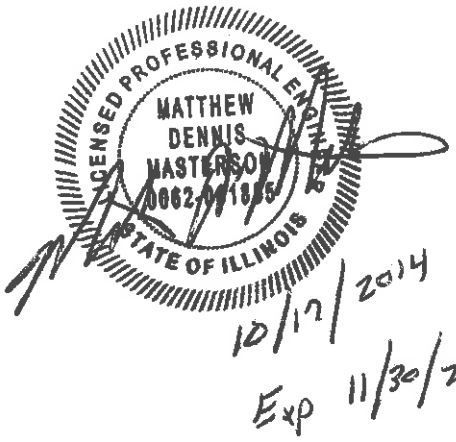
STRUCTURE GEOTECHNICAL REPORT

Double Box Culvert
U.S. Route 45 over Unnamed Stream

Proposed S.N. 097-2015
Existing S.N. 097-2007

F.A.P. Route 328
SECTION 109B-1
WHITE COUNTY, ILLINOIS
JOB NO. D-99-018-10
CONTRACT NO. 78163
PTB 148/33 WO# 06
KEG NO. 08-0060.06



10/17/2014

Exp 11/30/2015

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July 30, 2014
Revised October 17, 2014

Kaskaskia
Engineering Group, LLC

EXECUTIVE SUMMARY

Double Box Culvert – U.S. Route 45 over Unnamed Stream
F.A.P. Route 328
Section 109B-1
White County, Illinois
Job No. D-99-018-10
Contract No. 78163
PTB 148/33 WO #06
Proposed Structure No. 097-2015

This report summarizes the analysis of a proposed double box culvert for U.S. Route 45 over an Unnamed Stream near Sacramento, Illinois. The project is located in White County.

The bearing capacity of the natural soils indicates the ability to support the proposed loads.

Settlement should not be a concern for this replacement structure. The new culvert replaces an existing culvert in the same location, and substantial grading is not anticipated other than additional removal of existing soils for installation of the replacement culvert to proposed grades.

The slope stability analysis for the project was analyzed for an assumed wingwall sideslope geometry of 1 Vertical to 2 Horizontal (1V:2H) slopes. The required FOS for the three conditions modeled was met. If the design of the wingwall sideslopes exceeds the assumed geometry, Kaskaskia Engineering Group, LLC (KEG) should be notified to determine if the critical FOS are still met.

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EXHIBITS

1.0 Project Description and Proposed Structure Information

1.1 Introduction

The geotechnical study summarized in this report was performed by Kaskaskia Engineering Group, LLC (KEG) for a proposed double box culvert to be constructed on U.S. Route 45 over an unnamed stream near Sacramento, Illinois. The project is located in White County. The purpose of this report is to document subsurface geotechnical conditions, provide analyses of anticipated site conditions as they pertain to the project described herein, and to present design and construction recommendations for the proposed structure.

1.2 Project Description

The project consists of construction of a new double box culvert (S.N.097-2015) on U.S. Route 45 over an unnamed stream near Sacramento, Illinois.

The general location of the double box culvert is shown on a USGS Topographic Location Map, Exhibit A. The site lies within the limits of the Third Principal Meridian, (T. 6S R. 8E Section 4) within the Till Plains section of the Central Lowland Province and the Mt. Vernon Hill Country.

1.3 Proposed Structure Information

The proposed structure (S.N. 097-2015) will consist of a cast-in-place (CIP) double box culvert with horizontal cantilever wingwalls. The proposed structure will be built on a 0 degree skew. The proposed culvert centerline Station will be 194+03.00. The culvert will consist of two, 10 x 7 ft. barrels and will measure 35 ft. - 0 in. out-to-out headwalls. A Type, Size, and Location plan (TS&L) and Plan & Profile sheet (P&P) are included in Exhibit B.

Further substructure details will be based on the findings of this SGR.

2.0 Site Investigation, Subsurface Exploration, and Generalized Subsurface Conditions

The site exploration plan was developed and conducted by the Illinois Department of Transportation (IDOT). No on-site observations have been made by KEG personnel relative to existing conditions of the structure, stream, or roadway or of subsurface sample conditions.

Two standard penetration test (SPT) borings, designated 1-S and 2-S were completed on October 22, 2013. Boring 1-S was located at Station 194+31 and was offset 15 ft. right of the centerline of U.S. Route 45, and Boring 2-S was located at Station 193+74 and was offset 15 ft. left of the centerline of U.S. Route 45. Detailed information regarding the nature and thickness of the soils encountered and the results of the field sampling and laboratory testing are shown on the Boring Logs, Exhibit C. The soil profile for the borings can be found in Subsurface Profile, Exhibit D.

2.1 Subsurface Conditions

The profile at the boring locations exhibited layers of silty clay, silty loam, silty clay loam, clay, clay loam, sand, and gravel. The borings were terminated at a depth of 40 ft. and 49.7 ft., in clay shale. In general, the lithologic succession is as follows:

a) Silt Clay/Silty Clay Loam – Below 12-inches of crushed aggregate, the borings encountered approximately 17 ft. of silty clay and silty clay loam. The driving resistances (N-value) ranged from 1 to 9 blows per foot (bpf), with unconfined compressive strength (Q_u) values of 0.2 to 1.9 tons per square foot (tsf). The moisture content varied from 17 to 26 percent.

b) Sand and Gravel – In boring 1-S, a 7.5 ft. layer of sand and gravel was encountered below the silty clay. N-values ranged from 3 to 20 bpf, with a moisture content of 20 percent. A gradation performed on the samples resulted in 69 percent sand, 13 percent silt, 6 percent clay, and 12 percent gravel.

c) Clay/ Clay Loam – Below the sand and gravel in Boring 1-S and below the silty clay in Boring 2-S, 12 to 15 feet of clay and clay loam soils were encountered. N-values ranged from 2 to 27 bpf, with Q_u's of 0.6 to 2.3 tsf, and moisture contents of 13 to 25.

d) Clay and Wx Clay Shale – Below the clay and clay loam, the borings encountered 2.5 to 4.5 ft. of stiff clay and weathered clay shale, with N-values of 29 to 33 bpf, Q_u's of 2.5 to 4.5 tsf, and moisture contents of 9 to 14 percent.

f) Clay Shale – The borings were terminated at depths of 40 ft. and 49.7 ft., for Borings 1-S and 2-S, respectively, in hard, dry, clay shale. The clay shale had N-values ranging from 100 blows per 2-inches of penetration to 100 blows per 8-inches of penetration. Moisture contents were not obtained on the clay shales.

2.2 Bedrock

Bedrock consisting of clay shale was encountered consistently at elevation El. 379.4 in Boring 1-S and El. 379.4 in Boring 2-S. Each boring terminated in the clay shale at El. 368.4 and El. 378.4, respectively.

2.3 Groundwater

Groundwater was encountered in Boring 1-S at El. 399.9 and in Boring 2-S at El. 397.9. Surface water in the stream was noted at El. 412.1 on the borings.

It should be noted that the groundwater level is subject to seasonal and climatic variations. In addition, without extended periods of observation, measurement of true groundwater levels may not be possible.

3.0 Geotechnical Evaluations

3.1 Bearing Resistance

The soil encountered in the borings at the proposed bottom elevation of the culvert consisted of a stiff, silty clay. The soil characteristics at or below El. 408.0 were used to calculate the bearing resistance of the culvert.

The calculated allowable bearing value for the box culvert was found to be 3,500 psf, using a Bearing Resistance Factor of 0.5 (2014 AASHTO LRFD Bridge Design Specifications, 7th Edition). The applied bearing pressure from the culvert is estimated to be 412 psf.

If during construction, the conditions of the foundation subgrades encountered are not representative of the conditions of the borings, KEG should be contacted.

3.2 Settlement

The subsurface profile generally consisted of stiff cohesive, silty clays, and clays. Due to the proposed grades anticipated, the estimated applied pressures of the soils excavated for installation of the proposed structure weigh more than the weight of the proposed double box culvert, including the wingwalls and are such that settlement is not a concern for this structure.

3.3 Slope Stability

A stability analysis using Slope/W was performed using an assumed wingwall sideslope geometry of 6 feet, 1V:2H and soil characteristics from the borings. Three conditions were modeled: end-of-construction, long-term stability, and a design seismic event using a peak ground acceleration of 0.271g. A critical factor of safety (FOS) was calculated for each condition. According to current standard of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability and 1.0 for the design seismic event. The slope stability indicated that the required minimum FOS for all conditions was met.

In order to model the end-of-construction condition, undrained soil parameters were used with a friction angle of 0 degrees assumed for cohesive soils. Drained soil parameters with assumed friction angles of 26 and 33 degrees were used to model the long-term and seismic conditions to analyze the condition where excess pore water pressure from construction has dissipated. For the cohesive materials, a nominal cohesion value of 50 psf was included in the drained strength parameters.

