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ENGINEERING & TESTING, INC.

STRUCTURE GEOTECHNICAL REPORT

IL 166 over Sugar Creek
FAS Route 904
Section 101B-1
Existing Structure No. 100-0031
Proposed Structure No. 100-0101
Williamson County, Illinois

Prepared for:
Mr. Mike Cima, PE, SE
Chief Structural Engineer
Quigg Engineering, Inc.
2351 S. Dirksen Parkway
Springfield, Illinois 62703

CHRISTOPHER MATHEWS
062-067709
LICENSED
PROFESSIONAL
ENGINEER
STATE OF ILLINOIS

12/19/2023

Exp. 11/30/2025

Submittal Date:

December 19, 2023

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.
521 WEST MAIN STREET | SUITE 200 | BELLEVILLE, IL 62220

December 19, 2023

Mr. Mike Cima, PE, SE
Chief Structural Engineer
Quigg Engineering, Inc.
2351 S. Dirksen Parkway
Springfield, IL 62703

RE: ***Structure Geotechnical Report***
IL 166 over Sugar Creek
Structure 100-0031
Williamson County, Illinois
BFW No: 23069

Dear Mr. Cima:

Bacon Farmer Workman Engineering & Testing, Inc. (BFW), is pleased to present the attached Structure Geotechnical Report for the referenced project. It has been revised to address comments in the IDOT *Speed Letter* dated November 22, 2023 provided in regards to our *Structure Geotechnical Report* dated September 23, 20223. The foundation investigation was conducted in accordance with applicable IDOT and AASHTO Standards.

The attached report includes a review of pertinent project information, descriptions of site and subsurface conditions encountered, and our general recommendations for foundation design and construction of the proposed bridge.

Sincerely,

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

Christopher L. Mathews, P.E.
Geotechnical Engineer/Project Manager

Christopher N. Farmer, P.E.
Principal Engineer

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1. PROJECT DESCRIPTION AND SCOPE

The purpose of this geotechnical study was to use the provided subsurface information to prepare geotechnical recommendations for the proposed bridge replacement.

Plans are for the removal and replacement of an existing single span bridge on IL 166 over Sugar Creek. This structure is located approximately 0.3 miles southeast of the town of Creal Springs in Williamson County, Illinois. The existing structure (SN 100-0031) was originally built in 1933 as SBI Route 166, section 101-B and 101-C, and was reconstructed with a superstructure replacement in 1980.

The new structure will be a two-lane single-span bridge with reinforced concrete decks on continuous wide flange steel beams supported by integral abutments. The planned structure's length is 118 feet, and its width is 34'-10". The base of the existing abutment walls will be left in place to retain the proposed riprap. The structure will be designed according to the IDOT Bridge Manual and AASHTO LRFD Bridge Design Specifications. The site location is shown on Figure 1.1. The TS&L prepared by Quigg Engineering, Inc (QEI) is attached in Appendix A.

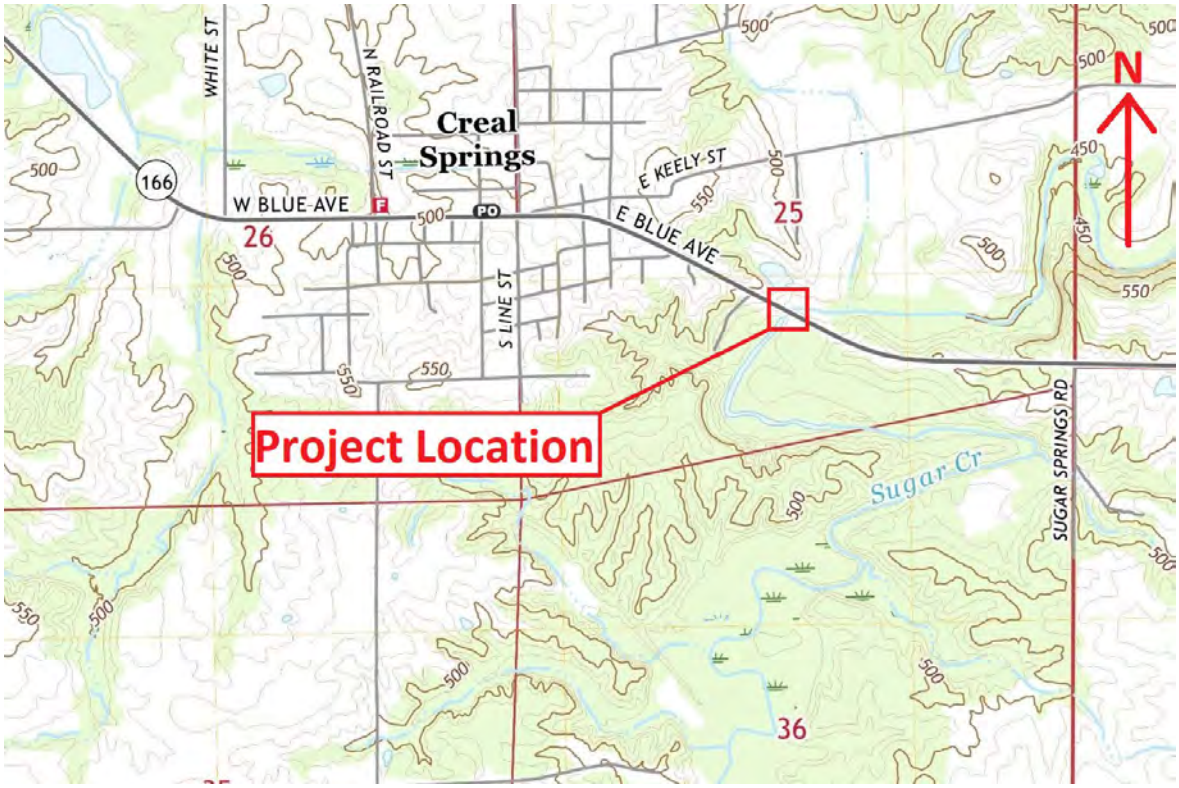


Figure 1.1. Project Location

2. FIELD EXPLORATION

The subsurface exploration was completed by IDOT in November 2013 and boring logs were provided to BFW in a letter dated May 5, 2021. One boring was advanced near each of the existing east and west abutments. Based on the information included on the provided borings logs, the borings were advanced using 8-inch outside diameter hollow steam augers and SPT samples were collected with an auto hammer. Rock coring techniques were used to collect rock core samples at both boring locations. Table 2.1 summarizes the boring locations and depths. The boring locations are shown on the TS&L in Appendix A.

Table 2.1 – Summary of Soil Testing Borings

Boring	Structure	Ground Surface Elevation (msl)	Depth (ft)	Station	Offset
1-S	East Abutment	469.3	30.8	242+72	12' RT
2-S	West Abutment	473.1	37.5	241+40	10' LT

2.1 *REGIONAL GEOLOGY*

According to the Illinois State Geological Survey's map titled *Geologic Map of the Creal Springs Quadrangle, Illinois' (IGQ-4)* this site is shown to be underlain by Pennsylvanian aged deposits of the Creal Springs member of the Spoon formation. The Spoon formation is comprised of shale, siltstone, sandstone, coal, and limestone. The sandstones are shown to be fine to medium grained, micaceous, and argillaceous. The limestone in this area is shown to be cherty in places with some being almost entirely silicified.

2.2 *SUBSURFACE CONDITIONS*

The surficial materials at each boring location consisted of 16 to 18 inches of hot mix asphalt. The natural soil profile generally consisted of clay and silty clay deposits near the surface transitioning to sandy clay loam, clay loam and silty clay loam at depths of 7 to 11.5 feet. The soils were generally very soft to medium stiff. Bedrock was encountered at depths ranging from 15.8 to 22 feet. The depth and elevation of bedrock encountered at each boring is summarized in Table 2.2. Rock coring was performed at both borings 1-S and 2-S. Three, 5-foot rock cores were obtained at each boring. Bedrock encountered was generally consistent between the two borings and consisted primarily of a dense gray sandstone with some shale interbeds encountered at boring 1-S at a depth of 25.8 to 30.8 feet.

Table 2.2 – Bedrock Depth and Elevation

Location	Ground Surface Elevation (msl)	Depth to Bedrock (ft)	Bedrock Elevation (msl)
1-S	469.3	15.8	453.5
2-S	473.1	22.0	451.1

2.3 *GROUNDWATER*

Groundwater was encountered during drilling in boring 2-S at a depth of 19.5 feet. Groundwater was not encountered during drilling in boring 1-S. It should be noted that the ground water level is dependent upon seasonal and climatic variations and may be present at different depths in the future.

3. GEOTECHNICAL EVALUATIONS

Based on the results of the subsurface exploration, current site conditions observed, and laboratory results, and our review of the project plans, the following geotechnical evaluations were performed. The recommendations developed from these evaluations should be used in the design of the bridge structures.

3.1 *BASIS FOR RECOMMENDATIONS*

The following recommendations are based on data from this exploration and the stated project information. In our evaluations, we have utilized both subsurface data provided by IDOT and our experience with similar structures and subsurface conditions. If the structural information is incorrect or changed after our reporting, or if the subsurface conditions encountered during the construction vary from those reported, our recommendations should be reviewed based on the changed conditions.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized based on soil test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil-engineering services during the site preparation, excavation, and foundation construction phases of the proposed project. The geotechnical engineer should observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.2 *SEISMIC CONSIDERATIONS*

3.2.1 Design Earthquake

According to *IDOT Geotechnical Manual*, bridge structures are required to be designed to an earthquake with a 7 percent Probability of Exceedance (PE) over a 75-year exposure period (i.e. a 1,000-year design earthquake). The 1,000-year design earthquake has a Moment Magnitude (Mw) of 7.7 and a Peak Ground Acceleration (PGA) of 0.39g as determined from data provided by the United States Geological Survey (USGS) National Seismic Hazard Mapping Project.

3.2.2 Seismic Site Classification and Design Parameters

The seismic site classification for the site was determined based on the subsurface data collected and the procedures outlined in the *IDOT Geotechnical Manual*. Specifically, IDOT spreadsheet BBS 149 was used to calculate the LRFD site classification. Based on the weighted average undrained shear strength in the upper 100 feet of the subsurface profile, Site Class C should be used for seismic design, as shown in Appendix C. Seismic design parameters are presented in Table 3.1.

Table 3.1 – Seismic Design Parameters

Seismic Design Parameters	
Site Class	C
F_A	1.11
F_V	1.62
F_{PGA}	1.01
S_S	0.73
S_1	0.18
PGA	0.39
A_s	0.394
S_{DS}	0.81
S_{D1}	0.30
SDC	B
Seismic Performance Zone	2

3.2.3 Liquefaction Analysis

The liquefaction potential analysis for the site was conducted using field and laboratory data and the techniques outlined in AGMU 10.1. The average seasonal groundwater elevation used in the analysis was estimated from the end of boring conditions and the seasonal weather conditions. Sands located above the groundwater table are not susceptible to liquefaction.

