STRUCTURE GEOTECHNICAL REPORT

S.N. 029-0069 (prop.)
029-0001 (exist.)

US 24 / IL 9 over Copperas Creek
FAP Route 317
Section (43-BR)BR
Fulton County

engineers + planners + land surveyors

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Prepared For:
Illinois Department of Transportation
Region 3 / District 4

May 14, 2020

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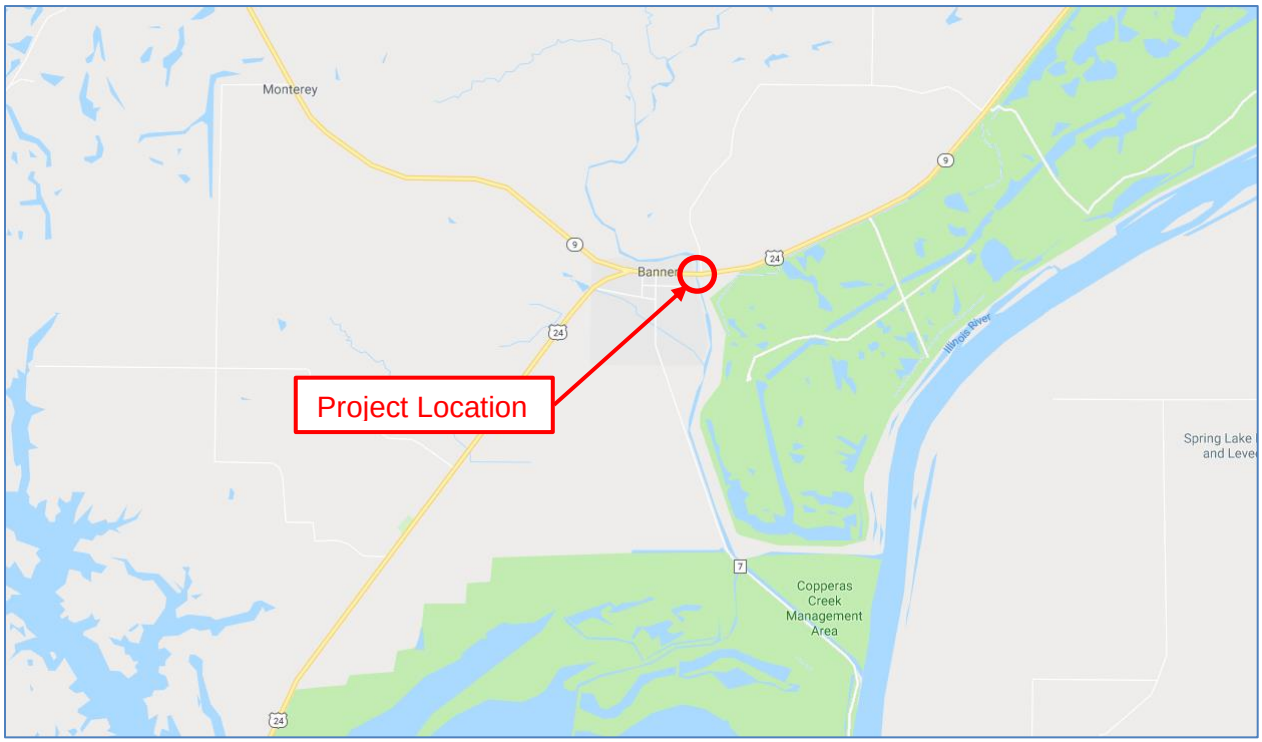
Project Description and Scope

General Information

Based on the preliminary TS&L, the existing four-span continuous, non-composite rolled-steel beam bridge will be completely replaced. The proposed structure consists of a two-span, fully-composite 48" deep steel plate girder superstructure with both spans equaling 132'-2". The resulting total bridge length is 267'-8" back to back of abutments. The superstructure is supported by integral abutments and a solid wall bent pier. Stage construction is proposed. The map below shows the location of the project.



Location Map

The centerline of US 24 / IL 9 is on a curved alignment with a radius of 6,550.81 feet. The bridge is to be constructed on a tangent alignment and offset laterally such that the total curvature offset is split at the ends and middle of the bridge. The proposed structure will be designed in accordance with 2017 AASHTO LRFD Bridge Design Specifications, 8th Edition.

The structure is planned to be built in two separate phases. An interim phase and an ultimate phase. For the interim phase, the bridge will carry two 12'-0" lanes of traffic, one in each direction, with 10'-0" (min.) shoulders on each side. The total width of the bridge for the interim phase is 48'-3" out to out and is depicted in the TS&L provided in the Appendix. The proposed letting date for the interim Phase is November 2020.

For the ultimate phase, the bridge will be widened to carry four 12'-0" through lanes, a 13'-0" center left-turn lane and 10'-0" (min.) shoulders on each side. The total width of the widened bridge for the ultimate phase is 85'-3" out to out. The ultimate cross-section is provided for

information only in the Appendix. There is no planned letting date for the ultimate phase. This SGR applies only to the interim phase structure.

The estimated reactions at the substructure bearings for Service Load I and Strength I are given in the table below:

Substructure Unit	DC (kips)	DW (kips)	[1]LL (kips)	Total Load (Service I)	Total Load (Strength I)
Abutments	583.0	104.5	368.7	1,055.2	1,537.7
Pier	1,834.8	391.6	646.5	2,872.9	4,012.3

[1] Impact is included at the abutments and omitted at the pier

Note: in addition to the reaction at the bearings, the above DC loads include additional unfactored dead loads of 237.1 kips and 416.5 kips to account for the abutment cap/approach slab and pier cap/wall, respectively.

Project Background

Phase I work for this project originally began in the early 2000's and a TS&L for this project was prepared by Stanley Consultants in 2011 in metric units. At that time, the District did not have plans for the interim phase as described above. The TS&L prepared in 2011, therefore, only depicted the ultimate five-lane bridge configuration. The TS&L was approved as a basis for preparation of final plans by the Bureau of Bridge and Structures on February 16, 2011. A Structure Geotechnical Report was not prepared at that time.

Due to costs and availability of funding, the District decided to put the project on-hold until adequate funding could be obtained. Due to the poor condition of the existing structure, the District subsequently decided to replace the bridge in the interim phase described above.

Field Exploration

Subsurface Exploration and Testing

The soil borings for the project were drilled and tested in 2006 during the early stages of the initial project. No new borings were obtained for the interim phase of the project. The 2006 borings consist of 5 soil borings and three rock cores.

Borings #1 and # 2 were drilled in the existing embankment cone laterally offset approximately 30' and 49' north of the northern edges of the proposed east and west abutments, respectively. Borings #3 and #4 were drilled in the stream channel. Boring #3 is approximately 22' north of the proposed bridge and boring #4 is approximately 13' south of the proposed bridge. Boring #5 was drilled in the existing overbank approximately 5' west of the centerline of the proposed pier, and approximately 1.8' north of the proposed centerline of US 24/IL 9. Borings #3, #4 and #5 were continued after auger refusal with rock cores.

Subsurface Conditions

Generally, the borings and rock cores indicate soft to very stiff cohesive material or loose to medium-dense cohesionless material overlaying rock consisting of weathered shale, sandstone and, in isolated areas, black coal. In the channel, rock was encountered around elevation 419. At the proposed west and east abutments, rock was encountered at elevation 425 and 442, respectively.

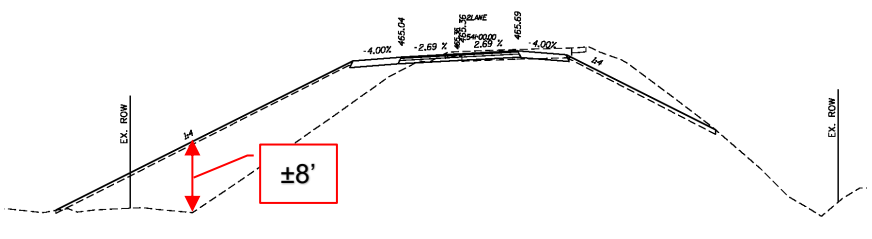
At the east abutment (Boring B-1), the material above rock consists of approximately 27.5' of stiff to very stiff clay loam or sandy clay loam with Qu values ranging from 1.8 to >4.5 tsf. At the west abutment, Boring B-2 indicates the material above rock consists of approximately 28' of very soft to medium clay loam or sandy clay loam with Qu values ranging from 0.5 tsf to 2.3 tsf. In the channel near the proposed pier location (Borings B-3, B-4 and B-5), indicate the material above rock consists of approximately 24' to 28' of very loose to loose, medium to coarse-grained brown sand with blow counts of 2 to 15 blows/foot.

The rock cores (B-3, B-4 and B-5) indicate layers of shale, sandstone and siltstone of varying strength and quality. Top of rock elevation ranges from 419 to 421. Beginning at the top of rock, the cores show a thin seam of very soft, poor quality shale or sandstone, followed by a ±5' layer of hard sandstone or shale with strengths of 200-500 tsf and RQD's of 50-60%. Below that, and to the bottom of the rock cores at elevation 399, is ±6' layer of soft silty shale or siltstone with strengths of 30-80 tsf and RQD's of 20-80%. At rock core B-5, this soft layer is only about 2-3' thick and indicates that higher strength sandstone or shale may exist below the bottom of the cores. Additionally, the rock core at the pier boring (B-5), shows a 3' thick layer of black coal at elevation 419 to 416.

Geotechnical Evaluations and Recommendations

Settlement

The proposed profile will result in a grade raise of approximately 0.0' and 3.5' at the west and east abutments, respectively. At the west abutment, the soil profile below the proposed embankment widening consists of very soft to soft silty or sandy clay loam with moisture contents ranging from 25% to 36% which are susceptible to large settlements when additional overburden pressures are added. Maximum depth of embankment fill at this location is approximately 8', resulting in 1.51" of calculated settlement. However, due to the location of maximum fill (as shown below) and the gentle proposed embankment slope of 1:4, this settlement is not anticipated to be problematic and therefore no mitigation is recommended.



Cross-Section (West Abutment)

At the east abutment, the proposed location of the abutment will be in front of the existing abutment, so settlement calculations assume an existing ground elevation of approximately elev. 550 after removal of the existing slope wall. This results in approximately 17 feet of fill to construct the new embankment in front of the existing abutment. At this location and based on boring B-1, settlement is estimated to be 0.45". No mitigation of settlement is necessary but effects of downdrag will be included in the resistance available computed for the foundation. Behind the existing abutment, the increase in grade raise of ±3.5' will result in an insignificant amount of settlement.

Slope Stability

Stability of the embankment slopes was conducted assuming a grade raise above the top of the existing embankment of 0' and 3.5' at the west and east abutments, respectively. Based on an elevation of 449.7 for the proposed overbank and the existing streambed elevation 439.0, the heights of the proposed embankments are and ±16' and ±28.8' at the west and east abutments, respectively. These slopes are based on a draft of the TS&L and may change slightly as the TS&L is developed, however the assumption used for the slope stability analysis are conservative and the results should be unaffected by minor updates to the TS&L.

The proposed side slopes will be graded to 1:4 or will be no steeper than the existing slopes. Since no distress or sloughing of the existing slopes was noted, the proposed side slopes are anticipated to be stable. It is anticipated that the relatively minor increase in the embankment height at the east abutment will not result in any stability issues, however the proposed slopes for both abutments were analyzed using the slope stability analysis software SLIDE2. For the west embankment, Boring B-2 was used to develop the SLIDE2 model. For the east embankment, a combination of borings B-1, B-3 and B-5 were used to develop the model. Modelling both undrained ($\emptyset = 0$) conditions and drained conditions, resulted in Factors of Safety (FOS) of 3.1 and 2.0 against slope failure. Boring data was collected using STP Split Spoon sampling, so the minimum computed FOS's exceeded the allowable FOS of 1.5.

Scour

Scour depths from the HEC-RAS hydraulic analysis are shown are:

West Abutment	2.42’ (Q100)	4.55’ (Q200)
Pier	7.68’ (Q100)	7.68’ (Q200)
East Abutment	1.41’ (Q100)	2.08’ (Q200)

Based on Boring B-5, the upper 8-9 feet of material at the proposed pier location consists of stiff to hard silty loam with Unconfined Compressive Strengths (Qu) ranging from 2.3 tsf to 1.7 tsf. In accordance with Section 2.3.6.3.2 of the Bridge Manual, a 50% reduction in the above scour depths is appropriate. Due to the proposed grade raise, the soils at the abutments will consist of new embankment constructed in accordance with the IDOT Standard Specifications for Road and Bridge Construction. Embankment material may consist of granular soils and a 0% reduction is therefore appropriate. If scour depth is above the bottom of the cap at the abutments, the bottom of cap is provided as the adjusted scour depth. The following adjusted scour elevations are provided for the TS&L plan.

Design Scour Elevation Table				
Event/Limit State	Design Scour Elev. (ft.)			Item 113
	W. Abut.	Pier 1	E. Abut.	
Q100	455.3	441.2	457.5	8
Q200	455.3	441.0	457.5	
Design	455.3	435.0	457.5	
Check	455.3	435.0	457.5	

Seismic Considerations

Based on the location of the proposed structure and boring data and in accordance with the 2017 AASHTO Standard Design Specifications, 8th edition, the ground motion site parameters are:

Peak Horizontal Acceleration (PGA)	= 0.048 g
Horizontal Response Spectral Acceleration Coeff. at 0.2-s on rock (S_S)	= 0.114 g
Horizontal Response Spectral Acceleration Coeff. at 1.0-s on rock (S_1)	= 0.048 9
Site factor at zero-period on acceleration response spectrum (f_{pga})	= 1.6
Site factor on short-period range of acceleration response spectrum (f_a)	= 1.6
Site factor on long-period range of acceleration response spectrum (f_v)	= 2.4

Based on Borings B-2, B-5 and B-1 for the West Abutment, Pier and East Abutment, respectively, the global Soil Site Class was determined to be Site Class D.

Based on the above, the following seismic data shall apply:

Seismic Data	
Seismic Performance Zone (SPZ) Pier 1	1
Design Spectral Acceleration at 1.0 sec. (S_{D1})	0.116 g
Design Spectral Acceleration at 0.2 sec. (S_{DS})	0.183 g
Soil Site Class	D

Foundation Recommendations

Based on the soil profile above bedrock, the depth to bedrock, the composition and quality of bedrock, and the proposed substructure types only driven piles and drilled shafts are practical foundation types.

Driven Piles

Driven piles are feasible at both abutments. Metal shell piles, while feasible, are not recommended due to the shallow depth of rock. We recommend H-piles driven to refusal. At the west and east abutments, we expect the H-piles to achieve bearing, after a nominal amount of penetration into shale, at approximately elevations 419 and 436, respectively. Estimated pile lengths at refusal are based on the reported blow counts at borings B-1 and B-2 along with observations of the strength and RQD values of similarly characterized shale in Rock Cores 3, 4 and 5. Additionally, the Factored Resistance Available shown for the piles at the East Abutment, has been reduced to account for downdrag losses from minor settlement as a result of the construction of the new embankment in front of the existing abutment.

Driven H-piles are also feasible at the pier, but the presence of an approximately 2.5’ to 3’ thick coal seam in boring B-5 complicates the pile length estimates. Larger H-piles may penetrate the coal layer and achieve bearing in the sandstone layer approximately 5’ below the coal where smaller H-piles may refuse in the coal layer. To be conservative, the pile length estimates shown below for the pier assume that all pile sizes will penetrate the coal seam.

West Abutment			
Pile Size	Nom. Req'd Bearing (kips)	Factored Resistance Available (kips)	Est. Pile Length (ft)
HP 8x36	286	157	39
HP 10x42	335	184	38
HP 10x57	454	250	41
HP 12x53	419	231	38
HP 12x63	497	274	40
HP 12x74	589	324	41
HP 12x84	664	365	42
HP 14x73	578	318	39
HP 14x89	705	388	41
HP 14x102	810	446	42

Pier			
Pile Size	Nom. Req'd Bearing (kips)	Factored Resistance Available (kips)	Est. Pile Length[1] (ft)
HP 8x36	286	157	26
HP 10x42	335	184	26
HP 10x57	454	250	27
HP 12x53	419	230	25
HP 12x63	497	273	27
HP 12x74	589	325	27
HP 12x84	664	366	28
HP 14x73	578	318	26
HP 14x89	705	387	27
HP 14x102	810	445	28

[1] Assumes piles will drive through coal seam between elevations ±418 and ±415

East Abutment			
Pile Size	Nom. Req'd Bearing (kips)	Factored Resistance Available (kips)	Est. Pile Length (ft)
HP 8x36	286	139	24
HP 10x42	335	163	24
HP 10x57	454	225	25
HP 12x53	419	206	25
HP 12x63	497	247	25
HP 12x74	589	293	25
HP 12x84	664	331	25
HP 14x73	578	288	25
HP 14x89	705	352	25
HP 14x102	810	404	25

One test pile is recommended at each substructure unit. The location of the test piles may be determined at the discretion of the structural engineer.

