



Geotechnical Subsurface Data Report (GSDR)
Route S-44-87 Bridge Replacement over Padgetts Creek
Union County, South Carolina
SCDOT Project ID P031832
S&ME Project No. 1361-20-048

PREPARED FOR:

**South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29201**

PREPARED BY:

**S&ME, Inc.
134 Suber Road
Columbia, South Carolina 29210**

March 19, 2021



March 19, 2021

South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29201

Attention: Mr. Trapp Harris, P.E.

Reference: **Closed and Load-Restricted Bridge Package 2021-1**
Geotechnical Subsurface Data Report (GSDR)
Route S-44-87 Bridge Replacement over Padgett's Creek
Union County, South Carolina
SCDOT Project ID P031832
S&ME Project No. 1361-20-048

Dear Mr. Harris:

The purpose of this report is to convey geotechnical information to the South Carolina Department of Transportation (SCDOT) for use by a contractor and is typically used with traditional design-bid-build projects. Our services were performed in general accordance with the *Scope of Services* provided in the *On-Call Consultant Work Order Request* by SCDOT, dated September 10, 2020, the SCDOT *Geotechnical Design Manual* (GDM), Version 2.0, dated January 2019.

S&ME appreciates this opportunity to work with you as your geotechnical engineering consultant on this project. Please contact us at (803) 561-9024 if you have any questions or need any additional information regarding this report.

Sincerely,

S&ME, Inc.

John P. Lewis, P.E.
Project Engineer

Robert C. Bruorton, P.E.
Senior Engineer



Matthew F. Cooke, P.G., P.E.
Senior Project Manager

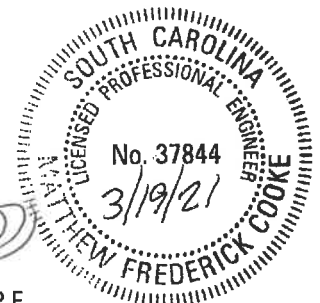




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1.0 Project Description

The proposed construction for this project includes replacement of the existing Delta Road (S-44-87) bridge over Padgetts Creek located in Union County, South Carolina, as shown in the *Site Location Plan*, attached as Figure 1 in Appendix I.

Table 1-1 – Bridge Location Summary

Project ID	Route	Route Name	Crossing	County	Latitude	Longitude
P031832	S-44-87	Delta Road	Padgetts Creek	Union	34.53533	-81.55769

From our review of the provided information, the existing bridge was built in 1954 and is 56 feet in length with two travel lanes. The proposed replacement bridge will be 70 feet in length. Additional information regarding the proposed replacement bridge has not been provided at this time.

2.0 Objective

The objective of this project was to explore the subsurface conditions along the proposed alignment as they pertain to the proposed improvements, and in conjunction with field and laboratory testing, to provide geotechnical data to be utilized for project design.

3.0 Scope of Work

As requested, representatives of S&ME were present for on-site field activities between October 15 and 19, 2020, to conduct the following testing:

- Two (2) Standard Penetration Test (SPT) borings (B-1 and B-2), with one boring near each proposed abutment location.

Testing was conducted at or near the requested locations provided in the *Scope of Services*, provided by SCDOT, dated September 10, 2020. Testing locations were modified as necessary due to utilities, terrain, to minimize traffic control impacts, and to facilitate safe working conditions.

Additionally, laboratory testing was performed on disturbed split-spoon and rock core samples collected in the field. The laboratory testing program is described in more detail in the following sections.

4.0 Test Locations

Testing locations for the proposed new bridge abutments were determined by subtracting the existing bridge length from the proposed new bridge length, dividing that distance by two, and measuring that divided distance



from the existing abutments. As-built survey of the testing locations was performed by Glenn Associates Surveying, Inc. The approximate testing locations are shown on the *Boring Location Plan*, included as Figure 2 in Appendix I. A summary of testing locations, including coordinates, elevation and alignment are presented in Table 1, *Test Location Summary*, in Appendix II. Surveyed coordinates are tabulated in decimal degree latitude and longitude as well as South Carolina State Plan northing and easting coordinates.

5.0 Exploration Procedures

The subsurface exploration for this project to date has included SPT borings. The following sections summarize the general outline of each test. The field testing data are organized into appendices of this report as follows:

- ◆ Appendix III – Soil Test Boring Records

5.1 Encroachment

S&ME contacted the Resident Maintenance Engineer for Union County to coordinate the field testing and traffic control along the SCDOT rights-of-way in-lieu of applying for an encroachment permit.

5.2 Traffic Control

Traffic control for the project was provided by Area Wide Protective (AWP) under subcontract to S&ME. Traffic control was performed in accordance with SCDOT requirements for *Flagging Operations Two-Lane Two-Way Roadways without Intersections* – SCDOT Standard Drawing 610-005-10.

5.3 Standard Penetration Test (SPT) Borings

Two (2) soil test borings with SPT sampling were performed between the dates of October 15 and 19, 2020 using a track-mounted Diedrich D-50 drill rig. Soil test borings with SPT sampling were performed using mud rotary drilling techniques. The borings were performed to drill bit refusal, followed by wireline rock coring in Boring B-2 only to the termination depth. A summary of the SPT borings performed is provided in the table below:

Table 5-1 – Boring Summary

Route	Bridge ID	Boring No.	Refusal Depth (ft)	Total Boring Depth (ft)	Pavement	Purpose
S-44-87	4470008700100	B-1	82.7	82.7	Asphalt	Proposed North Abutment
		B-2	69.4	75.4	Asphalt	Proposed South Abutment

Soil sampling and penetration testing were performed in general accordance with ASTM D1586 *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*. SPT was performed in each boring continuously in the upper 10 feet, followed by approximate 5-foot centers, thereafter. The split-barrel sampler was opened at the drill site and sloughed material was identified and separated from the recovered sample. The recovered sample



was visually described and classified by S&ME's rig geologist. A selected portion of the sample was placed in a glass jar with a moisture-proof lid. Where materials changed over the sample drive length, a sample of each material was retained. The sample jars were labeled, placed in cardboard boxes, and transported to the S&ME Columbia Office at the end of each workday.

5.3.1 Ground Water

Water level measurements were attempted immediately after completion of drilling and, where feasible, were repeated after a period of roughly 24 hours. We note that due to the use of drilling fluid additives in mud rotary borings, the water level readings recorded in the soil borings may not accurately reflect the ground water conditions at the site. Ground water readings were conducted in general accordance with ASTM D4750 *Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)*. A summary of the measured ground water depths and rough elevations are provided in the table below:

Table 5-2 – Ground Water Measurement Summary

Boring No.	Existing Grade (ft.)	GW Depth at TOB (ft.)	GW Elevation at TOB (ft.)	24-hr GW Depth (ft.)	24-hr GW Elevation (ft.)
B-1	322.8	7.1	315.7	7.7	315.1
B-2	322.3	6.9	315.4	7.4	314.9

After ground water measurements were complete, the borings were backfilled with bentonite chips, auger cuttings, or clean fill to within 20 feet of the existing ground surface then abandoned with Portland cement/bentonite grout. The surface pavements at each boring location were patched with commercially available bagged asphalt cold patch materials.

5.4 SPT Energy Measurements

SPT hammer energy measurements with a Pile Driving Analyzer (PDA) were performed by S&ME at an off-site location for the drill rig used on the project in general accordance with ASTM D4633 *Standard Test Method for Energy Measurement for Dynamic Penetrometers*. The SPT energy test results are summarized below and provided in Appendix VII. The N-values indicated on the soil test boring records are field values and were not corrected for overburden stress, rod length, borehole diameter or hammer efficiency.

Table 5-3 – S&ME Drilling Equipment Summary

Rig Make/Model	Serial No.	Carrier Type	Average SPT Energy Transfer Ratio (ETR), %
Diedrich D-50	382	Track	96.3

5.5 Wireline Rock Coring

Upon encountering refusal at Boring B-2, wireline rock coring was performed to a termination depth of 75.4 feet below the existing ground surface to explore the refusal materials in general accordance with ASTM D2113



Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration. Rock coring was performed using an NQ-size core barrel and wireline retrieval system. The recovered rock cores were visually logged by the S&ME rig geologist or engineer. The rock core samples were placed in cardboard core boxes and the boxes were labeled. Photographs were taken of each completed core box prior to any core being removed for laboratory testing. Completed core boxes were transported to the S&ME Columbia Office at the end of each workday. The rock cores were preserved, handled, and transported in general accordance with ASTM D5079.

6.0 Classification of Recovered Soil Samples

Recovered split-spoon samples were initially classified in general accordance with ASTM D2488 *Standard Practice for Description and Identification of Soils (Visual-Manual Method)*. After laboratory testing was completed, provisional field classifications were revised as necessary to provide a soil description that generally follows the terminology given by ASTM D2487 *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and AASHTO M145 *Recommended Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes*.

Interpreted subsurface conditions encountered by the SPT borings are shown on the boring records in Appendix III. These records represent our interpretation of the subsurface conditions based on the test data. Stratification lines on the boring records represent approximate boundaries between soil types; however, the actual transition may be gradual, and the thicknesses of the strata will vary across the site. The soil samples will be retained at our laboratory for a period of seven years, or until completion of substructure installation, whichever is earlier.

7.0 Classification of Recovered Rock Samples

Recovered rock core samples were reviewed and classified in general accordance with the SCDOT GDM Chapter 6, Section 6.3. Upon return to our laboratory, the rock core samples were reviewed by a Professional Geologist (PG). Recovered cores examined in the laboratory were assigned descriptive terms using Tables 6-15 through 6-22 of the GDM where applicable to the rock type. Rock lithologic descriptions, and applicable descriptive information are included on the Soil Test Boring Records in Appendix III. Discontinuities in the recovered cores were evaluated using the terminology in GDM Tables 6-23 through 6-29. The results of the discontinuity examination are tabulated in the *Rock Core Discontinuity Worksheets* for each cored borehole, included in Appendix III. After logging, selected sections of rock core were removed and prepared for laboratory compressive strength testing.

After laboratory testing was completed, the Rock Mass Rating (RMR) and Geological Strength Index (GSI) were computed in general accordance with Sections 6.3.12 and 6.3.11, respectively, of the GDM. A summary of the rock core is provided in Table 4 *Rock Core – Laboratory Testing Summary*, in Appendix II.

Interpreted subsurface conditions encountered during rock coring activities are shown on the records in Appendix III. These records represent our interpretation of the subsurface conditions based on the test data. Stratification lines on the boring records represent approximate boundaries between rock types; however, the actual transition may be gradual, and the thicknesses of the strata will vary across the site. The rock samples will be retained at our laboratory for a period of seven years, or until completion of substructure installation, whichever is earlier.



8.0 Laboratory Physical Tests

Laboratory testing consisting of index property testing, and corrosion series testing was performed on selected split-spoon samples, while unconfined compressive strength testing was performed on selected rock core samples. The testing was performed in general accordance with ASTM, AASHTO, or SC state test procedures as follows:

- Atterberg limits – ASTM D4318 / AASHTO T89/90
- Particle-size distribution – ASTM D422 / ASTM D6913 / AASHTO T88
- Percent-finer 200 sieve – ASTM D1140 / AASHTO T11
- Natural moisture content – ASTM D2216 / AASHTO T265
- Corrosion Series:
 - pH – ASTM G51 / AASHTO T289
 - Chloride – AASHTO T291
 - Sulfate – ASTM C1580 / AASHTO T290
 - Resistivity – AASHTO T288
- Unconfined Compression – ASTM D7012

Tables summarizing the laboratory test results are provided in Appendix II as follows:

- Table 2: Split Spoon Samples – Laboratory Classification Testing Summary
- Table 3: Split Spoon Samples – Corrosion Series Testing Summary
- Table 4: Rock Core – Laboratory Testing Summary

The individual laboratory test data sheets are organized into appendices of this report as summarized below:

- Appendix IV: Laboratory Test Results – Split Spoon Samples
- Appendix V: Laboratory Test Data Sheets – Corrosion Series
- Appendix VI: Laboratory Test Data Sheets – Rock Cores

9.0 Closing

This data report has been prepared in general accordance with procedures in SCDOT GDM Chapter 21 and with generally applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, express or implied, is made. The Geotechnical Engineer of Record for the project must review the data submitted in this report and develop their own interpretation of the testing results as they apply to design.

We relied on project information given to us to develop our exploration program. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes.

This report presents data from a limited field exploration program. Subsurface conditions will vary widely between explored areas. Some variations may not become evident until further exploration or construction. If



conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, bacteria). If there is a concern about these items, other studies should be performed.

Appendices

Appendix I – Figures



SOURCE: Google Maps



SITE LOCATION PLAN: S-44-87

JOB NAME: S-44-87 Replacement Bridge over Padgett's Creek		FIGURE NO. <div>1</div>
LOCATION: S-44-87 (Delta Road)		
CITY, STATE: Delta, South Carolina		
JOB NO.: 1361-20-048		
SCALE: NTS	CHECKED BY: MFC	
DATE: 3/19/2021	DRAWN BY: AKS	



Legend:

SOURCE: Google Earth



Approximate Boring Location



BORING LOCATION PLAN: S-44-87

JOB NAME: S-44-87 Replacement Bridge over Padgett's Creek
LOCATION: S-44-87 (Delta Road)
CITY, STATE: Delta, South Carolina
JOB NO.: 1361-20-048

FIGURE NO.

2

SCALE: NTS

CHECKED BY: MFC

DATE: 3/19/2021

DRAWN BY: JPL

Appendix II – Tables



Table 1: Test Location Summary

Bridge ID	Boring No.	Test/SampleType(s)						SC State Plane Northing (ft.)	SC State Plane Easting (ft.)	Latitude (degrees)	Longitude (degrees)	Elevation (ft-msl)	Alignment
		SPT	CPT	DMT	Seismic	Bulk	UD						
S-44-87	B-1	X						983592.2	1832043.8	34.53543	-81.55770	322.8	Existing
S-44-87	B-2	X						983517.9	1832046.3	34.53523	-81.55770	322.3	Existing



Table 2: Split Spoon Samples – Laboratory Classification Testing Summary

Route ID	Boring Number	Sample Number	Sample Depth (ft)	Natural Moisture (%)	Atterberg Limits			Percent Finer #10 (%)	Percent Finer #40 (%)	Percent Finer #200 (%)	Organic Content (%)	Soil Classification		
					LL	PL	PI					AASHTO	USCS	Strata
S-44-87	B-1	SS-1/SS-2	1-3	16.5	NP	NP	NP	94	68	23.5	-	A-1-b	SM	FILL
	B-1	SS-3	5.0-7.0	6.7	-	-	-	-	-	4.3	-	-	SP	FILL
	B-1	SS-5	9.0-11.0	38.1	38	24	14	100	97	79.0	-	A-6	CL	ALLUVIUM
	B-1	SS-6	13.5-15.0	45.5	31	24	7	100	98	39.0	-	A-4	SC-SM	ALLUVIUM
	B-1	SS-7	18.5-20.0	39.5	NP	NP	NP	-	-	23.0	-	-	SM	RESIDUUM
	B-1	SS-9	28.5-20.0	24.2	-	-	-	-	-	17.2	-	-	SM	RESIDUUM
	B-1	SS-11	38.5-40.0	19.2	-	-	-	-	-	18.2	-	-	SM	RESIDUUM
	B-2	SS-1/SS-2	1.0-5.0	14.7	NP	NP	NP	88	62	26.0	-	A-2-4	SM	FILL
	B-2	SS-6	13.5-15.0	-	-	-	-	99	70	6.0	-	-	SP-SM	ALLUVIUM
	B-2	SS-7	18.5-20.0	18.3	NP	NP	NP	-	-	14.6	-	-	SM	RESIDUUM
	B-2	SS-8	23.5-25	17.5	-	-	-	-	-	14.9	-	-	SM	RESIDUUM
	B-2	SS-12	43.5-45.0	18.1	32	24	8	-	-	19.4	-	-	SM	RESIDUUM

NT = Not Tested

NP = Non-plastic

Classification estimated based on test results and ASTM D2488 Visual Manual Procedure



Table 3: Split Spoon Samples - Corrosion Series Testing Summary

Route & Boring Number	Sample Depth (ft)	Sample Number	As-Rec'd Resistivity (Ohm-cm)	Minimum Resistivity (Ohm-cm)	Sulfates		Chlorides		pH
					(mg/kg)	(wt%)	(mg/kg)	(wt%)	
S-29-97 B-1	13.4 - 14.9	SS-6	10,050	6,700	4.6	0.0005	1.9	0.0002	7.1



Table 4: Rock Core - Laboratory Testing Summary

Route & Boring Number	Core Run No.	Core Run Top Depth	Core Run Bottom Depth	Recovery (%)	RQD	Sample Top Depth (ft)	Sample Bottom Depth (ft)	Unit Weight (pcf)	Unconfined Compressive Strength (psi)	RMR ⁽¹⁾	GSI ⁽²⁾ Range
S-29-97 B-1	RC-1	20.0	25.0	90	16	-	-	-	-	-	55
	RC-2	25.0	30.0	76	0	-	-	-	-	-	50
S-29-97 B-2	RC-1	13.8	15.6	83	61	-	-	-	-	-	75
	RC-2	15.6	20.6	100	86	15.8	16.2	162.1	8,235	64	75
						19.6	20.0	165.9	8,864		

Notes:

⁽¹⁾ RMR = Rock Mass Rating (Refer to SCDOT Geotechnical Design Manual, Chapter 6)

⁽²⁾ GSI = Geologic Strength Index (Refer to SCDOT Geotechnical Design Manual, Chapter 6)

Appendix III – Soil Test Boring Records

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)



Fill



Asphalt



Concrete



Topsoil



Gravel



Sand



Silt



Clay



Organic



Silty Sand



Clayey Sand



Sandy Silt



Clayey Silt



Sandy Clay



Silty Clay



Partially Weathered Rock



Cored Rock

WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring

▼ = Water Level Taken After 24 Hours

◀ = Loss of Drilling Water

HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY

Very Soft
Soft
Firm
Stiff
Very Stiff
Hard
Very Hard

STD. PENETRATION RESISTANCE BLOWS/FOOT

0 to 2
3 to 4
5 to 8
9 to 15
16 to 30
31 to 50
Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY

Very Loose
Loose
Medium Dense
Dense
Very Dense

STD. PENETRATION RESISTANCE BLOWS/FOOT

0 to 4
5 to 10
11 to 30
31 to 50
Over 50

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.



Soil Test Log Descriptors

k

Rock Type
 Indicate type of rock encountered (i.e. granite, limestone, shale, slate, etc.)

l

Color
 Describe the sample color while sample is still moist, using Munsell color chart.

m

Texture
 Describe the nonfracture structural features. Stratification is the layering of sedimentary rock and foliation is the layering of metaphoric rock

Descriptive Term	Criteria
Very Thickly Bedded	> 1.0 m
Thickly Bedded	0.5 to 1.0 m
Thinly Bedded	50 to 500 mm
Very Thinly Bedded	10 to 50 mm
Laminated	2.5 to 10 mm
Thinly Laminated	< 2.5 mm

n

Grain Size and Shape
 Describe the size and shape of all visible grains, typically used on sedimentary rock.

Size

Descriptor	mm
Very coarse grained	> 4.75
Coarse grained	2.00 – 4.75
Medium grained	0.425 – 2.00
Fine grained	0.075 – 0.425
Very Fine grained	< 0.075

Shape

Descriptive Term	Criteria
Angular	Shows little wear; edges and corners are sharp
Subangular	Shows definite effects of wear; edges and corners are slightly rounded off
Subrounded	Shows considerable wear; edges and corners are rounded to smooth curves
Rounded	Shows extreme wear; edges and corners are smoother to broad curves
Well-rounded	Completely worn; edges and corners are not present

Sieve size

Grain sizes greater than popcorn kernels

Individual grains easy to distinguish by eye

Individual grains distinguished by eye

Individual grains distinguished with difficulty

Individual grains cannot be distinguished by unaided eye

o

Weathering / Alteration
 Weathering is the physical disintegration of the minerals by atmospheric processes. Alteration is disintegration of the minerals by geothermal processes.

