ARKANSAS DEPARTMENT OF TRANSPORTATION

SUBSURFACE INVESTIGATION

STATE JOB NO. 050422

FEDERAL AID PROJECT NO. BFP-NHPP-0025(22)

SHIPMAN & BIG CREEKS STRS. & APPRS. (S)

STATE HIGHWAY 62 & 223 **SECTION** 12 & 2

IN FULTON **COUNTY**

The information contained herein was obtained by the Department for design and estimating purposes only. It is being furnished with the express understanding that said information does not constitute a part of the Proposal or Contract and represents only the best knowledge of the Department as to the location, character and depth of the materials encountered. The information is only included and made available so that bidders may have access to subsurface information obtained by the Department and is not intended to be a substitute for personal investigation, interpretation and judgment of the bidder. The bidder should be cognizant of the possibility that conditions affecting the cost and/or quantities of work to be performed may differ from those indicated herein.

ARKANSAS DEPARTMENT OF TRANSPORTATION
ARDOT.gov | IDriveArkansas.com | Lorie H. Tudor, P.E., Director
MATERIALS DIVISION
11301 West Baseline Road | P.O. Box 2261 | Little Rock, AR 72203-2261 | Phone: 501.569.2185 | Fax: 501.569.2368

November 20, 2023

TO: Mr. Rick Ellis, Bridge Engineer

SUBJECT: Job No. 050422
Shipman & Big Creeks Strs. & Apprs. (S)
Fulton County
Route 62, Section 12 & Route 223, Section 2

Introduction

Submitted herein are the results of the subsurface investigation and geotechnical recommendations developed for the proposed replacement bridge planned on Highway 223 in Fulton County.

This project consists of constructing a replacement bridge over Big Creek at an offset location east of the existing bridge alignment. The proposed bridge will be a Continuous W-Beam Unit with a total length of 370 feet and an out-to-out width of 32.5 feet. 2-Horizontal to 1-Vertical (2H:1V) end slopes and 3H:1V side slopes are planned at the replacement bridge embankments. Maximum embankment height varies from approximately 12 feet at the south abutment to 10 feet at the north abutment.

Field Investigation

A subsurface investigation was requested on February 3, 2022, by Bridge Division to develop recommendations for bridge foundations and to verify the suitability of bridge abutment embankment configuration. Subsurface conditions were investigated by drilling six (6) borings at or near the proposed locations. One boring at Station 214+60 C.L. Const. (Bent 3) was inaccessible due to rough terrain, wooded site conditions, and access limitations imposed by the landowner.

The approximate locations of the borings are presented in the Plan of Borings included in Attachment A. The borings were advanced with a track-mounted Acker Renegade rotary drill rig using a combination of hollow-stem auger, rotary wash, and rock coring drilling methods. The boring logs, showing the subsurface conditions encountered in the borings and the results of field and laboratory tests, are also included in Attachment A, immediately following the Plan of Borings. A legend is included after the boring logs to interpret/explain the symbols, terms, and conventions used on logs. Standard Penetration Tests (SPT) were conducted in accordance with ASTM D1586 for field testing and soil sampling. The hammer correction factor is indicated on the boring logs. Liners were not used inside the standard split-barrel samplers.

The number of blows required to drive the standard split-barrel sampler for each 6-inch increment of the total 18-inch drive were measured and recorded on the boring logs. SPT N-values are defined as the total number of blows required to advance the split barrel sampler the final 12 inches of the total 18-inch drive depth. The SPT N-values indicated on the logs are raw (uncorrected) blow counts measured in the field.

Core samples of bedrock were retrieved using NQ3-size triple-tube core barrels (rock core diameter of 1-3/4 in. and hole diameter of 3 in.). For each core run, Total Core Recovery (TCR)

and Rock Quality Designation (RQD) was determined in the field and further evaluated by licensed Professional Geologists (PG). TCR, expressed as a percent, is defined as the sum of all intact core pieces divided by the total length of the core run. RQD, also expressed as a percent, is defined as the sum of all intact core pieces that are longer than 4 in. divided by the total length of the core run. TCR and RQD values of each core run are indicated on each corresponding boring log. Core pictures are also included in Attachment A, following the boring logs and legend.

Additional Field Investigation

Due to the extreme variability of subsurface conditions encountered in the borings and the inability to perform a boring at the Bent 3 location, the Materials Division requested that additional subsurface information be gathered utilizing geophysical testing across the project site. Testing across the project site was conducted from August 29 through September 1, 2023. The scope of work performed by Geotechnology Inc. included two Electrical Resistivity Tomography (ERT) surveys to establish the top of rock along the bridge alignment. Two Multichannel Analysis of Surface Waves (MASW) surveys, in the vicinity of Bent 2 and Bent 4, were conducted to measure shear wave velocities at the north and south bridge abutments, to aid in developing seismic design considerations. The geophysical exploration report along with the findings are included in Attachment B.

Lab Investigation

All samples were brought to the Materials laboratory for further evaluation and testing. Soil samples were tested to evaluate index properties and to verify soil type and classification. Lab tests were performed on representative soil samples to determine moisture content, Atterberg limits, and/or gradation. Tested soils were classified by licensed Professional Geologists (PG) in accordance with both USCS and AASHTO soil classification systems.

Rock cores were first examined by a licensed PG to verify TCR and RQD measured in the field and to obtain parameters for determination of Geologic Strength Index (GSI) and Rock Mass Rating (RMR). Compressive strength of rock cores was then determined by laboratory uniaxial compressive tests on intact rock cores in accordance with ASTM D7012, Method C. Results of uniaxial compressive tests, RMR, and GSI are included in Attachment C.

These test results are plotted or indicated on the logs using appropriate denotation (symbols in accordance with scale, number, text, etc.). The laboratory tests and their corresponding ASTM and/or AASHTO test methods, and respective denotation on the boring logs are listed in Table 1.

Table 1: Summary of Laboratory Tests and Methods

Laboratory Test	ASTM	AASHTO	Denotation on Logs
Moisture Content	D2216	T 265	Solid Circle Symbol (●)
Grain Size Analysis by Sieving	D6913	T 88	Whole Number in the "Percent Passing No. 200 Sieve" Column (e.g., 12)
Atterberg Limits	D4318	T 89	Plus Sign (+) on the Right for Liquid Limit
		T 90	Plus Sign (+) on the Left for Plastic Limit
Uniaxial Compression of Rock Cores	D7012, Method C		

D_{50} For Scour Analysis

The particle size through which 50% of particles by weight passing, D_{50}, is summarized below in Table 2. Detailed particle size distribution curve used for D_{50} determination is included in Attachment D.

Table 2: Summary of D_{50} for Scour Analysis

Station	Sample Type	Location	D_{50}, mm
215+57, 29' Rt. of Const. C.L.	Bulk	Creek Bank	0.23

Generalized Site, Geological and Subsurface Conditions

Selected site pictures are included in Attachment E. Big Creek flows from east to west at the proposed bridge site. The topography surrounding the proposed bridge is relatively flat. The proposed bridge is to be located to the east of the existing bridge.

Alluvium associated with Big Creek consists of very loose to medium dense silty sand to sandy silt and soft to medium stiff sandy silty clay to sandy clay. The sediment grades downward becoming more graveliferous toward the base of this zone, forming loose to dense sand with silt and gravel to gravel with silt and sand.

The alluvial soils overlie a thick saprolite zone, i.e., a zone of highly weathered to completely weathered bedrock. North of Big Creek, in borings at stations 215+71 to 216+90, the completely/highly weathered zone extends to a depth ranging from 34.9 to 40.7 feet below ground level (bgl). The soil in this zone varies greatly from very soft to very hard, lean to fat clay to silty clay. Many samples contain some amount of sand and rock fragments. Layers of gravel, cobbles, and boulders were also encountered in this zone.

South of Big Creek, in borings at stations 213+14 to 216+90, holes were drilled to a depth of 101.5 feet bgl and bedrock was not encountered. The soil type varies greatly from medium dense to very dense, silt to silt with sand and very soft to very stiff, fat clay to lean clay with sand. Many samples had some amount of rock fragments. There are zones of gravel, cobbles, and boulders.

Boring 3, at Station 213+80, encountered a zone of higher total core recovery (TCR) from 94.5 to 109.5 feet bgl. It is unclear if this zone represents bedrock or boulders. Poor TCR was encountered in this boring from 109.5 to 119.5 feet bgl.

In this saprolite zone, there is a high potential to encounter random boulders and pinnacling of bedrock. The bedrock underlying the saprolite consists of dolostone of the Powell Formation. The Powell Formation is generally a fine-grained, light gray to greenish-gray, limy, argillaceous dolostone with thin beds of shale, sandstone, sandy dolostone, and occasionally chert.

A generalized Subsurface Profile is included in Attachment F to aid in visualizing subsurface conditions and stratigraphy. Considering natural variations in stratigraphy and subsurface conditions, deviation from these illustrated on the profile must be anticipated.

The estimated elevations of weathered (highly weathered to weathered) and competent rock (slightly weathered to unweathered), which are suitable for foundation embedment and as revealed by the borings, are summarized below in Table 3.

Table 3: Estimated Elevation of Competent Rock – Big Creek

Bent No.	Boring No.	Ground Surface Elevation @ Boring Location, ft.	Depth to Weathered Rock (ft.)	Estimated Elevation of Weathered Rock (ft.)	Depth to Competent Rock (ft.)	Estimated Elevation of Competent Rock (ft.)
1	1	790.6	Bedrock Not Encountered in Boring			
2	2	789.9	Bedrock Not Encountered in Boring			
2	3	789.9	Bedrock Not Encountered in Boring			
4	4	790.0	N/A	N/A	39.6	750
5	5	789.3	25.0	764	34.9	754
6	6	789.2	31.0	758	33.0	756

Seismic Conditions

Seismic Site Class and Seismic Performance Zone – Considering the weighted average of the soil shear wave velocities provided by Geotechnology's geophysical study, a **Seismic Site Class C (very dense soil and soft rock profile)** is calculated for the project site. Utilizing the Seismic Site Class C and the approximate GPS coordinates of the project site, the following design peak ground acceleration coefficient (A_S), design short-period spectral acceleration coefficient (S_{DS}), as well as design long-period spectral acceleration coefficient (S_{D1}), are determined. These seismic coefficients are summarized below in Table 4. The design Response Spectrum is presented in Attachment G.

Table 4: Summary of Design Ground Motion Acceleration Response Coefficients

Code- Based Acceleration Coefficient	Value (g)
A_S (Site PGA)	0.166
S_{DS} (0.2 sec)	0.372
S_{D1} (1 sec)	0.167

For the design long-period spectral acceleration coefficient (S_{D1}) of 0.167, a **Seismic Performance Zone 2** is considered applicable for the project site.

Liquefaction Potential – Liquefaction potential of the subsurface soils were evaluated based on the results of the borings and utilizing the current Microsoft Excel© spreadsheet developed for ARDOT by the University of Arkansas. Three (3) procedures are incorporated into this spreadsheet, i.e., Youd et al. (2001) procedure, Cetin et al. (2018) procedure, and Idriss and Boulanger (2014) procedure. The results of liquefaction analyses performed utilizing the Idriss and Boulanger (2014) procedure are recommended and presented in this report.

An earthquake Moment Magnitude (M_w) of 7.0 was modelled in the analyses for this site. Design peak ground acceleration coefficient (A_S) of 0.166 g was utilized. Three borings (Borings 1, 2 & 3) were analyzed for liquefaction potential. The results of liquefaction analyses are presented as a plot of calculated factor of safety against liquefaction versus depth below existing ground surface at the boring location. These results are provided in Attachment G for Bent 1 (Boring 1) and Bent 2 (Borings 2 & 3).

Although the spreadsheet was developed with the capability to calculate factor of safety against liquefaction to any depth, research suggest that there has only been one case in which liquefaction has occurred at a depth greater than 50 feet. Liquefaction below 50-foot depth is generally considered unlikely. Consequently, it is recommended liquefiable zones below 50-foot depth be neglected from design consideration.

Results of the analyses indicate that at both bridge embankments, factors of safety less than 1.0 have been calculated from 25 feet to 35 feet below natural ground. This indicates that localized liquefaction in these zones may occur. However, based on the liquefaction analysis overall liquefaction potential is considered low.

Approach Embankments

Settlement Potential – Design drawings provided by Bridge Division indicate up to 12 feet of fill will be placed on the south abutment (Bent 1) and up to 10 feet of fill will be placed on the north abutment (Bent 6). It is anticipated that most of the settlement that occurs will be elastic settlement and will take place shortly after loading is applied. Long-term consolidation settlement is expected to be minimal.

Embankment Stability – Stability analyses have been performed to evaluate the design abutment configuration. Slope stability analyses were performed utilizing a commercial computer program Slide2 (Version 2021) developed by RocScience. Spencer analysis method was utilized to analyze the more critical 2H:1V end slopes at the abutments. Three (3) general loading conditions were analyzed with respect to slope stability: Short Term/End of Construction

Condition, Long Term Condition, and Seismic/Pseudo-Static Condition. A horizontal acceleration coefficient (K_h) of 0.083 ($0.5A_s/g$) was utilized for analysis of the Seismic/Pseudo-Static Condition. A surcharge of 250 psf was included to model the live load under long term conditions.

The results of the analyses are presented in Table 5. The graphic results of slope stability analyses are shown in Attachment H. These results of stability analyses indicate the plan abutment configurations are acceptable.

Table 5: Results of Slope Stability Analyses

Slope	Loading Condition	Calculated Min. F.S.	Recommended Min. F.S.
2H:1V End Slope – Bent 1 (South Embankment)	End of Construction (Short Term)	4.03	1.3
	Long Term	1.73	1.4
	Pseudo-Static (Seismic)	2.36	1.05
2H:1V End Slope – Bent 6 (North Embankment)	End of Construction (Short Term)	3.20	1.3
	Long Term	1.71	1.4
	Pseudo-Static (Seismic)	2.17	1.05

Foundation Recommendations

Based on discussions with Bridge Division, it is understood concrete filled steel shell piles will be utilized to support the foundation loads at Bents 1, 2, and 3 and steel H-piles will be utilized to support the foundation loads at Bents 4, 5, and 6.

Concrete Filled Steel Shell Piles (Bents 1, 2, & 3) – Nominal axial capacities (compression and uplift) vs. pile tip penetration/elevation curves for single, 20-inch diameter concrete filled steel shell piles are provided in Attachment I. These nominal axial capacities have been calculated using the static analysis method. Utilizing the axial pile capacity curves, included in Attachment I, the minimum recommended pile length, to achieve the required design nominal axial compression pile capacities, provided by Bridge Division, for Bents 1 and 2, are summarized in Table 6 below. Based on the geophysical investigation performed by Geotechnology, and the lack of boring results in the vicinity of Bent 3, at this time it cannot be accurately determined whether bedrock will be encountered. Therefore, the recommended pile type and length cannot be accurately determined. It is recommended that an exploratory boring be performed at the Bent 3 location before the tip elevation of piling can be determined. Materials Division will be available to assist in obtaining boring information at this location and providing appropriate piling design information when the time comes.

Table 6: Recommended Pile Length / Penetration (Bents 1 & 2)

Bent No.	Boring No.	Required Nominal Axial Resistance (tons)	Estimated Shallowest Pile Tip Elevation (ft.)	Comments
1	1	101	746	Preboring through cobbles and boulders zone in overburden soils will be required
2	2 & 3	166.5	710	Preboring through cobbles and boulders zone in overburden soils will be required

For single, isolated foundations, a resistance factor (φ_{stat}) of 0.45 is recommended for calculating factored compression resistance and a resistance factor (φ_{up}) of 0.35 is recommended for determining factored uplift resistance. Considering the piles at the abutments will be driven after the embankment is in place, down drag on piling is expected to be negligible. In addition, these capacities are determined for piles driven to the required penetration/elevation.

The nominal capacities are based on single, isolated foundations. Group effect on pile resistance should be evaluated in accordance with AASHTO LRFD Sections 10.7.3.9 and 10.7.3.10 for compression resistance and uplift resistance, respectively. For evaluation of pile group settlement, Section 10.7.2.3 applies. Materials Division is available to assist in evaluating group effect upon request, when detailed pile group configuration is provided.

It is understood drivability analysis will be performed by the Structural Engineer.

Steel H-Piling (Bents 4, 5, & 6) – Based on the results of the borings and discussions with Bridge Division, it is recommended that steel H-piling be utilized to support the foundation loads for the intermediate bents and end bent of the proposed bridge on the north side of Big Creek (Bents 4, 5, & 6).

Steel H-piles should be driven to practical refusal and should penetrate through embankment fill in the abutment area, the overburden soils and highly weathered rock (if any), to bear in the resistant (defined as rock that refusal is expected at) weathered dolostone or slightly weathered dolostone.

Practical refusal is defined as a maximum penetration of 1.0 inch for 20 blows by a pile hammer. For estimating pile length, a pile embedment of 6 inches into the moderately hard weathered dolostone/slightly weathered dolostone is assumed for Bents 4, 5, and 6. This estimated penetration is based on the results of the borings and our experience with similar foundation rock. The results of the borings indicate moderate to severe driving conditions are expected to be experienced. Consequently, rock points are recommended for all H-piles driven to refusal.

A minimum pile penetration of 10 feet, measured below natural ground surface, is recommended. Greater pile length/penetration may be warranted by lateral resistance demand. Based on the results of the borings and the above assumed penetration into the resistant rock,

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the estimated shallowest pile tip elevation for Bents 4, 5, and 6 are summarized below in Table 7.

