Geotechnical Base Line Report (GBLR)

Route S-11-265 Bridge Replacement over Manning Creek
Cherokee County, South Carolina
SCDOT Project ID P038058
S&ME Project No. 1361-20-048

PREPARED FOR:

South Carolina Department of Transportation
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Columbia, South Carolina 29201

PREPARED BY:

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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 Base Line Report (GBLR)
Route S-11-265 Bridge Replacement over Manning Creek
Cherokee County, South Carolina
SCDOT Project ID P038058
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, and 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.
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SOUTH CAROLINA
S&ME, INC.
C00473
CERTIFICATE OF AUTHORIZATION

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1.0 Project Description

The proposed construction for this project includes replacement of the existing Manning Road (S-11-265) bridge over Manning Creek located in Cherokee County, 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
P038058	S-11-265	Manning Road	Manning Creek	Cherokee	35.06889	-81.44255

From our review of provided information, the existing bridge was built in 1958 and is 75 feet in length with two travel lanes. The proposed replacement bridge will be 90 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 7 and 8, 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 Cherokee County to coordinate the field testing and traffic control along the SCDOT rights-of-way instead 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 7 and 8, 2020 using a truck-mounted CME 55 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 to termination depths. 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-11-265	1170026500100	B-1	18.5	29.0	Asphalt	Proposed Southwest Abutment
		B-2	16.8	26.9	Asphalt	Proposed Northeast 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 20 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 engineer. 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	524.9	12.2	512.7	15.6	509.3
B-2	524.7	9.6	515.1	13.6	511.1

After ground water measurements were complete, the borings were backfilled with bentonite chips, auger cuttings, or clean fill to within 10 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 5-2 – S&ME Drilling Equipment Summary

Rig Make/Model	Serial No.	Carrier Type	Average SPT Energy Transfer Ratio (ETR), %
CME 55	328245	Truck	85.7

5.5 Wireline Rock Coring

Upon encountering refusal at the boring locations, wireline rock coring was performed to termination depths of 26.9 to 29.0 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 Subsurface Conditions

Assessment of the geotechnical conditions included review of available topographic, geologic and soils maps for relevant information.

9.1 Area Geology

The site is located within the Kings Mountain terrane of the Piedmont Physiographic Province of South Carolina. The Piedmont Province generally consists of well-rounded hills and ridges, which are dissected by a well-developed system of draws and streams. The Piedmont Province is predominantly underlain by metamorphic rock (formed by heat, pressure and/or chemical action) and igneous rock (formed directly from molten material), which were initially formed during the Precambrian and Paleozoic eras. The volcanic and sedimentary rocks deposited in the Piedmont Province during the Precambrian eras were the host for the metamorphism and were changed to gneiss and schist. The more recent Paleozoic era had periods of igneous emplacement, with at least several episodes of regional metamorphism resulting in the majority of the rock types seen today.

The topography and relief of the Piedmont Province have developed from differential weathering of the igneous and metamorphic rock. Because of the continued chemical and physical weathering, the rocks in the Piedmont Province are now generally covered with a mantle of soil that has weathered in place from the parent bedrock. These soils have variable thicknesses and are referred to as residuum or residual soils. The residuum is typically finer grained and has higher clay content near the surface because of the advanced weathering. Similarly, the soils typically become coarser grained with increasing depth because of decreased weathering. As the degree of weathering decreases, the residual soils generally retain the overall appearance, texture, gradation and foliations of the parent rock.

The boundary between soil and rock in the Piedmont is not sharply defined. A transitional zone termed "Partially Weathered Rock" is normally found overlying the parent bedrock. Partially Weathered Rock (PWR) is defined for engineering purposes as residual material with Standard Penetration Resistances (N-values) exceeding 100 blows per foot. The transition between hard/dense residual soils and PWR occurs at irregular depths due to variations in degree of weathering.

Water is typically present in the residual soils and within fractures in the PWR or underlying bedrock in the Piedmont. On upland ridges in the Piedmont, water may or may not be present in the residual soils above the PWR and bedrock. Alluvial soils, which have been transported and deposited by water, are typically found in floodplains and are generally saturated to within a few feet of the ground surface. Fluctuations in water levels are typical in residual soils and PWR in the Piedmont, depending on variations in precipitation, evaporation and surface water runoff. Seasonal high-water levels are expected to occur during or just after the typically wetter months of the year (November through April).

The existing roadway right-of-way includes areas of previously placed fill. It has been our experience that previously placed fill soils can change abruptly in composition or consistency over short horizontal distances. Previously placed fills often may contain hidden zones of detrimental materials and unsuitable soils or may contain voids.

9.2 Soil and Rock Stratification

The generalized subsurface conditions at the site are described below. An interpreted subsurface cross-sectional profile is attached as Figure 3 in Appendix I. The discussed subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring records included in

Appendix III should be reviewed for specific information at each boring location. The depth and thickness of the subsurface strata indicated on the boring records were estimated based on the drill cuttings and the samples recovered. The transition between materials may be more gradual than indicated on the boring records. Information on actual subsurface conditions exists only at the specific boring locations and is relevant to the time the exploration was performed. Variations may occur and should be expected at locations remote from the boring. The stratification lines were used for our analytical purposes and, unless specifically stated otherwise, should not be used as the basis for design or construction cost estimates.

Surface materials encountered at the existing ground surface in our borings consisted of 4 to 6 inches of asphalt pavement. A summary of the stratification across the bridge alignment is provided in the table below.

Table 9-1 – Soil Stratification Table

Geotechnical Strata Designation	Depth Interval Range (ft.)	USCS Soil Class or Rock Type	Range of Raw SPT N-values (bpf)	Comments
Existing Roadway Embankment Fill	0 to 10½	SC and CL	4 to 9	Loose, moist, fine to coarse sands with some with some medium plasticity fines, containing trace fine rocks fragments and roots. Soft to stiff, moist, low to medium plasticity clays with few to little fine to coarse sands, containing trace fine to coarse rock fragments and trace roots.
Quaternary Alluvium	9½ to 18½	CL and CH	4 to 5	Soft to firm, moist, low to high plasticity clays with few to little fine to coarse sands, little fine to coarse gravel, containing trace roots and organics.
Metamorphic Bedrock	18½ to 29	Metatuff	N/A	Slightly to highly weathered, extremely weak to strong, very poor to excellent quality rock.

The subsurface profile presented as Figure 3 in Appendix I illustrates interpolated conditions based on the boring data in the longitudinal direction. Interpolation of subsurface conditions between borings is an approximation based on reasonable engineering judgment and actual soil conditions beyond the test hole locations may vary substantially from those shown in the profiles.

10.0 Preliminary Design and Construction Considerations

Chapter 21 of the SCDOT GDM provides that the GBLR should provide limited (preliminary) geotechnical information on a D/B project, thus permitting the contractor to bid on the project with a certain degree of knowledge and acceptable risk. The preliminary design and construction considerations submitted herein are based, in part, upon data obtained from our preliminary field exploration and laboratory testing program. Subsurface conditions across the site will vary, as will grading and construction details. Additional geotechnical exploration and analysis will be required to provide detailed analysis and recommendations for the project.

10.1 Deep Foundations

Support for the bridge end bents appears possible with driven piles, drilled piles or drilled shafts. However, support of the bridge interior bents appears limited to drilled shafts.

10.1.1 Driven Piles

Driven steel H-pile foundations are anticipated to bear on material causing refusal to the borings. Driven steel H-piles are advantageous due primarily to their relative cost and ease for pile splicing and cutting. Piles are commonly paid for on an "in-place" basis and no charge is made for the length of steel cut off. The principal disadvantage associated with steel H-piles are their relatively small tip areas, which can result in very small end bearing resistance in residual soils since formation of a soil plug cannot be counted on in all cases to help with end bearing capacity development, hence piles will need to extend to sufficient depth to bear in rock. For piles driven to practical refusal in rock, factored pile resistance will be essentially the allowable stress of the steel pile cross sectional area.

10.1.2 Drilled Piles

Due to the depth to bedrock in the borings, and required bent dimensions, drilled pile foundations may be required. Drilled piles are normally required where the depth to rock is less than 10 to 15 feet, and where lateral loading demands require the pile to be extended into rock to achieve lateral stability. The capacity of a drilled pile is determined based on whether the pile is driven or not after being placed in the borehole. Where not driven, these piles shall be designed as a drilled shaft. Drilled piles are typically steel H-piles of HP12x53 or HP14x73 sizing. The borehole diameter required for a drilled pile is equal to the diagonal dimension of the H-pile plus 6 inches to allow for placement of the pile and concrete.

10.1.3 Drilled Shafts

Drilled shaft foundations are anticipated to be socketed into the underlying bedrock to provide the required axial and lateral resistance. Drilled shafts are normally used when large loads are anticipated, where allowable deformation is small, where the losses due to scour are large, where slope instability cannot be maintained using conventional methods or where there is a limitation on water crossing work. Drilled shaft diameters should be a minimum 6 inches larger than the column above the shaft and the rock socket at the base of the shaft. Construction casing is required.

10.1.4 Driving Considerations

The following considerations are provided for the use of driven piles and drilled piles that are driven after placement within the borehole.

The contractor should take care not to overdrive or overstress the piles during driving. Prior to installing piles, a wave equation analysis should be performed to evaluate whether the Contractor's proposed driving system (i.e., hammer type and size) is capable of efficiently driving the piles to the desired depths without damaging the piles, and to establish driving criteria. Per the GDM, practical refusal is defined as 5 blows per quarter (¼) inch or 20 blows per inch. Steel pile compressive stresses during driving should not exceed 0.9 times the yield strength of the steel section during driving. Because the metatuff bedrock is anticipated to be very hard, we recommend that the piles be equipped with driving points or shoes to protect the pile from damage during driving.

Specifically, for drilled piles, initial cores run in Borings B-1 and B-2 exhibited RQDs ranging from 27 to 43 percent. Piles cannot typically be driven into rock with RQDs exceeding 10 percent. Therefore, drilled piles that are required to be installed below the refusal depths noted on the borings will likely need to be designed as drilled shafts.

10.1.5 Drilling Considerations

The bedrock elevation along the alignment varied roughly 2 feet based on Borings B-1 and B-2 but may be more variable in other unexplored locations. The bedrock encountered in in Boring B-1 was generally moderately weathered with RQD values from 43 percent in the initial core run to 91 percent at depth. The bedrock encountered in boring B-2 was generally lower quality and was moderately weathered with some highly weathered zones and exhibited RQD values ranging from 14 to 27 percent. Therefore, difficult drilling and deeper penetration into the bedrock will likely be required to achieve proper bearing and lateral stability for the bridge foundations.

We anticipate drilled piles/shafts will be installed using the casing method of construction. Steel casing should be advanced and seated into the top of rock to provide an effective seal against overburden material falling into the shaft. Water may still enter the shaft through seams in the rock. If the wet method is used, either mineral slurry or potable water may be used during excavation and construction of the shaft. Ground water control is important during construction of drilled shafts. The observed ground water along the bridge alignment ranged from roughly 13½ to 15½ feet below the existing ground surface. Therefore, ground water control is important during construction of drilled piles/shafts

The overburden soil materials consisting of existing fill and alluvial soils can typically be excavated with a conventional earth auger. Low quality rock will necessitate use of a rock auger advanced by a large foundation drilling rig. Contractor should be required to provide augering equipment with adequate torque and power to install drilled piles/shafts through low quality rock using augers with hardened tungsten carbide bits. The speed of excavation depends upon the type of material being penetrated, size of foundation element and size of the drilling rig. The rate of penetration through these materials could be very slow and could require rotary percussion drills or core barrels to penetrate to relatively continuous bedrock encountered in the borings. Specialized drilling equipment may be required due to the observed rock strengths, depending on required penetration depths. This may include, but not be limited to, rock augers, core barrels, or rotary percussion drilling equipment.

Laboratory uniaxial strength test results performed on select cores from the southwest end bent boring indicate compressive strengths as summarized in the table below:

Table 10-1 – Rock Core Compressive Strength Summary

Boring No.	Core Run	Core Interval (ft)	Sample No.	Sample Depth (ft)	Compressive Strength (psi)
B-1	RC-1	18.5-23.5	RS-1	20.5-20.9	10,385
	RC-2	23.5-26.8	RS-2	23.5-23.9	9,008

Due to the highly jointed nature of the samples retrieved, samples of sufficient length for tested were limited. Compressive strengths obtained in the laboratory represent strong metamorphic rock which will pose substantial resistance to heavy duty drilling equipment. Diamond core barrels will be required to advance through hard rocks and contractor should be prepared to expend substantial time to advance the sockets in these materials.

10.1.6 Resistance Criteria

Axial resistance will likely govern the geotechnical foundation design and be developed in end bearing on the underlying bedrock. Due to the presence of soft clayey alluvial soils directly above bedrock, development of lateral resistance of the pile or drilled pile/shaft foundations may require penetration into bedrock.

10.2 Corrosion Potential Results

Corrosion series testing was performed to determine the potential for material deterioration of the proposed foundations. One composite sample was taken from selected recovered samples of Boring B-2 to perform pH, resistivity, sulfate, and chloride geochemical tests. This boring is representative of the northeast end bent. The sample was selected based on the proximity to the estimated soil/pile/ground water interface elevation.

Table 10-2 – Summary of Corrosion Series Testing

Sample	Depth (feet)	Minimum Resistivity (ohm-cm)	Sulfate Content (ppm)	Chloride Content (ppm)	pH
B-2 (SS-5)	8.5-10.0	2,345	35.6	109.9	6.4

The complete laboratory testing results of the corrosion series testing are provided in Appendix V and are summarized in Table 3 in Appendix II.

Section 7.19 of the GDM provides guidance on determining corrosion potential or aggressiveness. The following soil conditions from GDM Table 7-34 suggest aggressive conditions:

- pH less than 5.5;

- Chloride concentrations greater than 500 ppm (mg/kg);
- Sulfate concentrations greater than 1,000 ppm (mg/kg);
- Resistivity less than 2,000 ohm-cm;

Therefore, the site appears to be non-aggressive for foundations. However, interpretation of the data and corrosion protection of structural components shall be reviewed and provided by the structural engineer during the design phase of the project.

11.0 Closing

This base line 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-11-265

JOB NAME:	S-11-265 Bridge over Manning Creek		FIGURE NO.
LOCATION:	S-11-265 (Manning Road)		1
CITY, STATE:	Smyrna, South Carolina		
JOB NO.:	1361-20-048		
SCALE: NTS		CHECKED BY: MFC	
DATE: 3/19/2021		DRAWN BY: AKS	

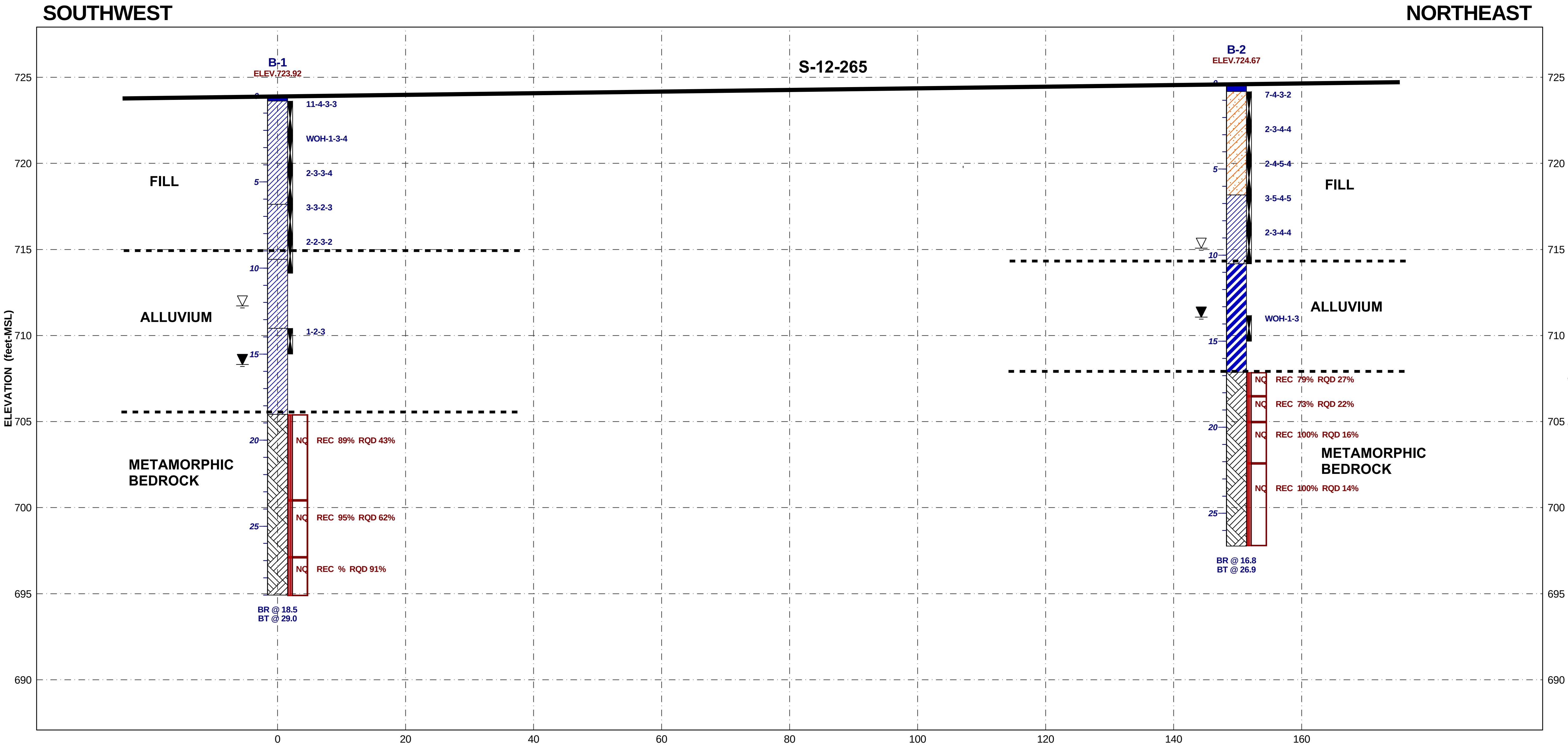
Legend:

Approximate Boring Location

SOURCE: Google Earth

BORING LOCATION PLAN: S-11-265

JOB NAME:	S-11-265 Bridge over Manning Creek		FIGURE NO.
LOCATION:	S-11-265 (Manning Road)		2
CITY, STATE:	Smyrna, South Carolina		
JOB NO.:	1361-20-048		
SCALE: NTS		CHECKED BY: MFC	
DATE: 3/19/2021		DRAWN BY: JPL	



SOIL TEST BORINGS

B-3 Boring Number
123.0 Elevation at GS

Water Level at Time of Boring

Water Level after 24 Hours

Hole Caved

Water Loss/Inflow

11-16-10 Standard Penetration Test (blows per foot).