Description

Residual Soil

Completely Weathered / Altered

Highly Weathered / Altered

Moderately Weathered / Altered

Slightly Weathered / Altered

Fresh

Recognition

Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand

Original minerals of rock have been almost entirely decomposed to secondary minerals, although the original fabric may be intact; material can be granulated by hand

More than half of the rock is decomposed; rock is weakened so that a minimum 1-7/8 inch diameter sample can be easily broken readily by hand across rock fabric

Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 1-7/8 inch diameter sample cannot be broken readily by hand across rock fabric

Rock is slightly discolored, but not noticeably lower in strength than fresh rock

Rock shows no discoloration, loss of strength, or other effect of weathering / alteration

Figure 6-16, SCDOT Soil Test Log Descriptors – Rock

6-38

January 2019

SCDOT Soil Test Log Descriptors

p

Rock Strength

Provide a qualitative assessment of the rock strength using either a geologic hammer or knife.

Description	Recognition	Approximately Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 – 150
Very Weak Rock	Can be peeled by pocket knife	150 – 700
Weak Rock	Can be peeled with difficulty by pocket knife	700 – 3,500
Medium Strong Rock	Can be indented 3/16 inch with sharp end of pick	3,500 – 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 – 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 – 35,000
Extremely Strong Rock	Can only be chipped with hammer blows	> 35,000

q

Strike and Dip

Dip of fracture surface measured relative to horizontal with bearing and direction (i.e. N30°down, etc.)

r

Discontinuity Type

F - Fault
J - Joint
Sh - Shear
Fo - Foliation
V - Vein
B - Bedding

s

Discontinuity Width (millimeters)

W - Wide (12.5 – 50)
MW - Moderately Wide (2.5 – 12.5)
N - Narrow (1.25 – 2.5)
VN - Very Narrow (< 1.25)
T - Tight (0)

t

Amount of Infilling

Su - Surface Stain
Sp - Spotty
Pa - Partially Filled
Fi - Filled
No - None

u

Type of Infilling

Cl - Clay
Ca - Calcite
Ch - Chloride
Fe - Iron Oxide
Gy - Gypsum/Talc
H - Healed
No - None
Py - Pyrite
Qz - Quartz
Sd - Sand

v

Surface Shape of Joint

Wa - Wavy
Pl - Planar
St - Stepped
Ir - Irregular

w

Discontinuity Spacing (feet)

EW - Extremely Wide (> 65)
W - Wide (22 – 65)
M - Moderate (7.5 – 22)
C - Close (2 – 7.5)
VC - Very Close (< 2)

x

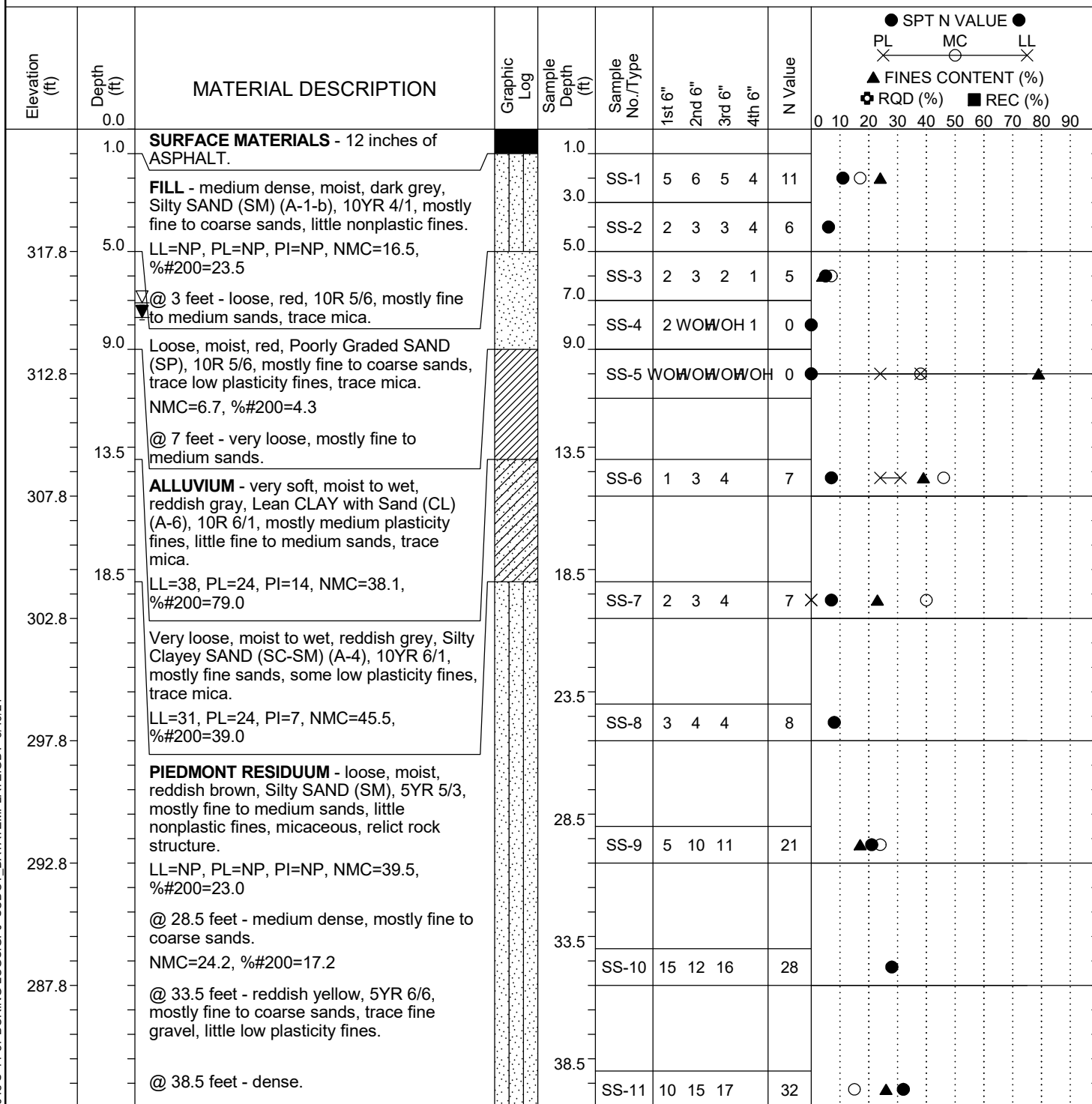
Roughness of Surface

Slk - Slickensided (surface has smooth, glassy finish with visual evidence of striations)
S - Smooth (surface appears smooth and feels so to the touch)
SR - Slightly Rough (asperities on the discontinuity surfaces are distinguishable and can be felt)
R - Rough (some ridges and side-angle steps are evident; asperities are clearly visible, and discontinuity surface feels very abrasive)
VR - Very Rough (near-vertical steps and ridges occur on the discontinuity surface)

Figure 6-17, SCDOT Soil Test Log Descriptors – Rock (con't)

SCDOT Soil Test Log

Project ID: P031832				County: Union		Boring No.: B-1		
Site Description:		S-44-87 BRO Padgetts Creek (S&ME Project 1361-20-048)					Route: S-44-87	
Eng./Geo.: AS		Boring Location: 7' N of NEB			Offset: 5' W of CL		Alignment: Existing	
Elev.: 322.8 ft	Latitude: 34.535434127	Longitude: -81.557704672		Date Started:			10/15/2020	
Total Depth: 82.7 ft	Soil Depth: 82.7 ft	Core Depth: NA ft		Date Completed:			10/15/2020	
Bore Hole Diameter (in): 3 7/8		Sampler Configuration			Liner Required: Y (N)		Liner Used: Y (N)	
Drill Machine: Diedrich D-50	Drill Method: RW		Hammer Type: Automatic		Energy Ratio:		96.3%	
Core Size: NA	Driller: J. Millwood		Groundwater: TOB 7.1 ft		24HR:		7.7 ft	



LEGEND

Continued Next Page

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:	P031832	County:	Union	Boring No.:	B-1
Site Description:	S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)			Route:	S-44-87
Eng./Geo.:	AS	Boring Location:	7' N of NEB	Offset:	5' W of CL
Elev.:	322.8 ft	Latitude:	34.535434127	Longitude:	-81.557704672
Total Depth:	82.7 ft	Soil Depth:	82.7 ft	Date Started:	10/15/2020
Core Depth:	NA ft	Date Completed:	10/15/2020		
Bore Hole Diameter (in):	3 7/8	Sampler Configuration		Liner Required:	Y (N)
Drill Machine:	Diedrich D-50	Drill Method:	RW	Energy Ratio:	96.3%
Core Size:	NA	Driller:	J. Millwood	Groundwater:	TOB 7.1 ft
				24HR	7.7 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 (%) + RQD (%) ■ REC (%)
		NMC=19.2, %200=18.2									0 10 20 30 40 50 60 70 80 90
277.8	43.5	@ 43.5 feet - very dense.		43.5	SS-12	21	33	44		77	
272.8	48.5	PARTIALLY WEATHERED ROCK - very dense, moist, reddish yellow, Silty SAND (SM), 5YR 6/6, mostly fine to coarse sands, little low plasticity fines, trace fine gravel, relict rock structure.		48.5	SS-13	2650/5"				100	
267.8	53.5	PIEDMONT RESIDUUM - very dense, moist, reddish yellow, Silty SAND (SM), 5YR 6/6, mostly fine to coarse sands, little low plasticity fines, trace fine gravel, relict rock structure.		53.5	SS-14	21	32	47		79	
262.8	58.5	PARTIALLY WEATHERED ROCK - very dense, moist, reddish yellow, Silty SAND (SM), 5YR 6/6, mostly fine to coarse sands, little low plasticity fines, trace fine gravel, relict rock structure.		58.5	SS-15	4050/5"				100	
257.8	63.5	PIEDMONT RESIDUUM - very dense, moist, reddish yellow, Silty SAND (SM), 5YR 6/6, mostly fine to coarse sands, little low plasticity fines, trace fine gravel, relict rock structure.		63.5	SS-16	24	47	44		91	
252.8	68.5	PARTIALLY WEATHERED ROCK - very dense, moist, reddish yellow, Silty SAND (SM), 5YR 6/6, mostly fine to coarse sands, little low plasticity fines, trace fine gravel, relict rock structure.		68.5	SS-17	3750/4"				100	
	73.5			73.5	SS-18	50/3"				100	
247.8	78.5			78.5	SS-19	50/4"				100	

LEGEND

Continued Next Page

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:	P031832			County:	Union			Boring No.:	B-1				
Site Description:	S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)							Route:	S-44-87				
Eng./Geo.:	AS			Boring Location:	7' N of NEB			Offset:	5' W of CL				
Elev.:	322.8 ft		Latitude:	34.535434127		Longitude:	-81.557704672		Date Started:	10/15/2020			
Total Depth:	82.7 ft		Soil Depth:	82.7 ft		Core Depth:	NA ft		Date Completed:	10/15/2020			
Bore Hole Diameter (in):	3 7/8		Sampler Configuration				Liner Required:	Y (N)		Liner Used:	Y (N)		
Drill Machine:	Diedrich D-50			Drill Method:	RW			Hammer Type:	Automatic		Energy Ratio:	96.3%	
Core Size:	NA			Driller:	J. Millwood			Groundwater:	TOB		7.1 ft	24HR	7.7 ft

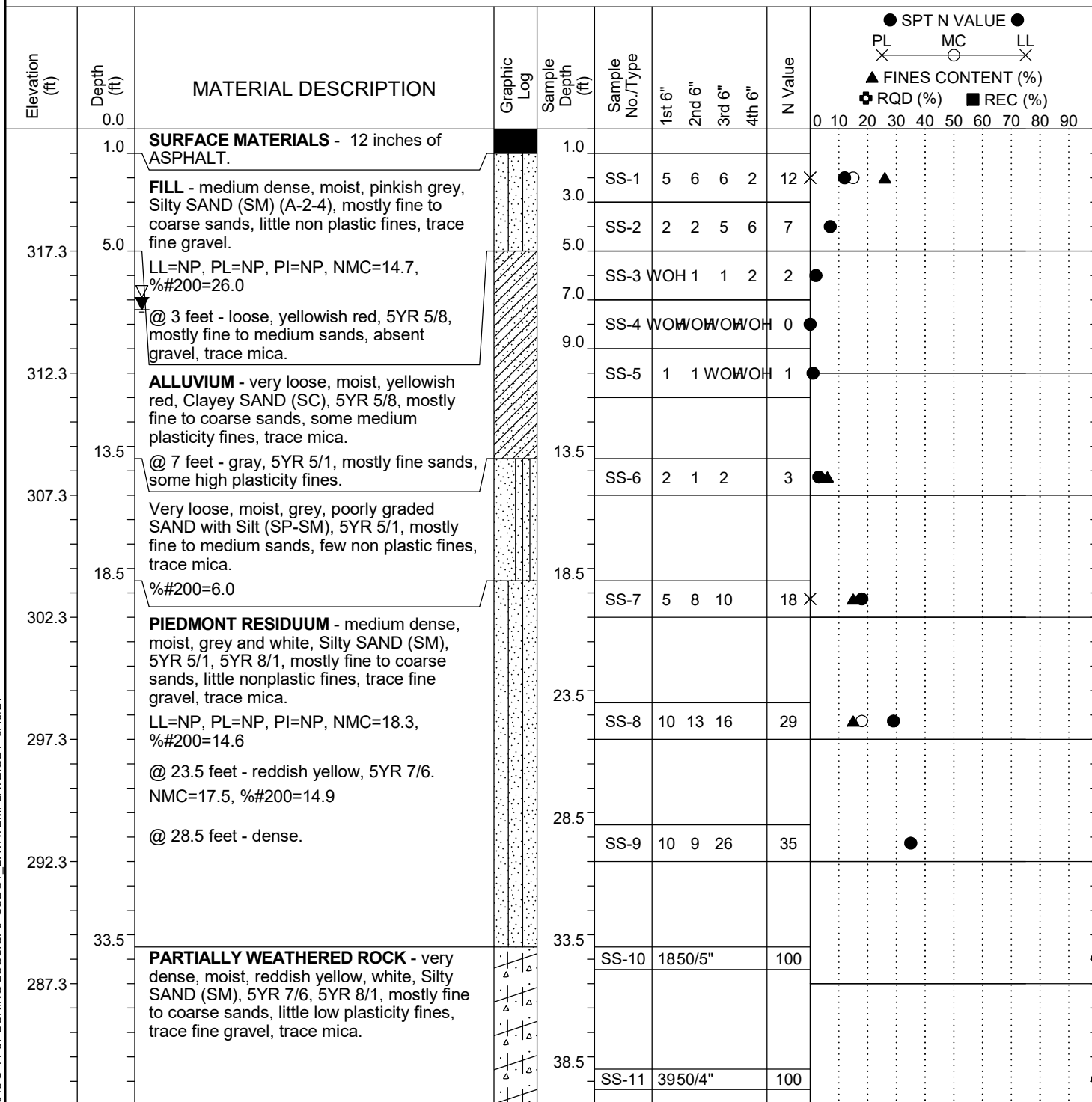
Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	<div> <div> ● SPT N VALUE ● </div> <div> PL X MC ○ LL X </div> <div> ▲ FINES CONTENT (%) </div> <div> ⊕ RQD (%) ■ REC (%) </div> </div>
322.8	82.7	Boring Terminated at 82.7 feet.									0 10 20 30 40 50 60 70 80 90
237.8											
232.8											
227.8											
222.8											
217.8											
212.8											
207.8											

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:	P031832	County:	Union	Boring No.:	B-2
Site Description:	S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)			Route:	S-44-87
Eng./Geo.:	AS	Boring Location:	7' S of SEB	Offset:	5' W of CL
Elev.:	322.3 ft	Latitude:	34.535229948	Longitude:	-81.557695005
Date Started:	10/16/2020				
Total Depth:	75.4 ft	Soil Depth:	69.4 ft	Core Depth:	6 ft
Date Completed:	10/19/2020				
Bore Hole Diameter (in):	3 7/8	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)				
Drill Machine:	Diedrich D-50	Drill Method:	RW / RC	Hammer Type:	Automatic
Energy Ratio:	96.3%				
Core Size:	NQ	Driller:	J. Millwood	Groundwater:	TOB 6.9 ft
24HR:	7.4 ft				



LEGEND

Continued Next Page

SAMPLER TYPE

DRILLING METHOD

SS - Split Spoon
UD - Undisturbed Sample
AWG - Rock Core, 1-1/8"

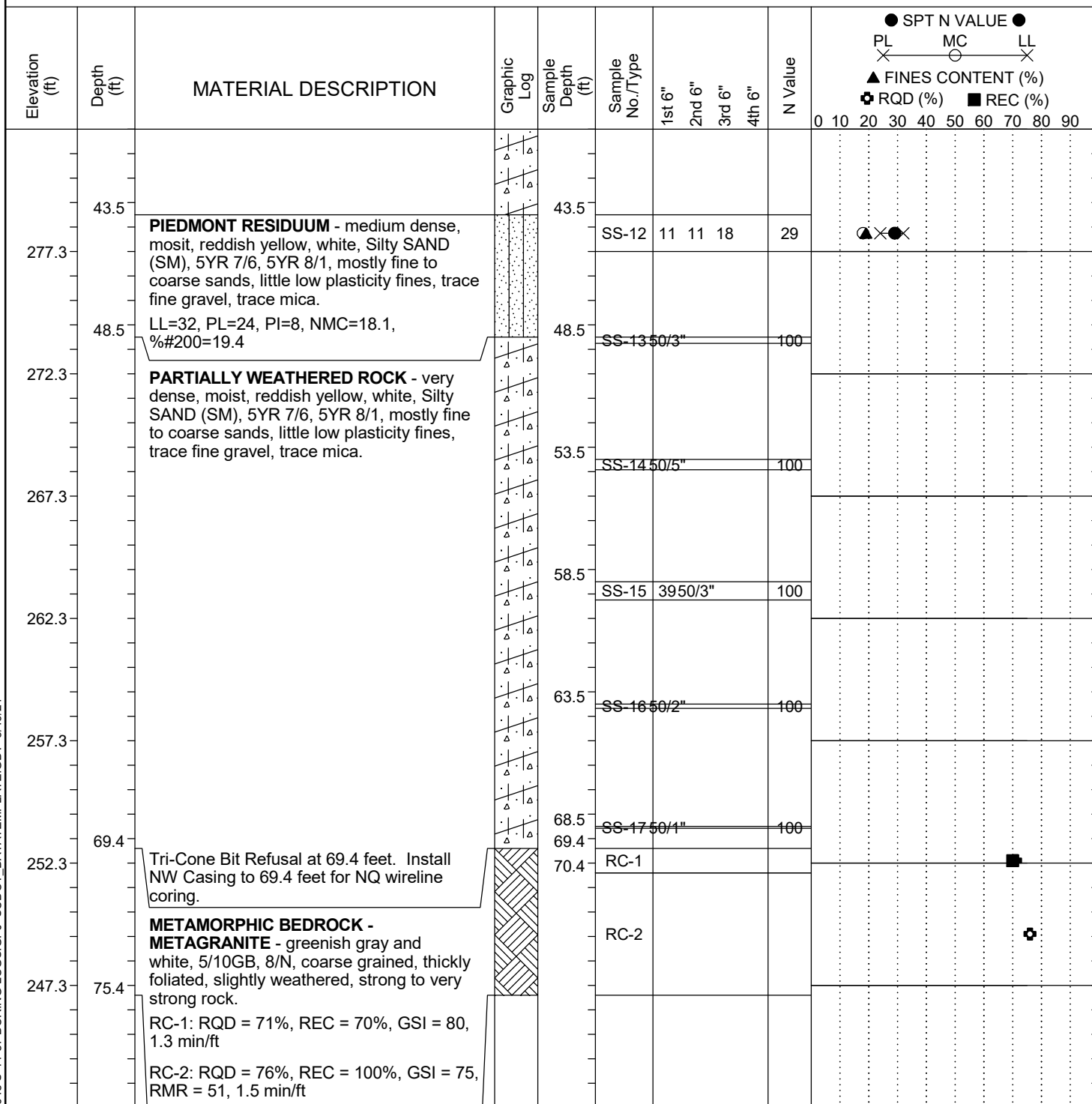
NQ - Rock Core, 1-7/8"
CU - Cuttings
CT - Continuous Tube