Drilled Shafts

The geological composition of Fulton County near the Copperas Creek area has been known to contain coal seams as well as open voids within the rock layers near and around the coal seam layers. Based on boring B-5, adequate factored resistance for shafts cannot be obtained above the coal seam and, due to the variable conditions encountered below the coal seam and the known issues mentioned above, the depth of the rock core is inadequate to properly determine the factored resistance of the shafts. If shafts are strongly desired, a new rock core that extends to a minimum elevation of 394 must be obtained. The new rock core should be obtained as close as practicable to the location of the proposed pier, but in no case further than approximately 15' in any direction from the pier.

Additionally, due to the fractured nature of coal and the likelihood of increased fracturing as a result of drilling operations for the installation of shafts, temporary casings to the top of shale will be necessary if drilled shafts are used.

Construction Considerations

Temporary Soil Retention System/Sheet Piling

Due to the weak soils at the west abutment, Temporary Cantilevered Sheet Pile does not appear feasible, therefore Temporary Soil Retention System is recommended for both abutments.

Cofferdams/Seal Coat

Based on the Estimated Water Surface Elevation of 447.2, the depth of water during construction could be as much as 12.2 ft. For this depth of water, a Type 2 Cofferdam will be required. Assuming the bottom of the proposed footing is set at elevation 435, seal coat concrete will be required.

Appendices

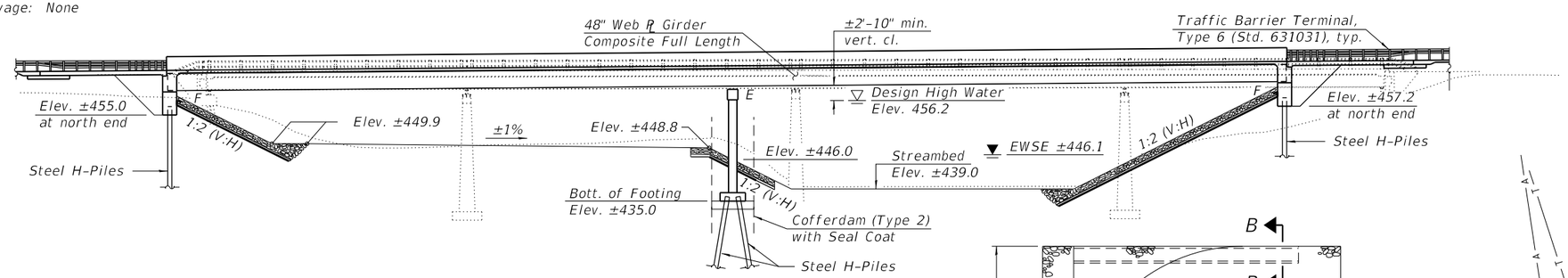
LAST SAVED DATE: $LASTSAVEDDATE$

Benchmark: Chiseled "□" on top of guardrail at southeast corner of bridge (S.N. 029-0001) over Copperas Creek east of Banner. Elev. 466.00.

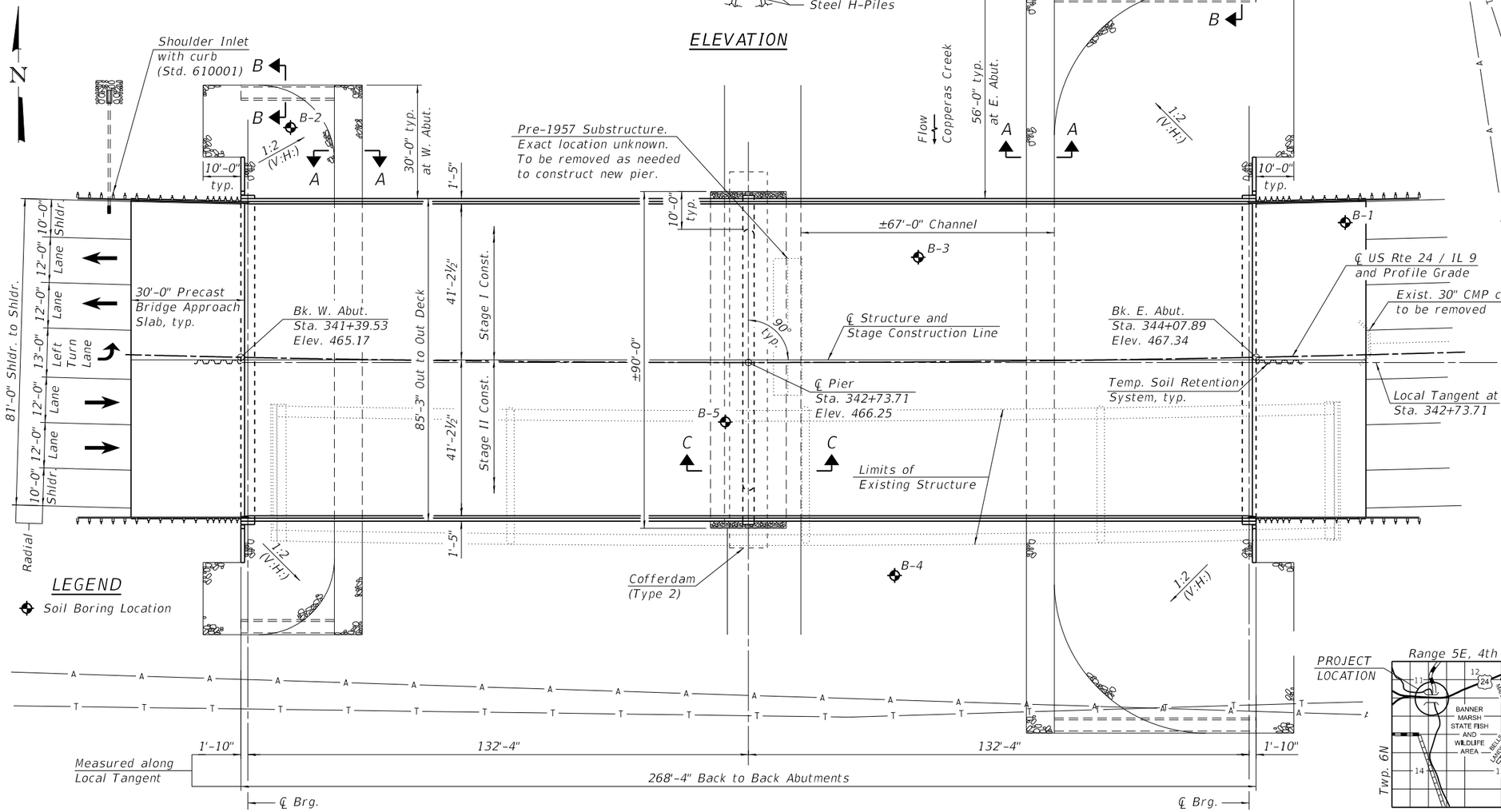
Existing Structure: S.N. 029-0001. Built as SBI Rte. 9 (F.A. Route 10), Section 43 BR-FR, at Station 1000+00.00 in 1957.
Superstructure: Consists of 4 span continuous rolled steel beams and reinforced concrete slab, non composite in all spans.
Substructure: Consists of stub abutments and solid wall type piers on steel piles.
Bk. to Bk. abutments is 281'-7" and Out to Out deck 35'-8".
Traffic is to be maintained utilizing stage construction.

Salvage: None

ELEVATION



PLAN



DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications, 8th Edition

LOADING HL-93

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

HIGHWAY CLASSIFICATION

FAP 317 – US Rte 24/IL Rte 9
Functional Class: Major Rural Arterial
ADT: 8900 (2017); 9022 (2032)
ADTT: 890 (2017); 902 (2032)
DHV: 812 (2032)
Design Speed: 70 m.p.h.
Posted Speed: 55 m.p.h.
2 Way Traffic
Directional Distribution: 59/41

DESIGN STRESSES

FIELD UNITS

f'c = 4,000 psi (Superstructure)
f'c = 3,500 psi (Substructure)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)

Note:
All structural steel shall be galvanized.

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.116g
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.183g
Soil Site Class = D

PROJECT LOCATION

LOCATION SKETCH

GENERAL PLAN
US ROUTE 24 / IL 9
OVER COPPERAS CREEK
FAP RTE 317 SECTION (43-BR)BR
FULTON COUNTY
STA. 342+73.71
STRUCTURE NUMBER 029-0069

FILE NAME: L:\Jobs\Wilmest Engineers\8711 IL 9 over Copperas Creek Ph I\CADD\CADD Sheets\SN 029_0001_TSL.dgn

design firm no. 184001036

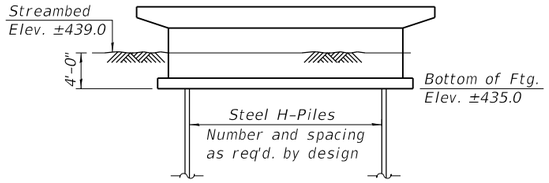
whks engineers + planners + land surveyors

USER NAME = dheberling	DESIGNED - SBC	REVISED	
FILE NAME = SN 029_0001_TSL.dgn	CHECKED - SDS	REVISED	
PLOT SCALE = 0.1667 ' / in.	DRAWN - DLH	REVISED	
PLOT DATE = 5/12/2020	CHECKED - SBC	REVISED	

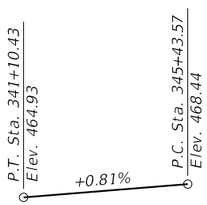
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN
STRUCTURE NO. 029-0069
SHEET NO. 1 OF 3 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
317	(43-BR)BR	FULTON	3	1
		CONTRACT NO. 68D34		
		ILLINOIS FED. AID PROJECT		

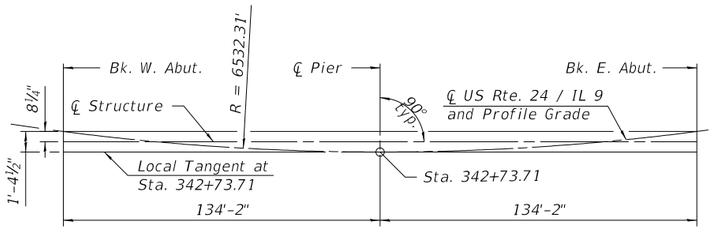


PIER SKETCH

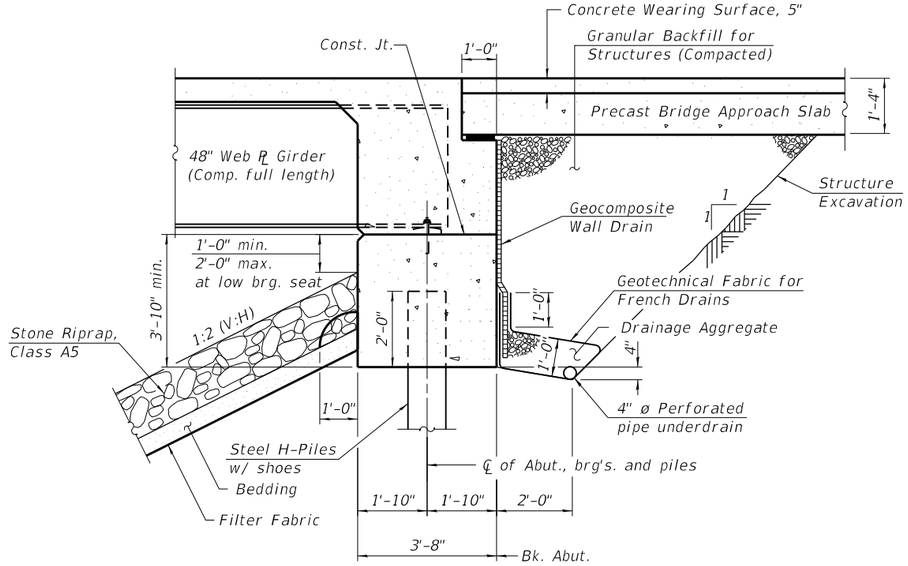


PROPOSED PROFILE GRADE

Along ℄ US Rte. 24 / IL 9



OFFSET SKETCH

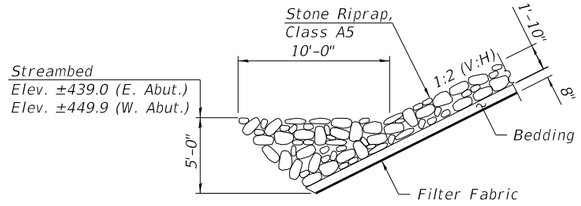


SECTION THRU INTEGRAL ABUTMENT

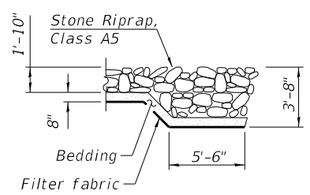
CURVE DATA

(Prop. Curve 5RC2)

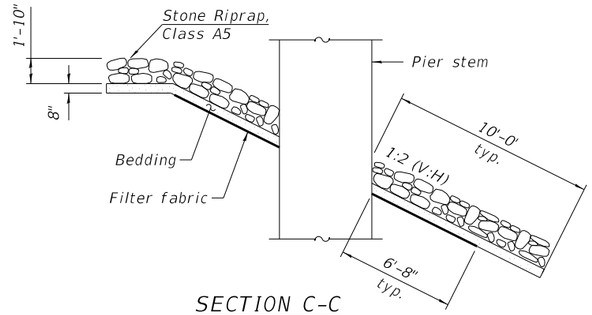
PI Sta. = 342+77.78
Δ = 6° 59' 09" (LT)
D = 0° 52' 38"
R = 6,532.31'
T = 398.72'
L = 796.45'
E = 12.16'
S.E. = 2.69%
P.C. Sta. = 338+79.06
P.T. Sta. = 346+75.51



SECTION A-A



SECTION B-B



SECTION C-C

WATERWAY INFORMATION

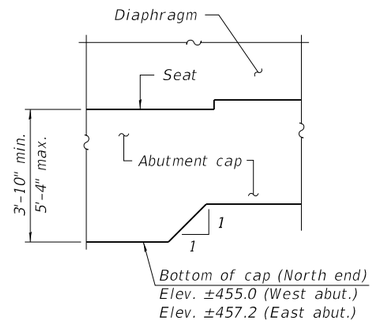
Drainage Area = 129.6 sq. mi.