The Modified Bishop Method, which generates circular-arc failure surfaces, was used to calculate the critical failure surfaces and FOS for the analyzed conditions. The FOS obtained in the analysis is shown in Table 3.1. Slope/W program output from this analysis can be found in Slope/W Slope Stability Analysis, Exhibit E.

Table 3.1 – Slope Stability Critical FOS

Location	End-of-Construction	Long Term	Seismic
East Wingwall Sideslope 6' high (1V:2H)	11.1	1.9	1.1
West Wingwall Sideslope 6' high (1V:2H)	7.9	1.9	1.1

3.4 Seismic Considerations

As per IDOT Bridge Manual v. 2009, Section 2.3.10, seismic data is not required for buried structures, including box culverts.

3.5 Scour

The approximate elevation at the bottom of the culvert inlet (P&P, Exhibit B) is El. 409.25. The design scour elevations for the proposed culvert are approximately 3 ft. below the invert elevations of the culvert. See Table 3.2 below. Per the TS&L, placement of Class A5 stone riprap has been considered on the upstream and downstream ends of the double box culvert to reduce the potential for future scour.

Table 3.2 – Design Scour Elevations

	Upstream	Downstream
Design Scour Elevation (ft.)	406.25 ft.	406.15 ft.

3.6 Mining Activity

According to the Illinois State Geological Survey (ISGS) website, coal mining has occurred in White County. According to the White County, Illinois Coal Mines and Underground Industrial Mines Map, dated September 18, 2013, obtained from the Illinois Geological Survey (ISGS) website (http://www.isgs.illinois.edu/maps-data-pub/coal-maps.shtml), the project site was not undermined.

The listed disclaimer indicates locations of some features on the mine map may be offset by 500 ft. or more due to errors in the original source maps, the compilation process, digitizing, or a combination of these factors. Refer to the Illinois State Geological Survey Mine Map, Exhibit F, for White County, for additional information.

4.0 Foundation Evaluations and Design Recommendations

4.1 Box Culvert

As discussed in Section 3.2 Settlement; the estimated applied pressures of the proposed culvert versus the applied pressures of soils removed to install the new culvert, and the allowable bearing

pressures of the soils supporting the new culvert, are such that settlement is not a concern for this structure. Based on the Culvert Manual, horizontal cantilever wingwalls shall be used, if length of the wingwalls are equal to or less than 14 feet. Based on the geometry of the box culvert and the proposed slopes, horizontal cantilever wingwalls appear suitable for the proposed culvert. In addition, a pre-cast box culvert alternative is applicable, however, based on the TS&L, we understand that such an alternate is not allowed with this replacement.

5.0 Construction Considerations

5.1 Construction Activities

Construction activities should be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction and any pertinent Special Provisions or Policies.

Should any design considerations assumed by KEG change, KEG should be contacted to determine if the recommendations still apply.

5.2 Temporary Sheeting and Soil Retention

To accommodate stage construction, shoring will be required. The native soils indicate adequate unconfined compressive strength and densities to approximate El. 383. If the retained height is less than 15 ft. and temporary shoring depths extend to, or are less than, the elevation noted above, IDOT Temporary Sheet Piling design charts should be feasible at this location. Temporary shoring using driving methods, may refuse as the tip elevations approach the hard, dry clay shales at or below El. 379.4.

5.3 Site and Soil Conditions

Provisions of the Standard Specifications should adequately address site and soil conditions.

6.0 Computations

Computations and analyses for special circumstances, if any, are included as exhibits. Please refer to each section of the report for reference to the exhibit containing any such calculations or analysis used.

7.0 Geotechnical Data

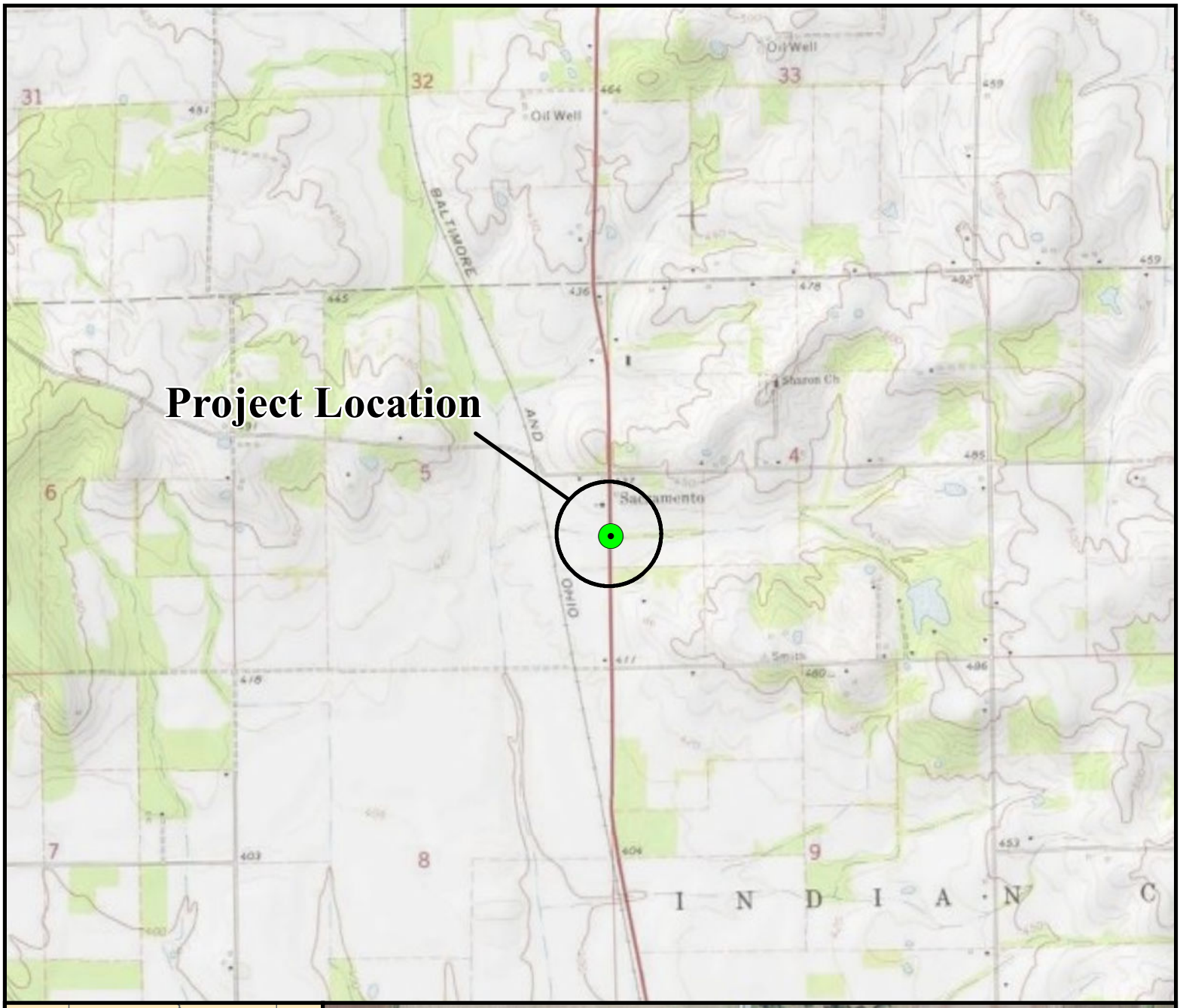
The soil boring logs can be found in Exhibit C. The Subsurface Profile can be found in Exhibit D.

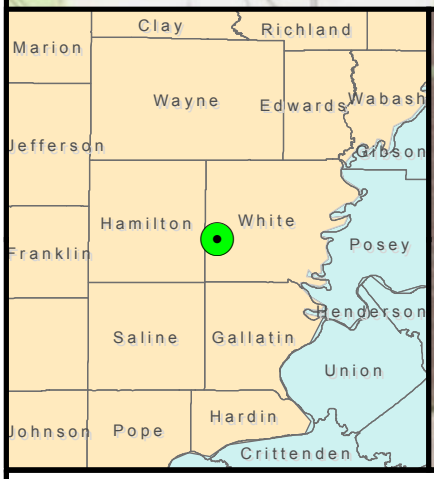
8.0 Limitations

The recommendations provided herein are for the exclusive use of Hampton, Lenzini, and Renwick, Inc. and the Illinois Department of Transportation. They are specific only to the project described and are based on the subsurface information obtained at two boring locations within the structure area, performed by IDOT in 2013, KEG's understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. KEG should be contacted if conditions encountered during construction are not consistent with those described.