Table 7: Recommended Shallowest Pile Tip Elevation (Bents 4, 5, & 6)

Bent No.	Boring No.	Estimated Shallowest Pile Tip Elevation (ft.)	Comments
4	4	750	Preboring through overburden soils will be required
5	5	761	Preboring through overburden soils and highly weathered dolostone will be required
6	6	755	

Geotechnical Input Parameters for LPile/Group – Lateral load analysis will be performed by the Structural Engineer using commercial computer programs LPile and/or Group. The geotechnical input parameters are in Attachment J.

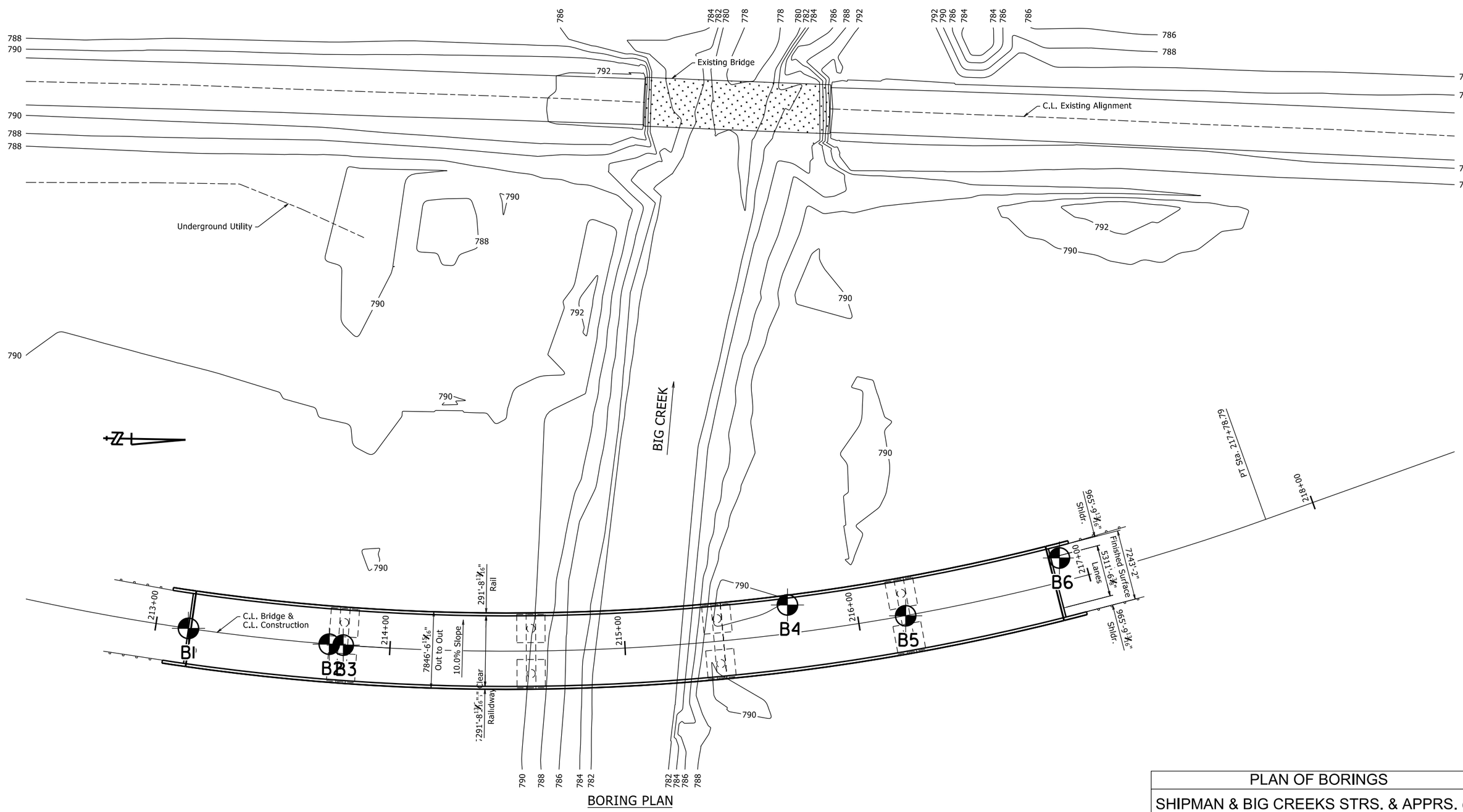
If there are any questions regarding these recommendations, please contact the Materials Division.

Paul Tinsley
Materials Engineer

PT:yz:mlg:mbb:jcs
cc: State Construction Engineer
District 5 Engineer
G. C. File

Attachment A

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
6	AR			
JOB NO.		050422		
PLAN OF BORINGS				



BORING PLAN

PLAN OF BORINGS

SHIPMAN & BIG CREEKS STRS. & APPRS. (S)
ROUTE 223, SECTION 2
FULTON COUNTY
FED. AID PROJECT

JOB NO. 050422	SHEET 1/1

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 1
PAGE 1 OF 3

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+14
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: July 12, 17, and 18, 2023
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 790.6						
			Moist, Loose, Brown Sandy Silt	-			4 4-3		
5			Moist, Loose, Brown Silty Clayey Sand with Some Gravel	SC-SM		32	2 5-3		
				-					
			Wet, Medium Dense, Brown Well Graded Sand with Silt and Gravel	SW-SM		9	12 13-16		
10				-					
			Wet, Dense, Brown Poorly Graded Sand with Silt and Gravel	SP-SM		12	14 16-22		
				-					
15			Wet, Soft, Light Brown Lean Clay	CL		89	0 2-2		
				-					
20			Wet, Soft, Light Brown Fat Clay with Rock Fragments	CH		80	2 1-1		
25				-			3 3-5		
30			Wet, Medium Stiff, Light Brown Clay with Sand and Some Rock Fragments				2 2-3		
35									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 1
PAGE 2 OF 3

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+14
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: July 12, 17, and 18, 2023
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 790.6	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
40			Wet, Medium Dense, Light Brown and Gray Silt with Some Rock Fragments	ML -	H	86	2 9-15		
45			Wet, Very Dense, Light Brown and Gray Silt with Trace Rock Fragments	ML	H	87	10 13-60 (11")		
50			Wet, Very Dense, Light Brown and Gray Gravel and Cobbles with Clay				60 (5")		
55			Cobbles and Boulders				60 (4")	60	18
60			No Sample Recovered					0	0
65			Gravel and Cobbles	-				8	0
70								0	0

REMARKS:

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BORING NO. 1
PAGE 3 OF 3

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+14
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: July 12, 17, and 18, 2023
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 790.6	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	%TCR	%RQD
75			No Sample Recovered						
80			Moist, Very Dense, Light Gray Poorly Cemented Silt				60 (5")		
85			Moist, Very Dense, Light Gray Poorly Cemented Silt with Trace Chert Fragments	ML -	H	87	23 30-60 (11")		
90			Moist, Dense, Light Gray Poorly Cemented Silt	ML -	H	96	11 12-19		
95			Moist, Very Dense, Light Gray Poorly Cemented Silt				60 (5")		
100			Moist, Very Dense, Light Brown and Light Gray Silt with Sand and Trace Chert Fragments	ML -	H	79	5 25-35		
105			Moist, Very Dense, Light Gray Poorly Cemented Silt with Sand and Some Rock Fragments Boring Terminated	ML		83	9 59-46		

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 1 OF 3

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+74
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: July 10 and 11, 2023
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 789.9						
5									
10									
15									
20									
25			Drilled to 50' before sampling.	-					
30									
35									

REMARKS:

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MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 2 OF 3

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+74
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: July 10 and 11, 2023
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 789.9						
40									
45									
50									
55			Wet, Loose, Light Brown Silt with Sand and Some Rock Fragments	ML		80	6 3-2		
				-					
60			Wet, Medium Stiff, Light Brown Fat Clay with Sand and Some Rock Fragments	CH		71	1 3-4		
							2 2-3		
65									
70			Wet, Very Dense, Light Brown and Gray Gravel and Cobbles with Clay	-			14 60 (5")		

REMARKS:

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MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 2
PAGE 3 OF 3

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+74
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: July 10 and 11, 2023
TYPE OF DRILLING:
Hollow Stem Auger-Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.9	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
75			Wet, Very Stiff, Light Brown and Gray Clay with Sand and Some Rock Fragments				0 14-6		
80			Wet, Stiff, Light Brown and Gray Lean Clay with Sand and Some Rock Fragments	CL		83	2 7-4		
85			Wet, Very Soft, Light Brown and Gray Clay with Sand and Some Rock Fragments	-			0 0-0		
90			Wet, Very Hard, Light Brown and Gray Silty Clay with Sand and Trace Rock Fragments Boulder - Harder layer encountered from 86. 5 to 87.2 feet below ground level.	CL-ML -		84	7 25-59		
95			Wet, Stiff, Light Brown Silty Clay with Rock Fragments	CL-ML		75	2 4-7		
100			Wet, Medium Dense, Light Brown Silt with Sand and Some Rock Fragments (No Sample recovered)	-			5 5-8		
105			Wet, Medium Dense, Brown Silt with Sand and Some Rock Fragments Boring Terminated	ML		80	9 9-9		

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 1 OF 4

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+80
LOCATION: Construction Centerline
LOGGED BY: Jesse Burdine

DATE: June 26 and 27, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 119.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 789.9						
			Moist, Medium Stiff, Brown Sandy Lean Clay	-					
				CL		65	3 3-4		
5				-					
				CL		65	2 2-3		
				-					
			Wet, Loose, Brown Sand with Silt and Some Gravel	SM		24	4 3-3		
10				-					
			Wet, Medium Dense, Brown Poorly Graded Gravel with Silt and Sand	GP-GM		9	8 10-11		
				-					
15									
			Wet, Soft, Light Brown and Light Gray Fat Clay	CH		87	1 2-1		
				-					
20									
			Wet, Soft, Light Brown and Light Brown Clay with Sand	CL		81	1 1-1		
				-			1 2-2		
25									
30									
			Wet, Hard, Light Brown and Light Gray Clay	CL		92	3 11-30		
35									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 2 OF 4

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+80
LOCATION: Construction Centerline
LOGGED BY: Jesse Burdine

DATE: June 26 and 27, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 119.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.9	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
40			Wet, Soft, Light Brown and Light Gray Clay	-			1 1-1		
45			Wet, Medium Dense, Light Brown Sandy Silt with Some Gravel	ML -		62	8 13-2		
50			Wet, Very Stiff, Light Brown Sandy Clay with Some Rock Fragments	CL		52	4 9-14		
55			Wet, Very Dense, Light Brown Rock Fragments with Clay and Sand Boulder Clay				60 (4")	12	0
60			Clay with Some Rock Fragments					6	0
65			Clay with Boulders					33	7
70			Clay with Trace Rock Fragments					2	0

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 3 OF 4

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+80
LOCATION: Construction Centerline
LOGGED BY: Jesse Burdine

DATE: June 26 and 27, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 119.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.9	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			(No Recovery)	-				0	0
75			Clay with Boulders					16	8
80			Clay with Trace Rock Fragments (No Recovery)					2	0
85								0	0
90			Clay with Gravel, Cobbles, and Boulders					16	0
95								72	55
100			Boulders					67	44
105									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 3
PAGE 4 OF 4

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 213+80
LOCATION: Construction Centerline
LOGGED BY: Jesse Burdine

DATE: June 26 and 27, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 119.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.9	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			Boulders with Clay					56	29
110			Clay with Some Rock Fragments					6	0
115			Clay with Boulders					30	0
120			Boring Terminated						
125									
130									
135									
140									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 4
PAGE 1 OF 2

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 215+71
LOCATION: 12' Left of Construction Centerline
LOGGED BY: Stanley Bates

DATE: June 13 and 14, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 57

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 790.0						
			Moist, Very Loose, Brown Silty Sand (Samples from 1.3 and 4.2 combined for testing)	-					
				SM		28	1 1-1		
5			Moist, Medium Dense, Brown Silty Sand with Some Gravel				2 3-11		
				-					
			Moist, Dense, Brown Silty Sand with Gravel	SM		20	7 15-30		
				-					
10			Wet, Loose, Brown and Gray Silty Gravel with Sand	GM		20	10 5-4		
				-					
			Wet, Dense, Light Brown and Light Gray Silty Sand with Rock Fragments	SM		35	20 40-9		
				-					
15			Wet, Medium Stiff, Light Brown and Gray Clay	CL		91	2 2-3		
				-					
20			Wet, Very Soft, Reddish Brown and Light Gray Clay with Sand and Trace Rock Fragments	CH		85	1 0-1		
				-					
25			Wet, Very Stiff, Reddish Brown and Light Gray Lean Clay with Sand and Some Rock Fragments	CL		80	4 12-9		
				-					
30			Wet, Stiff, Reddish Brown and Light Gray Lean Clay	CL		89	0 9-3		
35									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 4
PAGE 2 OF 2

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 215+71
LOCATION: 12' Left of Construction Centerline
LOGGED BY: Stanley Bates

DATE: June 13 and 14, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 57

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			SURFACE ELEVATION: 790.0						
			Wet, Hard, Reddish Brown and Light Gray Clay with Some Rock Fragments				0 / 1-58		
			Gravel and Cobbles with Clay						
			Clay with Boulders					43	37
40			Clay						
			DOLOSTONE - Slightly Weathered, Moderately Hard, Occasional Fractures, Gray	-				96	28
45									
			DOLOSTONE - Unweathered, Moderately Hard, Occasional Fractures, Occasional Vugs, Gray					100	78
50									
			DOLOSTONE - Unweathered with Slightly Weathered Layers, Moderately Hard, Occasional Fractures, Occasional Vugs, Gray					98	62
55									
			DOLOSTONE - Slightly Weathered, Moderately Hard, Occasional Fractures, Occasional Chert Nodules, Gray					100	82
			Boring Terminated						
60									
65									
70									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 5
PAGE 1 OF 2

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 216+20
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: June 20, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 54.9

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.3	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
			Moist, Soft, Brown Sandy Silty Clay	-					
				CL-ML		54	2 2-2		
5			Moist, Medium Dense, Brown Poorly Graded Sand with Silt and Gravel	- SP-SM -		12	3 5-16		
			Wet, Medium Dense, Brown Poorly Graded Sand with Silty Clay and Gravel	SP-SC		12	17 14-16		
10			Wet, Very Loose, Gravel with Silty Sand	-			3 2-2		
15									
			Wet, Soft, Light Brown and Gray Fat Clay	CH -		94	0 0-4		
20									
			Wet, Very Hard, Light Gray Lean Clay	CL		89	21 60 (5")		
25			DOLOSTONE - Highy Weathered, Soft, Light Gray				60 (5")		
30			DOLOSTONE WITH FREQUENT CLAY LAYERS - Slightly Weathered with Highly Weathered Layers, Moderately Hard with Soft Layers, Occasional Fractures, Gray					60	30
35								52	14

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 5
PAGE 2 OF 2

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 216+20
LOCATION: Construction Centerline
LOGGED BY: Stanley Bates

DATE: June 20, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 54.9

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.3	SOIL GROUP	MOISTURE CONTENT (%) PL — LL 10 20 30 40 50 60 70	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
40			DOLOSTONE - Slightly Weathered, Moderately Hard, Gray	-				100	88
45			DOLOSTONE - Slightly Weathered, Moderately Hard, Occasional Fractures, Occasional Chert Nodules, Gray					97	70
50			DOLOSTONE - Slightly Weathered, Moderately Hard, Occasional Fractures, Occasional Vugs, Gray					100	88
55			DOLOSTONE - Slightly Weathered, Moderately Hard, Frequent Fractures, Occasional Chert Nodules, Gray					90	42
60			Boring Terminated						
65									
70									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 6
PAGE 1 OF 2

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 216+90
LOCATION: 10' Left of Construction Centerline
LOGGED BY: Stanley Bates

DATE: June 21, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 55.7

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.2	SOIL GROUP	MOISTURE CONTENT (%) PL — LL (10 20 30 40 50 60 70)	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
				-					
			Moist, Very Loose, Brown Silty Sand	SM		30	2 2-1		
5				-					
				SM		24	2 2-2		
				-					
			Wet, Loose, Poorly Graded Sand with Silt and Gravel	SP-SM		8	3 4-6		
10				-					
				CH		87	2 1-2		
				-					
15			Wet, Soft, Brown and Gray Fat Clay (Completely Weathered Dolostone)	CH		92	0 1-2		
				-					
20				CL		92	3 4-2		
			Wet, Medium Stiff, Brown and Gray Lean Clay (Completely Weathered Dolostone)	-					
25				CL		62	1 3-5		
			Wet, Medium Stiff, Brown and Gray Sandy Lean Clay with Trace Rock Fragments (Completely Weathered Dolostone)	-					
30				CL-ML		74	5 60 (2")		
			Moist, Very Hard, Light Gray Silty Clay with Sand (Completely Weathered Dolostone)						
			DOLOSTONE - Highly Weathered					85	33
35									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SECTION

BORING NO. 6
PAGE 2 OF 2

JOB NO. 050422 Fulton County
JOB NAME: Shipman & Big Creeks Strs. & Apprs. (S)
Route 223, Section 2
STATION: 216+90
LOCATION: 10' Left of Construction Centerline
LOGGED BY: Stanley Bates

DATE: June 21, 2023
TYPE OF DRILLING:
Hollow Stem Auger - Diamond Core
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 55.7

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 789.2	SOIL GROUP	MOISTURE CONTENT (%) PL 10 20 30 40 50 60 70 LL	PERCENT PASSING NO. 200 SIEVE	NO. OF BLOWS PER 6-IN.	% TCR	% RQD
40			DOLOSTONE - Slightly Weathered with Occasional Highly Weathered Layers, Moderately Hard, Gray	-				65	36
45			DOLOSTONE - Slightly Weathered with Occastional Weathered Layers, Moderately Hard, Frequent Fractures, Occasional Vugs, Gray					94	58
50			DOLOSTONE - Slightly Weathered with Occastional Weathered Layers, Moderately Hard, Frequent Fractures, Occasional Chert Nodules, Gray					90	38
55			DOLOSTONE - Unweathered, Moderately Hard, Occasional Fractures, Occasional Chert Nodules, Gray					99	84
60			Boring Terminated						
65									
70									