Based on our analyses, the soils observed have sufficient strength and/or a plasticity index that make the threat of liquefaction minimal during the design earthquake. The liquefaction analysis results are presented in Appendix D.

While the amount of the seismically induced settlement is dependent on the magnitude and distance from the seismic event, we estimate that the settlements from the design earthquake will be negligible, so liquefaction mitigation techniques are not required. As no liquefaction is predicted for the site, the effects of liquefaction on axial pile capacity can be neglected.

3.3 *ABUTMENT APPROACH SETTLEMENT*

Based on the TS&L prepared by QEI, minimal grade changes will be required. Accordingly, minimal abutment settlement will occur and the effects of downdrag do not be considered in the evaluation of pile capacity.

3.4 *BRIDGE APPROACH SLABS*

The bridge approach slabs should be designed to bear on existing embankment soils or newly placed low plasticity structural fill. In evaluating the bearing resistance of the slabs, we recommend using a modulus of subgrade reaction of 150 pounds per square inch per inch of deflection (pci).

3.5 *BRIDGE FOUNDATIONS*

The bridge foundations must be designed to provide sufficient capacity to resist dead and live loads, including seismic loads. The estimated factored substructure loads provided by QEI are summarized in Table 3.2. Based on information provided by QEI, we recommend utilizing piles set in rock for foundation support.

Table 3.2 – Substructure Factored Loads

Loading Condition	Factored Substructure Load (kips)
Service	1,510
Strength-I	2,213
Extreme Event-I	1,215

3.5.1 Piles Set in Rock

Based on the depth to bedrock, we recommend steel H-piles set in bedrock be utilized for foundation support of the bridges. The structural capacity of piles is dependent upon the cross-sectional area of the pile and the allowable stress of the steel. The driven pile recommendations in this report assume the H-piles will conform to AASHTO M270 Grade 50 steel with a minimum yield stress of 50 kips per square inch (ksi). The piles should be spaced no closer than three pile diameters, center to center.

To develop capacity the H-piles will need to bear on bedrock. Based on information provided by QEI, we anticipate pre-coring of the piles and creation of a rock socket will be required to meet integral abutment requirements. Per the IDOT *Design Guide for Integral Abutment Pile* Selection, the piles at the east abutment should be pre-cored to a minimum depth of 10 feet below the bottom of the integral abutment due to the presence of shallow bedrock. Bedrock is estimated to be below the 10-foot critical depth at the west abutment; however, we recommend piles set in rock at this location as well. The top 10 feet of the pre-cored hole should be backfilled with granular bentonite with unconfined compressive strength of 1.0 tons per square foot. The portion of the pre-cored hole considered as part of the rock socket should be backfilled with concrete. The rock socket may be designed for a factored unit tip resistance of 1,000 ksf and factored unit side resistance of 25 ksf. The factored resistances were developed based strength limit state factors of 0.50 and 0.55 for tip and side resistances, respectively. We recommend a minimum rock socket depth of 5 feet into competent rock for lateral stability.

Section 6.13.2.3.5 of the *IDOT Geotechnical Manual* indicates a Geotechnical Resistance Factor (ϕ_G) of 0.70 should be used for H-piles set in rock. Additionally, the nominal capacity of piles set in rock is taken to be 100% of the pile section's yield strength. During the seismic event a Geotechnical Resistance Factor of 1.0 may be used. Geotechnical losses due to liquefaction or settlement do not need to be considered. Table 3.2 summarizes the H-Pile capacities for multiple piles sizes.

Table 3.3 – H-Pile Set in Rock Capacities

Pile Type	Structural Nominal Compressive Resistance (kips)	Factored Compressive Resistance, Static (ϕ_G= 0.70, kips)	Factored Compressive Resistance, Seismic (ϕ_G = 1.0, kips)
HP 12x53	775	542	775
HP 14x73	1,070	749	1,070
HP 14x89	1,305	914	1,305
HP 14x102	1,305	1050	1,305

3.5.2 Lateral Pile Response

The lateral response can be developed by modeling the soil/shaft interaction with the computer program LPILE. Discrete elements are used in LPILE to represent the shaft and non-linear soil using springs. The non-linear soil springs are commonly referred to as P-Y curves.

Table 3.3 summarizes the approximate soil modulus parameters (k) for the LPILE analyses (Reference: LPILE User's Manual, Ensoft, Inc., 2019) Any portion of the pile set in rock backfilled with bentonite or above bedrock be modeled as a stiff clay without free water. The portion of the rock socket backfilled with concrete should be modeled as strong rock.

Table 3.4 – LPILE Parameters

Material Type	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Rock Unconfined Compressive Strength (psi)
Stiff Clay without Free Water	120	1,000	0.010	--
Strong Rock	150	--	--	4,000

3.6 *SLOPE STABILITY*

Based on the information shown on the TS&L, 2H:1V end slopes with riprap armoring will be utilized for the abutments. The analyses were conducted using limit equilibrium slope stability methods and the commercially available software program Slide2 (developed by Rocscience, Inc.). The analyses considered soil properties from the subsurface exploration data, and the given slope geometries. To account for traffic loading, a surcharge load of 250 psf was applied to the analyses.

Three analyses were evaluated using the Bishop and Janbu analyses methods for the proposed slope geometry: end-of-construction (short-term, undrained), long-term (drained) and seismic. For the seismic evaluation, the peak ground acceleration (PGA) from the design earthquake along with procedures for seismic slope stability outlined in Federal Highway Administration (FHWA) publication FHWA-HI-99-012 Geotechnical Earthquake Engineering were utilized. Soil parameters used in the analyses and the results of the analyses are shown on the output plots in Appendix E. A critical factor of safety (FOS) was calculated for each condition. According to the *IDOT Geotechnical Manual*, the target FOS is 1.5 for end-of-construction and long-term slope stability and 1.0 for the design seismic event. The results of the analysis are shown on the following page in Table 3.

Based on the analysis performed, the proposed slopes meet the minimum required factor of safety of 1.5 (end-of-construction, long-term) and 1.0 (seismic).

Table 3.5 – Slope Stability Analysis Results

Location	Slope	Calculated Critical FOS		
		End-of-Construction	Long Term	Seismic
East Abutment	2H:1V	1.7	1.5	1.6
West Abutment	2H:1v	1.6	1.5	1.4

3.7 *SCOUR CONSIDERATIONS*

We understand that scour protection will be provided at the bridge abutments via Class A5 stone dumped riprap. Design scour elevation, as provided by QUE, are included in Table 3.6.

Table 3.5 – Scour Elevations

Event / Limit State	Design Scour Elevations (ft.)		Item 113
	W. Abut.	E. Abut.	
Q100	462.9	459.3	8
Q200	462.9	459.3	
Design	462.9	459.3	
Check	462.9	459.3	

4. CONSTRUCTION CONSIDERATIONS

Based on the TS&L, staged construction will be utilized, and a temporary soil retention system (TSRS) will be required. The IDOT *Temporary Soil Retention System* construction specification should be utilized for design of the TSRS.

All work performed for the proposed project should conform to the requirements in the *IDOT Standard Specifications for Road and Bridge Construction* and any pertinent special provisions or policies. Any deviation from the requirements in the manuals above should be approved by the design engineer.

5. LIMITATIONS

This report has been prepared for the exclusive use of Quigg Engineering, Inc. and its subconsultants for the project and the Illinois Department of Transportation The recommendations provided in the report are specific to the project described herein and are based on the information obtained from the soil boring locations provided by IDOT within the project limits. The analyses have been performed and the recommendations have been provided in this report are based on subsurface conditions determined at the location of the borings. The report may not reflect all variations that may occur between boring locations or at some other time, the nature and extend of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations provided herein considering the new conditions.

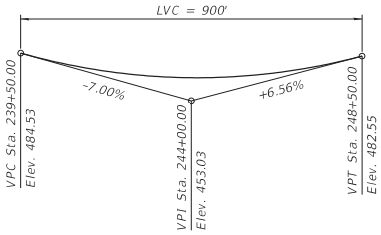
Appendix A

TS&L

Benchmark: Mag Spike set 2' above grade in Power Pole southwest of IL 166. Sta. 239+80.02, Offset 34.21' Rt., Elev. 480.86.

Existing Structure: SN 100-0031 was originally built in 1933 as SBI Route 166, Section 101-B and 101-C and was reconstructed with a superstructure replacement in 1980. The bridge is 73'-8" bk-bk abutments and 33'-0" out-out of deck. The superstructure consists of 33" PPC Deck Beams on closed abutments. The bridge has an HMA wearing surface and waterproofing membrane in place. The structure will be replaced using staged construction.

The base of the existing abutment walls will be left in place as shown to retain the proposed riprap.



PROFILE GRADE
(Along ℄ IL 166)

HIGHWAY CLASSIFICATION

F.A.S. Route 904 - IL 166
Functional Class: Major Collector
ADT: 1,150 (2021); 1,162 (2046)
ADTT: 127 (2021); 128 (2046)
DHV: 155 (Two-way)
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi (Substructure)
f'c = 4,000 psi (Superstructure)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50) *
* All structural steel shall be metalized.