EXHIBIT A

USGS TOPOGRAPHIC LOCATION MAP





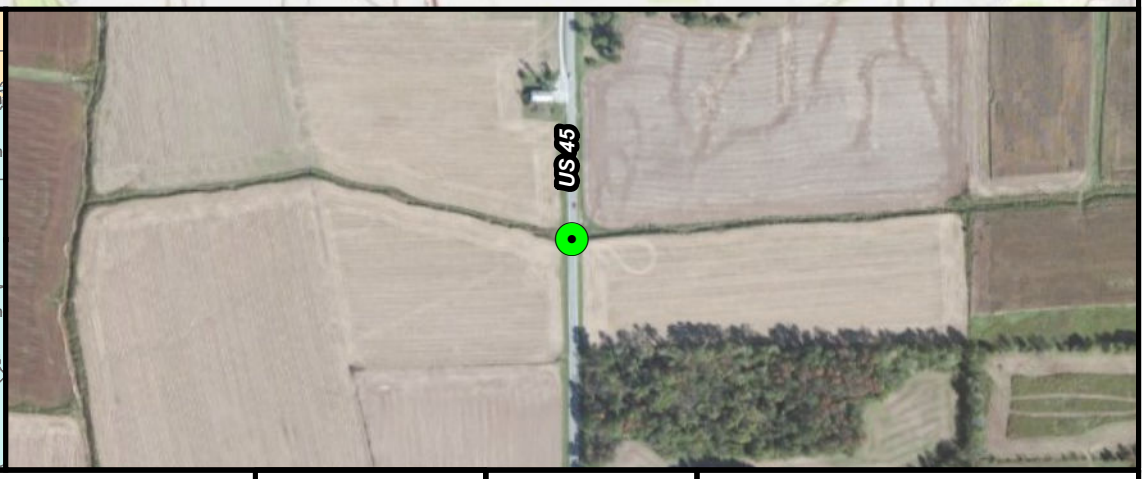


Exhibit A
Location Map
US 45 over Unnamed Stream
White County, Illinois

N

Designed By: MDM
Drawn By: MMJ
Checked By: MDM
Date: 7/23/14
Project #: 08-0060.06

Kaskaskia Engineering Group, LLC

EXHIBIT B

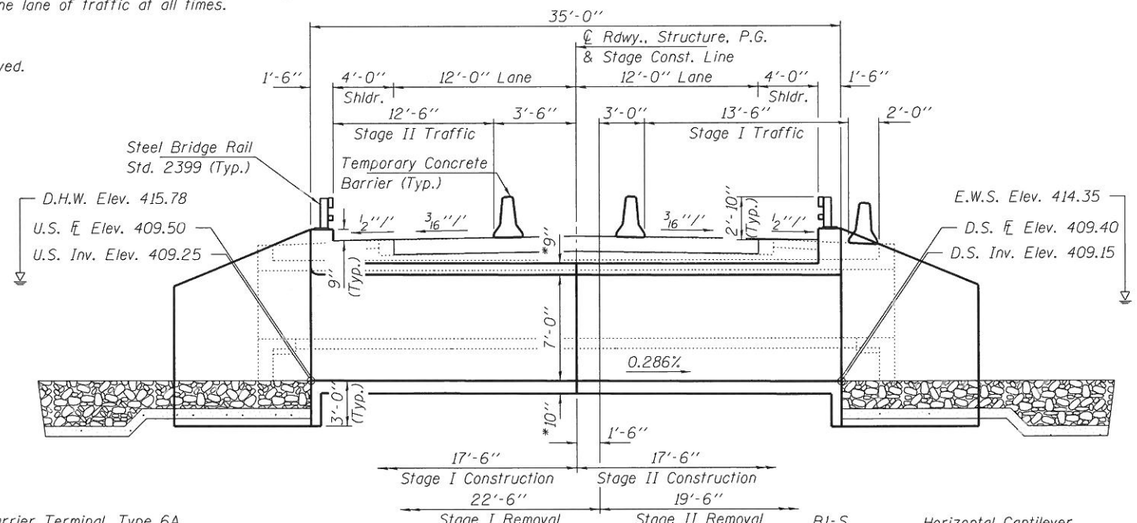
TS&L and P&P SHEETS

BENCHMARK: BM#40 - Spike in power pole 40' Lt., Sta. 195+23, Elev. 416.909.

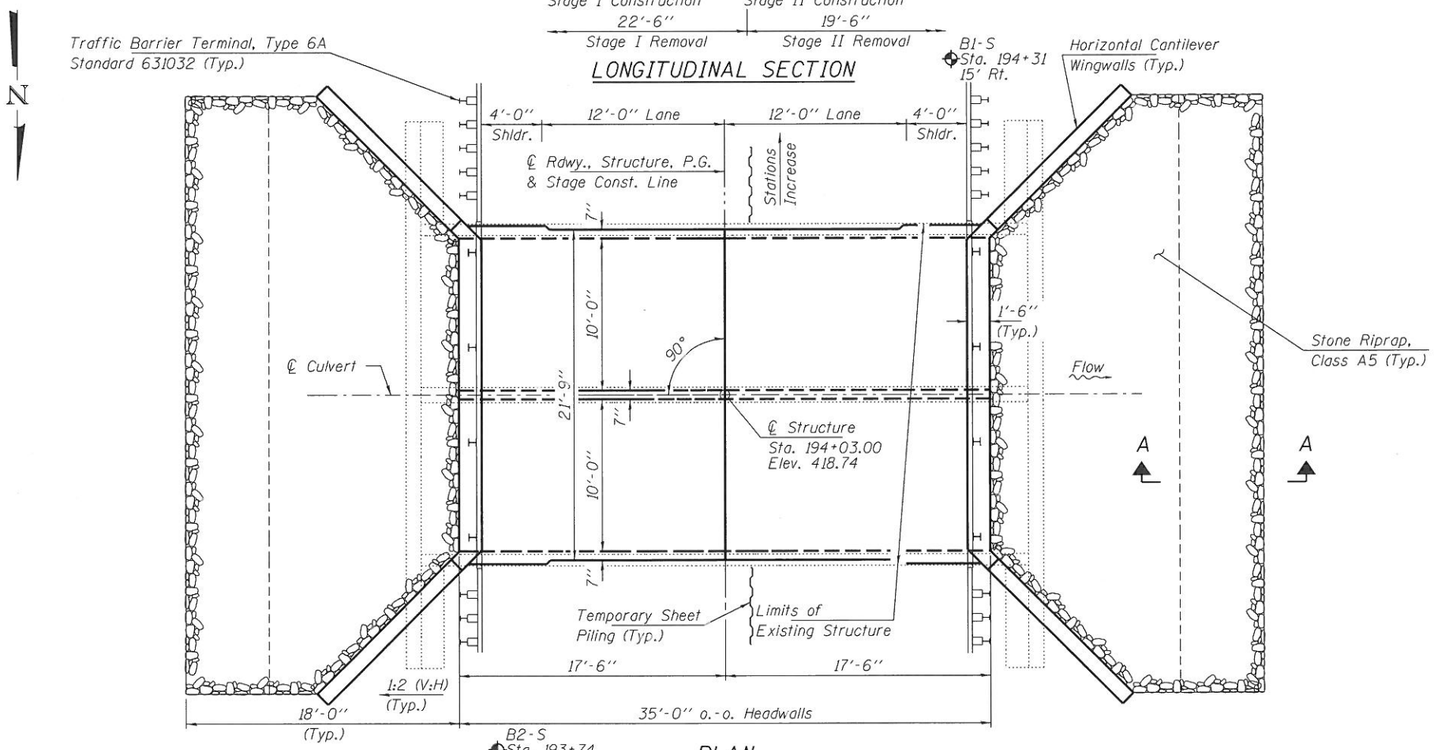
EXISTING STRUCTURE: SN 097-2007 was built in 1927 as SBI Route 140 Section 109. The structure is a double barrel 10'x4.5' box culvert 22.5' bk.-bk. sidewalls and 42.0' o.-o. length. The culvert is to be removed and replaced using staged construction to maintain one lane of traffic at all times.

Salvage: None

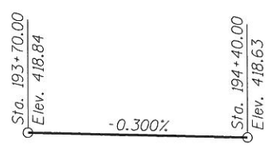
Precast alternate not allowed.