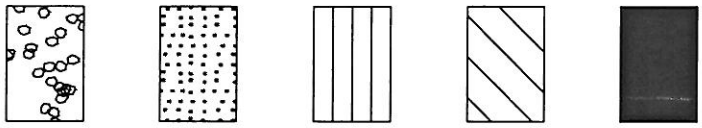
REMARKS:

LEGEND

SOIL TYPES

(SHOWN IN SYMBOL COLUMN)

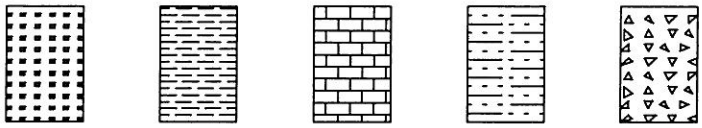
(PREDOMINANT TYPE SHOWN HEAVY)



GRAVEL | SAND | SILT | CLAY | ORGANIC MATTER

ROCK TYPES

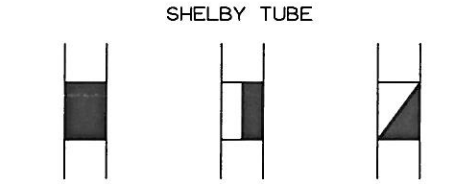
(SHOWN IN SYMBOL COLUMN)



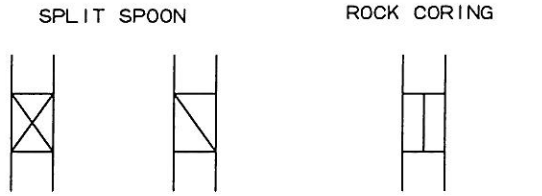
SANDSTONE | SHALE or SILTSTONE | LIMESTONE or DOLOMITE | ALTERNATING LAYERS of SHALE and SANDSTONE | OTHER

SAMPLER TYPES

(SHOWN IN SAMPLE COLUMN)



UNDISTURBED SAMPLE RECOVERY | DISTURBED SAMPLE RECOVERY | NO RECOVERY



SAMPLE RECOVERY | NO RECOVERY | % RECOVERY INDICATED ON LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

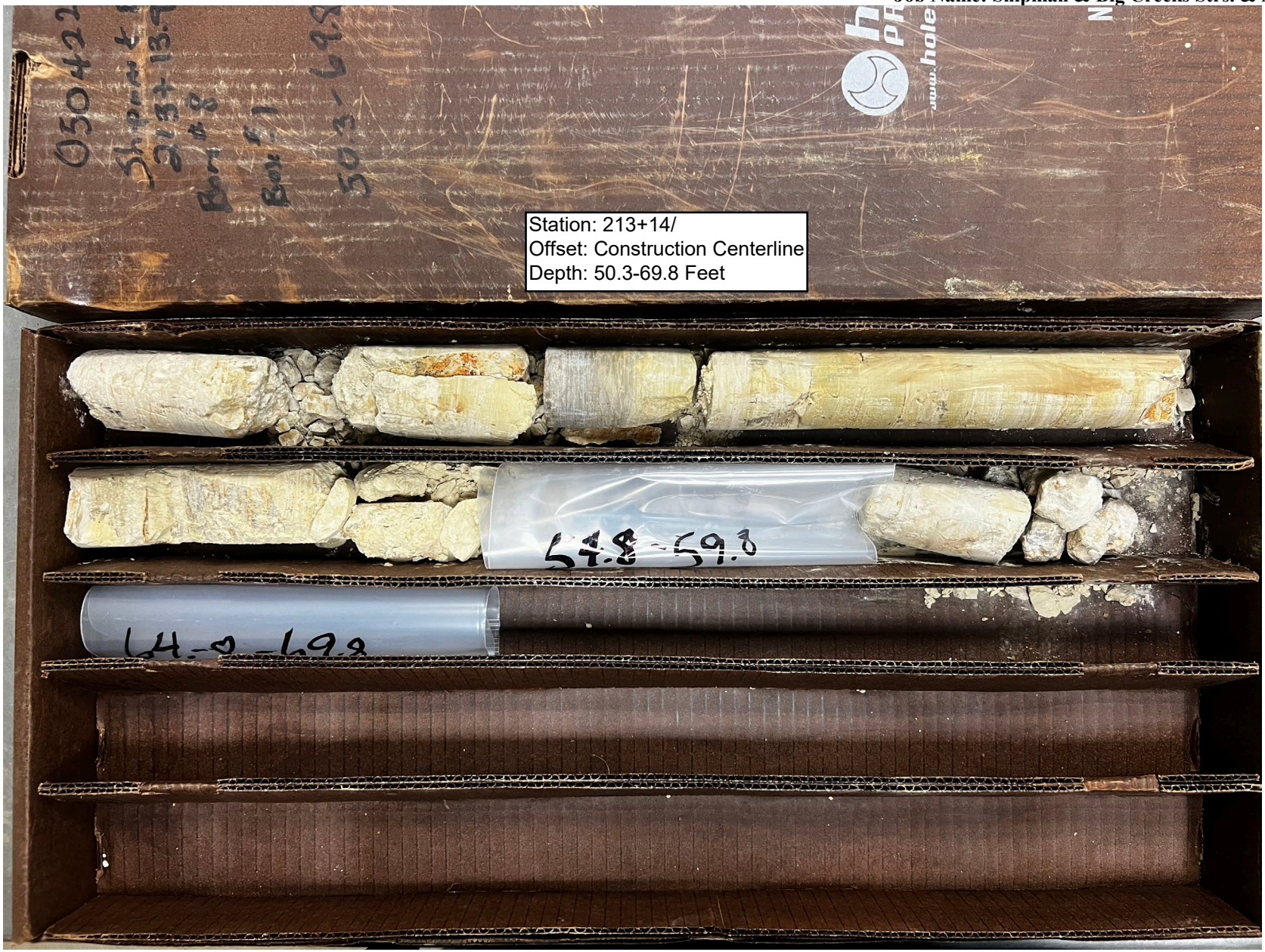
GRANULAR SOIL		CLAY		CLAY-SHALE		SHALE	
'N' Value	Density	'N' Value	Consistency	'N' Value	Consistency	'N' Value	Consistency
0-4	Very Loose	0-1	Very Soft	0-1	Very Soft		
5-10	Loose	2-4	Soft	2-4	Soft	31-60	Soft
11-30	Medium Dense	5-8	Medium Stiff	5-8	Medium Stiff	Over 60	
31-50	Dense	9-15	Stiff	9-15	Stiff	More than 2'	
Over 50	Very Dense	16-30	Very Stiff	16-30	Very Stiff	Penetration	
		31-60	Hard	31-60	Hard	in 60 Blows:	Medium Hard
		Over 60	Very Hard	Over 60	Very Hard	Less than 2'	
						Penetration	
						in 60 Blows:	Hard

1. Ground water elevations indicated on boring logs represent ground water elevations at date or time shown on boring log. Absence of water surface implies that no ground water data is available but does not necessarily mean that ground water will not be encountered at locations or within the vertical reaches of these borings.
2. Borings represent subsurface conditions at their respective locations for their respective depths. Variations in conditions between or adjacent to boring locations may be encountered.
3. Terms used for describing soils according to their texture or grain size distribution are in accordance with the Unified Soil Classification System.

Standard Penetration Test – Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary to drive the spoon 6.0 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and performing the test are recorded for each 6 inches of penetration on the drill log. The field "N" Value (N_f) can be obtained by adding the bottom two numbers for example: $\frac{6}{8-9} \Rightarrow 8+9=17 blows/ft$. The "N" Value corrected to 60% efficiency (N_{60}) can be obtained by multiplying N_f by the hammer correction factor published on the boring log.

ROCK CORE PHOTO

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)



ROCK CORE PHOTO

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)

ROCK CORE PHOTO

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)

ROCK CORE PHOTO

Job No.: 050422
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ROCK CORE PHOTO

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)

ROCK CORE PHOTO

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)

Attachment B

GEOTECHNOLOGY

A UES Company

GEOPHYSICAL EXPLORATION
HWY. 223 OVER BIG CREEK
SHIPMAN AND BIG CREEK
STRS. AND APPRS. (S)
FULTON COUNTY, ARKANSAS

ARKANSAS DEPARTMENT OF TRANSPORTATION
STATE PROJECT NO. 050422

Prepared for:
ARKANSAS DEPARTMENT OF TRANSPORTATION (ARDOT)
LITTLE ROCK, ARKANSAS

Prepared by:

GEOTECHNOLOGY, LLC
ST. LOUIS, MISSOURI

Date:

OCTOBER 2, 2023

Geotechnology Project No.:

J044257.01

SAFETY
QUALITY
INTEGRITY
PARTNERSHIP
OPPORTUNITY
RESPONSIVENESS

GEOTECHNOLOGY
A UES Company

October 2, 2023

Jessica Jackson
Arkansas Department of Transportation
PO Box 2261
Little Rock, Arkansas 72203

Re: Geophysical Exploration
Hwy 223 over Big Creek
Shipman and Big Creeks Strs. And Apprs. (S)
Fulton County, Arkansas
ARDOT Project No. 050422
Geotechnology Project No. J044257.01

Dear Ms. Jackson:

Presented in this report are the results of a geophysical exploration performed for the referenced project. This report includes our project understanding, observed site conditions and geophysical data interpretations.

It has been our pleasure to provide geophysical services to you, and we would welcome the opportunity to provide other services during the course of the project. Please contact us if you need further information or clarification about this document.

Very truly yours,

GEOTECHNOLOGY, LLC

Derek Duson, EI
Project Engineer

Jacob Monroe, P.E.
Project Engineer

DLD /CKK/JDM/ASE:dld

TABLE OF CONTENTS

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1.0 INTRODUCTION 3
1.1 Project and Site Description 3
1.2 Scope of Work 3
2.0 GEOPHYSICAL SURVEY 3
2.1 Electrical Resistivity Survey 3
2.1.1 ERT Method 3
2.1.2 Data Acquisition 3
2.1.3 Data Processing 4
2.1.4 Interpretations 4
2.2 MASW SURVEY 4
2.2.1 MASW Method 4
2.2.2 Data Acquisition and Processing 5
3.0 LIMITATIONS 5

APPENDIX A – FIGURES

Figure
Site Location and Topography 1
Aerial Photograph of Site and Geophysical Survey Location 2
Electrical Resistivity Survey Line 1 3
Electrical Resistivity Survey Line 2 4
Shear Wave Velocity Profile North Line 5
Shear Wave Velocity Profile South Line 6

APPENDIX B – PROVIDED BORING LOGS

1.0 INTRODUCTION

1.1 Project and Site Description

The Arkansas Department of Transportation (ARDOT) plans to replace the existing Highway 223 bridge over Big Creek in Fulton County, Arkansas. The site consists of relatively flat, open fields divided by Big Creek. Based on boring logs provided by ARDOT (see Appendix B), the top of rock varies in depth from between 25 feet to 40 feet on the north side of Big Creek to greater than 120 feet on the south side of Big Creek. A geophysical survey was requested to try to identify the top of rock.

1.2 Scope of Work

Geotechnology performed two electrical resistivity tomography (ERT) surveys to try to establish the approximate depth to the top of rock along the bridge alignment. Additionally, Multichannel Analysis of Surface Waves (MASW) surveys were performed to measure shear wave velocities at the north and south bridge abutments.

2.0 GEOPHYSICAL SURVEY

2.1 ERT Survey

2.1.1 ERT method

Electrical resistivity is a surface geophysical technique for which the resistivity of the subsurface is determined by transmitting current into the subsurface using two current electrodes and measuring the resulting ground voltage using pairs of potential electrodes. Resistivity values are measured in ohm-meters (Ohm-m). The resistivity of a subsurface material is based on several factors including lithology, conductivity of the matrix, porosity, permeability, clay content and moisture content. A combination of the dipole-dipole with the strong gradient array was used for the survey. This combination provides high resolution and higher signal levels compared to other array types. Anomalies can also be described in terms of conductivity, which is the reciprocal (*i.e.*, inverse) of the resistivity.

2.1.2 Data Acquisition

Electrical resistivity data were collected on August 29 through September 1, 2023 using a SuperSting R8 resistivity system manufactured by Advanced Geosciences, Inc. The resistivity lines were established at the locations presented on Figure 2, in Appendix A. The resistivity array consisted of 112 electrodes spaced at 10-foot intervals resulting in the total line lengths of approximately 1,110 feet. End points of the survey line were marked in the field and recorded using a differential global positioning system (dGPS). Elevation data were estimated based on the GPS data and available topographic maps (i.e., elevations are approximate).

2.1.3 Data Processing

The resistivity data were processed using Geotomo Res2DInv inversion software. The processing included data import, filtering "outlier" data points, incorporating elevations and generating two-dimensional vertical resistivity profiles using the robust constraint inversion method.

2.1.4 Interpretations

The resistivity models for Lines 1 and 2 are presented on Figures 3 and 4 in Appendix A. The maximum imaging depth on the resistivity profiles is approximately 220 feet (approximate elevation 570 feet). The imaging depth was truncated towards the ends of the profile to the ground surface due to the nature of electric field propagation.

On the north side of Big Creek, the interpreted top of rock appears to vary between 20 and 55 feet below the ground surface within the ERT profiles. This appears to agree with the MASW data and the ARDOT-supplied boring logs (i.e., B-4, B-5, and B-6, a copy of which is provided in Appendix B). In addition, there appears to be a low resistivity zone below the interpreted top of rock, on the north side of Big Creek, which may consist of weathered/fractured rock with a higher moisture content.

The interpreted top of rock to the south of Big Creek appears to be 190 to 195 feet below the ground surface within the ERT profiles. Above the top of rock, is the lower resistivity rock zone that may consist of wet, weathered, and/or fractured dolostone, with boulders and rock fragments based on the provided boring logs (i.e., B-1, B-2, and B-3). The higher resistivity area (centered approximately between distances 350 and 450 feet, in Figure 4) within this zone may indicate boulders with a relatively lower moisture content.

The interpreted high resistivity zone at a depth of approximately 0 to 20 feet (approximately elevations 788 to 767 feet) consists of low moisture silt, sand, and/or gravel.

Due to the interpretation of top of rock being so close to the boundary of the ERT profile, additional ground-truthing (e.g., exploratory borings) on the south side of Big Creek is recommended to verify the ERT interpretation.

2.2 MASW SURVEY

2.2.1 MASW Method

MASW surveys are performed by recording surface seismic energy (in the form of Rayleigh waves) produced by an "active" sledgehammer impact source and, if possible, using ambient "passive" sources such as vehicle traffic. The surface waves are detected by surface receivers (*i.e.*, geophones) and recorded using a seismograph. A shear wave velocity profile is constructed by analyzing the surface wave phase velocities versus frequency plots through an inversion process.

2.2.2 Data Acquisition and Processing

On August 29 and 30, Geotechnology performed MASW surveys on the north and south sides of Big Creek, near Bents 2 and 4 of the proposed bridge, see Figure 2. The survey consisted of collecting active data with a linear array of 24 geophones. The seismic array utilized a geophone spacing of 2, 4, and 10 feet, with active shot locations 0 to 48 feet off each end of the array. For passive data, the seismic array used a 10-foot geophone array.

MASW data were processed and modeled using ParkSEIS software (Park Seismic, LLC). A graph of the shear wave velocity profile for two locations is presented in Figures 5 and 6.

3.0 LIMITATIONS

This report was prepared for the exclusive use of the ARDOT for evaluating the project as it relates to the technical aspects discussed herein. It can be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions included in this report. Unless other contractual agreements were made, the services described in this report were carried out in accordance with the Terms for Geotechnology's Services that were attached to the proposal.

Geotechnology endeavored to perform the survey in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area. The findings and conclusions stated herein must be considered not as scientific certainties, but rather as professional opinions concerning the significance of the limited data gathered during the course of the survey. No warranty, express or implied, is made.

The geophysical analyses and conclusions contained in this report are based on the site conditions, project layout, grid size, geophysical data, and interpretive procedures described herein and are for preliminary planning purposes only. Geotechnology can make no interpretation as to the presence of underground features at locations beyond the survey lines.

Geophysical exploration methods are non-intrusive, indirect, and potentially influenced by a variety of natural or man-made conditions. The potential for interpreting the presence or absence of underground objects or voids is based on the recorded data as limited by site conditions and inherent resolution of the method used. While Geotechnology endeavors to provide likely geophysical interpretations based on the data available, interpretations of geophysical data are non-unique and may not represent actual conditions; hence, there will always be the potential of not observing a surface object or void or interpreting the presence of a subsurface object or void where one does not exist.

