ARKANSAS DEPARTMENT OF TRANSPORTATION

SUBSURFACE INVESTIGATION

STATE JOB NO. 101126

FEDERAL AID PROJECT NO. NHPP-0016(90)

WHITEMAN CREEK STR. & APPRS. (S)

STATE HIGHWAY 158 **SECTION** 5

IN CRAIGHEAD **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 22, 2022

TO: Mr. Rick Ellis, Bridge Engineer

SUBJECT: Job No. 101126
Whiteman Creek Str. & Apprs. (S)
Craighead County
Route 158, Section 5

Introduction

Submitted herein are results of subsurface investigation performed for and geotechnical recommendations developed for the proposed replacement bridge planned on Highway 158 in Craighead County.

The project consists of constructing one structure to replace the existing bridge spanning Whiteman Creek. The proposed bridge will consist of a 180 feet long continuous integral W-beam unit with three total spans ranging from 55 feet for Span 1, 70 feet for Span 2, and 55 feet for Span 3, and will have an out-to-out width of 36 feet. The proposed alignment will be located south of the existing bridge.

Based on the geotechnical investigation request from Bridge Division, foundation loads are expected to be supported on concrete filled steel shell piles at each bent. 3-Horizontal to 1-Vertical (3H:1V) side slopes and 2H:1V end slopes are planned at both ends of the new bridge utilizing fill. Maximum abutment embankment height varies from 7 feet to 15 feet.

Field Investigation

A subsurface investigation was requested on February 1, 2022 by Bridge Division personnel to develop recommendations for bridge foundations and abutment slopes. Four (4) borings were requested and two (2) borings were drilled. The requested borings at the intermediate bents were not performed due to site inaccessibility and relatively uniform subsurface conditions across each site. The end bent borings were offset left of centerline, due to conflicts with overhead and underground utilities.

The approximate locations of the borings are presented in the Plans 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 and rotary wash 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 attached 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. Correction factor for the hammer 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 penetration of the total 18-inch drive were counted and shown on the logs. SPT N-values are defined as the number of blows required to advance the split barrel the final 12 inches. The SPT N-values indicated on the logs are raw (uncorrected) blow counts measured in field.

Groundwater was also observed during the drilling process. Groundwater observations are noted on the logs.

Lab Investigation

All samples were brought to the Materials Division laboratory for further evaluation and testing. These 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 gradation. Tested soils are classified by licensed geologists in accordance with both USCS and AASHTO soil classification systems.

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

Table 1: Summary of Laboratory Tests

Laboratory Test	ASTM	AASHTO	Denotation on Logs
Moisture Content	D2216	T 265	Solid Circle Symbol (●)
Atterberg Limits	D4318	T 89	Plus Symbol (+) on the Right for Liquid Limit
		T 90	Plus Symbol (+) on the Left for Plastic Limit
Grain Size Distribution	D6913	T 88	Whole Number in the "- No. 200 %" Column (e.g., 12)

Site Conditions

The existing bridge (Bridge No. M4060) is a 30.8 feet wide, 145 feet long, 5 span bridge consisting of steel W-beams supported by timber columns spanning Little Bay Ditch. The existing bridge is located approximately 50 feet north of the proposed new construction at log mile 2.35 on Hwy. 158. Overhead power lines parallel the south side of the existing bridge and drain culverts parallel the north side of the existing bridge. There are steel guardrails leading up to the existing bridge and concrete barrier walls crossing the existing bridge.

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 curves used for D_{50} determination are included in Attachment C.

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

Hydraulic Feature Name	Station	Sample Type	Location	D_{50} (mm)
Whiteman Creek	315+50, 6' RT of C.L.	Bulk	Creek Bank	<0.075

Site Geology and General Subsurface Conditions

The existing bridge is located southeast of Crowley's Ridge and lies within the New Madrid Seismic Zone. The soil surrounding the project location consists of mapped Quaternary terrace deposits (map symbol Qt). These terrace deposits include a complex sequence of unconsolidated gravels, sandy gravels, sands, silty sands, silts, clayey silts, and clays. Individual deposits are often lenticular and discontinuous. These deposits can be further delineating as Late Wisconsin Stage valley train Level 2 (map symbol Pvl 1-2) which includes interfluve and relict channels. A valley train is a gently sloping plain underlain by glacial outwash and confined by valley walls. The valley train deposits are underlain by sands and clays of the Tertiary Period. Valley train deposits were encountered in both borings at approximately 25 to 30 feet below ground level through the remainder of the borings. Tertiary deposits were not encountered in either of the borings.

Seismic Conditions

Seismic Site Class and Seismic Performance Zone. In light of the average subsurface conditions as revealed by the borings, a **Seismic Site Class D (Stiff Soil Profile)** was calculated for the proposed bridge over Whiteman Creek. Utilizing the Seismic Site Class D 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 for this site. These seismic coefficients are summarized in Table 3. For the design long-period spectral acceleration coefficient (S_{D1}) of 0.634g, a **Seismic Performance Zone 4** is considered applicable.

Table 3: Design Ground Motion Acceleration Response Coefficients

Acceleration Coefficient	Value (g)
A_S (Site PGA)	0.822
S_{DS} (0.2 sec)	1.487
S_{D1} (1 sec)	0.634

Design Response Spectrums are presented in Attachment D.

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 University of Arkansas. Three (3) procedures are incorporated into this spreadsheet, i.e., Youd et al. (2001) procedure, Cetin et al. (2004) procedure, and Idriss and Boulanger (2008) procedure. The results of liquefaction analyses performed utilizing the more recent Idriss and Boulanger (2008) procedure are recommended and presented in this report.

An earthquake Moment Magnitude (M_w) of 7.0 was modelled in the analyses for both sites. Design peak ground acceleration coefficient (A_S) of 0.822g was utilized. Both borings were analyzed for liquefaction potential. The results of liquefaction analysis 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 E.

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.

The results of analysis indicate that at the east bridge embankment, factors of safety less than 1.0 have been calculated in some zones, however, these zones are generally greater than 50 feet in depth with the exception of one zone at 15 feet. At the west bridge embankment, a factor of safety less than 1.0 was not calculated within the first 50 feet. The overall liquefaction potential at the project site is considered low.

Approach Embankments

Embankment Configuration As noted, 2H:1V end slopes and 3H:1V side slopes are planned for the embankments. Maximum embankment height varies from 7 feet to 15 feet.

Settlement Potential The underlying soils mainly comprise of sandy silt, sand and silt. It is anticipated that most of the settlement that occurs will be elastic settlement and take place shortly after loading is applied. Long-Term consolidation settlement is expected to be minimal.

Approach 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 east and west abutment. 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 0.411 (0.822 A_S/g) was utilized for analysis of the Seismic / Psuedo-Static Condition. A surcharge of 250 psf is included to model the live load.

Plan Embankments Slope stability analyses were performed on the 2H:1V end slopes at the west abutment (Bent 4) and the east abutment (Bent 1), to evaluate suitability of the plan configuration. (Utilizing the plan layout, the east embankment is considered stable but the west embankment is considered unstable in the case of a seismic event.) Table 4 includes the results of the slope stability analyses with the plan embankment layout. Slope stability analysis results are included in Attachment F.

Table 4: Results of Slope Stability Analyses Utilizing Plan Configuration

Design Condition	Without Geogrid-Reinforcement		Recommended Minimum Factor of Safety
	East Embankment	West Embankment	
End of Construction (Short Term)	3.54	2.73	1.3
Long Term	1.65	1.57	1.3
Pseudo-Static (Seismic)	1.13	0.82	1.05

Geogrid-Reinforced Embankment – West Abutment As stated, the embankment layout at the west abutment was determined to be unstable with respect to the plan 2H:1V end slope configuration. Additional analyses have been performed to evaluate the stability of the embankment slope formed by undercutting subgrade and incorporating biaxial geogrid reinforcements. For the purpose of the analyses, the internal reinforcement was assumed to be structural geogrid with a minimum ultimate tensile strength of 7000 pounds per foot. Based on the results of slope stability analyses, the following configuration with geogrid reinforcement is found to be suitable (see Table 6). The slope stability analysis results, for the west abutment slope, utilizing geogrid reinforcement are included in Attachment G.

Table 5: Results of Slope Stability Analyses Utilizing Reinforcement Recommendations

Design Condition	With Geogrid-Reinforcement		Recommended Minimum Factor of Safety
	East Embankment	West Embankment	
End of Construction (Short Term)	NA	3.23	1.3
Long Term	NA	2.09	1.3
Pseudo-Static (Seismic)	NA	1.09	1.05

Table 6: Recommended Configuration for Geogrid Reinforcements

Abutment (Bent No.)	Initial Layer Elev. (ft.)	Vertical Interval (ft.)	Final Layer Elev. (ft.)	Number of Layers	Length (ft.)
West Abutment (Bent 4)	221	2.0	231	6	120

Conclusions and Recommendations Conventional embankment layout is suitable for the east abutment. Consequently, ground improvements / embankment reinforcement is not required at this bridge abutment. At the west abutment, undercut and incorporation of geogrid is recommended. The subgrade at the west bridge abutment should be undercut to an elevation of 221.0. Undercut should extend at least 5 feet in front of the toe of the end slope, 5 feet beyond the toe of the side slopes, and extend the length of the geogrid behind the crest of the end slope. Undercut should be backfilled with the same materials as embankment fill. Materials and construction of geogrid should conform to the requirements specified in the project Special Provision "Geosynthetic Internal Reinforced Embankment Construction" included in Attachment H. Recommended layout and details for geogrid is also included in Attachment H.

Deep Foundations

Axial Capacities. Based on the conversations with Bridge Division, it is understood that Concrete Filled Steel Shell Piles are to be utilized to support the foundation loads at all bents.

Design nominal axial compression pile capacities of 120 and 200 tons is required at the end bents and intermediate bents, respectively.

Nominal axial capacities (compression and uplift) vs. pile tip penetration / elevation curves for single, 16-in.-diameter and 24-in.-diameter Concrete Filled Steel Shell Piles at the end bents and intermediate bents, respectively, are provided in Attachment I. These nominal axial capacities have been calculated using 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, is summarized in Table 7 below.

Table 7: Recommended Pile Length / Penetration

Bent No.	Required Nominal Axial Resistance (tons)	Pile Diameter (in.)	Recommended Minimum Pile Length (ft.)
1	120	16	35
2	200	24	35
3	200	24	35
4	120	16	35

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 that piles at the abutments will be driven after the embankment is in place, downdrag on piling is expected to be negligible. In addition, these capacities are determined for piles driven to the required penetration / elevation. If jetting or other methods are used to assist in advancing the piles, re-evaluation of these pile capacities will be warranted.

The piles are expected to be tipped in the predominantly sandy / silty soils that are likely to be liquefied during driving with considerable resistance loss at the end of initial drive. If the required nominal bearing capacity has not been obtained when top of piles are 6 inches above plan grade, considerations may be given to restriking the piles with a warmed-up hammer after a minimum 24-hour waiting time.

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. Materials Division is available to provide geotechnical input parameters upon request.

Geotechnical Input Parameters for Lateral Load Analysis Using LPile. Lateral load analysis will be performed by the Structural Engineer using commercial computer program LPile.

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

Table 8a through 8d contain the geotechnical input parameters recommended for use in LPile lateral load analysis.

Table 8a: Recommended Geotechnical Parameters for LPile Analysis – Bent 1

Elevation (ft.)	p-y Curve Model	Effective Unit Weight (γ') (pcf)	Undrained Shear Strength (c_u) (psf)	Strain Factor (ε_{50})	Friction Angle (ϕ) (Deg.)	Soil Modulus (k) (pci)
Above Existing Grade (fill)	Soft Clay (Matlock)	125	750	0.01	NA	NA
Existing Grade to 216	Sand (Reese)	120	NA	NA	33	78
216 to 206	Sand (Reese)	58	NA	NA	32	40
206 to 121	Sand (Reese)	55	NA	NA	36	93
Below 121	Sand (Reese)	78	NA	NA	37	104

Table 8b: Recommended Geotechnical Parameters for LPile Analysis – Bent 2

Elevation (ft.)	p-y Curve Model	Effective Unit Weight (γ') (pcf)	Undrained Shear Strength (c_u) (psf)	Strain Factor (ε_{50})	Friction Angle (ϕ) (Deg.)	Soil Modulus (k) (pci)
Existing Grade to 216	Sand (Reese)	120	NA	NA	33	78
216 to 206	Sand (Reese)	58	NA	NA	32	40
206 to 121	Sand (Reese)	55	NA	NA	36	93
Below 121	Sand (Reese)	78	NA	NA	37	104

Table 8c: Recommended Geotechnical Parameters for LPile Analysis – Bent 3

Elevation (ft.)	p-y Curve Model	Effective Unit Weight (γ') (pcf)	Undrained Shear Strength (c_u) (psf)	Strain Factor (ε_{50})	Friction Angle (ϕ) (Deg.)	Soil Modulus (k) (pci)
Existing Grade to 211	Soft Clay (Matlock)	110	550	0.01	NA	NA
211 to 201	Soft Clay (Matlock)	42	400	0.02	NA	NA
201 to 137	Sand (Reese)	73	NA	NA	35	78

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

Table 8d: Recommended Geotechnical Parameters for LPile Analysis – Bent 4

Elevation (ft.)	p-y Curve Model	Effective Unit Weight (γ') (pcf)	Undrained Shear Strength (c_u) (psf)	Strain Factor (ε_{50})	Friction Angle (ϕ) (Deg.)	Soil Modulus (k) (pci)
Above Existing Grade (fill)	Soft Clay (Matlock)	125	750	0.01	NA	NA
Existing Grade to 222	Soft Clay (Matlock)	110	450	0.02	NA	NA
222 to 211	Stiff Clay w/o Free Water	110	550	0.01	NA	NA
211 to 201	Soft Clay (Matlock)	42	400	0.02	NA	NA
201 to 137	Sand (Reese)	73	NA	NA	35	78

Pile Installation. Piles should be installed in accordance with Section 805 (2014 Edition). Prior to piling, hammer systems furnished by the Contractor should be evaluated and approved by the Engineer.

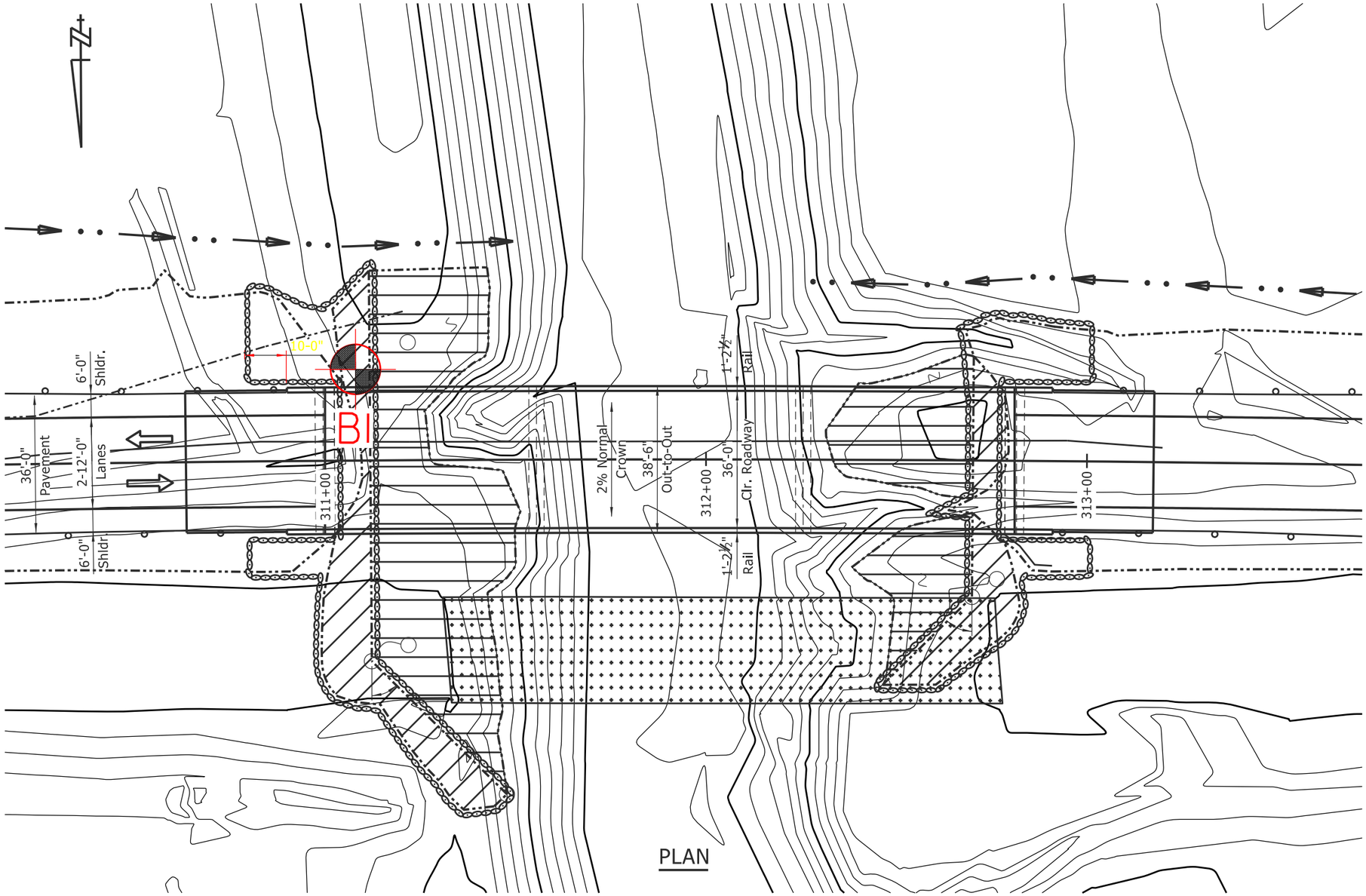
Prebore is not anticipated to be required. Water jetting, vibrating, or other means for the purpose of assisting pile penetration are generally not expected. If warranted by specific subsurface conditions, the use of water jetting or vibrating should be approved by the Engineer. In addition, the final 5 feet of pile penetration should be achieved by driving. Piling should be observed and recorded by the Engineer. Test piles are not required, but the contractor may pursue for information purposes.