DESIGN SPECIFICATIONS

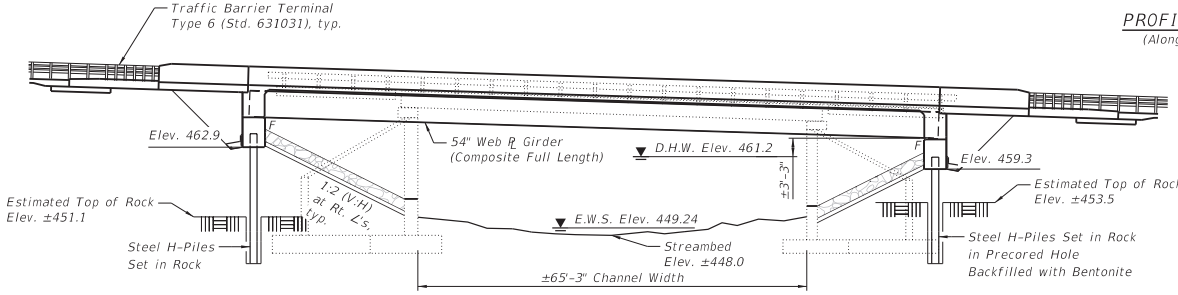
2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

LOADING HL-93

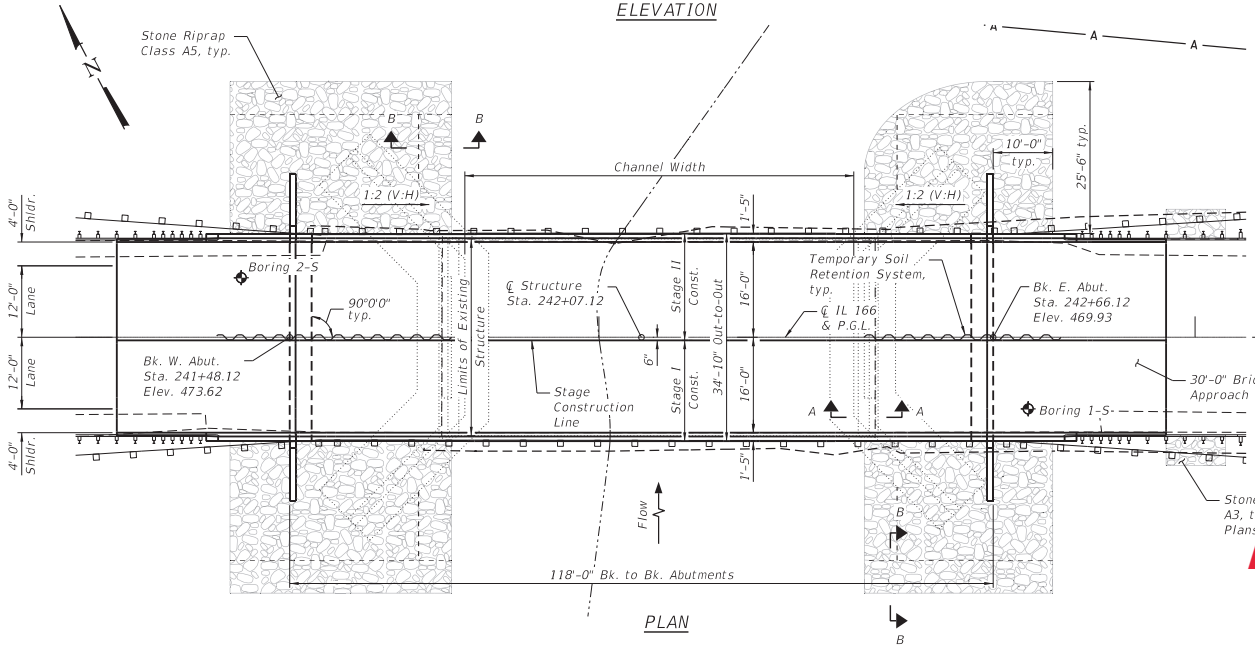
Allow 50#/sq. ft. for future wearing surface.

SEISMIC DATA

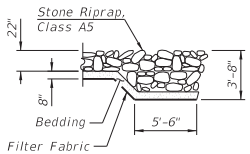
Seismic Performance Zone (SPZ) = 2
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.30g
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.81g
Soil Site Class = C



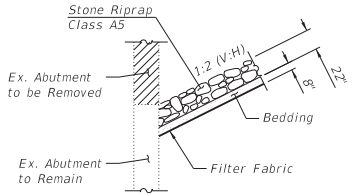
ELEVATION



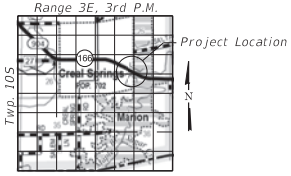
PLAN



SECTION B-B



SECTION A-A



LOCATION SKETCH

APPROVED
DECEMBER 06, 2023
AS A BASIS FOR
PREPARATION OF DETAILED PLANS

GENERAL PLAN & ELEVATION
IL 166 OVER SUGAR CREEK
F.A.S. ROUTE 904 - SECTION 101B-1
WILLIAMSON COUNTY
STATION 242+07.12
STRUCTURE NO. 100-0101

QUIGG ENGINEERING INC

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 2 SHEETS

F.A.S. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
904	101B-1	WILLIAMSON		
		CONTRACT NO. 78209		
		ILLINOIS FED. AID PROJECT		

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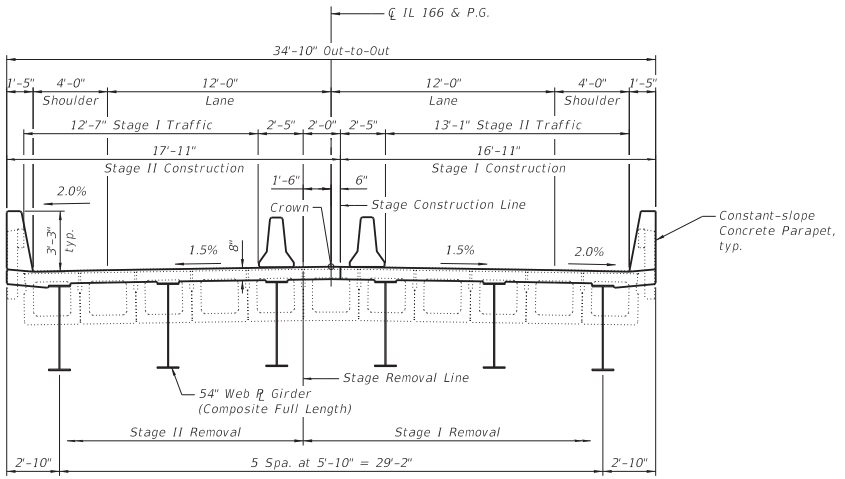
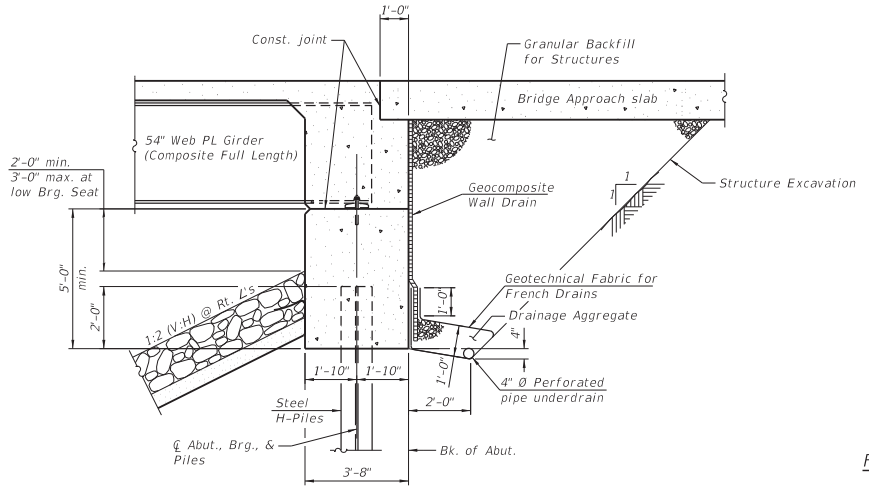


CROSS SECTION

(Looking East)



SECTION THRU INTEGRAL ABUTMENT

DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevations (ft.) W. Abut.	E. Abut.	Item 113
Q100	462.9	459.3	8
Q200	462.9	459.3	
Design	462.9	459.3	
Check	462.9	459.3	

WATERWAY INFORMATION

Drainage Area = 25.2 Sq. Mi.

Existing Overtopping Elev. 468.12 at Sta. 244+27
Proposed Overtopping Elev. 468.12 at Sta. 244+27

Flood	Freq. Yr.	Q C.F.S.	Opening Ft² Exist.	Opening Ft² Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
Ten-Year	10	3,230	592	624	459.4	1.2	1.0	460.6	460.4
Design	50	5,080	712	787	461.2	1.3	1.0	462.5	462.2
Base	100	5,900	752	845	461.8	1.4	1.0	463.2	462.8
Scour Check	200	6,750	792	905	462.4	1.6	1.1	464.0	463.5
Max. Calc.	500	8,000	832	966	463.0	1.8	1.2	464.8	464.2

10-Year Velocity through Existing Structure = 4.8 fps
10-Year Velocity through Proposed Structure = 4.5 fps

APPROVED

DECEMBER 06, 2023

AS A BASIS FOR
PREPARATION OF DETAILED PLANS

DETAILS
IL 166 OVER SUGAR CREEK
F.A.S. ROUTE 904 - SECTION 101B-1
WILLIAMSON COUNTY
STATION 242+07.12
STRUCTURE NO. 100-0101

MODEL: Default
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12/5/2023 8:12:19 AM

QUIGG ENGINEERING INC

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F.A.S. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
904	101B-1	WILLIAMSON		
		CONTRACT NO. 78209		
	ILLINOIS	FED. AID PROJECT		

Appendix B

Boring Logs

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Mike Stephenson
From:	Keith Roberts	By: Aaron Hayes
Subject:	Boring Logs	
Date:	May 5, 2021	

IL 166 (FAP 331) over Sugar Creek
Structure 100-0031 (Ex.)
Section: 101B-1 (Ex.)
Williamson County

Foundation boring logs have been obtained for design of the replacement of the structure listed above and are attached. The borings were drilled in 2013. Boring 2-S, near the west abutment, shows a potentially liquefiable layer at a depth of 16.0 to 18.5 ft. A liquefaction analysis should be completed once the proposed structure's final dimensions are determined.

An old boring completed for the design of the existing structure, reconstructed in 1980, has been attached for additional information.