Flood	Freq. Yr.	Discharge ft^3/s	Waterway Opening - $ft.^2$ Existing	Waterway Opening - $ft.^2$ Proposed	Natural H.W.E. ft.	Head - ft. Existing	Head - ft. Proposed	Headwater Elevation ft. Existing	Headwater Elevation ft. Proposed
	10	9,712	2,037	2,157	454.0	0.3	0.2	454.3	454.2
Design	50	15,609	2,551	2,689	456.2	0.6	0.4	456.8	456.6
Base	100	18,293	2,755	2,898	457.1	0.8	0.5	457.9	457.6
Scour Design Check	200	21,217	2,972	3,119	458.0	0.9	0.5	458.9	458.5
Max. Calc.	500	25,003	3,246	3,396	459.1	1.1	0.6	460.2	459.7

10 Year Velocity through Exist. Bridge = 5.3 ft./s
10 Year Velocity through Prop. Bridge = 5.3 ft./s

DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elev. (ft.) W. Abut.	Pier	E. Abut.	Item 113
Q100	455.0	441.2	457.2	8
Q200	455.0	441.0	457.2	
Design	455.0	435.0	457.2	
Check	455.0	435.0	457.2	



ABUTMENT CAP STEP DETAIL

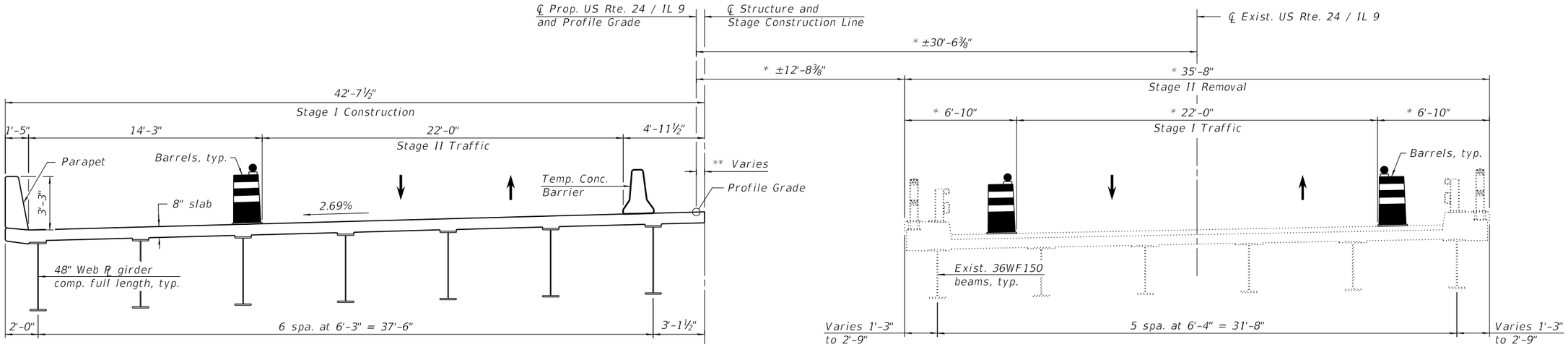
design firm no. 184001036
whks engineers + planners + land surveyors

USER NAME = dheberling	DESIGNED - SBC	REVISED	
FILE NAME = SN 029_0001_TSL.dgn	CHECKED - SDS	REVISED	
PLOT SCALE = 0.1667 ' / in.	DRAWN - DLH	REVISED	
PLOT DATE = 5/12/2020	CHECKED - SBC	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

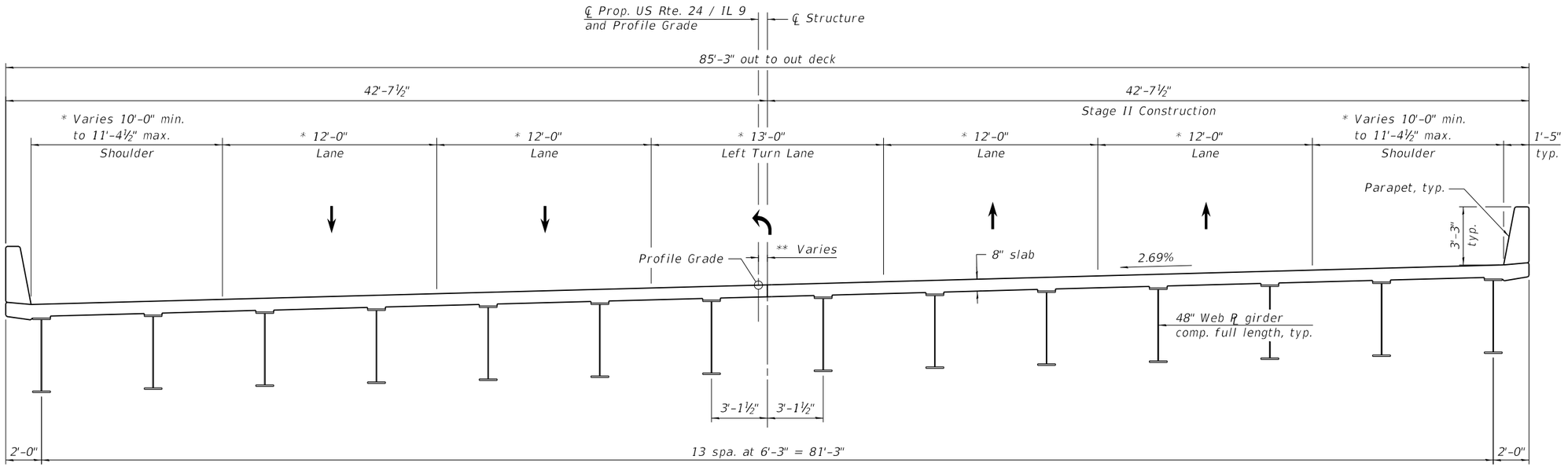
GENERAL DATA
STRUCTURE NO. 029-0069
SHEET NO. 2 OF 3 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
317	(43-BR)BR	FULTON	3	2
		CONTRACT NO. 68D34		
	ILLINOIS FED. AID PROJECT			



STAGE I CONSTRUCTION AND STAGE II REMOVAL

(Looking East)



STAGE II CONSTRUCTION AND FINAL CROSS SECTION

(Looking East)

* Radial Dimensions

** See Offset Sketch

design firm no. 184001036

whks engineers + planners + land surveyors

USER NAME = dheberling	DESIGNED - SBC	REVISED	
FILE NAME = SN 029_0001_TSL.dgn	CHECKED - SDS	REVISED	
PLOT SCALE = 0.1667 ' / in.	DRAWN - DLH	REVISED	
PLOT DATE = 5/12/2020	CHECKED - SBC	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

STAGE CONSTRUCTION
STRUCTURE NO. 029-0069
SHEET NO. 3 OF 3 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
317	(43-BR)BR	FULTON	3	3
		CONTRACT NO. 68D34		
	ILLINOIS	FED. AID PROJECT		

PHASE 1 - 5 LANE
METRIC ALIGNMENT

PHASE 1 - ROSKAMP RD.
METRIC ALIGNMENT

COPPERAS CREEK

541+53.00
73.16 LT.
(10+410
55.0' LT.)

543+19.13
46.16 LT.
(10+460.5
28.0' LT.)

544+32.63
53.58 LT.
(10+495
35.4' LT.)

542+68.14
1.78 LT.
(10+445
16.4' RT.)

543+12.55
37.92 RT.
(10+458.5
56.1' RT.)

BORING 1
BORING 2
BORING 3
BORING 4
BORING 5

FW-5

N ROSKAMP RD

HMA

30" CMP

PC Sta 539+53.60

546+76.87

Sta 10+569.224 BK
Sta 10+570.390 AH
EQUATION

10+350
10+400
10+450
10+500
10+550

540+00
545+00

US 24 (IL 9)

2 LANE PROPOSED
ALIGNMENT

PAVED DITCH

(TEL)

R

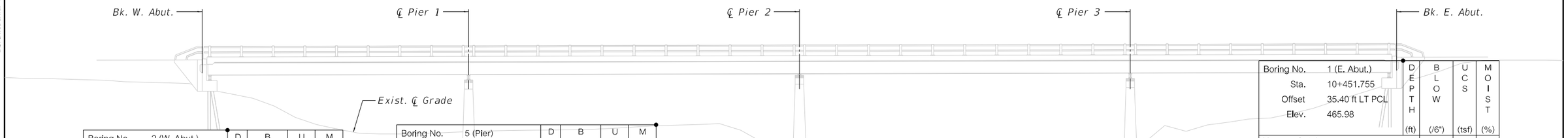
O&C

ROCK

N

0 50 100 150
SCALE IN FEET

D468D34_Boring Locations.dgn 11/30/2018 9:59:16 AM



Boring No. 2 (W. Abut.) | Sta. 10+410 | Offset 55.00 ft LT PCL | Elev. 449.62

DEPTH (ft)	BLOW (/6")	UCS (tsf)	MOIST (%)
No sample taken: Setting augers			
447.62			
Brown SILTY CLAY LOAM	H		
	1 2	0.5 P	27.0
trace of sand	-5 H		
	H H	0.5 S	25.0
442.62			
Brown MEDIUM SAND	2		
	2 2		16.0
440.12			
Brown, Grey CLAY LOAM trace of sand	-10 H		
	1 1	0.6 B	36.0
437.62			
Grey SANDY CLAY LOAM	H		
	H H	0.3 P	27.0
435.12			
Grey Medium SAND and GRAVEL	-15 2		
	1 2		21.0
	1		
	1 1		17.0
430.12			
Brown Coarse SAND and GRAVEL	-20		
	8 7		
	4		
	4 4		7.0
425.12			
Brown, Grey Medium GRAVEL and 25mm LIMESTONE	-25 2		
	100@3"		10.0
422.62			
Grey SHALE	14		
421.42	60 40@2"		16.0
AUGER REFUSAL @ 8.6m			

End of Boring

Boring No. 5 (Pier) | Sta. 10+445 | Offset 16.40 ft RT PCL | Elev. 450.86

DEPTH (ft)	BLOW (/6")	UCS (tsf)	MOIST (%)
Brown SILTY LOAM	1		
	1 2	2.0 P	10.0
	1		
	-5 4 5	1.7 S	15.0
	3		
	3 4	2.3 P	18.0
441.86			
Light Brown/Brown SILTY LOAM	1		
	-10 1 2	1.2 P	25.0
439.36			
Grey SILTY LOAM	H		
	1 1	0.8 P	33.0
	H		
	-15 1 1	1.2 B	31.0
434.36			
Grey Fine-Med SAND	1		
	4 5		22.0
	1		
	-20 1 1		21.0
429.86			
Brown, Grey Coarse SAND and GRAVEL	2		
	2 1		12.0
	15		
	-25 10 10		16.0
	6		
	9 7		16.0
421.86			
Grey SHALEY CLAY	10		
	-30 32 47		15.0
419.36			
Grey SHALEY CLAY/SHALE 418.36	16		
	56 44@1'		13.0
Black COAL			

Borehole continued with rock coring

Boring No. 4 (Pier) | Sta. 10+458.5 | Offset 56.10 ft RT PCL | Elev. 438.26

DEPTH (ft)	BLOW (/6")	UCS (tsf)	MOIST (%)
Brown Medium to Coarse SAND and GRAVEL			
0-5.0m Similar soils as B#3 No moistures or N values taken	-5		
	-10		
	-15		
421.76			
Grey CLAY SHALE	6		
	32 35		14.0
	11		
trace of coal	-20 100@3"		15.0
416.76			
Black COAL 416.26	12		
Grey SHALEY CLAY	15 28		38.0 13.0
	30		
413.26	-25 100@2"		18.0

Borehole continued with rock coring

Boring No. 3 (Pier) | Sta. 10+460.5 | Offset 28.00 ft LT PCL | Elev. 438.69

DEPTH (ft)	BLOW (/6")	UCS (tsf)	MOIST (%)
Brown Medium to Coarse SAND	1		
	H 1		21.0
	1		
	-5 H 1		20.0
	1		
	1 1		18.0
	H		
	-10 2 1		19.0
427.19			
Brown Medium to Coarse SAND and GRAVEL	3		
	3 5		14.0
	8		
	-15 7 8		14.0
	12		
421.19	17		13.0
Grey CLAY SHALE	83@2"		16.0
	32		
	-20 30 70		11.0
	100@4"		13.0

Borehole continued with rock coring

Boring No. 1 (E. Abut.) | Sta. 10+451.755 | Offset 35.40 ft LT PCL | Elev. 465.98

DEPTH (ft)	BLOW (/6")	UCS (tsf)	MOIST (%)
No sample taken: Setting augers			
464.48			
Brown GRAVEL LOAM	5		
	8 9	4.0 P	6.0
461.98			
Brown, Light Brown CLAY LOAM	2		
	-5 8 10	3.7 S	13.0
	4		
	5 10	>4.5 P	11.0
	3		
	-10 5 6	>4.5 P	10.0
454.48			
Brown, Grey SANDY CALY LOAM	4		
	5 6	>4.5 P	11.0
451.98			
Grey CLAY LOAM	2		
	-15 8 5	1.8 S	16.0
449.48			
Grey SILTY LOAM	2		
	3 4	2.3 B	25.0
446.98			
Dark Grey SHALEY CLAY	4		
	-20 5 11	3.0 B	18.0
	11		
	23 37		12.0
441.98			
Dark Grey SHALE	17		
	-25 41 59@5"		10.0
	45		
438.48	100@6"		10.0
AUGER REFUSAL @ 8.38m			

End of Boring

SUBSURFACE DATA PROFILE
US ROUTE 24 / IL 9
OVER COPPERAS CREEK
FAP RTE 317 SECTION (43-BR)BR
FULTON COUNTY
STA. 542+73.91
STRUCTURE NUMBER 029-0069

LAST SAVED DATE: 1/15/2019

FILE NAME: L:\Jobs\Midwest Engineers\8711 IL 9 over Copperas Creek Ph I\Reports\SGN\029_0001_Boring Data Profile.dgn

design firm no. 184001036

whks engineers + planners + land surveyors

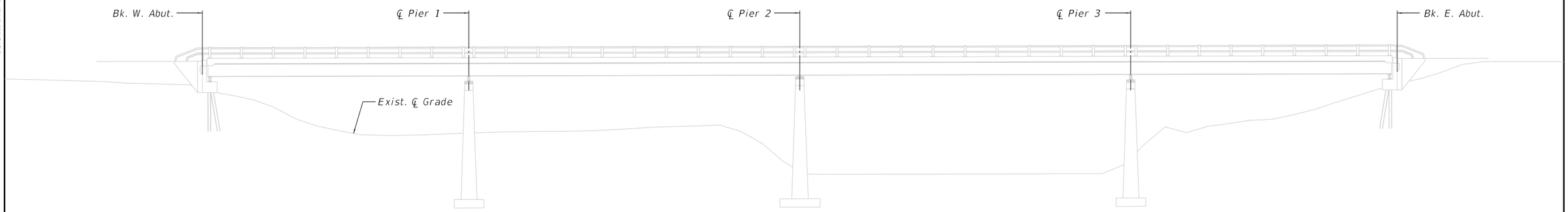
USER NAME = dheberling	DESIGNED - SBC	REVISED	
FILE NAME = 029_0001_Boring Data Profile.dgn	CHECKED - SDS	REVISED	
PLOT SCALE = 0.2 '\" / in.	DRAWN - DLH	REVISED	
PLOT DATE = 1/15/2019	CHECKED - SBC	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

DRILLED BORINGS
STRUCTURE NO. 029-0069
SHEET NO. 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
317	(43-BR)BR	FULTON	2	1
		CONTRACT NO. 68D34		
	ILLINOIS FED. AID PROJECT			

LAST SAVED DATE: 1/15/2019



Boring No. 5 (Pier)
Sta. 10+445
Offset 16.40 ft RT PCL

Rock Mass Rating (RMR) = 2, Very Poor Rock

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)	MOISTURE (%)
415.86							
Grey SHALE RMR = 34, Poor Rock	-35					6.0	10
						14.2	9
413.36						15.1	7
Brown and Grey Coarse Gravels RMR = 21, Very Poor Rock		2	70	10			
	-40						
409.86							
Grey SANDSTONE RMR = 41, Fair Rock						178.4	2
						201.2	2
407.26		3	100	50		623.5	1
Grey SHALE RMR = 29, Poor Rock						466.4	1
						27.8	6
	-45					41.1	6
404.56						15.8	7
Grey SANDSTONE RMR = 69, Good Rock						194.0	2
403.36						314.1	2
Grey SANDSTONE RMR = 13, Very Poor Rock		4	80	0			
	-50						
398.36							

End of Boring

Boring No. 4 (Pier)
Sta. 10+458.5
Offset 56.10 ft RT PCL

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)	MOISTURE (%)
413.26	-25						
Grey, Light Grey SANDY SHALE		1	95	65			
412.26						75.9	4
Light Grey SANDSTONE w/ dark grey laminations						221.2	4
						151.4	6
						190.5	6
						238.8	9
						248.7	8
	-30					346.6	7
407.06		2	88	58		295.1	6
Grey, Light Grey SANDY SHALE							
						29.4	6
						30.9	7
	-35					38.9	6
402.66		3	100	29		32.8	7
Light Grey Fine SANDSTONE/SILTSTONE							
401.26						42.5	8
Light Grey SHALE 400.96							
Light Grey SANDSTONE 400.56							
Light Grey SHALE 399.76							
Light Grey SANDSTONE (laminated) 398.96							
Grey SILTY SHALE w/ very thin sandstone seams 395.26	-40					84.6	7

End of Boring

Boring No. 3 (Pier)
Sta. 10+460.5
Offset 28.00 ft LT PCL

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)	MOISTURE (%)
414.69							
Light Grey SANDSTONE w/ dark grey laminations from 7.3m - 8.1m	-25	1	97	93		172.8	7
						189.6	7
						172.8	8
						146.5	9
						220.9	9
	-30					318.9	9
408.69		2	95	72		459.9	7
Light Grey SHALE						341.7	6
406.69						22.8	7
Light Grey Fine SANDSTONE/SILTSTONE w/ sandy shale seams						21.1	8
404.69						63.4	7
Light Grey SILTSTONE/SILTY w/ dark grey laminations and sandy seams	-35	3	98	82		81.4	7
						60.4	6
402.69							
Light Grey SANDSTONE w/ dark grey laminations 401.99						63.0	7
						81.9	7
Light Grey SILTY SHALE w/ dark grey laminations 401.49						88.7	6
Dark Grey/Grey SHALE w/ thin sandy seams						71.9	6
						62.6	7
399.69						92.0	7

End of Boring

SUBSURFACE DATA PROFILE
US ROUTE 24 / IL 9
OVER COPPERAS CREEK
FAP RTE 317 SECTION (43-BR)BR
FULTON COUNTY
STA. 542+73.91
STRUCTURE NUMBER 029-0069

FILE NAME: L:\Jobs\Midwest Engineers\8711 IL 9 over Copperas Creek PH I\Reports\SSR\029_0001_Boring Data Profile.dgn

design firm no. 184001036
whks engineers + planners + land surveyors

USER NAME = dheberling	DESIGNED - SBC	REVISED	
FILE NAME = 029_0001_Boring Data Profile.dgn	CHECKED - SDS	REVISED	
PLOT SCALE = 0.2 '\" / in.	DRAWN - DLH	REVISED	
PLOT DATE = 1/15/2019	CHECKED - SBC	REVISED	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

ROCK CORINGS
STRUCTURE NO. 029-0069
SHEET NO. 2 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
317	(43-BR)BR	FULTON	2	2
		CONTRACT NO. 68D34		
	ILLINOIS FED. AID PROJECT			

Illinois Department of Transportation
Division of Highways
IDOT

SOIL BORING LOG

Date 8/29/06

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek LOGGED BY JAR

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG.