Paul Tinsley
Materials Engineer

PT:yz:mlg:pjt:pwc
cc: State Construction Engineer
District 10 Engineer
Roadway Design Engineer
G. C. File

Attachment A

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
6	AR			
JOB NO.		101126		
PLAN OF BORINGS				



PLAN

BORING	STATION	OFFSET
B1	311+08	24' LT
B2	314+01	26' RT

PLAN OF BORINGS

WHITEMAN CREEK STR. & APPRS. (S)
ROUTE 158, SECTION 5
CRAIGHEAD COUNTY
FED. AID PROJ. NHPP-0016(90)

JOB NO. 101126 | SHEET 1/1

SCALE: 1"=30'

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SEC.

BORING NO. 1
PAGE 1 OF 4

JOB NO. 101126 Craighead County
JOB NAME: Whiteman Creek Str. & Apprs. (S)
Route 158, Section 5
STATION: 311+08
LOCATION: 24' Left of Construction Centeline
LOGGED BY: Stanley Bates

DATE: August 2 and 3, 2022
TYPE OF DRILLING:
Hollow Stem Auger to 10' - Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 116.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 231.4	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
5			Dry, Medium Dense, Brown Clayey Sand with Gravel	-		18	18 11-7		
			Dry, Brown, Very Stiff Clay with Organic Matter (Wood)				4 12-5		
10			Moist, Soft, Gray Sandy Clay			54	1 1-2		
15			Moist, Medium Dense, Brown and Gray Poorly Graded Sand with Silt	SP-SM -		11	4 7-7		
20			Wet, Medium Dense, Brown and Gray Poorly Graded Sand with Silt	SP-SM -		5	4 7-10		
25			Wet, Medium Dense, Gray Silt	ML -		93	0 4-8		
30			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	SP-SM -		6	8 13-13		
35			Wet, Dense, Gray Poorly Graded	SP -		4	8 15-16		

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SEC.

BORING NO. 1
PAGE 2 OF 4

JOB NO. 101126 Craighead County
JOB NAME: Whiteman Creek Str. & Apprs. (S)
Route 158, Section 5
STATION: 311+08
LOCATION: 24' Left of Construction Centeline
LOGGED BY: Stanley Bates

DATE: August 2 and 3, 2022
TYPE OF DRILLING:
Hollow Stem Auger to 10' - Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 116.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 231.4	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			Sand	SP		3	8 15-19		
45			Wet, Medium Dense, Gray Poorly Graded Sand with Silt	SP-SM -		10	6 12-14		
50			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM -		5	10 20-27		
55			Wet, Medium Dense, Gray Poorly Graded Sand	SP -		3	7 11-10		
60			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM -		5	9 19-26		
65			Wet, Dense, Gray Poorly Graded Sand	SP -		3	9 13-23		
70			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM -		5	13 21-23		

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SEC.

BORING NO. 1
PAGE 3 OF 4

JOB NO. 101126 Craighead County
JOB NAME: Whiteman Creek Str. & Apprs. (S)
Route 158, Section 5
STATION: 311+08
LOCATION: 24' Left of Construction Centeline
LOGGED BY: Stanley Bates

DATE: August 2 and 3, 2022
TYPE OF DRILLING:
Hollow Stem Auger to 10' - Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 116.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 231.4	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			Wet, Medium Dense, Gray Poorly Graded Sand with Silt and Trace Gravel	SP-SM -		6	8 11-15		
80			Wet, Dense, Gray Poorly Graded Sand	SP -		2	11 13-22		
85				SP -		3	12 18-20		
90			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM -		5	9 19-26		
95			Wet, Medium Dense, Gray Poorly Graded Sand	SP -		3	5 9-10		
100				SP -		4	3 7-19		
105			Wet, Dense, Gray Poorly Graded	SP -		4	8 18-23		

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SEC.

BORING NO. 1
PAGE 4 OF 4

JOB NO. 101126 Craighead County
JOB NAME: Whiteman Creek Str. & Apprs. (S)
Route 158, Section 5
STATION: 311+08
LOCATION: 24' Left of Construction Centeline
LOGGED BY: Stanley Bates

DATE: August 2 and 3, 2022
TYPE OF DRILLING:
Hollow Stem Auger to 10' - Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 116.5

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
110			Sand	SP		4	8 15-23		
				-					
			Wet, Very Dense, Gray Sand with Silt	SP-SM		5	20 35-41		
				-					
115			Wet, Dense, Gray Poorly Graded Sand with Silt and Some Gravel	SP-SM		5	11 18-30		
			Boring Terminated						
120									
125									
130									
135									
140									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SEC.

BORING NO. 2
PAGE 1 OF 3

JOB NO. 101126 Craighead County
JOB NAME: Whiteman Creek Str. & Apprs. (S)
Route 158, Section 5
STATION: 314+01
LOCATION: 26' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: August 1 and 2, 2022
TYPE OF DRILLING:
Hollow Stem Auger to 9.5' - Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 231.8	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
5			Wet, Soft, Brown Sandy Clay with Some Gravel	-		51	2 1-3		
10			Moist, Medium Stiff, Gray Lean Clay with Sand and Some Gravel	CL -		72	1 3-4		
15			Moist, Medium Stiff, Gray Sandy Clay	- -		63	1 3-4		
20			Wet, Soft, Gray Lean Clay with Sand and Organic Matter (Wood)	CL -		79	1 1-1		
25			Wet, Soft, Gray Lean Clay	CL -		90	0 0-2		
30			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM		11	9 19-19		
35									

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SEC.

BORING NO. 2
PAGE 2 OF 3

JOB NO. 101126 Craighead County
JOB NAME: Whiteman Creek Str. & Apprs. (S)
Route 158, Section 5
STATION: 314+01
LOCATION: 26' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: August 1 and 2, 2022
TYPE OF DRILLING:
Hollow Stem Auger to 9.5' - Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 231.8	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			Wet, Medium Dense, Gray Sand with Silt				8 12-18		
45			Wet, Dense, Gray Sand with Silt	-			9 13-18		
50			Wet. Dense, Gray Sand				9 16-22		
55			Wet, Medium Dense, Gray Sand				8 13-14		
60			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM		5	4 22-18		
65			Wet, Medium Dense, Gray Sand				8 11-16		
70			Wet, Dense, Gray Sand	-			10 15-24		

REMARKS:

ARKANSAS DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION - GEOTECHNICAL SEC.

BORING NO. 2
PAGE 3 OF 3

JOB NO. 101126 Craighead County
JOB NAME: Whiteman Creek Str. & Apprs. (S)
Route 158, Section 5
STATION: 314+01
LOCATION: 26' Right of Construction Centerline
LOGGED BY: Stanley Bates

DATE: August 1 and 2, 2022
TYPE OF DRILLING:
Hollow Stem Auger to 9.5' - Rotary Wash
EQUIPMENT: Acker 2

HAMMER CORRECTION FACTOR: 1.55

COMPLETION DEPTH: 101.5

DEPTH FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURFACE ELEVATION: 231.8	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, Medium Dense, Gray Sand with Silt				7 13-16		
							7 12-13		
80									
			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM		9	11 19-20		
85									
							8 15-17		
90			Wet, Dense, Gray Sand	-			10 16-19		
95									
			Wet, Very Dense, Gray Poorly Graded Sand with Silt	SP-SM -		5	12 23-30		
100									
			Wet, Dense, Gray Poorly Graded Sand with Silt	SP-SM		5	13 19-20		
			Boring Terminated						
105									

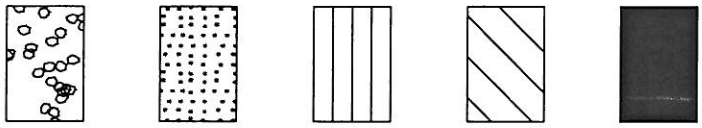
REMARKS:

LEGEND

SOIL TYPES

(SHOWN IN SYMBOL COLUMN)

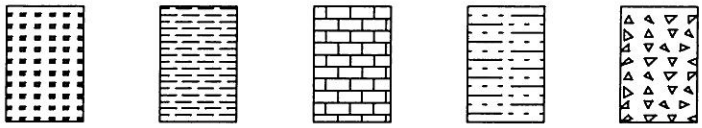
(PREDOMINANT TYPE SHOWN HEAVY)



GRAVEL | SAND | SILT | CLAY | ORGANIC MATTER

ROCK TYPES

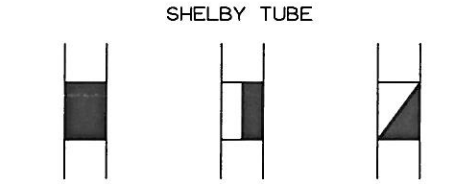
(SHOWN IN SYMBOL COLUMN)



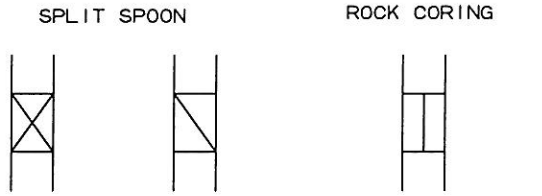
SANDSTONE | SHALE or SILTSTONE | LIMESTONE or DOLOMITE | ALTERNATING LAYERS of SHALE and SANDSTONE | OTHER

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.

Attachment B

Materials Division

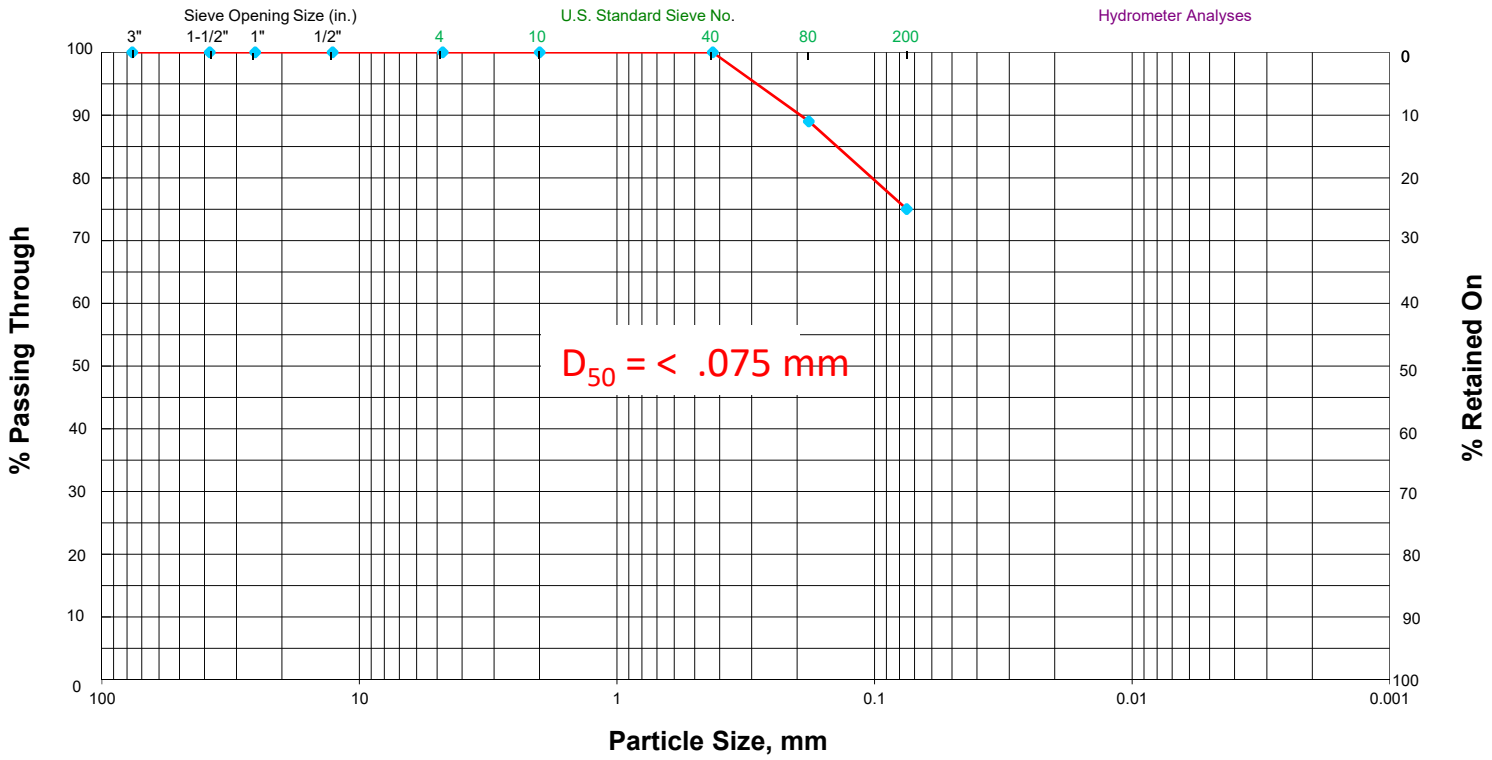
Results of Classification Tests
ARDOT Project No.: 101126
Project: Whiteman Creek Str. & Apprs. (S)
Site: Route 158, Section 5 / County: Craighead

Summarized by: JCS
Checked by: PWC

NA=Not Available
NT=No Test

Sample Identification				Atterberg Limits			% Fines	Soil Classification	
Boring	Station	Offset	Depth, ft	LL	PL	PI		USCS	AASHTO
1	311+08	24' LT	2.5-4.0	NT			18	NA	NA
1	311+08	24' LT	5-6.5	NT			NA		
1	311+08	24' LT	7.5-9.0	NT			54	NA	NA
1	311+08	24' LT	10.0-11.5	Non-Plastic			11	SP-SM	A-2-4
1	311+08	24' LT	15.0-16.5	Non-Plastic			5	SP-SM	A-3
1	311+08	24' LT	20.0-21.5	Non-Plastic			93	ML	A-4
1	311+08	24' LT	25.0-26.5	Non-Plastic			6	SP-SM	A-3
1	311+08	24' LT	30.0-31.5	Non-Plastic			4	SP	A-3
1	311+08	24' LT	35.0-36.5	Non-Plastic			3	SP	A-3
1	311+08	24' LT	40.0-41.5	Non-Plastic			10	SP-SM	A-3
1	311+08	24' LT	45.0-46.5	Non-Plastic			5	SP-SM	A-3
1	311+08	24' LT	50.0-51.5	Non-Plastic			3	SP	A-3
1	311+08	24' LT	55.0-56.5	Non-Plastic			5	SP-SM	A-3
1	311+08	24' LT	60.0-61.5	Non-Plastic			3	SP	A-3
1	311+08	24' LT	65.0-66.5	Non-Plastic			5	SP-SM	A-3
1	311+08	24' LT	70.0-71.5	Non-Plastic			6	SP-SM	A-3
1	311+08	24' LT	75.0-76.5	Non-Plastic			2	SP	A-3
1	311+08	24' LT	80.0-81.5	Non-Plastic			3	SP	A-3
1	311+08	24' LT	85.0-86.5	Non-Plastic			5	SP-SM	A-3
1	311+08	24' LT	90.0-91.5	Non-Plastic			3	SP	A-3
1	311+08	24' LT	95.0-96.5	Non-Plastic			4	SP	A-3
1	311+08	24' LT	100.0-101.5	Non-Plastic			4	SP	A-3
1	311+08	24' LT	105.0-106.5	Non-Plastic			4	SP	A-3
1	311+08	24' LT	110.0-111.5	Non-Plastic			5	SP-SM	A-3
1	311+08	24' LT	115.0-116.5	Non-Plastic			5	SP-SM	A-3
2	314+01	26' RT	4.5-6.0	NT			51	NA	NA
2	314+01	26' RT	9.5-11.0	39	16	23	72	CL	A-6
2	314+01	26' RT	15.0-16.5	NT			63	NA	NA
2	314+01	26' RT	20.0-21.5	28	17	11	79	CL	A-6
2	314+01	26' RT	25.0-26.5	31	18	13	90	CL	A-6
2	314+01	26' RT	30.0-31.5	Non-Plastic			11	SP-SM	A-2-4
2	314+01	26' RT	55.0-56.5	Non-Plastic			5	SP-SM	A-3
2	314+01	26' RT	80.0-81.5	Non-Plastic			9	SP-SM	A-3
2	314+01	26' RT	95.0-96.5	Non-Plastic			5	SP-SM	A-3
2	314+01	26' RT	100.0-101.5	Non-Plastic			5	SP-SM	A-3