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing

RW - Rotary Wash
RC - Rock Core

SCDOT Soil Test Log

Project ID:	P031832	County:	Union	Boring No.:	B-2
Site Description:	S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)			Route:	S-44-87
Eng./Geo.:	AS	Boring Location:	7' S of SEB	Offset:	5' W of CL
Elev.:	322.3 ft	Latitude:	34.535229948	Longitude:	-81.557695005
Date Started:	10/16/2020				
Total Depth:	75.4 ft	Soil Depth:	69.4 ft	Core Depth:	6 ft
Date Completed:	10/19/2020				
Bore Hole Diameter (in):	3 7/8	Sampler Configuration		Liner Required:	Y (N)
Liner Used:	Y (N)				
Drill Machine:	Diedrich D-50	Drill Method:	RW / RC	Hammer Type:	Automatic
Energy Ratio:	96.3%				
Core Size:	NQ	Driller:	J. Millwood	Groundwater:	TOB 6.9 ft
24HR	7.4 ft				



LEGEND

Continued Next Page

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:	P031832			County:	Union			Boring No.:	B-2			
Site Description:	S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)							Route:	S-44-87			
Eng./Geo.:	AS			Boring Location:	7' S of SEB			Offset:	5' W of CL			
Elev.:	322.3 ft		Latitude:	34.535229948		Longitude:	-81.557695005		Date Started:	10/16/2020		
Total Depth:	75.4 ft		Soil Depth:	69.4 ft		Core Depth:	6 ft		Date Completed:	10/19/2020		
Bore Hole Diameter (in):	3 7/8		Sampler Configuration				Liner Required:	Y (N)		Liner Used:	Y (N)	
Drill Machine:	Diedrich D-50		Drill Method:	RW / RC			Hammer Type:	Automatic		Energy Ratio:	96.3%	
Core Size:	NQ		Driller:	J. Millwood			Groundwater:	TOB		24HR	7.4 ft	

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value	<div> <div> ● SPT N VALUE ● </div> <div> PL MC LL </div> <div> X X X </div> <div> ▲ FINES CONTENT (%) </div> <div> + RQD (%) ■ REC (%) </div> </div>
		@ 70.7 feet - qu = 11,268 psi @ 71.9 feet - qu = 20,411 psi Boring Terminated at 75.4 feet.									0 10 20 30 40 50 60 70 80 90
237.3											
232.3											
227.3											
222.3											
217.3											
212.3											
207.3											

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	



Rock Core Discontinuity Worksheet

Project Name: S-44-87 over Padgett's Creek
 Project Number: 1361-20-048
 Driller (Company/Name): S&ME/Justin Millwood
 Logged By: AKS
 Date: 10/19/2020

Boring Number: B-2
 Core Barrel Type: NQ
 Core Barrel Length: 5.0'
 Coring Technique: wireline
 Number of Core Boxes: 1

Depth (ft)	Disc. No.	Disc. Type	Dip Angle (deg)	Disc. Width (mm)	Infill Amount	Infill Type	Surface Shape	Surface Roughness	Notes
69.5	1	J	2	W	No	No	Pl	Sr	
71.2	2	J	76	N	No	No	Pl	Sr	
71.3	3	J	80	N	No	No	Pl	Sr	
72.1	4	J	7	VN	No	No	Pl	Sr	
72.9	5	J	31	VN	Fi	Cl	Pl	Sr	
73	6	J	17	VN	No	No	Pl	Sr	
73.5	7	J	5	VN	No	No	Pl	Sr	
73.9	8	J	N/A	MW	Pa	Fe	Ir	Sr	Highly Fractured Zone from 73.9' - 74.9'



Rock Core Photo Log

Boring: B-2	Box: 1 of 1	Date: 10/16/2020	Driller: J. Millwood	Geologist: A. Syms
Run: RC-1	Length: 1.0	Depth Int: 69.4-70.4	Recovery: 70%	RQD: 71%
Run: RC-2	Length: 5.0	Depth Int: 70.4-75.4	Recovery: 100%	RQD: 76%





Drill Rig Photo Log

Bridge: S-44-87

Boring: B-1

Date: 10/15/2020

Driller: J. Millwood

Geologist: A. Syms





Drill Rig Photo Log

Bridge: S-44-87

Boring: B-2

Date: 10/16/2020

Driller: J. Millwood

Geologist: A. Syms



Appendix IV – Laboratory Test Data Sheets – Split-Spoon Samples



INDEX PROPERTIES VERSUS DEPTH

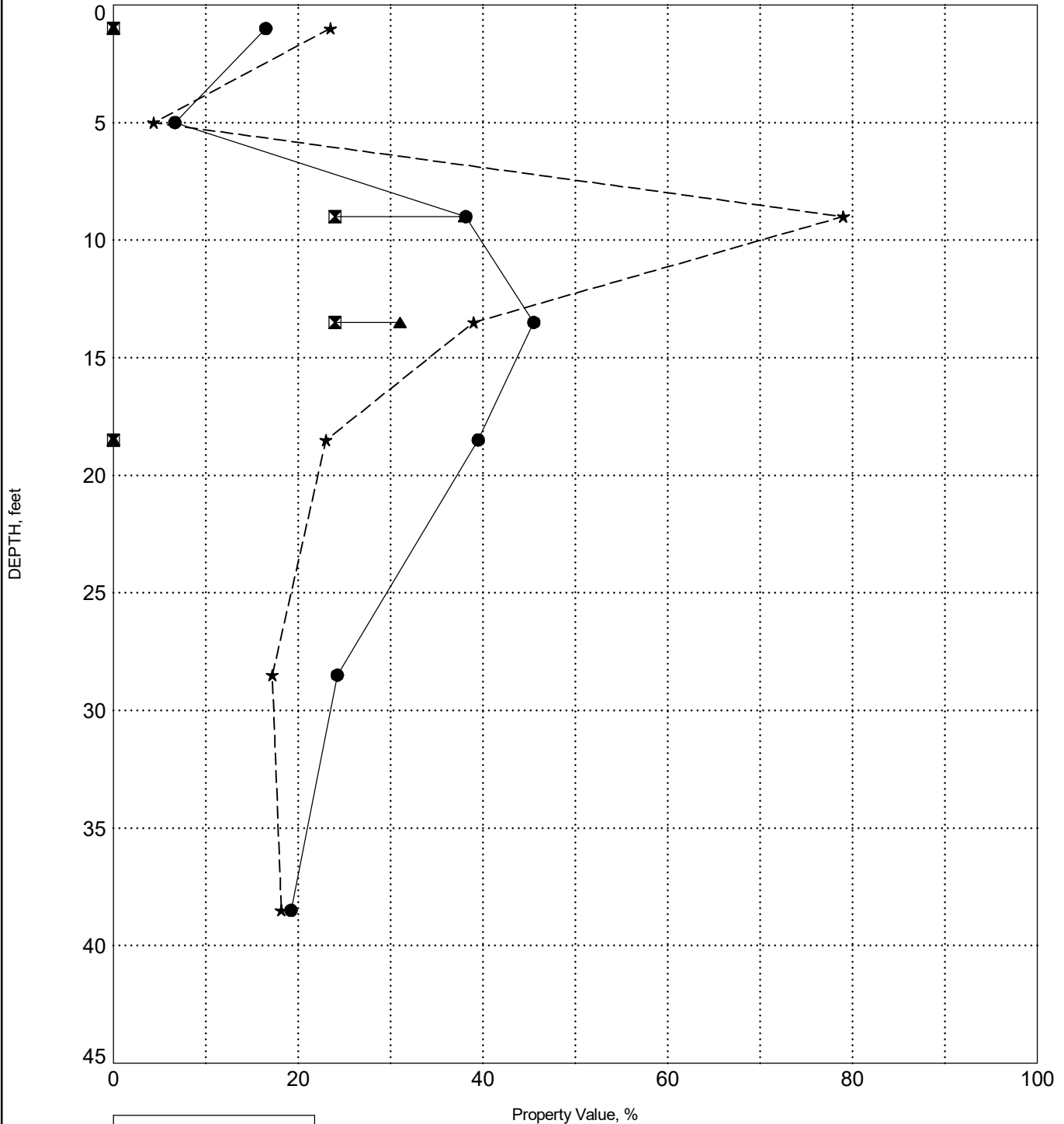
PROJECT ID P031832

PROJECT NAME S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Union

SURFACE ELEVATION: 322.8

BORING B-1



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



INDEX PROPERTIES VERSUS DEPTH

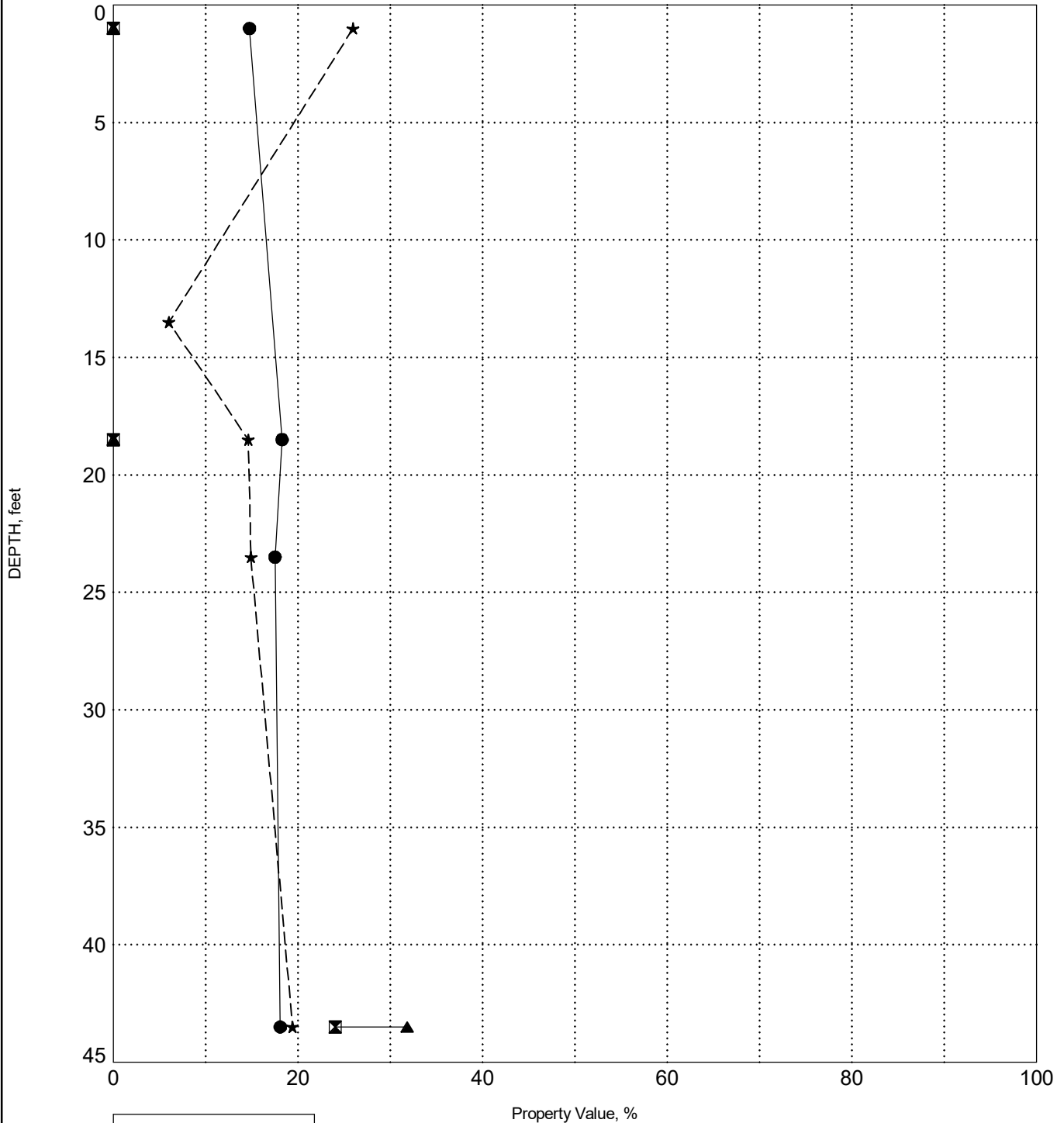
PROJECT ID P031832

PROJECT NAME S-44-87 BRO Padgetts Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Union

SURFACE ELEVATION: 322.3

BORING B-2



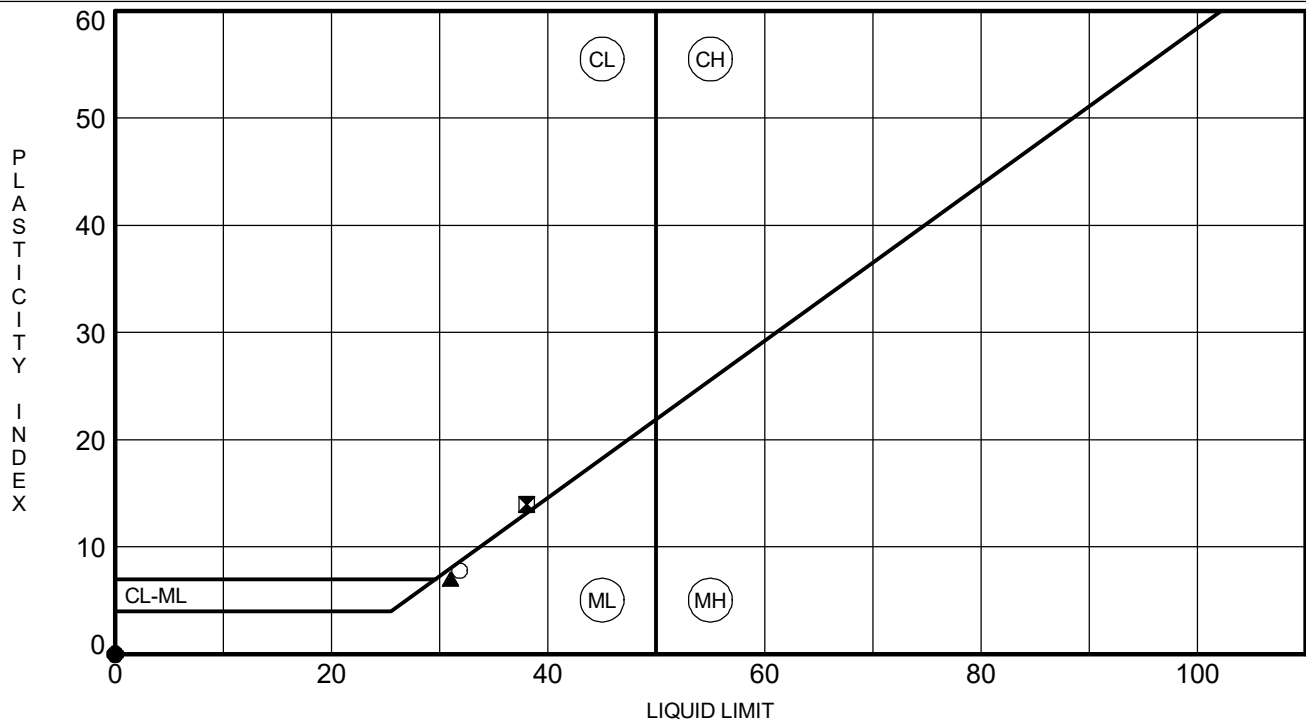
LEGEND	
●	Water Content
⊠	Plastic Limit
▲	Liquid Limit
★	Fines

ATTERBERG LIMITS' RESULTS

PROJECT ID P031832

PROJECT NAME S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Union

[illegible]

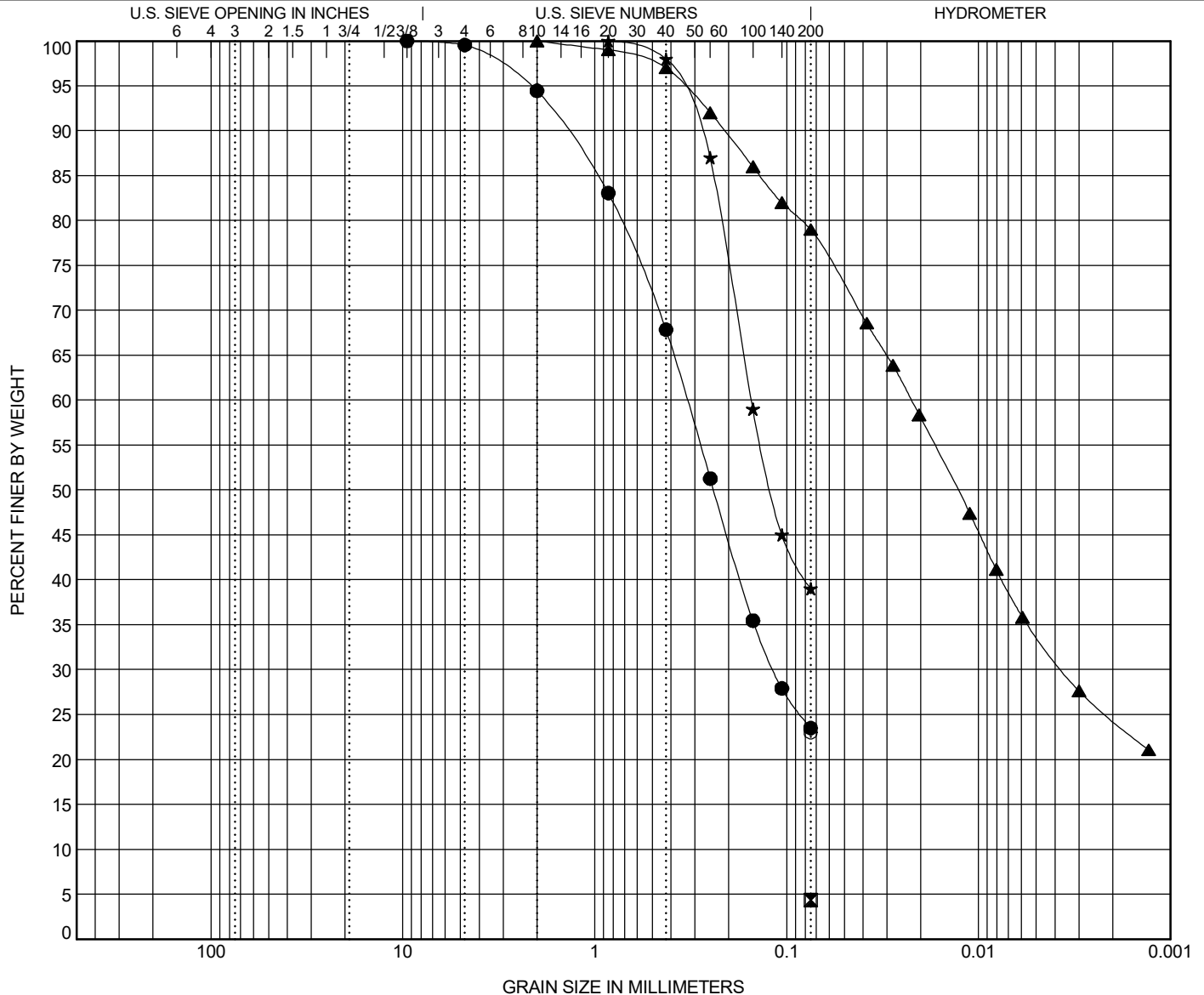


GRAIN SIZE DISTRIBUTION

PROJECT ID P031832

PROJECT NAME S-44-87 BRO Padgett's Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Union



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification					LL	PL	PI	Cc	Cu
● B-1	1.0	SILTY SAND (SM)					NP	NP	NP		
■ B-1	5.0	POORLY GRADED SAND (SP)									
▲ B-1	9.0	LEAN CLAY WITH SAND (CL)					38	24	14		
★ B-1	13.5	SILTY CLAYEY SAND (SC-SM)					31	24	7		
⊙ B-1	18.5	SILTY SAND (SM)					NP	NP	NP		
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt		%Clay	
● B-1	1.0	9.5	0.331	0.117		0.5	76.1	23.5			
■ B-1	5.0	0.075						4.3			
▲ B-1	9.0	2	0.022	0.004		0.0	21.0	45.2		33.8	
★ B-1	13.5	0.85	0.153			0.0	61.0	39.0			
⊙ B-1	18.5	0.075						23.0			

