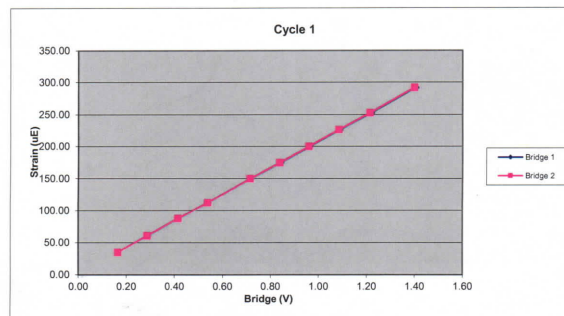
PDA Equipment Calibration



512AWJ		Cycle 1		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1203.06	34.31	0.16	0.16
3	2126.16	60.40	0.29	0.29
4	3077.44	86.97	0.42	0.42
5	3982.41	111.72	0.54	0.54
6	5285.39	149.30	0.72	0.72
7	6200.50	174.57	0.84	0.84
8	7099.62	199.59	0.96	0.96
9	8021.85	226.03	1.09	1.08
10	8981.90	252.42	1.22	1.21
11	10350.08	291.62	1.40	1.40

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7371.63	Force Calibration (lb/V)	7404.01
Offset	-2.95	Offset	-5.32
Correlation	1.000000	Correlation	0.999999
Strain Calibration (µE/V)	207.13	Strain Calibration (µE/V)	208.04
Offset	0.34	Offset	0.27
Correlation	0.999991	Correlation	0.999992

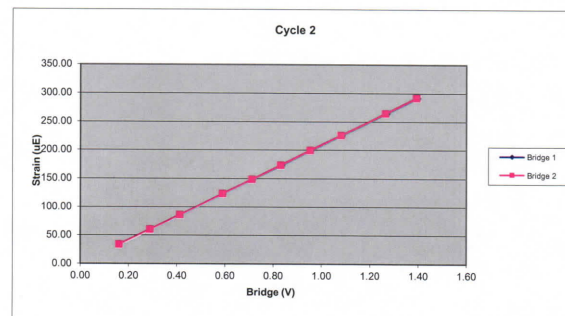
Force Strain Calibration	
EA (Kips)	35589.20
Offset	-14.99
Correlation	0.999992



512AWJ		Cycle 2		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1195.16	33.02	0.16	0.16
3	2140.49	59.36	0.29	0.29
4	3060.77	84.68	0.41	0.41
5	4361.31	122.48	0.59	0.59
6	5276.03	147.78	0.71	0.71
7	6152.73	172.65	0.83	0.83
8	7048.15	198.82	0.96	0.95
9	8008.49	225.14	1.08	1.08
10	9364.20	264.06	1.27	1.26
11	10320.35	291.14	1.40	1.39

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7383.19	Force Calibration (lb/V)	7408.85
Offset	1.99	Offset	1.61
Correlation	0.999999	Correlation	1.000000
Strain Calibration (µE/V)	209.13	Strain Calibration (µE/V)	209.86
Offset	-1.28	Offset	-1.29
Correlation	0.999988	Correlation	0.999991

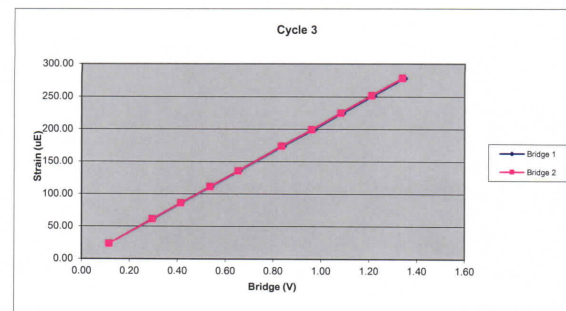
Force Strain Calibration	
EA (Kips)	35302.85
Offset	47.38
Correlation	0.999989