Attachments
AWH:ah

cc: Soils File
S:\Materials Geotechnical Unit\gINT\PROJECTS\Projects File\Williamson\Structures

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 11/1/13

ROUTE FAS 904 (IL 166) **DESCRIPTION** Bridge over Sugar Creek **LOGGED BY** L. Estel

SECTION 101B-1 (existing) **LOCATION** At ECL of Creal Springs (near E. Abut.), **SEC.** 25, **TWP.** 10S, **RNG.** 3E, 3 **PM**

COUNTY Williamson **DRILLING METHOD** Hollow Stem Auger (8" O.D., 3.25" I.D.) **HAMMER TYPE** Auto SPT 140 lbs

STRUCT. NO. 100-0031
Station 242+10

BORING NO. 1-S
Station 242+72
Offset 12.0ft Rt
Ground Surface Elev. 469.3 ft

Surface Water Elev. 449.7 ft
Stream Bed Elev. ft

Groundwater Elev.:
▽ **First Encounter** ft
▽ **Upon Completion** ft
▼ **After** Hrs. ft

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Cored pavement, 18" HMA
467.80				
	2			Stiff Brown, Moist SILTY CLAY
	2	1.5	17	
	2	B		
464.80				
-5	1			Medium Brown, V. Moist CLAY
	1	0.7	27	
	1	B		
462.30				
	1			Stiff Brown, Moist SILTY CLAY LOAM
	1	1.1	24	
	2	B		
				% Fines <#200: 90%, LL 34, PI 14 (Estimated - based on visual ID and historical database)
459.80				
-10	1			Medium Brown, V. Moist SANDY CLAY LOAM to CLAY LOAM
	2	0.6	14	
	1	S		
				% Fines <#200: 50%, LL<40, PI>11 (Estimated - based on visual ID and historical database)
	WOH			
	1	0.6	18	
	1	S		
454.80				
-15	2			Loose Brown and Grey, Moist Broken SANDSTONE with CLAY
	7			
453.50	50/3"			
				(Borehole continued with rock coring.)
-20				

Bottom of hole @ 30.8 ft

No free water observed

Ground surface elevation referenced to Benchmark @ SW corner of SN 100-0031; Elev. 470.40

Hammer Efficiency: 75%
To convert "N" values to "N60", multiply by 1.25

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\MATERIALS GEOTECHNICAL UNIT\GINT\PROJECTS\PROJECTS FILE\WILLIAMSON\STRUCTURES\100-0031 IL 166 OVER SUGAR CREEK 2020.GPJ Data Template D6TEMPLT.GDT Date Printed 5/4/21
Latitude 37 37 00.88 Longitude -88 49 40.61 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

ROCK CORE LOG

Date 11/1/13

ROUTE FAS 904 (IL 166) **DESCRIPTION** Bridge over Sugar Creek **LOGGED BY** L. Estel

SECTION 101B-1 (existing) **LOCATION** At ECL of Creal Springs (near E. Abut.), **SEC.** 25, **TWP.** 10S, **RNG.** 3E, 3 **PM**

COUNTY Williamson **CORING METHOD** Conventional rotary with water

STRUCT. NO. 100-0031
Station 242+10

BORING NO. 1-S
Station 242+72
Offset 12.0ft Rt
Ground Surface Elev. 469.3 **ft**

CORING BARREL TYPE & SIZE NV3 5FT NWJ
Core Diameter 1.78 **in**
Top of Rock Elev. 453.80 **ft**
Begin Core Elev. 453.50 **ft**

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
V. Dense Brown and Grey, Dry SANDSTONE	453.50	1	100	57		315.3
						240.1
	-20					331.2
(Grey)		2	100	48		
						375.2
	-25					220.2
Hard Grey, Dry CLAY SHALE and SANDSTONE	443.50	3	93	28		
						361.9
						443.8
	-30					
	438.50					542.5
Ground surface elevation referenced to BM at SW corner of SN 100-0031; Elev. 470.40	-35					

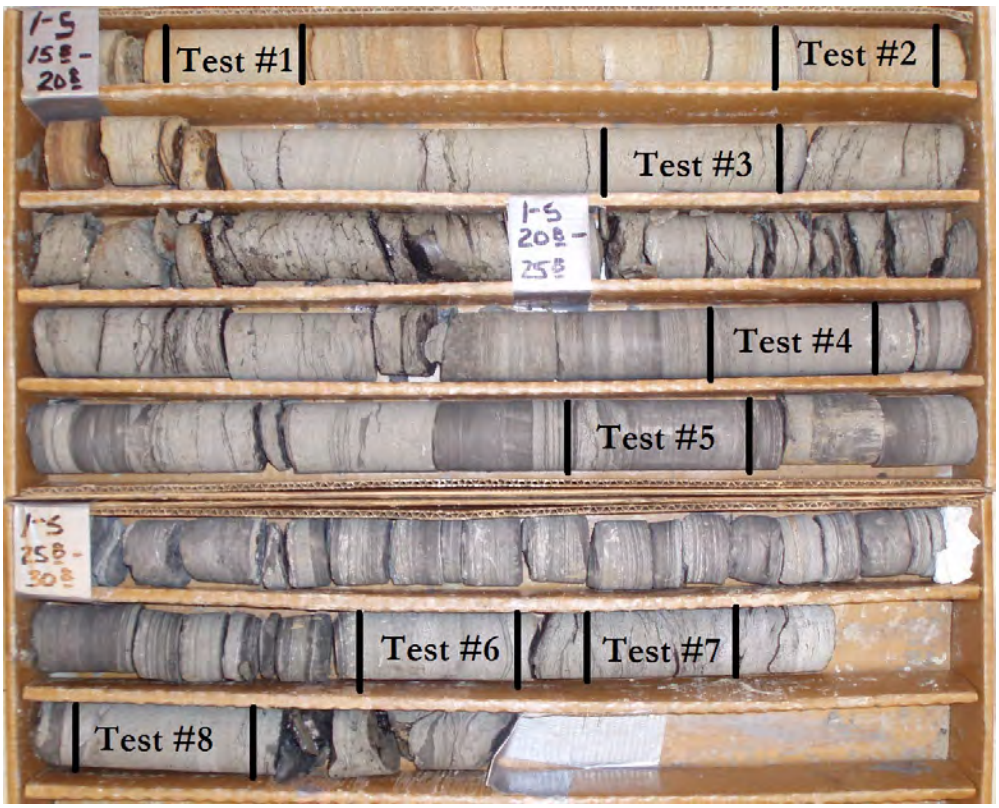
Color pictures of the cores Yes, attached
Cores will be stored for examination until 5 Years after Construction
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)
RQD is the ratio of the total length of sound core specimens >4" to total length of core run

BBS, form 138 (Rev. 8-99)

ROCK CORE 100-0031 IL 166 OVER SUGAR CREEK 2020.GPJ D6TEMPLT.GDT 5/4/21

Illinois Department of Transportation
District Nine Materials
Unconfined Compressive Strength

FAS 904 (IL 166)
Structure 100-0031 (Boring 1-S)
Williamson County



Boring #	Specimen#	Depth	Unconfined Compression
1-S	1	16.1’	4,379 psi
1-S	2	17.5’	3,335 psi
1-S	3	19.1’	4,600 psi
1-S	4	23.1’	5,211 psi
1-S	5	24.8’	3,058 psi
1-S	6	28.5’	5,026 psi
1-S	7	29.1’	6,164 psi
1-S	8	30.0’	7,535 psi

Note: Sample #6 broke in two (2) pieces. Ran test anyway.

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 11/4/13

ROUTE FAS 904 (IL 166) **DESCRIPTION** Bridge over Sugar Creek **LOGGED BY** L. Estel

SECTION 101-B (original) **LOCATION** At ECL of Creal Springs (near W. Abut.), **SEC.** 25, **TWP.** 10S, **RNG.** 3E, 3 **PM**

COUNTY Williamson **DRILLING METHOD** Hollow Stem Auger (8" O.D., 3.25" I.D.) **HAMMER TYPE** Auto SPT 140 lbs

STRUCT. NO. 100-0031
Station 242+10

BORING NO. 2-S
Station 241+40
Offset 10.0ft Lt
Ground Surface Elev. 473.1 ft

Surface Water Elev. 449.7 ft
Stream Bed Elev. ft

Groundwater Elev.:
▽ **First Encounter** 453.6 ft
▽ **Upon Completion** ft
▼ **After** Hrs. ft

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Cored Pavement, 16" HMA
471.60				
				Soil over Concrete Pavement
469.60				
	1			Stiff Brown and mottled Grey, Moist to V. Moist SILTY CLAY
	1	1.1	20	
-5	1	B		
	1			
	1	1.1	20	
	2	S		
464.60				
	1			Medium Brown, V. Moist CLAY
	1	0.6	23	
-10	2	B		
461.60	WOH			
	1	0.3	29	Soft Grey, V. Moist SILTY CLAY LOAM
	1	B		% Fines <#200: 90%, LL 34, PI 14 (Est. based on visual ID and historical database)
459.60				
	1			Soft Grey and Brown, V. Moist SANDY CLAY LOAM to CLAY LOAM
	1	0.3	22	
-15	1	B		% Fines <#200: 50%, LL<40, PI>11 (Est. based on visual ID and historical database)
457.10				
	2			Stiff Grey, Moist SILT LOAM
	2	1.2	21	% Fines <#200: 91%, LL 28, PI 9 (Est. based on visual ID and historical database)
	4	B		
454.60				
	WOH			
▽	WOH	0.1	25	
-20	1	B		

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				V. Soft Grey, Wet SILTY CLAY % Fines <#200: 85%, LL 44, PI 23 (Est. based on visual ID and historical database) *(continued)*
	WOH			
451.10	1			
450.90	100/2"			V. Dense Grey and Brown, Damp SANDSTONE
				(Borehole continued with rock coring.)
				Bottom of hole @ 37.2 ft
-25				
				Free water observed @ 19.5 ft
				Ground surface elevation referenced to benchmark at SW corner of SN 100-0031; Elev. 470.40
				Hammer efficiency : 75%
				To convert "N" values to "N60", multiply by 1.25
-30				
-35				
-40				

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\MATERIALS GEOTECHNICAL UNIT\GINT\PROJECTS\PROJECTS FILE\WILLIAMSON\STRUCTURES\100-0031 IL 166 OVER SUGAR CREEK 2020.GPJ Data Template D6TEMPLT.GDT Date Printed 5/4/21
Latitude 37 37 01.70 Longitude -88 49 42.10 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

ROCK CORE LOG

Date 11/4/13

ROUTE FAS 904 (IL 166) **DESCRIPTION** Bridge over Sugar Creek **LOGGED BY** L. Estel

SECTION 101B-1 (existing) **LOCATION** At ECL of Creal Springs (near W. Abut.), **SEC.** 25, **TWP.** 10S, **RNG.** 3E, 3 **PM**

COUNTY Williamson **CORING METHOD** Conventional rotary with water

STRUCT. NO. 100-0031
Station 242+10

BORING NO. 2-S
Station 241+40
Offset 10.0ft Lt
Ground Surface Elev. 473.1 **ft**

CORING BARREL TYPE & SIZE NV3 5FT NWJ
Core Diameter 1.78 **in**
Top of Rock Elev. 451.10 **ft**
Begin Core Elev. 450.90 **ft**

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
V. Dense Grey, Dry SANDSTONE	450.90	1	100	77		
						260.7
						322.6
	-25					
						313.1
						459.4
						182.2
V. Dense Grey, Dry SANDSTONE		2	100	100		
						323.8
						317.9
	-30					
						444.5
						377.9
V. Dense Grey, Dry SANDSTONE		3	100	100		
						436.1
	-35					483
						374.2
	435.60					
	-40					
Ground surface elevation referenced to BM at SW corner of SN 100-0031; Elev. 470.40						

Color pictures of the cores Yes, On File
Cores will be stored for examination until 5 Years after Construction
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)
RQD is the ratio of the total length of sound core specimens >4" to total length of core run

BBS, form 138 (Rev. 8-99)