Attachment C



101126 Particle Size Distribution Curve

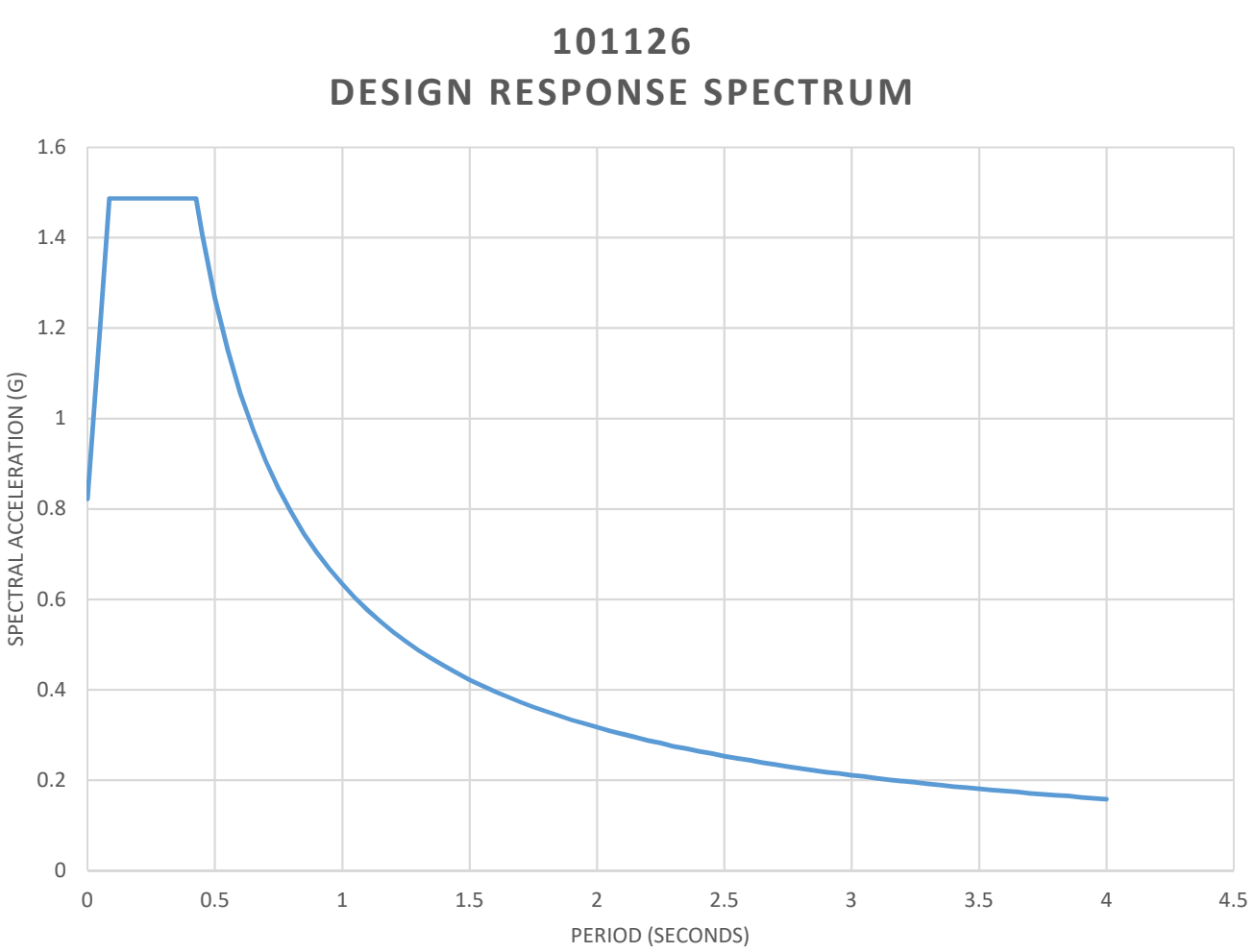
Station 315+50 / 6' Rt of CL - Whiteman Creek

Attachment D

Title:	101126
Latitude:	35.747787
Longitude:	-90.611171
Site Class	D

Get USGS Data

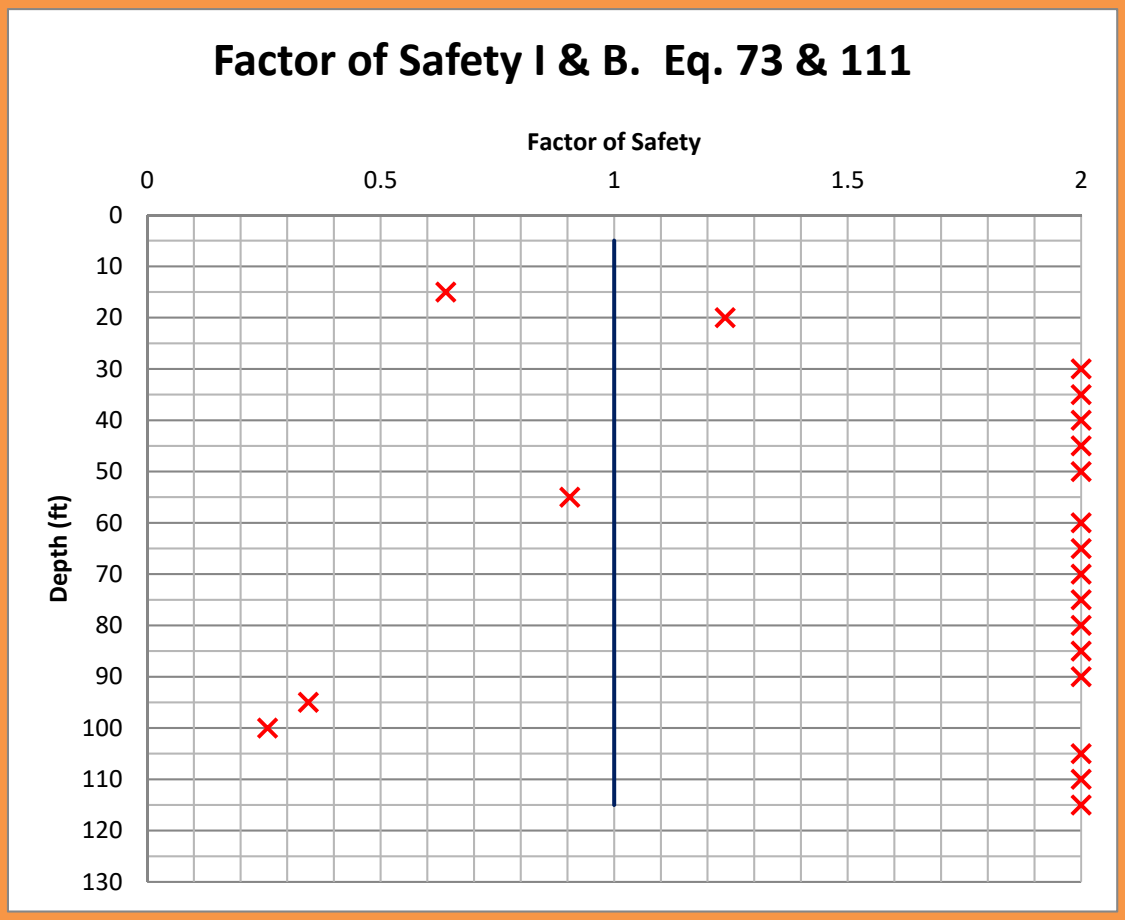
PGA:	0.822
F_{PGA}:	1
A_S:	0.822
S_S:	1.487
F_A:	1
S_{DS}:	1.487
S_1:	0.392
F_V:	1.616
S_{D1}:	0.634
S_{Dc}:	D
T_S:	0.426
T_0:	0.085



Attachment E

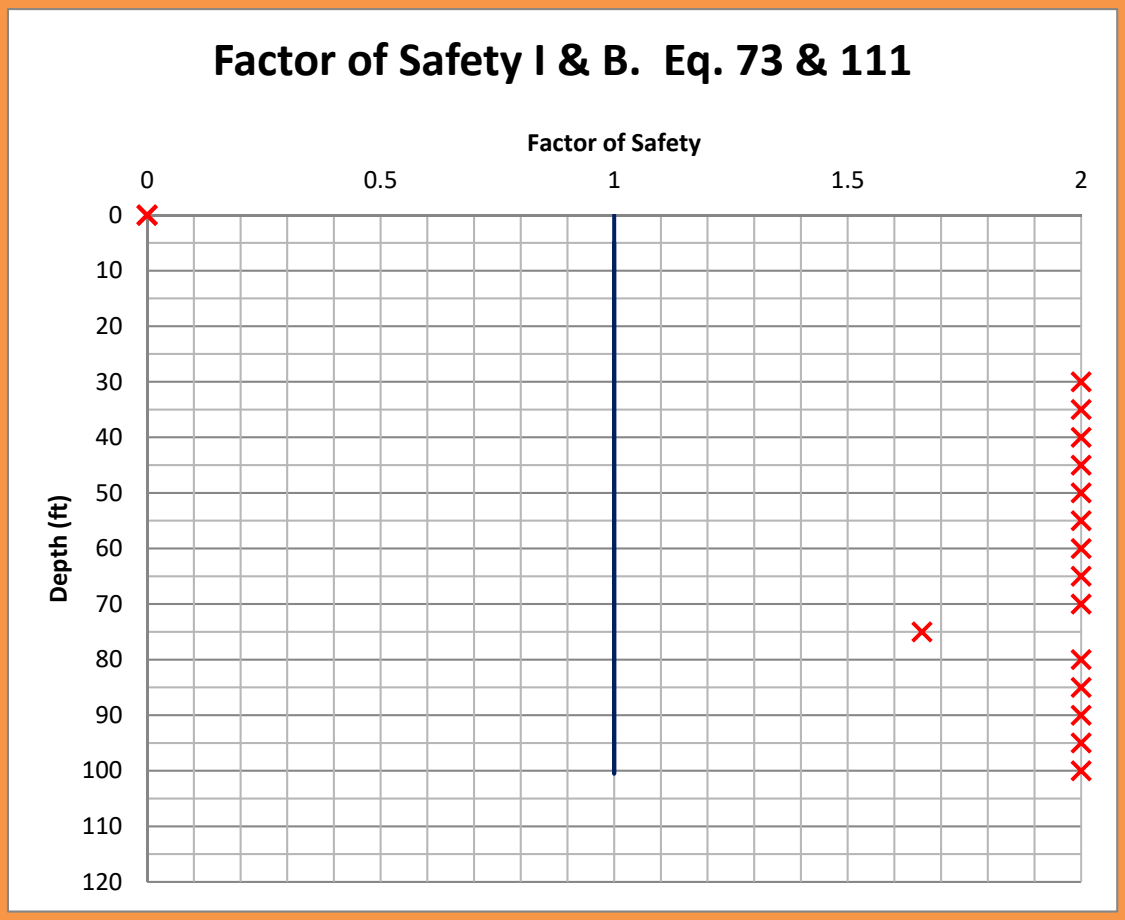
101126 - B1

Boring Elevation



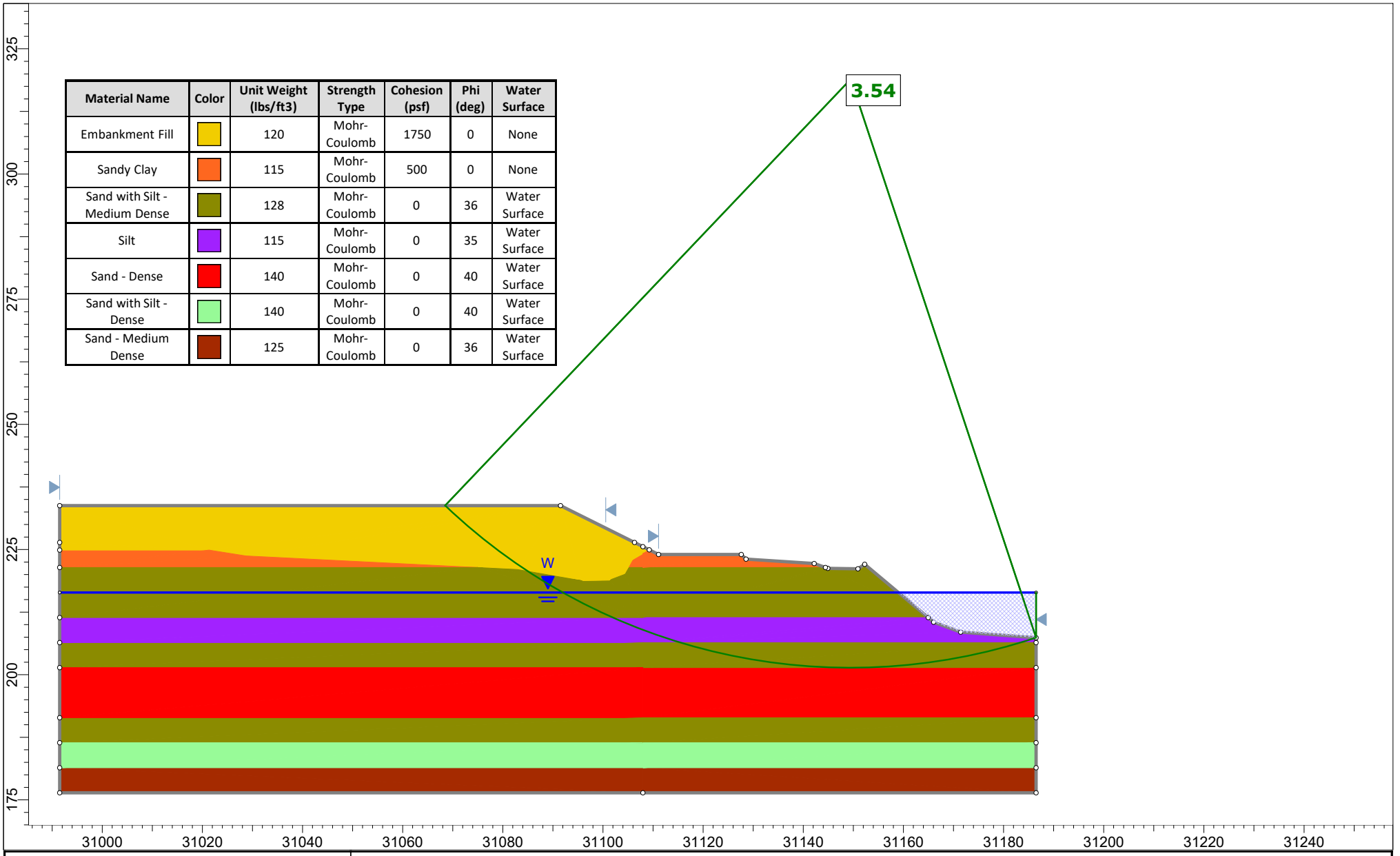
101126 - B2

Boring Elevation



Attachment F

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0	None
Sandy Clay		115	Mohr-Coulomb	500	0	None
Sand with Silt - Medium Dense		128	Mohr-Coulomb	0	36	Water Surface
Silt		115	Mohr-Coulomb	0	35	Water Surface
Sand - Dense		140	Mohr-Coulomb	0	40	Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40	Water Surface
Sand - Medium Dense		125	Mohr-Coulomb	0	36	Water Surface

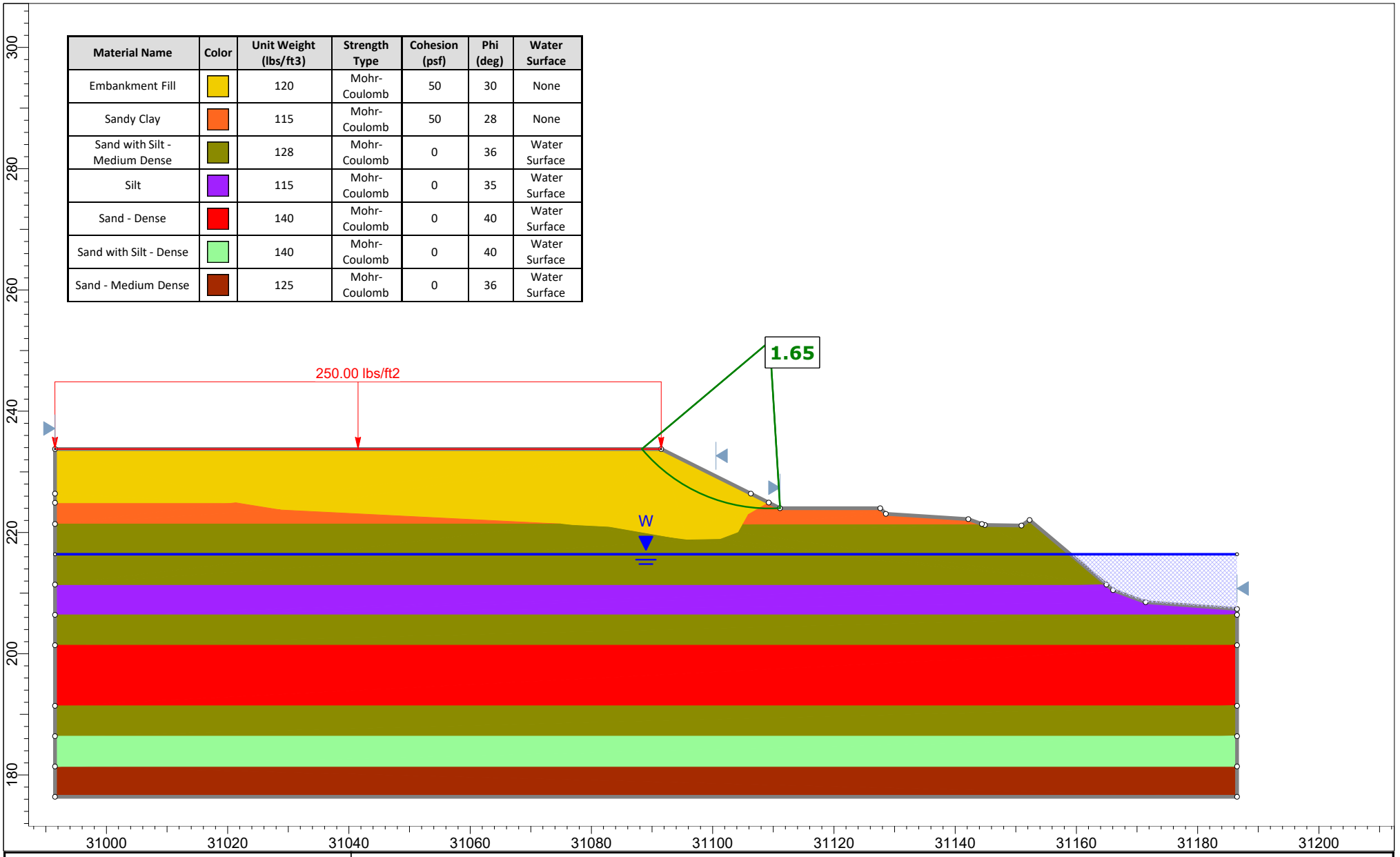


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Short Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, East Embankment
Date	10/18/2022		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment Fill		120	Mohr-Coulomb	50	30	None
Sandy Clay		115	Mohr-Coulomb	50	28	None
Sand with Silt - Medium Dense		128	Mohr-Coulomb	0	36	Water Surface
Silt		115	Mohr-Coulomb	0	35	Water Surface
Sand - Dense		140	Mohr-Coulomb	0	40	Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40	Water Surface
Sand - Medium Dense		125	Mohr-Coulomb	0	36	Water Surface