12in Undisturbed Sample Recovery in Inches

NX Core Barrel Size
REC 80% Recovery in Percent
RQD 56% Rock Quality Designation

BT Boring Termination Depth
BR Boring Refusal

LEGEND OF MATERIAL GRAPHICS FOR SOIL TEST BORINGS

- Asphalt
- CH, High Plasticity Clay
- CL, Low Plasticity Clay
- Bedrock
- SC, Clayey Sand

The depicted stratigraphy is shown for illustrative purposes only and is not warranted. Separations between different strata may be gradual and likely vary considerably from those shown. Profiles between nearby borings have been estimated using reasonable engineering care and judgment. The actual subsurface conditions will vary between boring locations.

SUBSURFACE PROFILE

PROJECT: S-11-265 BRO Manning Creek

SCDOT PROJECT ID: P038058

LOCATION: Cherokee County, SC

JOB NO: 1361-20-048

DATE: 2/22/21

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-11-265	B-1	X						1177547.4	1867516.9	35.06880	-81.44268	524.9	Existing
S-11-265	B-2	X						1177596.1	1867592.7	35.06893	-81.44242	524.7	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-11-265	B-1	SS-1/SS-2	0.3-4.3	17.7	38	19	19	98.9	93.8	76.7	-	A-6	CL	FILL
	B-1	SS-4	6.3-8.3	21.1	41	23	18	-	-	88.6	-	-	CL	FILL
	B-1	SS-5	8.3-10.3	22.4	39	23	16	98.0	96.0	90.0	-	A-6	CL	ALLUVIUM
	B-1	SS-6	13.5-15.0	22.8	28	19	9	98.0	94.0	85.0	-	A-4	CL	ALLUVIUM
	B-2	SS-1	0.5-2.5	12.3	47	20	27	89.3	79.7	50.0	-	A-7-6	SC	FILL
	B-2	SS-4	6.5-8.5	18.9	38	17	21	-	-	86.1	-	-	CL	FILL

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)	Mininmum Resistivity (Ohm-cm)	Sulfates		Chlorides		pH
					(mg/kg)	(wt%)	(mg/kg)	(wt%)	
SS-11-265 B-2	8.5 - 10.0	SS-5	2,881	2,345	35.6	0.0036	109.9	0.0110	6.4

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-11-265 B-1	RC-1	18.5	23.5	89	43	20.5	20.9	168	10,385	23	44
	RC-2	23.5	26.8	95	62	23.5	23.9	168	9,008	28	48-52
	RC-3	26.8	29.0	100	91	-	-	-	-	-	55-58
S-11-265 B-2	RC-1	16.8	18.2	79	27	-	-	-	-	-	42
	RC-2	18.2	19.7	73	22	-	-	-	-	-	35
	RC-3	19.7	22.1	100	15	-	-	-	-	-	30-32
	RC-4	22.1	26.9	100	14	-	-	-	-	-	30

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	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	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%.

SCDOT 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	Sieve size
Very coarse grained	> 4.75	Grain sizes greater than popcorn kernels
Coarse grained	2.00 – 4.75	Individual grains easy to distinguish by eye
Medium grained	0.425 – 2.00	Individual grains distinguished by eye
Fine grained	0.075 – 0.425	Individual grains distinguished with difficulty
Very Fine grained	< 0.075	Individual grains cannot be distinguished by unaided eye

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

o **Weathering / Alteration**

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

Description	Recognition
Residual Soil	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
Completely Weathered / Altered	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
Highly Weathered / Altered	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
Moderately Weathered / Altered	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
Slightly Weathered / Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh	Rock shows no discoloration, loss of strength, or other effect of weathering / alteration

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

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)

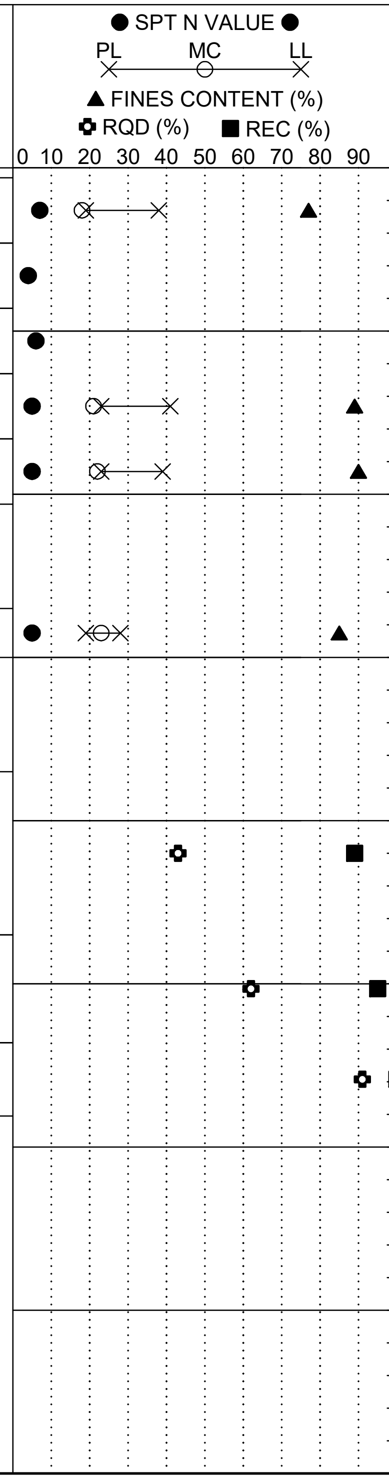
Figure 6-17, SCDOT Soil Test Log Descriptors – Rock (con't)

SCDOT Soil Test Log

Project ID:	P038058	**County:**	Cherokee	**Boring No.:**	B-1
Site Description:	S-11-265 BRO Manning Creek (S&ME Project 1361-20-048)			**Route:**	S-11-265
Eng./Geo.: NB	**Boring Location:** 7.5' SW of SWEB	**Offset:** 6' S of CL		**Alignment:**	Existing
Elev.: 524.9 ft	**Latitude:** 35.0688	**Longitude:** -81.44268		**Date Started:**	10/8/2020
Total Depth: 29 ft	**Soil Depth:** 18.5 ft	**Core Depth:** 10.5 ft		**Date Completed:**	10/8/2020
Bore Hole Diameter (in): 3 7/8	**Sampler Configuration**	**Liner Required:** Y (N)		**Liner Used:**	Y (N)
Drill Machine: CME 55	**Drill Method:** RW / DC / RC	**Hammer Type:** Automatic		**Energy Ratio:**	85.7%
Core Size: NQ	**Driller:** T. Miller	**Groundwater:**	**TOB** 12.2 ft	**24HR**	15.6 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION
	0.0	
	0.3	**SURFACE MATERIALS** - 4 inches of ASPHALT.
519.9		**FILL** - firm to soft, moist, reddish yellow, Lean CLAY with Sand (CL) (A-6), 7.5YR 6/8, mostly medium plasticity fines, little fine to medium sands, trace fine to coarse rock fragments. LL=38, PL= 19, PI=19, NMC=17.7, %#200 = 76.7
	6.3	Soft, moist, reddish yellow, Lean CLAY (CL), 7.5YR 6/8, mostly low to medium plasticity fines, few fine to medium sand, trace fine to coarse rock fragments. LL=41, PL= 23, PI=18, NMC=21.1, %#200=88.6 @ 8.3 feet - (A-6), LL=39, PL= 23, PI=16, NMC=22.4, %#200=90.0
514.9 / 509.9	9.5 / 13.5	**ALLUVIUM** - firm, slightly moist, strong brown, Lean CLAY (CL), 7.5YR 5/8, mostly medium plasticity fines, few fine sands, trace roots.
504.9	18.5	Firm, slightly moist to moist, gray, Lean CLAY with Sand (CL) (A-4), [7.5YR 5/1], mostly low plasticity fines, little fine sands. LL=28 , PL= 19, PI=9 , NMC=22.8 , %#200 = 85.0 SPT Refusal at 18.5 feet. Install NW Casing to 18.5 feet for NQ wireline coring.
499.9 / 494.9 / 489.9	29.0	**METAMORPHIC BEDROCK - METATUFF** - bluish gray (5B 5/1), very fine to medium grained, poorly foliated, quartz feldspar, slightly to moderately weathered, strong, H-MH, J (0-60° dip, VC, partly open to very wide, Ir-Pl, S-SR, No), high-angle (~85°) fractures near 18.5, 25, and 26.5 ft, few healed joints RC-1: %REC=89, RQD=43, GSI=44, RMR=23, 9.4 min/ft, qu=10,385 psi RC-2: %REC=95, RQD=62, GSI=48-52, RMR=28, 4.5 min/ft, qu=9,008 psi RC-3: %REC=100, RQD=91, GSI=55-58, 4.3 min/ft
		Boring Terminated at 29 feet.

Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
0.3	SS-1	11	4	3	3	7
2.3	SS-2	WOH	1	3	4	4
4.3	SS-3	2	3	3	4	6
6.3	SS-4	3	3	2	3	5
8.3	SS-5	2	2	3	2	5
13.5	SS-6	1	2	3		5
18.5	RC-1					
23.5	RC-2					
26.8	RC-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-11-265 Over Manning Creek
Project Number: 1361-20-048
Driller (Company/Name): S&ME/Ted Miller
Logged By: NB
Date: 10/8/2021

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

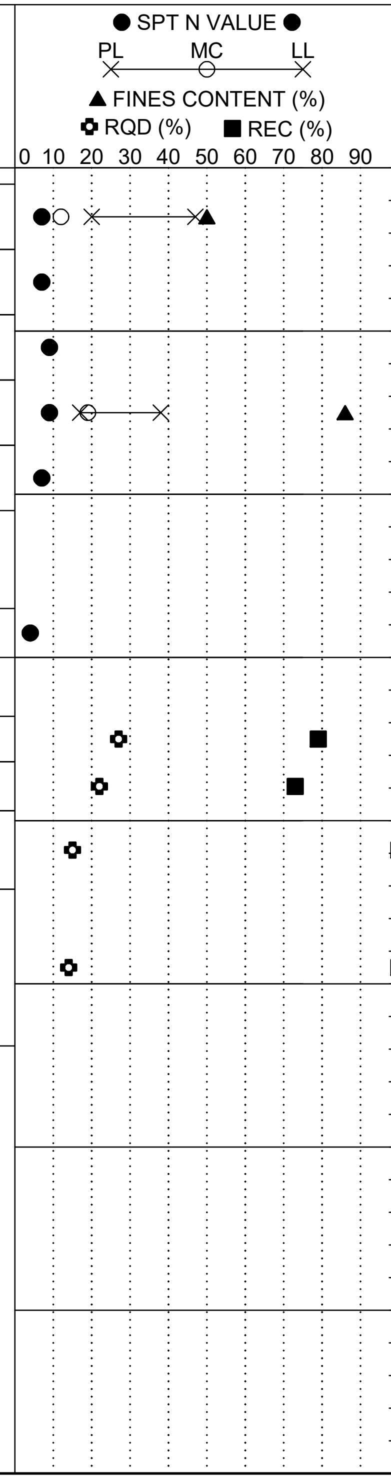
Depth (ft)	Disc. No.	Disc. Type	Dip Angle (deg)	Disc. Width (mm)	Infill Amount	Infill Type	Surface Shape	Surface Roughness	Notes
18.5	1	J	0 to 60	W	No	N/A	Pl	S-SR	multiple joints between 18.5 and 26.5
25	2	J	85	W	H	N/A	Pl	SR	ranging from 0 to 85 degree dip, slightly rough
26.5	3	J	85	W	H	N/A	Pl	SR	few healed joints

SCDOT Soil Test Log

Project ID:	P038058		**County:**	Cherokee		**Boring No.:**	B-2
Site Description:	S-11-265 BRO Manning Creek (S&ME Project 1361-20-048)					**Route:**	S-11-265
Eng./Geo.:	NB	**Boring Location:**	7.5' NE of NEEB	**Offset:**	6' S of CL	**Alignment:**	Existing
Elev.:	524.7 ft	**Latitude:**	35.06893	**Longitude:**	-81.44242	**Date Started:**	10/7/2020
Total Depth:	26.9 ft	**Soil Depth:**	16.8 ft	**Core Depth:**	10.1 ft	**Date Completed:**	10/8/2020
Bore Hole Diameter (in):	3 7/8	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 55	**Drill Method:**	RW / DC / RC	**Hammer Type:**	Automatic	**Energy Ratio:**	85.7%
Core Size:	NQ	**Driller:**	T. Miller	**Groundwater:**	**TOB** 9.6 ft	**24HR**	13.6 ft

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION
524.7	0.0	
	0.5	**SURFACE MATERIALS** - 6 inches of ASPHALT.
		FILL - loose, slightly moist, reddish-brown, Clayey fine to coarse SAND (SC), (A-7-6), 7.5YR 6/8, some medium plasticity fines, trace roots, trace fine rock fragments. LL=47, PL= 20, PI=27, NMC=12.3, %#200=50.0
519.7	6.5	Stiff, slightly moist, reddish-brown, Lean CLAY (CL), 7.5YR 6/8, mostly medium plasticity fines, little fine to coarse sands, trace roots, trace fine rock fragments. LL=38 , PL= 17, PI=21, NMC=18.9, %#200=86.1
514.7	10.5	**ALLUVIUM** - soft, slightly moist to moist, gray, Fat CLAY (CH), 7.5YR 5/1, mostly high plasticity fines, little fine to coarse gravel, trace organics.
509.7	16.8	SPT Refusal at 16.8 feet. Install NW Casing to 16.8 feet for NQ wireline coring.
504.7		**METAMORPHIC BEDROCK - METATUFF** - bluish gray (5B 6/1), light olive brown (2.5Y 5/4), very fine to medium grained, poorly foliated, quartz feldspar, moderately weathered with highly weathered zones, extremely weak to strong, MH, J (0-90° dip, VC, open to very wide, Ir-St-Pl, S-SR, No) RC-1: %REC=79, RQD=27, GSI=42, 4.9 min/ft RC-2: %REC=73, RQD=22, GSI=35, 3.5 min/ft RC-3: %REC=100, RQD=15, GSI=30-32, 3.6 min/ft RC-4: %REC=100, RQD=14, GSI=30, 9.4 min/ft
499.7	26.9	Boring Terminated at 26.9 feet.
494.7		
489.7		

Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	4th 6"	N Value
0.5	SS-1	7	4	3	2	7
2.5	SS-2	2	3	4	4	7
4.5	SS-3	2	4	5	4	9
6.5	SS-4	3	5	4	5	9
8.5	SS-5	2	3	4	4	7
13.5	SS-6	WOH	1	3		4
16.8	RC-1					
18.2	RC-2					
19.7	RC-3					
22.1	RC-4					



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-11-265 Over Manning Creek
Project Number: 1361-20-048
Driller (Company/Name): S&ME/Ted Miller
Logged By: NB
Date: 10/8/2021

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
16.8-26.9	1	J	0-90	MW-W	No	N/A	Pl	S-SR	highly jointed rock between 16.8 and 26.9. Dip angles ranging from 0 to 90 degrees, slightly rough, moderately wide to wide.