ROCK CORE 100-0031 IL 166 OVER SUGAR CREEK 2020.GPJ D6TEMPLT.GDT 5/4/21

Illinois Department of Transportation
District Nine Materials
Unconfined Compressive Strength

FAS 904 (IL 166)
Structure 100-0031 (Boring 2-S)
Williamson County

Boring #	Specimen#	Depth	Unconfined Compression
2-S	1	23.3’	3,621 psi
2-S	2	23.8’	4,481 psi
2-S	3	25.1’	4,349 psi
2-S	4	25.8’	6,381 psi
2-S	5	27.0’	2,531 psi
2-S	6	27.8’	4,497 psi
2-S	7	28.5’	4,415 psi
2-S	8	31.0’	6,174 psi
2-S	9	31.8’	5,249 psi
2-S	10	33.9’	6,057 psi
2-S	11	34.8’	6,709 psi
2-S	12	36.5’	5,197 psi

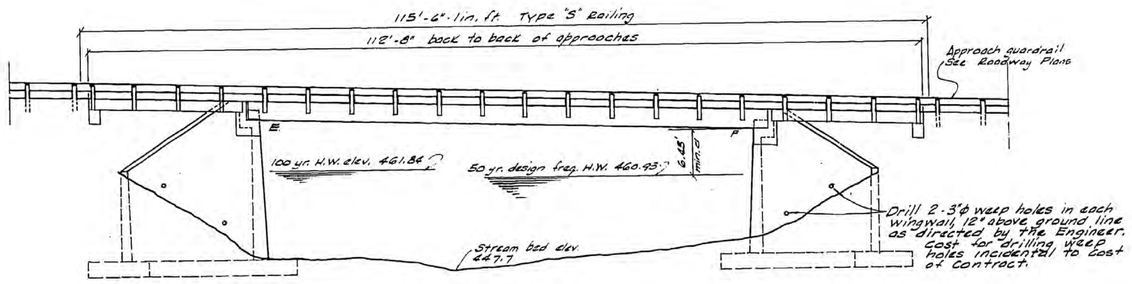
Note: Sample #5 broke, ran test anyway.

Rte.	Section	County	Tot. Sheets	Sheet No.
FAS 904	101 BC-DR	Williamson	19	1/4
Sta. 242+10.00				
FHWA Rte.	Illinois Proj.	P-99-005-77		

Bridge sheet 1 of 6 sheets

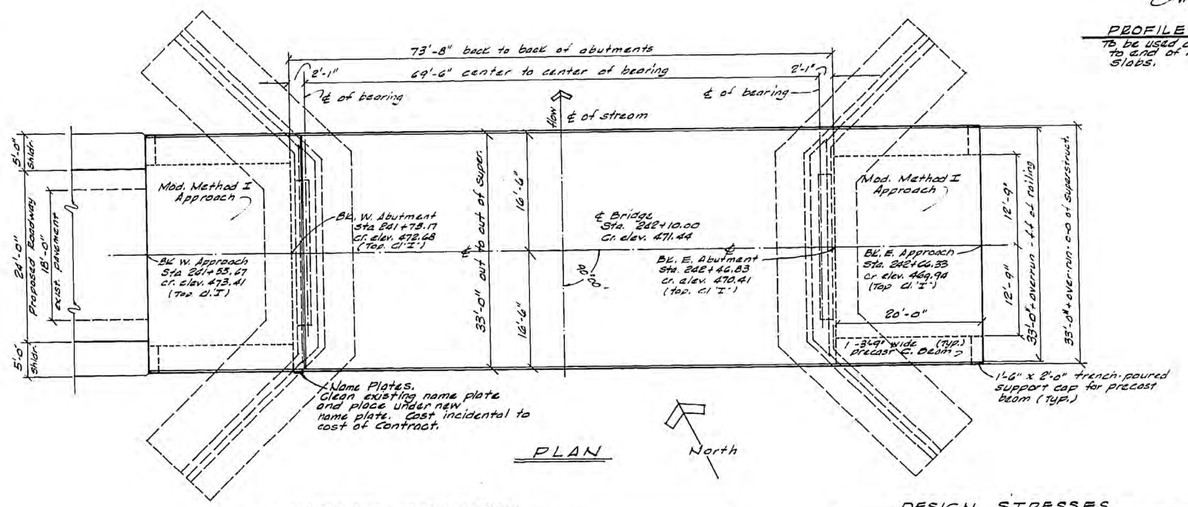
B.M. — RR Spike in 16" oak, 41' left of Sta. 232+05 elev. 532.98

Existing Structure: 1 76' Pony Truss on closed R.C. abutments. 21' roadway, concrete deck. Superstructure and portions of substructure to be removed by Contractor. No salvage. Traffic maintained by use of temporary run-around.



ELEVATION

PROFILE GRADE
To be used only from end to end of Approach Slabs.



PLAN

Boring 1-S
Sta. 241+54
70' Rte. ℄ Roadway.

WATERWAY INFORMATION

Drainage area:	16,086 Acres = 25.0 Sq. miles
Character:	10% cultivated, 60% pasture, 30% timber
Design discharge: (50 yr. frequency)	9,648 c.f.s.
Existing opening: (below 50 yr. H.W.)	728 Sq. ft.
Required opening: (below 50 yr. H.W.)	728 Sq. ft.
Proposed opening: (below 50 yr. H.W.)	728 Sq. ft.
created head for 50 yr. discharge	= 0.16 ft.
100 yr. frequency discharge:	5,342 c.f.s.
created head for 100 yr. discharge	= 0.25 ft.

GENERAL NOTES:

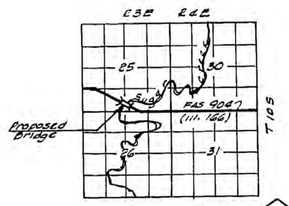
1. The top surface of the beams shall be finished in accordance with Article 505.06 of the Standard Specifications, except the surface shall not be roughened by grooming. The finished surface shall be free of depressions or high spots with sharp corners.
2. For Waterproofing Membrane System, see Special Provisions.
3. For boring data, see Bidding Proposal.
4. Expansion guards not cast into beams shall be fabricated and erected in accordance with Article 503.07(C) of the Standard Specifications and are in the item "STRUCTURAL STEEL".
5. All "STRUCTURAL STEEL" shall be shop painted with two(2) coats of Basic Lead Silica Chromate paint.
6. Reinforcement bars shall conform to AASWTO M-31 or M-53, Grade 60.
7. It shall be the responsibility of the Contractor to verify all dimensions and conditions existing in the field prior to construction and ordering of materials.
8. Item "Removal of Existing Superstructure" shall be in accordance with Art. 501.02 of the Std. Spec. Concrete removal of required portions of the substructure shall be in accordance with Art. 501.03 of the Standard Specifications.

BILL OF MATERIALS

Item	Unit	Super.	Sub.	Total
Class 'X' Concrete	cu.yd.	0.7	26.7	27.4
Reinforcement Bars	lbs.	110	2880	2990
Precast Concrete Bridge Slab	sq. ft.	249	—	249
Prestressed Precast Concrete Deck Beams(33")	sq. ft.	2332	—	2332
Steel Railing - Type "S"	lin. ft.	231	-	231
Bituminous Concrete Surface Mixture 'D'. Cl.I	Tons	57.5	-	57.5
R.C.C. Mortar Fairing Course	lin. ft.	730	-	730
Waterproofing Membrane System	sq. yd.	268	—	268
Structural Steel	lbs.	2210	-	2210
Preformed Joint Sealer (2½")	lin. ft.	33	-	33
Removal of Existing Superstructure	each	1	—	1
Concrete Removal	cu. yd.	-	22.1	22.1
Pavement Removal	sq. yd.	78	-	78
Name Plate	each	1	-	1

STATION 242+10
SUGAR CREEK
REBUILT 19
FAS RTE 904 SEC 101 BC-DR
FA PROJECT BR-S-904(105)
LOADING H&20
STRUCTURE NO.*

LETTERING FOR NAME PLATE
See Std. 211.3-1
* Structure No. to be provided by District.



LOCATION MAP.
Sec. 25, T10S, R3E, 3rd P.M. North

DESIGN STRESSES

	Field Units	Precast Units	Prestressed Precast Units
f'_c =	1400 psi	1800 psi	
f_c =	3500 psi	4500 psi	5000 psi
f'_{ci} =			4000 psi
f_s =	24,000 psi	20,000 psi	
f'_{si} =			270,000 psi
			189,000 psi
n =	9	8	

- Design specifications — AASHTO 1977 & 1978 interim 25 lbs/ft² allowance made for future resurfacing.
- Loading HS 20-44

APPROVED
FOR STRUCTURAL ADEQUACY ONLY
Chief Bridge & Traffic Structures

Rudolph P. Sandoval
2182 REGISTERED STRUCTURAL ENGINEER OF ILLINOIS

GENERAL PLAN & ELEVATION

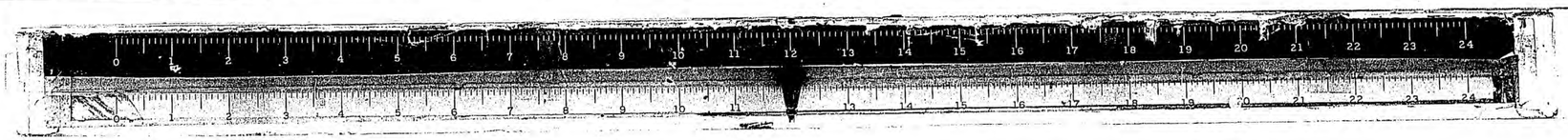
PROJECT
FAS Rte 904 (Ill. 166) over Sugar Creek
SECTION 101 BC-DR

Williamson County, Illinois
Station 242+10.00

08-02.003 | October, 1978

MOSS, JOHNSON, SANDOVAL & ASSOC. LTD.