COUNTY Fulton DRILLING METHOD CME 750 HSA HAMMER TYPE Auto

STRUCT. NO. 029-0069(prop)
Station 10+451.755

BORING NO. 1 (E. Abut)
Station 10+495
Offset 35.40ft LT PCL
Ground Surface Elev. 465.98 ft

Surface Water Elev. 438.47 ft
Stream Bed Elev. 438.26 ft

Groundwater Elev.:
First Encounter None ft
Upon Completion None ft
After 24 Hrs. None ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
No sample taken: Setting augers			
464.48			
Brown GRAVEL LOAM	5		
	8 9	4.0 P	6.0
461.98			
Brown, Light Brown CLAY LOAM	2		
-5	8 10	3.7 S	13.0
Bottom of E. Abutment Cap Elevation 455.6	4		
	5 10	>4.5 P	11.0
	3		
-10	5 4	>4.5 P	10.0
454.48			
Brown, Grey SANDY CLAY LOAM	4		
	5 6	>4.5 P	11.0
451.98			
Grey CLAY LOAM	2		
-15	8 5	1.8 S	16.0
449.48			
Grey SILTY LOAM	2		
	3 4	2.3 B	25.0
446.98			
Dark Grey SHALEY CLAY	4		
-20	5	3.0	18.0

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	11	B	
Dark Grey SHALEY CLAY *(continued)*			
	11		
	23 37		12.0
441.98			
Dark Grey SHALE	17		
-25	41 59@5"		10.0
	45		
438.48	100@6"		10.0
AUGER REFUSAL @ 8.38m			
End of Boring			
-30			
-35			
-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
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)

Illinois Department of Transportation

Division of Highways
IDOT

SOIL BORING LOG

Date 8/31/06

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek LOGGED BY JAR

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG.

COUNTY Fulton DRILLING METHOD CME 750 HSA HAMMER TYPE Auto

STRUCT. NO. 029-0069(prop)
Station 10+451.755

BORING NO. 2 (W. Abut)
Station 10+410
Offset 55.00ft LT PCL
Ground Surface Elev. 449.62 ft

Surface Water Elev. 438.47 ft
Stream Bed Elev. 438.26 ft

Groundwater Elev.:
First Encounter 440.1 ft ▼
Upon Completion NA wash ft
After 24 Hrs. 441.1 ft ▼

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material Description
				No sample taken: Setting augers
447.62				
	H			Brown SILTY CLAY LOAM
	1 2	0.5 P	27.0	
				trace of sand
-5	H			
	H H	0.5 S	25.0	
442.62				
	2			Brown Medium SAND
	2 2		16.0	
▽				
440.12 ▼				
-10	H			Brown, Grey CLAY LOAM
	1 1	0.6 B	36.0	trace of sand
437.62				
	H			Grey SANDY CLAY LOAM
	H H	0.3 P	27.0	
435.12				
-15	2			Grey Medium SAND and GRAVEL
	1 2		21.0	
	1			
	1 1		17.0	
430.12				
-20	1			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material Description
	8 7			Brown Coarse SAND and GRAVEL *(continued)*
	4			
	4 4		7.0	
425.12				
-25	2			Brown, Grey Medium GRAVEL and 25mm LIMESTONE
	100@3"		10.0	
422.62				
	14			Grey SHALE
	60		16.0	
421.42	40@2"			
				AUGER REFUSAL @ 8.6m End of Boring
-30				
-35				
-40				

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation

Division of Highways
IDOT

SOIL BORING LOG

Date 9/8/06

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek LOGGED BY JAR

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG.

COUNTY Fulton DRILLING METHOD CME 750/55 HSA HAMMER TYPE Auto

STRUCT. NO. 029-0069(prop)
Station 10+451.755

BORING NO. 3 (Pier)
Station 10+460.5
Offset 28.00ft LT PCL
Ground Surface Elev. 438.69 ft

Surface Water Elev. 438.47 ft
Stream Bed Elev. 438.26 ft

Groundwater Elev.:
First Encounter 438.7 ft
Upon Completion 438.7 ft
After 24 Hrs. 438.7 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Brown Medium to Coarse SAND			
	1		
	H 1		21.0
	1		
-5	H 1		20.0
	1		
	1 1		18.0
	H		
-10	2 1		19.0
427.19			
Brown Medium to Coarse SAND and GRAVEL	3		
	3 5		14.0
	8		
-15	7 8		14.0
	12		
421.19	17		13.0
Grey CLAY SHALE	83@2"		16.0
	32		
-20	30		11.0
Grey CLAY SHALE *(continued)*	70		
	100@4"		13.0
414.69			
Borehole continued with rock coring.			
-25			
-30			
-35			
-40			

Bottom of Pier Footing/ Encasement Elev. 435.0

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
IDOT

ROCK CORE LOG

Date 9/8/06

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek LOGGED BY JAR

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG.

COUNTY Fulton CORING METHOD DUAL BARREL

STRUCT. NO. 029-0069(prop) CORING BARREL TYPE & SIZE NWD4 5'
Station 10+451.755

Core Diameter 2.1 in
Top of Rock Elev. 421.19 ft
Begin Core Elev. 414.69 ft

BORING NO. 3 (Pier)
Station 10+460.5
Offset 28.00ft LT PCL
Ground Surface Elev. 438.69 ft

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)	MOISTURE (%)
Lt Gr SANDSTONE W/ dk gr laminations from 7.3m - 8.1m	414.69	1	97	93		172.8	7
	-25					189.6	7
						172.8	8
						146.5	9
						220.9	9
						318.9	9
		2	95	72		459.9	7
Lt Gr SHALE	408.69	-30				341.7	6
						22.8	7
Lt Gr Fine SANDSTONE/SILTSTONE W/ sandy shale seams	406.69					21.1	8
						63.4	7
Lt Gr SILTSTONE/SILTY SHALE w/ dk gr laminations & sandy seams	404.69	3	98	82		81.4	7
	-35					60.4	6
Lt Gr SANDSTONE W/ dk. gr laminations	402.69					63.0	7
Lt Gr SILTY SHALE W/dk gr laminations	401.99					81.9	7
Dk Gr/Gr SHALE w/ thin sandy seams	401.49					88.7	6
						71.9	6
						62.6	7
End of Boring	399.69					92.0	7
	-40						

Color pictures of the cores No
Cores will be stored for examination until COMPLETION
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation

Division of Highways
IDOT

SOIL BORING LOG

Date 9/7/06

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek LOGGED BY JAR

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG.

COUNTY Fulton DRILLING METHOD CME 55 HSA HAMMER TYPE Auto

STRUCT. NO. 029-0069(prop)
Station 10+451.755

BORING NO. 4 (Pier)
Station 10+458.5
Offset 56.10ft RT PCL
Ground Surface Elev. 438.26 ft

Surface Water Elev. 438.47 ft
Stream Bed Elev. 438.26 ft

Groundwater Elev.:
First Encounter 438.3 ft
Upon Completion 438.3 ft
After 24 Hrs. 438.3 ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
				Brown Med to Cse SAND and GRAVEL
				0-5.0m Similar soils as B#3 No moistures or N values taken
				Bottom of Pier Footing/ Encasement Elev. 435.0
-5				
-10				
-15				
				421.76 Grey CLAY SHALE
	6			
	32		14.0	
	35			
	11			
-20	100@3"		15.0	

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
				trace of coal Grey CLAY SHALE *(continued)*
				416.76 Black COAL 416.26
	12			Gr SHALEY CLAY
	15		38.0	
	28		13.0	
	30			
-25	100@2"		18.0	413.26
				Borehole continued with rock coring.
-30				
-35				
-40				

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
IDOT

ROCK CORE LOG

Date 9/7/06

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek LOGGED BY JAR

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG.

COUNTY Fulton CORING METHOD DUAL BARREL

STRUCT. NO. 029-0069(prop)
Station 10+451.755

CORING BARREL TYPE & SIZE NWD4 5'

Core Diameter 2.1 in
Top of Rock Elev. 420.76 ft
Begin Core Elev. 413.26 ft

BORING NO. 4 (Pier)
Station 10+458.5
Offset 56.10ft RT PCL
Ground Surface Elev. 438.26 ft

		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)	MOISTURE (%)
Gr, Lt Gr SANDY SHALE	413.26		1	95	65			
	412.26							
Lt Gr SANDSTONE W/ dk. gr laminations							75.9	4
							221.2	4
							151.4	6
							190.5	6
							238.8	9
							248.7	8
		-30						
							346.6	7
			2	88	58			
	407.06						295.1	6
Gr, Lt Gr SANDY SHALE								
							29.4	6
							30.9	7
		-35					38.9	6
	402.66		3	100	29			
Lt Gr Fine SANDSTONE/SILTSTONE							32.8	7
	401.26						42.5	8
Lt Gr SHALE	400.86							
Lt Gr SANDSTONE	400.56							
Lt Gr SHALE	399.76							
Lt Gr SANDSTONE (laminated)	398.96							
Gr SILTY SHALE W/ v. thin sandstone seams	398.26	-40					84.6	7
End of Boring								
		-45						

Color pictures of the cores No
Cores will be stored for examination until COMPLETION
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

Illinois Department of Transportation

Division of Highways
IDOT

SOIL BORING LOG

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek Date 8/15/07

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG. LOGGED BY JAR

COUNTY Fulton DRILLING METHOD CME 750 HSA HAMMER TYPE Auto

STRUCT. NO. 029-0069(prop)
Station 10+451.755

BORING NO. 5 (Pier)
Station 10+445
Offset 16.40ft RT PCL
Ground Surface Elev. 450.86 ft

Surface Water Elev. 438.47 ft
Stream Bed Elev. 438.26 ft

Groundwater Elev.:
First Encounter ft
Upon Completion NA wash ft
After 24 Hrs. 446.0 ft ▽

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	Brown SILTY LOAM		
	1		
	1 2	2.0 P	10.0
	1		
▽-5	4 5	1.7 S	15.0
	3		
	3 4	2.3 P	18.0
441.86			
	Lt. Brown/Brown SILTY LOAM		
	1		
-10	1 2	1.2 B	25.0
439.36			
	Gray SILTY LOAM		
	H		
	1 1	0.8 P	33.0
	H		
-15	1 1	1.2 B	31.0
434.36			
	Gray Fine-Med SAND		
	1		
	4 5		22.0
	1		
-20	1		21.0

Bottom of Pier Footing/ Encasement Elev. 435.0

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	Gray Fine-Med SAND *(continued)*		
	1		
429.86			
	Brown & Gray Cse. SAND & GRAVEL		
	2		
	2 1		12.0
	15		
-25	10 10		16.0
	6		
	9 7		16.0
421.86			
	Gray SHALEY CLAY		
	10		
-30	32 47		15.0
419.36			
	Gray SHALEY CLAY/SHALE		
	16		
418.36	56		13.0
	Black COAL		44@1"
	Borehole continued with rock coring.		
-35			
-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
IDOT

ROCK CORE LOG

Date 8/15/07

ROUTE FAP 317 & 689 (US 24 & IL 9) DESCRIPTION US 24 over Copperas Creek LOGGED BY JAR

SECTION (43R)BR; (43BR)BR LOCATION , SEC. , TWP. , RNG.

COUNTY Fulton CORING METHOD DUAL BARREL

STRUCT. NO. 029-0069(prop) CORING BARREL TYPE & SIZE NWD4 5'
Station 10+451.755

Core Diameter 2.1 in
Top of Rock Elev. 419.36 ft
Begin Core Elev. 418.36 ft

BORING NO. 5 (Pier)
Station 10+445
Offset 16.40ft RT PCL
Ground Surface Elev. 450.86 ft

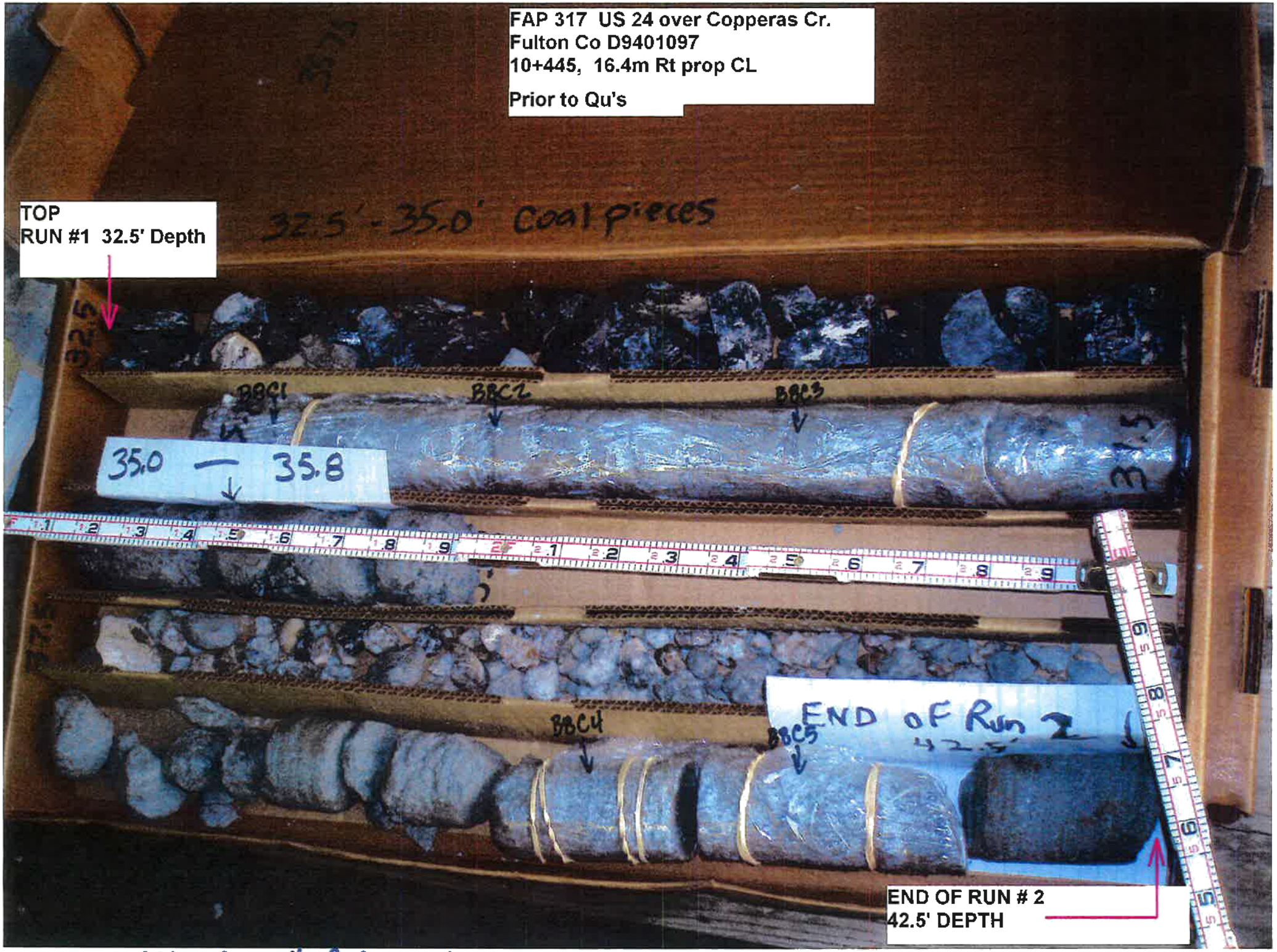
DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)	MOISTURE (%)
Black COAL *(continued)* Rock Mass Rating(RMR)= 2, Very Poor Rock						
415.86 -35						
Gray SHALE RMR = 34, Poor Rock					6.0	10
					14.2	9
413.36					15.1	7
Brown & Gray Cse. GRAVELS RMR= -21, Very Poor Rock	2	70	10			
-40						
409.86						
Gray SANDSTONE RMR= 41, Fair Rock					178.4	2
					201.2	2
	3	100	50		623.5	1
407.26					466.4	1
Gray SHALE RMR= 29, Poor Rock					27.8	6
-45					41.1	6
					15.8	7
404.56						
Gray SANDSTONE RMR = 69, Good Rock					194.0	2
403.36					314.1	2
Gray, thin SANDSTONE & SHALE layers RMR = 13, Very Poor Rock	4	80	0			
-50						
398.36						