GRAIN SIZE 1361-20-048 S-44-87 BORING LOGS.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/8/21

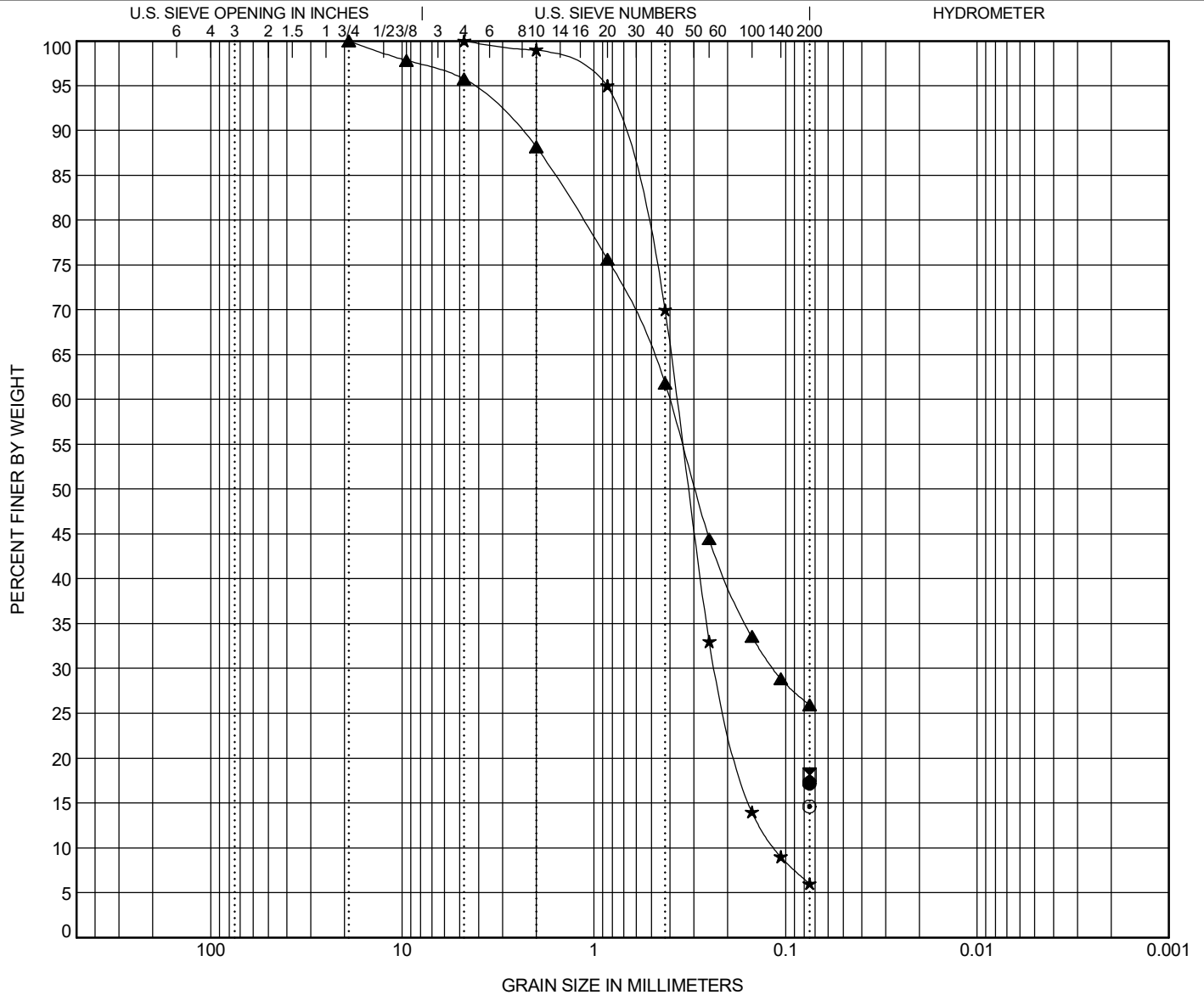


GRAIN SIZE DISTRIBUTION

PROJECT ID P031832

PROJECT NAME S-44-87 BRO Padgetts Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Union



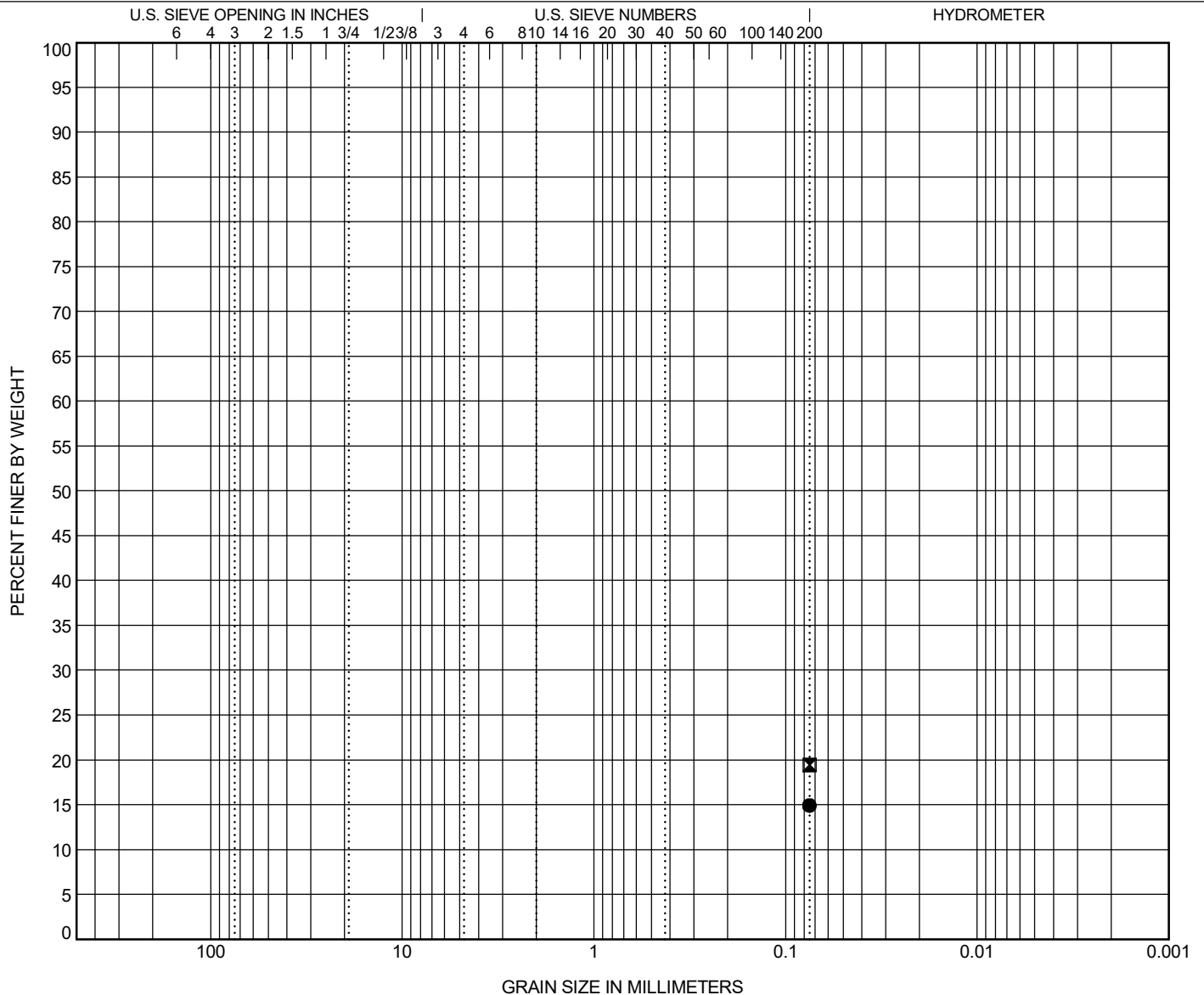


GRAIN SIZE DISTRIBUTION

PROJECT ID P031832

PROJECT NAME S-44-87 BRO Padgetts Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Union



Appendix V – Laboratory Test Data Sheets – Corrosion Series Testing



Results Only Soil Testing for SCDOT Bridge Package 2021-01 DB Prep

December 8, 2020

**Prepared for:
Matthew F. Cooke
S&ME, Inc.
134 Suber Road
Columbia, SC 29210
mcooke@smeinc.com**

**Project X Job#: S201125D
Client Job or PO#: 1361-20-48**

Respectfully Submitted,

Eduardo Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com





Soil Analysis Lab Results

Client: S&ME, Inc.
Job Name: SCDOT Bridge Package 2021-01 DB Prep
Client Job Number: 1361-20-48
Project X Job Number: S201125D
December 8, 2020

	Method	AASHTO T290		AASHTO T291		AASHTO T288		AASHTO T289
Bore# / Description	Depth	Sulfates SO ₄ ²⁻		Chlorides Cl ⁻		Resistivity As Rec'd Minimum		pH
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)	
SS-7 B-2; S-11-97 Bridge	18.5-20.0	34.8	0.0035	8.2	0.0008	31,490	26,800	6.7
SS-6/SS-7 B-2; S-11-119 Bridge	8.2-14.4	8.7	0.0009	21.4	0.0021	13,400	8,710	6.7
SS-5 B-2; S-11-265 Bridge	8.5-10.0	35.6	0.0036	109.9	0.0110	2,881	2,345	6.4
SS-4 B-1; S-12-58 Bridge	6.0-8.0	31.1	0.0031	23.9	0.0024	25,460	18,760	6.4
SS-4/SS-5 B-2; S-12-300 (2310) Bridge	6.0-10.0	19.3	0.0019	103.7	0.0104	3,283	2,479	6.5
SS-6 B-1; S-12-300 (2490) Bridge	13.5-15.0	36.1	0.0036	21.0	0.0021	9,380	8,040	6.7
SS-7/SS-8 B-2; S-20-214 Bridge	18.5-25.0	9.9	0.0010	7.4	0.0007	49,580	23,450	7.1
SS-6 B-1; S-29-97 Bridge	13.4-14.90	4.6	0.0005	1.9	0.0002	10,050	6,700	7.1
SS-4/SS-5 B-2; S-44-87 Bridge	7.0-11.0	45.9	0.0046	15.3	0.0015	16,080	15,410	6.2

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract



Ship Samples To: 29990 Technology Dr, Suite 13, Murrieta, CA 92563

[illegible]

Appendix VI – Laboratory Test Data Sheets – Rock Cores

UNCONFINED COMPRESSION (ASTM D7012 Method C)



S&ME, Inc. - Knoxville 3313 Topside Road, Louisville, TN 37777

Project Name: SCDOT Bridge Package 2021-1

Project Number: 1361-20-048

Report Date: February 25, 2021

Reviewed By: N. Randy Rainwater

Boring No.	Sample No.	Depth (ft)	Dimensions, in.		Shape (See Key)	Area (in ²)	Unit Weight (lbs/ft ³)	Loading Rate (psi/sec)	Maximum Load (lbs)	Strength (psi)	Moisture (%)
			Length	Diameter							
S-44-87. B-2	RS-1	70.7 - 71.1	4.16	1.98	A	3.08	163.6	63	34,705	11,268	0.1
S-44-87, B-2	RS-2	71.9 - 72.3	4.41	1.98	A	3.08	164.8	78	62,866	20,411	0.0

NOTES: Effective (as received) unit weight as determined by RTH 109-93.

Loading rates were selected to target reaching failure between 2 and 15 minutes.

Test results for specimens not meeting the requirements of ASTM D4543-19 may differ from a test specimen that meets the requirements of ASTM D4543.

SHAPE KEY

ASTM D4543-19 Standard Practice for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerance Section 1.2 - "Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content and chemistry, and other natural geologic processes. As such, it is not always possible to obtain or prepare rock core specimens that satisfy the desirable tolerances given in this practice. Most commonly, this situation presents itself with weaker, more porous, and poorly cemented rock types and rock types containing significant or weak (or both) structural features. For rock types which are difficult to prepare, all reasonable efforts shall be made to prepare a specimen in accordance with this practice and for the intended test procedure. However, when it has been determined by trial and error that this is not possible, prepare the rock specimen to the closest tolerances practicable and consider this to be the best effort and report it as such and if allowable or necessary for the intended test, capping the ends of the specimen as discussed in this practice is permitted."

- A Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)
- B Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness & parallelism, and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness. Specimen prepared to closest tolerances practicable.
- C Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness & parallelism. Specimen did not meet the desired tolerances for side straightness and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.
- D Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness. Specimen did not meet the desired tolerances for side straightness, parallelism and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.
- E Test specimen measurements met the desired shape tolerances of ASTM D4543-19 for end flatness and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness and parallelism. Specimen prepared to closest tolerances practicable.

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

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



1413 Topside Road, Louisville, TN 37777

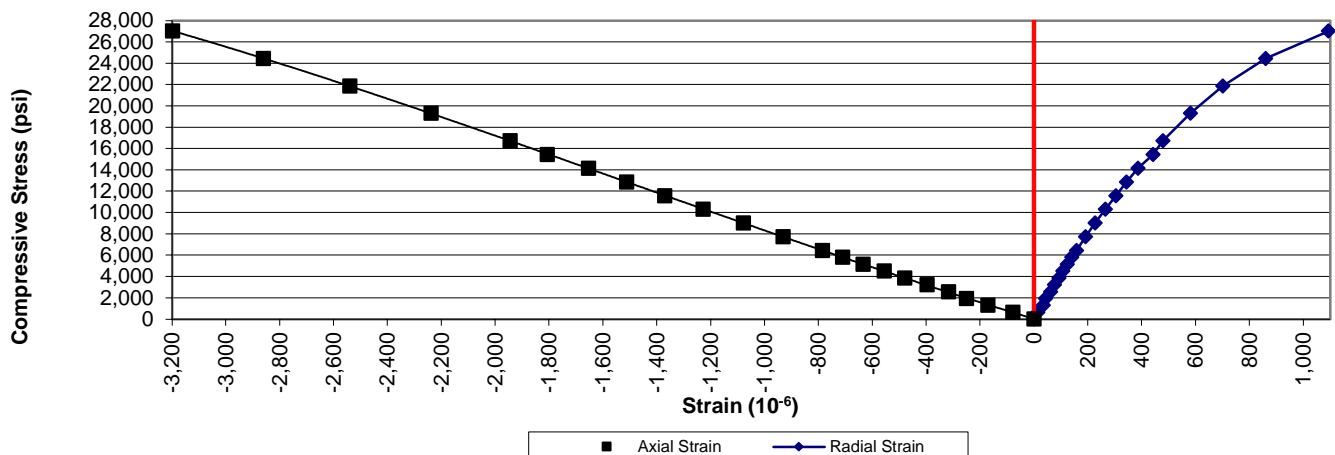
Project:	SCDOT Bridge Package 2021-1	Diameter, in.:	1.99	Date:	1/23/2021
Project No.:	1361-20-048	Length, in.:	4.32	Tested by:	Tori Igoe
Boring Id:	S-11-300, B-2	Unit Weight, pcf:	169.9	Reviewed by:	N. Randy Rainwater
Sample No:	RS-1	Moisture Content, %:	0.0		
Depth (ft):	21.0 - 21.4	Load Rate, psi/sec:	82		

Data Point	Strain (10^{-6})		Load (lb)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio	Remarks Failure
	axial	radial					
1	0	0	0	0	0.00	0.00	
2	-78	15	2,000	643	8.24	0.19	
3	-170	35	4,000	1,286	7.56	0.21	
4	-250	43	6,000	1,929	7.72	0.17	
5	-317	62	8,000	2,572	8.11	0.20	
6	-396	77	10,000	3,215	8.12	0.19	
7	-479	93	12,000	3,859	8.06	0.19	
8	-556	108	14,000	4,502	8.10	0.19	
9	-634	124	16,000	5,145	8.12	0.20	
10	-710	141	18,000	5,788	8.15	0.20	
11	-785	158	20,000	6,431	8.19	0.20	
12	-931	192	24,000	7,717	8.29	0.21	
13	-1,078	228	28,000	9,003	8.35	0.21	
14	-1,228	266	32,000	10,289	8.38	0.22	
15	-1,371	305	36,000	11,576	8.44	0.22	
16	-1,512	344	40,000	12,862	8.51	0.23	
17	-1,653	387	44,000	14,148	8.56	0.23	
18	-1,806	443	48,000	15,434	8.55	0.25	
19	-1,944	479	52,000	16,720	8.60	0.25	
20	-2,238	582	60,000	19,293	8.62	0.26	
21	-2,539	701	68,000	21,865	8.61	0.28	
22	-2,860	861	76,000	24,437	8.54	0.30	
23	-3,198	1,093	84,000	27,010	8.45	0.34	
			90,872	29,219			Failure

TNR - Test Not Requested

Comments: Loading rate was selected to target reaching failure between 2 and 15 minutes.
Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)

Stress vs. Strain



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



1413 Topside Road, Louisville, TN 37777

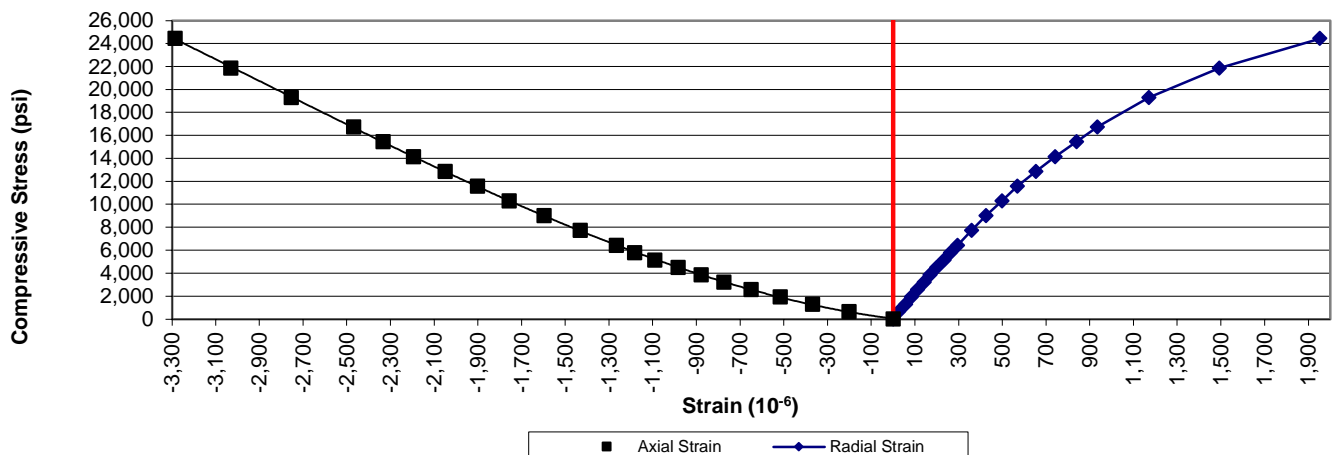
Project:	SCDOT Bridge Package 2021-1	Diameter, in.:	1.99	Date:	1/23/2021
Project No.:	1361-20-048	Length, in.:	4.52	Tested by:	Tori Igoe
Boring Id:	S-11-300, B-2	Unit Weight, pcf:	163.7	Reviewed by:	N. Randy Rainwater
Sample No:	RS-2	Moisture Content, %:	0.1		
Depth (ft):	28.0 - 28.4	Load Rate, psi/sec:	84		

Data Point	Strain (10^{-6})		Load (lb)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio	Remarks
	axial	radial					
1	0	0	0	0	0.00	0.00	
2	-202	25	2,000	643	3.18	0.12	
3	-369	58	4,000	1,286	3.49	0.16	
4	-517	84	6,000	1,929	3.73	0.16	
5	-650	112	8,000	2,572	3.96	0.17	
6	-774	142	10,000	3,215	4.15	0.18	
7	-878	169	12,000	3,859	4.40	0.19	
8	-984	200	14,000	4,502	4.58	0.20	
9	-1,091	233	16,000	5,145	4.72	0.21	
10	-1,182	263	18,000	5,788	4.90	0.22	
11	-1,266	295	20,000	6,431	5.08	0.23	
12	-1,432	360	24,000	7,717	5.39	0.25	
13	-1,597	425	28,000	9,003	5.64	0.27	
14	-1,757	498	32,000	10,289	5.86	0.28	
15	-1,901	569	36,000	11,576	6.09	0.30	
16	-2,050	653	40,000	12,862	6.27	0.32	
17	-2,195	741	44,000	14,148	6.45	0.34	
18	-2,334	839	48,000	15,434	6.61	0.36	
19	-2,468	935	52,000	16,720	6.77	0.38	
20	-2,754	1,171	60,000	19,293	7.01	0.43	
21	-3,030	1,492	68,000	21,865	7.22	0.49	
22	-3,285	1,953	76,000	24,437	7.44	0.59	
			79,601	25,595			Failure