LONGITUDINAL SECTION

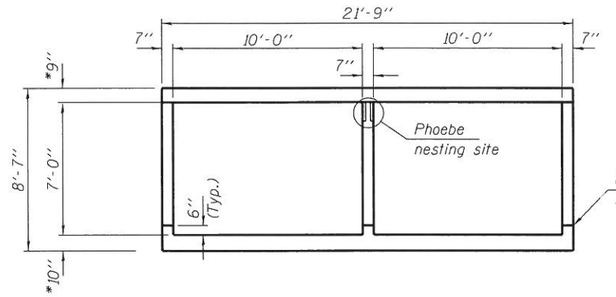


PLAN



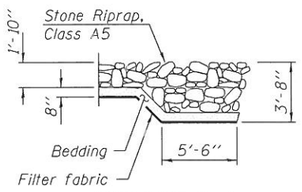
PROFILE GRADE

(along ℄ roadway)

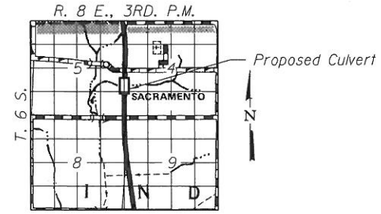


SECTION THRU BARREL

*Slab thickness may be refined in final design.



SECTION A-A



LOCATION SKETCH

WATERWAY INFORMATION

Drainage Area = 0.8 Sq. Mi.

Existing Low Grade Elev. 416.4 @ Sta. 200+00
Proposed Low Grade Elev. 416.4 @ Sta. 200+00

Flood		Freq. Yr.	Q (C.F.S.) Exist.	Q (C.F.S.) Prop.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Natural H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	Main Channel	10	442	486	65	100					
	Relief Struct.		137	93	20	20					
	Total		579	579	85	120	415.25	0.84	0.00	416.09	415.25
Existing Over-topping	Main Channel	25	542	669	70						
	Relief Struct.		253	126	20	20					
	Total		795	795	90	20	415.61	1.10	0.33	416.71	415.94
Design	Main Channel	50	574	774	75	110					
	Relief Struct.		405	205	20	20					
	Total		979	979	95	130	415.78	1.14	0.80	416.92	416.58
Base	Main Channel	100	602	814	80	115					
	Relief Struct.		558	346	20	20					
	Total		1160	1160	100	135	416.00	1.05	0.76	417.05	416.76

DESIGN SPECIFICATIONS

2012 AASHTO LRFD Bridge Design Specifications with 2103 interims.

LOADING HL-93

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

DESIGN STRESSES

f'c = 3,500 psi
fy = 60,000 psi (Reinf.)

HIGHWAY CLASSIFICATION

FAP Route 328 - US 45
Functional Class: other principal arterial
ADT: 1600 (2011) / 1603 (2032)
ADTT: 240 / 240 (15%)
DHV: 120 (2032)
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.
Directional Distribution: 50% / 50%

DESIGN SCOUR ELEVATION TABLE

Design Scour Elevation (ft.)	Upstream	Downstream
	406.25	406.15

GENERAL PLAN
US ROUTE 45
OVER UNNAMED STREAM
FAP ROUTE 328 - SECTION 109B-1
WHITE COUNTY
STATION 194+03.00
STRUCTURE NUMBER 097-2015

FILE NAME = 0972007-sht-culvert.dgn	USER NAME =	DESIGNED - M.D.C.	REVISED -
HAMPTON, LENZINI AND RENWICK, INC. 3065 STEVENSON DRIVE, SUITE 201 SPRINGFIELD, ILLINOIS 62703 ILLINOIS PROFESSIONAL DESIGN FIRM LS / PE / SE (CORP. 184.000793)		CHECKED - T.J.A.	REVISED -
	PLOT SCALE =	DRAWN - D.A.B.	REVISED -
	PLOT DATE = 7/10/2014	CHECKED - S.M.S.	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN
STRUCTURE NO. 097-2015
SHEET NO. 1 OF 1 SHEETS

FAP	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
328	109B-1	WHITE		
		CONTRACT NO. 78163		
	ILLINOIS FED. AID PROJECT			

PLAN
SURVEYED
PLOTTED
ALIGNMENT CHECKED
RT. OF WAY CHECKED
CADD FILE NAME
NOTE BOOK
NO.
DATE
BY

STATION 194+03
DOUBLE 10' SPAN x 7' RISE
REINFORCED CONCRETE BOX CULVERT
LENGTH = 35'; SKEW = 0°

+59 F.E.
EXISTING R.O.W. LINE
CROPLAND
CONSTRUCTION LIMITS
℄ PROPOSED IMPROVEMENT
90°
40' R.O.W.
40' EXIST. R.O.W.
191 F.A.P. 328 / U.S. 45 192 193 194 195+00 196
12'
12'
4'
4'
DOUBLE BOX CULVERT
+98 F.E.
EXISTING R.O.W. LINE
CROPLAND
IMPROVEMENT BEGINS
STATION 193+70
IMPROVEMENT ENDS
STATION 194+40
CONSTRUCTION LIMITS
BM#40

0 20' 40'
GRAPHIC SCALE

EXISTING STRUCTURE NO. 097-2007
STATION 194+03
DOUBLE 10' SPAN x 4.5' RISE
REINFORCED CONCRETE BOX CULVERT
LENGTH = 42'; SKEW = 0°

PROFILE
SURVEYED
PLOTTED
ALIGNMENT CHECKED
BM. NOTED
STRUCTURE NOTATNS CHKD
NOTE BOOK
NO.
DATE
BY

BM#40 - R.R. SPIKE IN POWER POLE
40' LT., STA. 195+23
ELEV. 416.909

440 435 430 425 420 415 410 405 400

V.P.I. STA. 193+70.00
ELEV. 418.84
V.P.I. STA. 194+40.00
ELEV. 418.63
PCC PAVEMENT 10"
PROPOSED ℄ GRADE
100 YEAR H.W. ELEV. 416.00
50 YEAR H.W. ELEV. 415.78
-0.300%
EXISTING ℄ GRADE
1V:2H
1V:2H
EXIST. ℄ ELEV. 412.0
PROP. U.S.F.L. 409.5
PROP. D.S.F.L. 409.4

420.04 419.83 419.61 419.34 419.14 418.95 418.72 418.75 418.62 418.49 418.27 418.06 417.87

191+00 191+50 192+00 192+50 193+00 193+50 194+00 194+50 195+00 195+50 196+00 196+50

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HAMPTON, LENZINI AND RENWICK, INC.		DRAWN - T.W.K.	REVISED -
3085 STEVENSON DRIVE, SUITE 201 SPRINGFIELD, ILLINOIS 62703	PLOT SCALE = #SCALE#	CHECKED - M.D.C.	REVISED -
ILLINOIS PROFESSIONAL DESIGN FIRM LS / PE / SE CORP. 184.000659	PLOT DATE = 7/9/2014	DATE - 10/18/11	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

PLAN & PROFILE
U.S. 45

SCALE: | SHEET NO. 2 OF 3 SHEETS | STA. | TO STA.

F.A.P.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
328	109B-1	WHITE		
		CONTRACT NO.		
	ILLINOIS FED. AID PROJECT			

EXHIBIT C

BORING LOGS

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAP 328 (US 45) Over stream

Route: FAP 328 (US 45) Structure Number: 097-2007 Date: 10/22/2013

Section 109 Bored By: R Moberly

County: White Location: Sacramento Checked By: R Graeff

Boring No 1-S
Station 194+31
Offset 15' Rt CL
Ground Surface 418.4 Ft

Surf Wat Elev: 412.1
Ground Water Elevation
when Drilling 399.9
At Completion
At: Hrs:

	DEPTH	BLOW	Qu tsf	W%
Crushed aggregate				
417.4				
Medium, moist, brown, Silty Clay Loam A-6		2		
		3	0.9S	17
		4		
413.9				
Very soft, very moist, brown, Silty Clay Loam A-6	5.0	1		
		1	0.2B	25
		WH		
411.4				
Stiff, moist, grey mottled brown, Silt Loam to Silty Clay Loam A-4		1		
		4	1.3S	17
		4		
408.9				
Stiff, moist, brown mottled grey, Silty Clay A-6	10.0	1		
		3	1.1B	24
		4		
		2		
		4	1.6B	21
		5		
	15.0	1		
		3	1.2B	26
		4		
401.4				
Medium dense, very moist, brown, Sand and gravel with clay binder A-4		3		
		9		
		11		
398.9				
Very loose to Medium dense, wet, brown, Sand with some gravel and clay	20.0	2		
		5		20
		6		
69% Sand				
13% Silt				
6% Clay		WH		
12% Gravel		1		
		2		
393.9				
	25.0	WH		