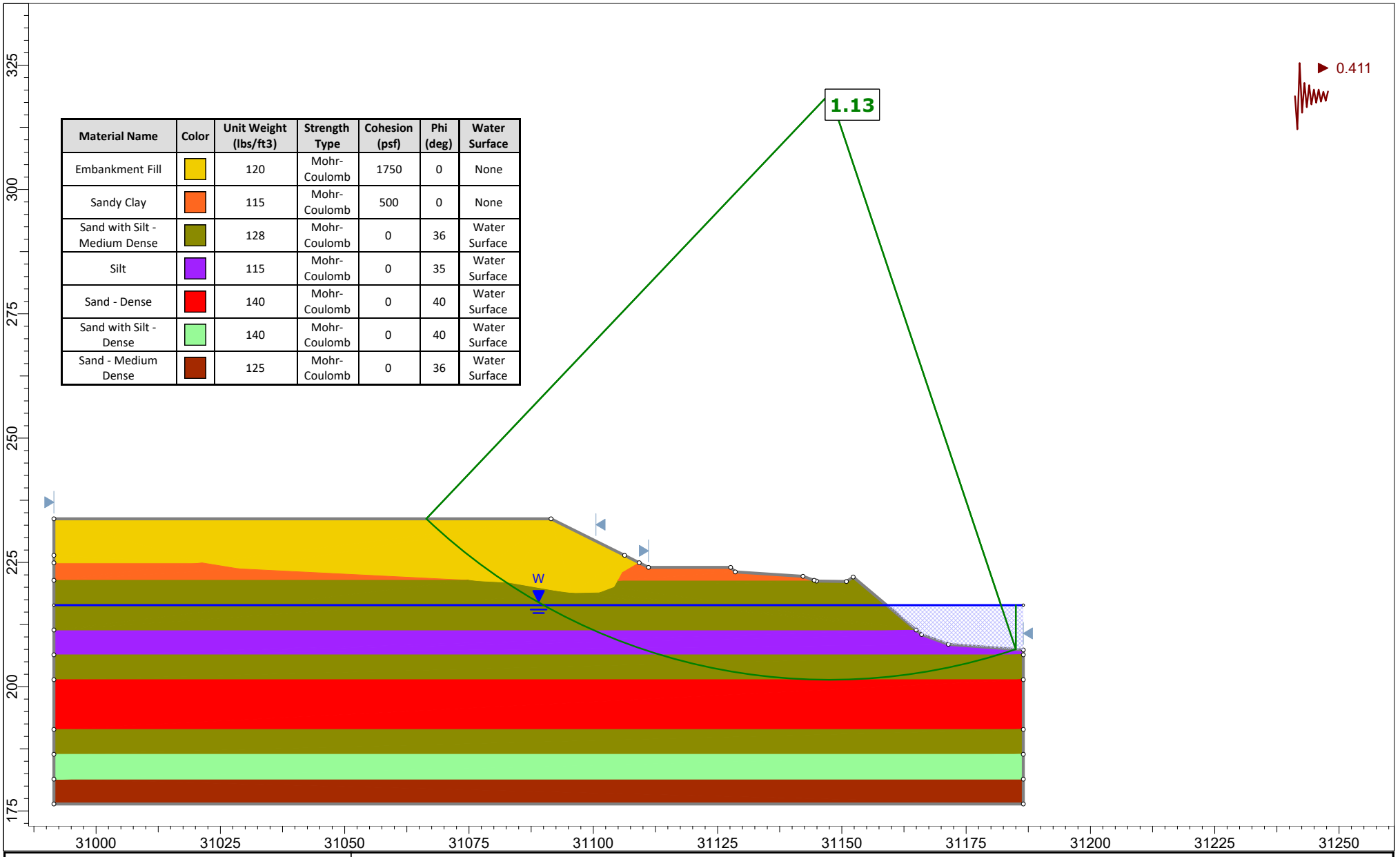


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Long Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, East Embankment
Date	10/18/2022		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0	None
Sandy Clay		115	Mohr-Coulomb	500	0	None
Sand with Silt - Medium Dense		128	Mohr-Coulomb	0	36	Water Surface
Silt		115	Mohr-Coulomb	0	35	Water Surface
Sand - Dense		140	Mohr-Coulomb	0	40	Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40	Water Surface
Sand - Medium Dense		125	Mohr-Coulomb	0	36	Water Surface

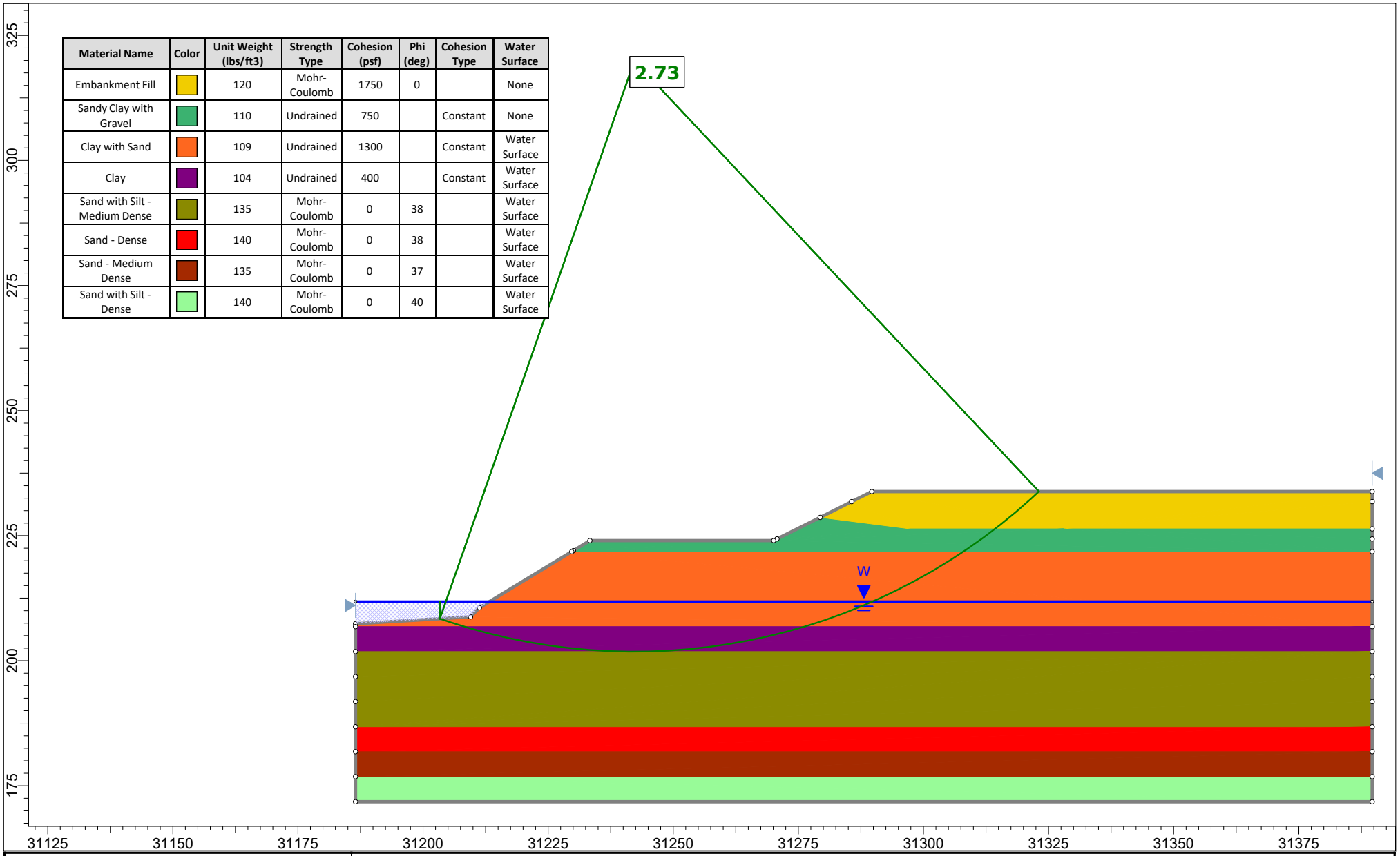


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Seismic
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, East Embankment
Date	10/24/2022		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface

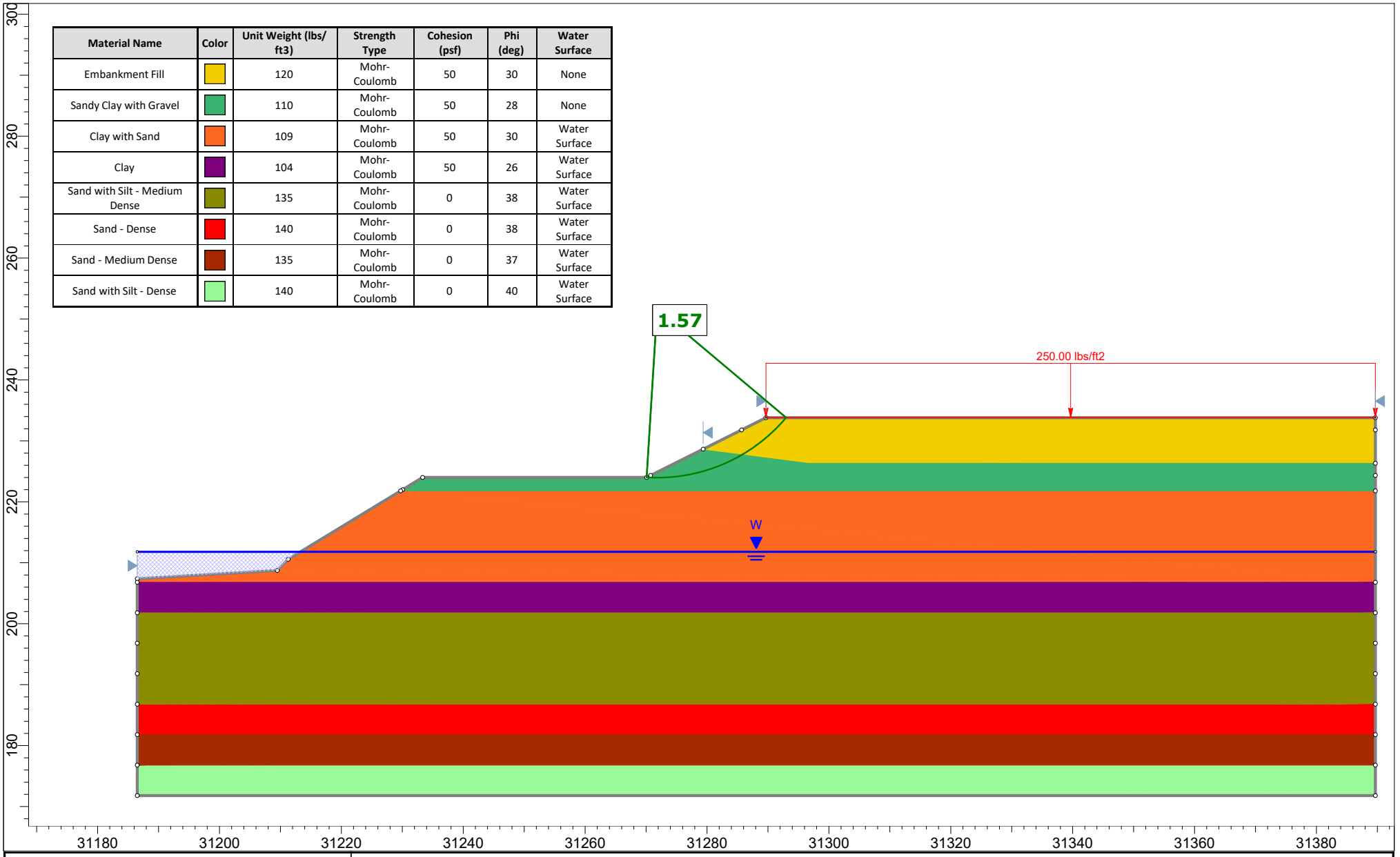


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Short Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	10/20/2022		

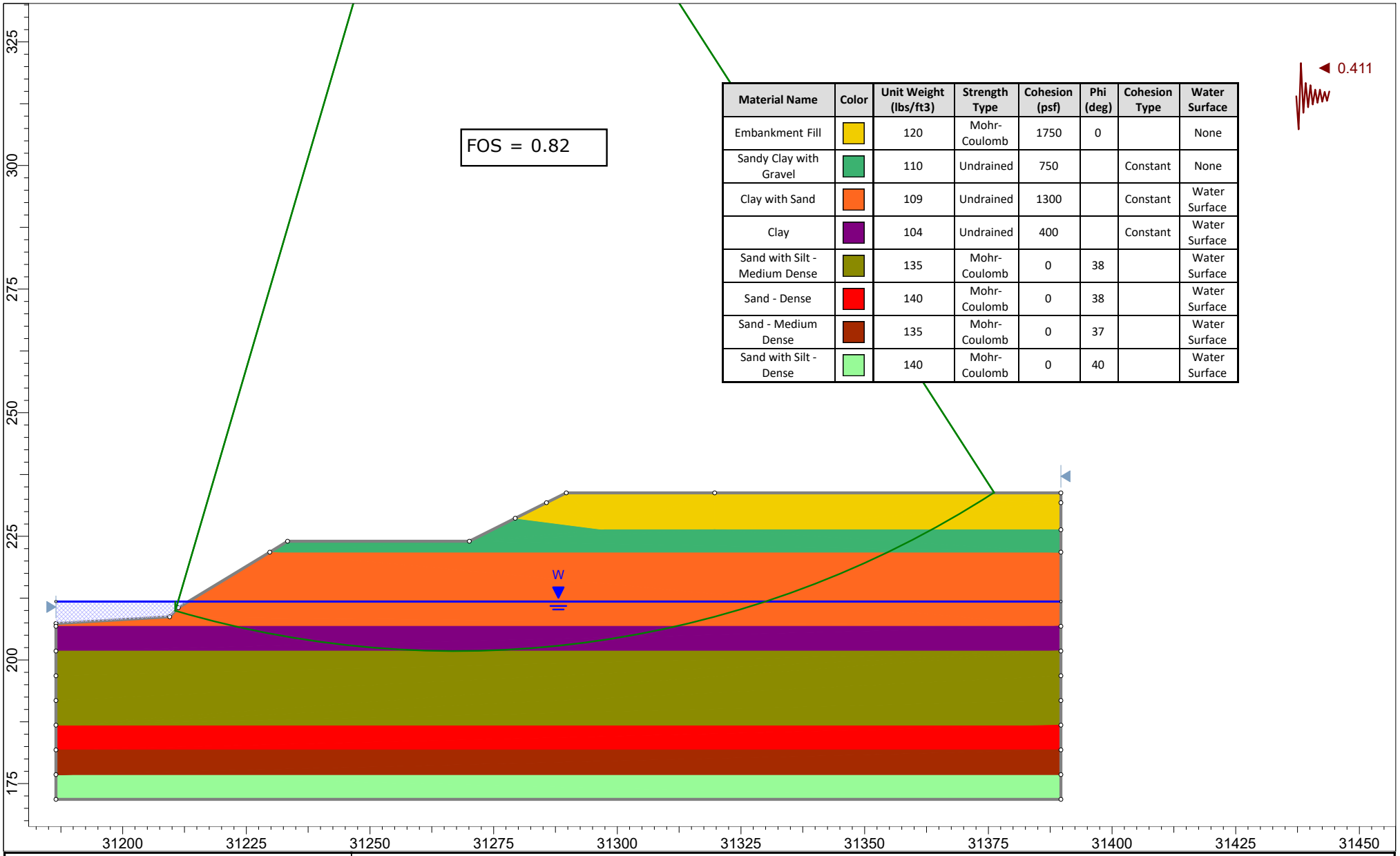
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment Fill		120	Mohr-Coulomb	50	30	None
Sandy Clay with Gravel		110	Mohr-Coulomb	50	28	None
Clay with Sand		109	Mohr-Coulomb	50	30	Water Surface
Clay		104	Mohr-Coulomb	50	26	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38	Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38	Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37	Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40	Water Surface



rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Long Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	10/20/2022		