APPENDIX A – FIGURES

Figure 1 – Site Location and Topography

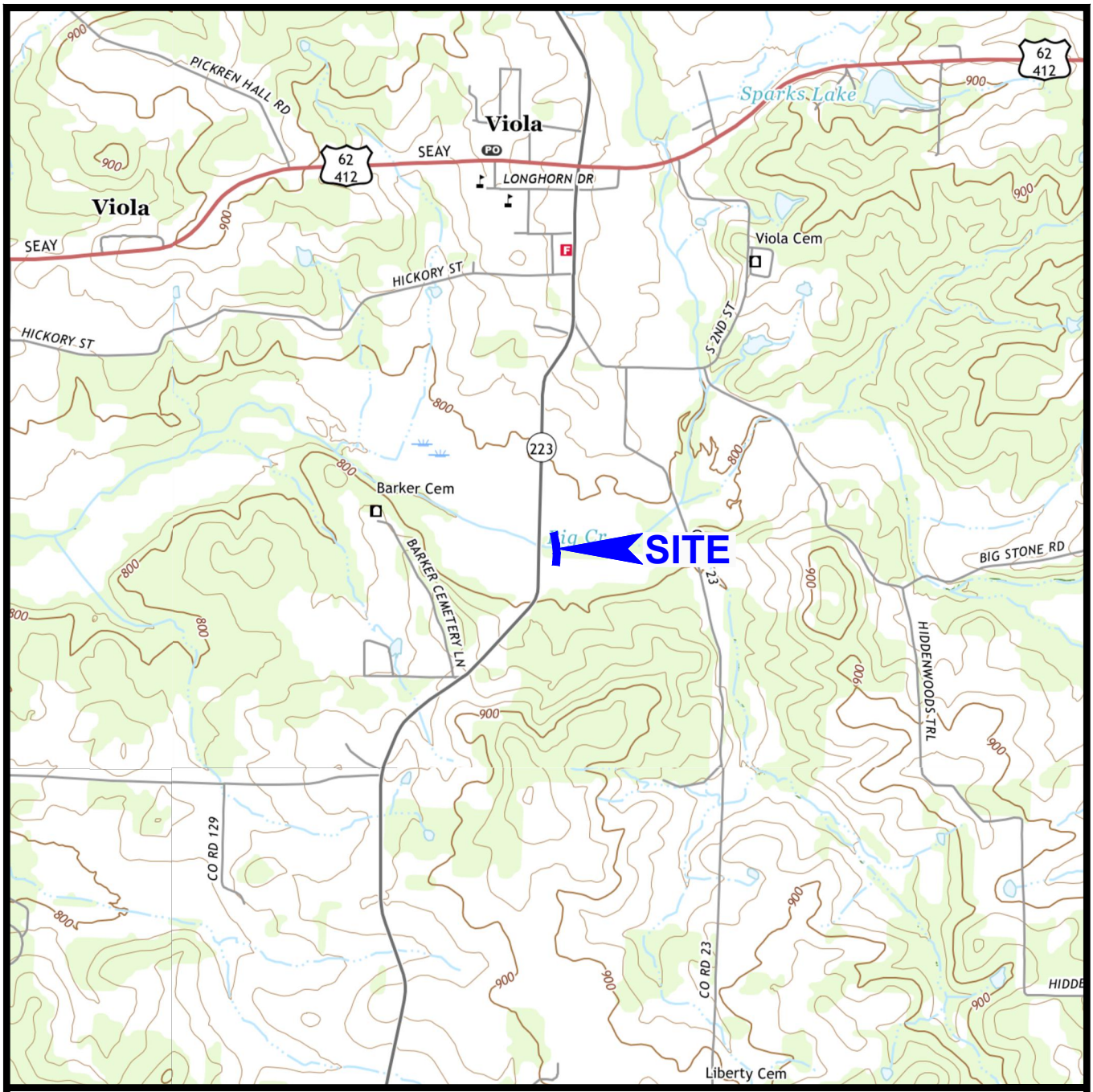
Figure 2 – Aerial Photograph of Site and Geophysical Survey Location

Figure 3 – Electrical Resistivity Survey Line 1

Figure 4 – Electrical Resistivity Survey Line 2

Figure 5 – Shear Wave Velocity Profile North Line

Figure 6 – Shear Wave Velocity Profile South Line



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Viola, Gepp, Byron and Elizabeth, Arkansas quadrangles, last revised in 2020.

0 2,000 4,000

SCALE IN FEET

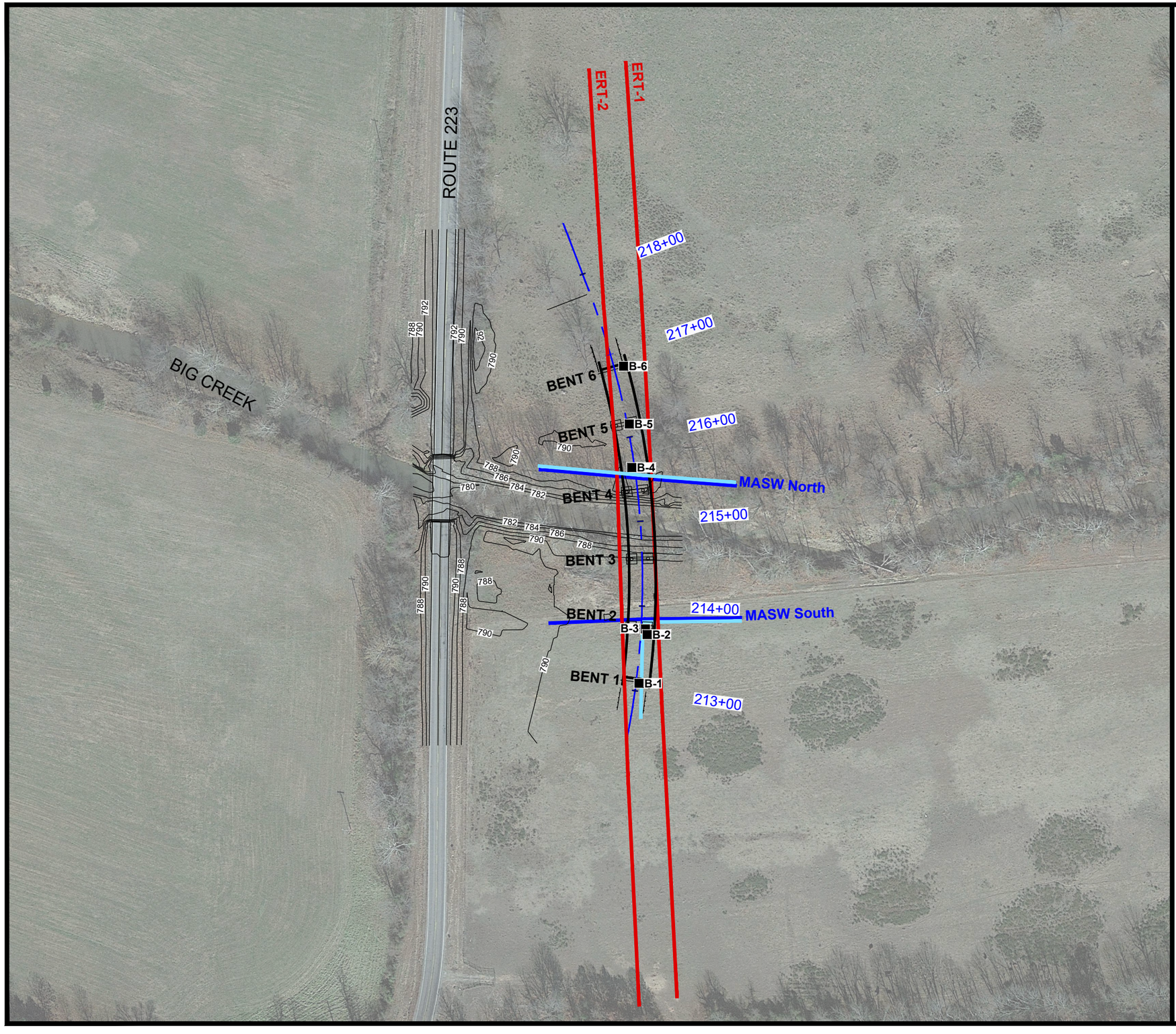
Drawn By: WAH	Ck'd By: CKK	App'vd By: DLD
Date: 9-8-23	Date: 9-26-23	Date: 9-26-23

GEOTECHNOLOGY
A UES Company

Geophysical Exploration
Highway 223 Bridge over Big Creek
Fulton County, Arkansas

SITE LOCATION AND TOPOGRAPHY

Project Number	FIGURE 1
J044257.01	



NOTES

1. Plan adapted from a November 5, 2022 aerial photograph courtesy of Google Earth and an undated drawing titled "Plan of Borings", supplied by the client.

2. ERT and MASW lines were located in the field using a dGPS device.

LEGEND

- Electrical Resistivity Survey Line (ERT)
- MASW Survey Line - Active Array
- MASW Survey Line - Passive Array
- Previous Boring Location by Others

N

0 120 240

SCALE IN FEET

Drawn By: WAH	Ck'd By: CKK	App'vd By: DLD
Date: 9-8-23	Date: 9-26-23	Date: 9-26-23

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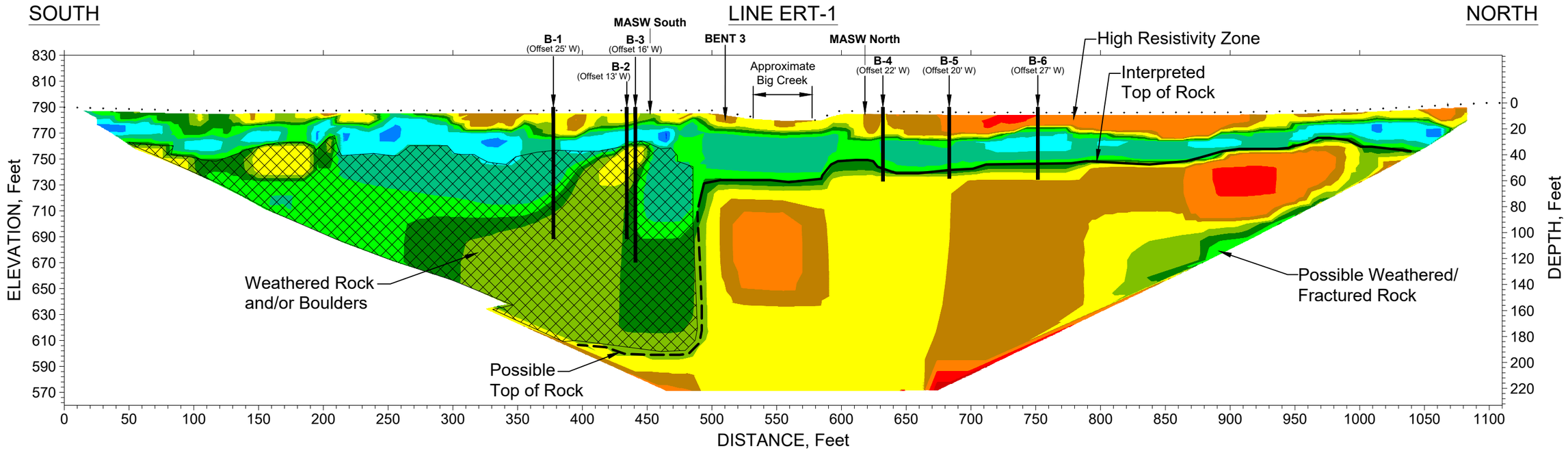
A UES Company

Geophysical Exploration
Highway 223 Bridge over Big Creek
Fulton County, Arkansas

AERIAL PHOTOGRAPH OF SITE AND GEOPHYSICAL SURVEY LOCATIONS

Project Number
J044257.01

FIGURE 2



Resistivity (ohm/m)

0 1 2.5 5 10 25 50 75 100 125 150 200 250 500 750 1000 2000

NOTES

1. See Figure 2 for location of Line ERT-1.
2. Elevations and depths are approximate.
3. Zero feet on the depth scale equals 793.13 feet on the elevation scale.

0 40 80 160

SCALE IN FEET

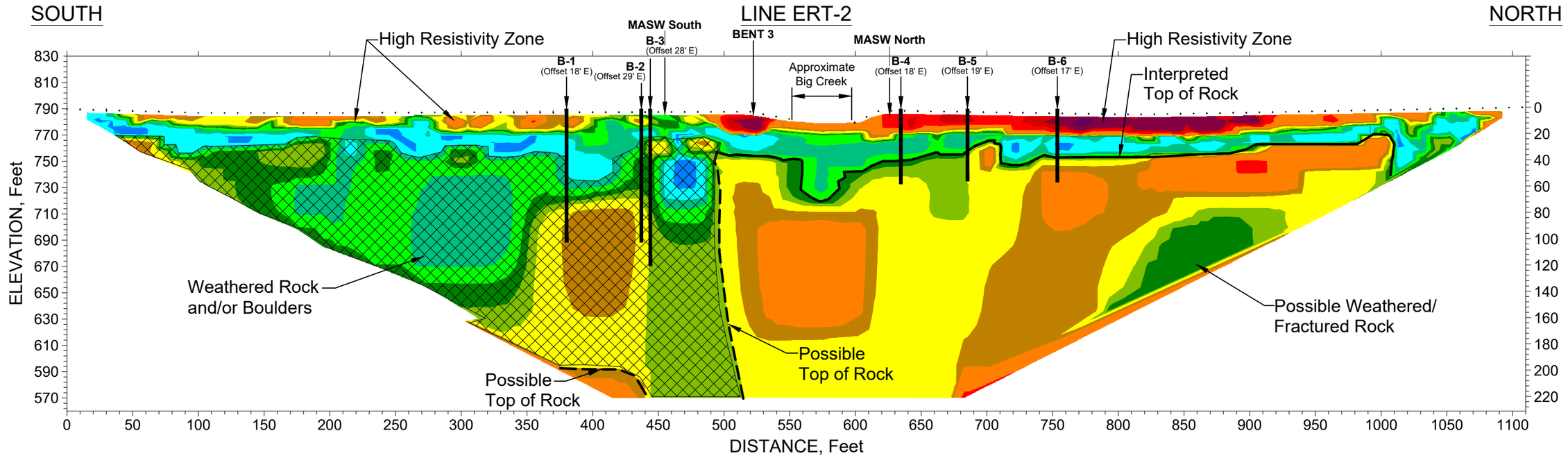
Drawn By: WAH	Ck'd By: CKK	App'vd By: DLD
Date: 9-15-23	Date: 9-26-23	Date: 9-26-23

GEOTECHNOLOGY
A UES Company

Geophysical Exploration
Highway 223 Bridge over Big Creek
Fulton County, Arkansas

ELECTRICAL RESISTIVITY SURVEY
LINE 1

Project Number	FIGURE 3
J044257.01	



Resistivity (ohm/m)

0 1 2.5 5 10 25 50 75 100 125 150 200 250 500 750 1000 2000

NOTES

1. See Figure 2 for location of Line ERT-2.
2. Elevations and depths are approximate.
3. Zero feet on the depth scale equals 791.18 feet on the elevation scale.

0 40 80 160

SCALE IN FEET

Drawn By: WAH	Ck'd By: CKK	App'vd By: DLD
Date: 9-15-23	Date: 9-26-23	Date: 9-26-23

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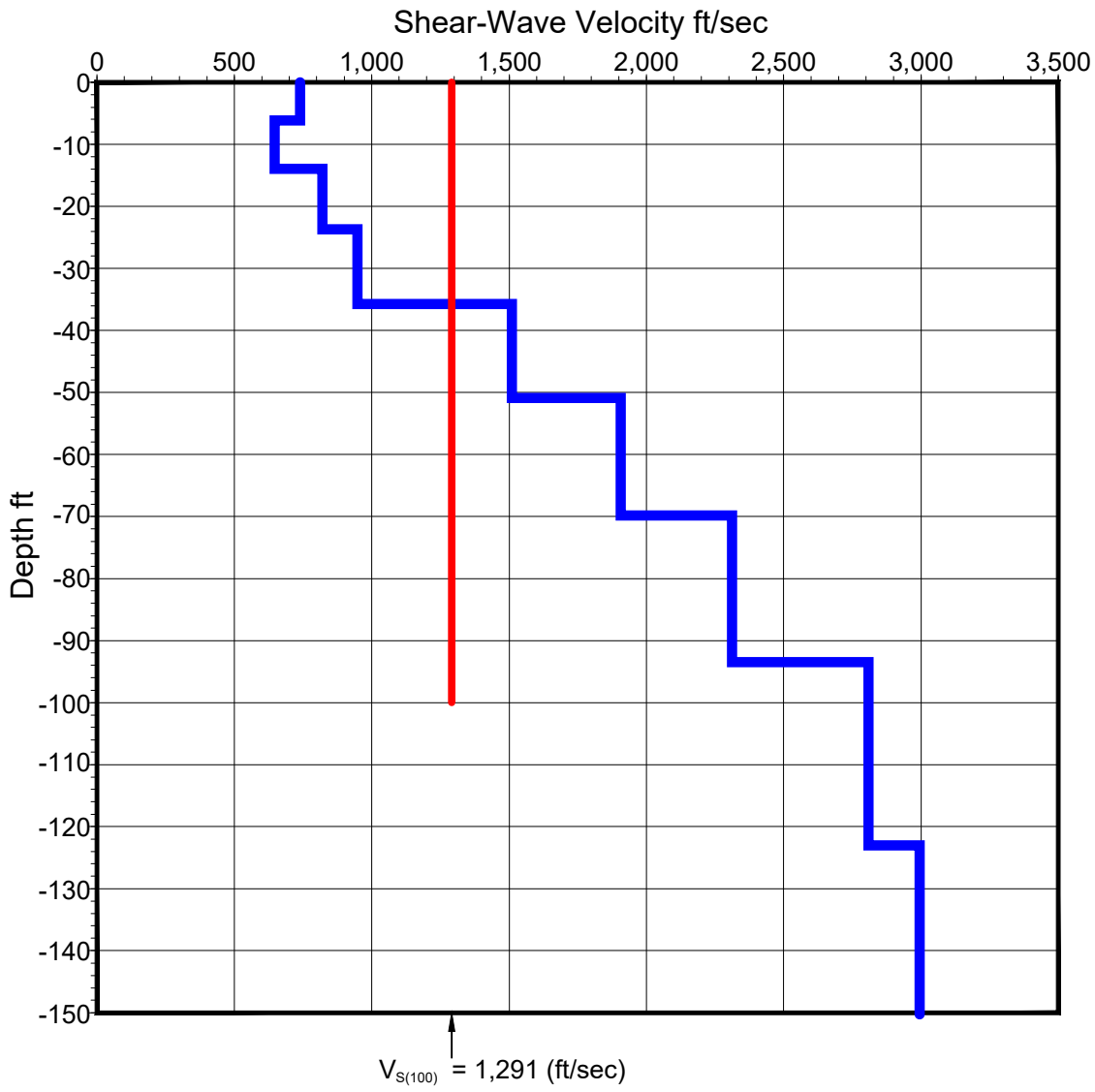
A UES Company