512AWJ		Cycle 3		
Sample	Force (lb)	Strain (µE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	843.37	22.72	0.11	0.11
3	2199.17	60.67	0.30	0.29
4	3069.54	85.62	0.42	0.41
5	3979.10	110.64	0.54	0.54
6	4849.18	135.11	0.66	0.65
7	6197.28	173.33	0.84	0.84
8	7134.13	198.98	0.97	0.96
9	8033.64	224.83	1.09	1.08
10	8976.83	251.64	1.22	1.21
11	9937.94	277.86	1.35	1.34

Bridge 1		Bridge 2	
Force Calibration (lb/V)	7369.64	Force Calibration (lb/V)	7419.12
Offset	-2.56	Offset	0.17
Correlation	0.999999	Correlation	0.999999
Strain Calibration (µE/V)	206.99	Strain Calibration (µE/V)	208.38
Offset	-1.03	Offset	-0.95
Correlation	0.999995	Correlation	0.999995

Force Strain Calibration	
EA (Kips)	35602.66
Offset	34.21
Correlation	0.999994



Bridge Excitation (V) 5
Shunt Resistor (ohm) 60.4k

Calibration Factors		512AWJ	
Bridge 1 (µE/V)	207.75	Bridge 2 (µE/V)	208.76
EA Factor (Kips)	35498.24	Area (in ²)	1.18

Calibrated by: Sam Davis
Calibrated Date: 8/31/2022

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

Accelerometer Calibration Certificate
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.
Calibration performed on 03Aug2022

Serial No: K5998 Temperature: 74.7 °F
Model: PR Humidity: 53%
Calibrated on: Channel 3 on 8G 5161 LE

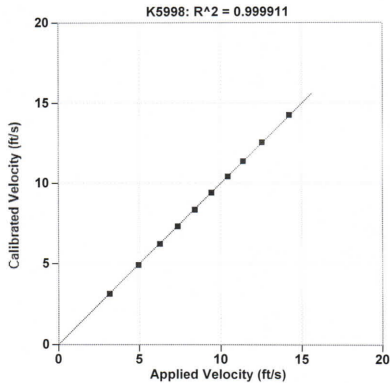
PDA CALIBRATION FACTOR
403.5 mv/5000g
(80.7 μ v/g)
R²: 0.999911 [Chip programmed]

Operator: William Johnson

Signed

Ref Acc 1: 72505! Cal on: 24Mar2022
1035 g/s/volt
Ref Acc 2: 72517! Cal on: 24Mar2022
1049 g/s/volt

Reference accelerometer calibrations are traceable to
the United States National Institute of Standards and
Technology (NIST).



Date printed: 03Aug2022, version: 2020.30.170 -1.89

Accelerometer Calibration Certificate
Pile Dynamics, Inc.



Calibrated by Pile Dynamics, Inc.
Calibration performed on 03Aug2022

Serial No: K10493 Temperature: 74.7 °F
Model: PR Humidity: 53%
Calibrated on: Channel 3 on 8G 5161 LE

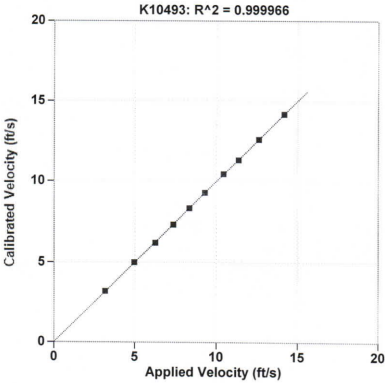
PDA CALIBRATION FACTOR
411.9 mv/5000g
(82.4 μ v/g)
R²: 0.999966 [Chip programmed]

Operator: William Johnson

Signed

Ref Acc 1: 72505! Cal on: 24Mar2022
1035 g/s/volt
Ref Acc 2: 72517! Cal on: 24Mar2022
1049 g/s/volt

Reference accelerometer calibrations are traceable to
the United States National Institute of Standards and
Technology (NIST).



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