End of Boring

Color pictures of the cores Yes

Cores will be stored for examination until COMPLETION

The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)



BBC1 = Sample # of Run, Run by BMPA


TOP of RUN #3
42.5'
RTE 24
COPPERAS CR
B#
10+445
16.4m Rt PCL
CORE 42.5' -
52.5'
Prior to Qu's
FAP 317 US 24 over Copperas
Cr. Fulton Co. D9401097
10+445, 16.4m Lt prop CL
Bottom of
Run #4
52.5' Depth

Illinois Department of Transportation

Memorandum

To: Derek Parish, Heather Shoup, Darren Reents
Bill Kramer, Riyad Wahab

From: Kurt Schmuck BMPR Soils Lab

Subject: Rock Core Compression Testing

Date: September 21, 2007

County: Fulton
Route: FAP-317 & 689 (US-24 & IL-9)
Section: (43BR) BR
Job # : D-94-010-97
Contract:
S.N. 029-0069 prop. over Copperas Creek
Date: 9/19/2007

Unconfined Compressive Strength of Intact Rock Cores
ASTM D-2938

All samples trimmed to maintain a length-to-diameter ratio of 2.0 to 2.5. ASTM D-4543

Approximate Stress Rate @ 20 psi/sec.
* Denotes strain rate of 2% per min. for soft materials.

Boring: BB -~~8~~ 5
Station: 10+445 16.4m Rt. prop.CL

Sample	Depth (ft.)	Dia. (in.)	Area (in^2.)	Length (in.)	Weight (grams)	As Tested Moist. %	Unit Weight (lbs / ft^3) Wet	Unit Weight (lbs / ft^3) Dry	Compressive Strength Data: Load (lbs)	Stress (psi)	Stress (tsf)	Stress (ksf)	Deflec. (in.)
---	---	---	---	---	---	---	---	---	---	---	---	---	---
B8C1*•	35.8 - 36.3	1.950	2.986	3.880	449.0	9.60	147.6	134.7	250	84	6.0	12.1	0.110
B8C2*•	36.3 - 36.8	1.900	2.835	4.027	436.2	8.93	145.5	133.6	560	198	14.2	28.4	0.143
B8C3*•	36.8 - 37.5	2.009	3.170	3.962	478.5	7.41	145.1	135.1	665	210	15.1	30.2	0.153
B8C4*•	41.5 - 41.8	2.005	3.157	3.614	382.0	2.44	127.5	124.5	7825	2478	178.4	356.9	0.022
B8C5 •	41.8 - 42.2	2.020	3.205	3.975	443.0	2.13	132.5	129.7	8955	2794	201.2	402.4	0.027
B8C6 •	42.8 - 43.3	2.034	3.249	3.930	528.2	0.96	157.6	156.1	28140	8660	623.5	1247.1	0.031
B8C7•	43.3 - 43.6	2.035	3.253	3.345	443.1	0.94	155.2	153.7	21070	6478	466.4	932.8	0.031
B8C8*•	43.6 - 43.9	1.970	3.048	3.842	464.8	6.25	151.2	142.3	1175	385	27.8	55.5	0.110
B8C9*•	43.9 - 44.2	1.955	3.002	3.924	485.2	6.06	156.9	148.0	1715	571	41.1	82.3	0.096
B8C10*	45.4 - 45.9	1.984	3.092	4.045	506.3	6.98	154.2	144.2	680	220	15.8	31.7	0.079
B8C11	46.3 - 47.1	2.022	3.211	3.920	440.1	1.91	133.2	130.7	8650	2694	194.0	387.9	0.027
B8C12	47.1 - 47.5	2.019	3.202	3.957	455.7	1.92	137.0	134.5	13965	4362	314.1	628.1	0.026

Illinois Department of Transportation

Memorandum

To: Derek Parish, Heather Shoup, Darren Reents
Bill Kramer, Riyad Wahab

From: Kurt Schmuck BMPR Soils Lab

Subject: Rock Core Compression Testing

Date: September 21, 2007

County: Fulton
Route: FAP-317 & 689 (US-24 & IL-9)
Section: (43BR) BR
Job # : D-94-010-97
Contract:
S.N. 029-0069 prop. over Copperas Creek
Date: 9/19/2007

Unconfined Compressive Strength of Intact Rock Cores
ASTM D-2938

All samples trimmed to maintain a length-to-diameter ratio of 2.0 to 2.5. ASTM D-4543

Approximate Stress Rate @ 20 psi/sec.
* Denotes strain rate of 2% per min. for soft materials.

Boring: BB -8 S
Station: 10+445 16.4m Rt. prop.CL

Sample	Depth (ft.)	Dia. (in.)	Area (in^2.)	Length (in.)	Weight (grams)	As Tested Moist. %	Unit Weight (lbs / ft^3)		Compressive Strength Data				
							Wet	Dry	Load (lbs)	Stress (psi)	Stress (tsf)	Stress (ksf)	Deflec. (in.)
---	---	---	---	---	---	---	---	---	---	---	---	---	---
B8C1*	35.8 - 36.3	1.950	2.986	3.880	449.0	9.60	147.6	134.7	250	84	6.0	12.1	0.110
B8C2*	36.3 - 36.8	1.900	2.835	4.027	436.2	8.93	145.5	133.6	560	198	14.2	28.4	0.143
B8C3*	36.8 - 37.5	2.009	3.170	3.962	478.5	7.41	145.1	135.1	665	210	15.1	30.2	0.153
B8C4*	41.5 - 41.8	2.005	3.157	3.614	382.0	2.44	127.5	124.5	7825	2478	178.4	356.9	0.022
B8C5	41.8 - 42.2	2.020	3.205	3.975	443.0	2.13	132.5	129.7	8955	2794	201.2	402.4	0.027
B8C6	42.8 - 43.3	2.034	3.249	3.930	528.2	0.96	157.6	156.1	28140	8660	623.5	1247.1	0.031
B8C7	43.3 - 43.6	2.035	3.253	3.345	443.1	0.94	155.2	153.7	21070	6478	466.4	932.8	0.031
B8C8*	43.6 - 43.9	1.970	3.048	3.842	464.8	6.25	151.2	142.3	1175	385	27.8	55.5	0.110
B8C9*	43.9 - 44.2	1.955	3.002	3.924	485.2	6.06	156.9	148.0	1715	571	41.1	82.3	0.096
B8C10*	45.4 - 45.9	1.984	3.092	4.045	506.3	6.98	154.2	144.2	680	220	15.8	31.7	0.079
B8C11	46.3 - 47.1	2.022	3.211	3.920	440.1	1.91	133.2	130.7	8650	2694	194.0	387.9	0.027
B8C12	47.1 - 47.5	2.019	3.202	3.957	455.7	1.92	137.0	134.5	13965	4362	314.1	628.1	0.026

Shoup, Heather Z

From: Schmuck, Kurt W
Sent: Friday, September 21, 2007 2:03 PM
To: Parish, Derek C; Shoup, Heather Z; Reents, Darren L
Cc: Kramer, William M; Wahab, Riyad M
Subject: D-4 Copperas Creek Rock Cores ...
Attachments: Rock Cores Fulton Co SN 029-0069.doc

Ladies and Gentlemen,

Attached is a Word document with the results of unconfined compression testing of rock cores for the following District 4 project:

Fulton Co. FAP-317 & 689 (US-24 & IL-9) SN: 029-0069 prop. over Copperas Creek

Kurt Schmuck
BMPR Soils Lab

COHESIVE SOIL SETTLEMENT ESTIMATE

Illinois Department of Transportation

LOCATION AND BORING USED =====West Abutment / Boring B-2
TYPE OF SURCHARGE ==========2 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) ==25 FT

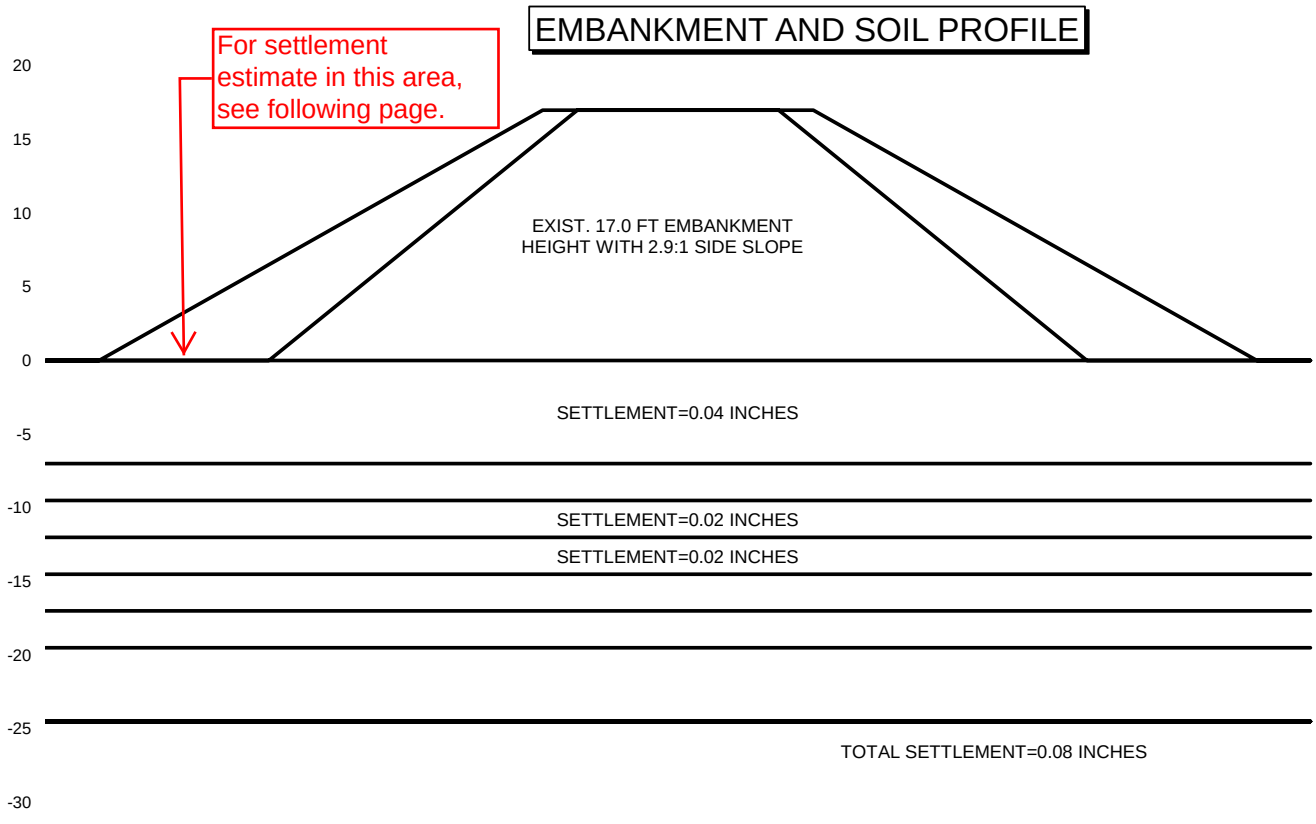
NEW EMBANKMENT:
NEW EMBANKMENT FILL UNIT WEIGHT ==========125 PCF
NEW EMBANKMENT FILL HEIGHT ==========17 FT
PROPOSED WIDTH AT TOP ==========43 FT
PROPOSED WIDTH AT BOTTOM ==========184 FT (which is a 4.1:1 slope)

EXISTING EMBANKMENT (IF ANY):
EXISTING EMBANKMENT UNIT WEIGHT ==========120 PCF
EXISTING EMBANKMENT HEIGHT ==========17 FT
EXISTING WIDTH AT TOP ==========32 FT
EXISTING WIDTH AT BASE ==========130 FT (which is a 2.9:1 slope)

ASSUMPTIONS:
Soil Deposit is Normally Consolidated
Cohesive Layers are Saturated
Soils have a Low Sensitivity
Liquid Limit (LL)=Moist. Content (MC%)
Initial Void Ratio (Eo)=2.7*(MC%)/100
Comp. Index (Cc)=0.009*(LL-10)
Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
7.0	120	0.50	27	2.459	0.086	0.729	0.153	0.361	**0.04**
2.5	120	0.00	16	2.999	0.094	0.432	0.054	1.000	**Granular**
2.5	120	0.60	36	3.127	0.102	0.972	0.234	0.309	**0.02**
2.5	120	0.30	27	3.249	0.113	0.729	0.153	0.550	**0.02**
2.5	120	0.00	21	3.367	0.126	0.567	0.099	1.000	**Granular**
2.5	120	0.00	17	3.480	0.140	0.459	0.063	1.000	**Granular**
5.0	120	0.00	7	3.644	0.162	0.189	0.000	1.000	**Granular**

TOTAL SETTLEMENT UNDER CENTER OF CONTINUOUS EMBANKMENT = 0.08 IN.



Illinois Department of Transportation

COHESIVE SOIL SETTLEMENT ESTIMATE

Settlement along side of widened west abutment cone

LOCATION AND BORING USED ===== West Abutment / Boring B-2
TYPE OF SURCHARGE ========== 3 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 25 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 125 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 8 FT
- PROPOSED WIDTH AT TOP ========== 10 FT
- PROPOSED WIDTH AT BOTTOM ========== 10 FT (which is a MUST EQUA
- PROPOSED LENGTH OF RECTANGULAR SURCHARGE==== 12 FT