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface

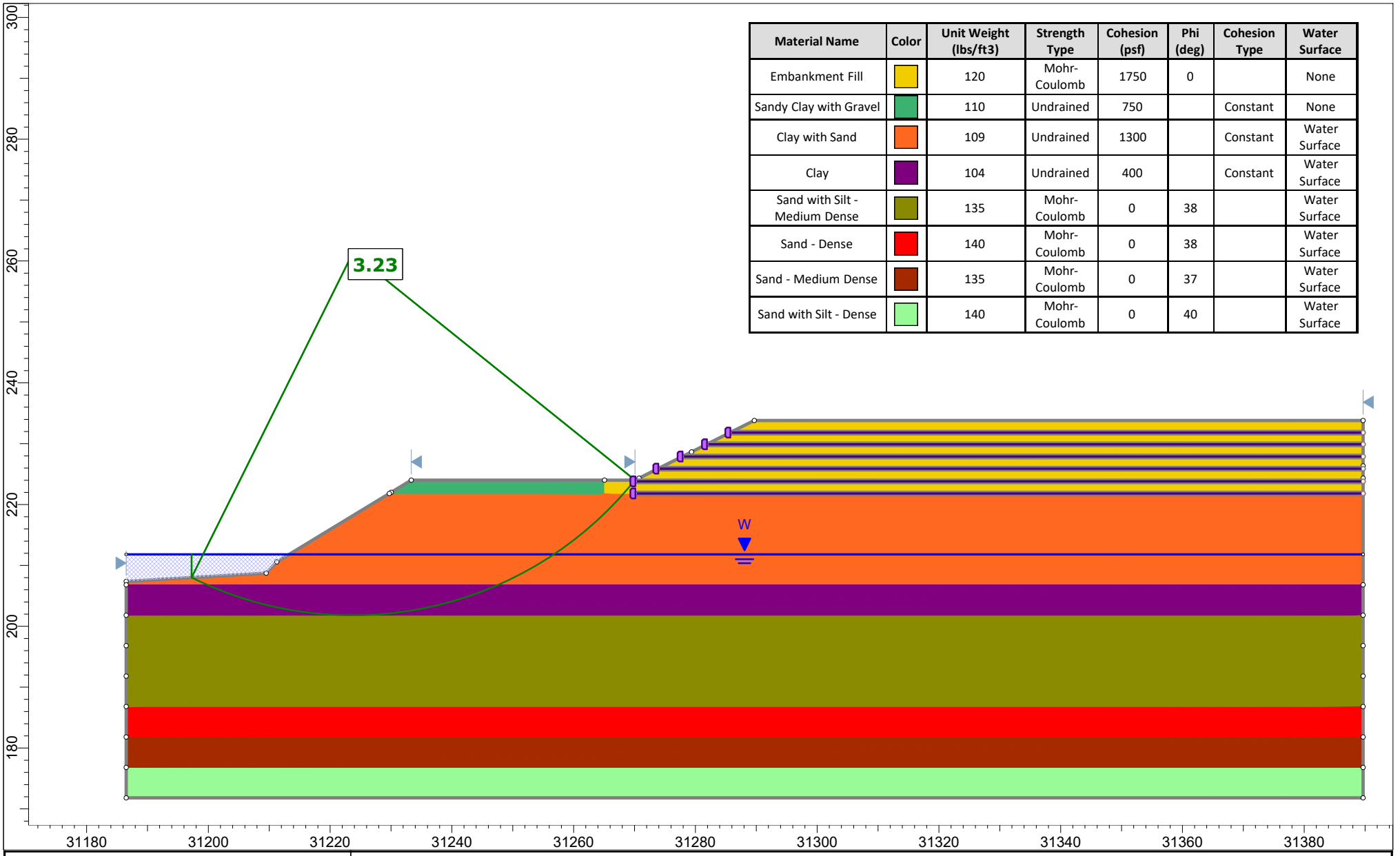
rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Seismic
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	10/20/2022		

Attachment G

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface

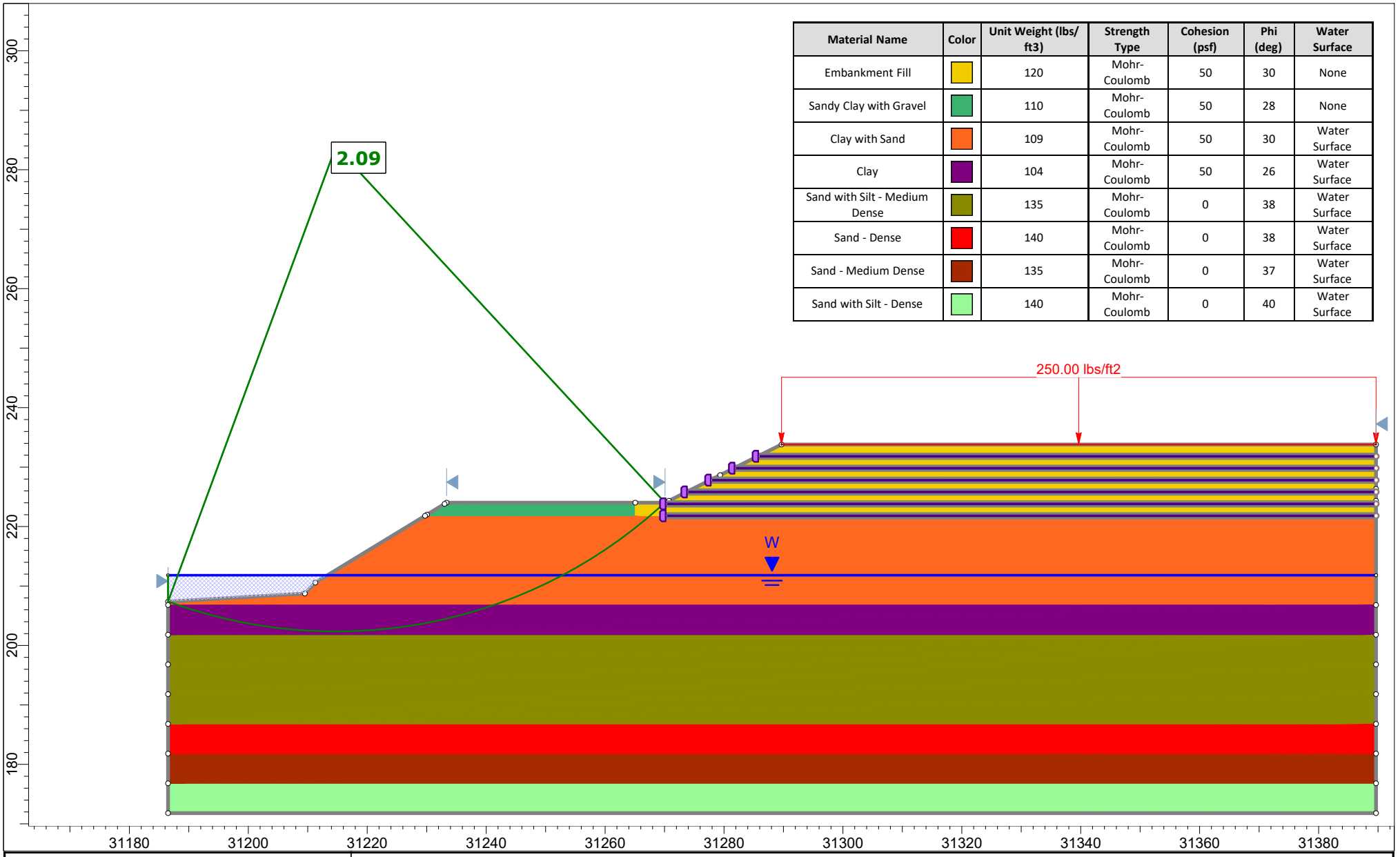


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Short Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	11/2/2022		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment Fill		120	Mohr-Coulomb	50	30	None
Sandy Clay with Gravel		110	Mohr-Coulomb	50	28	None
Clay with Sand		109	Mohr-Coulomb	50	30	Water Surface
Clay		104	Mohr-Coulomb	50	26	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38	Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38	Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37	Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40	Water Surface

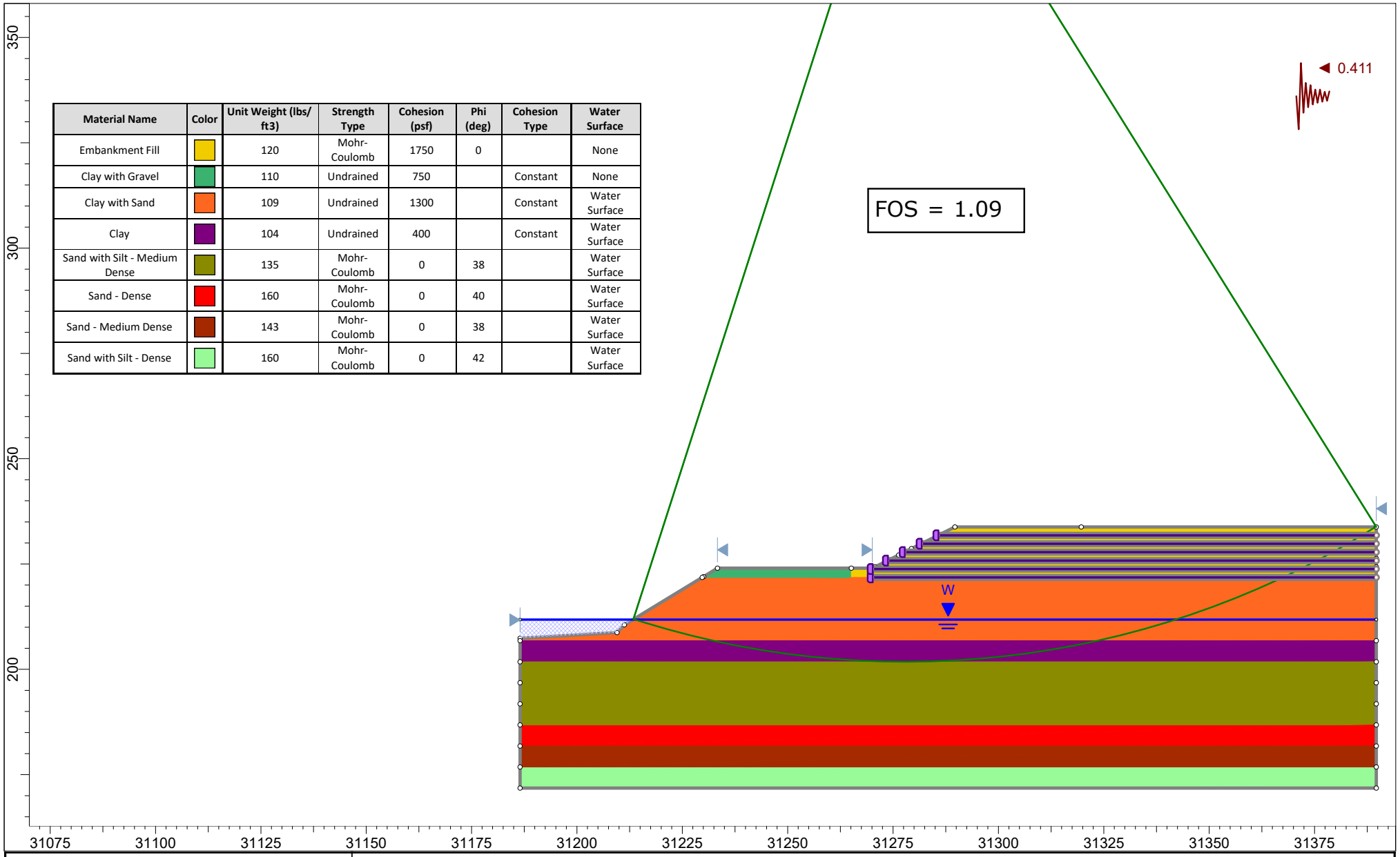


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Long Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	11/2/2022		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		160	Mohr-Coulomb	0	40		Water Surface
Sand - Medium Dense		143	Mohr-Coulomb	0	38		Water Surface
Sand with Silt - Dense		160	Mohr-Coulomb	0	42		Water Surface

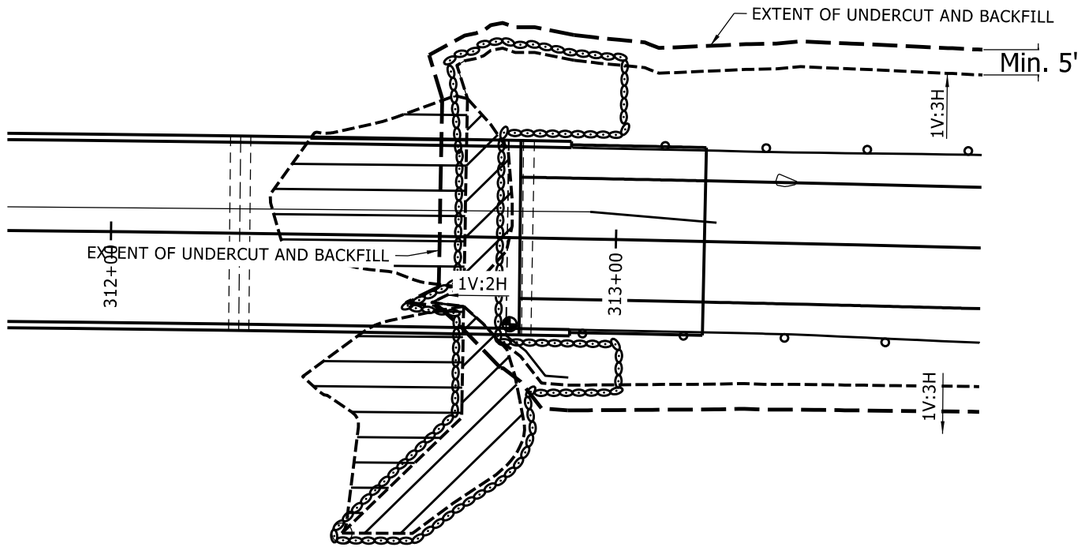


rocscience

SLIDEINTERPRET 9.020

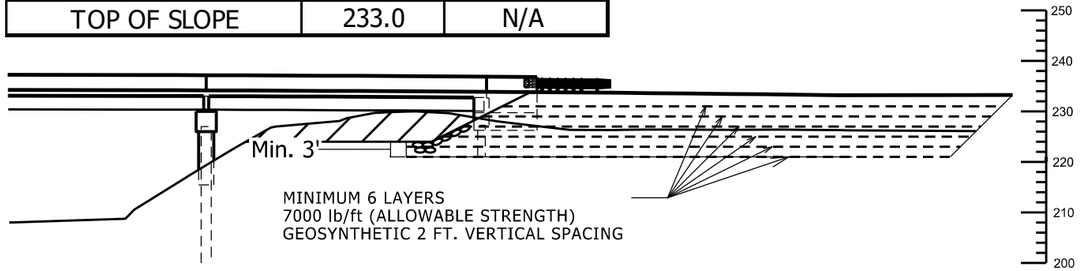
Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Seismic
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	10/31/2022		

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
6	AR			
JOB NO.		101126		
GEOGRID REINFORCEMENT DETAILS				

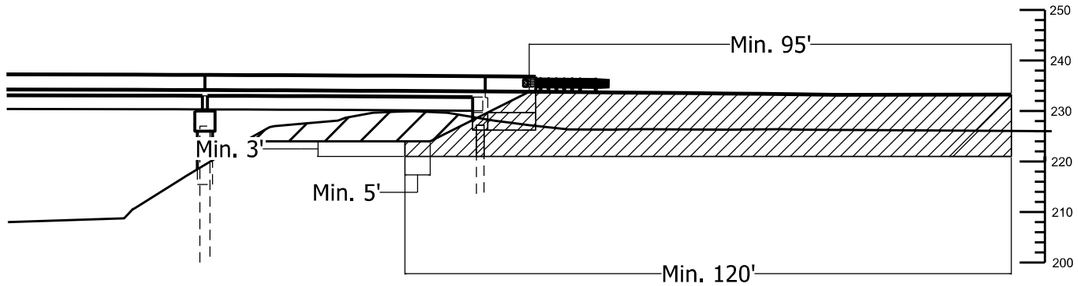


UNDERCUT PLAN

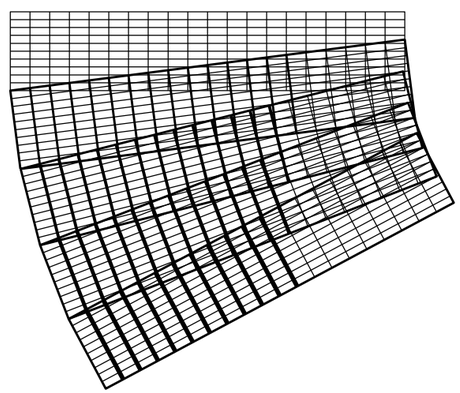
WEST ABUTMENT		
REINFORCEMENT LAYER	ELEVATION	LENGTH (FT)
1st LAYER	221.0	120
2nd LAYER	223.0	120
3rd LAYER	225.0	120
4th LAYER	227.0	120
5th LAYER	229.0	120
6th LAYER	231.0	120
TOP OF SLOPE	233.0	N/A