Geophysical Exploration
Highway 223 Bridge over Big Creek
Fulton County, Arkansas

ELECTRICAL RESISTIVITY SURVEY
LINE 2

Project Number
J044257.01

FIGURE 4



LEGEND

Shear Wave Velocity Profile

Weighted Average Shear Wave Velocity for Top 100 Feet

Drawn By: WAH	Ck'd By: CKK	App'vd By: DLD
Date: 9-15-23	Date: 9-26-23	Date: 9-26-23

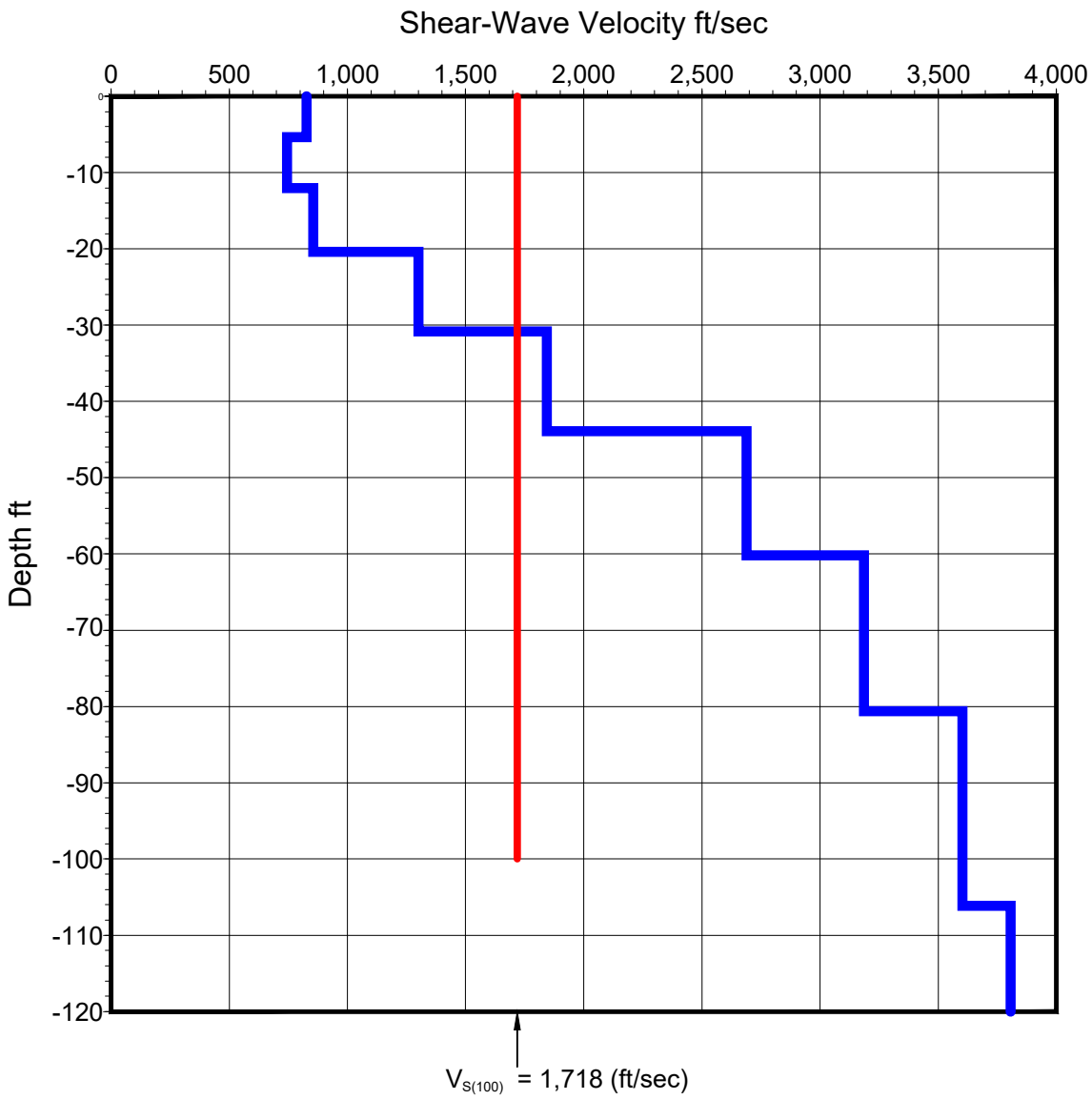
GEOTECHNOLOGY
A UES Company

Geophysical Exploration
Highway 223 Bridge over Big Creek
Fulton County, Arkansas

SHEAR WAVE VELOCITY PROFILE
NORTH LINE

Project Number
J044257.01

FIGURE 5



LEGEND

Shear Wave Velocity Profile

Weighted Average Shear Wave Velocity for Top 100 Feet

Drawn By: WAH	Ck'd By: CKK	App'vd By: DLD
Date: 9-15-23	Date: 9-26-23	Date: 9-26-23

GEOTECHNOLOGY
A UES Company

Geophysical Exploration
Highway 223 Bridge over Big Creek
Fulton County, Arkansas

SHEAR WAVE VELOCITY PROFILE
SOUTH LINE

Project Number
J044257.01

FIGURE 6

Attachment C

Summary of Rock Core Unconfined Compression Test Results

Project Number: 050422
Project Name: Shipman & Big Creeks Strs. & Apprs. (S)
Date Tested: 7/26/2023

Boring No.	Station	Location	Sample No.	Depth (ft.)	Diameter (in.)	Height (in.)	Weight g	Unit Weight pcf	Total Load (lbs.)	Correction Factor	Stress (psi)	Remarks
5	216+20	C.L.	1	33.3	1.75	3.44	356.83	164	14,280	0.975	5,937	
5	216+20	C.L.	2	36.7	1.75	3.42	349.62	162	15,910	0.974	6,615	
5	216+20	C.L.	3	44.5	1.76	3.48	362.74	163	19,880	0.978	8,171	
4	215+71	12' LT	4	42.0	1.75	3.52	366.70	165	24,110	1.000	10,024	
4	215+71	12' LT	5	46.7	1.75	3.64	376.63	164	27,120	1.000	11,275	
4	215+71	12' LT	6	51.5	1.75	3.32	345.61	165	17,940	0.966	7,459	
6	216+90	10' LT	7	33.0	1.75	3.39	338.07	158	13,800	0.971	5,737	
6	216+90	10' LT	8	36.5	1.74	3.47	344.00	159	8,360	0.978	3,516	
6	216+90	10' LT	9	43.1	1.75	3.69	366.02	157	8,180	1.000	3,401	
6	216+90	10' LT	10	48.8	1.75	3.38	336.52	158	10,790	0.970	4,486	
3	213+80	C.L.	11	95.4								Broke before testing

ROCK MASS RATING SUMMARY

JOB # 050422 **GSI** 75

SAMPLE #1

Station/Location	215+71/12' Lt
Depth (ft)	42.0
	Relative Rating
Uniaxial Compressive Strength	7
RQD	8
Spacing of Joints	20
Condition of Joints	20
Groundwater Conditions	7
Sum	*62*
Class Number	**II**
Description	**GOOD ROCK**

SAMPLE #2

Station/Location	215+71/12' Lt
Depth (ft)	46.7
Uniaxial Compressive Strength	7
RQD	13
Spacing of Joints	20
Condition of Joints	20
Groundwater Conditions	7
Sum	*67*
Class Number	**II**
Description	**GOOD ROCK**

SAMPLE #3

Station/Location	215+71/12' Lt
Depth (ft)	51.5
	Relative Rating
Uniaxial Compressive Strength	4
RQD	13
Spacing of Joints	20
Condition of Joints	20
Groundwater Conditions	7
Sum	*64*
Class Number	**II**
Description	**GOOD ROCK**

SAMPLE #4

Station/Location	216+20/CL
Depth (ft)	33.3
	Relative Rating
Uniaxial Compressive Strength	4
RQD	13
Spacing of Joints	10
Condition of Joints	20
Groundwater Conditions	7
Sum	*54*
Class Number	**III**
Description	**FAIR ROCK**

SAMPLE #5

Station/Location	216+20/CL
Depth (ft)	36.7
	Relative Rating
Uniaxial Compressive Strength	4
RQD	17
Spacing of Joints	20
Condition of Joints	20
Groundwater Conditions	7
Sum	*68*
Class Number	**II**
Description	**GOOD ROCK**

SAMPLE #6

Station/Location	216+20/CL
Depth (ft)	44.5
	Relative Rating
Uniaxial Compressive Strength	7
RQD	17
Spacing of Joints	20
Condition of Joints	20
Groundwater Conditions	7
Sum	*71*
Class Number	**II**
Description	**GOOD ROCK**

SAMPLE #7

Station/Location	216+90/10' Lt
Depth (ft)	33.0
	Relative Rating
Uniaxial Compressive Strength	4
RQD	8
Spacing of Joints	10
Condition of Joints	12
Groundwater Conditions	7
Sum	*41*
Class Number	**III**
Description	**FAIR ROCK**

SAMPLE #8

Station/Location	216+90/10' Lt
Depth (ft)	36.5
	Relative Rating
Uniaxial Compressive Strength	2
RQD	8
Spacing of Joints	20
Condition of Joints	12
Groundwater Conditions	7
Sum	*49*
Class Number	**III**
Description	**FAIR ROCK**

SAMPLE #9

Station/Location	216+90/10' Lt
Depth (ft)	43.1
	Relative Rating
Uniaxial Compressive Strength	2
RQD	8
Spacing of Joints	10
Condition of Joints	20
Groundwater Conditions	7
Sum	*47*
Class Number	**III**
Description	**FAIR ROCK**

SAMPLE #10

Station/Location	216+90/10' Lt
Depth (ft)	48.8
	Relative Rating
Uniaxial Compressive Strength	4
RQD	13
Spacing of Joints	20
Condition of Joints	20
Groundwater Conditions	7
Sum	*64*
Class Number	**II**
Description	**GOOD ROCK**

SAMPLE #11

Station/Location	
Depth (ft)	
	Relative Rating
Uniaxial Compressive Strength	
RQD	
Spacing of Joints	
Condition of Joints	
Groundwater Conditions	
Sum	
Class Number	
Description	

SAMPLE #12

Station/Location	
Depth (ft)	
	Relative Rating
Uniaxial Compressive Strength	
RQD	
Spacing of Joints	
Condition of Joints	
Groundwater Conditions	
Sum	
Class Number	
Description	

SAMPLE #13

Station/Location	
Depth (ft)	
	Relative Rating
Uniaxial Compressive Strength	
RQD	
Spacing of Joints	
Condition of Joints	
Groundwater Conditions	
Sum	
Class Number	
Description	

SAMPLE #14

Station/Location	
Depth (ft)	
	Relative Rating
Uniaxial Compressive Strength	
RQD	
Spacing of Joints	
Condition of Joints	
Groundwater Conditions	
Sum	
Class Number	
Description	

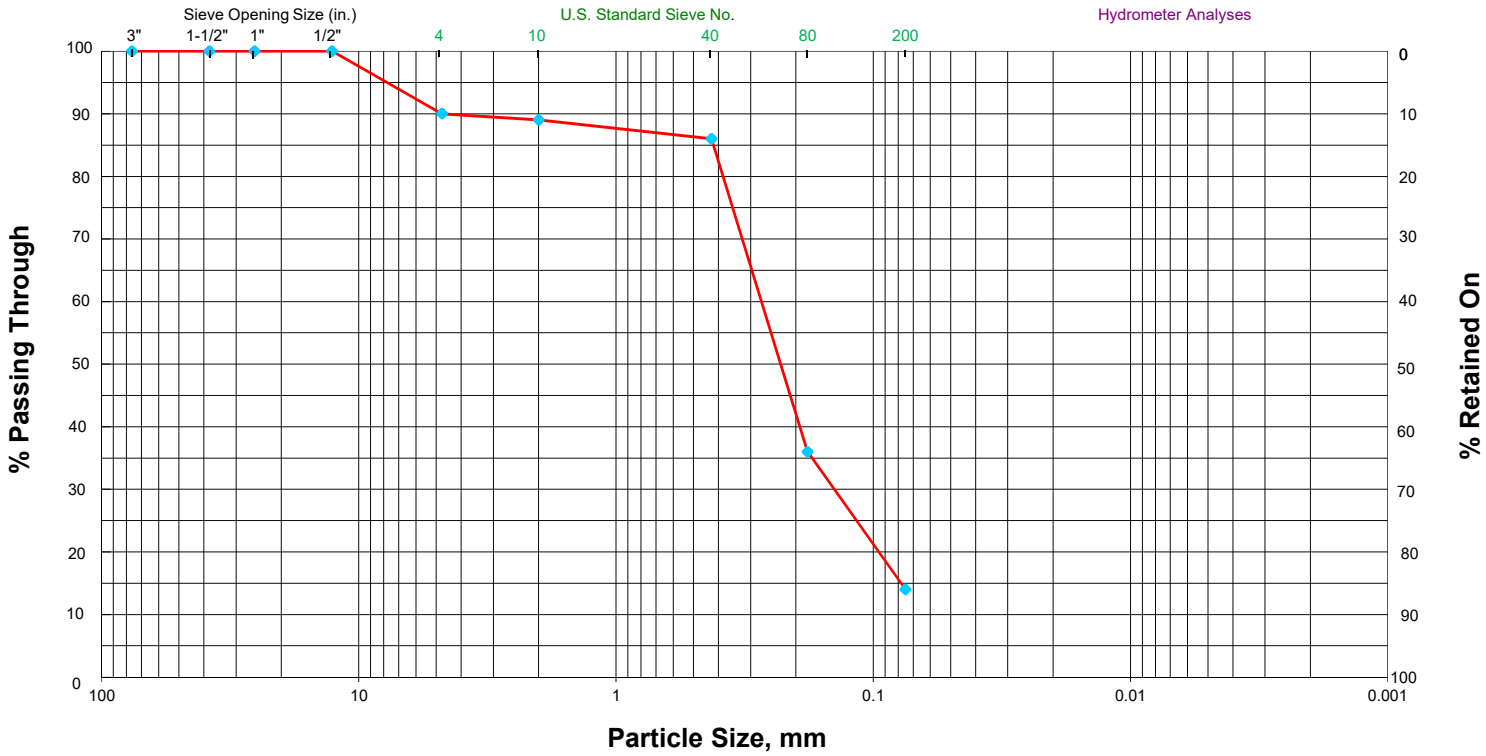
SAMPLE #15

Station/Location	
Depth (ft)	
	Relative Rating
Uniaxial Compressive Strength	
RQD	
Spacing of Joints	
Condition of Joints	
Groundwater Conditions	
Sum	
Class Number	
Description	

SAMPLE #16

Station/Location	
Depth (ft)	
	Relative Rating
Uniaxial Compressive Strength	
RQD	
Spacing of Joints	
Condition of Joints	
Groundwater Conditions	
Sum	
Class Number	
Description	

Attachment D



Particle Size Distribution Curve

Station 215+57/29' Rt of Const. CL

Attachment E

SITE PICTURES

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)
Fulton County

Location of borings 1, 2, and 3. South end of proposed new bridge location looking north. (July 2023).

SITE PICTURES

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)
Fulton County

Location of borings 4 and 5. North end of proposed new bridge location looking south. (June 2023).

SITE PICTURES

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)
Fulton County

Looking north from north bank towards proposed location for the north bridge end (June 2023).

SITE PICTURES

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)
Fulton County

Big Creek channel Looking east from existing bridge (upstream)(June 2023).