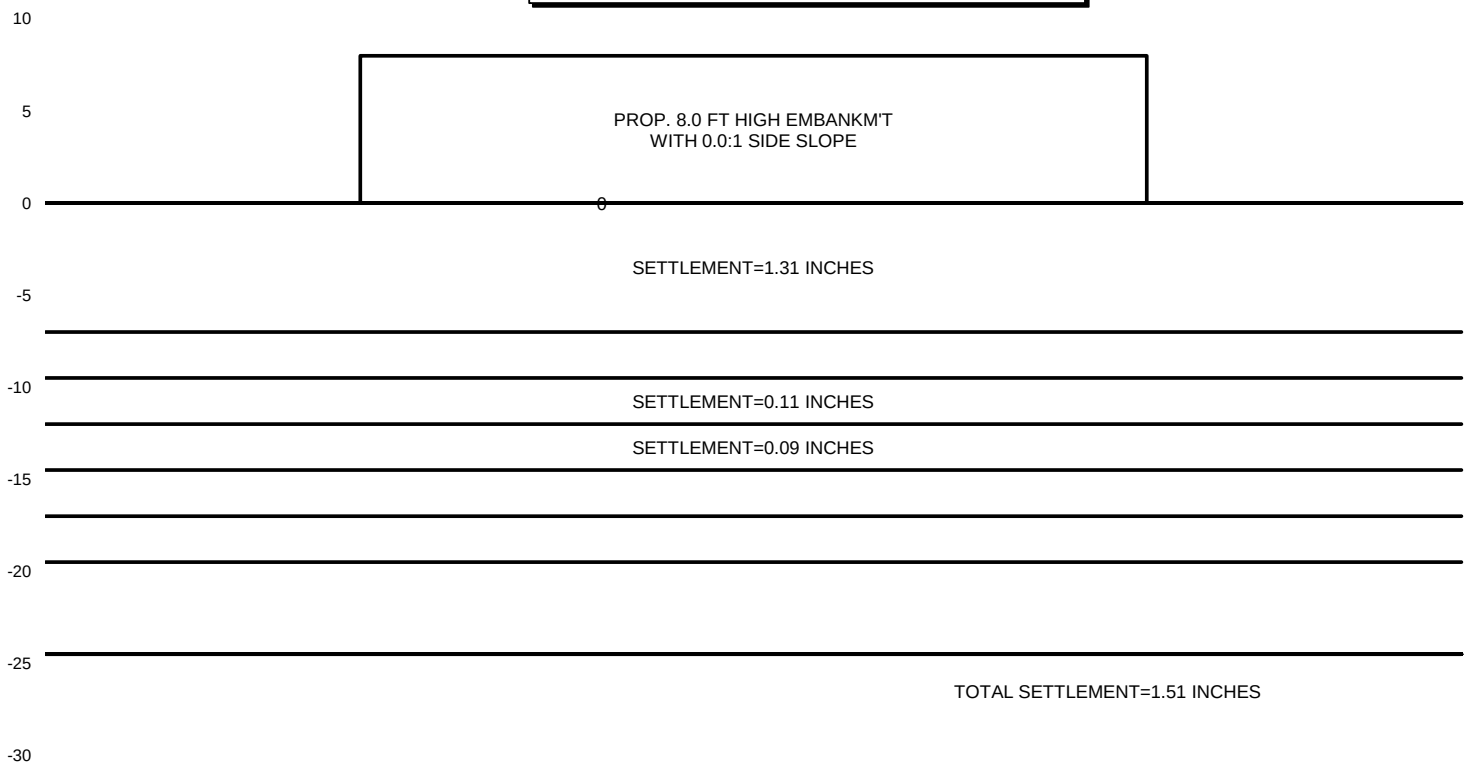
EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 120 PCF
- EXISTING EMBANKMENT HEIGHT ========== 0 FT
- EXISTING WIDTH AT TOP ========== 0 FT
- EXISTING WIDTH AT BASE ========== 0 FT (which is a 0.0:1 slope)
- EXISTING LENGTH OF RECTANGULAR SURCHARGE====== 0 FT

ASSUMPTIONS:
- Soil Deposit is Normally Consolidated
- Cohesive Layers are Saturated
- Soils have a Low Sensitivity
- Liquid Limit (LL)=Moist. Content (MC%)
- Initial Void Ratio (Eo)=2.7*(MC%)/100
- Comp. Index (Cc)=0.009*(LL-10)
- Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
7.0	120	0.50	27	0.420	0.872	0.729	0.153	0.361	**1.31**
2.5	120	0.00	16	0.990	0.480	0.432	0.054	1.000	**Granular**
2.5	120	0.60	36	1.290	0.344	0.972	0.234	0.309	**0.11**
2.5	120	0.30	27	1.590	0.253	0.729	0.153	0.550	**0.09**
2.5	120	0.00	21	1.890	0.192	0.567	0.099	1.000	**Granular**
2.5	120	0.00	17	2.190	0.149	0.459	0.063	1.000	**Granular**
5.0	120	0.00	7	2.640	0.107	0.189	0.000	1.000	**Granular**

TOTAL SETTLEMENT UNDER CENTER OF RECTANGULAR FOOTING = 1.51 IN.

EMBANKMENT AND SOIL PROFILE



COHESIVE SOIL SETTLEMENT ESTIMATE

Illinois Department of Transportation

LOCATION AND BORING USED ===== East Abutment / Boring B-1
TYPE OF SURCHARGE ========== 2 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 22 FT

NEW EMBANKMENT:
- NEW EMBANKMENT FILL UNIT WEIGHT ========== 125 PCF
- NEW EMBANKMENT FILL HEIGHT ========== 17 FT
- PROPOSED WIDTH AT TOP ========== 43 FT
- PROPOSED WIDTH AT BOTTOM ========== 124 FT (which is a 2.4:1 slope)

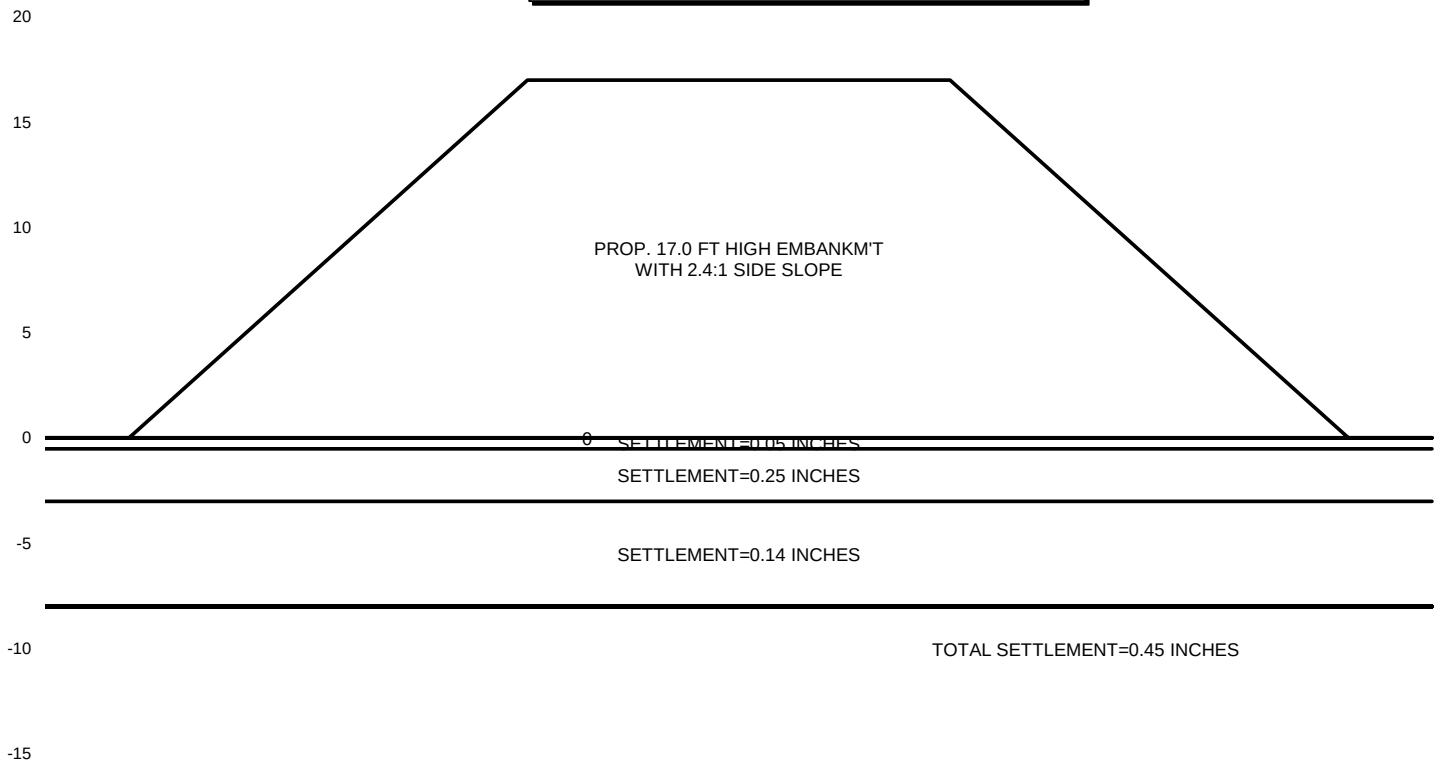
EXISTING EMBANKMENT (IF ANY):
- EXISTING EMBANKMENT UNIT WEIGHT ========== 120 PCF
- EXISTING EMBANKMENT HEIGHT ========== 0 FT
- EXISTING WIDTH AT TOP ========== 0 FT
- EXISTING WIDTH AT BASE ========== 0 FT (which is a 0.0:1 slope)

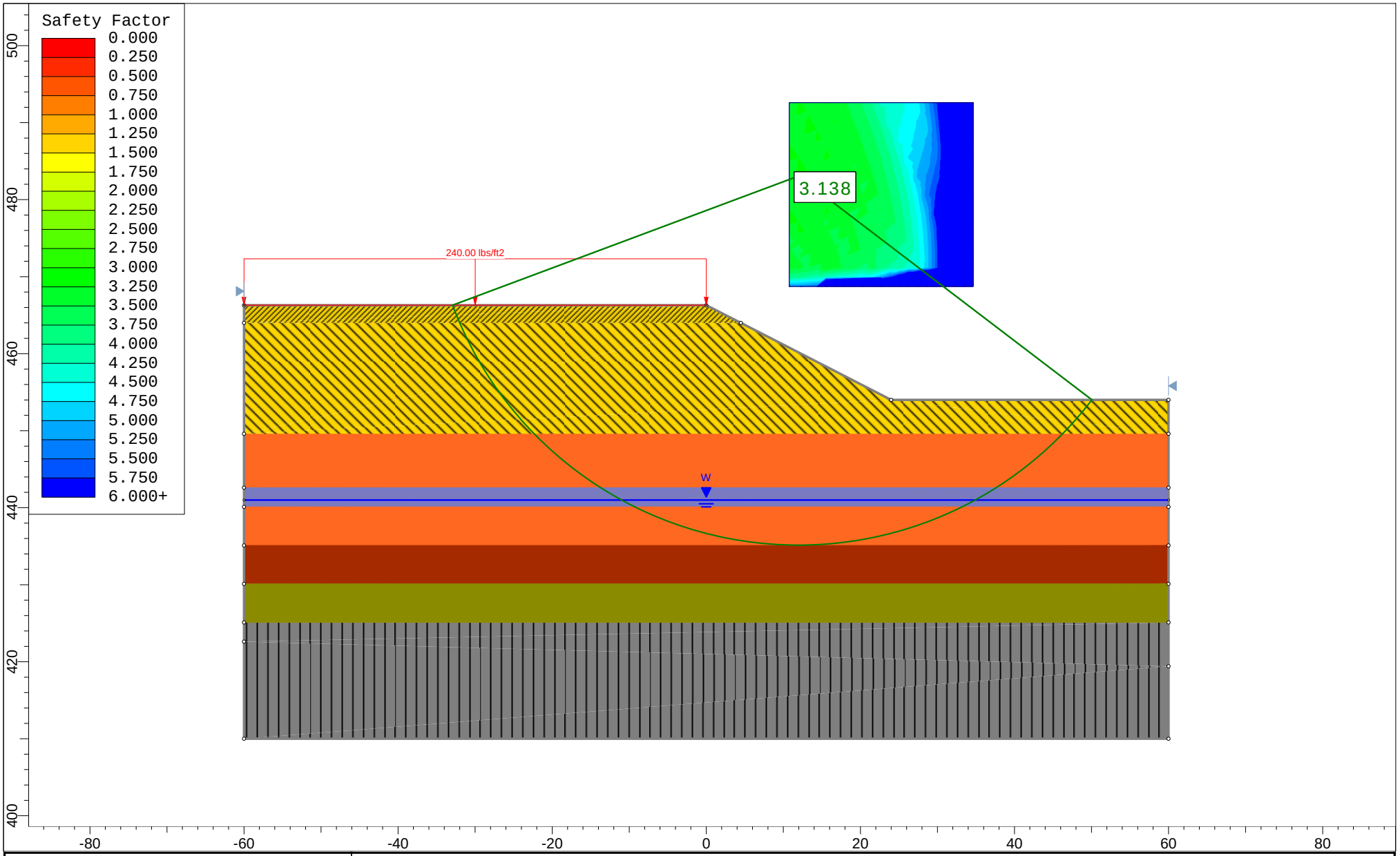
ASSUMPTIONS:
- Soil Deposit is Normally Consolidated
- Cohesive Layers are Saturated
- Soils have a Low Sensitivity
- Liquid Limit (LL)=Moist. Content (MC%)
- Initial Void Ratio (Eo)=2.7*(MC%)/100
- Comp. Index (Cc)=0.009*(LL-10)
- Neglecting Granular & Secondary Settlem't

LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
0.5	120	1.80	16	0.031	2.125	0.432	0.054	0.121	**0.05**
2.5	120	2.30	25	0.212	2.125	0.675	0.135	0.100	**0.25**
5.0	120	3.00	16	0.662	2.122	0.432	0.054	0.100	**0.14**

TOTAL SETTLEMENT UNDER CENTER OF CONTINUOUS EMBANKMENT = 0.45 IN.

EMBANKMENT AND SOIL PROFILE





rocscience	Project	US 24 / IL 9 over Copperas Creek		
	Analysis Description	West Abutment - Undrained		
	Drawn By	S.D. Sanford	Scale 1:207	Company WHKS & Co.
	Date	12/5/2018, 8:58:37 AM		File Name Slide1_West Abutment_Short-term Undrained.slmd

SLIDEINTERPRET 8.018

Slide Analysis Information

Slide1_West Abutment_Short-term Undrained

Project Summary

File Name:	Slide1_West Abutment_Short-term Undrained.slmd
Slide Modeler Version:	8.018
Compute Time:	00h:00m:00.212s
Project Title:	US 24 / IL 9 over Copperas Creek
Analysis:	West Abutment - Undrained
Author:	S.D. Sanford
Company:	WHKS & Co.
Date Created:	12/5/2018, 8:58:37 AM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical

Analysis Methods Used

	Bishop simplified
	Janbu simplified
Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: Park and Miller v.3

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius Increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined
Minimum Area: Not Defined
Minimum Weight: Not Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Loading

- 1 Distributed Load present

Distributed Load 1

Distribution: Constant
Magnitude [psf]: 240
Orientation: Normal to boundary

Materials

Property	Proposed Embankment	Existing Embankment	Silty Clay Loam	Brown Medium Sand	Med. Sand and Gravel	Coarse Sand and Gravel	Shale
Color							
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Undrained	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Infinite strength
Unit Weight [lbs/ft3]	130	127	115	125	125	130	142
Allow Sliding Along Boundary							Yes
Cohesion [psf]	2500	2000	500	0	0	0	
Friction Angle [°]	10	6		33	35	40	
Cohesion Type			Constant				
Water Surface	None	None	Water Table	Water Table	Water Table	Water Table	None
Hu Value			0	1	1	1	
Ru Value	0	0					0

Global Minimums

Method: bishop simplified

FS	3.137680
Center:	11.961, 483.056
Radius:	47.914
Left Slip Surface Endpoint:	-32.928, 466.300
Right Slip Surface Endpoint:	50.060, 454.000
Resisting Moment:	4.90185e+06 lb-ft
Driving Moment:	1.56225e+06 lb-ft
Total Slice Area:	1515.65 ft2
Surface Horizontal Width:	82.9882 ft
Surface Average Height:	18.2634 ft

Method: janbu simplified

FS	3.324450
Center:	11.961, 491.410
Radius:	56.257
Left Slip Surface Endpoint:	-38.382, 466.300
Right Slip Surface Endpoint:	53.977, 454.000
Resisting Horizontal Force:	83659.2 lb
Driving Horizontal Force:	25164.8 lb
Total Slice Area:	1666.94 ft2
Surface Horizontal Width:	92.3584 ft
Surface Average Height:	18.0486 ft

Valid/Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	4497
Number of Invalid Surfaces:	354

Error Codes:

Error Code -108 reported for 97 surfaces
Error Code -112 reported for 257 surfaces

Method: janbu simplified

Number of Valid Surfaces:	3707
Number of Invalid Surfaces:	1144

Error Codes:

Error Code -108 reported for 108 surfaces
Error Code -111 reported for 780 surfaces
Error Code -112 reported for 256 surfaces