TNR - Test Not Requested

Comments: Loading rate was selected to target reaching failure between 2 and 15 minutes.
Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)

Stress vs. Strain



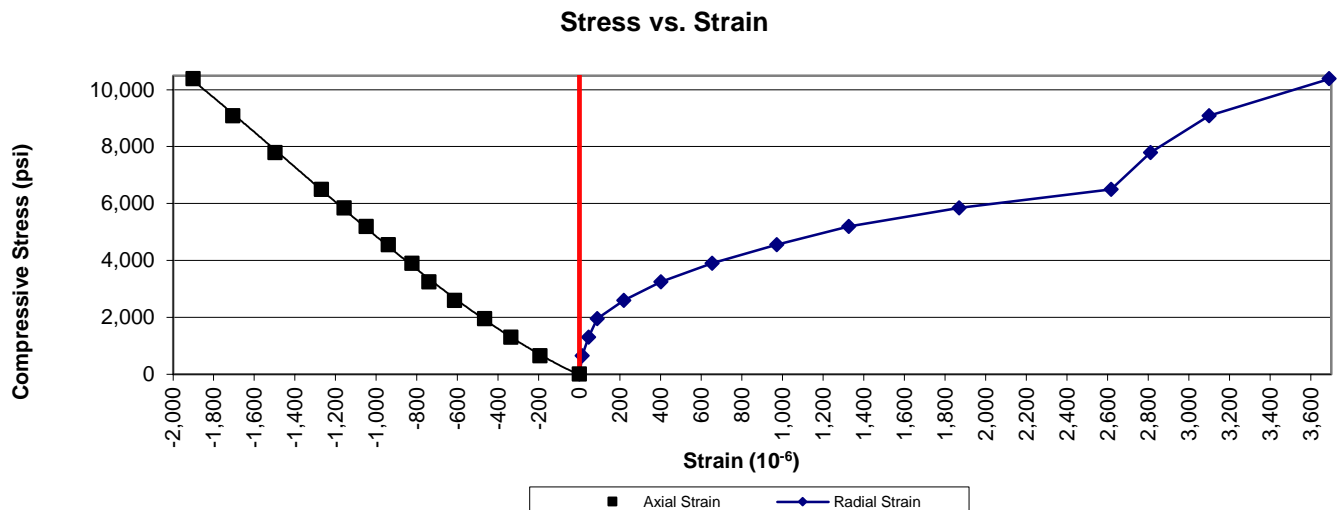


Project:	SCDOT Bridge Package 2021-1	Diameter, in.:	1.98	Date:	2/23/2021
Project No.:	1361-20-048	Length, in.:	4.16	Tested by:	Tori Igoe
Boring Id:	S-44-87, B-2	Unit Weight, pcf:	163.6	Reviewed by:	N. Randy Rainwater
Sample No:	RS-1	Moisture Content, %:	0.1		
Depth (ft):	70.7 - 71.1	Load Rate, psi/sec:	63		

[illegible]

TNR - Test Not Requested

Comments:	Loading rate was selected to target reaching failure between 2 and 15 minutes. Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)
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UNCONFINED COMPRESSION WITH YOUNG'S MODULUS AND POISSON'S RATIO
(ASTM D7012 Method C and D)



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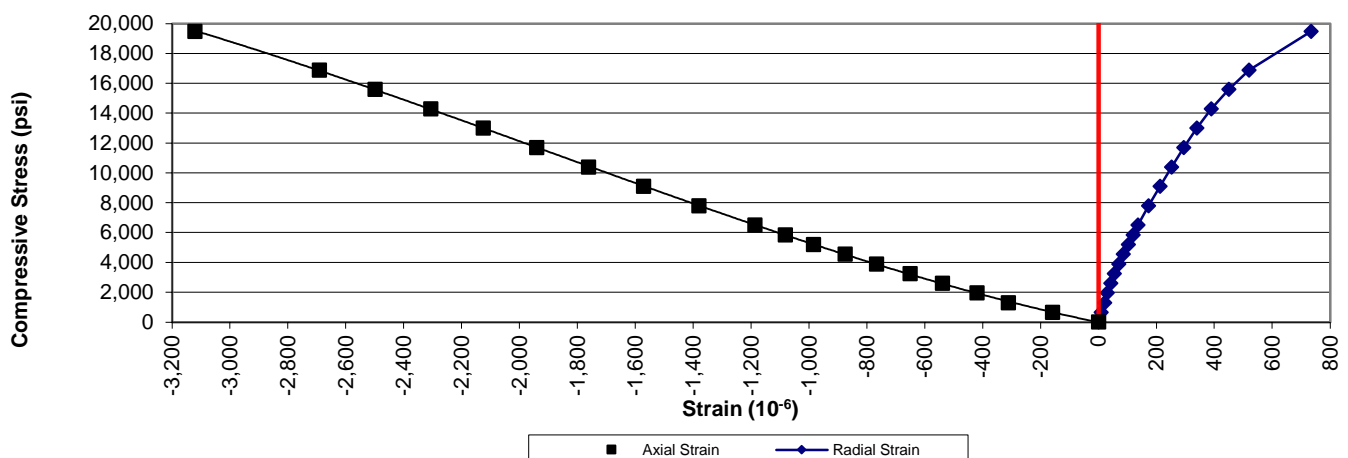
Project:	SCDOT Bridge Package 2021-1	Diameter, in.:	1.98	Date:	2/23/2021
Project No.:	1361-20-048	Length, in.:	4.41	Tested by:	Tori Igoe
Boring Id:	S-44-87, B-2	Unit Weight, pcf:	164.8	Reviewed by:	N. Randy Rainwater
Sample No:	RS-2	Moisture Content, %:	0.0		
Depth (ft):	71.9 - 72.3	Load Rate, psi/sec:	78		

Data Point	Strain (10^{-6})		Load (lb)	Compressive Stress (psi)	Secant Modulus $\times 10^6$ (psi)	Poisson's Ratio	Remarks Failure
	axial	radial					
1	0	0	0	0	0.00	0.00	
2	-159	9	2,000	649	4.08	0.06	
3	-311	22	4,000	1,299	4.18	0.07	
4	-420	30	6,000	1,948	4.64	0.07	
5	-539	42	8,000	2,597	4.82	0.08	
6	-651	55	10,000	3,247	4.99	0.08	
7	-767	70	12,000	3,896	5.08	0.09	
8	-875	86	14,000	4,545	5.19	0.10	
9	-984	103	16,000	5,195	5.28	0.10	
10	-1,081	120	18,000	5,844	5.41	0.11	
11	-1,187	136	20,000	6,494	5.47	0.11	
12	-1,380	173	24,000	7,792	5.65	0.13	
13	-1,571	213	28,000	9,091	5.79	0.14	
14	-1,761	252	32,000	10,390	5.90	0.14	
15	-1,940	294	36,000	11,688	6.02	0.15	
16	-2,125	340	40,000	12,987	6.11	0.16	
17	-2,306	389	44,000	14,286	6.20	0.17	
18	-2,498	450	48,000	15,584	6.24	0.18	
19	-2,691	520	52,000	16,883	6.27	0.19	
20	-3,120	734	60,000	19,481	6.24	0.24	
			52,866	17,164			Failure

TNR - Test Not Requested

Comments: Loading rate was selected to target reaching failure between 2 and 15 minutes.
Test specimen measurements met the desired shape tolerances of ASTM D4543-19 (side straightness, end flatness & parallelism, and end perpendicularity to axis)

Stress vs. Strain



**PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING
CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES
(ASTM D4543)**



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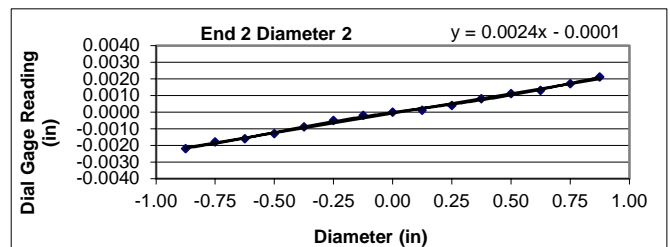
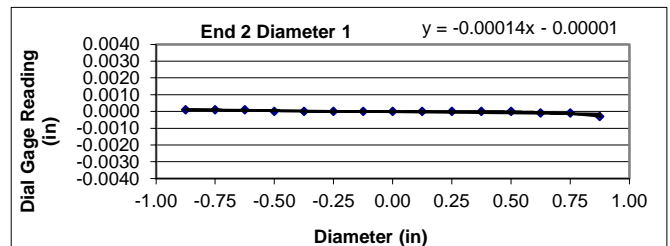
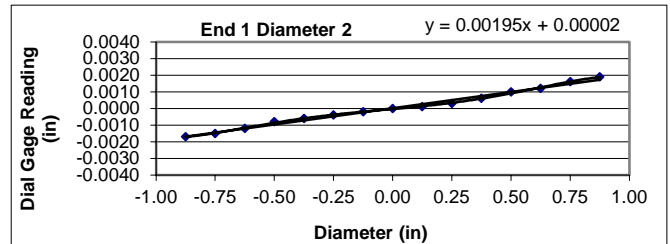
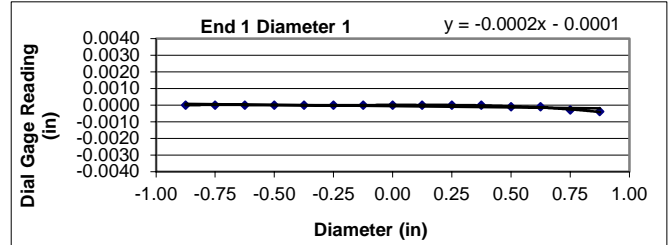
Project: SCDOT Bridge Package 2021-1	Diameter (in): 1.98	Date: 2/9/2021
Project No.: 1361.20-048	Length (in): 4.16	Tested by: Tori Igoo
Boring Id: S-44-87, B-2	Unit Weight (pcf): 163.6	Reviewed by: N. Randy Rainwater
Sample No.: RS-1	Moisture Content (%): 0.1	
Depth (ft): 70.7 - 71.1		

Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in.? YES Straightness Tolerance Met? YES

End Flatness and Parallelism Readings (Procedure FP1)

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0000	-0.0017	0.0001	-0.0022
- 6/8	0.0000	-0.0015	0.0001	-0.0018
- 5/8	0.0000	-0.0012	0.0001	-0.0016
- 4/8	0.0000	-0.0008	0.0000	-0.0013
- 3/8	0.0000	-0.0006	0.0000	-0.0009
- 2/8	0.0000	-0.0004	0.0000	-0.0005
- 1/8	0.0000	-0.0002	0.0000	-0.0002
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	0.0001	0.0000	0.0001
2/8	0.0000	0.0003	0.0000	0.0004
3/8	0.0000	0.0006	0.0000	0.0008
4/8	-0.0001	0.0010	0.0000	0.0011
5/8	-0.0001	0.0012	-0.0001	0.0013
6/8	-0.0003	0.0016	-0.0001	0.0017
7/8	-0.0004	0.0019	-0.0003	0.0021



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

Flatness Tolerance Met? YES

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

Parallelism Diameter 1

End 1:	Slope of Best Fit Line:	-0.00016
	Angle of Best Fit Line:	-0.00900
End 2:	Slope of Best Fit Line:	-0.00014
	Angle of Best Fit Line:	-0.00819
	Max Angular Difference:	0.00

Parallelism Diameter 2

End 1:	Slope of Best Fit Line:	0.00195
	Angle of Best Fit Line:	0.11181
End 2:	Slope of Best Fit Line:	0.00235
	Angle of Best Fit Line:	0.13489
	Max Angular Difference:	-0.02

Parallelism Tolerance Met? YES

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

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0004	0.0002	YES
End 1 Diam 2	0.0036	0.0018	YES
End 2 Diam 1	0.0004	0.0002	YES
End 2 Diam 2	0.0043	0.0022	YES

Perpendicularity Tolerance Met? YES

**PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING
CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES
(ASTM D4543)**



1413 Topside Road, Louisville, TN 37777

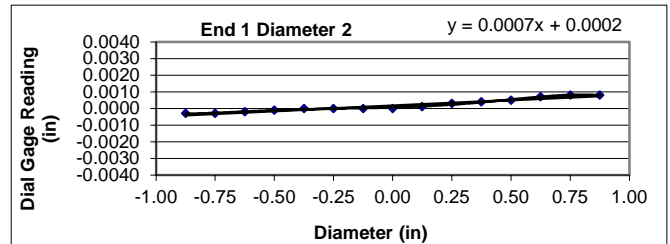
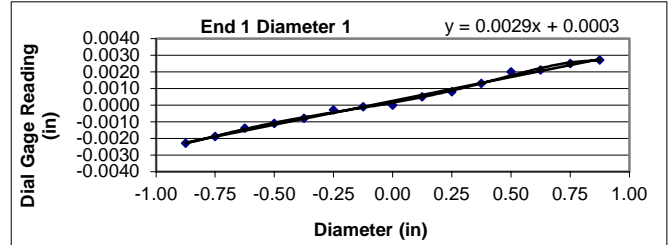
Project:	SCDOT Bridge Package 2021-1	Diameter (in):	1.98	Date:	2/9/2021
Project No.:	1361-20-048	Length (in):	4.41	Tested by:	Tori Igoo
Boring Id:	S-44-87, B-2	Unit Weight (pcf):	164.8	Reviewed by:	N. Randy Rainwater
Sample No.:	RS-2	Moisture Content (%):	0.0		
Depth (ft):	71.9 - 72.3				

Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in.? YES Straightness Tolerance Met? YES

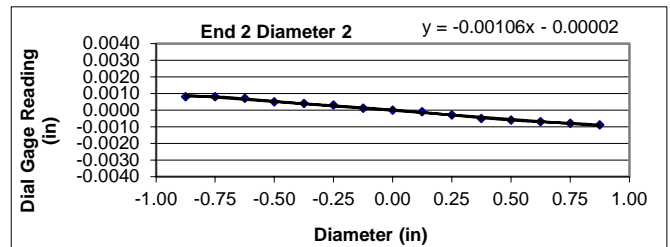
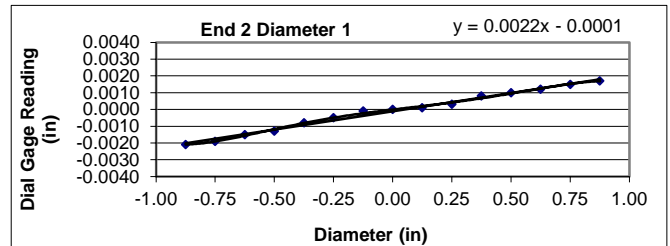
End Flatness and Parallelism Readings (Procedure FP1)

Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	-0.0023	-0.0003	-0.0021	0.0008
- 6/8	-0.0019	-0.0003	-0.0019	0.0008
- 5/8	-0.0014	-0.0002	-0.0015	0.0007
- 4/8	-0.0011	-0.0001	-0.0013	0.0005
- 3/8	-0.0008	0.0000	-0.0008	0.0004
- 2/8	-0.0003	0.0000	-0.0005	0.0003
- 1/8	-0.0001	0.0000	-0.0001	0.0001
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0005	0.0001	0.0001	-0.0001
2/8	0.0008	0.0003	0.0003	-0.0003
3/8	0.0013	0.0004	0.0008	-0.0005
4/8	0.0020	0.0005	0.0010	-0.0006
5/8	0.0021	0.0007	0.0012	-0.0007
6/8	0.0025	0.0008	0.0015	-0.0008
7/8	0.0027	0.0008	0.0017	-0.0009



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

Flatness Tolerance Met? YES



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

Parallelism Diameter 1

End 1:	Slope of Best Fit Line:	0.00287
	Angle of Best Fit Line:	0.16436
End 2:	Slope of Best Fit Line:	0.00218
	Angle of Best Fit Line:	0.12490
	Max Angular Difference:	0.04

Parallelism Diameter 2



End 1:	Slope of Best Fit Line:	0.00066
	Angle of Best Fit Line:	0.03782
End 2:	Slope of Best Fit Line:	-0.00106
	Angle of Best Fit Line:	-0.06057
	Max Angular Difference:	0.10



Parallelism Tolerance Met? YES

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

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0050	0.0025	YES
End 1 Diam 2	0.0011	0.0006	YES
End 2 Diam 1	0.0038	0.0019	YES
End 2 Diam 2	0.0017	0.0009	YES

Perpendicularity Tolerance Met? YES

7	 		Date: 2/12/2021 - 2/23/2021
	Photographer: Tori Iggoe		
Location / Orientation		S-44-87, B-2, RS-1 (70.7' – 71.1')	
Remarks		Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method D)	

8	 		Date: 2/12/2021 - 2/23/2021
	Photographer: Tori Iggoe		
Location / Orientation		S-44-87, B-2, RS-2 (71.9' – 72.3')	
Remarks		Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method D)	

Appendix VII – SPT Hammer Energy Measurements



Report of SPT Energy Measurements
S&ME Diedrich D-50 Track (Serial No. 382)
Spartanburg, South Carolina
S&ME Project No. 1535-20-200

PREPARED FOR:

**North Carolina Department of Transportation
Geotechnical Engineering Unit
1589 Mail Service Center
Raleigh, North Carolina 27699**

PREPARED BY:

**S&ME, Inc.
9751 Southern Pine Boulevard
Charlotte, North Carolina 28273**

June 1, 2020



June 1, 2020

North Carolina Department of Transportation
Geotechnical Engineering Unit
1589 Mail Service Center
Raleigh, North Carolina 27699

Attention: Shunyi (Chris) Chen, Ph.D., P.E.

Cc: Ms. Cheryl A. Youngblood, L.G.
Ms. Christina M. Bruinsma, L.G.

Reference: **Report of SPT Energy Measurements**
S&ME Diedrich D-50 Track (Serial No. 382)
Edgefield County, South Carolina
S&ME Project No. 1535-20-200
NC PE Firm License No. F-0176

Dear Dr. Chen:

We have completed the Standard Penetration Test (SPT) energy measurements on the automatic hammer used with S&ME's Diedrich D-50 track-mounted drill rig (Serial No. 382). This service was performed by Mr. Heath Forbes, P.E. of our firm on May 7, 2020, in general accordance with ASTM D4633 and the most recent revision of the North Carolina Department of Transportation (NCDOT) Geotechnical Engineering Unit's requirements. Review of the data quality and analyses was performed by Mr. Gregory Canivan, P.E. of our firm. Copies of the Certificates of Proficiency issued by Pile Dynamics based on the Dynamic Measurement and Analysis Proficiency Test for Mr. Forbes and Mr. Canivan are included in Appendix I. The testing procedures, equipment used during testing, and detailed results are presented in this report.

1.0 Dynamic Testing Methodology

Testing was performed using a model PAX (Serial No. 3726L) Pile Driving Analyzer™ (PDA) manufactured by Pile Dynamics, Inc. The PDA was used to record and interpret data from two piezoresistive accelerometers (Serial Nos. K10673 and K10674) bolted to a 2.65-foot long BW drill rod (Serial No. 102) internally instrumented with two strain transducers. Calibration sheets for the accelerometers and the instrumented rod are included in Appendix II. The instrumented BW drill rod has a cross-sectional area of 1.82 square inches and an outside diameter of approximately 2.125 inches. Therefore, we calculate the inside diameter to be approximately 1.5 inches at the gauge location. The accelerometers and strain gauges, which are diametrically opposed near the middle of the instrumented rod, monitor acceleration and strain for each hammer blow. The analyzer converts the data to velocities and forces and computes the maximum transferred hammer energies with the "EFV" method described in ASTM D4633. Preliminary results are recorded and displayed in real time for each blow.