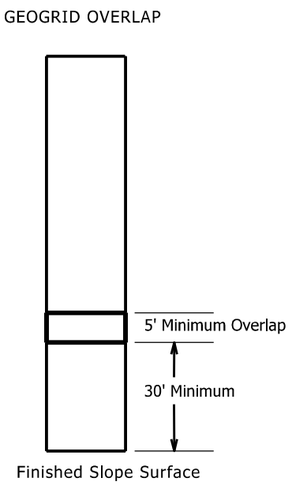


GEOGRID LAYOUT



UNDERCUT PROFILE



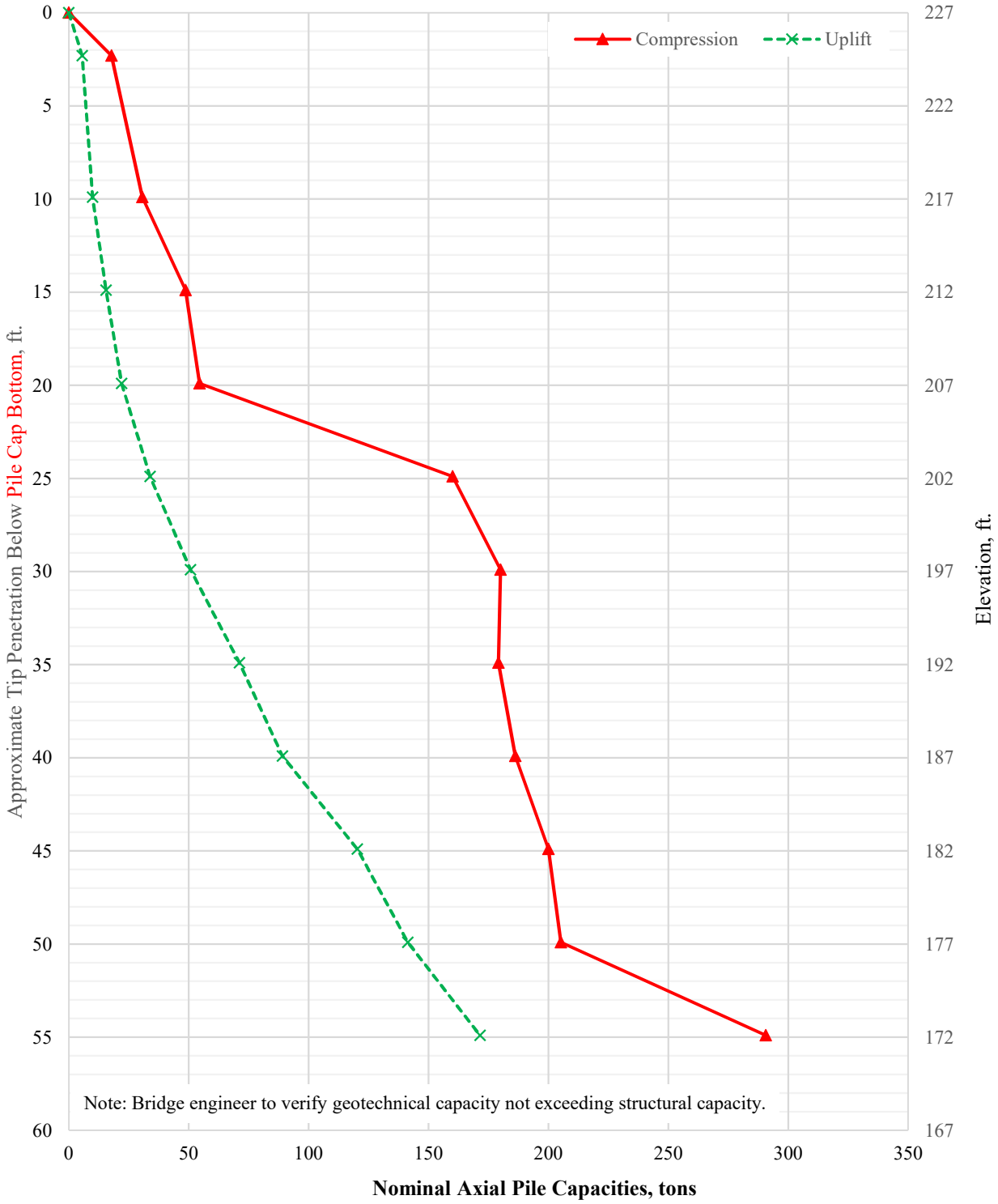


GEOGRID OVERLAP SPECIAL DETAILS

NOTES:
1. OVERLAPS OF GEOGRID BETWEEN ROLLS SHALL BE LOCATED AT NO LESS THAN 30 FEET FROM THE FINISHED SLOPE FACE.
2. A MINIMUM FILL THICKNESS OF 6 INCHES IS REQUIRED PRIOR TO OPERATION OF TRACKED VEHICLES OVER THE GEOGRID.
3. PAYMENT OF GEOGRID WILL BE SUBSIDIARY TO "COMPACTED EMBANKMENT".
4. UNDERCUT AND BACKFILL SHOULD EXTEND A MINIMUM OF 5 FT. BEYOND THE ABUTMENT FRONT SLOPE TOE, TO A MINIMUM DEPTH OF 3 FT. BELOW THE PLAN SUBGRADE.
5. UNDERCUT AND BACKFILL SHOULD EXTEND A MINIMUM OF 5 FT. BEYOND THE ABUTMENT SIDE SLOPE TOE, TO A MINIMUM DEPTH OF 3 FT. BELOW THE PLAN SUBGRADE.

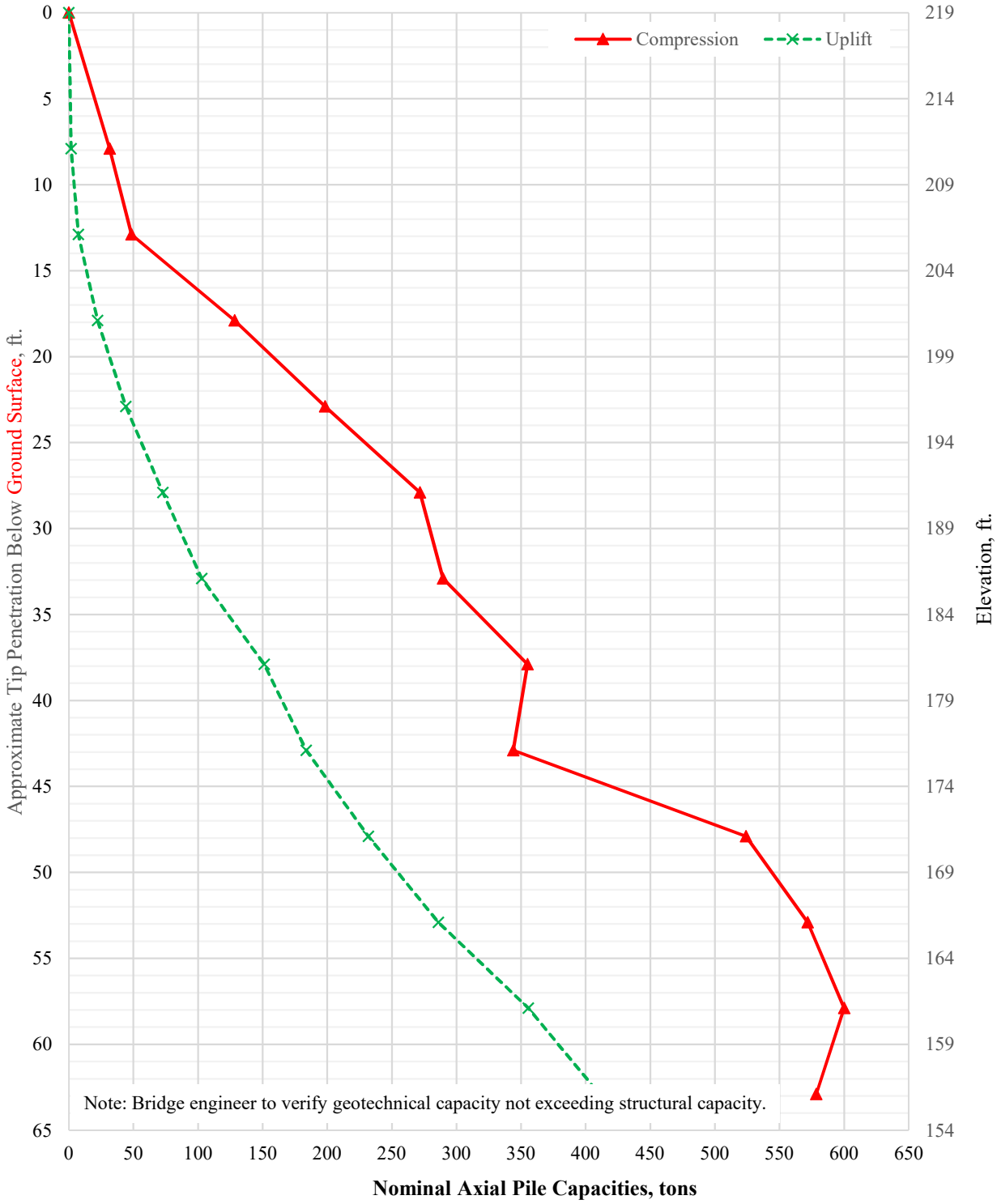
GEOGRID REINFORCEMENT DETAILS	
WHITEMAN CREEK STR. & APPRS. (S) ROUTE 158, SECTION 5 CRAIGHEAD COUNTY FED. AID PROJ. NHPP-0016(90)	
JOB NO. 101126	SHEET 1/1
NTS	

Attachment I



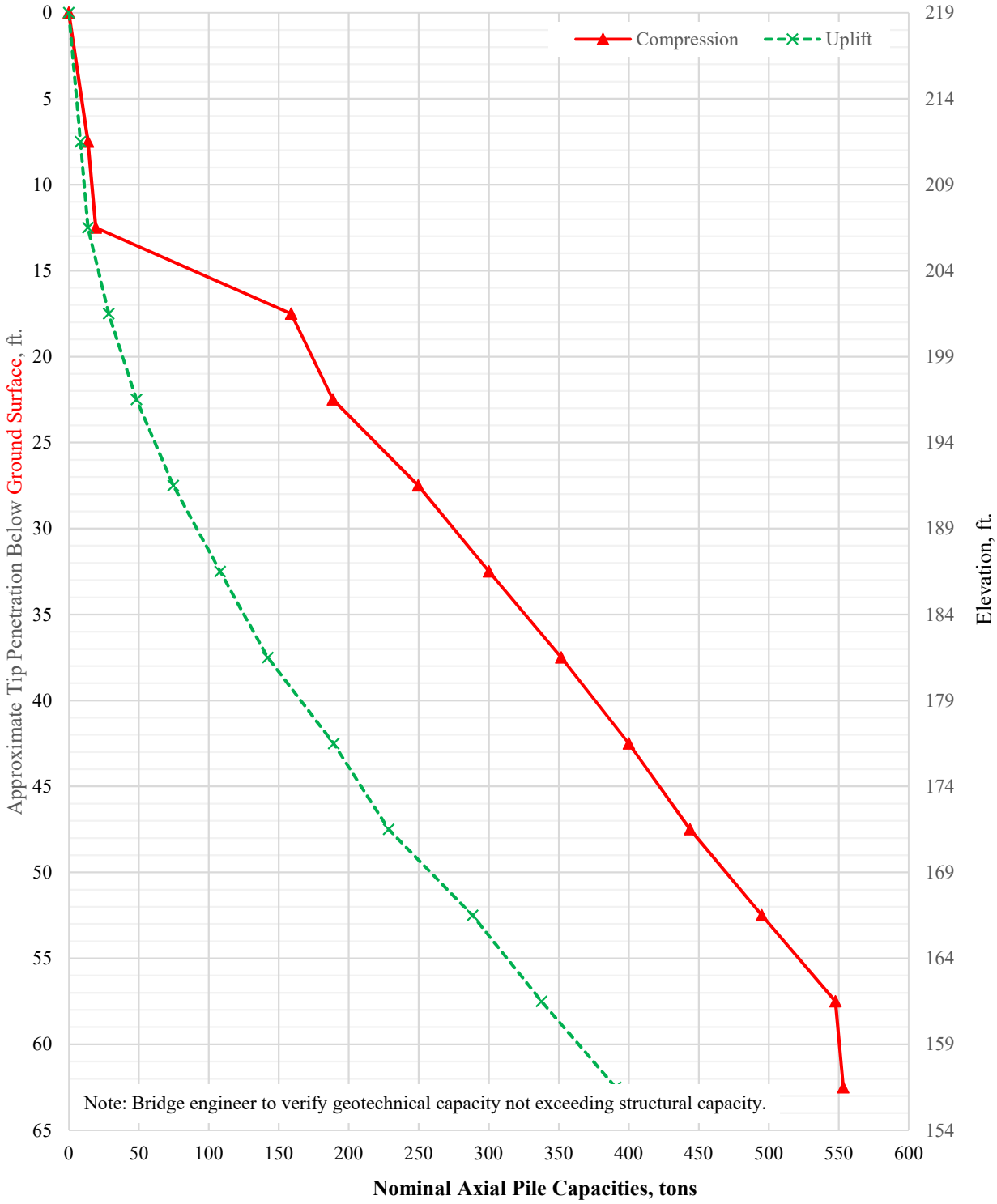
SINGLE 18"-DIAMETER CLOSED-END STEEL SHELL PILE

Bent 1 - Sta. 311+01, CL
Whiteman Creek, Route 158, Section 5
Project No.: 101126
Location: Craighead County



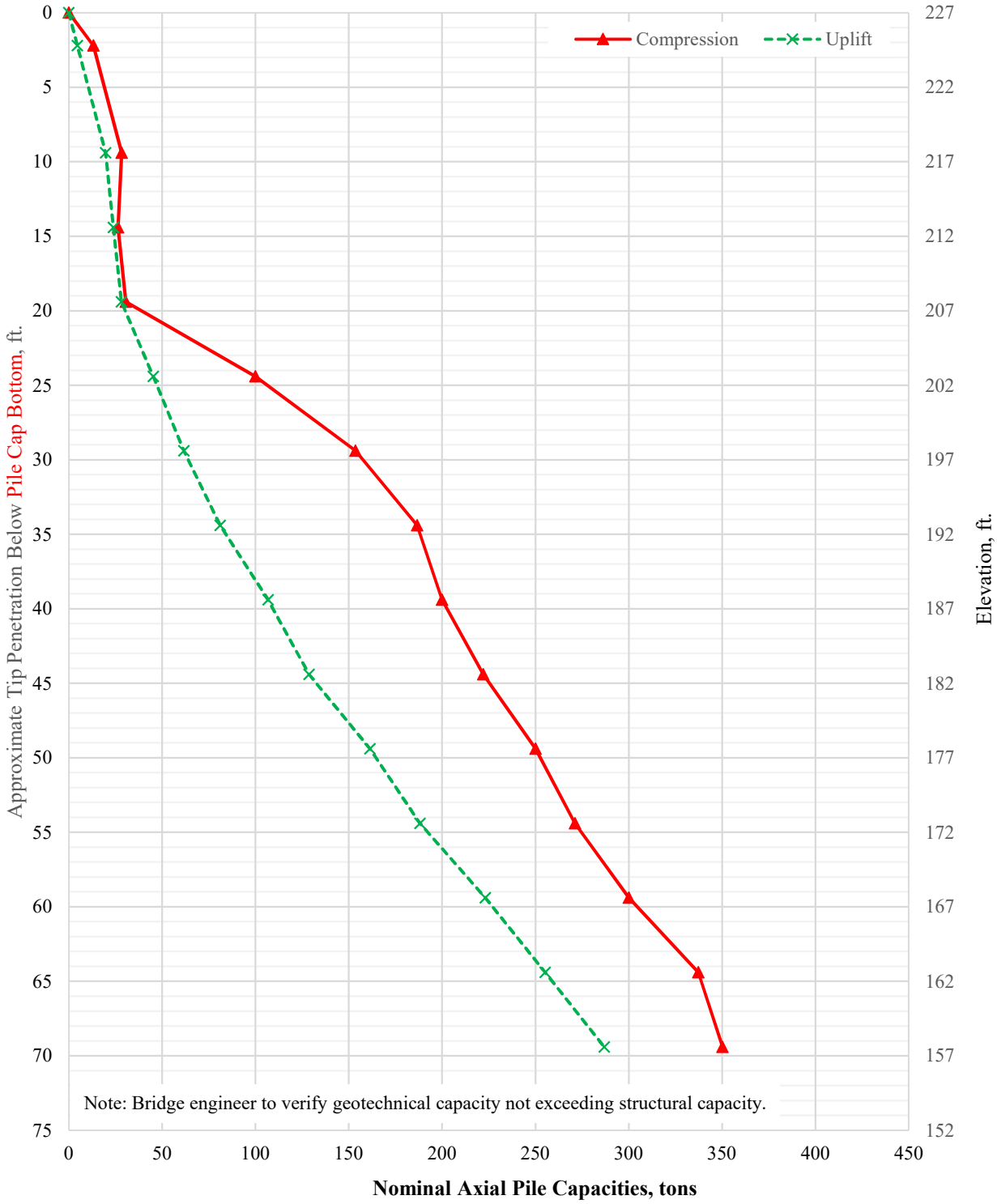
SINGLE 24"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 2 - Sta. 311+55.5, CL
Whiteman Creek, Route 158, Section 5
Project No.: 101126
Location: Craighead County



SINGLE 24"-DIAMETER CLOSED-END STEEL SHELL PILE

Bent 3 - Sta. 312+25.5, CL
Whiteman Creek, Route 158, Section 5
Project No.: 101126
Location: Craighead County



SINGLE 16"-DIAMETER CONCRETE FILLED STEEL SHELL PILE

Bent 4 - Sta. 312+81, CL
Whiteman Creek, Route 158, Section 5
Project No.: 101126
Location: Craighead County

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

April 13, 2023

TO: Mr. Rick Ellis, Bridge Engineer

SUBJECT: Job No. 101126
Whiteman Creek Str. & Apprs. (S)
Craighead County
Route 158, Section 5

Introduction

Submitted herein are supplemental results of slope stability analysis and Simplified Newmark analysis performed on the revised layout for the west embankment of the proposed Hwy. 158 Bridge over Little Bay Ditch. The original proposed west embankment consisted of 2-Horizontal to 1-Vertical end slopes. The 2H:1V end slope was determined to be unstable without reinforcement. The results of these analyses are included in Attachment A and are also located in the Geotechnical Report for Job No. 101126, dated November 22, 2022. In order to achieve the minimum required factor of safety for the seismic condition, geogrid was recommended to reinforce the west embankment.