Design: R.P.S.	Drawn: J.F.J.	Checked: R.P.S.	Field book/Page: 4/4	Sheet/of: 1/5
Date: October 24, 1978	Revised:		Job no.: 08-02-003	



BRIDGE FOUNDATION BORING LOG

PROJECT —
ROUTE F.A.S. 904
SEC. 101RC-DR
COUNTY WILLIAMSON

Boring No. 1-S
Station 291+56
Offset 70' Rt. CL 904

BRIDGE STRUCTURE CARRYING F.A.S. 904 (ILL. 166) OVER SUGAR CREEK
STA. 292+10

Date MAY, 1978
Bored By JOEL CONGIARDO
Checked By GARY L. PULLEY

Surface Water El. NONE
Groundwater El. at Completion —
After — Hours —

100-0031

Elevation	N	Qu t/s.f.	(E) w %
Ground Surface 460.7			
0			
SOFT VERY MOIST BROWN CLAY LOAM TO SILTY CLAY LOAM A-4	3	0.3B	25
455.8			
-5	100 BLOWS 2"		
HARD MOIST BROWN SANDSTONE			
455.7			
HARD DAMP BROWN TO GREY SANDSTONE		CORED 83% RECOVERY	
450.7 -10			
HARD DAMP GREY SANDSTONE		CORED 100% RECOVERY	
445.7 -15			
BOTTOM OF HOLE = 15.0'. DURING CORING OPERATIONS H_2O WAS USED FROM -5.0' TO -15.0'.			
-20			
-25			
-30			
-35			
-40			
-45			

N – Standard Penetration Test – Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu – Unconfined Compressive Strength – t/sf

w – Water Content – percentage of oven dry weight – %

Type failure:
B – Bulge Failure
S – Shear Failure
E – Estimated Value
P – Penetrometer

Appendix C

LRFD Seismic Site Classification

Illinois Department of Transportation

SEISMIC SITE CLASS DETERMINATION

PROJECT TITLE=====SN 100-0101 - IL 166 over Sugar Creek

Substructure 1

Base of Substruct. Elev. (or ground surf for bents	459.1	ft.
Pile or Shaft Dia.	12	inches
Boring Number	1-S	
Top of Boring Elev.	469.3	ft.
Approximate Fixity Elev.	453.1	ft.

Individual Site Class Definition:

N (bar): 100 (Blows/ft.) Soil Site Class C <----Controls
N_{ch} (bar): 100 (Blows/ft.) Soil Site Class C
s_u (bar): 5 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation (ft)	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	465.8	3.50	4	1.50	
	463.3	2.50	4	0.70	
	460.8	2.50	2	1.10	B
	458.3	2.50	3	0.60	
	455.8	2.50	2	0.60	
	453.3	2.50	9	0.60	B
41.8	411.3	42.00	100	5.00	
83.8	369.3	42.00	100	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents	462.8	ft.
Pile or Shaft Dia.	12	inches
Boring Number	2-S	
Top of Boring Elev.	473.1	ft.
Approximate Fixity Elev.	456.8	ft.

Individual Site Class Definition:

N (bar): 29 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 100 (Blows/ft.) Soil Site Class C
s_u (bar): 2.91 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation (ft)	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	468.1	5.00	2	1.10	
	465.6	2.50	3	1.10	
	463.1	2.50	2	0.60	B
	460.6	2.50	2	0.30	
	458.1	2.50	2	0.30	
1.2	455.6	2.50	6	1.20	
3.7	453.1	2.50	2	0.10	
6.2	450.6	2.50	2	0.10	B
43.7	413.1	37.50	100	5.00	
83.7	373.1	40.00	100	5.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)		ft.
Pile or Shaft Dia.		inches
Boring Number		
Top of Boring Elev.		ft.
Approximate Fixity Elev.		ft.

Individual Site Class Definition:

N (bar): _____ (Blows/ft.) NA
N_{ch} (bar): _____ (Blows/ft.) NA
s_u (bar): _____ (ksf) NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation (ft)	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)		ft.
Pile or Shaft Dia.		inches
Boring Number		
Top of Boring Elev.		ft.
Approximate Fixity Elev.		ft.

Individual Site Class Definition:

N (bar): _____ (Blows/ft.) NA
N_{ch} (bar): _____ (Blows/ft.) NA
s_u (bar): _____ (ksf) NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation (ft)	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Global Site Class Definition: Substructures 1 through 2

N (bar): 65 (Blows/ft.) Soil Site Class C
N_{ch} (bar): 100 (Blows/ft.) Soil Site Class C
s_u (bar): 3.96 (ksf) Soil Site Class C <----Controls

Appendix D

Liquefaction Analysis

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 1-S
ELEVATION OF BORING GROUND SURFACE ========== 469.30 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 10.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.300
EARTHQUAKE MOMENT MAGNITUDE ========== 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 75 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.948**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **317** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.69
Source-To-Site Distance, R (km) = 56.49
Ground Motion Prediction Equations = NMSZ
PGA = **0.297**

	BORING DATA							CONDITIONS DURING DRILLING						CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
465.8	3.5	4	1.5					0.064	0.224	7.993	7.993	0.096	0.126	0.441	0.441	1.410	**0.128**	0.928	**0.181**	**N.L. (1)**
463.3	6	2	0.7					0.055	0.362	3.807	3.807	0.064	0.117	0.734	0.734	1.236	**0.075**	0.872	**0.170**	**N.L. (1)**
460.8	8.5	3	1.1					0.060	0.512	5.655	5.655	0.077	0.122	1.039	1.039	1.157	**0.085**	0.816	**0.159**	**N.L. (1)**
458.3	11	3	0.6		11	30	24	0.053	0.644	5.792	5.792	0.078	0.053	1.171	1.233	1.130	**0.084**	0.760	**0.156**	**N.L. (2)**
455.8	13.5	3	0.6		11	30	18	0.053	0.777	5.827	5.827	0.078	0.053	1.304	1.522	1.105	**0.082**	0.707	**0.161**	**N.L. (2)**
453.3	16	9	0.6		11	30	18	0.053	0.909	17.712	17.712	0.189	0.053	1.436	1.810	1.115	**0.199**	0.657	**0.162**	**N.L. (2)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR w_c/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60}$ > 25
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 2-S
ELEVATION OF BORING GROUND SURFACE ========== 473.10 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 19.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 19.50 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.300
EARTHQUAKE MOMENT MAGNITUDE ========== 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 75 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.948**

AVG. SHEAR WAVE VELOCITY (top 40')
$V^{*}_{s,40'}$ = **243** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.69
Source-To-Site Distance, R (km) = 56.49
Ground Motion Prediction Equations = NMSZ
PGA = **0.297**

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
468.1	5	2	1.1					0.123	0.615	3.502	3.502	0.062	0.123	0.615	0.615	1.281	**0.075**	0.851	**0.166**	**N.L. (1)**
465.6	7.5	3	1.1					0.123	0.923	4.818	4.818	0.071	0.123	0.923	0.923	1.181	**0.079**	0.779	**0.152**	**N.L. (1)**
463.1	10	3	0.6					0.116	1.213	4.800	4.800	0.071	0.116	1.213	1.213	1.118	**0.075**	0.713	**0.139**	**N.L. (1)**
460.6	12.5	2	0.3					0.108	1.483	3.150	3.150	0.059	0.108	1.483	1.483	1.074	**0.060**	0.654	**0.128**	**N.L. (1)**
458.1	15	2	0.3					0.108	1.753	3.066	3.066	0.059	0.108	1.753	1.753	1.039	**0.058**	0.602	**0.117**	**N.L. (1)**
455.6	17.5	6	1.2					0.124	2.063	8.811	8.811	0.103	0.124	2.063	2.063	1.006	**0.098**	0.558	**0.109**	**N.L. (1)**
453.1	20	1	0.1	85	23	44	25	0.035	2.150	1.468	6.762	0.086	0.035	2.150	2.181	0.997	**0.081**	0.520	**0.103**	**N.L. (2)**
451.1	22	1	0.1	85	23	44	25	0.035	2.220	1.463	6.755	0.086	0.035	2.220	2.376	0.990	**0.080**	0.495	**0.103**	**N.L. (2)**

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
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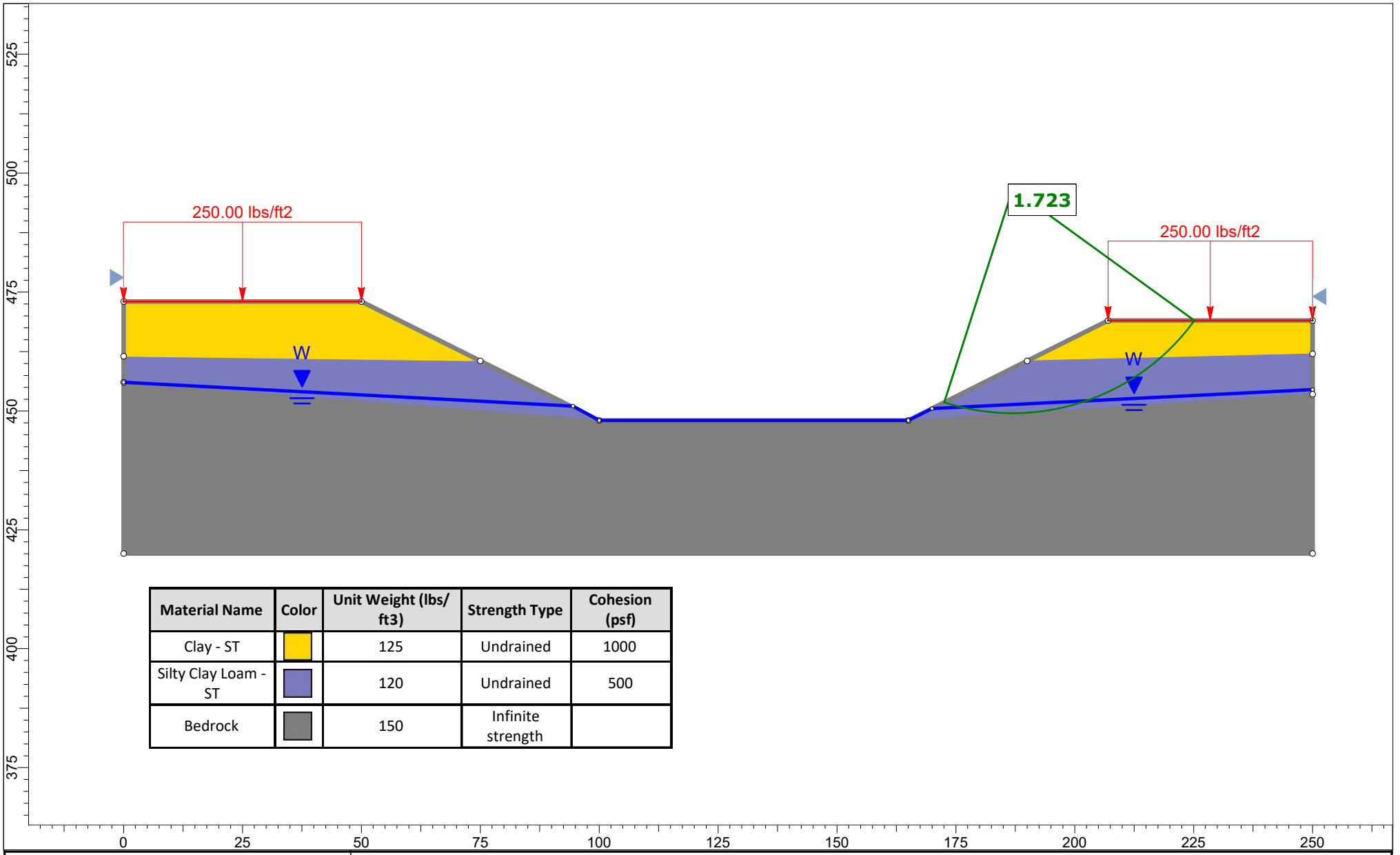
Appendix E