2.0 Testing and Observations

S&ME personnel were on site May 7, 2020, to observe and perform high-strain dynamic testing during SPT sampling on the Diedrich D-50 track-mounted drill rig operated by Justin Millwood of S&ME. The measurements were taken during drilling and sampling of a test hole at a power transmission line project site in Edgefield County, South Carolina. SPT energy measurements were recorded during four sampling intervals at depths of approximately 28.5, 33.5, 38.5, and 43.5 ft below the ground surface. The information presented in the tables below summarizes the equipment and tooling used during the SPT energy measurements.

Table 2-1: Drill Rig Information

Manufacturer	Diedrich
Model	D-50
Serial Number	382
Operator	J. Millwood
Carrier	Track

Table 2-2: Hammer Information

Model / Type	Diedrich / Auto
Serial Number	382
Anvil Height (inches)	N/A – Anvil Built into Casing of Auto Hammer
Anvil Diameter (inches)	N/A – Anvil Built into Casing of Auto Hammer
Typical Drop Height (inches)	30
Typical Ram Weight (pounds)	140
Ram Serial Number	N/A

Table 2-3: Drilling and Instrumented Rod Information

Drill Rod Type	BW
OD (inches)	2.125
ID (inches)	1.5
Cross-Sectional Area (in²)	1.82
Typical Lengths (feet)	2 ft, 5 ft, and 10 ft
Instrumented Rod Type	BW (Serial No. 102)
OD (inches)	2.125
ID (inches)	1.5
Cross-Sectional Area (in²)	1.82
Total Instrumented Rod Length (feet)	2.65
Length Below Gages (feet)	1.31
Split-Spoon Length (feet)	2.93



3.0 Dynamic Testing Results

The total rod length from the instrumentation to the tip of the split-spoon sampler was determined by adding 4.24 ft to the drill rod length at each sample depth. The SPT Energy Measurement Data Summary tables in Appendix III present the test data from every hammer blow at each sampling interval, along with representative force and velocity traces for each test interval. Per ASTM D4633, only the blows from the final foot of each sample interval (i.e. the blows that determine the N-value) are considered when computing the average measurement values of each test interval.

The reported blow counts obtained by the drill rig personnel, a summary of the test data, and average computed hammer energy and transfer ratio values are provided in Table 3-1. Based on the test data, the automatic hammer on the Diedrich D-50 operated at an average rate of about 42 blows per minute (bpm) during dynamic testing. The measured average transferred hammer energy (EFV) of the four sample intervals ranged from 337 to 347 ft-lbs, which corresponds to Energy Transfer Ratio (ETR) values of 96.4 to 99.1%, respectively. Plots and tables of the following are also included in Appendix III and present the test data with depth for each test interval:

- Penetration vs. BLC¹
- Penetration vs. FMX²
- Penetration vs. EFV³
- Penetration vs. CSX⁴
- Penetration vs. VMX⁵
- Penetration vs. ETR⁶
- ETR vs. Rod Length
- Average ETR vs. Rod Length

Table 3-1: Summary of Dynamic Testing Results

Data Set ID	Sample Depth (ft)	Drill Rod Length (ft)	Instrumentation to Sampler Tip Length (ft)	Blows per 6" Increment / N-value	Soil Sample Description (Piedmont Residual)	Avg. BPM	Avg. EFV (ft-lbs)	Avg. ETR (%)
1	28.5 – 30	29	33.24	10-14-21 / 35	SILTY SAND	40.4	334	95.3
2	33.5 – 35	34	38.24	5-5-10 / 15	CLAY	40.4	340	97.2
3	38.5 – 40	39	43.24	3-5-8 / 13	SILTY SAND	40.4	340	97.1
4	43.5 – 45	44	48.24	5-8-7 / 15	SILTY SAND	39.2	339	96.8
Overall Average						40.2	337	96.3

The overall average transferred hammer energy for the automatic hammer on the Diedrich D-50 track-mounted drill rig was 337 foot-pounds, with an average ETR of 96.3%.

¹ BLC - Blow Count per 6-in. increment

² FMX - Maximum Compressive Force

³ EFV – Maximum Transferred Energy

⁴ CSX – Maximum Compressive Stress

⁵ VMX – Maximum Velocity

⁶ ETR – Energy Transfer Ratio – Ratio of Calculated Energy to Theoretical Energy of 140 lb hammer falling 30 inches



4.0 Limitations of Report

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions contained in this report were based on the applicable standards of our profession in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

5.0 Closing

S&ME appreciates the opportunity to provide this report to the North Carolina Department of Transportation, Geotechnical Engineering Unit. Please let us know if you have any questions concerning this report.

Sincerely,

S&ME, Inc.

A handwritten signature in black ink, appearing to read 'R. Heath Forbes'.

R. Heath Forbes, P.E.
Project Engineer
S.C. Registration No. 29560



Gregory J. Canivan, P.E.
Technical Principal
N.C. Registration No. 028593

Appendices:

- Appendix I - Certificates of Proficiency
- Appendix II - Instrumented Rod and Accelerometer Calibration Sheets
- Appendix III - Diedrich D-50 Track (SN 382) SPT Energy Measurements Summary Plots and Tables

Appendix I – Certificates of Proficiency



This documents that

**Greg Canivan
S&ME Inc.**

has on October 8, 2014 achieved the rank of

MASTER


on the Dynamic Measurement and Analysis Proficiency Test.

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended that individuals at the Master level seek to attain Expert level through additional study within five years of the date of this document***

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate. This certificate can be verified at www.PDAproficiencytest.com.


Steven A. Hall, Executive Director
Pile Driving Contractors Association




Garland Likins, President
Pile Dynamics, Inc

No. 721



This documents that
Heath Forbes, P.E.
S&ME, Inc.

has on October 31, 2017 achieved the rank of

ADVANCED

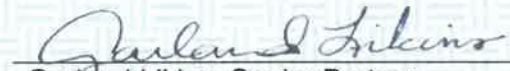
on the **Dynamic Measurement and Analysis Proficiency Test.**

The individual identified on this document demonstrated to the degree granted above an understanding of theory, data quality evaluation, interpretation and signal matching for high strain dynamic testing of deep foundations. ***It is recommended that individuals at the Advanced level seek Master or Expert levels through additional study within six years of the date of this document.***

The ability of the individual named to provide appropriate knowledge and advice on a specific project is not implied or warranted by the Pile Driving Contractors Association or Pile Dynamics, Inc. **This certificate can be verified at www.PDAproficiencytest.com.** The Pile Driving Contractors Association or Pile Dynamics, Inc. assumes no liability for foundation testing and analysis work performed by the bearer of this certificate.


Steven A. Hall, Executive Director
Pile Driving Contractors Association




Garland Likins, Senior Partner
Pile Dynamics, Inc.

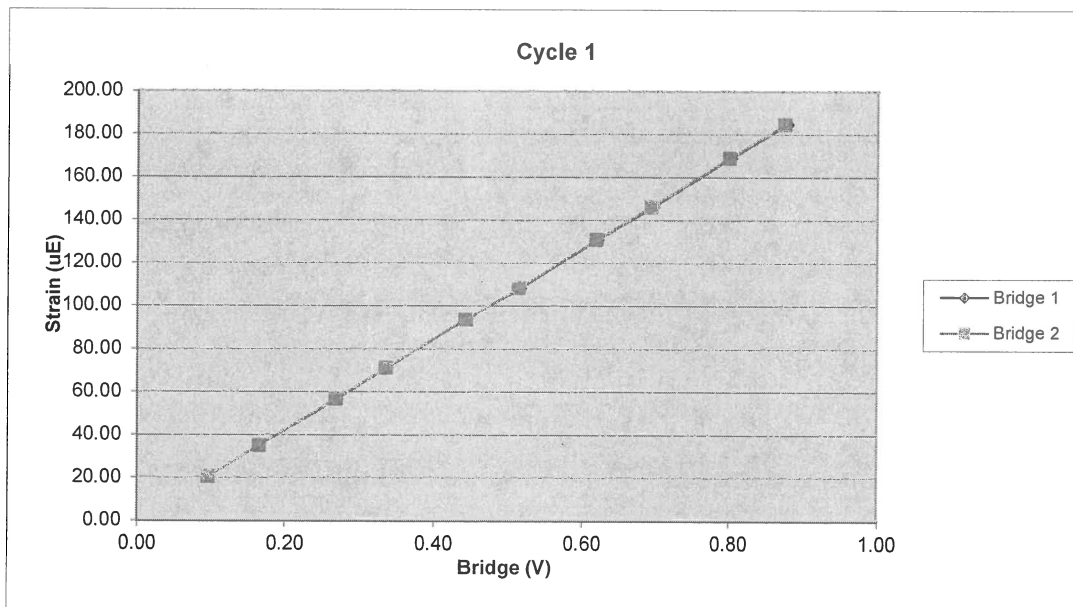
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Appendix II – Calibration Sheets

102BW		Cycle 1		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1095.24	20.23	0.10	0.10
3	1886.37	34.92	0.16	0.16
4	3088.81	56.56	0.27	0.27
5	3858.71	71.04	0.34	0.34
6	5085.34	93.60	0.44	0.44
7	5908.54	108.17	0.51	0.51
8	7119.44	130.81	0.62	0.62
9	7983.55	146.15	0.69	0.69
10	9219.63	168.88	0.80	0.80
11	10084.73	184.60	0.88	0.87

Bridge 1		Bridge 2	
Force Calibration (lb/V)	11500.87	Force Calibration (lb/V)	11534.91
Offset	-2.16	Offset	-7.27
Correlation	0.999999	Correlation	0.999999
Strain Calibration ($\mu\text{E}/\text{V}$)	210.25	Strain Calibration ($\mu\text{E}/\text{V}$)	210.88
Offset	0.30	Offset	0.21
Correlation	0.999993	Correlation	0.999995

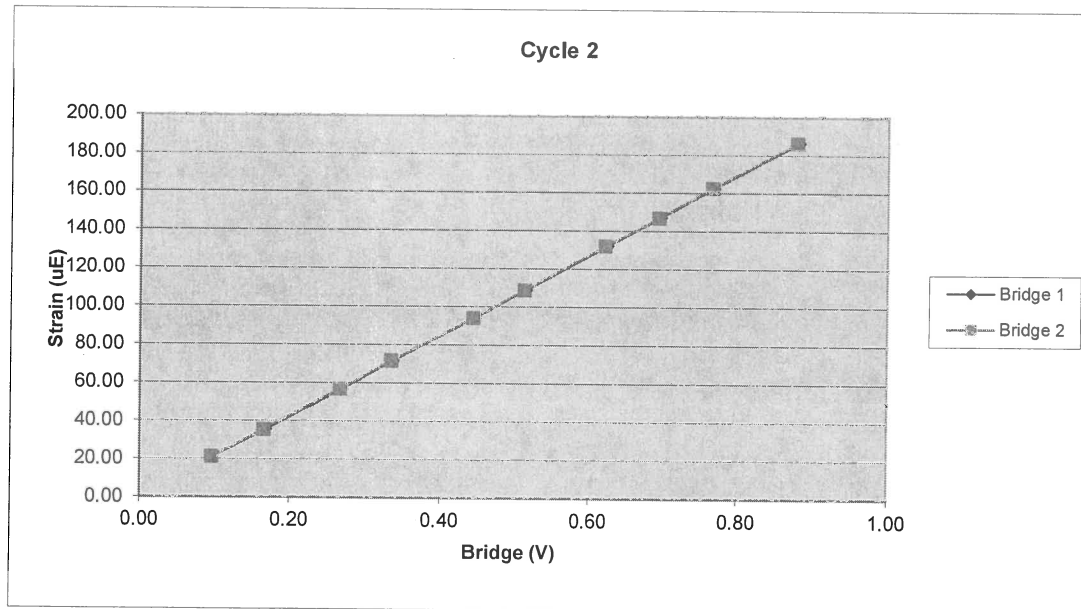
Force Strain Calibration	
EA (Kips)	54698.97
Offset	-18.70
Correlation	0.999994



102BW		Cycle 2		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	1120.61	20.82	0.10	0.10
3	1926.89	35.33	0.17	0.17
4	3094.72	56.55	0.27	0.27
5	3888.41	71.48	0.34	0.33
6	5144.16	93.89	0.44	0.44
7	5940.80	108.73	0.51	0.51
8	7193.60	131.98	0.62	0.62
9	8040.99	146.97	0.70	0.69
10	8848.65	162.51	0.77	0.77
11	10165.37	186.33	0.88	0.88

Bridge 1		Bridge 2	
Force Calibration (lb/V)	11552.98	Force Calibration (lb/V)	11555.35
Offset	-0.36	Offset	15.25
Correlation	0.999997	Correlation	0.999998
Strain Calibration ($\mu\text{E/V}$)	211.64	Strain Calibration ($\mu\text{E/V}$)	211.68
Offset	0.03	Offset	0.31
Correlation	0.999993	Correlation	0.999993

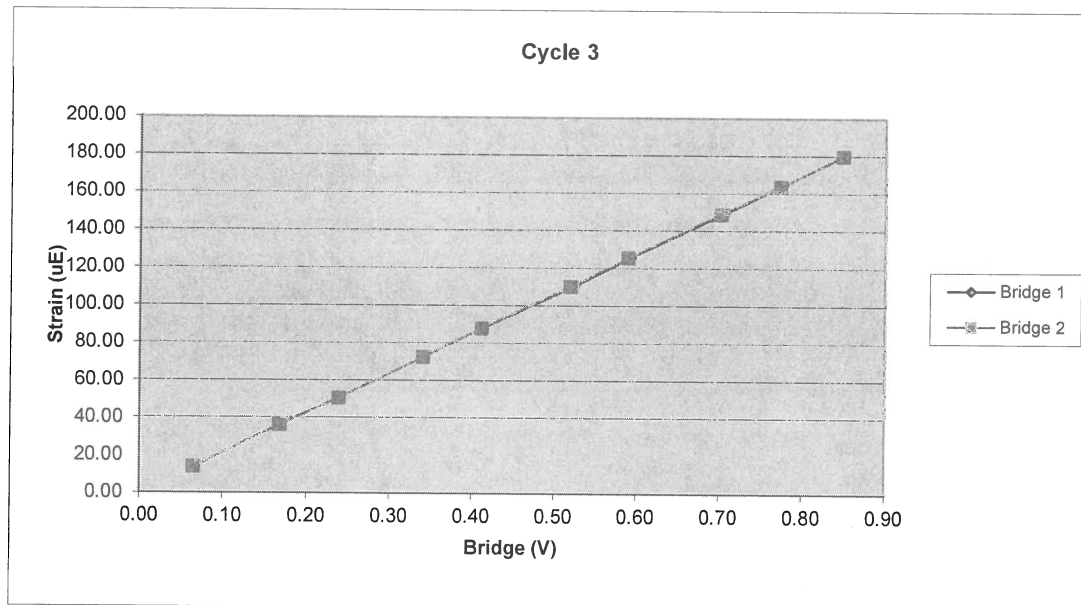
Force Strain Calibration	
EA (Kips)	54586.80
Offset	-1.83
Correlation	0.999989



102BW		Cycle 3		
Sample	Force (lb)	Strain (μE)	Bridge 1 (V)	Bridge 2 (V)
1	0.00	0.00	0.00	0.00
2	728.19	13.83	0.07	0.06
3	1910.96	36.06	0.17	0.17
4	2721.96	50.60	0.24	0.24
5	3901.78	72.41	0.34	0.34
6	4724.79	87.76	0.41	0.41
7	5973.85	110.13	0.52	0.52
8	6776.59	125.45	0.59	0.59
9	8061.64	148.89	0.70	0.70
10	8899.20	163.80	0.77	0.77
11	9736.37	179.68	0.85	0.85

Bridge 1		Bridge 2	
Force Calibration (lb/V)	11507.00	Force Calibration (lb/V)	11517.03
Offset	-19.88	Offset	-19.40
Correlation	0.999996	Correlation	0.999997
Strain Calibration ($\mu\text{E/V}$)	211.37	Strain Calibration ($\mu\text{E/V}$)	211.56
Offset	0.34	Offset	0.35
Correlation	0.999987	Correlation	0.999992

Force Strain Calibration	
EA (Kips)	54438.54
Offset	-38.30
Correlation	0.999990

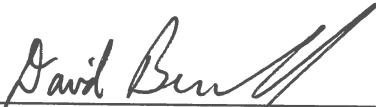


Bridge Excitation (V) 5
Shunt Resistor (ohm) 60.4k

Calibration Factors	102BW		
Bridge 1 ($\mu\text{E/V}$)	211.09	Bridge 2 ($\mu\text{E/V}$)	211.37
EA Factor (Kips)	54574.77	Area (in^2)	1.82

Calibrated by:

Calibrated Date:



6/1/2018

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

File Dynamics, Inc.				TG F2	DPF
File Dynamics 2018-07-26 10:47		FS — 10	BN 6241 SL 970/ 3440/ 99	PJ: PN: HOPBAR	A 4 -- US F 2 3.3
LE 17.0 ft AR 1.7 in2 EM 30000 Ksi SP 0.492 K/ft3 WS 16810 ft/s WC 7312 ft/s JC 0.40 FM 1.00 UM 1.00 EA/C 30.3 Ks/ft UN KIPS*0.1 FR 20000 MB 90 DL -41 UT -1 IP 0.00 PK 1 TM-PEAK F1/2 500/ 213 F3/4 213/ 213 A1/2 999/ 999 A3/4 999/ 340					
TS 12 TB 8.0		E B PD: K10673 T1 9.4 2L/C 4.7		VA 1000 UE 1024 LP 0.00 ft LI 1.0	
ACCEPT SQ-OFF FL-OFF PR-OFF		VMX= 4.4 FMX= 68 AMX= 149 EMX= 0.3 MEX= 133 FVP= 1.00			
ACCEPT 		ACCELEROMETER CALIBRATION N.I.S.T. Traceable SERIAL NUMBER: K10673 CALIBRATION FACTOR: .068 mV/g PAK (*5000): 340 DATE: 26 July 18 PDA OPERATOR: [Signature]			
<-AT:PIEZORESISTIVE		OP: laine lver:5.011		AT:PIEZOELECTRIC->	

Smart Sensor

Smart Chip Programmed By A.W. on 26 July 18 CRC Value BA96

Pile Dynamics, Inc.		TG F2	DPF
File Dynamics 2018-07-26 10:43	FS — BN 6235 10 SL 964/ 3440/ 2	PJ: PN: HOPBAR	A 4 -- US F 2 3.3
LE 17.0 ft AR 1.7 in2 EM 30000 Ksi SP 0.492 K/ft3 WS 16810 ft/s WC 7312 ft/s			
JC 0.40 FM 1.00 UM 1.00			
EA/C 30.3 Ks/ft UN KIPS*0.1 FR 20000 MB 90			
DL -40 UT -1 IP 0.00 PK 1 TM-PEAK			
F1/2 500/ 213 F3/4 213/ 213 A1/2 999/ 999 A3/4 999/ 370			
TS 12 TB 8.0	E B PD: K10674 T1 9.5 2L/C 4.7 UA 1000	VE 1024	LP 0.00 ft LI 1.0
ACCEPT SQ-OFF FL-OFF PR-OFF		VMX= 4.4 FMX= 67 AMX= 149 EMX= 0.3 MEX= 131 FVP= 1.00	
ACCEPT 		ACCELEROMETER CALIBRATION N.I.S.T. Traceable SERIAL NUMBER: K10674 CALIBRATION FACTOR: .074 mV/g PAK (*5000): 370 DATE: 26 July 18 PDA OPERATOR: <i>[Signature]</i>	
←-AT:PIEZORESISTIVE		AT:PIEZOELECTRIC→	

Smart Sensor

Smart Chip Programmed By A.W. on 26 July 18 CRC Value 3E56

Certificate of Calibration

Pile Dynamics, Inc. certifies that the

Pile Driving Analyzer®, Model PAX

Serial Number: 3726 L

was calibrated on 30 Aug. 2018
using a PDA Calibration Box whose output was calibrated with test equipment
traceable to NIST.

This certificate is valid for 2 years from above date.