Due to the cost of reinforcing the west embankment, alternative mitigation options were examined. The geometric layout of the west embankment was revised by reducing the height of the embankment and lowering the cut elevations at the bridge end. The revised layout was analyzed utilizing both slope stability analysis and Simplified Newmark analysis.

Slope Stability Analysis

The slope stability analysis for the revised west bridge end embankment was performed utilizing Slide2 (Version 2021) developed by RocScience. The results of these analyses are included in Table 1 and Attachment B. As shown in the results, the factor of safety for Short Term/End of Construction and Long Term conditions were determined to be adequate, but the factor of safety for the Seismic condition was determined to be below the minimum required value.

Table 1. Results of Slope Stability Analysis

Method	Loading Condition	Factor of Safety
Bishop Simplified Method	Short Term / End of Construction	3.12
	Long Term	1.57
	Seismic	0.87

Simplified Newmark Analysis

Due to the inadequate factor of safety under the Seismic Loading condition, the embankment was analyzed utilizing Simplified Newmark method analysis and the Horizontal Yield Acceleration (K_y) as shown in Attachment B. Utilizing the calculations in Attachment C and the determined (K_y) value, the displacement is calculated as **3.0 in.** The calculated displacement is

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

smaller than the typically acceptable displacement of 6 in. as recommended by *NCHRP Report 611*.

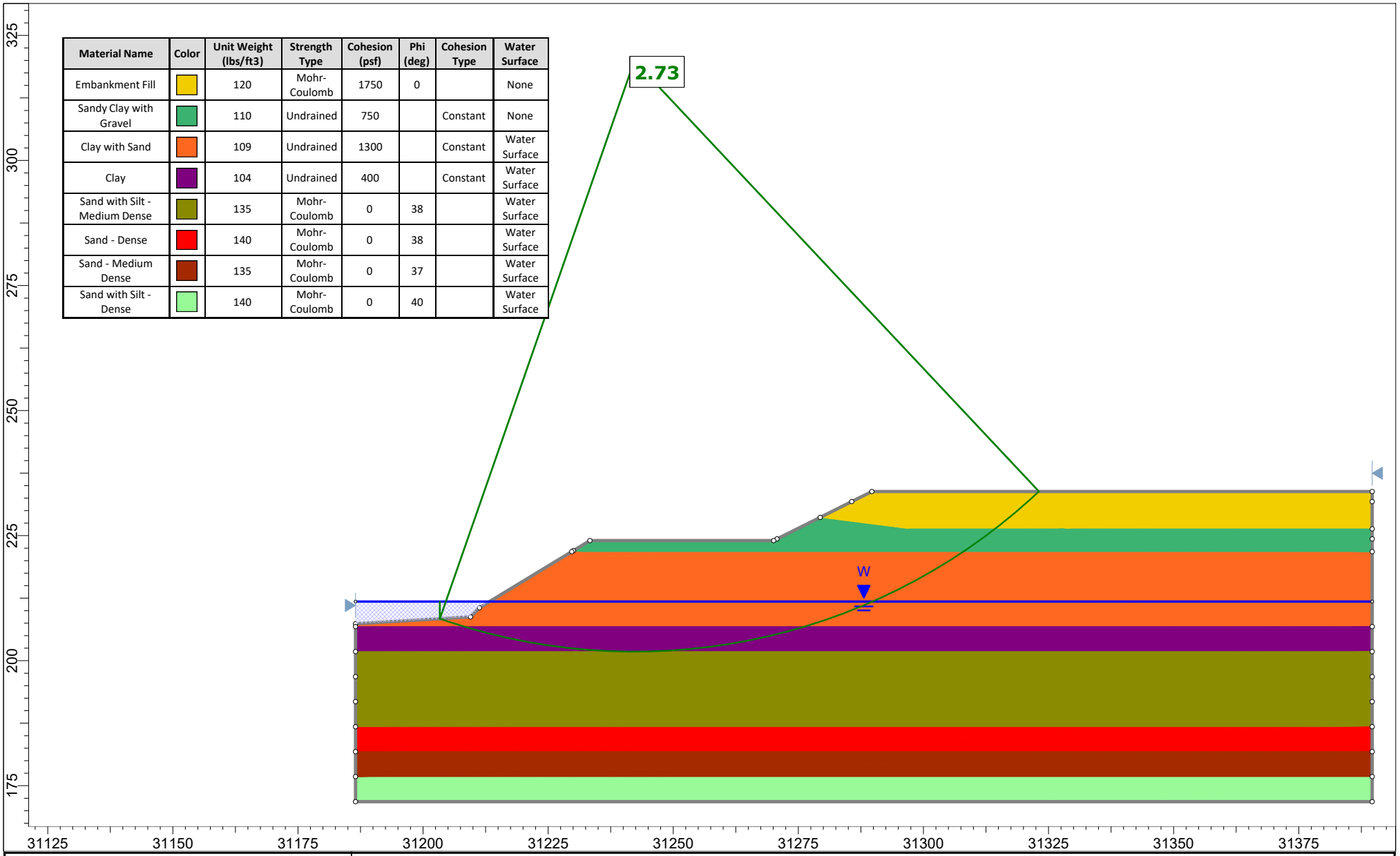
If Bridge Division determines that the calculated displacement is unacceptable or if there are any questions or concerns regarding the analyses or calculations that were performed, please contact Materials Division.

Paul Tinsley
Materials Engineer

PT:yz:pjt:mlg
cc: State Construction Engineer
District 10 Engineer
Roadway Design Engineer

Attachment A

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface

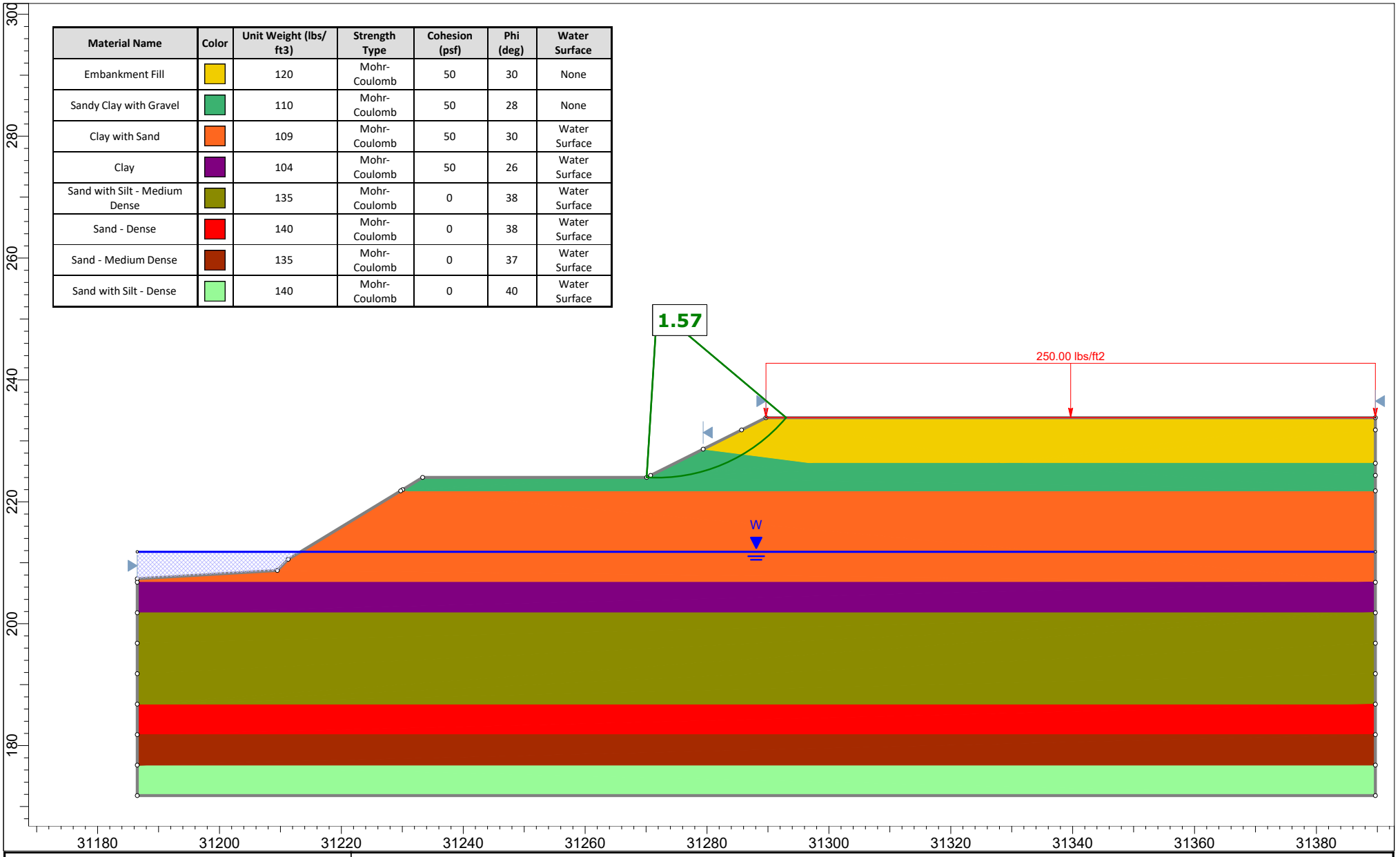


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Short Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	10/20/2022		

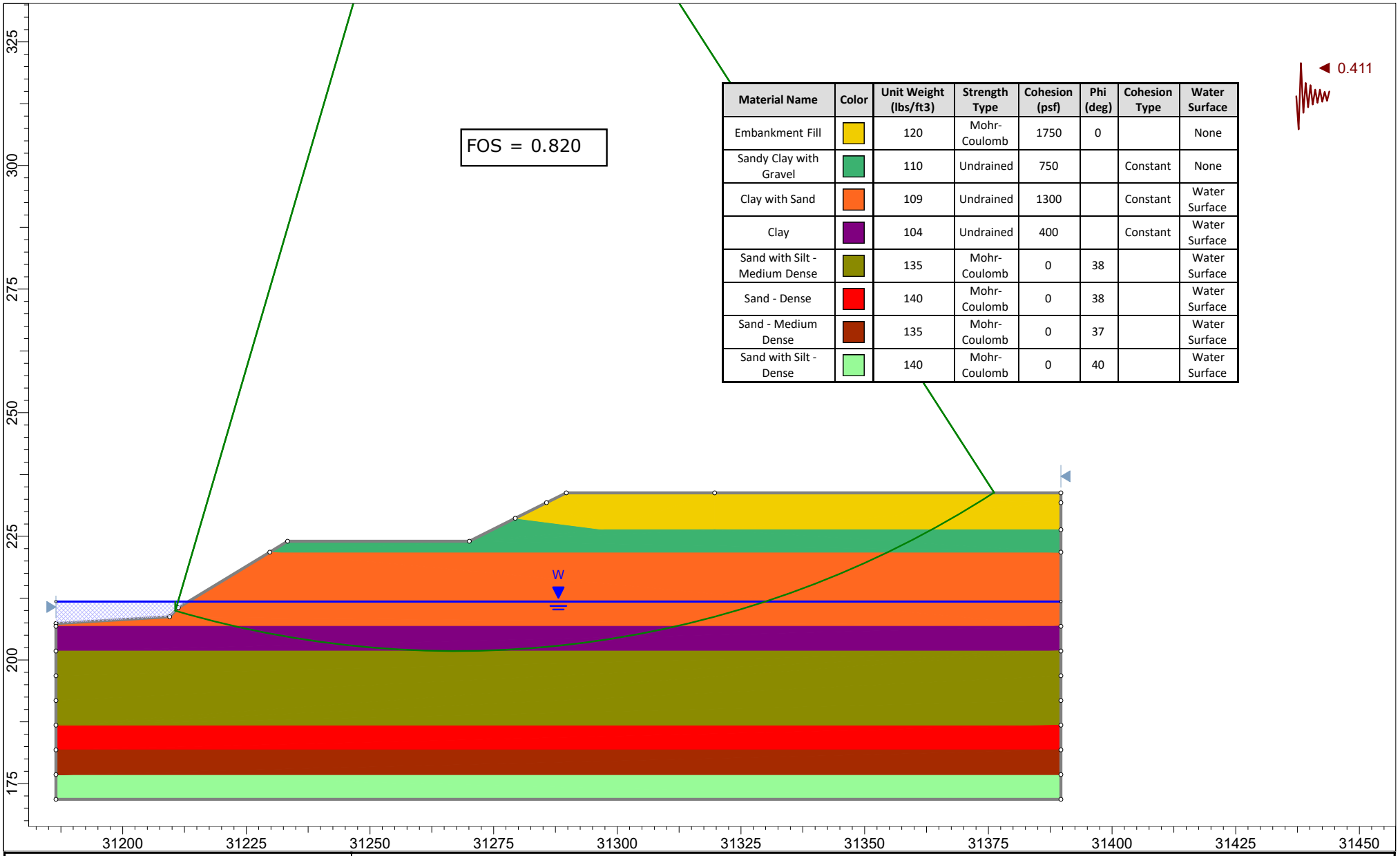
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment Fill		120	Mohr-Coulomb	50	30	None
Sandy Clay with Gravel		110	Mohr-Coulomb	50	28	None
Clay with Sand		109	Mohr-Coulomb	50	30	Water Surface
Clay		104	Mohr-Coulomb	50	26	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38	Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38	Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37	Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40	Water Surface



rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Long Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	10/20/2022		