Error Codes

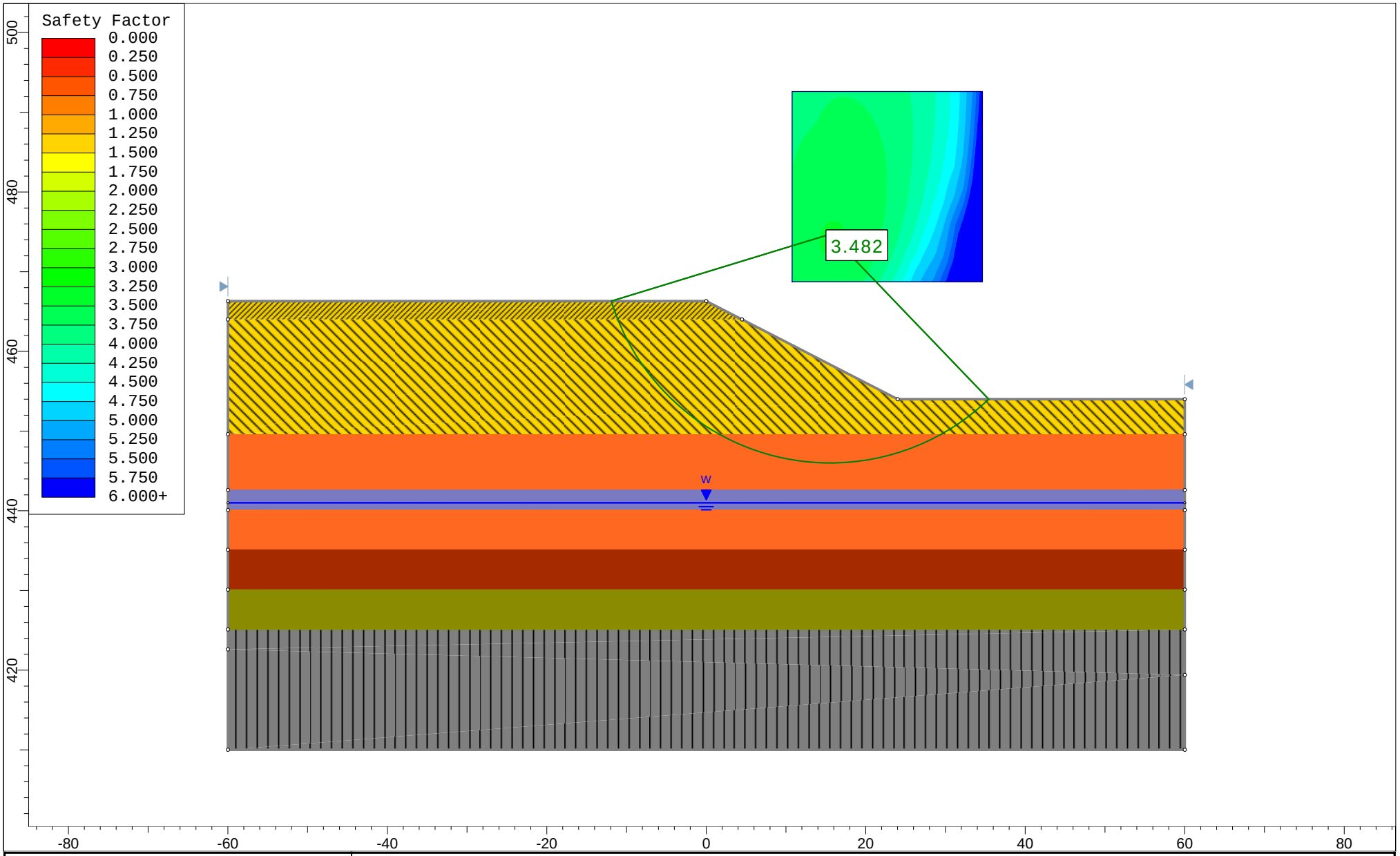
The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

- **Global Minimum Query (bishop simplified) - Safety Factor: 3.13768**



rocscience

SLIDEINTERPRET 8.018

Project	US 24 / IL 9 over Copperas Creek		
Analysis Description	West Abutment - Drained		
Drawn By	S.D. Sanford	*Scale* 1:200	*Company* WHKS & Co.
Date	12/5/2018, 8:58:37 AM		*File Name* Slide1_West Abutment_Long-term Drained.slmd

Slide Analysis Information

Slide1_West Abutment_Long-term Drained

Project Summary

File Name:	Slide1_West Abutment_Long-term Drained.slmd
Slide Modeler Version:	8.018
Compute Time:	00h:00m:00.178s
Project Title:	US 24 / IL 9 over Copperas Creek
Analysis:	West Abutment - Drained
Author:	S.D. Sanford
Company:	WHKS & Co.
Date Created:	12/5/2018, 8:58:37 AM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical

Analysis Methods Used

Bishop simplified

Janbu simplified

Number of slices:	25
Tolerance:	0.005
Maximum number of iterations:	50
Check malpha < 0.2:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	10
Composite Surfaces:	Disabled
Reverse Curvature:	Create Tension Crack
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Proposed Embankment	Existing Embankment	Silty Clay Loam	Brown Medium Sand	Med. Sand and Gravel	Coarse Sand and Gravel	Shale
Color							
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Infinite strength
Unit Weight [lbs/ft3]	130	127	115	125	125	130	142
Allow Sliding Along Boundary							Yes
Cohesion [psf]	400	400	200	0	0	0	
Friction Angle [°]	37	35	24	33	35	40	
Water Surface	None	None	Water Table	Water Table	Water Table	Water Table	None
Hu Value			Automatically Calculated	Automatically Calculated	Automatically Calculated	Automatically Calculated	
Ru Value	0	0					0

Global Minimums

Method: bishop simplified

FS	3.482230
Center:	15.541, 474.702
Radius:	28.701
Left Slip Surface Endpoint:	-11.903, 466.300
Right Slip Surface Endpoint:	35.420, 454.000
Resisting Moment:	1.46679e+06 lb-ft
Driving Moment:	421221 lb-ft
Total Slice Area:	474.065 ft2
Surface Horizontal Width:	47.3225 ft
Surface Average Height:	10.0177 ft

Method: janbu simplified

FS	3.147670
Center:	15.541, 472.315
Radius:	27.054
Left Slip Surface Endpoint:	-10.836, 466.300
Right Slip Surface Endpoint:	35.453, 454.000
Resisting Horizontal Force:	41526.9 lb
Driving Horizontal Force:	13192.9 lb
Total Slice Area:	489.069 ft2
Surface Horizontal Width:	46.2899 ft
Surface Average Height:	10.5654 ft

Valid/Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	4747
Number of Invalid Surfaces:	104

Error Codes:

Error Code -108 reported for 91 surfaces
Error Code -112 reported for 13 surfaces

Method: janbu simplified

Number of Valid Surfaces:	4742
Number of Invalid Surfaces:	109

Error Codes:

Error Code -108 reported for 103 surfaces
Error Code -111 reported for 3 surfaces
Error Code -112 reported for 3 surfaces

Error Codes

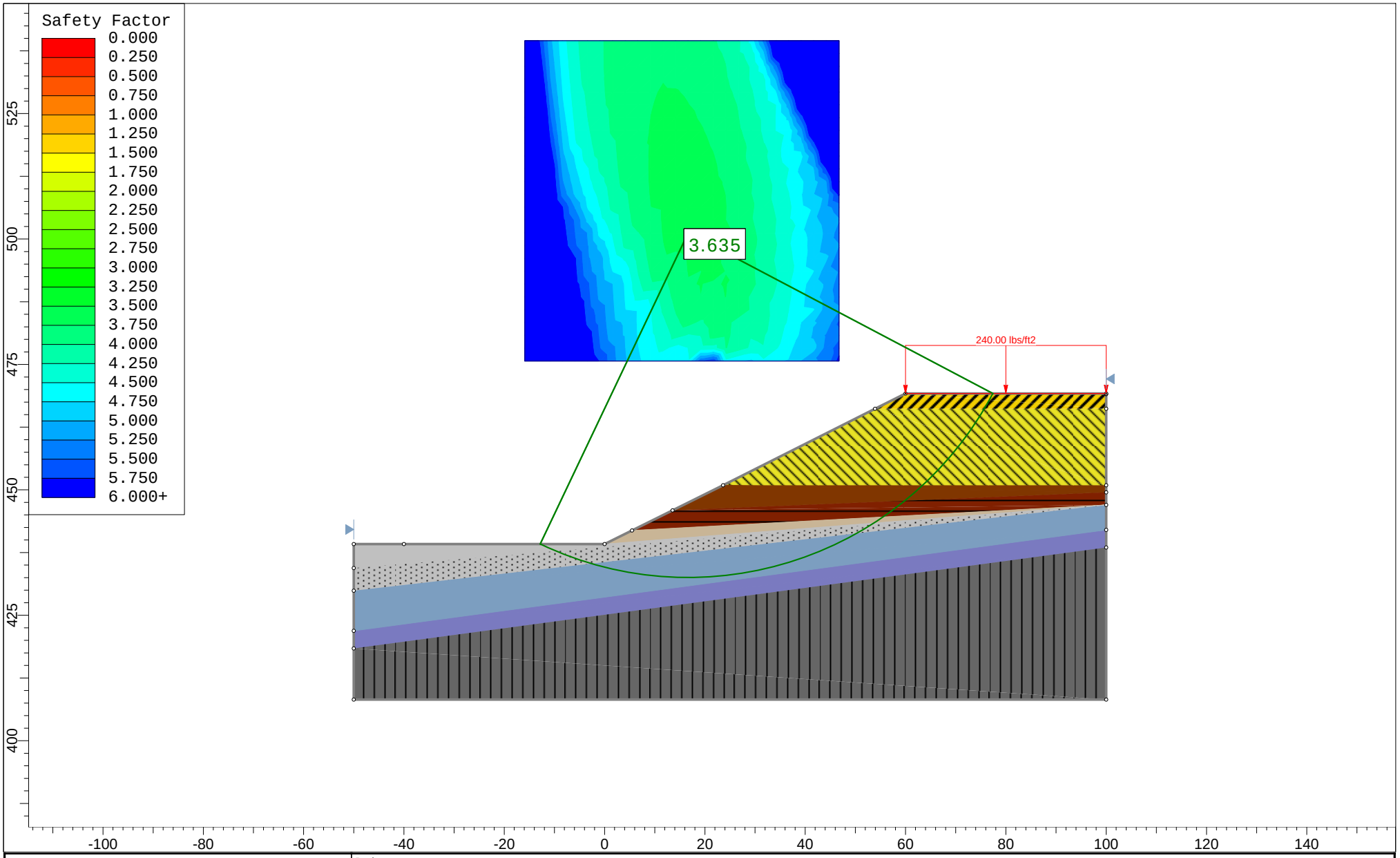
The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

- **Global Minimum Query (bishop simplified) - Safety Factor: 3.48223**



rocscience

SLIDEINTERPRET 8.018

Project	US 24 / IL 9 over Copperas Creek		
Analysis Description	West Abutment - Undrained		
Drawn By	S.D. Sanford	*Scale* 1:317	*Company* WHKS & Co.
Date	12/5/2018, 8:58:37 AM	*File Name*	Slide1_East Abutment_Short-term Undrained.slmd

Slide Analysis Information

Slide1_East Abutment_Short-term Undrained

Project Summary

File Name:	Slide1_East Abutment_Short-term Undrained.slmd
Slide Modeler Version:	8.018
Compute Time:	00h:00m:04.373s
Project Title:	US 24 / IL 9 over Copperas Creek
Analysis:	West Abutment - Undrained
Author:	S.D. Sanford
Company:	WHKS & Co.
Date Created:	12/5/2018, 8:58:37 AM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Janbu simplified
	Janbu corrected
	Spencer
	Sarma
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes
Sarma Interslice Strength Option:	Computed Average Value

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	10
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

- 1 Distributed Load present

Distributed Load 1

Distribution:	Constant
Magnitude [psf]:	240
Orientation:	Normal to boundary

Materials

Property	Proposed Embankment	Existing Embankment	Brown Silty Clay Loam	Brown Silty Loam	Lt. Brown Silty Loam	Gray Silty Loam	Grey Fine Sand	Coarse Sand and Gravel
Color								
Strength Type	Undrained	Undrained	Undrained	Undrained	Undrained	Undrained	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	120	130	125	127	125	121	122	125
Cohesion [psf]	3700	3700	1700	2000	1200	1000	0	0
Friction Angle [°]							30	40
Cohesion Type	Constant	Constant	Constant	Constant	Constant	Constant		
Water Surface	None	None	None	None	None	None	None	None
Ru Value	0	0	0	0	0	0	0	0

Property	Shaley Clay	Shale
Color		
Strength Type	Mohr-Coulomb	Infinite strength
Unit Weight [lbs/ft3]	20	20
Allow Sliding Along Boundary		Yes
Cohesion [psf]	1000	
Friction Angle [°]	44	
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: bishop simplified

FS	3.634990
Center:	16.666, 501.204
Radius:	68.663
Left Slip Surface Endpoint:	-12.832, 439.200
Right Slip Surface Endpoint:	77.415, 469.200
Resisting Moment:	1.43589e+07 lb-ft
Driving Moment:	3.95018e+06 lb-ft
Total Slice Area:	1316.25 ft2
Surface Horizontal Width:	90.2466 ft
Surface Average Height:	14.585 ft

Method: janbu simplified

FS	3.725120
Center:	16.666, 508.865
Radius:	76.962
Left Slip Surface Endpoint:	-16.042, 439.200
Right Slip Surface Endpoint:	82.619, 469.200
Resisting Horizontal Force:	187942 lb
Driving Horizontal Force:	50452.5 lb
Total Slice Area:	1497.22 ft2
Surface Horizontal Width:	98.6607 ft
Surface Average Height:	15.1754 ft

Method: janbu corrected

FS	3.986820
Center:	16.666, 508.865
Radius:	76.962
Left Slip Surface Endpoint:	-16.042, 439.200
Right Slip Surface Endpoint:	82.619, 469.200
Resisting Horizontal Force:	201145 lb
Driving Horizontal Force:	50452.5 lb
Total Slice Area:	1497.22 ft2
Surface Horizontal Width:	98.6607 ft
Surface Average Height:	15.1754 ft

Method: spencer

FS	3.756330
Center:	16.666, 513.973
Radius:	80.193
Left Slip Surface Endpoint:	-12.316, 439.200
Right Slip Surface Endpoint:	83.197, 469.200
Resisting Moment:	1.77021e+07 lb-ft
Driving Moment:	4.7126e+06 lb-ft
Resisting Horizontal Force:	180525 lb
Driving Horizontal Force:	48058.9 lb
Total Slice Area:	1358.51 ft2
Surface Horizontal Width:	95.5128 ft
Surface Average Height:	14.2234 ft

Method: sarma

FS	3.600170
Center:	16.666, 501.204
Radius:	68.663
Left Slip Surface Endpoint:	-12.832, 439.200
Right Slip Surface Endpoint:	77.415, 469.200
Total Slice Area:	1316.25 ft2
Surface Horizontal Width:	90.2466 ft
Surface Average Height:	14.585 ft

Valid/Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces:	7182
Number of Invalid Surfaces:	254

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 31 surfaces
Error Code -112 reported for 186 surfaces

Method: janbu simplified

Number of Valid Surfaces: 6959
Number of Invalid Surfaces: 477

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 36 surfaces
Error Code -111 reported for 218 surfaces
Error Code -112 reported for 186 surfaces

Method: janbu corrected

Number of Valid Surfaces: 6959
Number of Invalid Surfaces: 477

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 36 surfaces
Error Code -111 reported for 218 surfaces
Error Code -112 reported for 186 surfaces

Method: spencer

Number of Valid Surfaces: 3986
Number of Invalid Surfaces: 3450

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 54 surfaces
Error Code -111 reported for 3173 surfaces
Error Code -112 reported for 186 surfaces

Method: sarma

Number of Valid Surfaces: 6925
Number of Invalid Surfaces: 511

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 36 surfaces
Error Code -111 reported for 252 surfaces
Error Code -112 reported for 186 surfaces