SITE PICTURES

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)
Fulton County

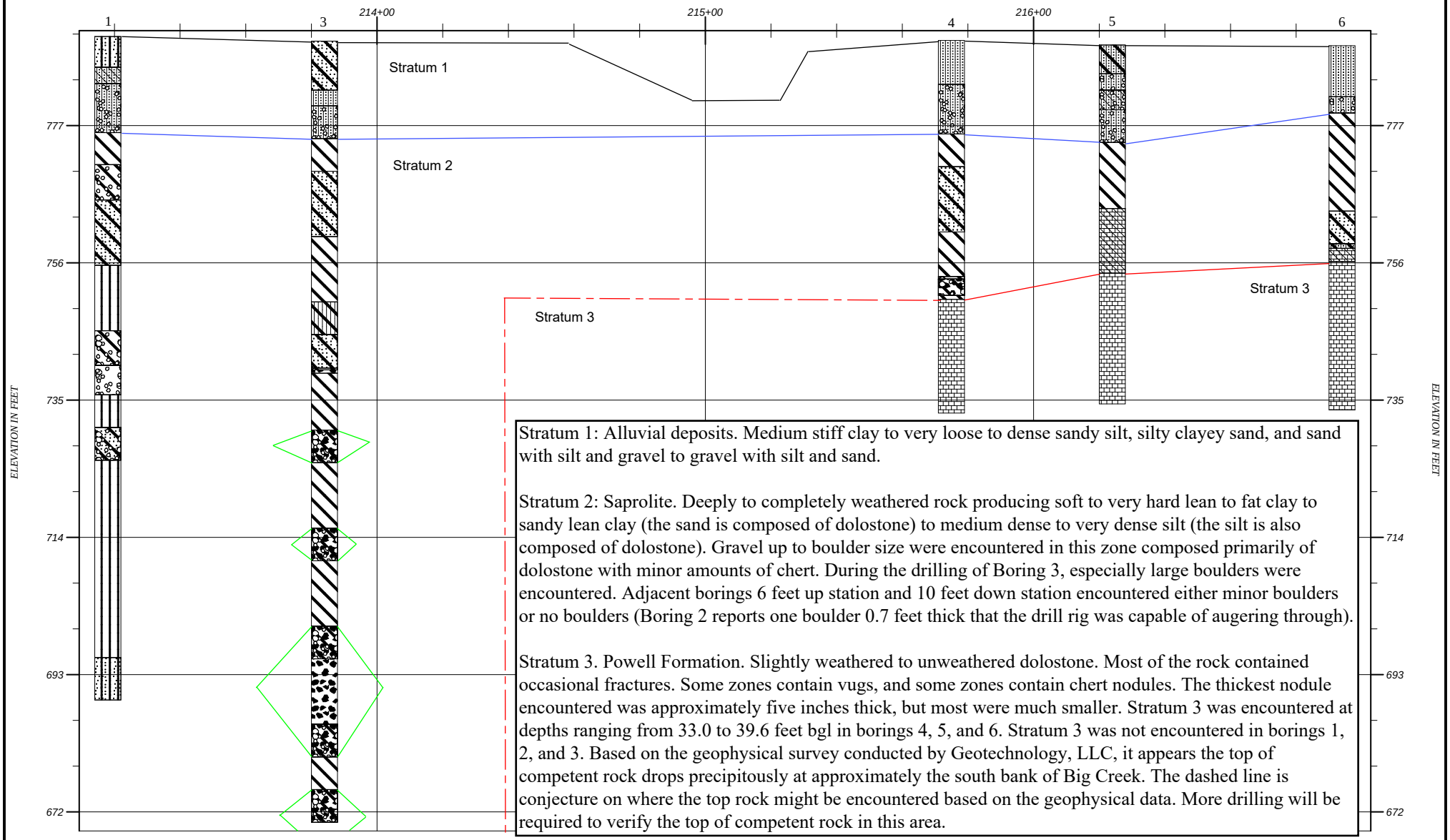
Alluvial deposits exposed in the north bank, west (downstream) of the existing bridge.
These exposed deposits are typical of what was observed in the top 10-15 feet in borings (June 2023).

SITE PICTURES

Job No.: 050422
Job Name: Shipman & Big Creeks Strs. & Apprs. (S)
Fulton County

East side of existing bridge looking downstream (June 2023)

Attachment F



Stratum 1: Alluvial deposits. Medium stiff clay to very loose to dense sandy silt, silty clayey sand, and sand with silt and gravel to gravel with silt and sand.

Stratum 2: Saprolite. Deeply to completely weathered rock producing soft to very hard lean to fat clay to sandy lean clay (the sand is composed of dolostone) to medium dense to very dense silt (the silt is also composed of dolostone). Gravel up to boulder size were encountered in this zone composed primarily of dolostone with minor amounts of chert. During the drilling of Boring 3, especially large boulders were encountered. Adjacent borings 6 feet up station and 10 feet down station encountered either minor boulders or no boulders (Boring 2 reports one boulder 0.7 feet thick that the drill rig was capable of augering through).

Stratum 3. Powell Formation. Slightly weathered to unweathered dolostone. Most of the rock contained occasional fractures. Some zones contain vugs, and some zones contain chert nodules. The thickest nodule encountered was approximately five inches thick, but most were much smaller. Stratum 3 was encountered at depths ranging from 33.0 to 39.6 feet bgl in borings 4, 5, and 6. Stratum 3 was not encountered in borings 1, 2, and 3. Based on the geophysical survey conducted by Geotechnology, LLC, it appears the top of competent rock drops precipitously at approximately the south bank of Big Creek. The dashed line is conjecture on where the top rock might be encountered based on the geophysical data. More drilling will be required to verify the top of competent rock in this area.

Plan View

Strata symbols

- sandy silt
- silty, clayey sand
- silty sand with gravel
- clay
- silty clayey sand and gravel
- limestone/dolomite
- clay with gravel
- sandy clay
- silt/cemented silt
- clay with gravel and cobbles
- gravel and cobbles
- limestone with clay seams
- sandy clay with gravel and cobbles
- silty sand
- silty clay
- sandy clay with gravel
- boulders
- sandy, silty clay
- clay with gravel, cobbles, and boulders

Arkansas Department of Transportation

Generalized Subsurface Profile

HORIZONTAL SCALE: Not to scale	DRAWN BY/APPROVED BY	DATE DRAWN
VERTICAL SCALE: Not to scale		9/27/2023

Shipman & Big Creeks Strs. & Apprs. (S)

Route 223, Section 2

PROJECT NO. 050422

Fulton County

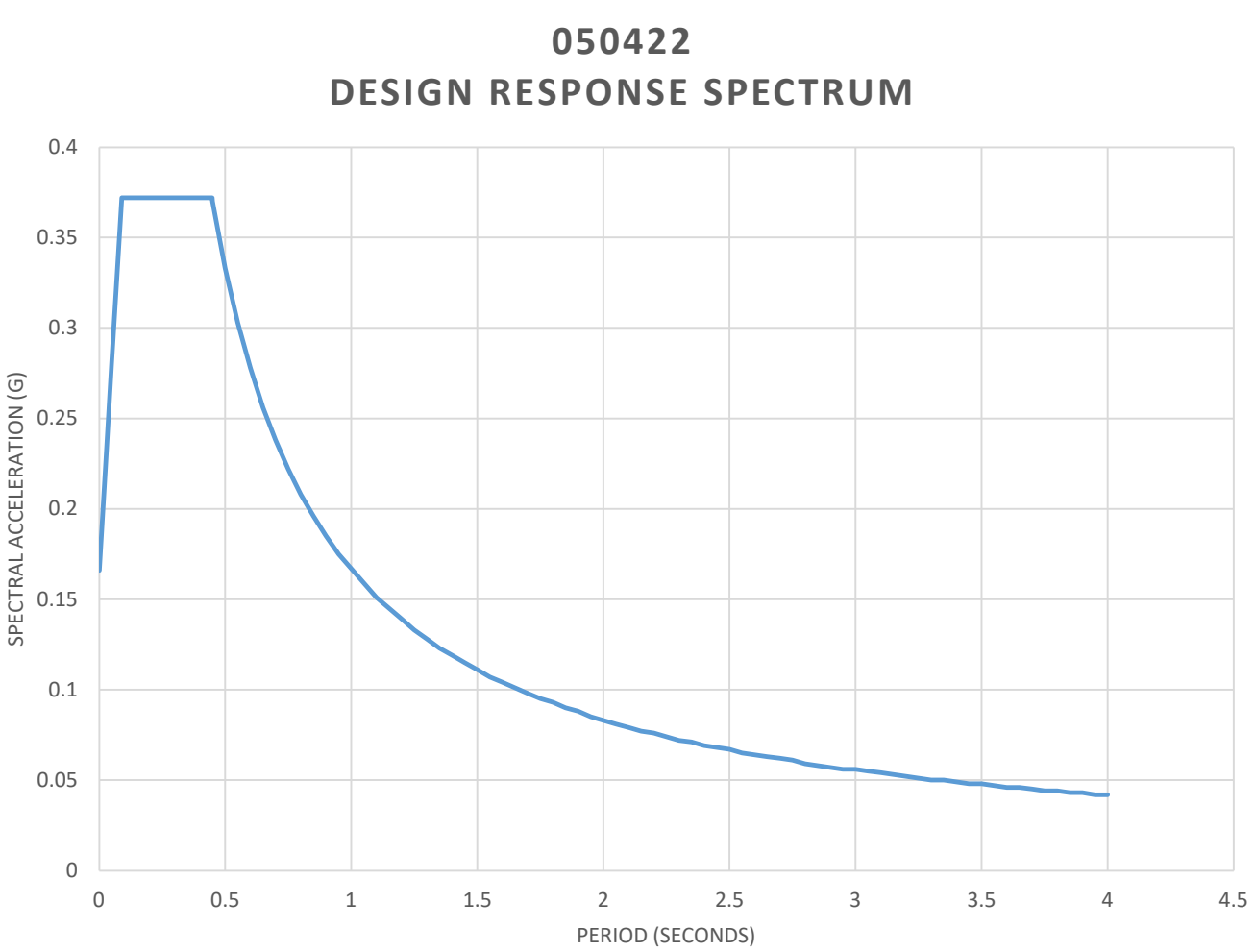
FIGURE NUMBER

Attachment G

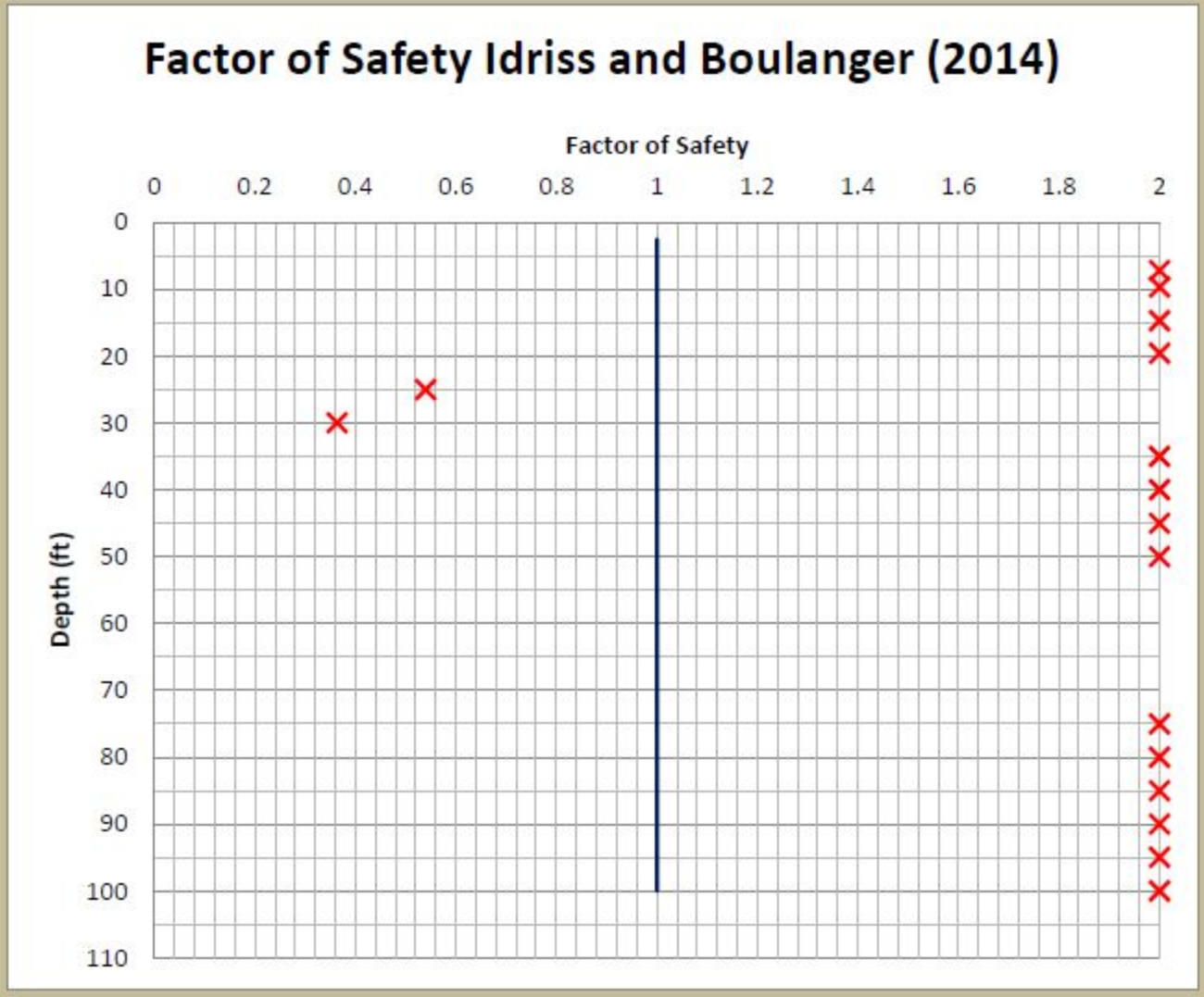
Title:	050422
Latitude:	36.3828278
Longitude:	-91.982578
Site Class	C

Get USGS Data

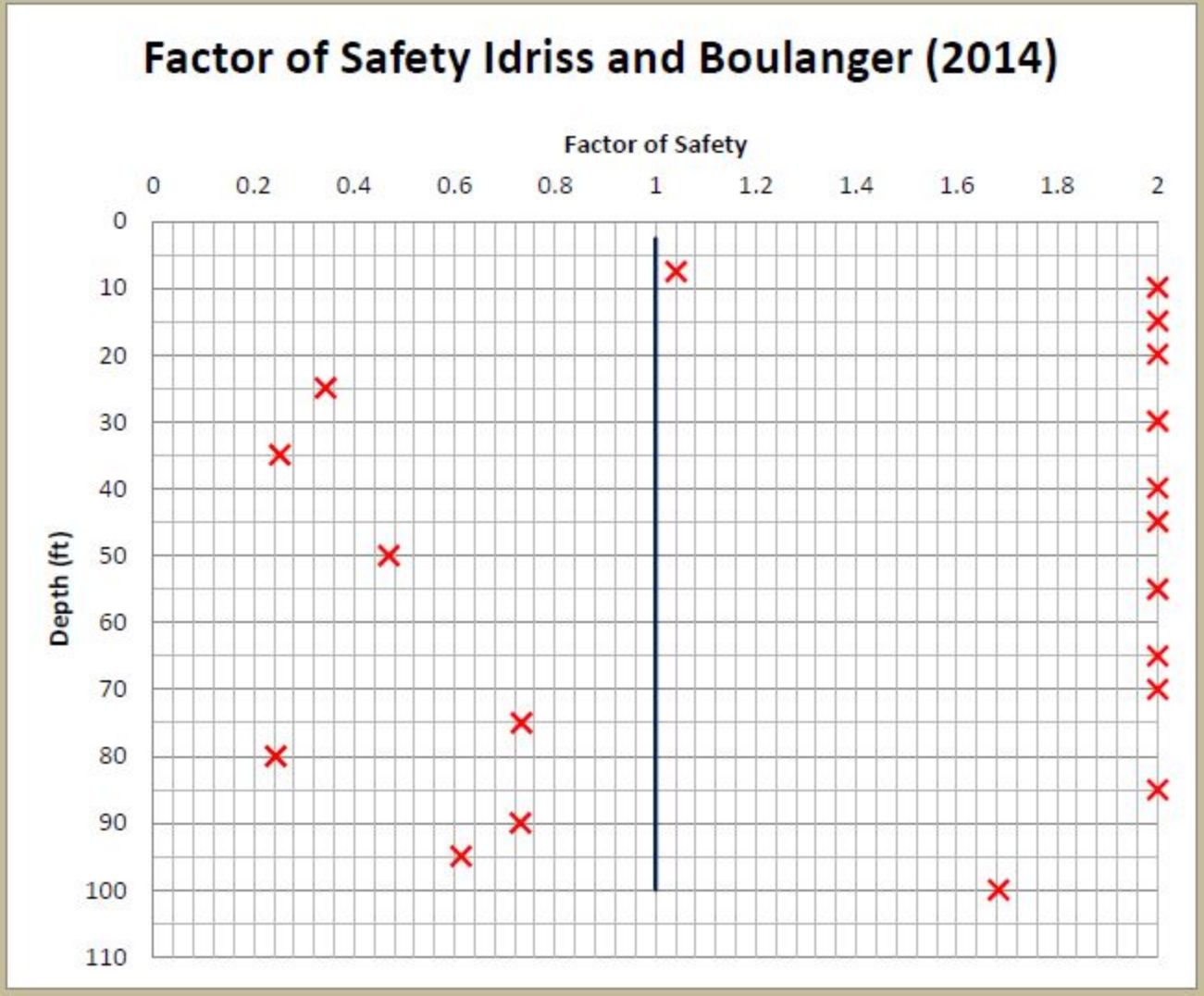
PGA:	0.138
F_{PGA}:	1.2
A_S:	0.166
S_S:	0.31
F_A:	1.2
S_{DS}:	0.372
S_1:	0.098
F_V:	1.7
S_{D1}:	0.167
S_{Dc}:	B
T_S:	0.448
T_0:	0.09