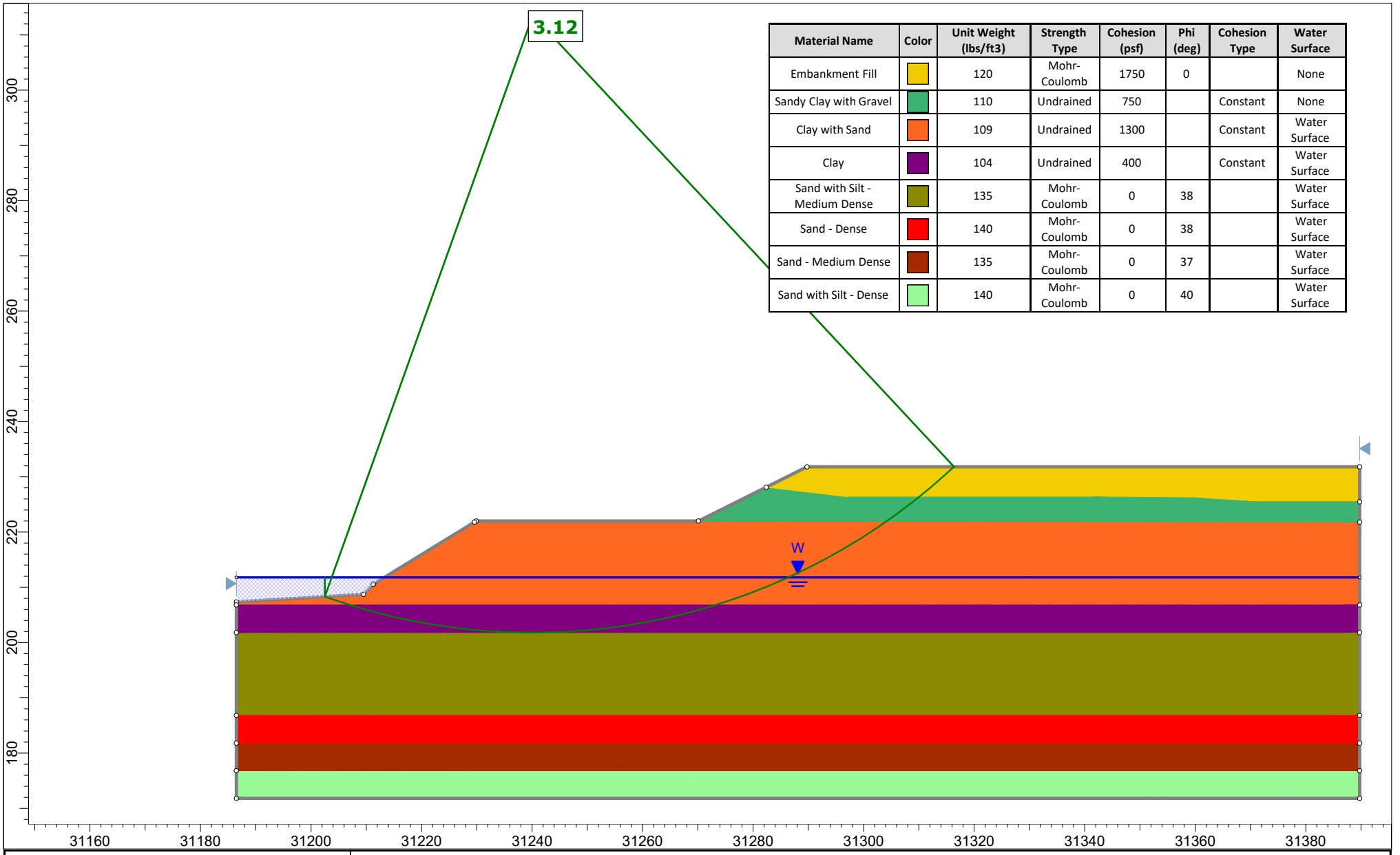
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface

rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	1	Analysis Type	Seismic
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch, West Embankment
Date	10/20/2022		

Attachment B



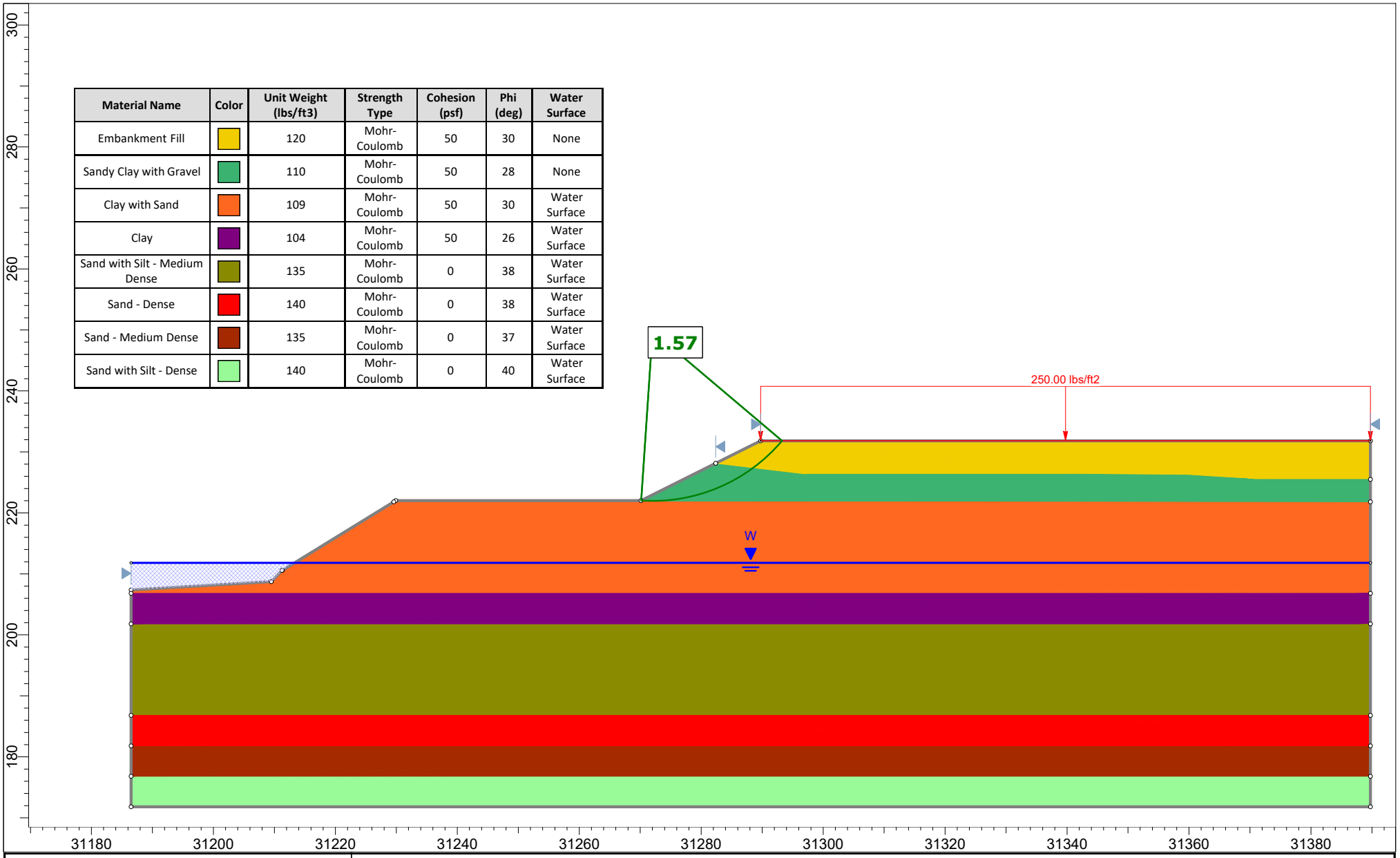
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface

rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	West Embankment	Analysis Type	Short Term / End of Construction
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch
Date	4/13/2023		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment Fill		120	Mohr-Coulomb	50	30	None
Sandy Clay with Gravel		110	Mohr-Coulomb	50	28	None
Clay with Sand		109	Mohr-Coulomb	50	30	Water Surface
Clay		104	Mohr-Coulomb	50	26	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38	Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38	Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37	Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40	Water Surface



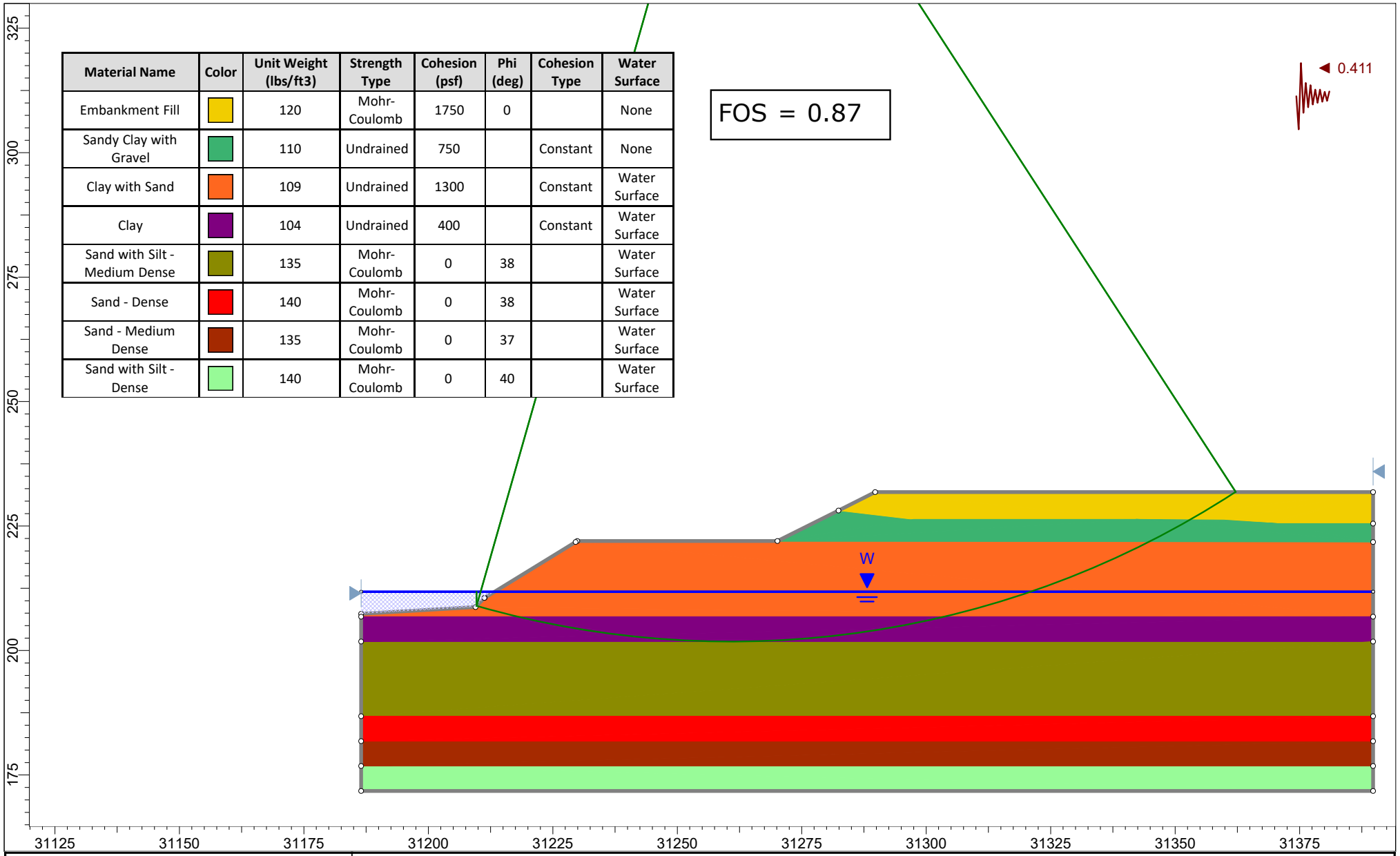
rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	West Embankment	Analysis Type	Long Term
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch
Date	4/13/2023		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface

FOS = 0.87

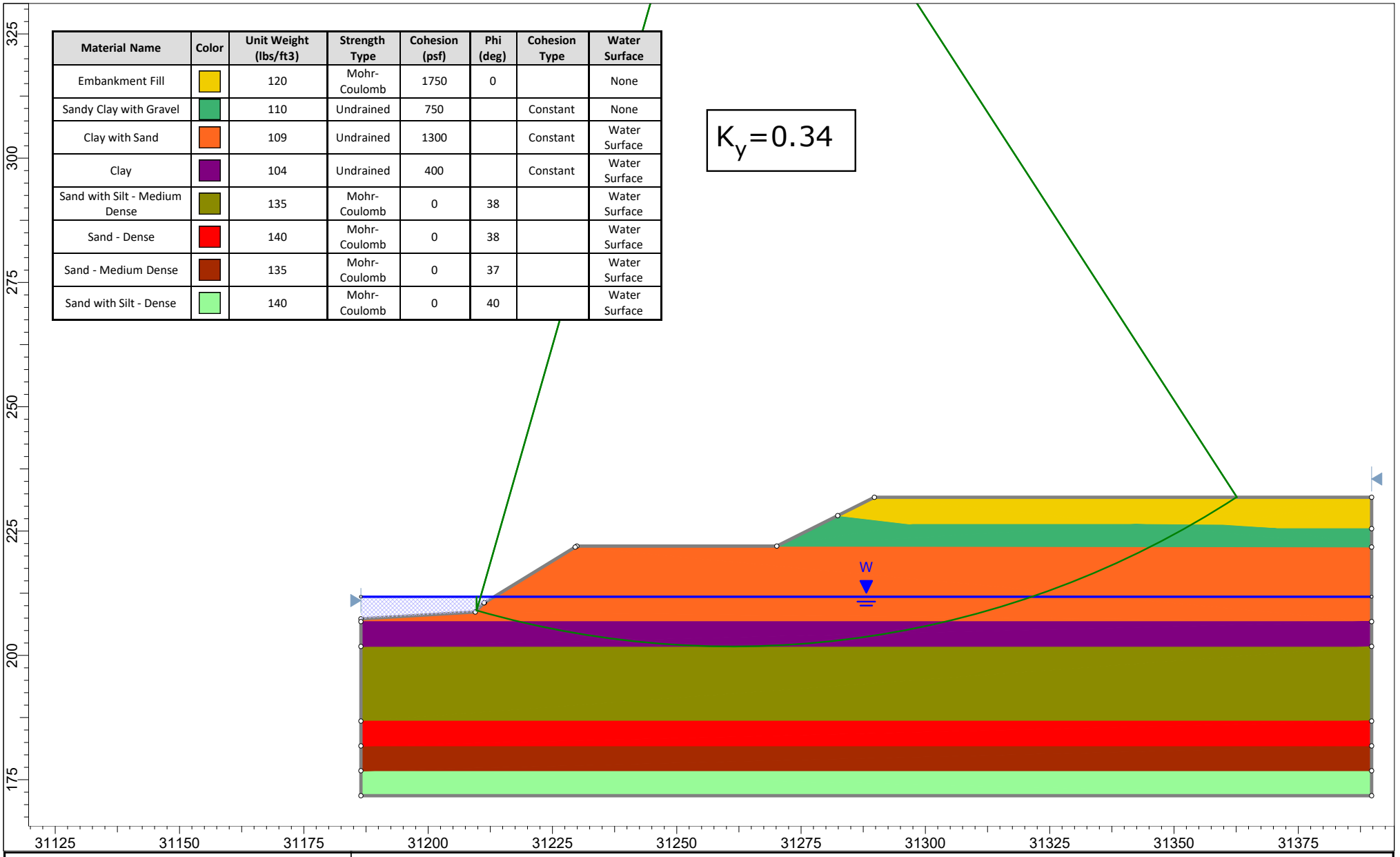


rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	West Embankment	Analysis Type	Seismic
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch
Date	4/12/2023		

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Water Surface
Embankment Fill		120	Mohr-Coulomb	1750	0		None
Sandy Clay with Gravel		110	Undrained	750		Constant	None
Clay with Sand		109	Undrained	1300		Constant	Water Surface
Clay		104	Undrained	400		Constant	Water Surface
Sand with Silt - Medium Dense		135	Mohr-Coulomb	0	38		Water Surface
Sand - Dense		140	Mohr-Coulomb	0	38		Water Surface
Sand - Medium Dense		135	Mohr-Coulomb	0	37		Water Surface
Sand with Silt - Dense		140	Mohr-Coulomb	0	40		Water Surface



rocscience

SLIDEINTERPRET 9.020

Project	101126 - Whiteman Creek Str. & Apprs. (S)		
Site	West Embankment	Analysis Type	Seismic
Analyzed By	PT	Configuration	Hwy. 158 over Little Bay Ditch
Date	4/12/2023		

Attachment C

SIMPLIFIED NEWMARK BLOCK ANALYSIS - NCHRP 611

1. Seismic Coefficients

Seismic coeffients from USGS Seismic Hazard Web using GPS = 35.747787, -90.611171 and Seismic Site Class D

$PGA := 0.822$ $\quad F_{PGA} := 1.00$ $\quad A_S := F_{PGA} \cdot PGA = 0.822$

$S_S := 1.487$ $\quad F_A := 1.00$ $\quad S_{DS} := F_A \cdot S_S = 1.487$

$S_1 := 0.392$ $\quad F_V := 1.616$ $\quad S_{D1} := F_V \cdot S_1 = 0.633$

$k_{max} := A_S$ *Peak ground acceleration coefficient at the ground surface (Eq. 7-1)*

$PGV := 55 \ S_{D1} \cdot \frac{in}{s} = 34.8 \ \frac{in}{s}$ *Peak Ground Velocity for M = 7.5 (Eq. 5-11)*

$\beta := \frac{S_{D1}}{k_{max}} = 0.771$ *Part of Eq. 7-2 to calculate reduction factor for peak ground acceleration*

2. Embankment Parameters

$H := 9.81 \ ft$ *Embankment or wall height*

$\alpha := 1 + 0.01 \cdot \frac{H}{ft} \cdot (0.5 \cdot \beta - 1) = 0.94$ *Reduction factor accounting for fill height for Seismic Site Classes C, D, and E foundations (Eq. 7-2)*

$k_{av} := \alpha \cdot k_{max} = 0.772$ *Peak ground acceleration adjusted by fill height (Eq. 7-1)*

$k_y := 0.340$ *Yield acceleration of the failure mass, i.e., horizontal acceleration that results in a factor of safety of 1.0 in a pseudo-static limit equilibrium stability analysis, bckcalculated by using stability analysis software*

$k_{max} := k_{av} = 0.772$

3. Newmark Block Displacement

$$A := -1.51 - 0.74 \cdot \log\left(\frac{k_y}{k_{max}}\right) + 3.27 \cdot \log\left(1 - \frac{k_y}{k_{max}}\right)$$

$$B := -0.80 \cdot \log\left(k_{max}\right) + 1.59 \cdot \log\left(\frac{PGV}{\frac{in}{s}}\right)$$

$d := 10^{(A+B)} \cdot in = 3.0 \ in$ *Esimated permanent displacement (Eq. 5-8)*