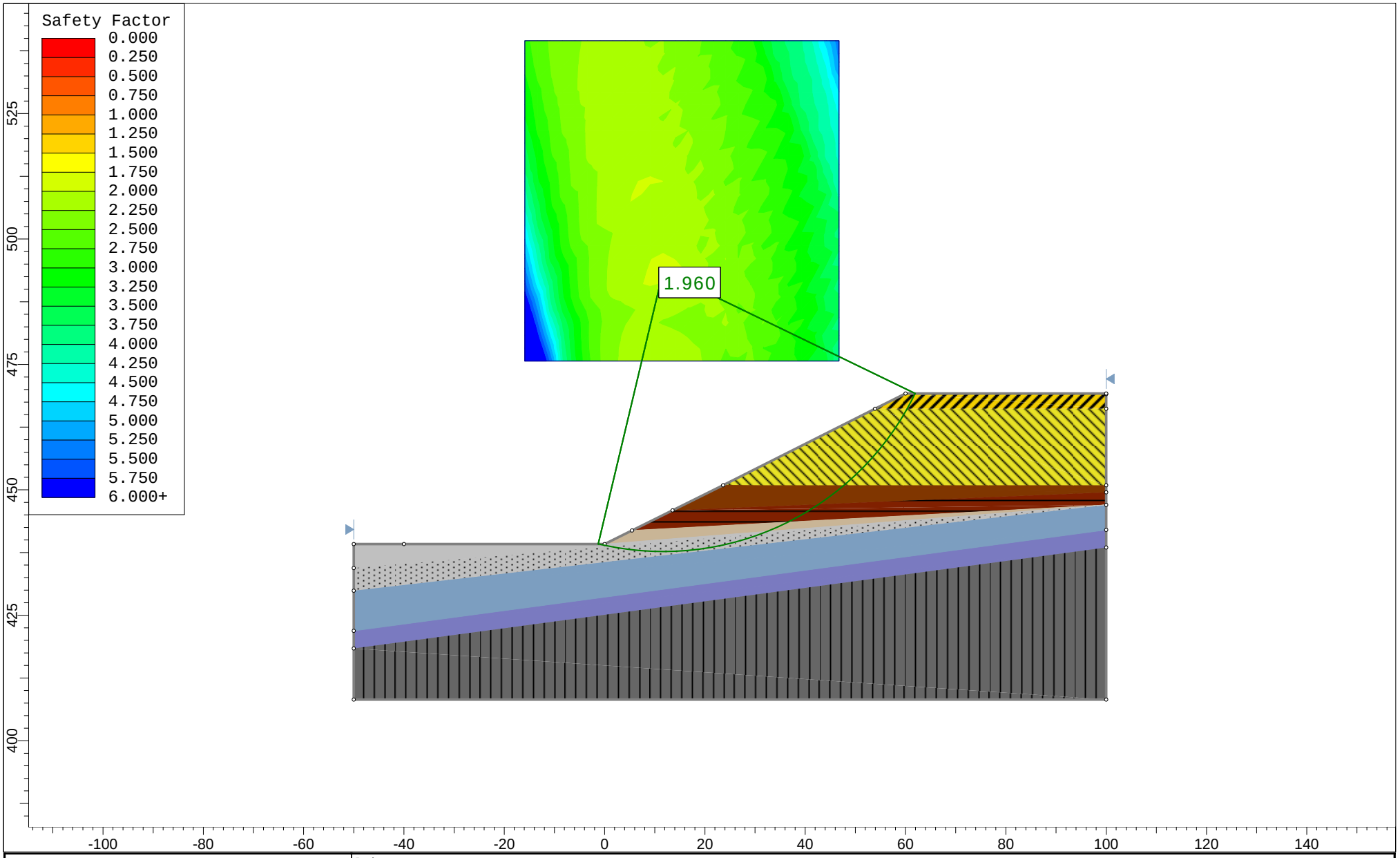
Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

- **Global Minimum Query (bishop simplified) - Safety Factor: 3.63499**



rocscience

SLIDEINTERPRET 8.018

Project	US 24 / IL 9 over Copperas Creek		
Analysis Description	East Abutment - Drained		
Drawn By S.D. Sanford	*Scale* 1:317	*Company* WHKS & Co.	
Date 12/5/2018, 8:58:37 AM		*File Name* Slide1_East Abutment_Long Term Drained.slmd	

Slide Analysis Information

Slide1_East Abutment_Long Term Drained

Project Summary

File Name:	Slide1_East Abutment_Long Term Drained.slmd
Slide Modeler Version:	8.018
Compute Time:	00h:00m:01.394s
Project Title:	US 24 / IL 9 over Copperas Creek
Analysis:	East Abutment - Drained
Author:	S.D. Sanford
Company:	WHKS & Co.
Date Created:	12/5/2018, 8:58:37 AM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Bishop simplified
	Janbu simplified
	Janbu corrected
	Spencer
	Sarma
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes
Sarma Interslice Strength Option:	Computed Average Value

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Grid Search
Radius Increment:	10
Composite Surfaces:	Disabled
Reverse Curvature:	Invalid Surfaces
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Proposed Embankment	Existing Embankment	Brown Silty Clay Loam	Brown Silty Loam	Lt. Brown Silty Loam	Gray Silty Loam	Grey Fine Sand	Coarse Sand and Gravel
Color								
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	120	130	125	127	125	121	122	125
Cohesion [psf]	400	400	250	300	200	150	0	0
Friction Angle [°]	37	35	33	34	31	29	30	40
Water Surface	None	None	None	None	None	None	None	None
Ru Value	0	0	0	0	0	0	0	0

Property	Shaley Clay	Shale
Color		
Strength Type	Mohr-Coulomb	Infinite strength
Unit Weight [lbs/ft3]	20	20
Allow Sliding Along Boundary		Yes
Cohesion [psf]	200	
Friction Angle [°]	44	
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: bishop simplified

FS	1.959910
Center:	11.657, 493.543
Radius:	55.860
Left Slip Surface Endpoint:	-1.273, 439.200
Right Slip Surface Endpoint:	61.934, 469.200
Resisting Moment:	3.22786e+06 lb-ft
Driving Moment:	1.64694e+06 lb-ft
Total Slice Area:	594.632 ft2
Surface Horizontal Width:	63.2066 ft
Surface Average Height:	9.40776 ft

Method: janbu simplified

FS	1.874660
Center:	14.162, 493.543
Radius:	55.700
Left Slip Surface Endpoint:	0.629, 439.512
Right Slip Surface Endpoint:	64.261, 469.200
Resisting Horizontal Force:	52342.7 lb
Driving Horizontal Force:	27921.1 lb
Total Slice Area:	657.462 ft2
Surface Horizontal Width:	63.6312 ft
Surface Average Height:	10.3324 ft

Method: janbu corrected

FS	1.999660
Center:	14.162, 493.543
Radius:	55.700
Left Slip Surface Endpoint:	0.629, 439.512
Right Slip Surface Endpoint:	64.261, 469.200
Resisting Horizontal Force:	55832.6 lb
Driving Horizontal Force:	27921.1 lb
Total Slice Area:	657.462 ft2
Surface Horizontal Width:	63.6312 ft
Surface Average Height:	10.3324 ft

Method: spencer

FS	1.950270
Center:	11.657, 493.543
Radius:	55.860
Left Slip Surface Endpoint:	-1.273, 439.200
Right Slip Surface Endpoint:	61.934, 469.200
Resisting Moment:	3.21197e+06 lb-ft
Driving Moment:	1.64694e+06 lb-ft
Resisting Horizontal Force:	48278.2 lb
Driving Horizontal Force:	24754.6 lb
Total Slice Area:	594.632 ft2
Surface Horizontal Width:	63.2066 ft
Surface Average Height:	9.40776 ft

Method: sarma

FS	1.950600
Center:	11.657, 493.543
Radius:	55.860
Left Slip Surface Endpoint:	-1.273, 439.200
Right Slip Surface Endpoint:	61.934, 469.200
Total Slice Area:	594.632 ft2
Surface Horizontal Width:	63.2066 ft
Surface Average Height:	9.40776 ft

Valid/Invalid Surfaces

Method: bishop simplified

Number of Valid Surfaces: 7370
Number of Invalid Surfaces: 66

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 29 surfaces

Method: janbu simplified

Number of Valid Surfaces: 7362
Number of Invalid Surfaces: 74

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 36 surfaces
Error Code -111 reported for 1 surface

Method: janbu corrected

Number of Valid Surfaces: 7362
Number of Invalid Surfaces: 74

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 36 surfaces
Error Code -111 reported for 1 surface

Method: spencer

Number of Valid Surfaces: 7104
Number of Invalid Surfaces: 332

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 38 surfaces
Error Code -111 reported for 257 surfaces

Method: sarma

Number of Valid Surfaces: 7362
Number of Invalid Surfaces: 74

Error Codes:

Error Code -103 reported for 37 surfaces
Error Code -108 reported for 36 surfaces
Error Code -111 reported for 1 surface

Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge

Slice Data

- **Global Minimum Query (bishop simplified) - Safety Factor: 1.95991**

Illinois Department of Transportation

SEISMIC SITE CLASS DETERMINATION

PROJECT TITLE=====US 24/IL 9 over Copperas Creek. S.N. 029-0001 (exist.) S.N. 029-0069 (prop.)

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	456.6	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-2	
Top of Boring Elev.	450.6	ft.
Approximate Fixity Elev.	450.6	ft.

Individual Site Class Definition:

N (bar):	7 (Blows/ft.)	Soil Site Class E	
N_{ch} (bar):	12 (Blows/ft.)	Soil Site Class E	<----Controls
s_u (bar):	2.16 (ksf)	Soil Site Class C	

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
3.0	447.6	2.98	1	0.00	B
5.5	445.1	2.50	3	0.50	
8.0	442.6	2.50	1	0.50	B
10.5	440.1	2.50	2	0.60	B
13.0	437.6	2.50	1	0.30	B
15.5	435.1	2.50	3	0.00	B
20.5	430.1	5.00	2	0.00	B
23.0	427.6	2.50	15	0.00	
25.5	425.1	2.50	8	0.00	B
100.0	350.6	74.52	100	4.50	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	450	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-5	
Top of Boring Elev.	450.9	ft.
Approximate Fixity Elev.	444	ft.

Individual Site Class Definition:

N (bar):	19 (Blows/ft.)	Soil Site Class D	
N_{ch} (bar):	43 (Blows/ft.)	Soil Site Class D	<----Controls
s_u (bar):	3.51 (ksf)	Soil Site Class C	

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	449.4	1.50	1	0.01	
	446.9	2.50	3	2.00	
	444.4	2.50	9	1.70	
2.1	441.9	2.50	7	2.30	B
4.6	439.4	2.50	3	1.20	B
7.1	436.9	2.50	2	0.80	
9.6	434.4	2.50	2	1.20	B
12.1	431.9	2.50	9	0.00	
14.1	429.9	2.00	2	0.00	B
16.6	427.4	2.50	3	0.00	
19.1	424.9	2.50	20	0.00	
22.1	421.9	3.00	16	0.00	B
24.6	419.4	2.50	16	0.00	B
27.1	416.9	2.50	79	0.00	B
28.1	415.9	1.00	150	0.00	B
112.0	332.0	83.90	150	4.50	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)	458.6	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-1	
Top of Boring Elev.	465.98	ft.
Approximate Fixity Elev.	452.6	ft.

Individual Site Class Definition:

N (bar):	60 (Blows/ft.)	Soil Site Class C	<----Controls
N_{ch} (bar):	92 (Blows/ft.)	Soil Site Class C	
s_u (bar):	2.17 (ksf)	Soil Site Class C	

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	463.5	2.50	1	1.00	B
	461.0	2.50	17	1.00	B
	458.5	2.50	18	1.00	B
	456.0	2.50	15	1.00	B
	453.5	2.50	9	1.00	B
2.6	450.0	3.50	11	1.00	B
3.1	449.5	0.52	13	1.80	B
5.6	447.0	2.50	7	2.30	B
8.1	444.5	2.50	16	0.00	
10.6	442.0	2.50	60	0.00	B
13.1	439.5	2.50	100	0.00	
99.8	352.8	86.70	100	4.50	R

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	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Global Site Class Definition: Substructures 1 through 3

N (bar):	29 (Blows/ft.)	Soil Site Class D	
N_{ch} (bar):	49 (Blows/ft.)	Soil Site Class D	<----Controls
s_u (bar):	2.63 (ksf)	Soil Site Class C	

Illinois Department of Transportation

INTEGRAL ABUTMENT FEASIBILITY ANALYSIS

Modified 10/30/17

GENERAL DATA

STRUCTURE NUMBER	029-0069		TOTAL STRUCTURE LENGTH	264.00	FT
STRUCTURE TYPE	MULTI-SPAN		NUMBER OF SPANS	2	
STRUCTURE SKEW	0	DEGREES	END SPAN LENGTH	132.00	FT
SUPER. DATA IN REFERENCE TO SUB. DATA	ABUT 1		ADJACENT INTERIOR SPAN LENGTH	132.00	FT

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN)

BEAM TYPE	PLATE GIRDER	
TOP FLANGE WIDTH	14.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	48.00	IN
WEB THICKNESS	0.50	IN
BOTTOM FLANGE WIDTH	14.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	6.25	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN)

TOP FLANGE WIDTH	14.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	48.00	IN
WEB THICKNESS	0.50	IN
BOTTOM FLANGE WIDTH	14.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	6.25	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

ABUTMENT #1 DATA

ABUTMENT NAME	West	
ABUTMENT REFERENCE BORING	B-2	
BOTTOM OF ABUTMENT ELEVATION	456.5	FT
ESTIMATED NUMBER OF PILES AT ABUT.	8	
PILE SPACING PERP. TO CL	6.25	FT

ABUTMENT #2 DATA

ABUTMENT NAME	East	
ABUTMENT REFERENCE BORING	B-1	
BOTTOM OF ABUTMENT ELEVATION	458.6	FT
ESTIMATED NUMBER OF PILES AT ABUT.	8	
PILE SPACING PERP. TO CL	6.25	FT

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
449.62	6.88	0.5		
447.62	2.00	0.5		
445.12	2.50	0.5		
442.62	2.50	0.5		
441.12	1.50		4	1.7

15.38 FT = TOTAL DEPTH ENTERED

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
450.00	8.60	1.0		
449.48	0.52	1.8		
446.98	2.50	2.3		
441.98	5.00		100	4.2
438.48	3.50		200	4.7

20.12 FT = TOTAL DEPTH ENTERED

ENTER 10 FT OF SOIL DATA

WEIGHTED AVERAGE Qu FOR ABUTMENT #1 = 0.62 TSF

PILE STIFFNESS MODIFIER FOR ABUTMENT #1
= 1/(1.45-[0.3*0.62]) = 0.79

ENTER 10 FT OF SOIL DATA

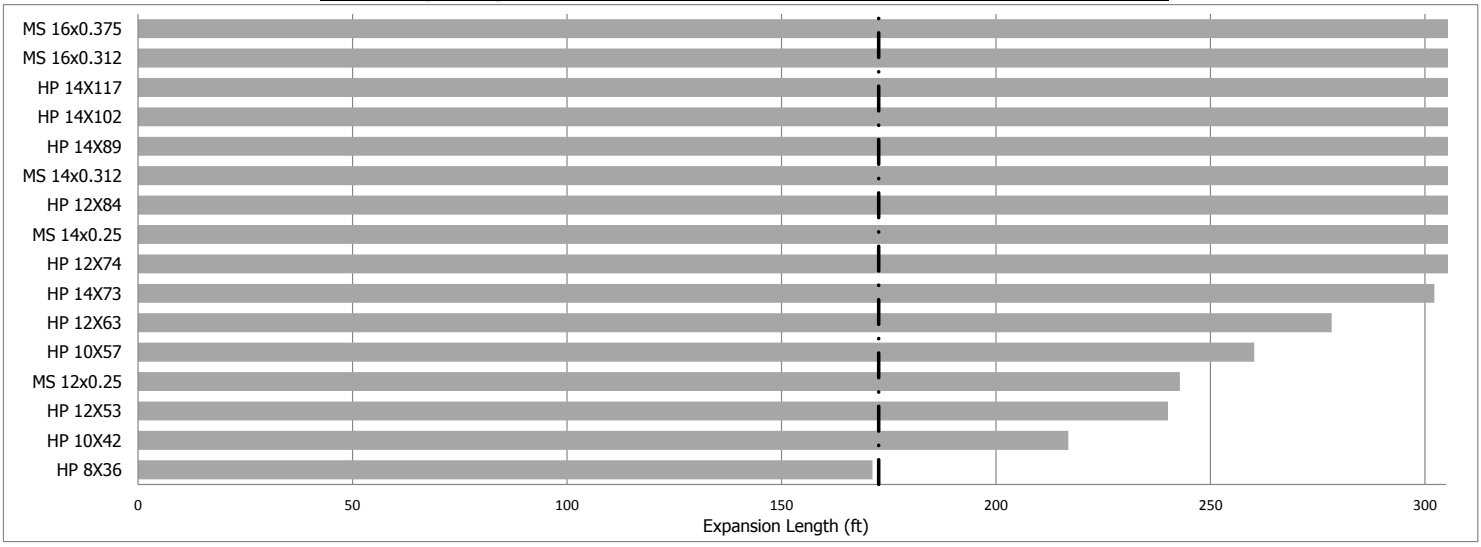
WEIGHTED AVERAGE Qu FOR ABUTMENT #2 = 2.61 TSF

PILE STIFFNESS MODIFIER FOR ABUTMENT #2
= 1/(1.45-[0.3*2.61]) = 1.50

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 = [0.79*8*0+1.5*8*264]/[0.79*8+1.5*8] = 172.66 FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 = [1.5*8*0+0.79*8*264]/[1.5*8+0.79*8] = 91.34 FT

ABUT 1 (West) - EXPANSION LENGTH LIMIT CHART - 0 DEG. SKEW



= Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration. (Note: The same size pile should be used at both abutments.)