Rock Core Photo Log

Boring: B-1	Box: 1 of 2	Date: 10/8/2020	Driller: T. Miller	Geologist: J. Gathro
Run: RC-1	Length: 5.0	Depth Int: 18.5-23.5	Recovery: 89%	RQD: 43%
Run: RC-2	Length: 5.0	Depth Int: 23.5-26.8	Recovery: 95%	RQD: 62%

Boring: B-1	Box: 2 of 2	Date: 10/8/2020	Driller: T. Miller	Geologist: J. Gathro
Run: RC-3	Length: 2.2	Depth Int: 26.8-29.0	Recovery: 100%	RQD: 91%

Rock Core Photo Log

Boring: B-2	Box: 1 of 1	Date: 10/8/2020	Driller: T. Miller	Geologist: J. Gathro
Run: RC-1	Length: 1.4	Depth Int: 16.8-18.2	Recovery: 79%	RQD: 27%
Run: RC-2	Length: 1.5	Depth Int: 18.2-19.7	Recovery: 73%	RQD: 22%
Run: RC-3	Length: 2.4	Depth Int: 19.7-22.1	Recovery: 100%	RQD: 15%
Run: RC-4	Length: 4.8	Depth Int: 22.1-26.9	Recovery: 100%	RQD: 14%

16.8' →

← 26.9'

Drill Rig Photo Log

Bridge: S-11-265	Boring: B-1	Date: 10/8/2020	Driller: T. Miller	Geologist: N. Binder

Drill Rig Photo Log

Bridge: S-11-265	Boring: B-2	Date: 10/7/2020	Driller: T. Miller	Geologist: N. Binder

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

INDEX PROPERTIES VERSUS DEPTH

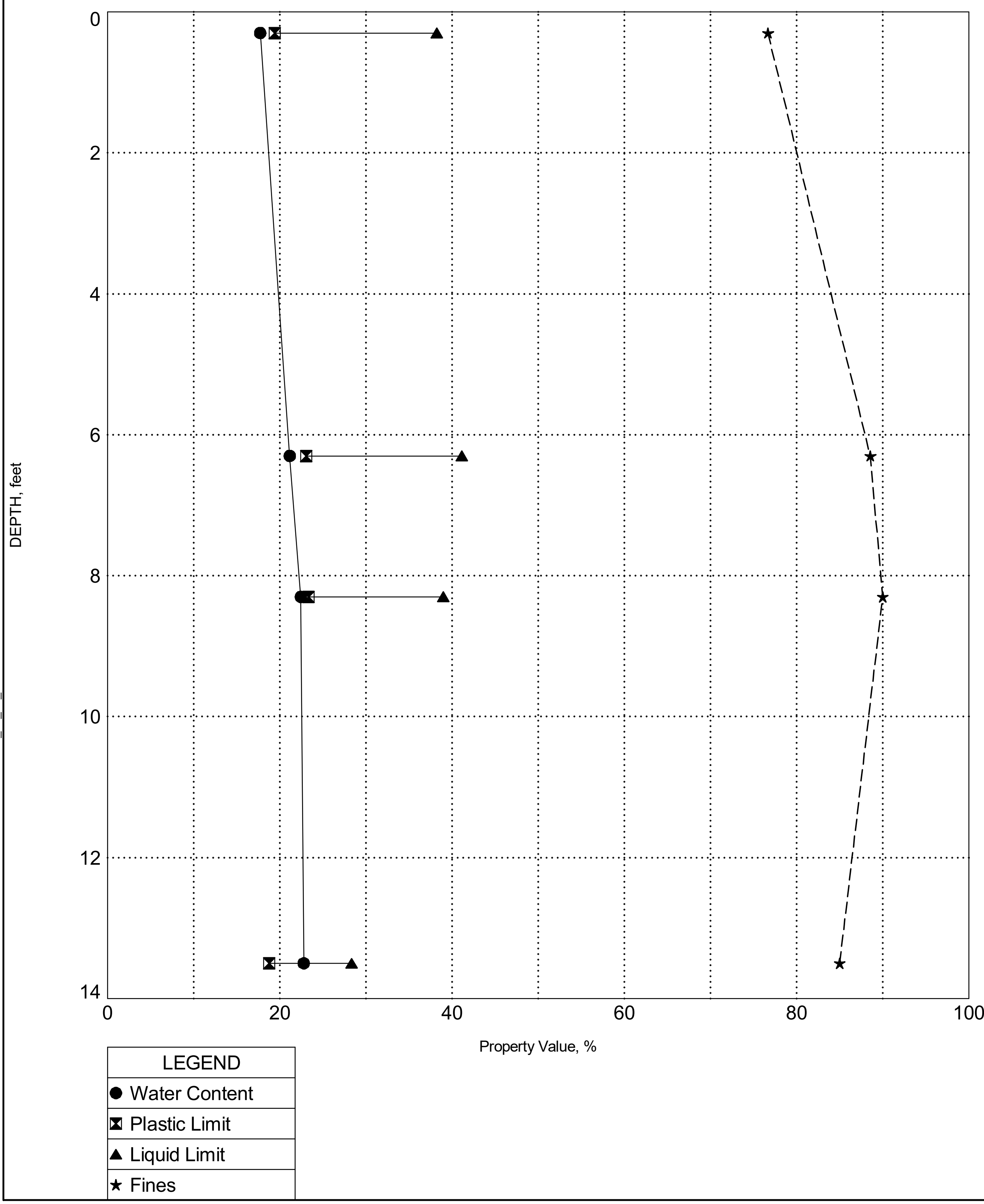
PROJECT ID P038058

PROJECT NAME S-11-265 BRO Manning Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Cherokee

BORING B-1

SURFACE ELEVATION: 524.9



INDEX PROPERTIES VERSUS DEPTH

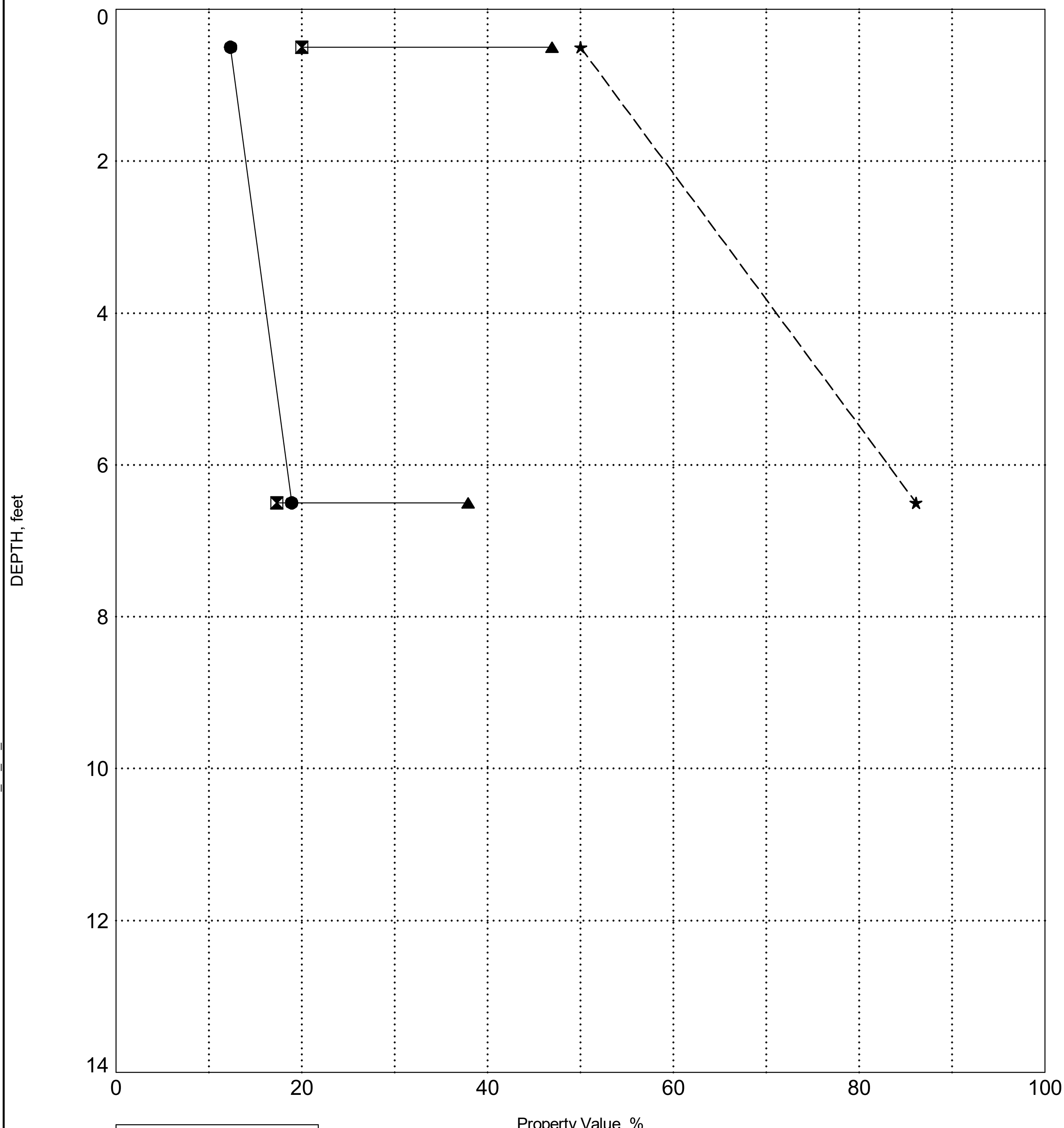
PROJECT ID P038058

PROJECT NAME S-11-265 BRO Manning Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Cherokee

BORING B-2

SURFACE ELEVATION: 524.7



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

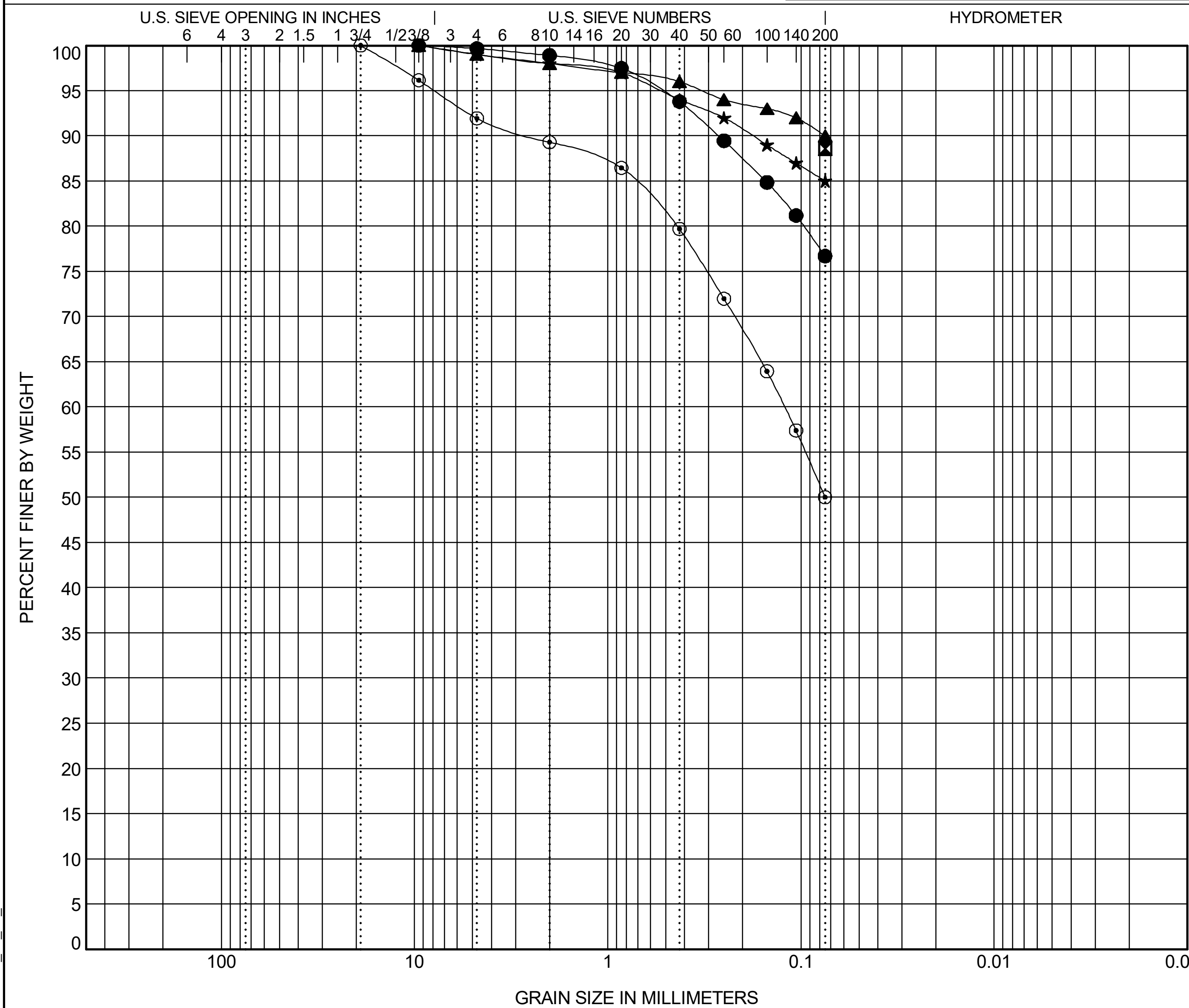
INDEX PROPS 1361-20-048 S-11-265 BORING LOGS.GPJ SCDOT DATA TEMPLATE_01_30_2015.GDT 2/8/21

GRAIN SIZE DISTRIBUTION

PROJECT ID P038058

PROJECT NAME S-11-265 BRO Manning Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Cherokee



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**0.3**	**lean CLAY with SAND (CL)**	**38**	**19**	**19**		
⊠	**B-1**	**6.3**	**lean CLAY (CL)**	**41**	**23**	**18**		
▲	**B-1**	**8.3**	**lean CLAY (CL)**	**39**	**23**	**16**		
★	**B-1**	**13.5**	**lean CLAY with sand (CL)**	**28**	**19**	**9**		
⊙	**B-2**	**0.5**	**clayey SAND (SC)**	**47**	**20**	**27**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**0.3**	**9.5**				**0.3**	**23.0**	**76.7**	
⊠	**B-1**	**6.3**	**0.075**						**88.6**	
▲	**B-1**	**8.3**	**9.5**				**1.0**	**9.0**	**90.0**	
★	**B-1**	**13.5**	**9.5**				**1.0**	**14.0**	**85.0**	
⊙	**B-2**	**0.5**	**19**	**0.122**			**8.1**	**41.9**	**50.0**	

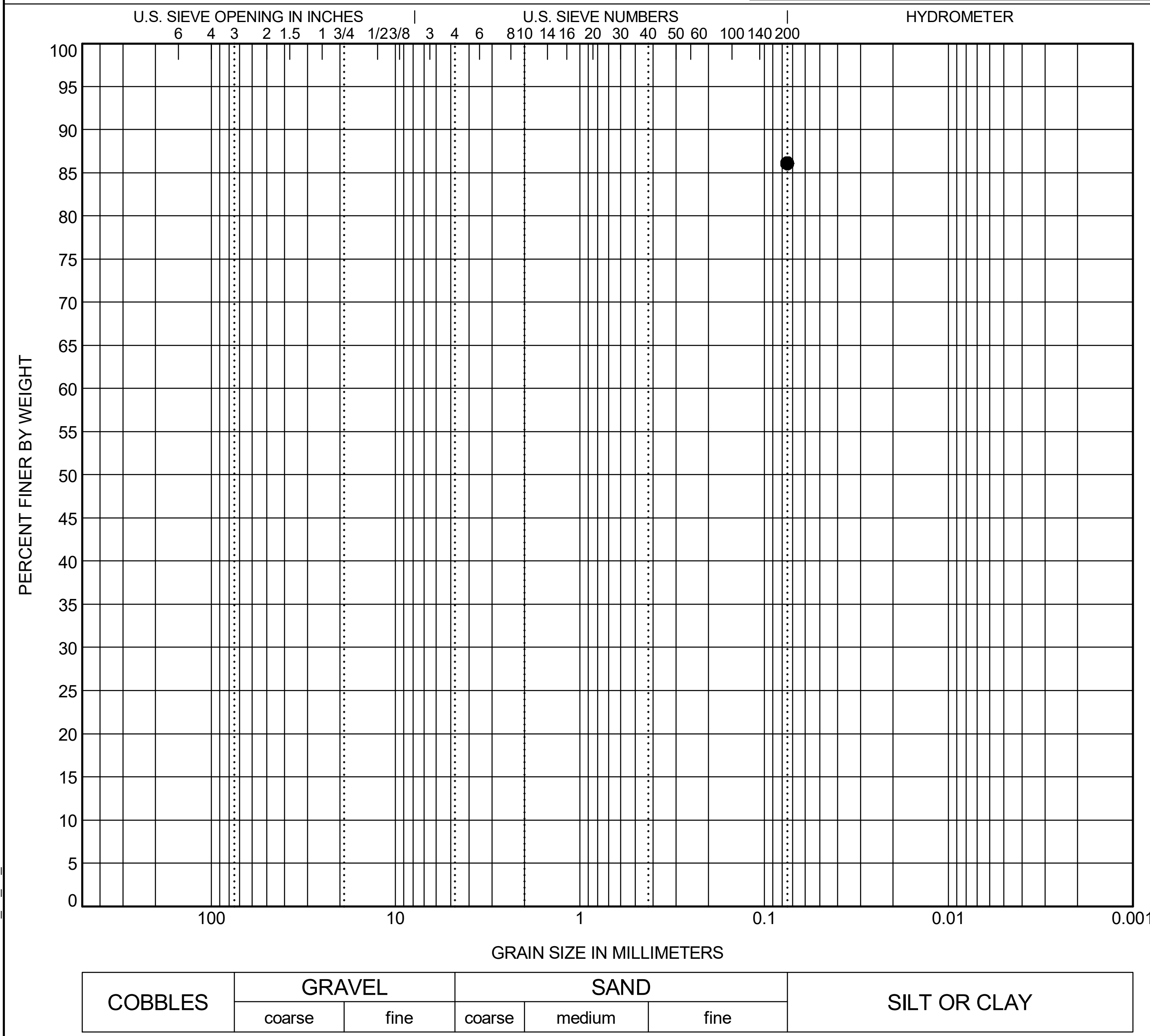
GRAIN SIZE DISTRIBUTION

SCDOT

PROJECT ID P038058

PROJECT NAME S-11-265 BRO Manning Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Cherokee