	DEPTH	BLOW	Qu tsf	W%
Medium, very moist, brown, Silty Clay A-6		1	0.6B	25
		1		
391.4				
Medium to stiff, very moist, grey, Clay A7-6		WH		
		1	0.7B	17
		1		
	30.0	1		
		2	1.0B	16
		3		
383.9				
		1		
		3	1.2B	16
		3		
Stiff, moist, grey, Clay Loam A7-6	35.0	3		
		12	1.9S	13
		15		
381.9				
Very stiff, moist, grey, Clay A7-6 to weathered Clay Shale		4		
		13	2.5S	14
		16		
379.4				
Hard, dry, grey, Clay Shale				
	40.0	100/8"		
Bottom of hole = 49.7 feet				
Free water observed at 18.5 feet				
Elevation referenced to TBM at pp SW; Elev.= 416.9 feet				
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)	45.0	100/4"		
To convert "N" values to "N60" multiply by 1.25				
Hard, dry, grey, Clay Shale				
368.4	50.0	100/2"		

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

FAP 328 (US 45) Over stream

Sheet 1 of 1

Route: FAP 328 (US 45) Structure Number: 097-2007 Date: 10/22/2013

Section 109 Bored By: R Moberly

County: White Location: Sacramento Checked By: R Graeff

Boring No 2-S
Station 193+74
Offset 15' Lt CL
Ground Surface 418.4 Ft

Surf Wat Elev: 412.1
Ground Water Elevation
when Drilling 397.9
At Completion
At: Hrs:

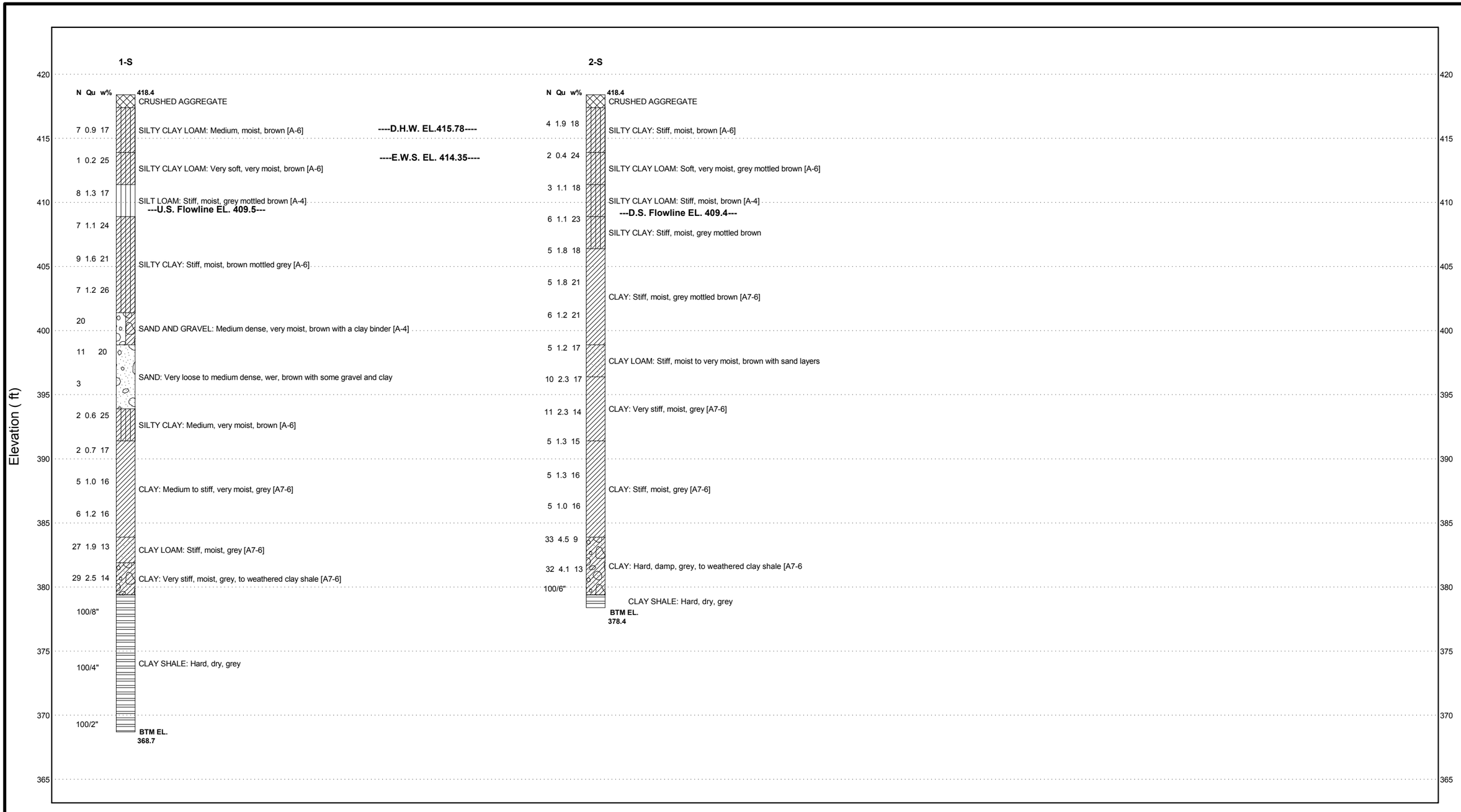
	DEPTH	BLOW	Qu tsf	W%
Crushed aggregate				
417.4				
Stiff, moist, brown, Silty Clay to Clay A-6		1		
		2	1.9B	18
		2		
413.9				
Soft, very moist, grey mottled brown, Silty Clay Loam A-6	5.0	1		
		1	0.4B	24
		1		
411.4				
Stiff, moist, brown, Silty Clay Loam A-4		WH		
		1	1.1S	18
		2		
408.9				
Stiff, moist, grey mottled brown, Silty Clay A-6	10.0	1		
		3	1.1B	23
		3		
406.4				
Stiff, moist, grey mottled brown, Clay to Silty Clay A7-6		1		
		2	1.8B	18
		3		
	15.0	2		
		2	1.8B	21
		3		
		1		
		3	1.2B	21
		3		
398.9				
Stiff, moist to very moist, brown, Clay Loam A-6 w/ sand layers	20.0	1		
		2	1.2S	17
		3		
396.4				
Very stiff, moist, grey, Clay to Clay Loam A7-6		2		
		4	2.3B	17
		6		
	25.0	1		

	DEPTH	BLOW	Qu tsf	W%
Very stiff, moist, grey, Clay to Clay Loam A7-6		5	2.3B	14
		6		
391.4				
Stiff, moist, grey, Clay A7-6		1		
		2	1.3B	15
		3		
	30.0	1		
		2	1.3B	16
		3		
		1		
		2	1.0B	16
		3		
383.9				
Hard, damp, grey, Clay A7-6 to weathered Clay Shale	35.0	4		
		15	4.5S	9
		18		
		4		
		12	4.1S	13
		20		
379.4				
Hard, dry, grey, Clay Shale				
378.4	40.0	100/6"		
Bottom of hole = 40.0 feet				
Free water observed at 20.5 feet				
Elevation referenced to TBM at pp SW; Elev.= 416.9 feet	45.0			
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
To convert "N" values to "N60" multiply by 1.25	50.0			

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)