Boring 1

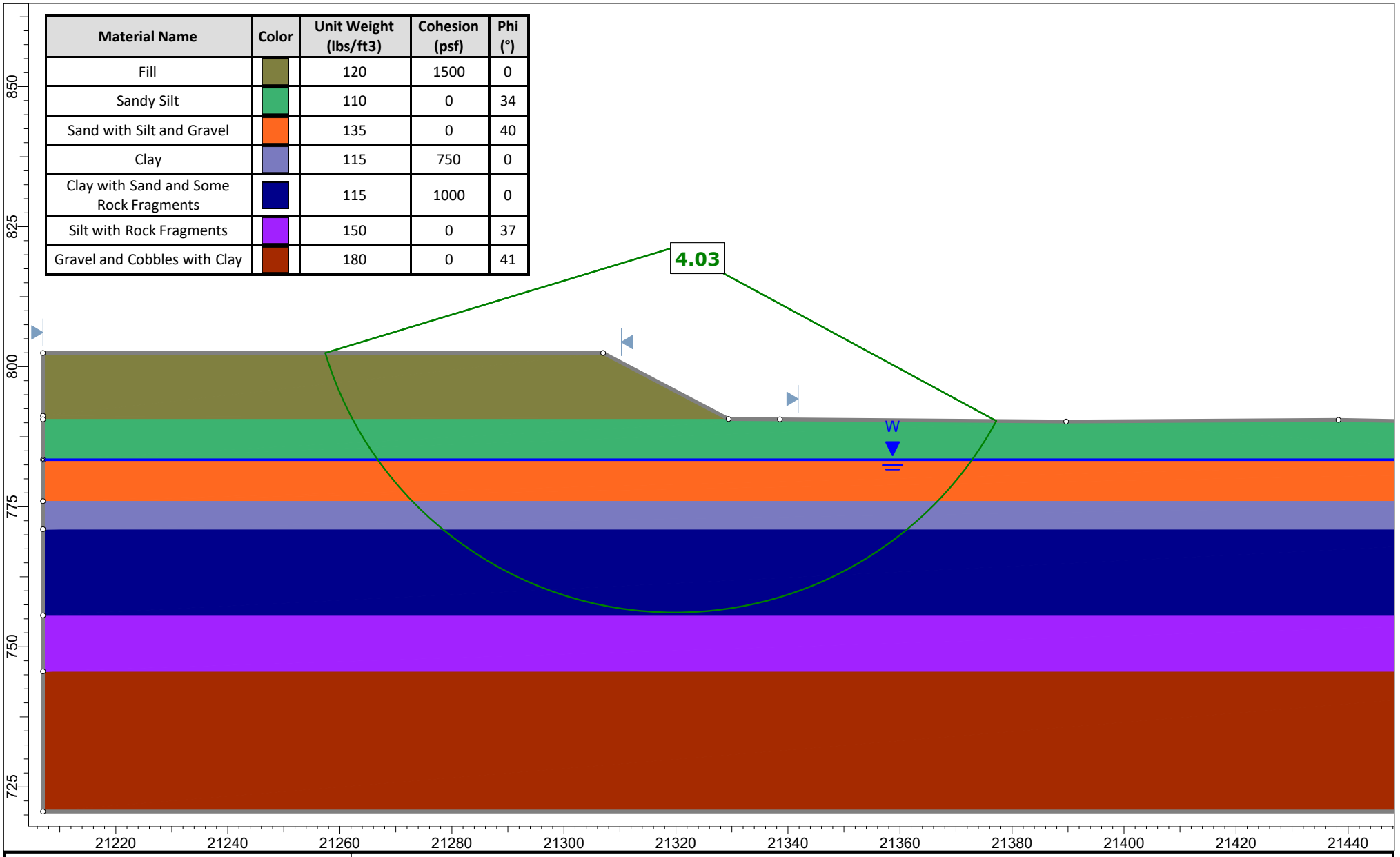

Factor of Safety Idriss and Boulanger (2014)
Factor of Safety
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110

Borings 2 & 3


Factor of Safety Idriss and Boulanger (2014)
Factor of Safety
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Depth (ft)
0
10
20
30
40
50
60
70
80
90
100
110

Attachment H

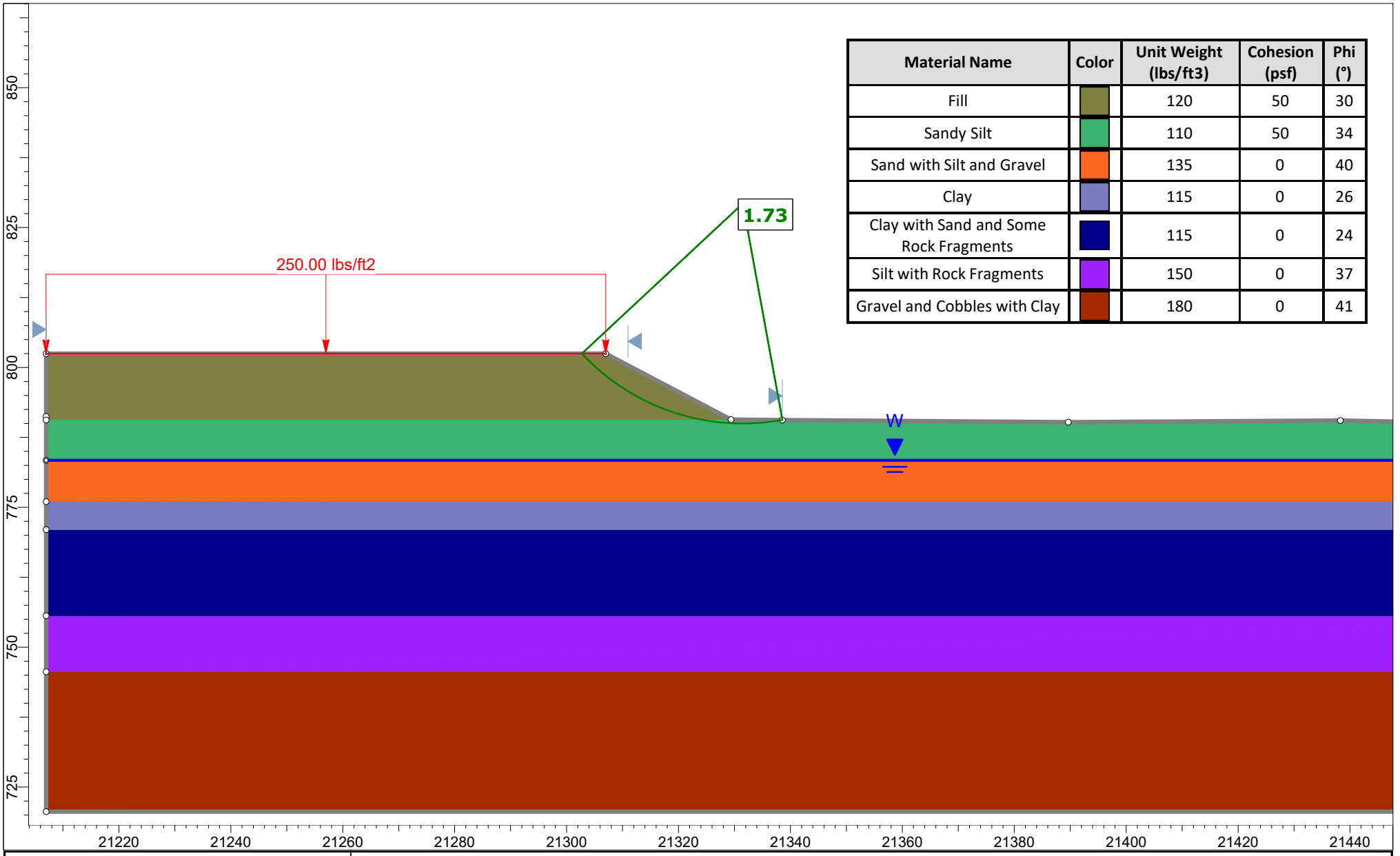
Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (°)
Fill		120	1500	0
Sandy Silt		110	0	34
Sand with Silt and Gravel		135	0	40
Clay		115	750	0
Clay with Sand and Some Rock Fragments		115	1000	0
Silt with Rock Fragments		150	0	37
Gravel and Cobbles with Clay		180	0	41



rocscience

SLIDEINTERPRET 9.028

Project	050422 Hwy. 223, Shipman & Big Creeks Strs. & Apprs. (S)		
Site	Site 1/1	Analysis Type	Short Term
Analyzed By	MBB	Configuration	South Bridge End, 1V : 2H End Slope
Date	8/30/2023		

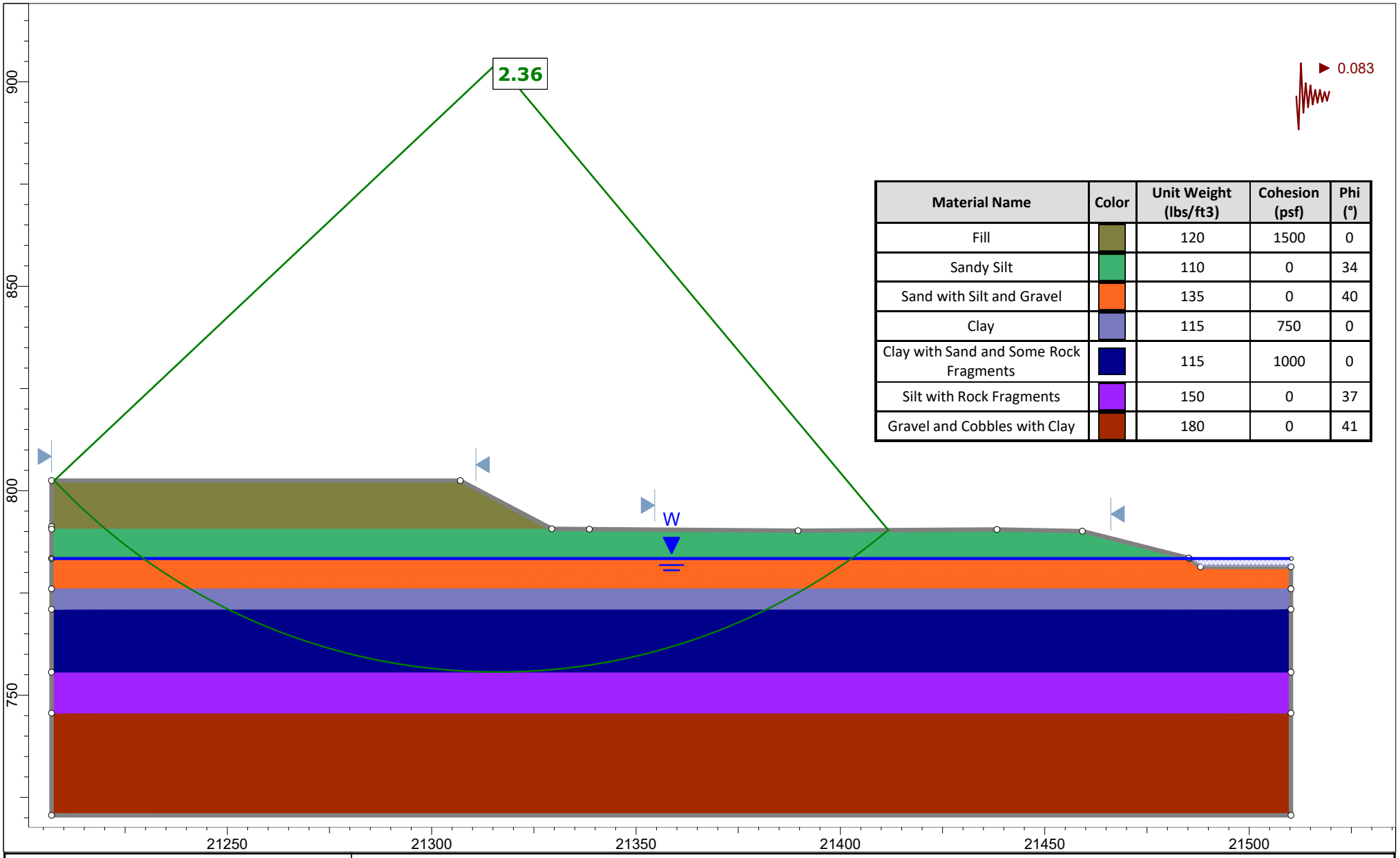


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (°)
Fill		120	50	30
Sandy Silt		110	50	34
Sand with Silt and Gravel		135	0	40
Clay		115	0	26
Clay with Sand and Some Rock Fragments		115	0	24
Silt with Rock Fragments		150	0	37
Gravel and Cobbles with Clay		180	0	41

rocscience

SLIDEINTERPRET 9.028

Project	050422 Hwy. 223, Shipman & Big Creeks Strs. & Apprs. (S)		
Site	Site 1/1	Analysis Type	Long Term
Analyzed By	MBB	Configuration	South Bridge End, 1V : 2H End Slope
Date	11/7/2023		



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (°)
Fill		120	1500	0
Sandy Silt		110	0	34
Sand with Silt and Gravel		135	0	40
Clay		115	750	0
Clay with Sand and Some Rock Fragments		115	1000	0
Silt with Rock Fragments		150	0	37
Gravel and Cobbles with Clay		180	0	41

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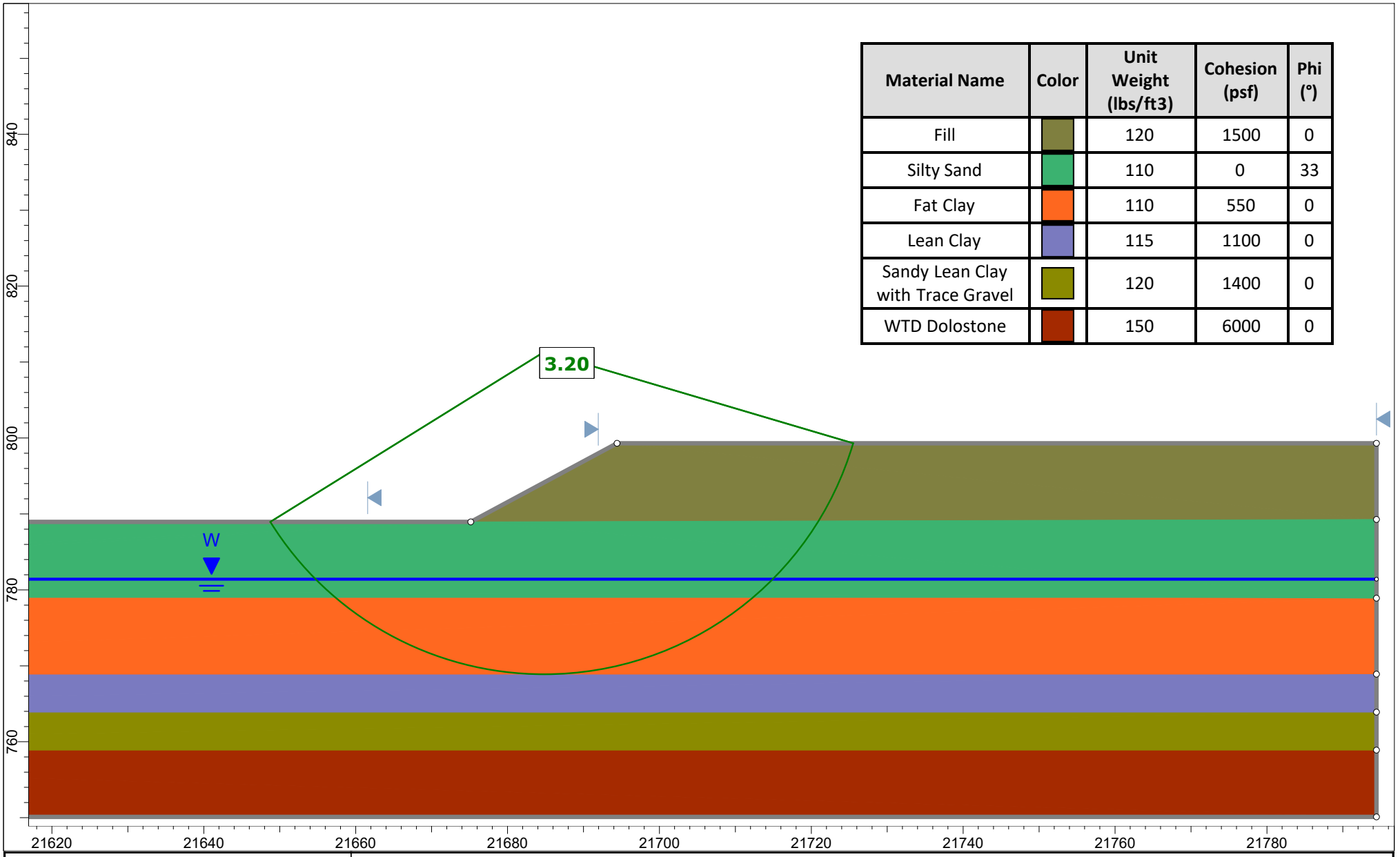
SLIDEINTERPRET 9.028

Project	050422 Hwy. 223, Shipman & Big Creeks Strs. & Apprs. (S)		
Site	Site 1/1	Analysis Type	Seismic Condition
Analyzed By	MBB	Configuration	South Bridge End, 1V : 2H End Slope
Date	9/27/2023		

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (°)
Fill		120	1500	0
Silty Sand		110	0	33
Fat Clay		110	550	0
Lean Clay		115	1100	0
Sandy Lean Clay with Trace Gravel		120	1400	0
WTD Dolostone		150	6000	0