	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-2**	**6.5**	**lean CLAY (CL)**	**38**	**17**	**21**		

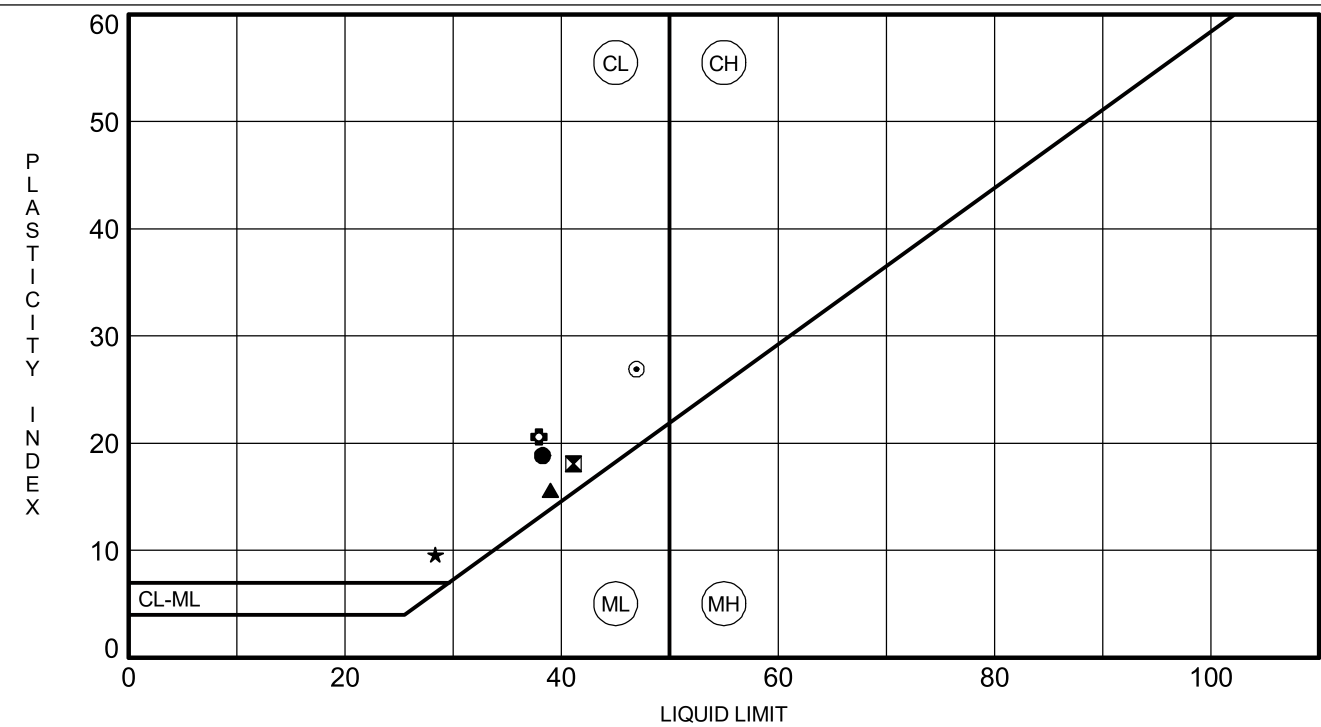
	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-2**	**6.5**	**0.075**						**86.1**	

ATTERBERG LIMITS' RESULTS

SCDOT

PROJECT ID P038058 **PROJECT NAME** S-11-265 BRO Manning Creek (S&ME Project 1361-20-048)

PROJECT COUNTY Cherokee



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**B-1**	**0.3**	**38**	**19**	**19**	**77**	**lean CLAY with SAND (CL)**
⧗	**B-1**	**6.3**	**41**	**23**	**18**	**89**	**lean CLAY (CL)**
▲	**B-1**	**8.3**	**39**	**23**	**16**	**90**	**lean CLAY (CL)**
★	**B-1**	**13.5**	**28**	**19**	**9**	**85**	**lean CLAY with sand (CL)**
⊙	**B-2**	**0.5**	**47**	**20**	**27**	**50**	**clayey SAND (SC)**
✿	**B-2**	**6.5**	**38**	**17**	**21**	**86**	**lean CLAY (CL)**

Appendix V – Laboratory Test Data Sheets – Corrosion Series

Results Only Soil Testing for SCDOTBridge 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

REGISTERED PROFESSIONAL ENGINEER
EDUARDO HERNANDEZ
No. M37102
MECHANICAL
STATE OF CALIFORNIA

Soil Analysis Lab Results

Client: S&ME, Inc.
Job Name: SCDOTBridge 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

Project X
Corrosion Engineering
Corrosion Control - Soil, Water, and Metallurgy Lab

Lab Request Sheet Chain of Custody
Phone: (213) 928-7213 · Fax (951) 226-1720 · www.projectxcorrosion.com
Ship Samples To: 29990 Technology Dr, Suite 13, Murrieta, CA 92563

Project X Job Number

IMPORTANT: Please complete Project and Sample Identification Data as you would like it to appear in report & include this form with samples.

Company Name:	S&ME, Inc.	**Contact Name:**	Matt Cooke	**Phone No:**	803-561-9024
Mailing Address:	134 Suber Road, Columbia, SC 29210	**Contact Email:**	mcooke@smeinc.com		
Accounting Contact:	Kathryn Friedrichs	**Invoice Email:**	AP@smeinc.com		
Client Project No:	1361-20-48	**Project Name:**	SCDOT Bridge Package 2021-01 DB Prep		

P.O. #: 1361-20-48	3-5 Day Standard	3 Day Guarantee 50% mark-up	24 Hr RUSH 100% mark-up
(Business Days) Turn Around Time:	✔		

Results By: ☐ Phone ☐ Fax ☑ Email

Date & Received by :

Special Instructions:
Use AASHTO Methods for resistivity, pH, sulfate, and chloride

ANALYSIS REQUESTED (Please circle)

Soil Resistivity	Geo Quad / Full Corrosion Series	Caltrans CTM643; AASHTO T2888; ASTM G187
pH	Geo Quad / Full Corrosion Series	Caltrans CTM643; AASHTO T 289; ASTM G 51
Sulfate	Geo Quad / Full Corrosion Series	Caltrans CTM417; AASHTO T 290; ASTM D4327
Chloride	Geo Quad / Full Corrosion Series	Caltrans CTM422; AASHTO T 291; ASTM D4327
Redox Potential	Full Corrosion Series	SM 2580B; ASTM G200
Sulfide	Full Corrosion Series	SM 4500-S2
Ammonia	Full Corrosion Series	SM 4500-NH3; ASTM D6919
Nitrate	Full Corrosion Series	SM 4500-NO3; ASTM D4327
Flouride	Full Corrosion Series	ASTM D4327
Phosphate	Full Corrosion Series	ASTM D4327
Lithium	Full Corrosion Series	ASTM D6919
Sodium	Full Corrosion Series	ASTM D6919
Potassium	Full Corrosion Series	ASTM D6919
Magnesium	Full Corrosion Series	ASTM D6919
Calcium	Full Corrosion Series	ASTM D6919
BiCarbonate	Full Corrosion Series	SM 2320B
Full Corrosion Series		
Soil Corrosivity Evaluation Report	Reports	*Req: Min. 3 Samples, site map, and groundwater info
Water Corrosivity Mini Report	Reports	
Moisture Content		ASTM D2216
Total Alkalinity		SM 2520B
Thermal Resistivity		
Metallurgical Analysis		
Langelier Index		
Puckorius Index		
XRF Elemental Analysis		
Water Hardness		

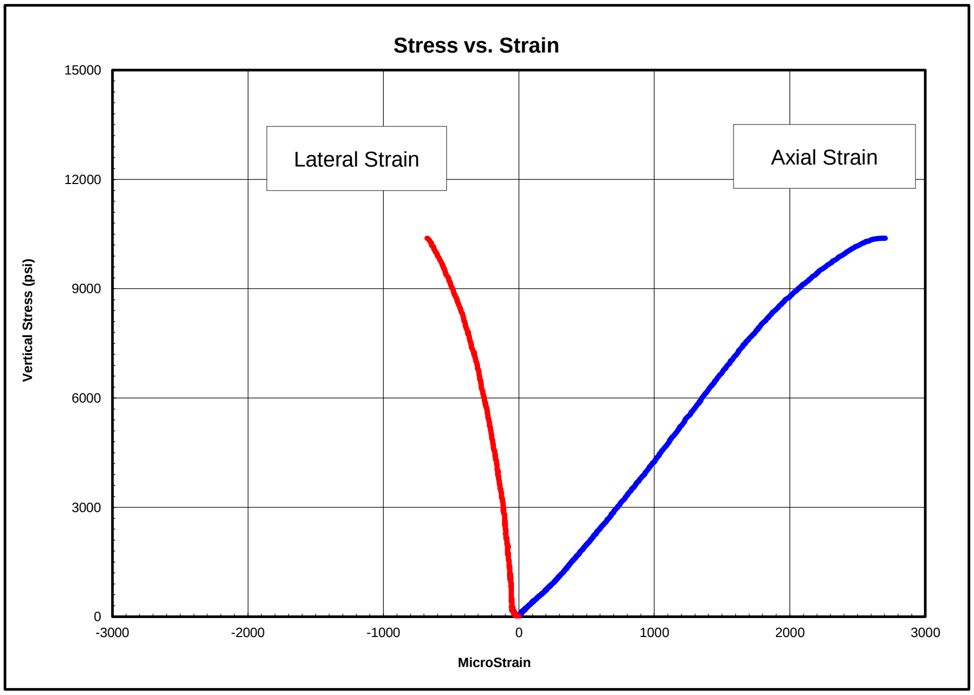
Default Method

#	SAMPLE ID - BORE #	DESCRIPTION	DEPTH (ft)	DATE COLLECTED	Soil Resistivity	pH	Sulfate	Chloride	Redox Potential	Sulfide	Ammonia	Nitrate	Flouride	Phosphate	Lithium	Sodium	Potassium	Magnesium	Calcium	BiCarbonate	Full Corrosion Series	Soil Corrosivity Evaluation Report	Water Corrosivity Mini Report	Moisture Content	Total Alkalinity	Thermal Resistivity	Metallurgical Analysis	Langelier Index	Puckorius Index	XRF Elemental Analysis	Water Hardness
1	SS-7 - B-2	S-11-97 Bridge	18.5-20.0	10/6/20	X	X	X	X																							
2	SS-6/SS-7 - B-2	S-11-119 Bridge	8.2 - 14.4	10/22/20	X	X	X	X																							
3	SS-5 - B-2	S-11-265 Bridge	8.5 - 10.0	10/7/20	X	X	X	X																							
4	SS-4 - B-1	S-12-58 Bridge	6.0-8.0	10/8/20	X	X	X	X																							
5	SS-4/SS-4 - B-2	S-12-300 (2310) Bridge	6.0-10.0	10/16/20	X	X	X	X																							
6	SS-6 - B-1	S-12-300 (2490) Bridge	13.5-15.0	10/14/20	X	X	X	X																							
7	SS-7/SS-8 - B-2	S-20-214 Bridge	18.5-25.0	10/23/20	X	X	X	X																							
8	SS-6 - B-1	S-29-97 Bridge	13.4-14.9	10/6/20	X	X	X	X																							
9	SS-4/SS-5 - B-2	S-44-87 Bridge	7.0-11.0	10/19/20	X	X	X	X																							
10																															
11																															
12																															
13																															
14																															
15																															

Appendix VI – Laboratory Test Data Sheets – Rock Cores

Client:	S&ME, Inc.
Project Name:	SCDOT Bridge Package 2021-1
Project Location:	South Carolina
GTX #:	313047
Test Date:	1/18/2021
Tested By:	cmh
Checked By:	jsc
Boring ID:	S-11-265, B-1
Sample ID:	RS-1
Depth, ft:	20.5-20.9
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 10,385 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1000-3800	4,460,000	0.13
3800-6600	4,890,000	0.25
6600-9300	4,010,000	0.35

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	S&ME, Inc.	Test Date:	1/13/2021
Project Name:	SCDOT Bridge Package 2021-1	Tested By:	cmh
Project Location:	South Carolina	Checked By:	smd
GTX #:	313047		
Boring ID:	S-11-265, B-1		
Sample ID:	RS-1		
Depth:	20.5-20.9 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.80	4.80	4.80		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	661.36				
Bulk Density, lb/ft^3	168			**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.4			**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

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

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00020	0.00010	0.00010	0.00020	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00020	-0.00030	-0.00040

Difference between max and min readings, in:

0° = 0.00020 90° = 0.00060

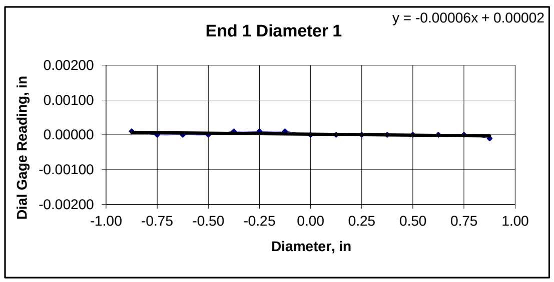
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00020	-0.00050

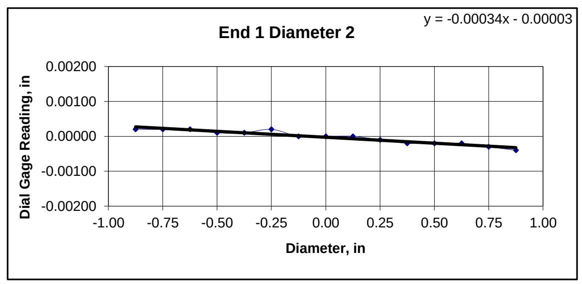
Difference between max and min readings, in:

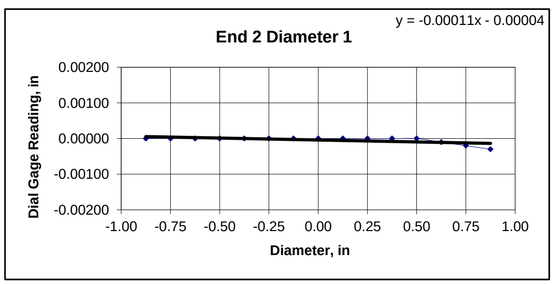
0° = 0.0003 90° = 0.0006

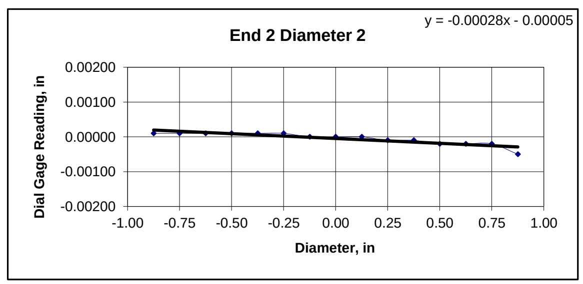
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00030

Flatness Tolerance Met? YES









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00006
Angle of Best Fit Line:	0.00327

End 2:

Slope of Best Fit Line	0.00011
Angle of Best Fit Line:	0.00622

Maximum Angular Difference: 0.00295

Parallelism Tolerance Met? YES

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00034
Angle of Best Fit Line:	0.01948

End 2:

Slope of Best Fit Line	0.00028
Angle of Best Fit Line:	0.01588

Maximum Angular Difference: 0.00360

Parallelism Tolerance Met? YES

Spherically Seated

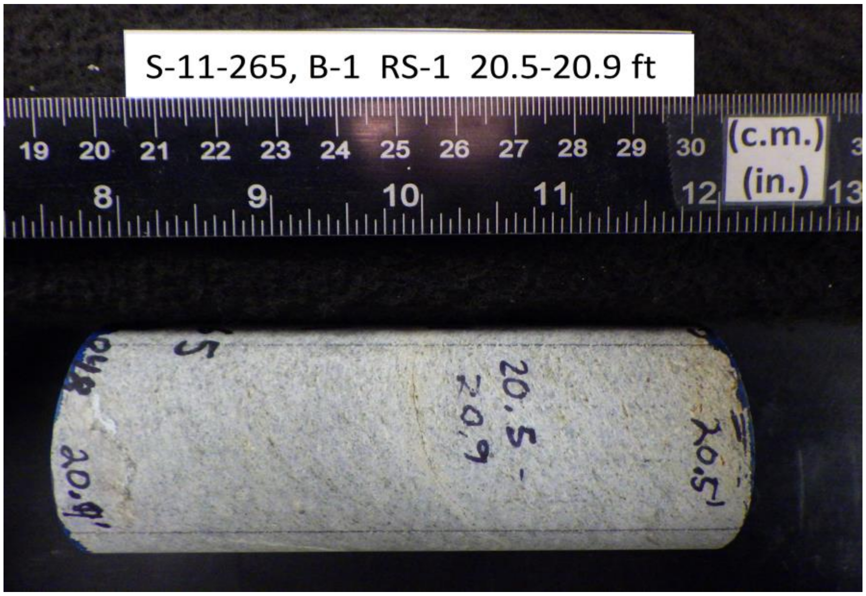
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	1.990	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00060	1.990	0.00030	0.017	YES
END 2					
Diameter 1, in	0.00030	1.990	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00060	1.990	0.00030	0.017	YES