Tested by:



A handwritten signature in black ink, appearing to be 'L. ...', written over a horizontal line.

Pile Dynamics, Inc.
30725 Aurora Road
Cleveland, Ohio 44139 USA

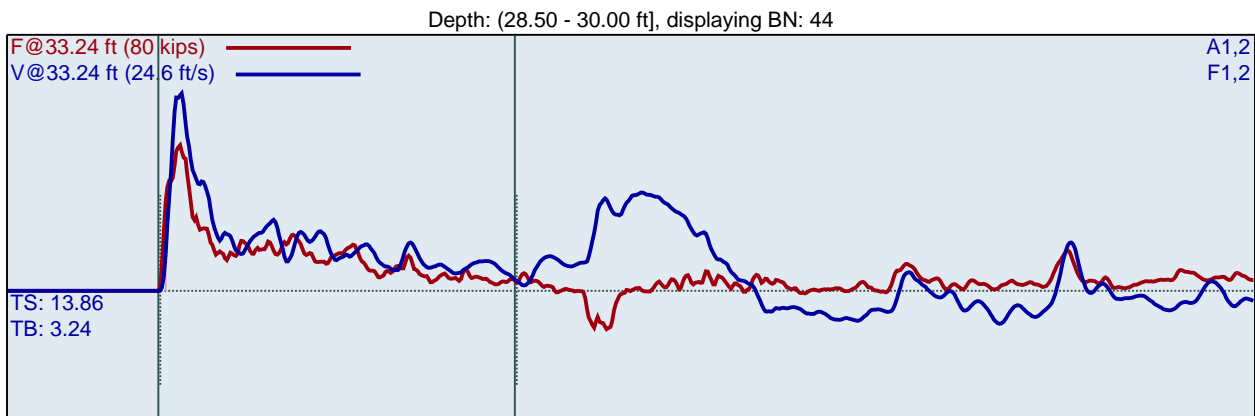
Appendix III - SPT Energy Measurements Plots and Tables

Diedrich D50 (SN 382)
H. Forbes
B-14A

Annual Calibration
Test date: 5/7/2020

AR: 1.82 in²
LE: 33.24 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



F1 : [102 BW-1] 211.09 PDICAL (1) FF1
F2 : [102 BW-2] 211.37 PDICAL (1) FF1

A1 (PR): [K10674] 370 mv/6.4v/5000g (1) VF1
A2 (PR): [K10673] 340 mv/6.4v/5000g (1) VF1

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

DFN: Final Displacement

CSX: Compression Stress Maximum

EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

BL#	LP	BC	BPM	FMX	VMX	DMX	DFN	CSX	EFV	ETR
	ft	/6"	bpm	kips	ft/s	in	in	ksi	ft-lb	%
1	28.55	11	52.3	44	16.9	1.06	0.55	24.2	298	85.0
2	28.59	11	52.1	48	17.5	0.75	0.55	26.6	319	91.1
3	28.64	11	40.6	46	17.2	0.73	0.55	25.1	326	93.2
4	28.68	11	40.4	47	17.6	0.65	0.55	25.7	333	95.1
5	28.73	11	40.5	49	18.3	0.62	0.55	26.7	338	96.6
6	28.77	11	40.7	47	17.8	0.61	0.55	26.0	336	95.9
7	28.82	11	40.4	47	18.1	0.62	0.55	25.9	336	95.9
8	28.86	11	40.4	46	18.1	0.62	0.55	25.5	334	95.3
9	28.91	11	40.7	45	17.6	0.63	0.55	24.5	328	93.8
10	28.95	11	40.7	45	17.7	0.59	0.55	24.6	323	92.2
11	29.00	11	40.4	44	17.8	0.57	0.55	24.4	327	93.4
12	29.04	14	40.4	46	18.4	0.54	0.43	25.4	331	94.5
13	29.07	14	40.3	49	19.3	0.55	0.43	26.8	342	97.7
14	29.11	14	40.3	46	17.9	0.54	0.43	25.2	329	94.0
15	29.14	14	40.4	46	18.3	0.55	0.43	25.3	335	95.6
16	29.18	14	40.5	46	18.3	0.55	0.43	25.3	331	94.5
17	29.21	14	40.4	46	18.8	0.55	0.43	25.3	337	96.3
18	29.25	14	40.6	45	18.4	0.52	0.43	24.5	331	94.6
19	29.29	14	40.4	43	17.8	0.48	0.43	23.8	322	91.9
20	29.32	14	40.5	46	19.1	0.46	0.43	25.1	334	95.4
21	29.36	14	40.3	46	18.8	0.45	0.43	25.1	336	96.0
22	29.39	14	40.3	44	18.0	0.43	0.43	24.2	323	92.4
23	29.43	14	40.5	44	18.7	0.43	0.43	24.3	329	94.1
24	29.46	14	40.2	45	18.9	0.43	0.43	24.6	335	95.6
25	29.50	14	40.3	46	19.3	0.45	0.43	25.1	338	96.7
26	29.52	21	40.7	47	19.4	0.40	0.29	25.6	331	94.7
27	29.55	21	40.1	48	20.0	0.42	0.29	26.5	345	98.5

28	29.57	21	40.6	44	18.0	0.39	0.29	24.1	321	91.8
29	29.60	21	40.3	45	19.0	0.41	0.29	24.9	335	95.8
30	29.62	21	40.3	44	18.2	0.40	0.29	23.9	328	93.7
31	29.64	21	40.4	46	19.3	0.41	0.29	25.0	334	95.4
32	29.67	21	40.2	46	19.3	0.41	0.29	25.4	340	97.1
33	29.69	21	40.5	45	18.9	0.40	0.29	24.7	333	95.3
34	29.71	21	40.7	43	18.4	0.39	0.29	23.9	323	92.4
35	29.74	21	40.1	46	19.2	0.40	0.29	25.1	338	96.7
36	29.76	21	40.5	47	19.6	0.39	0.29	25.8	337	96.3
37	29.79	21	40.3	45	18.8	0.39	0.29	24.5	333	95.0
38	29.81	21	40.4	48	20.0	0.39	0.29	26.3	343	98.0
39	29.83	21	39.9	47	19.2	0.40	0.29	25.8	344	98.2
40	29.86	21	40.5	46	19.1	0.38	0.29	25.2	336	95.9
41	29.88	21	40.5	47	19.5	0.40	0.29	25.8	340	97.2
42	29.90	21	40.2	45	18.6	0.38	0.29	24.8	332	95.0
43	29.93	21	40.4	47	19.7	0.39	0.29	25.9	338	96.4
44	29.95	21	40.3	46	19.0	0.38	0.29	25.0	334	95.5
45	29.98	21	40.6	44	18.3	0.37	0.29	24.2	324	92.5
46	30.00	21	40.1	46	19.1	0.38	0.29	25.2	337	96.2
Average			40.4	46	18.9	0.43	0.34	25.1	334	95.3
Std Dev			0.2	1	0.6	0.06	0.07	0.7	6	1.7
Maximum			40.7	49	20.0	0.55	0.43	26.8	345	98.5
Minimum			39.9	43	17.8	0.37	0.29	23.8	321	91.8
N-value: 35										

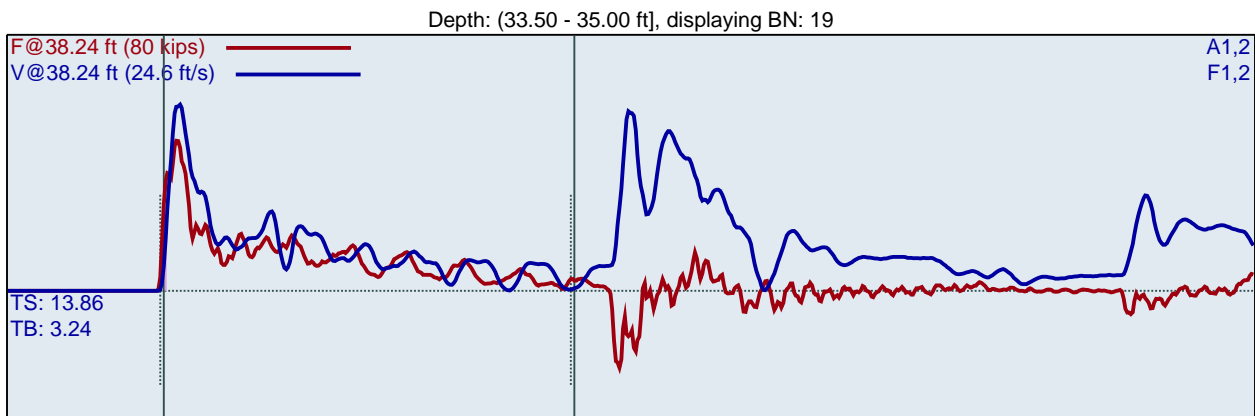
Sample Interval Time: 132.91 seconds.

Diedrich D50 (SN 382)
H. Forbes
B-14A

Annual Calibration
Test date: 5/7/2020

AR: 1.82 in²
LE: 38.24 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



F1 : [102 BW-1] 211.09 PDICAL (1) FF1
F2 : [102 BW-2] 211.37 PDICAL (1) FF1

A1 (PR): [K10674] 370 mv/6.4v/5000g (1) VF1
A2 (PR): [K10673] 340 mv/6.4v/5000g (1) VF1

BL#	LP ft	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	DFN in	CSX ksi	EFV ft-lb	ETR %
1	33.58	6	1.9	46	19.3	1.53	1.00	25.5	322	92.1
2	33.67	6	2.7	44	19.6	1.44	1.00	24.2	342	97.7
3	33.75	6	40.7	46	19.3	1.33	1.00	25.0	347	99.1
4	33.83	6	40.9	43	18.3	1.14	1.00	23.9	333	95.1
5	33.92	6	40.4	46	19.3	1.14	1.00	25.4	343	98.0
6	34.00	6	40.4	44	18.0	1.07	1.00	24.0	340	97.0
7	34.10	5	40.8	44	18.6	1.20	1.20	24.3	337	96.4
8	34.20	5	40.1	45	19.2	1.20	1.20	25.0	353	100.7
9	34.30	5	40.4	45	19.2	1.20	1.20	24.7	345	98.6
10	34.40	5	40.4	48	19.9	1.20	1.20	26.6	349	99.7
11	34.50	5	40.6	47	19.4	1.20	1.20	25.9	345	98.5
12	34.55	10	40.1	46	18.6	0.85	0.60	25.4	342	97.7
13	34.60	10	40.8	45	18.5	0.83	0.60	24.9	331	94.6
14	34.65	10	40.2	49	19.7	0.81	0.60	27.0	348	99.5
15	34.70	10	40.5	48	18.4	0.80	0.60	26.3	334	95.4
16	34.75	10	40.2	49	19.3	0.77	0.60	26.8	342	97.8
17	34.80	10	40.4	48	18.4	0.76	0.60	26.4	336	95.9
18	34.85	10	40.4	49	18.7	0.71	0.60	26.7	336	96.1
19	34.90	10	40.5	47	17.9	0.73	0.60	25.8	325	92.8
20	34.95	10	40.1	48	19.2	0.70	0.60	26.4	340	97.1
21	35.00	10	40.4	49	18.9	0.68	0.60	26.9	340	97.1
Average			40.4	47	18.9	0.91	0.80	25.9	340	97.2
Std Dev			0.2	2	0.5	0.21	0.28	0.9	7	2.0
Maximum			40.8	49	19.9	1.20	1.20	27.0	353	100.7
Minimum			40.1	44	17.9	0.68	0.60	24.3	325	92.8

N-value: 15

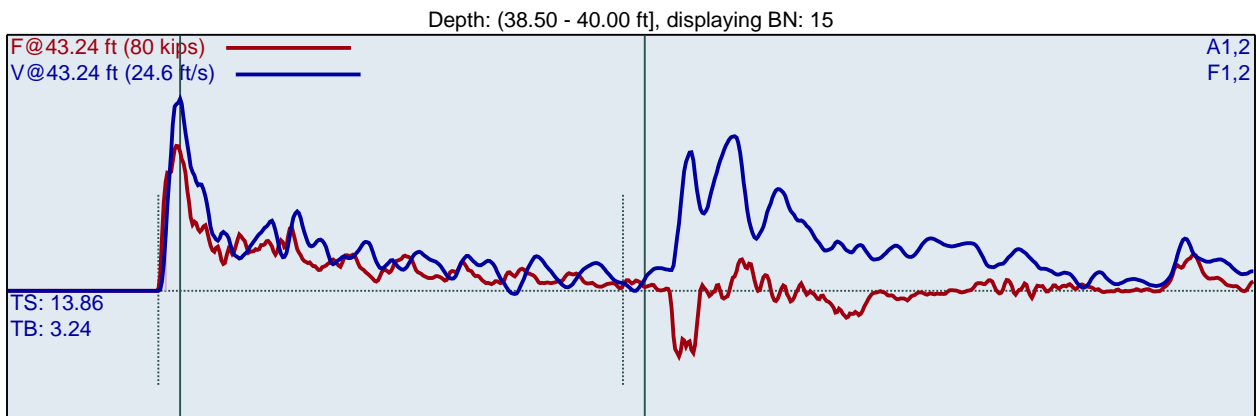
Sample Interval Time: 50.14 seconds.

Diedrich D50 (SN 382)
H. Forbes
B-14A

Annual Calibration
Test date: 5/7/2020

AR: 1.82 in²
LE: 43.24 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



F1 : [102 BW-1] 211.09 PDICAL (1) FF1
F2 : [102 BW-2] 211.37 PDICAL (1) FF1

A1 (PR): [K10674] 370 mv/6.4v/5000g (1) VF1
A2 (PR): [K10673] 340 mv/6.4v/5000g (1) VF1

BL#	LP ft	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	DFN in	CSX ksi	EFV ft-lb	ETR %
1	38.63	4	51.4	49	17.8	1.94	1.50	26.8	325	93.0
2	38.75	4	3.9	48	19.2	1.73	1.50	26.3	351	100.2
3	38.88	4	40.4	47	19.1	1.68	1.50	26.1	348	99.5
4	39.00	4	40.6	46	18.6	1.56	1.50	25.3	344	98.3
5	39.10	5	40.3	48	18.9	1.35	1.20	26.5	349	99.7
6	39.20	5	40.4	48	18.3	1.26	1.20	26.1	341	97.4
7	39.30	5	40.3	48	18.4	1.29	1.20	26.5	348	99.4
8	39.40	5	40.7	46	17.7	1.21	1.20	25.0	332	94.9
9	39.50	5	40.6	48	18.6	1.20	1.20	26.1	340	97.2
10	39.56	8	40.4	47	18.3	0.98	0.75	25.8	333	95.1
11	39.63	8	40.1	45	17.7	0.92	0.75	25.0	336	96.1
12	39.69	8	40.6	46	18.3	0.79	0.75	25.5	327	93.4
13	39.75	8	40.3	47	19.3	0.81	0.75	25.8	343	98.0
14	39.81	8	40.1	49	20.1	0.81	0.75	26.9	352	100.4
15	39.88	8	40.8	45	18.5	0.77	0.75	24.9	330	94.3
16	39.94	8	40.0	47	19.6	0.75	0.75	26.1	343	98.0
17	40.00	8	40.2	46	19.1	0.75	0.75	25.4	345	98.5
Average			40.4	47	18.7	0.99	0.92	25.8	340	97.1
Std Dev			0.2	1	0.7	0.22	0.22	0.6	7	2.1
Maximum			40.8	49	20.1	1.35	1.20	26.9	352	100.4
Minimum			40.0	45	17.7	0.75	0.75	24.9	327	93.4
N-value: 13										

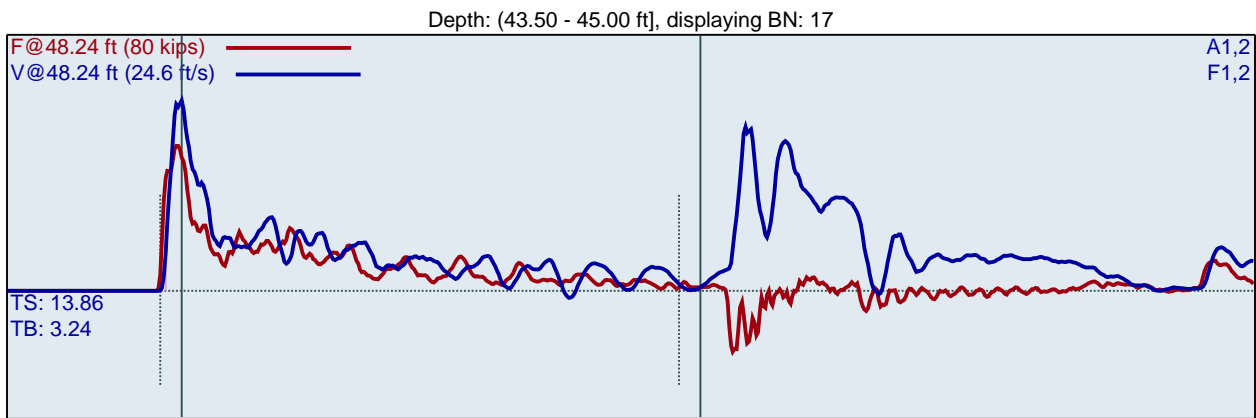
Sample Interval Time: 37.78 seconds.

Diedrich D50 (SN 382)
H. Forbes
B-14A

Annual Calibration
Test date: 5/7/2020

AR: 1.82 in²
LE: 48.24 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft³
EM: 30000 ksi



F1 : [102 BW-1] 211.09 PDICAL (1) FF1
F2 : [102 BW-2] 211.37 PDICAL (1) FF1

A1 (PR): [K10674] 370 mv/6.4v/5000g (1) VF1
A2 (PR): [K10673] 340 mv/6.4v/5000g (1) VF1

BL#	LP ft	BC /6"	BPM bpm	FMX kips	VMX ft/s	DMX in	DFN in	CSX ksi	EFV ft-lb	ETR %
1	43.63	4	2.4	45	18.5	1.50	1.50	25.0	332	94.9
2	43.75	4	18.0	46	19.0	1.50	1.50	25.3	340	97.3
3	43.88	4	40.6	45	18.7	1.50	1.50	24.7	337	96.3
4	44.00	4	40.4	45	18.9	1.50	1.50	24.8	338	96.6
5	44.06	8	40.7	46	19.0	0.91	0.75	25.4	338	96.5
6	44.13	8	40.6	49	19.7	1.00	0.75	26.7	344	98.3
7	44.19	8	40.3	45	18.4	0.96	0.75	25.0	336	96.1
8	44.25	8	40.7	44	18.1	0.81	0.75	24.4	327	93.5
9	44.31	8	40.3	47	19.4	0.90	0.75	25.9	346	98.7
10	44.38	8	40.9	48	19.3	0.84	0.75	26.3	336	96.1
11	44.44	8	40.4	47	18.7	0.81	0.75	25.6	332	94.9
12	44.50	8	40.4	48	19.8	0.77	0.75	26.6	345	98.6
13	44.57	7	40.4	45	18.5	0.86	0.86	24.7	340	97.0
14	44.64	7	40.7	49	19.7	0.86	0.86	26.8	347	99.2
15	44.71	7	40.9	46	18.5	0.86	0.86	25.2	331	94.5
16	44.79	7	40.2	49	19.7	0.86	0.86	26.9	347	99.1
17	44.86	7	40.6	45	18.3	0.86	0.86	24.9	335	95.6
18	44.93	7	40.2	48	19.7	0.86	0.86	26.6	345	98.7
19	45.00	7	20.9	45	18.1	0.86	0.86	24.9	335	95.6
Average			39.2	47	19.0	0.87	0.80	25.7	339	96.8
Std Dev			4.9	2	0.6	0.06	0.05	0.8	6	1.8
Maximum			40.9	49	19.8	1.00	0.86	26.9	347	99.2
Minimum			20.9	44	18.1	0.77	0.75	24.4	327	93.5

N-value: 15

Sample Interval Time: 29.85 seconds.