EXHIBIT D

SUBSURFACE PROFILE



Kaskaskia Engineering Group, LLC

SUBSURFACE PROFILE:US 45 Over Unnamed Stream

Route: FAP 328
Section: 109B-1
County: White

PRINTERMOD2 11X17 FAP 328 (US 45) OVER STREAM.GPJ IL_DOT.GDT 7/22/14

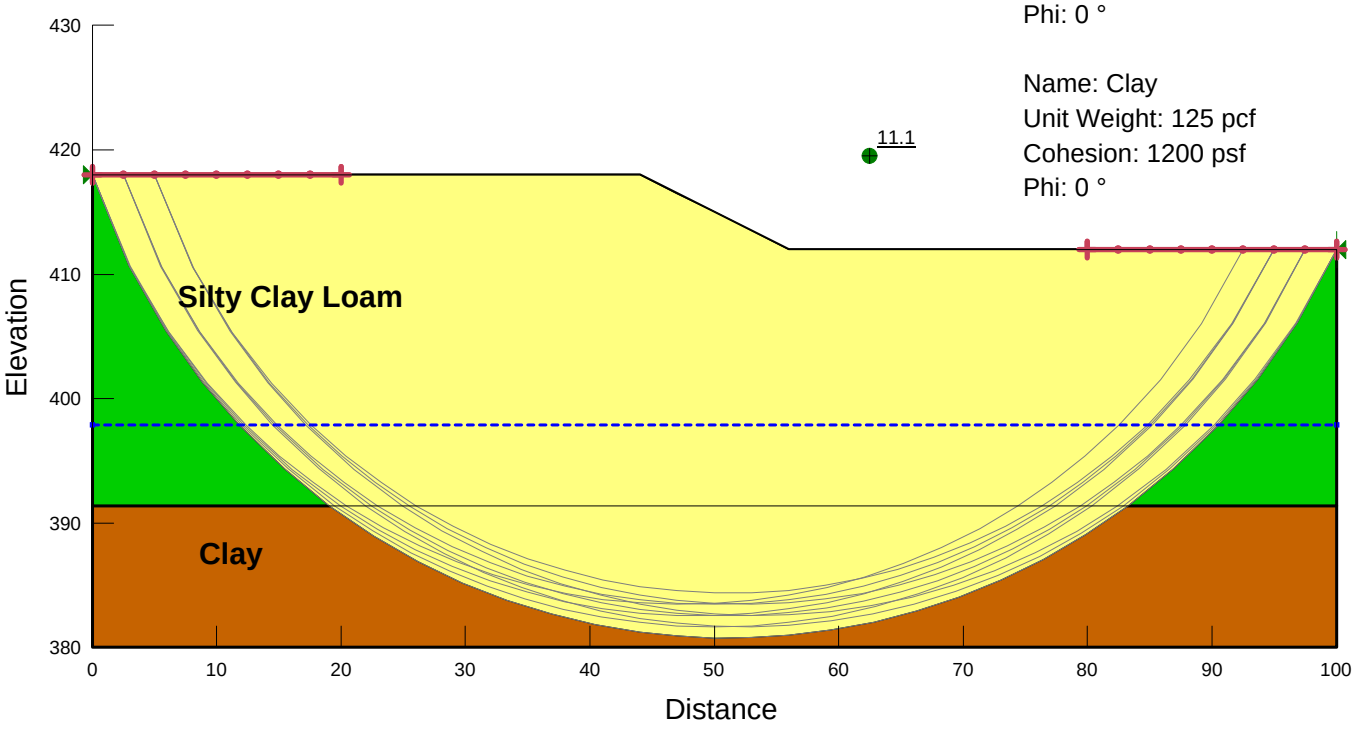
EXHIBIT E

SLOPE/W SLOPE STABILITY ANALYSIS

US Route 45 over Unnamed Stream
FAP Route 328 - Section 109B -1
East Side Slope
End of Construction Analysis

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion: 1700 psf
Phi: 0 °

Name: Clay
Unit Weight: 125 pcf
Cohesion: 1200 psf
Phi: 0 °



SLOPE/W Analysis

US Route 45 over Unnamed Stream – FAP Route 328 – Section 109B-1

East Side Slope: End of Construction (Undrained) Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Silty Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 1700 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 1200 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (0, 418) ft
Left-Zone Right Coordinate: (20, 418) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (80, 412) ft
Right-Zone Right Coordinate: (100, 412) ft
Right-Zone Increment: 8
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (0, 418) ft
Right Coordinate: (100, 412) ft

Piezometric Lines

Piezometric Line 1

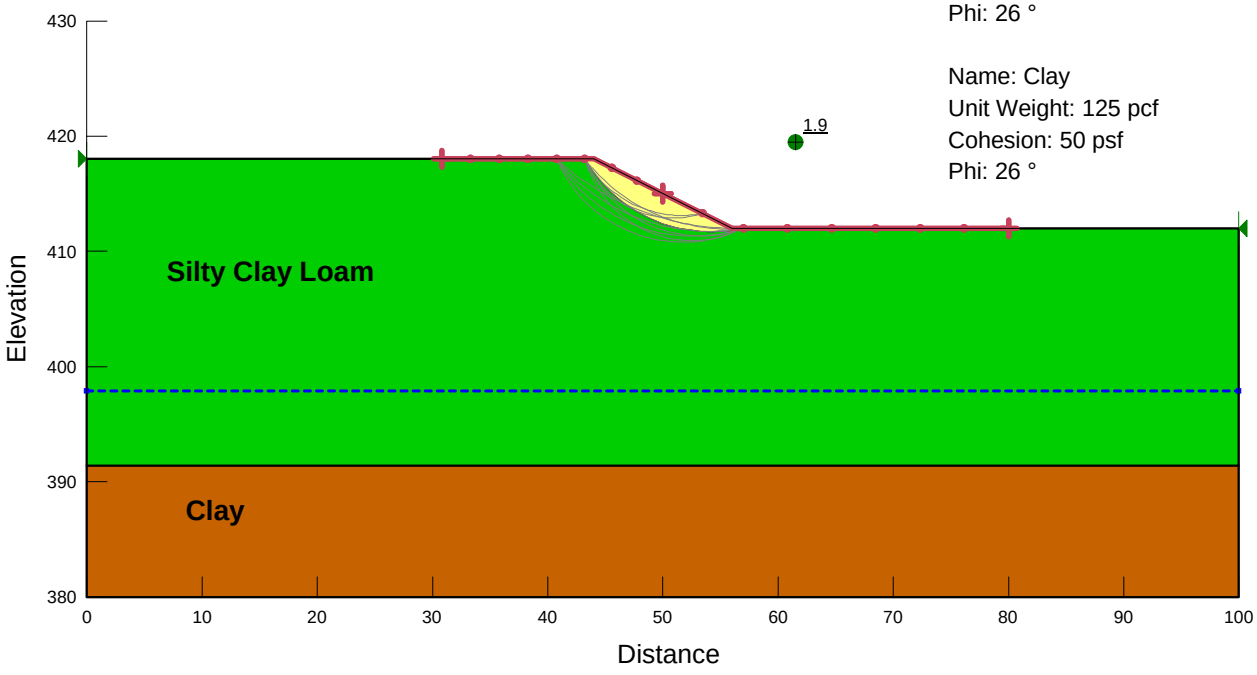
Coordinates

	X (ft)	Y (ft)
	0	397.9
	100	397.9

US Route 45 over Unnamed Stream
FAP Route 328 - Section 109B -1
East Side Slope
Long Term Analysis

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °

Name: Clay
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °



SLOPE/W Analysis

US Route 45 over Unnamed Stream – FAP Route 328 – Section 109B-1

East Side Slope: Long Term Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Silty Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (30.80545, 418) ft
Left-Zone Right Coordinate: (50, 415) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (50, 415) ft
Right-Zone Right Coordinate: (80, 412) ft
Right-Zone Increment: 8
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (0, 418) ft
Right Coordinate: (100, 412) ft

Piezometric Lines

Piezometric Line 1

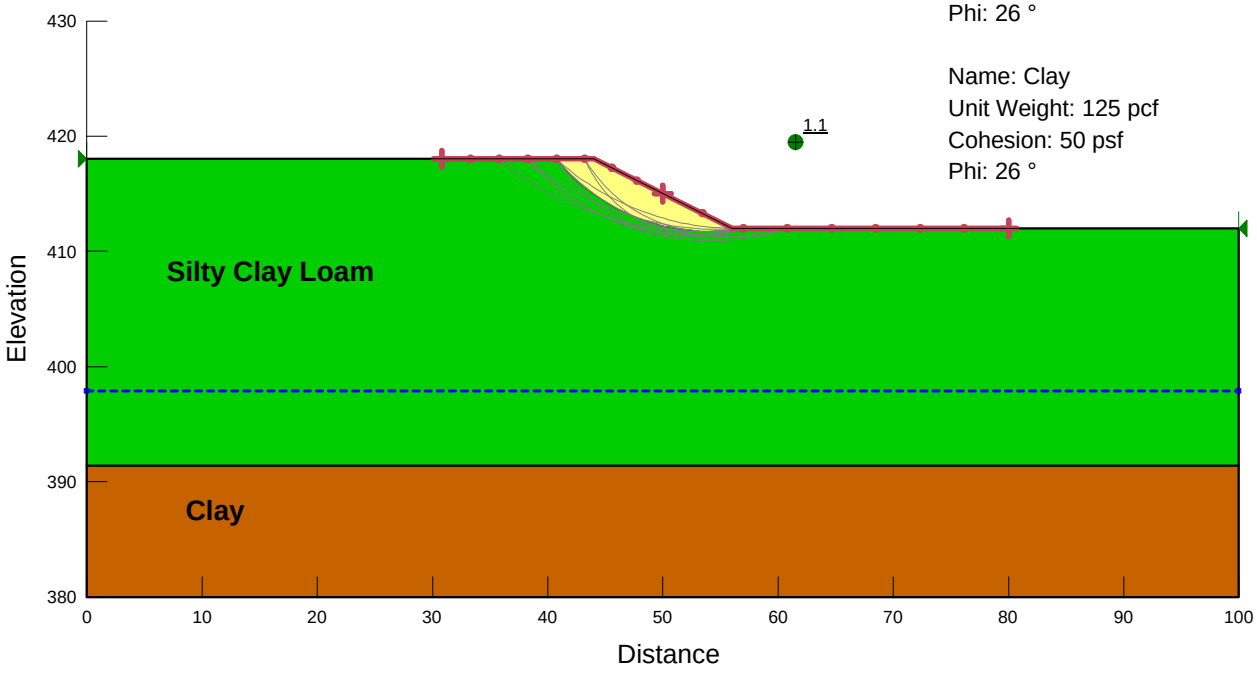
Coordinates

	X (ft)	Y (ft)
	0	397.9
	100	397.9

US Route 45 over Unnamed Stream
FAP Route 328 - Section 109B -1
East Side Slope
Seismic Analysis
PGA = 0.271 g