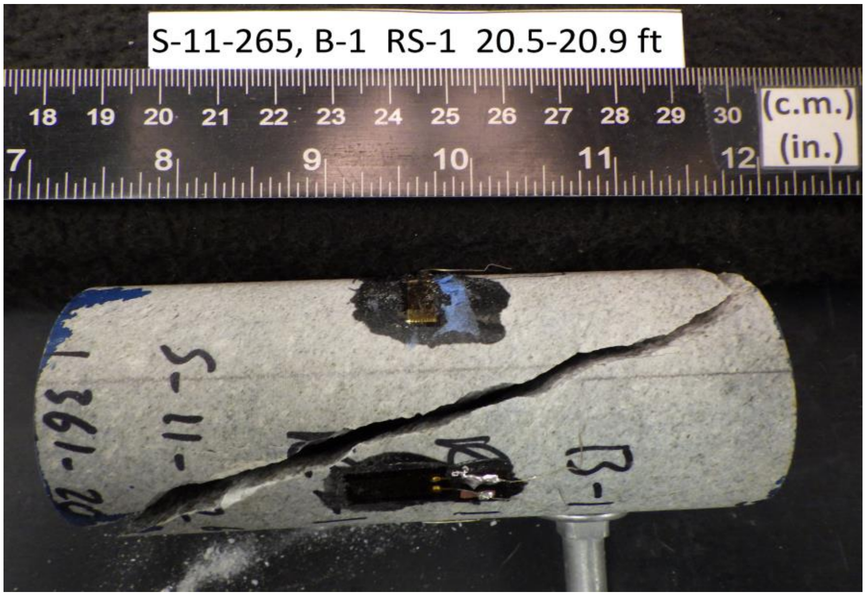
Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? YES

Client:	S&ME, Inc.
Project Name:	SCDOT Bridge Package 2021-1
Project Location:	South Carolina
GTX #:	313047
Test Date:	1/18/2021
Tested By:	cmh
Checked By:	smd
Boring ID:	S-11-265, B-1
Sample ID:	RS-1
Depth, ft:	20.5-20.9



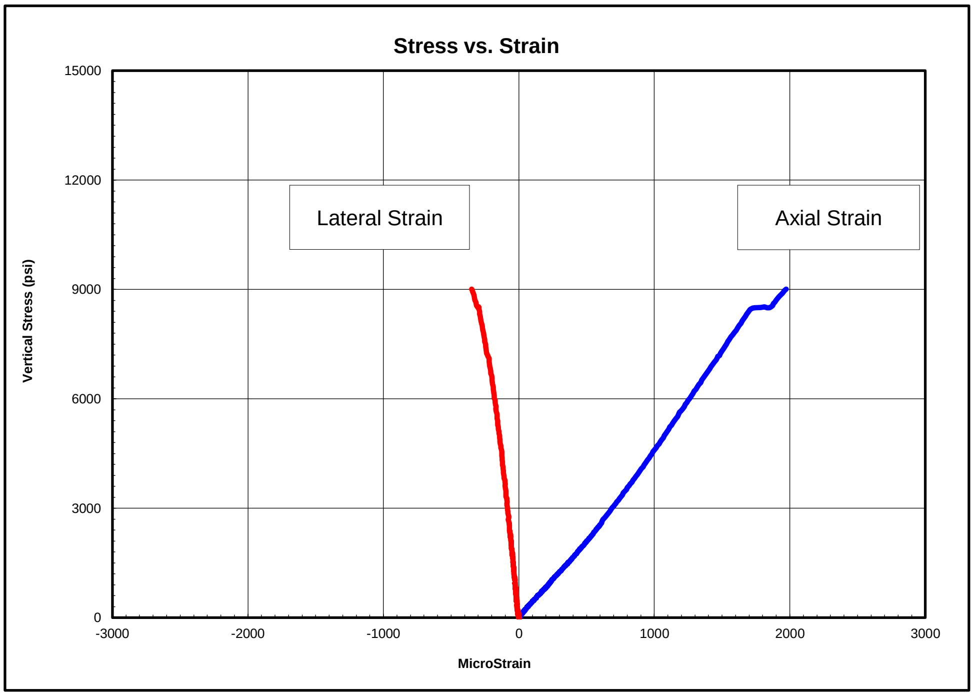
After cutting and grinding



After break

Client:	S&ME, Inc.
Project Name:	SCDOT Bridge Package 2021-1
Project Location:	South Carolina
GTX #:	313047
Test Date:	1/18/2021
Tested By:	cmh
Checked By:	jsc
Boring ID:	S-11-265, B-1
Sample ID:	RS-2
Depth, ft:	23.5-23.9
Sample Type:	rock core
Sample Description:	See photographs Intact material failure

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 9,008 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
900-3300	4,330,000	0.12
3300-5700	5,310,000	0.17
5700-8100	5,470,000	0.26

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

GeoTesting EXPRESS

Client:	S&ME, Inc.	Test Date:	1/14/2021
Project Name:	SCDOT Bridge Package 2021-1	Tested By:	cmh
Project Location:	South Carolina	Checked By:	smd
GTX #:	313047		
Boring ID:	S-11-265, B-1		
Sample ID:	RS-2		
Depth:	23.5-23.9 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.88	4.88	4.88		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	672.63				
Bulk Density, lb/ft^3	168	**Minimum Diameter Tolerence Met?**		**YES**	
Length to Diameter Ratio:	2.5	**Length to Diameter Ratio Tolerance Met?**		**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

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

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00020
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020

Difference between max and min readings, in:

0° = 0.00040 90° = 0.00020

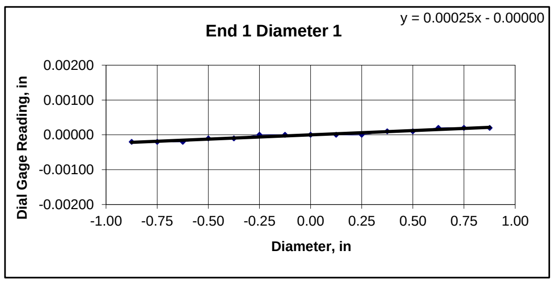
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00020	0.00020	0.00020	0.00030
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030

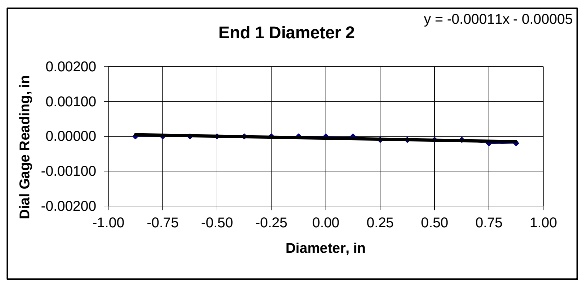
Difference between max and min readings, in:

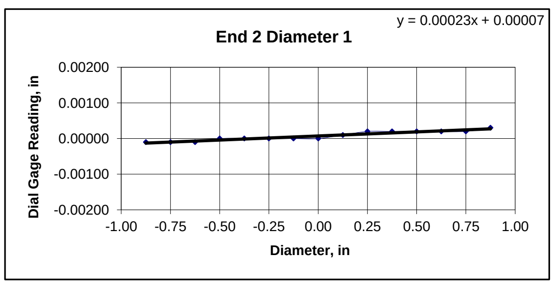
0° = 0.0004 90° = 0.0003

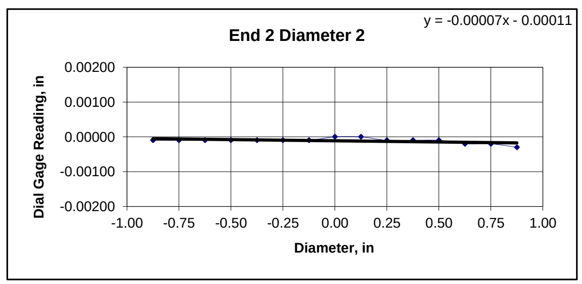
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00020

Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00025
Angle of Best Fit Line:	0.01408

End 2:

Slope of Best Fit Line	0.00023
Angle of Best Fit Line:	0.01310

Maximum Angular Difference: 0.00098

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00011
Angle of Best Fit Line:	0.00655

End 2:

Slope of Best Fit Line	0.00007
Angle of Best Fit Line:	0.00393

Maximum Angular Difference: 0.00262

Parallelism Tolerance Met? **YES**
Spherically Seated

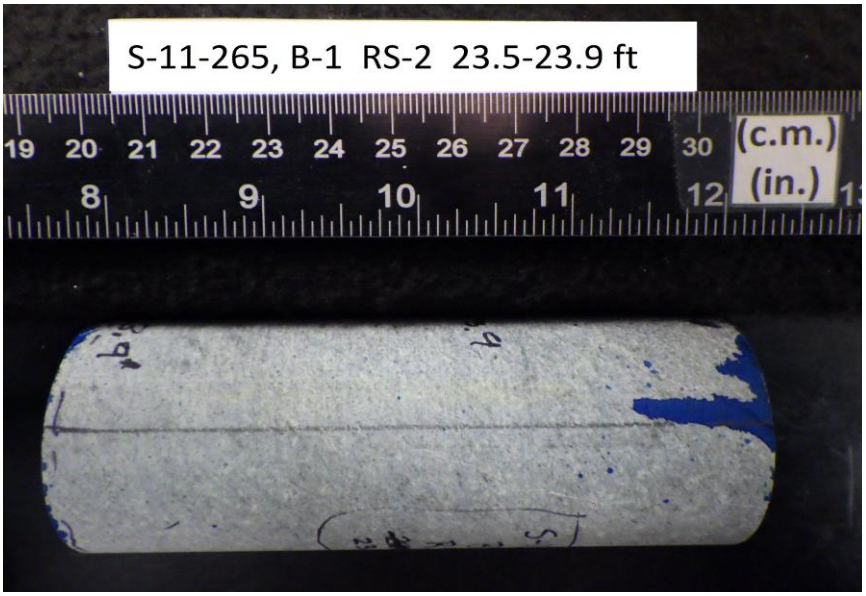
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

Maximum angle of departure must be $\leq$ 0.25°

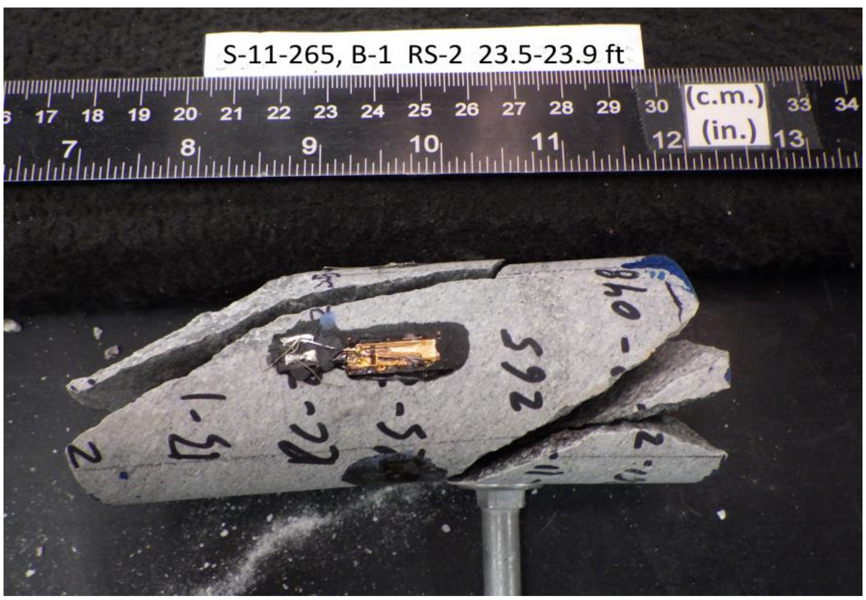
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	1.990	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00020	1.990	0.00010	0.006	YES
END 2					
Diameter 1, in	0.00040	1.990	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00030	1.990	0.00015	0.009	YES

Perpendicularity Tolerance Met? **YES**

Client:	S&ME, Inc.
Project Name:	SCDOT Bridge Package 2021-1
Project Location:	South Carolina
GTX #:	313047
Test Date:	1/18/2021
Tested By:	cmh
Checked By:	smd
Boring ID:	S-11-265, B-1
Sample ID:	RS-2
Depth, ft:	23.5-23.9



After cutting and grinding



After break

Appendix VII – SPT Hammer Energy Measurements

Report of SPT Energy Measurements
S&ME CME 55 Truck (Serial No. 328245)
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 CME 55 Truck (Serial No. 328245)
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 CME 55 truck-mounted drill rig (Serial No. 328245). 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 the 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^{TM} (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-foot long AW drill rod (Serial No. 203) internally instrumented with two strain transducers. Calibration sheets for the accelerometers and the instrumented rod are included in the Appendix II. The instrumented AW drill rod has a cross-sectional area of 1.19 square inches at the gage locations. The accelerometers and strain gages, 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 CME 55 truck-mounted drill rig operated by Ted Miller 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. Due to an error that occurred during testing, the data from the 28.5-ft interval has been omitted from this report and the calculations of average transferred hammer energy. 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	CME
Model	55
Serial Number	328245
Operator	T. Miller
Carrier	Truck

Table 2-2: Hammer Information

Model / Type	CME / Auto
Serial Number	328245
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	AW
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Typical Lengths (feet)	2 ft, 5 ft, and 10 ft
Instrumented Rod Type	AW (Serial No. 203)
OD (inches)	1.75
ID (inches)	1.25
Cross-Sectional Area (in^2)	1.19
Total Instrumented Rod Length (feet)	2.0
Length Below Gages (feet)	0.75
Split-Spoon Length (feet)	2.8

3.0 Dynamic Testing Results

The total rod length from the instrumentation to the tip of the split-spoon sampler was determined by adding 3.55 ft to the drill rod length at each sample depth. The SPT Energy Measurement Data Summary tables in the 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 CME 55 operated at an average rate of about 51 blows per minute (bpm) during dynamic testing. The measured average transferred hammer energy (EFV) of the three sample intervals ranged from 297 to 302 ft-lbs, which corresponds to Energy Transfer Ratio (ETR) values of 84.7 to 86.3%, respectively. Plots and tables of the following are also included in the Appendix and present the test data with depth for each test interval:

- Penetration vs. BLC[1]
- Penetration vs. FMX[2]
- Penetration vs. EFV[3]
- Penetration vs. CSX[4]
- Penetration vs. VMX[5]
- Penetration vs. ETR[6]
- 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	33.5 – 35	35	38.55	8-13-7 / 20	CLAY	52.1	297	84.7
2	38.5 – 40	40	43.55	4-8-9 / 17	SANDY SILT	49.8	300	85.8
3	43.5 – 45	45	48.55	8-16-21 / 37	SILTY SAND	51.9	302	86.3
					Overall Average	**51.4**	**300**	**85.7**

The overall average transferred hammer energy for the automatic hammer on the CME 55 truck-mounted drill rig was 300 foot-pounds, with an average ETR of 85.7%.

[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.

NORTH CAROLINA PROFESSIONAL SEAL 028593 ENGINEER GREGORY J. CANIVAN

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 – CME 55 Truck (SN 328245) SPT Energy Measurements Summary Plots and Tables

Appendix I - Certificates of Proficiency

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

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

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Pile Dynamics, Inc.

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.