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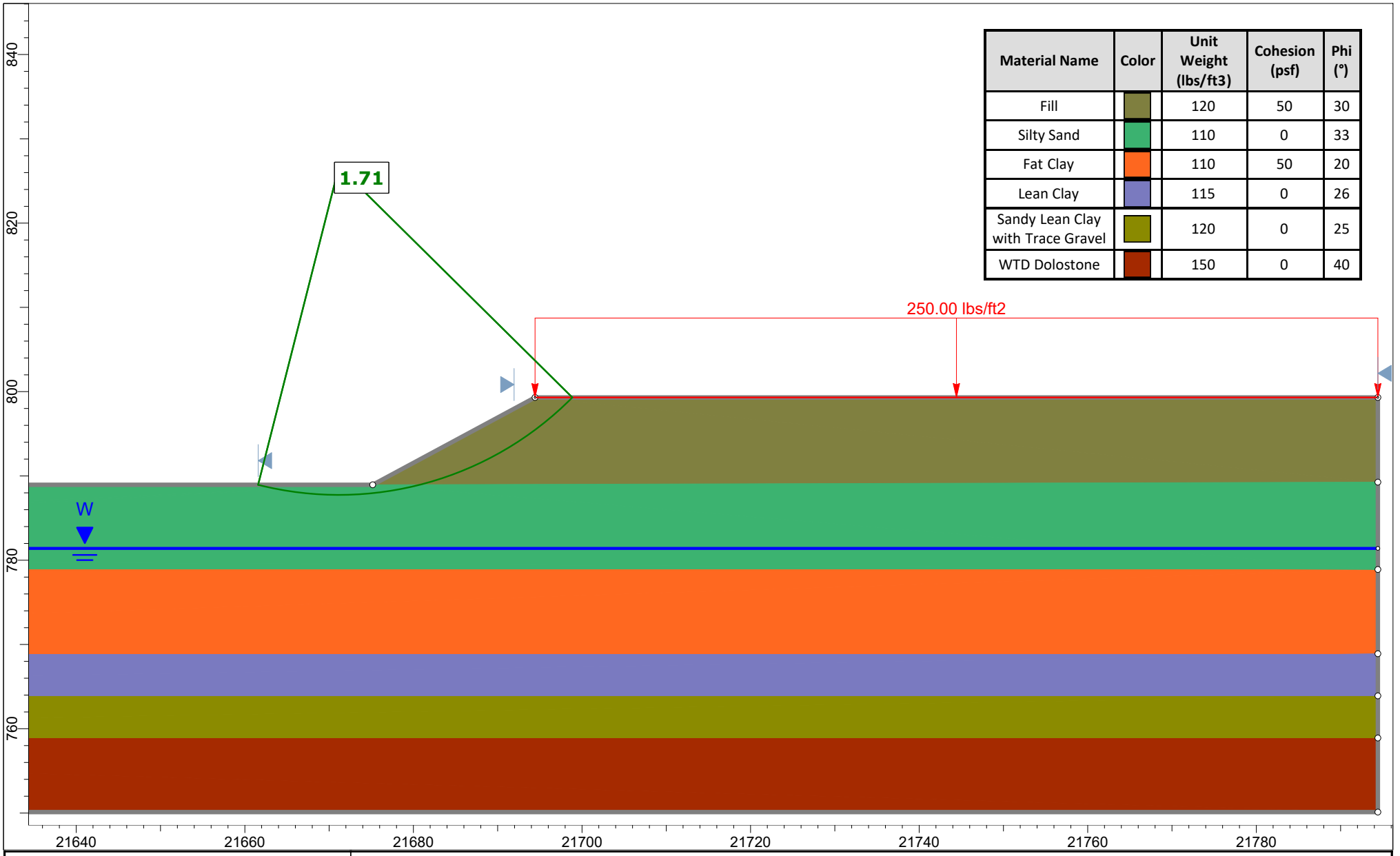
SLIDEINTERPRET 9.028

Project	050422 Hwy. 223, Shipman & Big Creeks Strs. & Apprs. (S)		
Site	Site 1/1	Analysis Type	Short Term
Analyzed By	MBB	Configuration	North Bridge End, 1V : 2H End Slope
Date	8/30/2023		



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (°)
Fill		120	50	30
Silty Sand		110	0	33
Fat Clay		110	50	20
Lean Clay		115	0	26
Sandy Lean Clay with Trace Gravel		120	0	25
WTD Dolostone		150	0	40

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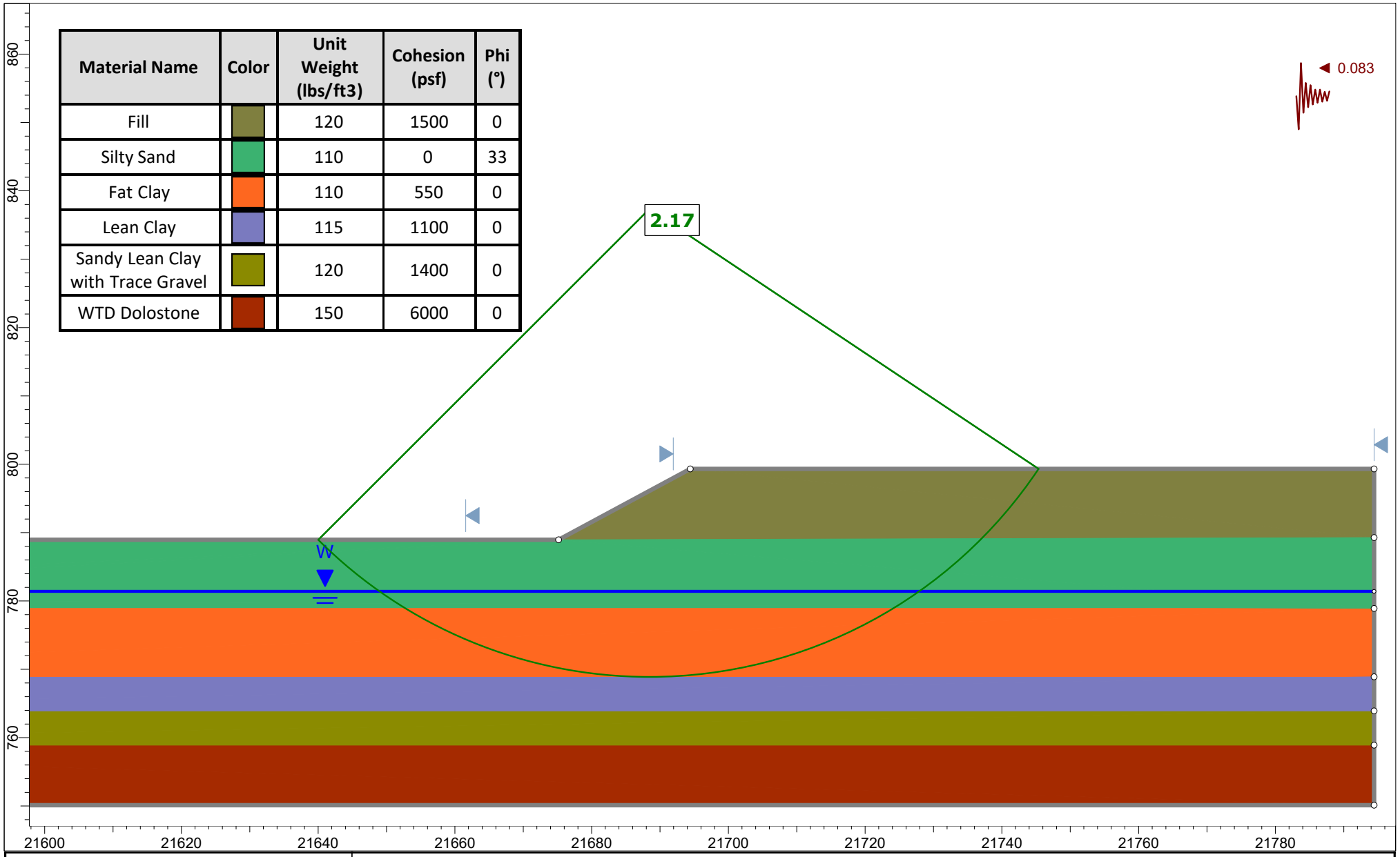
SLIDEINTERPRET 9.028

Project	050422 Hwy. 223, Shipman & Big Creeks Strs. & Apprs. (S)		
Site	Site 1/1	Analysis Type	Long Term
Analyzed By	MBB	Configuration	North Bridge End, 1V : 2H End Slope
Date	8/30/2023		

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (°)
Fill		120	1500	0
Silty Sand		110	0	33
Fat Clay		110	550	0
Lean Clay		115	1100	0
Sandy Lean Clay with Trace Gravel		120	1400	0
WTD Dolostone		150	6000	0



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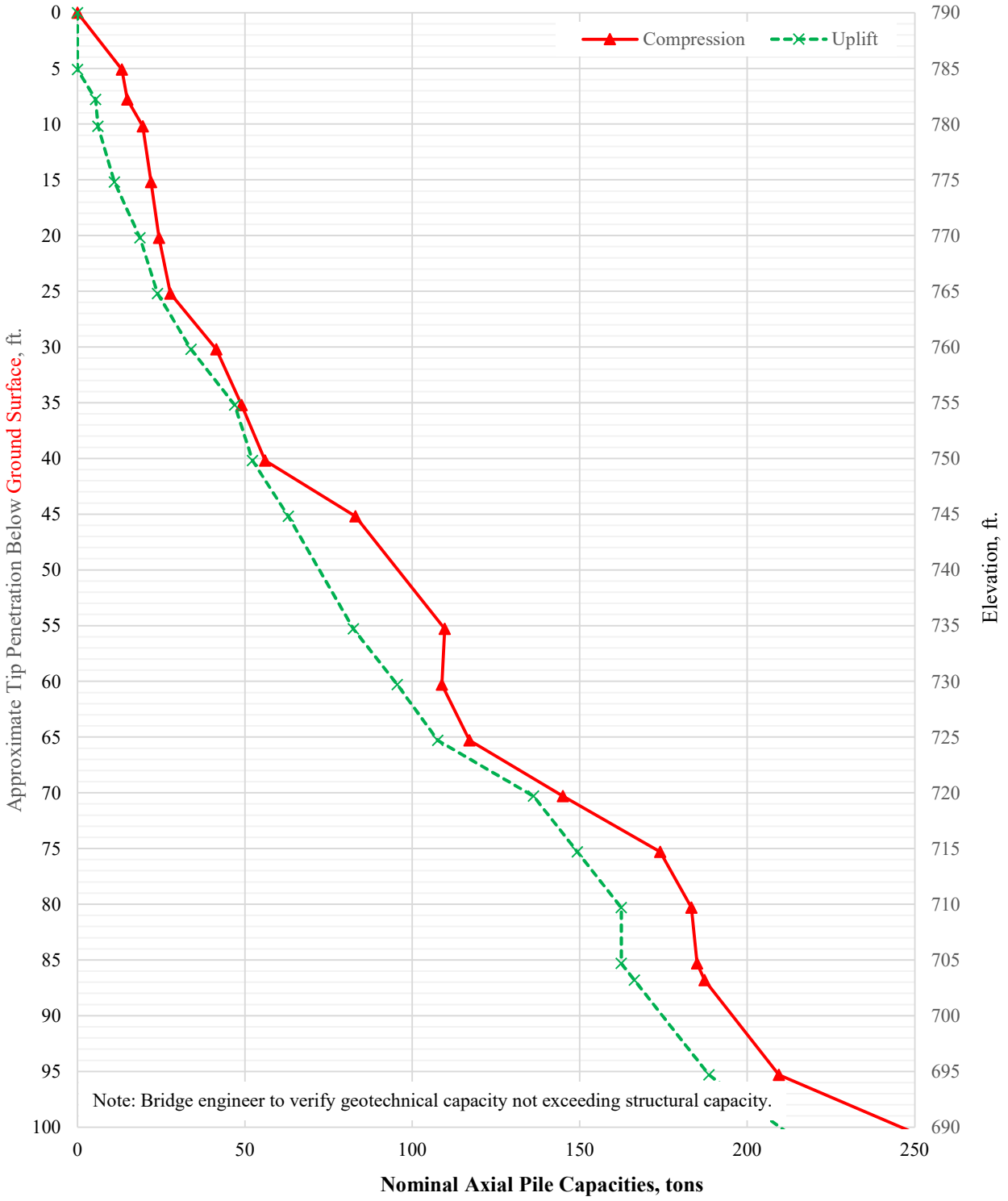
SLIDEINTERPRET 9.028

Project	050422 Hwy. 223, Shipman & Big Creeks Strs. & Apprs. (S)		
Site	Site 1/1	Analysis Type	Seismic Condition
Analyzed By	MBB	Configuration	North Bridge End, 1V : 2H End Slope
Date	9/27/2023		

Attachment I

SINGLE 20"-DIAMETER CLOSED-END STEEL SHELL PILE

Bent 1 - Sta. 213+14
Project No.: 050422
Location: Fulton County



SINGLE 20"-DIAMETER CLOSED-END STEEL SHELL PILE

Bent 2 - Sta. 213+80
Project No.: 050422
Location: Fulton County

Attachment J

Job No.:	050422
Site No.:	Big Creek

Input by:	MLG	10/3/2023
Checked by:		
Back-checked by:		

Bent 1

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci	Uniaxial Compressive Strength, q_u, psi	Rock Mass Modulus, E_{rm}, 10^6 psi	RQD, %
Top	Bottom										
Above Ground Surface		Fill	Soft Clay (Matlock)	120	750	0.0100	N/A	N/A	N/A	N/A	N/A
Ground	783	Sand & Silt	Sand (Reese)	105	N/A	N/A	33.0	78	N/A	N/A	N/A
783	776	Sand w/ Silt & Gravel	Sand (Reese)	75	N/A	N/A	38.0	119	N/A	N/A	N/A
776	755.5	Clay	Soft Clay (Matlock)	50	900	0.0100	N/A	N/A	N/A	N/A	N/A
755.5	745.5	Silt w/ Gravel	Sand (Reese)	70	N/A	N/A	36.0	92	N/A	N/A	N/A
745.5	725.5	Gravel & Cobbles	Sand (Reese)	90	N/A	N/A	38.0	119	N/A	N/A	N/A
Below 725.5		Poorly Cemented Silt	Sand (Reese)	80	N/A	N/A	37.0	104	N/A	N/A	N/A

Bent 2 / 3

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci	Uniaxial Compressive Strength, q_u, psi	Rock Mass Modulus, E_{rm}, 10^6 psi	RQD, %
Top	Bottom										
Ground	782.5	Sandy Clay	Stiff Clay w/o Free Water (Reese)	115	1150	0.0070	N/A	500	N/A	N/A	N/A
782.5	775	Sand & Gravel w/ Silt	Sand (Reese)	65	N/A	N/A	34.0	66	N/A	N/A	N/A
775	750	Clay	Soft Clay (Matlock)	45	500	0.0200	N/A	N/A	N/A	N/A	N/A
750	745	Sandy Silt w/ some Gravel	Sand (Reese)	65	N/A	N/A	34.0	66	N/A	N/A	N/A
745	740	Sandy Clay w/ some Gravel	Stiff Clay w/ Free Water (Reese)	60	2000	0.0070	N/A	500	N/A	N/A	N/A
740	735	Silt w/ Sand & some Gravel	Sand (Reese)	55	N/A	N/A	29.0	20	N/A	N/A	N/A
735	725	Clay w/ Sand & some Gravel	Stiff Clay w/ Free Water (Reese)	50	1150	0.0070	N/A	500	N/A	N/A	N/A
725	720	Gravel & Cobble w/ Clay	Sand (Reese)	90	N/A	N/A	38.0	119	N/A	N/A	N/A
720	695	Clay w/ Sand & some Gravel	Stiff Clay w/ Free Water (Reese)	60	2100	0.0050	N/A	1000	N/A	N/A	N/A
Below 695		Silt w/ Sand & some Gravel	Sand (Reese)	65	N/A	N/A	33.0	52	N/A	N/A	N/A

Bent 4

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci	Uniaxial Compressive Strength, q_u, psi	Rock Mass Modulus, E_{rm}, 10^6 psi	RQD, %
Top	Bottom										
Ground	780.5	Silty Sand	Sand (Reese)	110	N/A	N/A	33.0	78	N/A	N/A	N/A
780.5	775.5	Silty Sand w/ Gravel	Sand (Reese)	60	N/A	N/A	33.0	52	N/A	N/A	N/A
775.5	750.5	Clay w/ some Gravel	Stiff Clay with Free Water (Reese)	50	1150	0.0070	N/A	500	N/A	N/A	N/A
750.5	745	Slightly Weathered Dolostone	Weak Rock	100	N/A	0.0005	N/A	N/A	10000	3.1	28.0
Below 745		Unweathered Dolostone	Weak Rock	100	N/A	0.0005	N/A	N/A	9200	3.6	72

Bent 5

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci	Uniaxial Compressive Strength, q_u, psi	Rock Mass Modulus, E_{rm}, 10^6 psi	RQD, %
Top	Bottom										
Ground	785	Silty Clay	Soft Clay (Matlock)	110	750	0.0100	N/A	N/A	N/A	N/A	N/A
785	782.5	Sand w/ Silt & Gravel	Sand (Reese)	115	N/A	N/A	36.0	146	N/A	N/A	N/A.
782.5	774.5	Sand & Gravel	Sand (Reese)	55	N/A	N/A	30.0	20	N/A	N/A	N/A
774.5	764.5	Clay	Soft Clay (Matlock)	50	750	0.01	N/A	N/A	N/A	N/A	N/A
764.5	754.5	Highly Weathered Dolostone	Weak Rock	100	N/A	0.0005	N/A	N/A	5700	4.5	19
Below 754.5		Slightly Weathered Dolostone	Weak Rock	95	N/A	0.0005	N/A	N/A	7200	4.1	82

Bent 6

Elevation, ft		Material	Model	Effective Unit Weight, γ',pcf	Undrained Shear Strength of Soil (C_u) (psf)	Strain Factor (ε_{50} for Soil) / k_m for Rock)	Friction Angle, ϕ, °	Soil Modulus, k, pci	Uniaxial Compressive Strength, q_u, psi	Rock Mass Modulus, E_{rm}, 10^6 psi	RQD, %
Top	Bottom										
Above Ground Surface		Fill	Soft Clay (Matlock)	120	750	0.0100	N/A	N/A	N/A	N/A	N/A
Ground	781.5	Silty Sand	Sand (Reese)	105	N/A	N/A	30.0	20	N/A	N/A	N/A
781.5	779	Sand w/ Silt & Gravel	Sand (Reese)	60	N/A	N/A	33.0	52	N/A	N/A	N/A
779	756	Clay	Soft Clay (Matlock)	50	950	0.01	N/A	N/A	N/A	N/A	N/A
Below 756		Dolostone	Weak Rock	95	N/A	0.0005	N/A	N/A	4100	3.9	52