Slope Stability Analysis

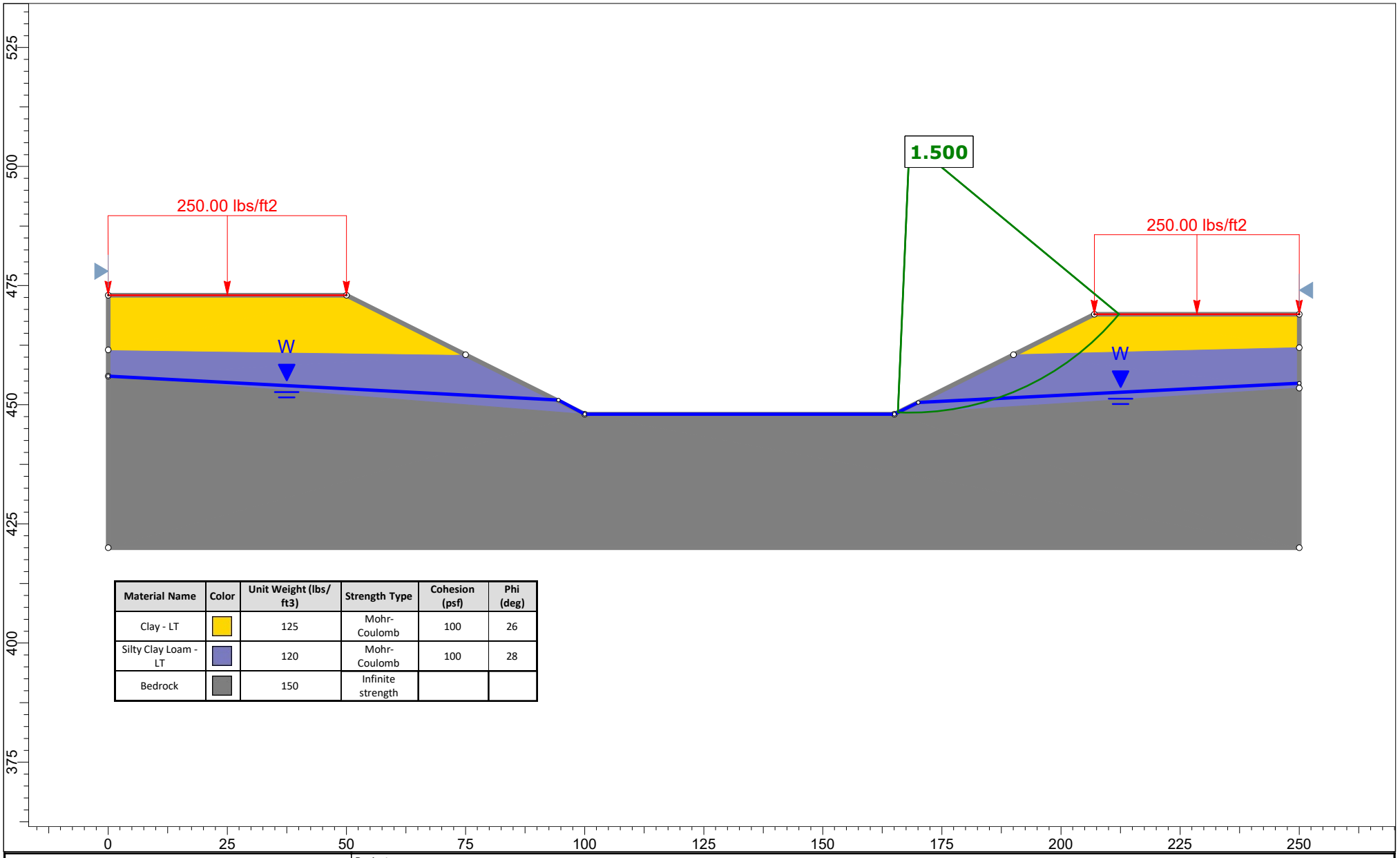


Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)
Clay - ST		125	Undrained	1000
Silty Clay Loam - ST		120	Undrained	500
Bedrock		150	Infinite strength	

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC

SLIDEINTERPRET 9.019

Project	23069 - IL 166 over Sugar Creek		
Group	Ebut	*Scenario*	ST
Drawn By	CLM	*Company*	BFW Engineering & Testing, Inc.
Date		*File Name*	Stability Analysis.slmd



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Clay - LT		125	Mohr-Coulomb	100	26
Silty Clay Loam - LT		120	Mohr-Coulomb	100	28
Bedrock		150	Infinite strength		

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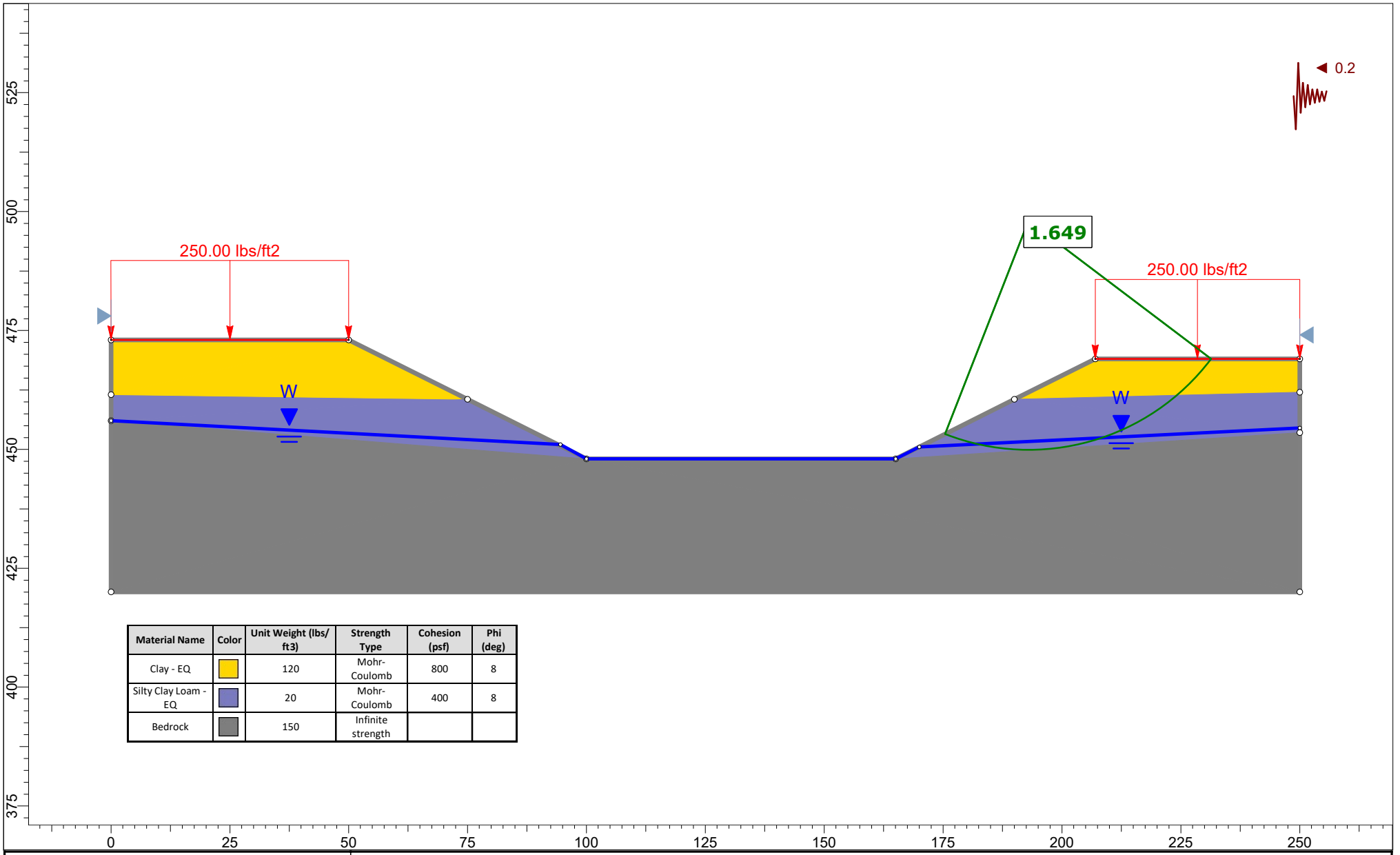
ENGINEERING & TESTING, INC

SLIDEINTERPRET 9.019

Project	23069 - IL 166 over Sugar Creek		
Group	Ebut	*Scenario*	LT
Drawn By	CLM	*Company*	BFW Engineering & Testing, Inc.
Date	6/1/2023, 12:26:32 AM	*File Name*	Stability Analysis.slmd



Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Clay - EQ		120	Mohr-Coulomb	800	8
Silty Clay Loam - EQ		20	Mohr-Coulomb	400	8
Bedrock		150	Infinite strength		