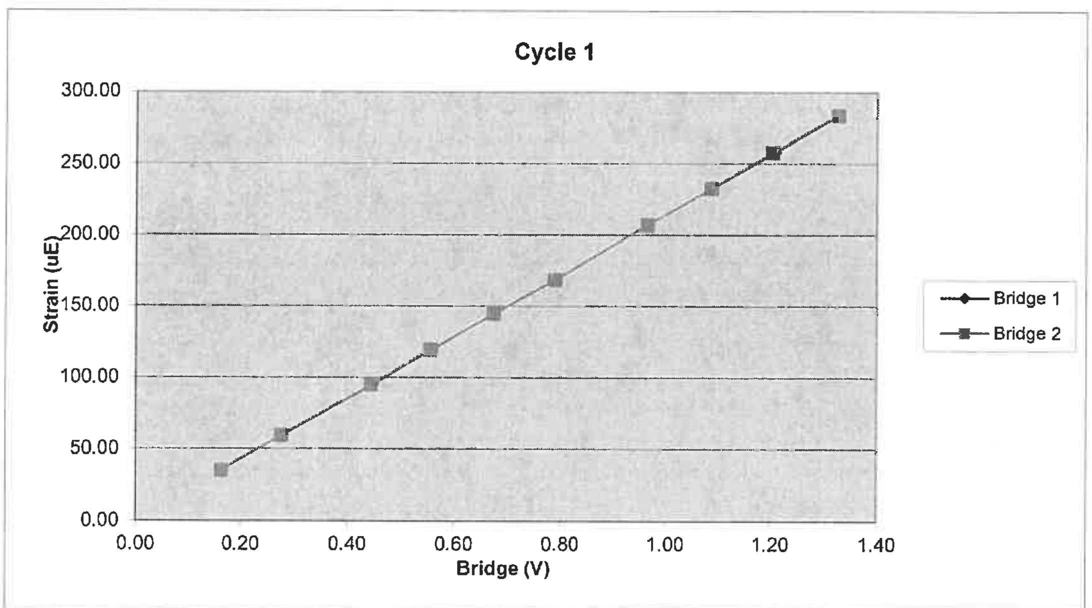
No. 2425

Appendix II - Calibration Sheets

203AWJ		Cycle 1		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	1238.45	35.09	0.16	0.16
3	2101.82	59.39	0.28	0.28
4	3386.54	94.77	0.44	0.44
5	4235.08	119.35	0.56	0.56
6	5136.73	144.58	0.67	0.67
7	6021.00	168.91	0.79	0.79
8	7359.61	207.34	0.97	0.97
9	8298.94	232.84	1.09	1.09
10	9187.31	257.76	1.21	1.20
11	10120.00	284.12	1.33	1.33

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7630.77**	**Force Calibration (lb/V)**	**7630.97**
Offset	-7.83	Offset	-3.17
Correlation	1.000000	Correlation	0.999999
Strain Calibration (µE/V)	**213.97**	**Strain Calibration (µE/V)**	**213.98**
Offset	0.12	Offset	0.25
Correlation	0.999992	Correlation	0.999995

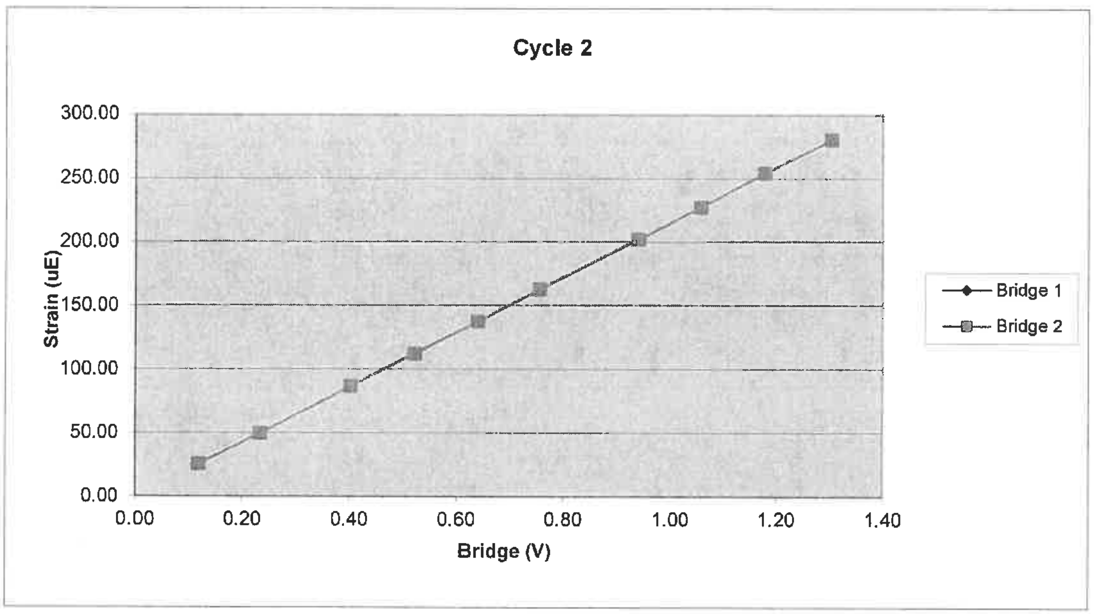
Force Strain Calibration	
EA (Kips)	**35662.28**
Offset	-12.17
Correlation	0.999993



203AWJ		Cycle 2		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	883.29	25.21	0.12	0.12
3	1765.61	49.65	0.23	0.23
4	3049.75	86.59	0.40	0.40
5	3958.42	112.20	0.52	0.52
6	4857.33	137.43	0.64	0.64
7	5743.75	162.78	0.76	0.76
8	7145.42	202.15	0.94	0.94
9	8044.14	227.44	1.06	1.06
10	8969.22	253.99	1.18	1.18
11	9924.95	280.34	1.30	1.30

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7617.86**	**Force Calibration (lb/V)**	**7627.07**
Offset	**-11.91**	Offset	**-18.36**
Correlation	**0.999998**	Correlation	**1.000000**
Strain Calibration (µE/V)	**215.30**	**Strain Calibration (µE/V)**	**215.56**
Offset	**-0.14**	Offset	**-0.33**
Correlation	**0.999995**	Correlation	**0.999996**

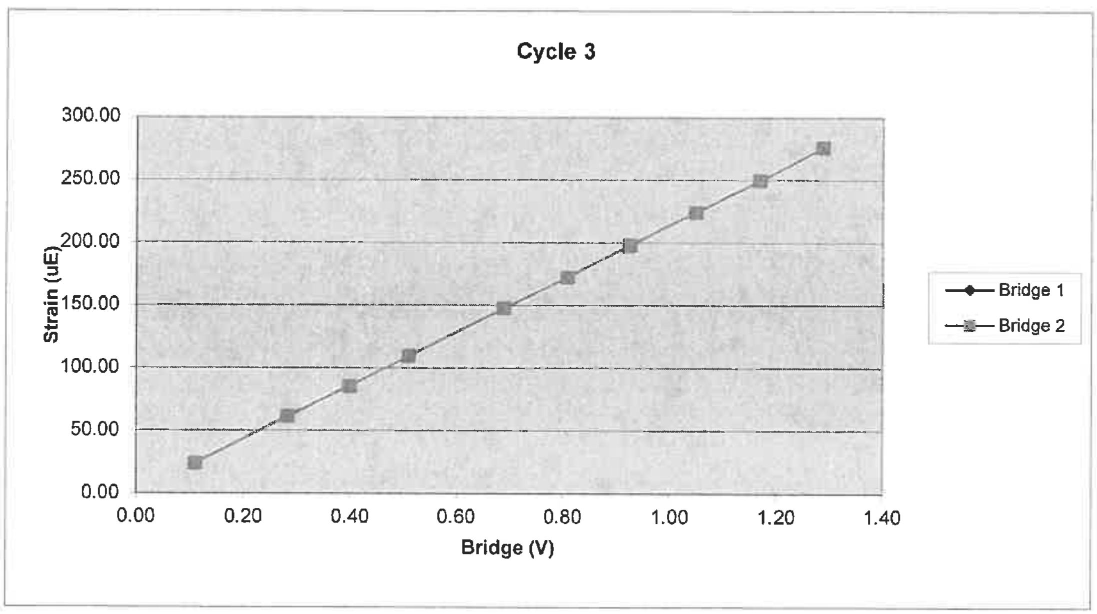
Force Strain Calibration	
EA (Kips)	**35381.61**
Offset	**-6.76**
Correlation	**0.999996**



203AWJ		Cycle 3		
Sample	**Force (lb)**	**Strain (µE)**	**Bridge 1 (V)**	**Bridge 2 (V)**
1	0.00	0.00	0.00	0.00
2	843.85	23.93	0.11	0.11
3	2145.36	61.00	0.28	0.28
4	3029.63	85.25	0.40	0.40
5	3880.71	109.47	0.51	0.51
6	5241.19	147.71	0.69	0.69
7	6147.33	172.47	0.81	0.81
8	7034.72	198.06	0.92	0.92
9	7979.71	224.33	1.05	1.05
10	8906.15	249.58	1.17	1.17
11	9817.56	275.86	1.29	1.29

Bridge 1		**Bridge 2**	
Force Calibration (lb/V)	**7623.93**	**Force Calibration (lb/V)**	**7629.88**
Offset	**-3.49**	Offset	**-9.59**
Correlation	**0.999999**	Correlation	**0.999999**
Strain Calibration (µE/V)	**213.65**	**Strain Calibration (µE/V)**	**213.81**
Offset	**0.47**	Offset	**0.30**
Correlation	**0.999992**	Correlation	**0.999991**

Force Strain Calibration	
EA (Kips)	**35684.19**
Offset	**-20.08**
Correlation	**0.999992**



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

Calibration Factors	**203AWJ**		
Bridge 1 (µE/V)	**214.31**	**Bridge 2 (µE/V)**	**214.45**
EA Factor (Kips)	**35576.02**	**Area (in^2)**	**1.19**

Calibrated by: David [signature]
Calibrated Date: 2/26/2019

Pile Dynamics Inc
30725 Aurora Rd
Solon, OH 44139

Traceable to N.I.S.T.

Pile Dynamics, Inc. TG F2 DPF

Pile Dynamics
2018-07-26 10:47

FS — 10

BN 6241
SL 970/ 3440/ 99

PJ:
PN: HOPBAR

A 4
F 2

-- VS
3.3

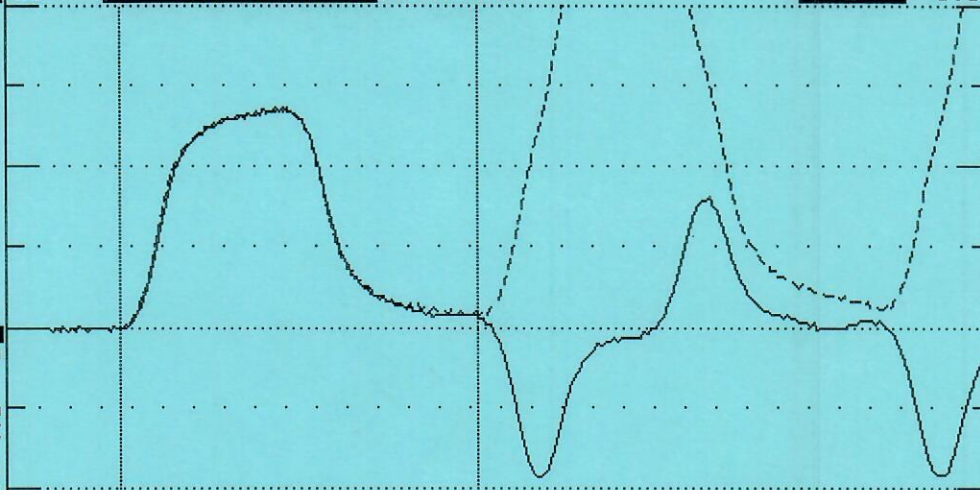
LE 17.0 ft
AR 1.7 in2
EM 30000 Ksi
SP 0.492 K/ft3
WS 16810 ft/s
WC 7312 ft/s

JC 0.40
FM 1.00
VM 1.00

EA/C 30.3 Ks/ft
VN KIPS*0.1
FR 20000 MB 90

DL -41
VT -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 E B PD: K10673 LP 0.00 ft
TB 8.0 T1 9.4 2L/C 4.7 VA 1000 VE 1024 LI 1.0

VMX= 4.4 FMX= 68 AMX= 149
EMX= 0.3 MEX= 133 FVP= 1.00

ACCEPT SQ-OFF FL-OFF PR-OFF

ACCEPT

ACCELEROMETER CALIBRATION N.I.S.T. Traceable

SERIAL NUMBER: K10673

CALIBRATION FACTOR: .068 mV/G

PAK (*5000): 340 DATE: 26JUL18

PDA OPERATOR: [signature]

<-AT:PIEZORESISTIVE OP: laine [ver:5.01] AT:PIEZOELECTRIC->

Smart Sensor

Smart Chip Programmed By Z.W. **on** 26JUL18 **CRC Value** BA96

Pile Dynamics, Inc. TG F2 DPF

Pile Dynamics
2018-07-26 10:43

FS — 10 | BN 6235 | SL 964/ 3440/ 2 | PJ: | PN: HOPBAR | A 4 | F 2 | -- VS 3.3

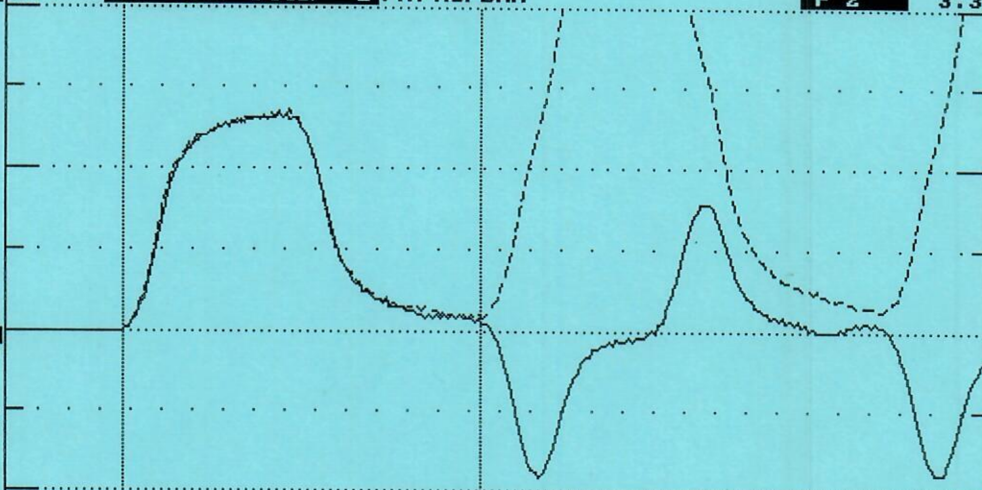
LE 17.0 ft
AR 1.7 in2
EM 30000 Ksi
SP 0.492 K/ft3
WS 16810 ft/s
WC 7312 ft/s

JC 0.40
FM 1.00
VM 1.00

EA/C 30.3 Ks/ft
UN KIPS*0.1
FR 20000 MB 90

DL -40
VT -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 E B PD: K10674 LP 0.00 ft
TB 8.0 T1 9.5 2L/C 4.7 VA 1000 VE 1024 LI 1.0

VMX= 4.4 FMX= 67 AMX= 149
EMX= 0.3 MEX= 131 FVP= 1.00

ACCEPT SQ-OFF FL-OFF PR-OFF

ACCEPT

ACCELEROMETER CALIBRATION N.I.S.T. Traceable

SERIAL NUMBER: K10674

CALIBRATION FACTOR: .074 mV/G

PAK (*5000): 370 DATE: 26JUL18

PDA OPERATOR: [signature]

<-AT:PIEZORESISTIVE OP: laine [ver:5.01] AT:PIEZOELECTRIC->

Smart Sensor

Smart Chip Programmed By J. W. **on** 26JUL18 **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.

PILE DYNAMICS, INC. CORPORATE SEAL 1972 OHIO

Tested by:

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

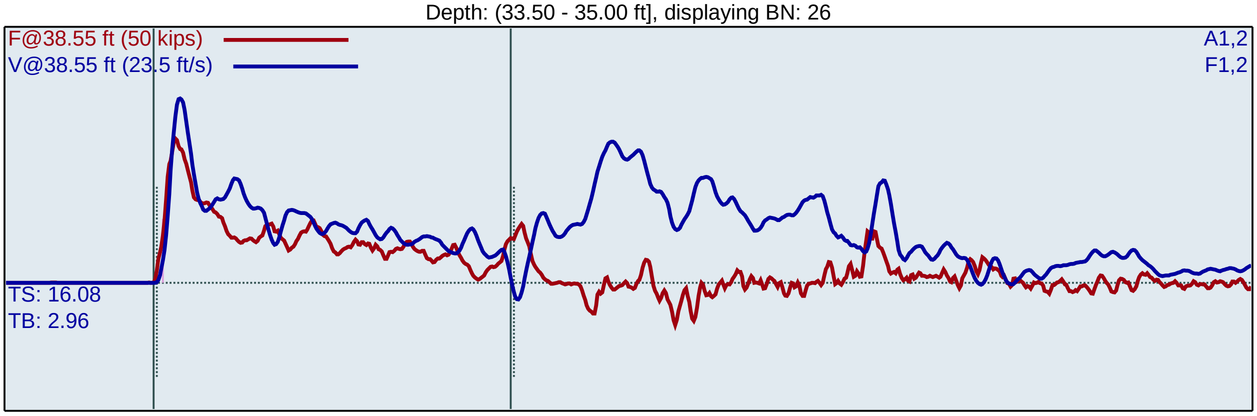
Appendix III - SPT Energy Measurements Plots and Tables