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °

Name: Clay
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °



SLOPE/W Analysis

US Route 45 over Unnamed Stream – FAP Route 328 – Section 109B-1

East Side Slope: Seismic Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Silty Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (30.80545, 418) ft
Left-Zone Right Coordinate: (50, 415) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (50, 415) ft
Right-Zone Right Coordinate: (80, 412) ft
Right-Zone Increment: 8
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (0, 418) ft
Right Coordinate: (100, 412) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	397.9
	100	397.9

Seismic Loads

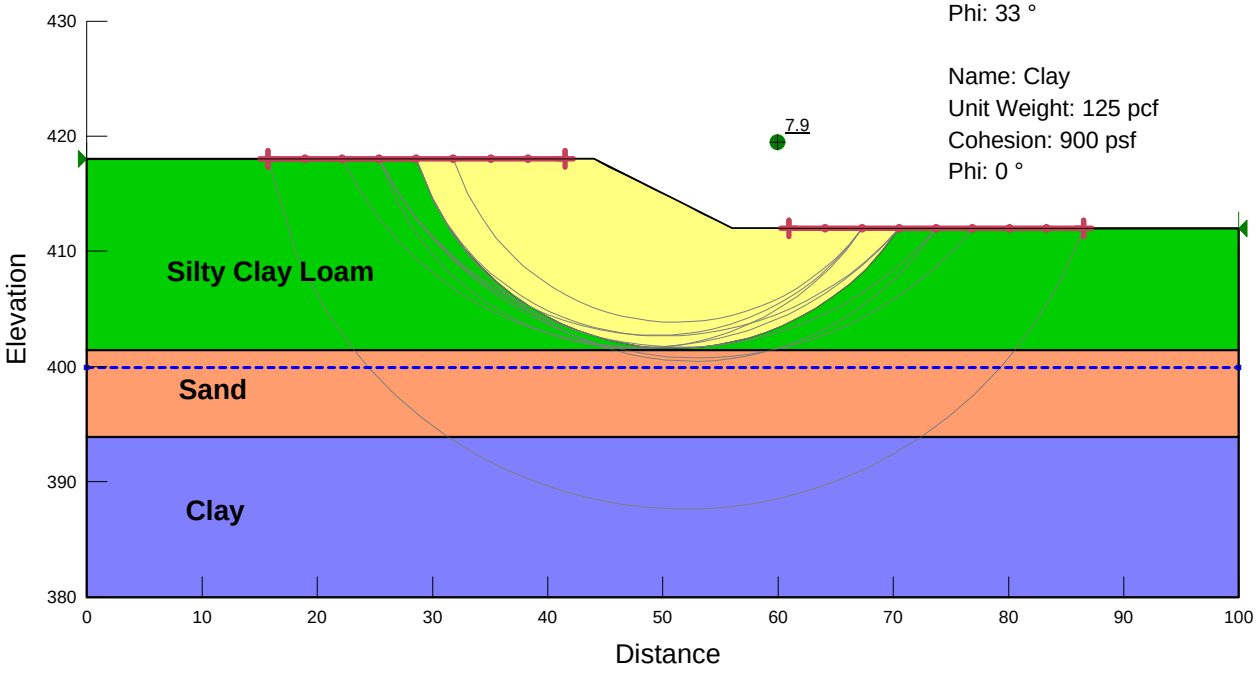
Horz Seismic Load: 0.271
Ignore seismic load in strength: No

US Route 45 over Unnamed Stream
FAP Route 328 - Section 109B -1
West Side Slope
End of Construction Analysis

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion: 1000 psf
Phi: 0 °

Name: Sand
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 33 °

Name: Clay
Unit Weight: 125 pcf
Cohesion: 900 psf
Phi: 0 °



SLOPE/W Analysis

US Route 45 over Unnamed Stream – FAP Route 328 – Section 109B-1

West Side Slope: End of Construction (Undrained) Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Silty Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 1000 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 900 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (15.7, 418) ft
Left-Zone Right Coordinate: (41.5, 418) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (60.9, 412) ft
Right-Zone Right Coordinate: (86.5, 412) ft
Right-Zone Increment: 8
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (0, 418) ft
Right Coordinate: (100, 412) ft

Piezometric Lines

Piezometric Line 1

Coordinates

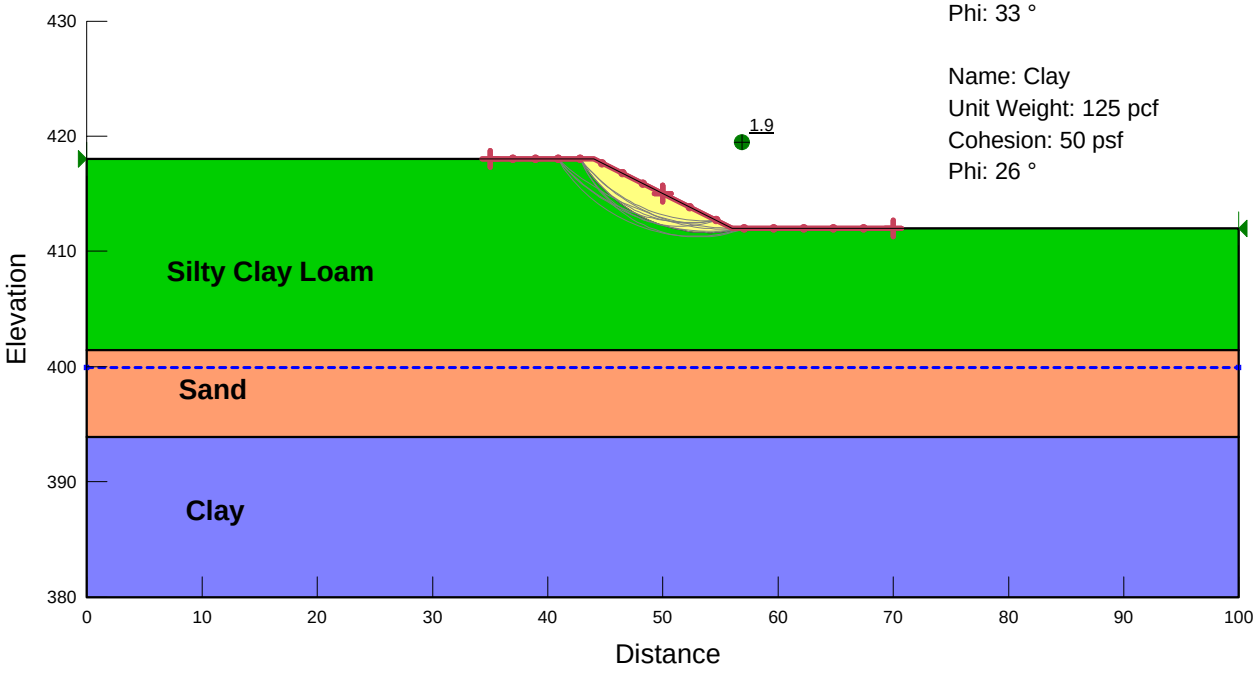
	X (ft)	Y (ft)
	0	399.9
	100	399.9

US Route 45 over Unnamed Stream
FAP Route 328 - Section 109B -1
West Side Slope
Long Term Analysis

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °

Name: Sand
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 33 °

Name: Clay
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °



SLOPE/W Analysis

US Route 45 over Unnamed Stream – FAP Route 328 – Section 109B-1

West Side Slope: Long Term Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Silty Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (35, 418) ft
Left-Zone Right Coordinate: (50, 415) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (50, 415) ft
Right-Zone Right Coordinate: (70, 412) ft
Right-Zone Increment: 8
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (0, 418) ft
Right Coordinate: (100, 412) ft