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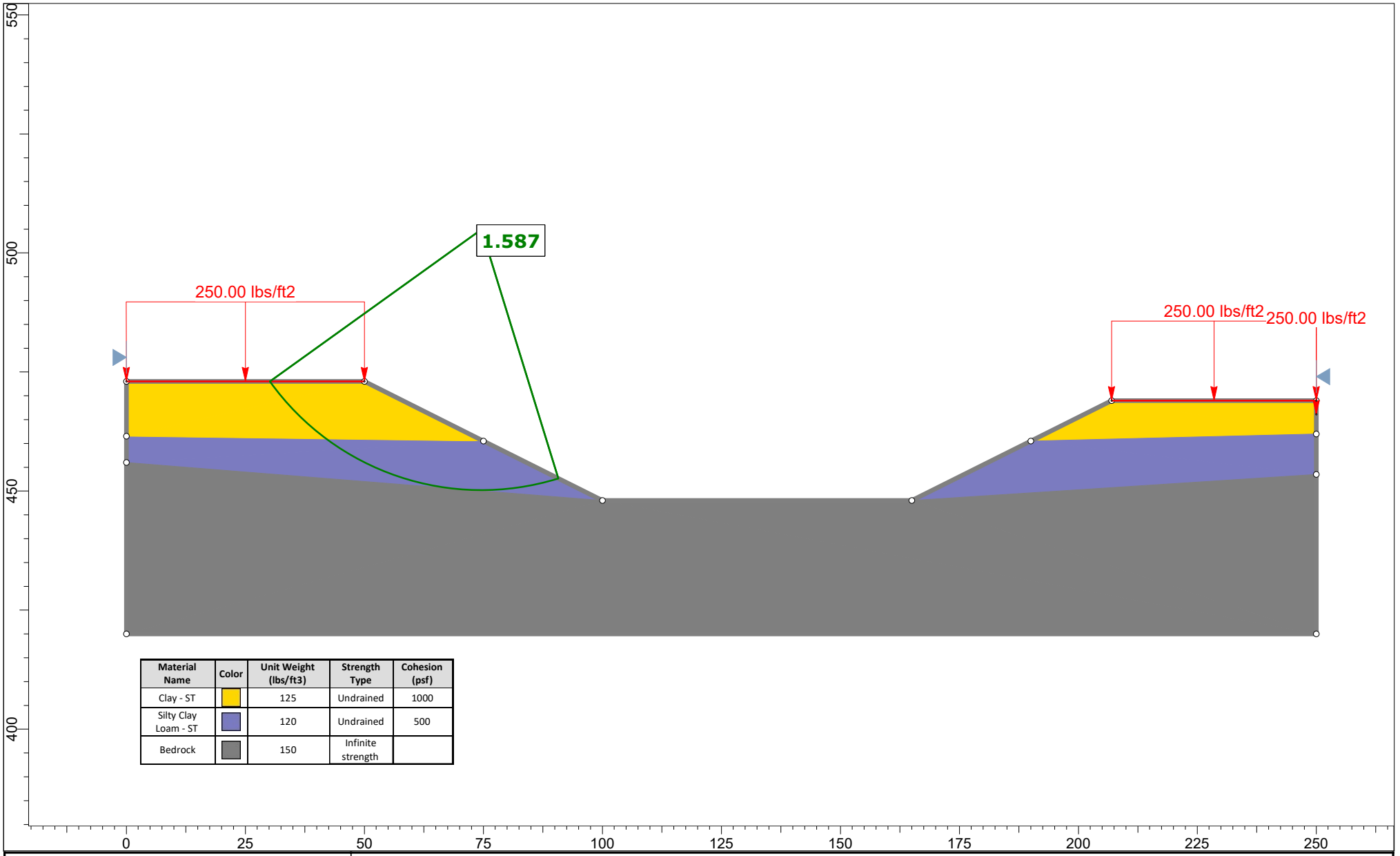
SLIDEINTERPRET 9.019

Project	23069 - IL 166 over Sugar Creek		
Group	Ebut	*Scenario*	EQ
Drawn By	CLM	*Company*	BFW Engineering & Testing, Inc.
Date	6/1/2023, 12:26:32 AM	*File Name*	Stability Analysis.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)
Clay - ST		125	Undrained	1000
Silty Clay Loam - ST		120	Undrained	500
Bedrock		150	Infinite strength	

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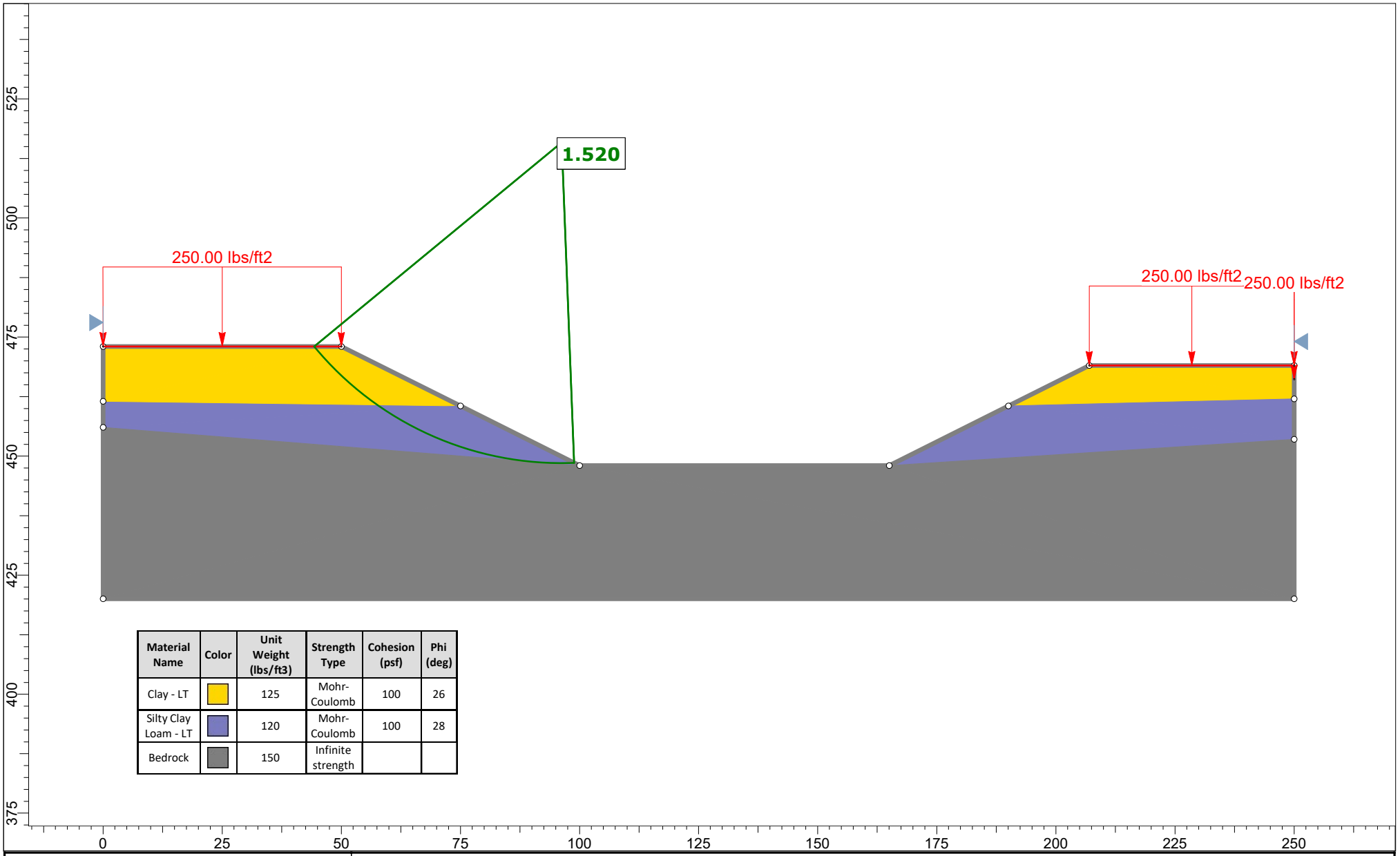
SLIDEINTERPRET 9.019

Project	23069 - IL 166 Over Sugar Creek		
Group	WAbut	*Scenario*	ST
Drawn By	CLM	*Company*	BFW Engineering & Testing, Inc.
Date	6/1/2023, 12:26:32 AM	*File Name*	Stability Analysis.slmd



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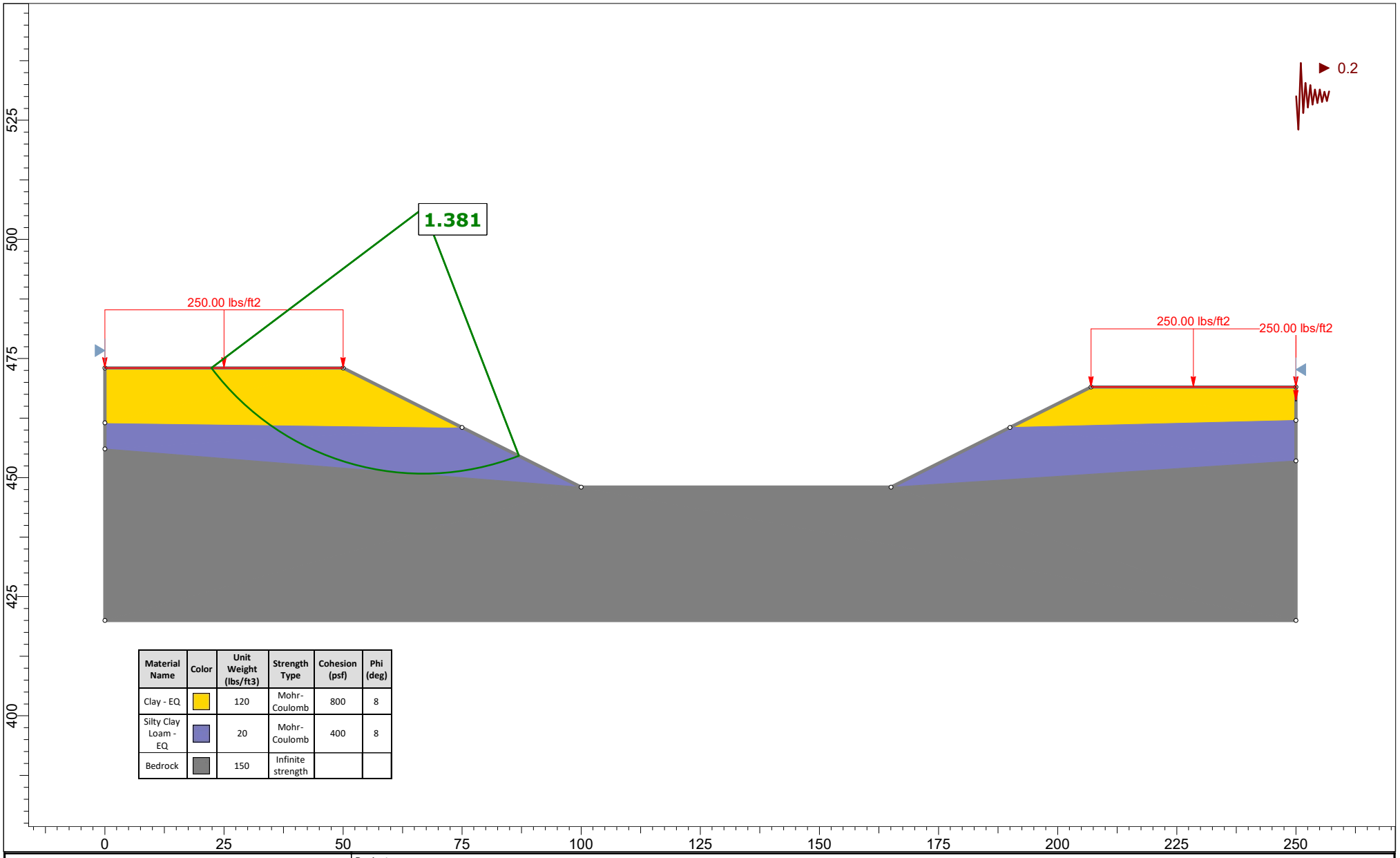

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
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