SPT Analyzer Results PDA-S Ver. 2019.30.82 - Printed: 5/22/2020

CME 55 (SN 328245) Annual Calibration
H. Forbes Test date: 5/7/2020
B-14B

AR: 1.19 in^2 SP: 0.492 k/ft3
LE: 38.55 ft EM: 30000 ksi
WS: 16807.9 ft/s

Depth: (33.50 - 35.00 ft], displaying BN: 26



F1 : [203-AWJ] 214 PDICAL (1) FF1
F2 : [203-AWJ] 214 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	33.56	8	1.9	29	17.8	1.05	0.75	24.1	280	79.9
2	33.63	8	58.3	29	17.6	0.93	0.75	24.2	299	85.3
3	33.69	8	52.5	29	17.5	0.90	0.75	24.0	297	84.7
4	33.75	8	52.0	29	17.6	0.88	0.75	24.3	302	86.2
5	33.81	8	52.2	29	17.8	0.82	0.75	24.4	300	85.6
6	33.88	8	51.9	29	17.6	0.79	0.75	24.2	301	86.0
7	33.94	8	52.4	29	17.4	0.76	0.75	24.6	302	86.3
8	34.00	8	52.2	29	17.2	0.75	0.75	24.1	296	84.5
9	34.04	13	52.1	29	17.1	0.66	0.46	24.4	301	86.0
10	34.08	13	52.1	29	16.9	0.60	0.46	24.0	296	84.7
11	34.12	13	52.3	29	17.3	0.57	0.46	24.1	299	85.6
12	34.15	13	51.9	29	17.4	0.54	0.46	24.3	298	85.1
13	34.19	13	52.2	29	17.4	0.55	0.46	24.5	300	85.9
14	34.23	13	51.9	29	16.9	0.54	0.46	24.0	290	82.9
15	34.27	13	52.0	29	17.2	0.55	0.46	24.2	297	84.9
16	34.31	13	52.1	29	17.0	0.55	0.46	24.0	291	83.2
17	34.35	13	52.0	29	17.4	0.59	0.46	24.4	294	83.9
18	34.38	13	52.2	29	17.1	0.66	0.46	24.4	292	83.5
19	34.42	13	52.2	30	17.3	0.87	0.46	25.0	297	84.9
20	34.46	13	52.1	29	16.6	0.97	0.46	24.1	294	84.1
21	34.50	13	52.1	29	16.8	1.04	0.46	24.2	295	84.4
22	34.57	7	52.1	29	17.0	1.00	0.86	24.2	291	83.2
23	34.64	7	52.2	29	18.0	0.93	0.86	24.3	300	85.8
24	34.71	7	52.0	29	17.9	0.98	0.86	24.3	309	88.3
25	34.79	7	52.1	29	17.2	0.89	0.86	24.2	296	84.5
26	34.86	7	52.0	28	16.9	0.89	0.86	23.7	296	84.6
27	34.93	7	52.1	29	16.9	0.87	0.86	24.2	297	84.8

28	35.00	7	51.9	30	16.7	0.86	0.86	25.3	296	84.5
		Average	52.1	29	17.2	0.76	0.60	24.3	297	84.7
		Std Dev	0.1	0	0.3	0.18	0.19	0.3	4	1.2
		Maximum	52.3	30	18.0	1.04	0.86	25.3	309	88.3
		Minimum	51.9	28	16.6	0.54	0.46	23.7	290	82.9

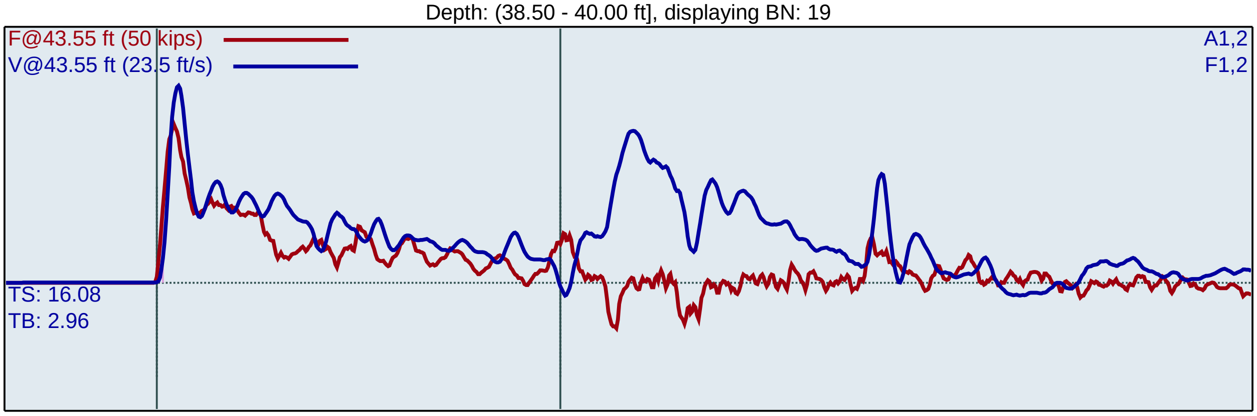
N-value: 20

Sample Interval Time: 53.08 seconds.

CME 55 (SN 328245) Annual Calibration
H. Forbes Test date: 5/7/2020
B-14B

AR: 1.19 in^2 SP: 0.492 k/ft3
LE: 43.55 ft EM: 30000 ksi
WS: 16807.9 ft/s

Depth: (38.50 - 40.00 ft], displaying BN: 19



F1 : [203-AWJ] 214 PDICAL (1) FF1
F2 : [203-AWJ] 214 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	BC	BPM	FMX	VMX	DMX	DFN	CSX	EFV	ETR
	ft	/6"	bpm	kips	ft/s	in	in	ksi	ft-lb	%
1	38.63	4	56.8	29	16.7	2.59	1.50	24.0	282	80.5
2	38.75	4	1.9	27	17.0	1.83	1.50	22.4	291	83.1
3	38.88	4	49.8	28	17.2	1.58	1.50	23.1	293	83.8
4	39.00	4	50.1	28	16.9	1.50	1.50	23.7	294	84.0
5	39.06	8	49.8	28	16.9	1.17	0.75	23.7	295	84.3
6	39.13	8	50.0	28	16.4	1.00	0.75	23.8	297	84.8
7	39.19	8	49.7	29	17.0	0.98	0.75	24.0	298	85.0
8	39.25	8	49.8	29	17.0	1.05	0.75	24.2	299	85.5
9	39.31	8	50.1	29	17.6	0.99	0.75	24.7	295	84.3
10	39.38	8	49.8	30	17.6	1.06	0.75	25.1	300	85.8
11	39.44	8	49.8	30	17.6	0.97	0.75	24.9	301	85.9
12	39.50	8	49.9	29	17.8	0.91	0.75	24.7	302	86.4
13	39.56	9	49.9	30	17.4	0.92	0.67	24.8	301	86.0
14	39.61	9	49.6	30	17.6	0.88	0.67	25.0	296	84.5
15	39.67	9	49.9	30	17.8	0.79	0.67	25.0	301	86.0
16	39.72	9	49.7	30	17.8	0.79	0.67	25.1	304	86.8
17	39.78	9	50.0	30	17.6	0.75	0.67	25.1	301	86.0
18	39.83	9	49.7	31	18.1	0.77	0.67	25.8	303	86.6
19	39.89	9	49.9	31	18.1	0.74	0.67	26.1	311	88.8
20	39.94	9	49.7	30	17.9	0.70	0.67	24.8	306	87.4
21	40.00	9	49.6	29	18.0	0.67	0.67	24.0	296	84.6
		Average	49.8	29	17.5	0.89	0.71	24.8	300	85.8
		Std Dev	0.1	1	0.5	0.14	0.04	0.6	4	1.2
		Maximum	50.1	31	18.1	1.17	0.75	26.1	311	88.8
		Minimum	49.6	28	16.4	0.67	0.67	23.7	295	84.3

N-value: 17

Sample Interval Time: 55.15 seconds.

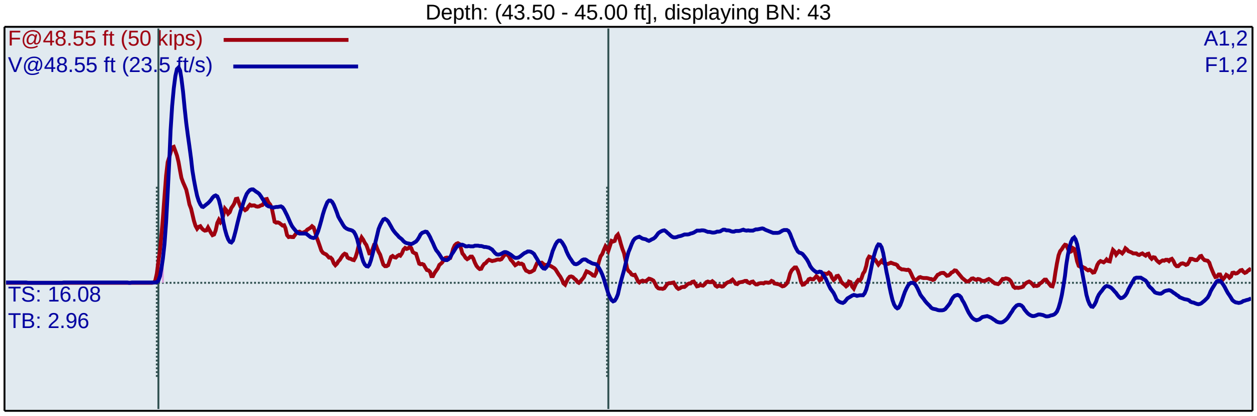
CME 55 (SN 328245)
H. Forbes
B-14B

Annual Calibration
Test date: 5/7/2020

AR: 1.19 in^2
LE: 48.55 ft
WS: 16807.9 ft/s

SP: 0.492 k/ft3
EM: 30000 ksi

Depth: (43.50 - 45.00 ft], displaying BN: 43



F1 : [203-AWJ] 214 PDICAL (1) FF1
F2 : [203-AWJ] 214 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	BC	BPM	FMX	VMX	DMX	DFN	CSX	EFV	ETR
	ft	/6"	bpm	kips	ft/s	in	in	ksi	ft-lb	%
1	43.56	8	1.9	26	18.2	1.58	0.75	21.9	284	81.0
2	43.63	8	57.1	26	18.2	1.32	0.75	22.3	288	82.3
3	43.69	8	48.4	26	18.2	1.05	0.75	21.7	286	81.7
4	43.75	8	48.6	27	18.7	1.06	0.75	22.8	296	84.6
5	43.81	8	48.1	26	18.6	0.98	0.75	21.5	288	82.2
6	43.88	8	1.9	27	19.3	0.93	0.75	22.6	301	86.0
7	43.94	8	51.8	26	18.6	0.90	0.75	21.9	294	83.9
8	44.00	8	52.2	27	18.7	0.84	0.75	22.3	293	83.7
9	44.03	16	52.1	27	17.9	0.71	0.37	22.7	297	84.8
10	44.06	16	51.7	27	18.7	0.64	0.37	22.5	307	87.6
11	44.09	16	52.5	26	17.7	0.57	0.37	22.0	287	82.1
12	44.13	16	51.6	27	18.7	0.56	0.38	22.7	305	87.0
13	44.16	16	51.8	26	18.4	0.51	0.37	21.8	294	84.0
14	44.19	16	52.3	27	18.6	0.51	0.37	22.5	303	86.7
15	44.22	16	51.5	26	18.1	0.50	0.37	22.0	288	82.3
16	44.25	16	52.0	27	18.5	0.49	0.37	22.4	302	86.2
17	44.28	16	52.0	27	18.8	0.49	0.37	22.5	303	86.5
18	44.31	16	52.1	26	18.1	0.48	0.37	22.0	294	83.9
19	44.34	16	51.8	26	18.1	0.47	0.38	22.2	297	84.8
20	44.38	16	51.8	25	18.0	0.50	0.37	21.3	300	85.7
21	44.41	16	51.8	26	18.1	0.44	0.38	21.7	298	85.0
22	44.44	16	51.9	26	18.2	0.45	0.38	21.7	298	85.0
23	44.47	16	51.9	25	18.1	0.45	0.38	21.4	302	86.4
24	44.50	16	51.7	26	17.5	0.44	0.38	21.5	302	86.4
25	44.52	21	51.9	27	17.9	0.44	0.29	22.3	303	86.5
26	44.55	21	51.7	27	18.0	0.46	0.29	22.6	301	86.0
27	44.57	21	51.9	26	17.9	0.47	0.29	22.0	302	86.4
28	44.60	21	51.6	27	18.6	0.47	0.29	22.6	306	87.5
29	44.62	21	51.8	27	19.0	0.49	0.29	22.7	310	88.7
30	44.64	21	51.6	28	18.9	0.48	0.29	23.1	305	87.1
31	44.67	21	51.9	27	18.7	0.49	0.29	22.7	308	88.0

32	44.69	21	51.7	26	18.7	0.49	0.29	22.2	304	86.9
33	44.71	21	52.1	27	18.7	0.49	0.29	22.3	304	86.7
34	44.74	21	51.8	27	19.1	0.49	0.29	22.9	308	88.0
35	44.76	21	51.9	28	19.3	0.50	0.29	23.4	310	88.6
36	44.79	21	51.9	27	18.8	0.47	0.29	23.0	299	85.5
37	44.81	21	51.6	28	19.2	0.47	0.29	23.4	303	86.6
38	44.83	21	52.1	29	19.6	0.48	0.29	24.0	310	88.6
39	44.86	21	51.7	28	19.5	0.48	0.29	23.6	306	87.4
40	44.88	21	51.7	27	19.5	0.48	0.29	22.8	309	88.2
41	44.90	21	51.9	27	18.9	0.47	0.29	22.4	300	85.7
42	44.93	21	52.1	28	19.3	0.48	0.29	23.4	306	87.5
43	44.95	21	51.6	27	19.8	0.47	0.29	22.3	301	86.1
44	44.98	21	51.6	27	19.0	0.46	0.29	22.7	298	85.2
45	45.00	21	51.9	27	19.2	0.46	0.29	22.8	301	86.1
		Average	51.9	27	18.6	0.49	0.32	22.5	302	86.3
		Std Dev	0.2	1	0.6	0.05	0.04	0.6	5	1.6
		Maximum	52.5	29	19.8	0.71	0.38	24.0	310	88.7
		Minimum	51.5	25	17.5	0.44	0.29	21.3	287	82.1

N-value: 37

Sample Interval Time: 136.91 seconds.

Summary of SPT Test Results

Project: CME 55 (SN 328245), 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

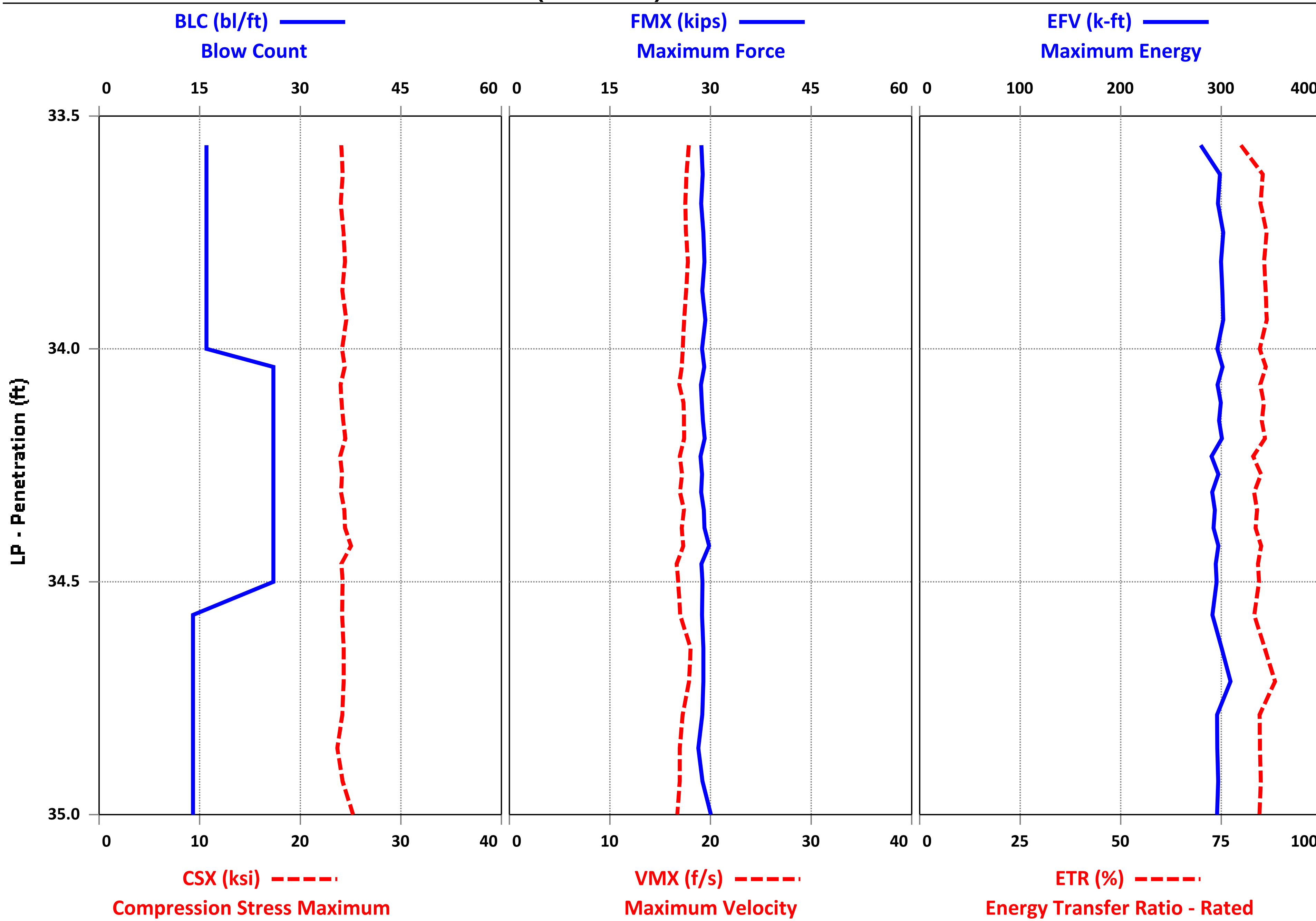
Instr. Length ft	Start Depth ft	Final Depth ft	Blows Applied /6"	**N Value**	**N60 Value**	Average BPM bpm	Average FMX kips	Average VMX ft/s	Average DMX in	Average DFN in	Average CSX ksi	Average EFV ft-lb	Average ETR %
38.55	33.50	35.00	**8-13-7**	**20**	**28**	52.1	29	17.2	0.76	0.60	24.3	297	84.7
43.55	38.50	40.00	**4-8-9**	**17**	**24**	49.8	29	17.5	0.89	0.71	24.8	300	85.8
48.55	43.50	45.00	**8-16-21**	**37**	**52**	51.9	27	18.6	0.49	0.32	22.5	302	86.3
					Overall Average Values:	51.4	28	18.0	0.65	0.49	23.5	300	85.7
					Standard Deviation:	0.9	1	0.8	0.21	0.20	1.2	5	1.5
					Overall Maximum Value:	52.5	31	19.8	1.17	0.86	26.1	311	88.8
					Overall Minimum Value:	49.6	25	16.4	0.44	0.29	21.3	287	82.1