Summary of SPT Test Results

Project: Diedrich D50 (SN 382), Test Date: 5/7/2020

BPM: Blows/Minute

FMX: Maximum Force

VMX: Maximum Velocity

DMX: Maximum Displacement

DFN: Final Displacement

CSX: Compression Stress Maximum

EFV: Maximum Energy

ETR: Energy Transfer Ratio - Rated

Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	N Value	N60 Value	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average DFN in	Average CSX ksi	Average EFV ft-lb	Average ETR %
33.24	28.50	30.00	11-14-21	35	56	40.4	46	18.9	0.43	0.34	25.1	334	95.3
38.24	33.50	35.00	6-5-10	15	24	40.4	47	18.9	0.91	0.80	25.9	340	97.2
43.24	38.50	40.00	4-5-8	13	20	40.4	47	18.7	0.99	0.92	25.8	340	97.1
48.24	43.50	45.00	4-8-7	15	24	39.2	47	19.0	0.87	0.80	25.7	339	96.8
Overall Average Values:						40.2	46	18.9	0.70	0.62	25.5	337	96.3
Standard Deviation:						2.2	2	0.6	0.28	0.30	0.8	7	2.1
Overall Maximum Value:						40.9	49	20.1	1.35	1.20	27.0	353	100.7
Overall Minimum Value:						20.9	43	17.7	0.37	0.29	23.8	321	91.8



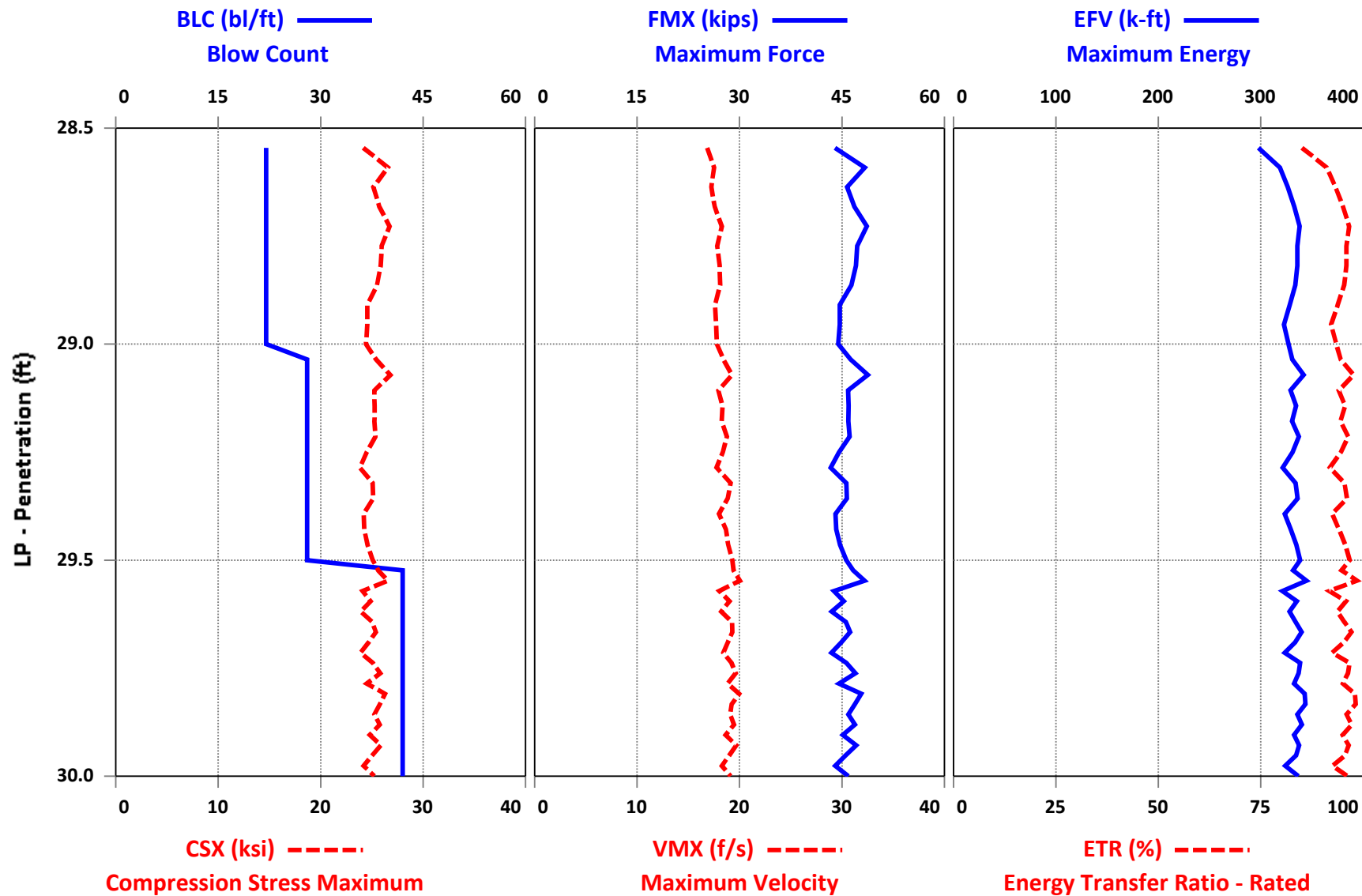
Printed: 22-May-2020

Pile Dynamics, Inc. - PDILOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Test started: 07-May-2020



Diedrich D50 (SN 382) - 28.5 to 30 ft





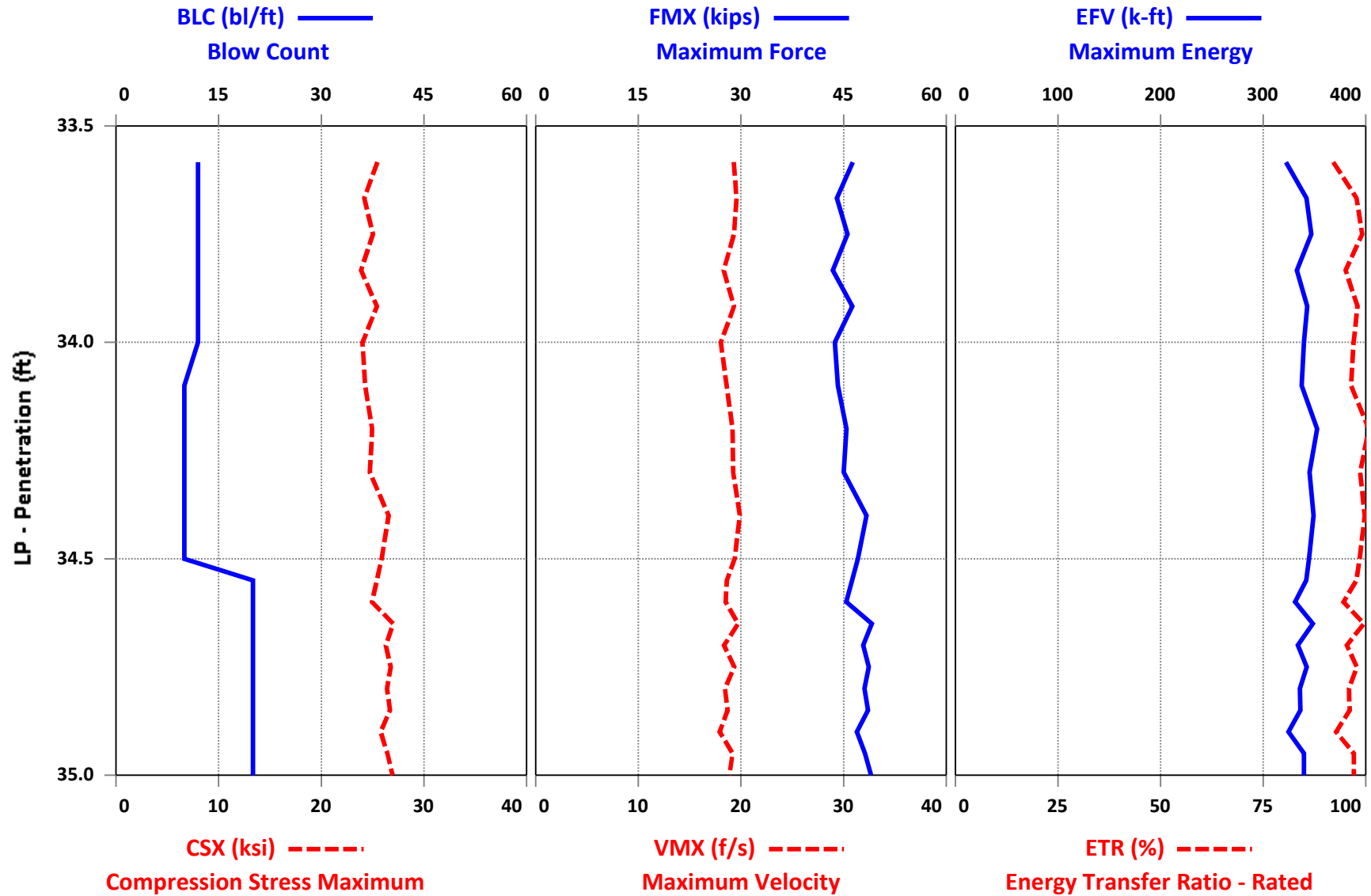
Printed: 22-May-2020

Pile Dynamics, Inc. - PDILOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Test started: 07-May-2020



Diedrich D50 (SN 382) - 33.5 to 35 ft





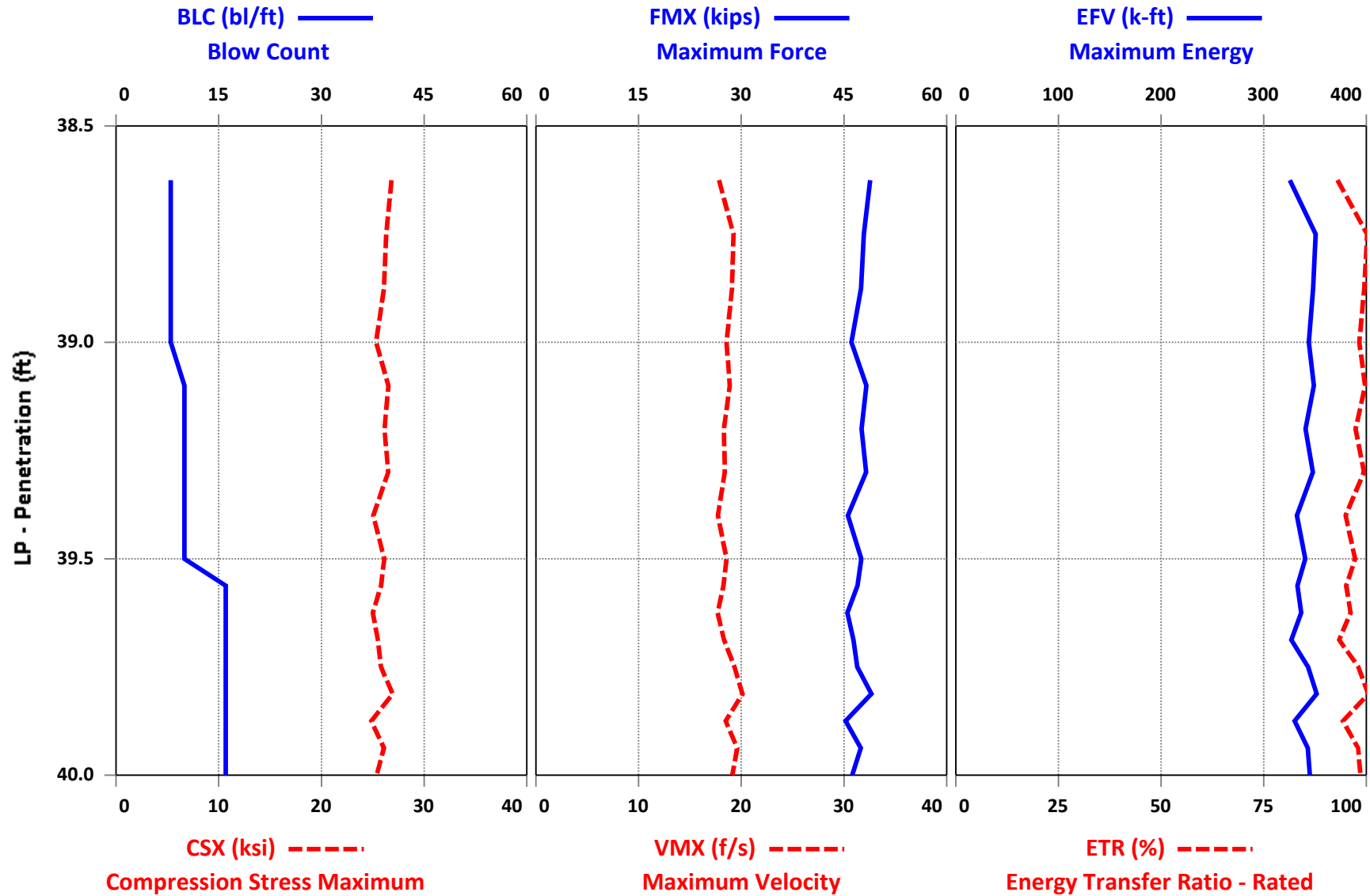
Printed: 22-May-2020

Pile Dynamics, Inc. - PDILOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Test started: 07-May-2020



Diedrich D50 (SN 382) - 38.5 to 40 ft





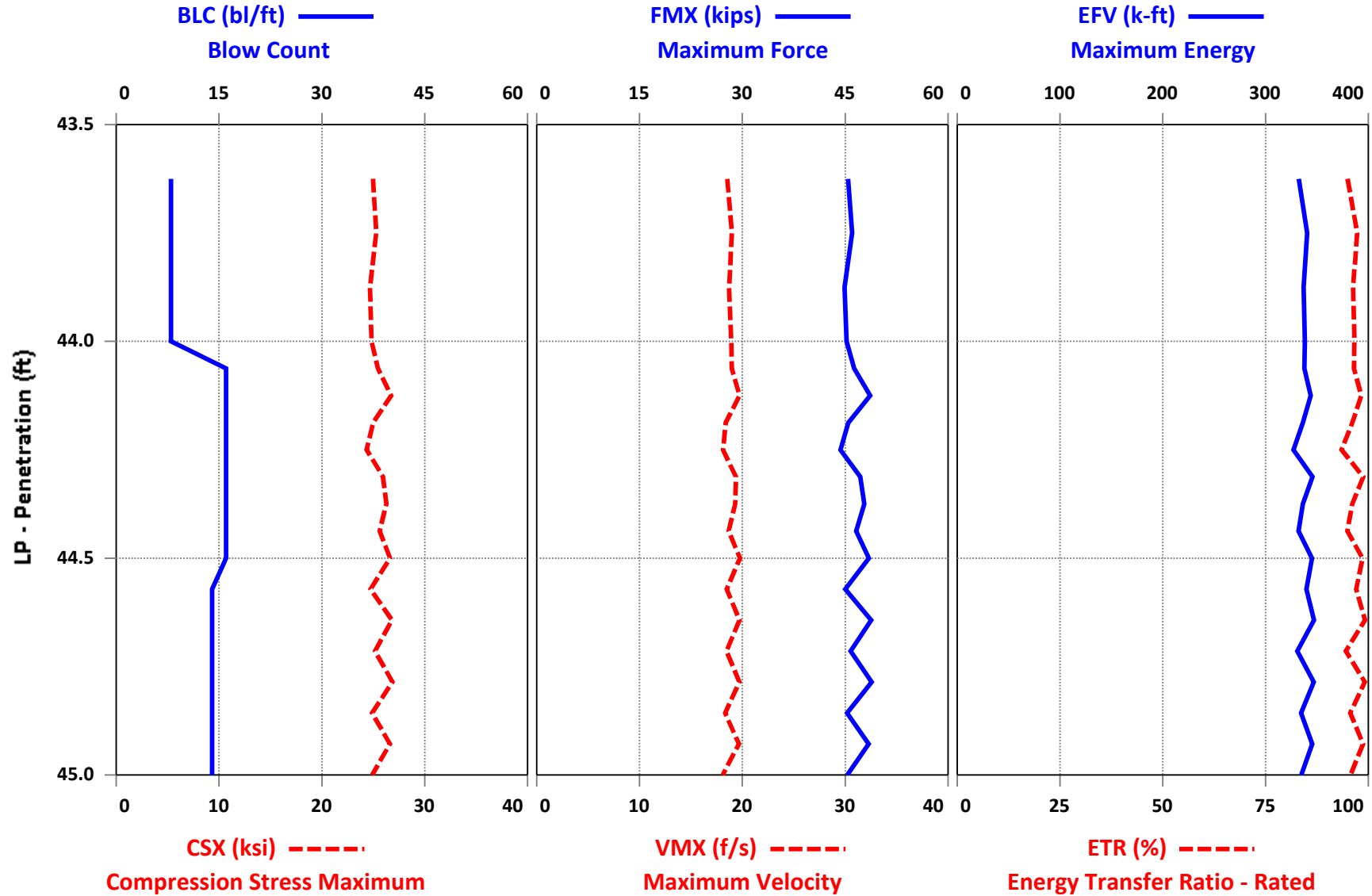
Printed: 22-May-2020

Pile Dynamics, Inc. - PDILOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Test started: 07-May-2020

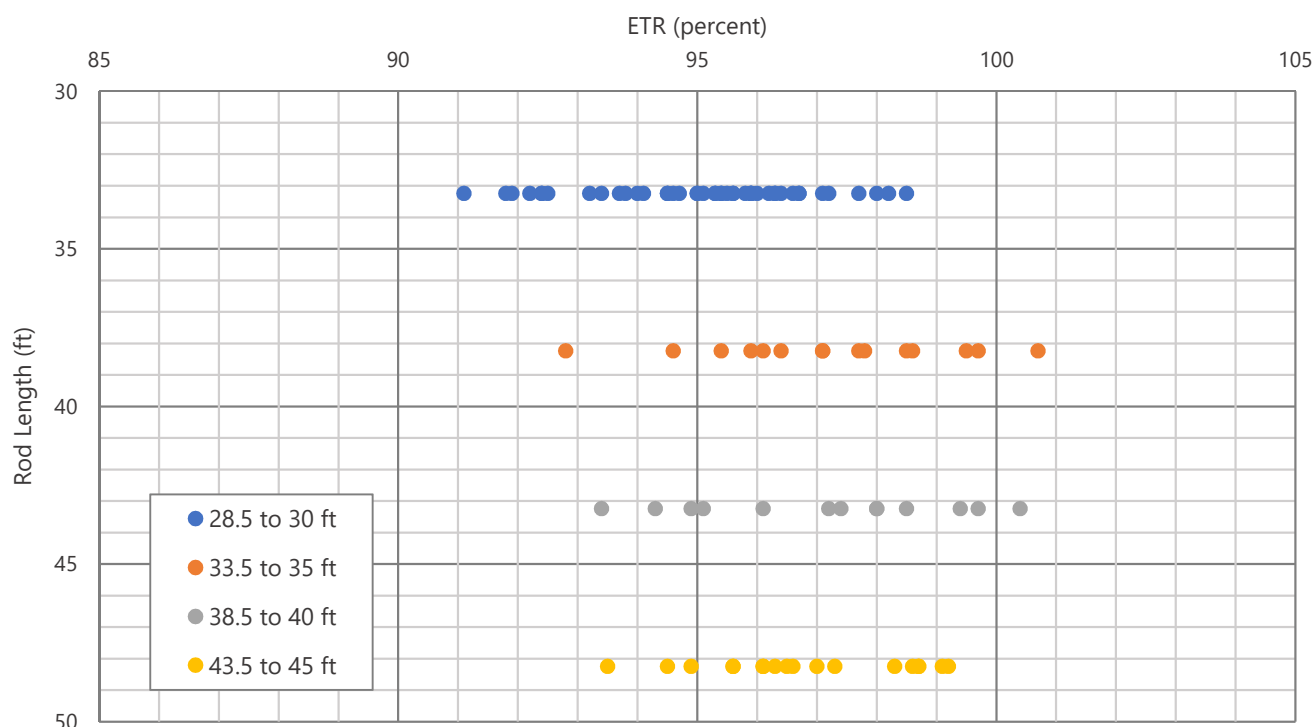


Diedrich D50 (SN 382) - 43.5 to 45 ft





ETR versus Rod Length
Diedrich D-50 Track (SN 382)



Average ETR versus Rod Length ± 1 Standard Deviation
Diedrich D-50 Track (SN 382)