Printed: 22-May-2020

Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Test started: 07-May-2020

CME 55 (SN 328245) - 33.5 to 35 ft

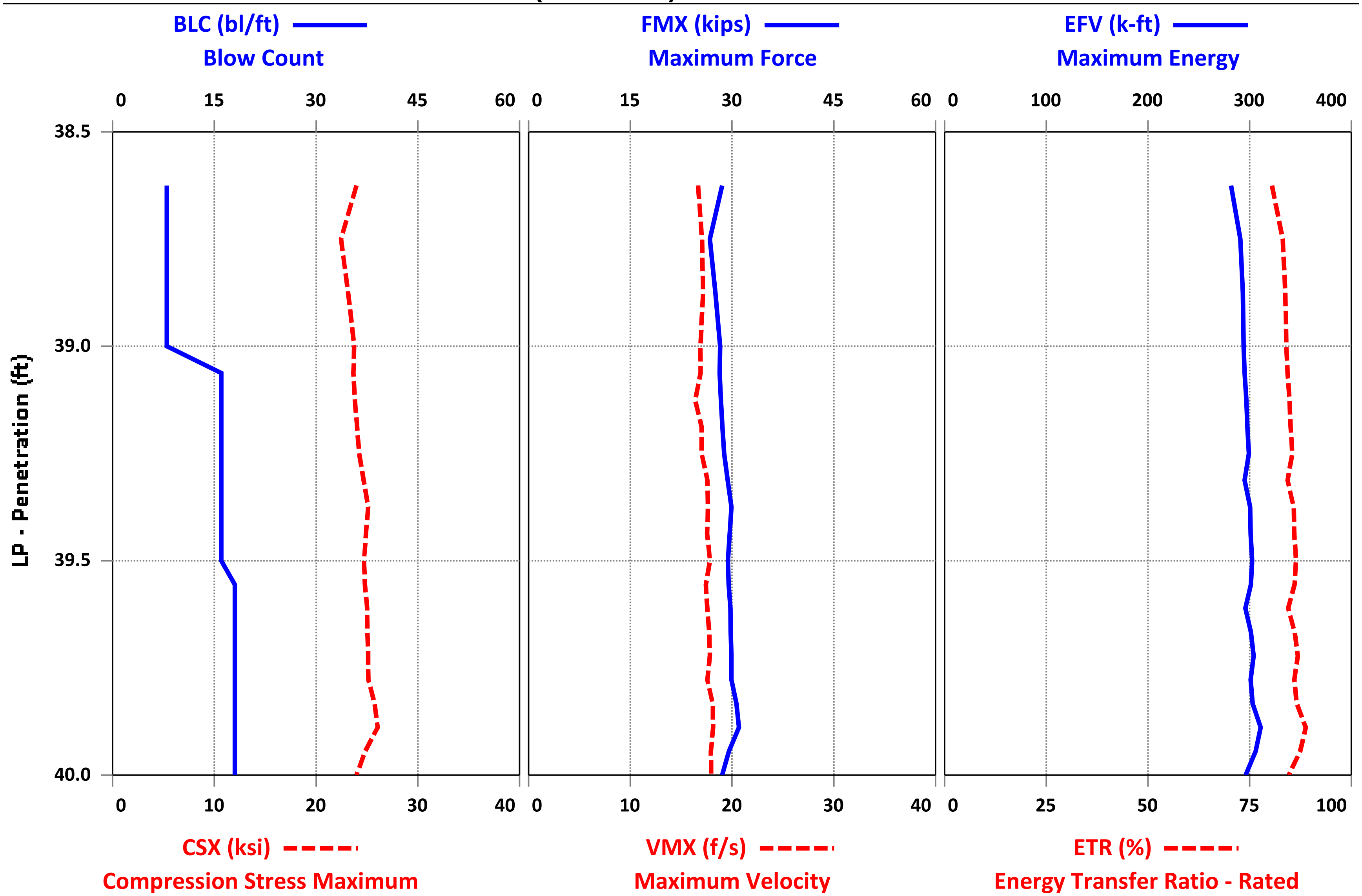


Printed: 22-May-2020

Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

Test started: 07-May-2020

CME 55 (SN 328245) - 38.5 to 40 ft

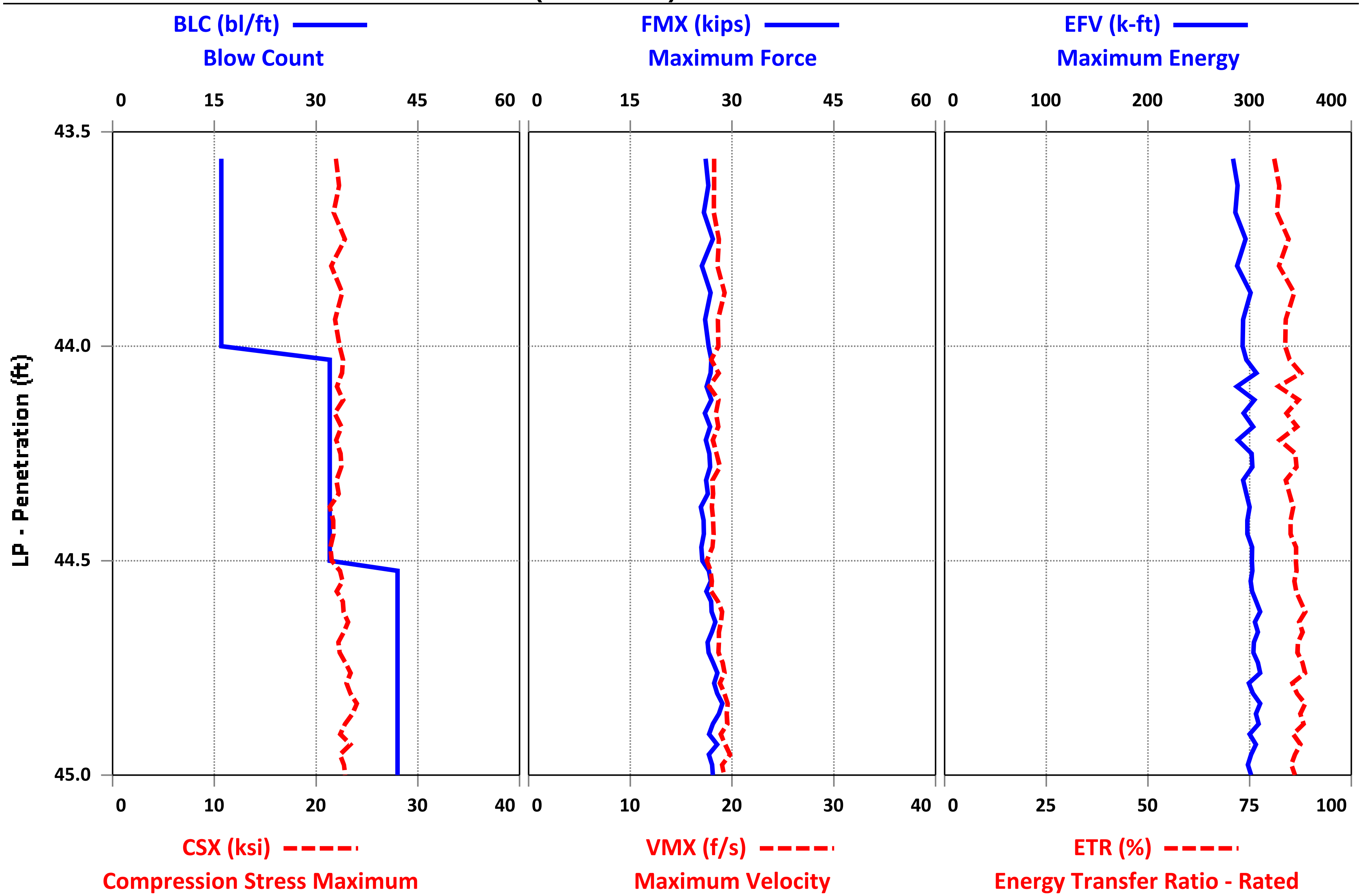


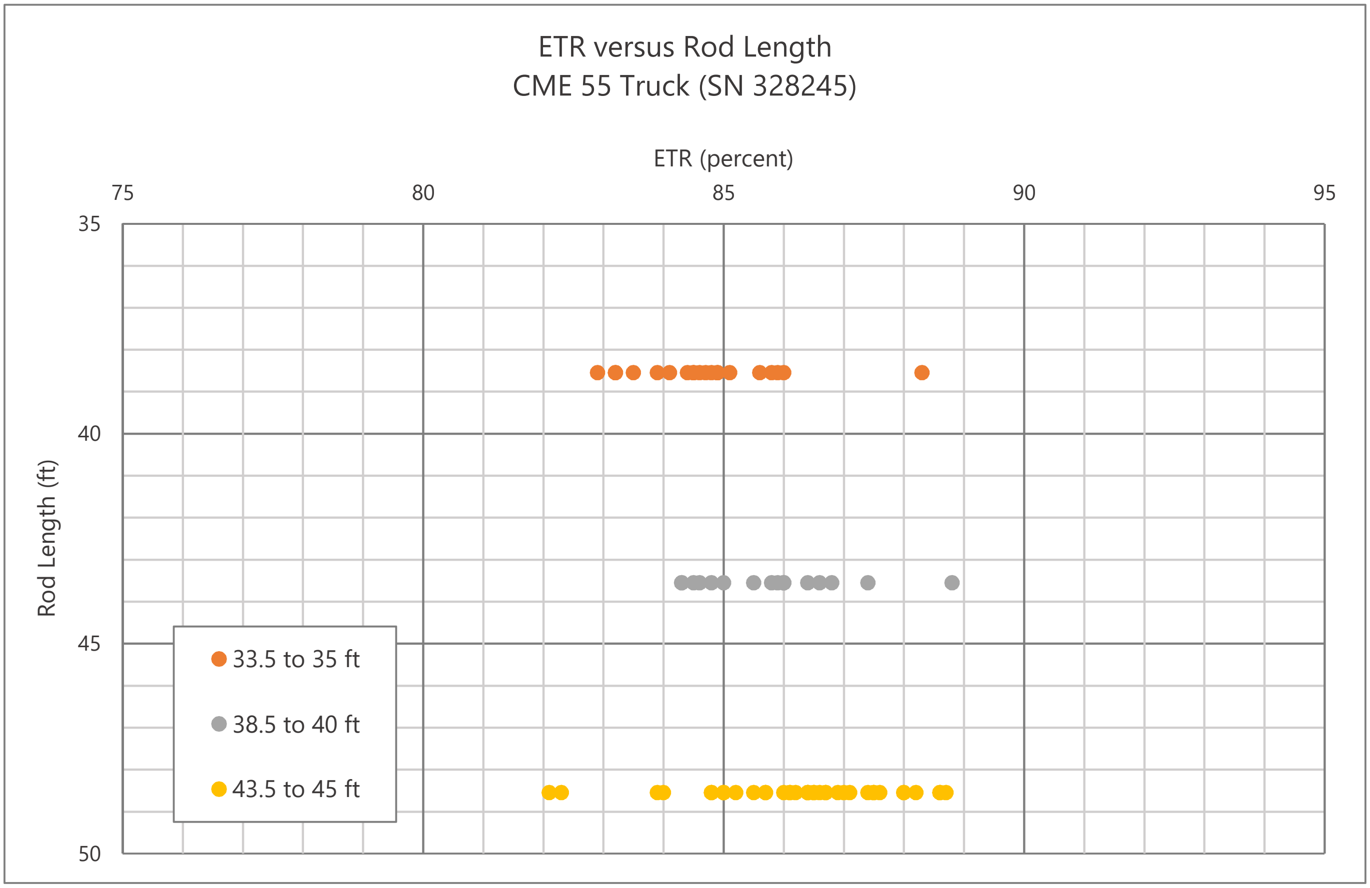
Pile Dynamics, Inc. - PDIPLOT2 Ver 2017.2.58.5 - Case Method & iCAP® Results

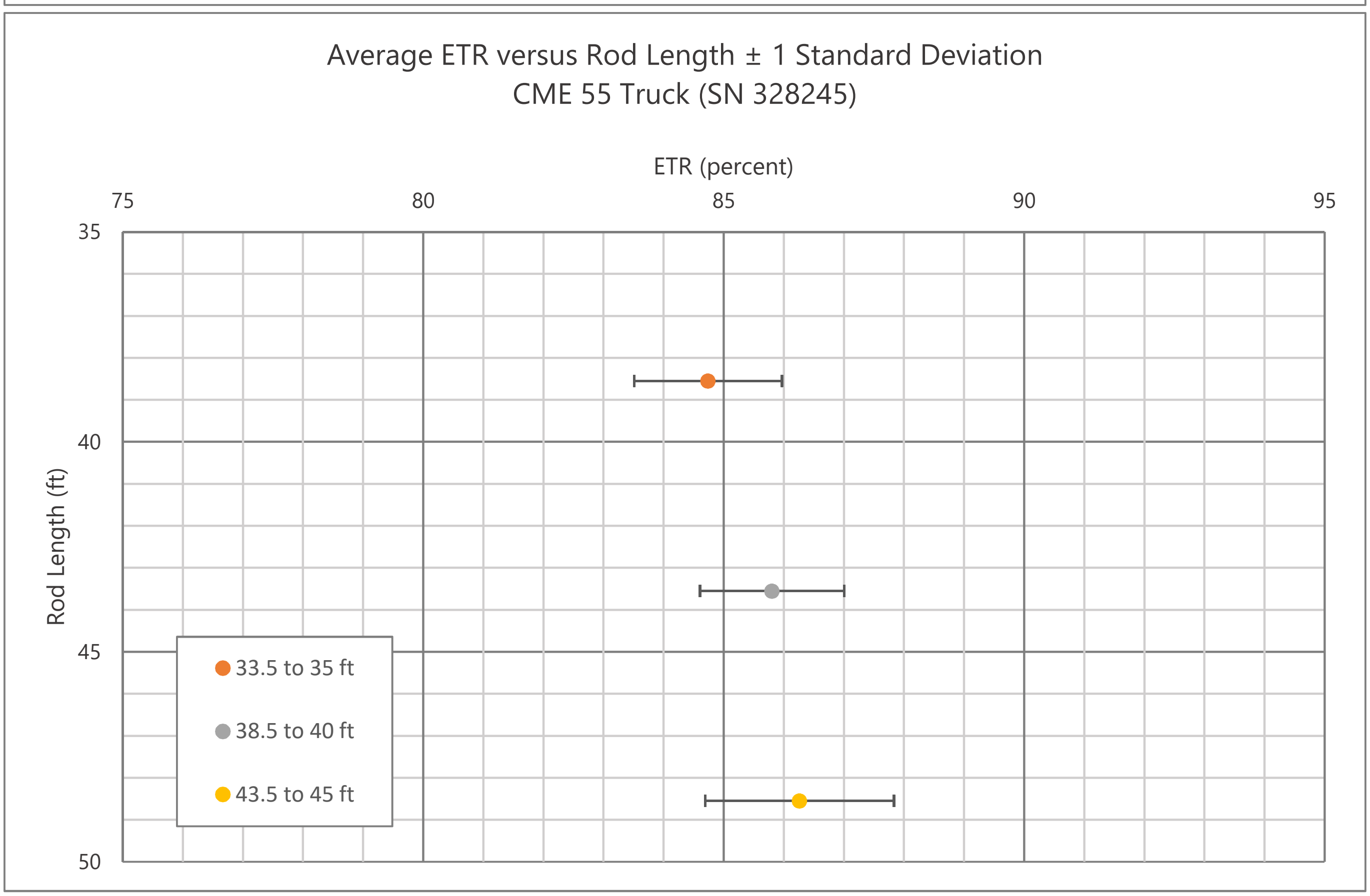
Printed: 22-May-2020

Test started: 07-May-2020

CME 55 (SN 328245) - 43.5 to 45 ft




ETR versus Rod Length
CME 55 Truck (SN 328245)
ETR (percent)
75
80
85
90
95
Rod Length (ft)
35
40
45
50
33.5 to 35 ft
38.5 to 40 ft
43.5 to 45 ft


Average ETR versus Rod Length ± 1 Standard Deviation
CME 55 Truck (SN 328245)
ETR (percent)
75
80
85
90
95
Rod Length (ft)
35
40
45
50
33.5 to 35 ft
38.5 to 40 ft
43.5 to 45 ft