Piezometric Lines

Piezometric Line 1

Coordinates

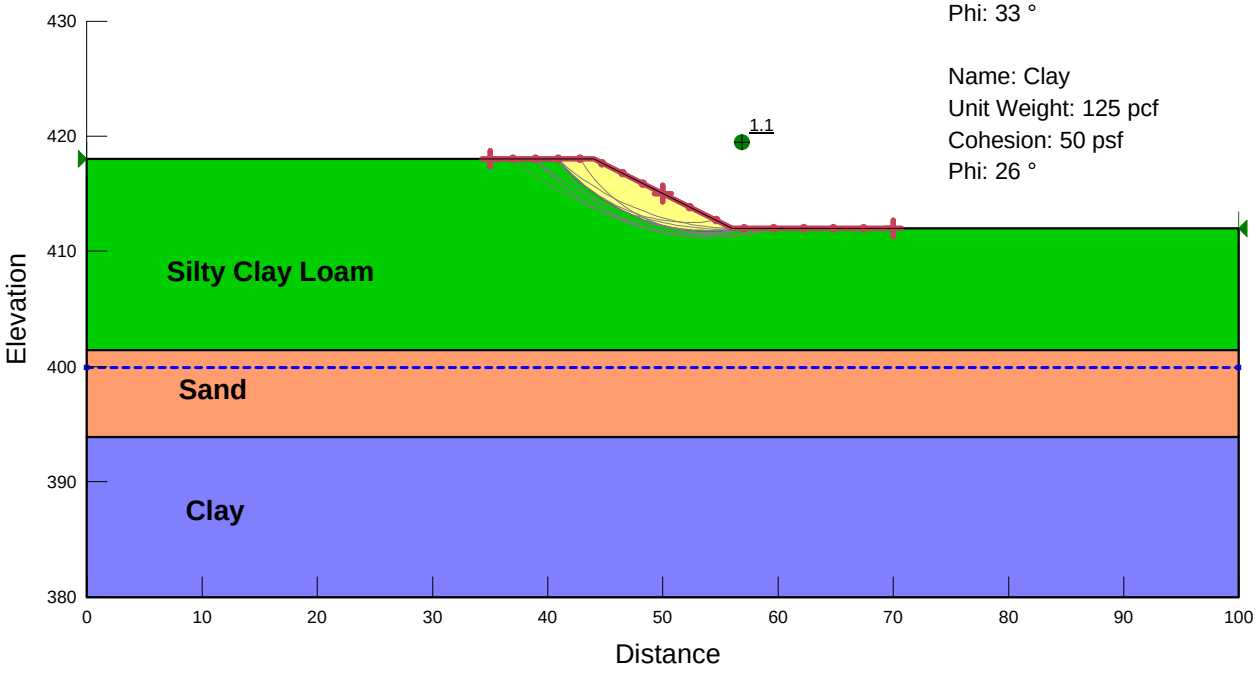
	X (ft)	Y (ft)
	0	399.9
	100	399.9

US Route 45 over Unnamed Stream
FAP Route 328 - Section 109B -1
West Side Slope
Seismic Analysis
PGA = 0.271 g

Name: Silty Clay Loam
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °

Name: Sand
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 33 °

Name: Clay
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °



SLOPE/W Analysis

US Route 45 over Unnamed Stream – FAP Route 328 – Section 109B-1

West Side Slope: Seismic Analysis

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W Analysis

Kind: SLOPE/W
Method: Bishop, Ordinary and Janbu
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No

FOS Distribution
- FOS Calculation Option: Constant

Advanced
- Number of Slices: 30
- Optimization Tolerance: 0.01
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2000
- Optimization Convergence Tolerance: 1e-007

Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Silty Clay Loam

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sand

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 33 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Clay

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion: 50 psf
Phi: 26 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (35, 418) ft
Left-Zone Right Coordinate: (50, 415) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (50, 415) ft
Right-Zone Right Coordinate: (70, 412) ft
Right-Zone Increment: 8
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (0, 418) ft
Right Coordinate: (100, 412) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	0	399.9
	100	399.9

Seismic Loads

Horz Seismic Load: 0.271
Ignore seismic load in strength: No

EXHIBIT F

ISGS MINE MAP

ILLINOIS STATE GEOLOGICAL SURVEY

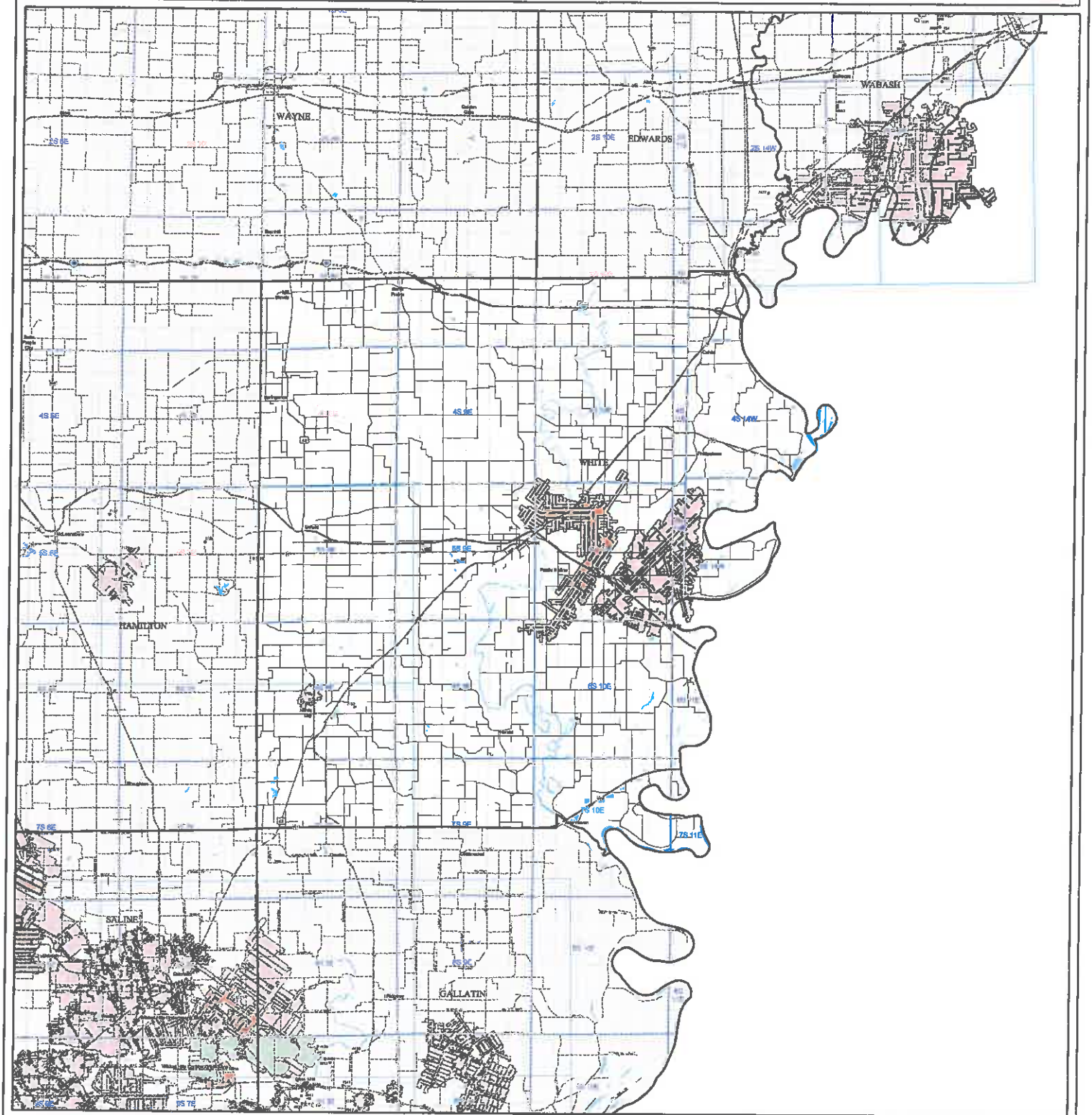
ILLINOIS

For further information contact:
Prairie Research Institute
Illinois State Geological Survey
University of Illinois at Urbana-Champaign
615 East Peabody Drive
Champaign, Illinois 61820-6964
(217) 333-4747
http://www.isgs.illinois.edu

Coal Mines and Underground Industrial Mines
WHITE
County

County Coal Map Series
ISGS Coal Section
Map construction: September 16, 2013

County coal maps and select quadrangle maps available as downloadable PDF files at:
http://www.isgs.illinois.edu/



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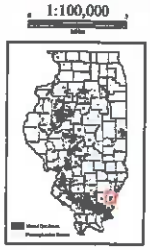

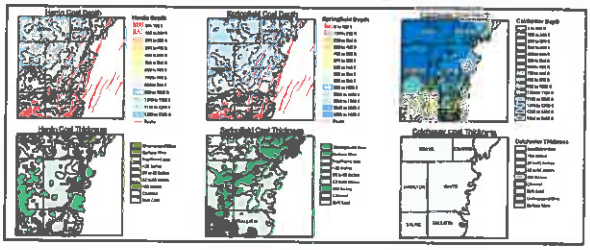

- County
- Township
- Section
- Quadrangle study (Available on Website)
- Lake or river
- Coal mine - active
- Underground coal mine - abandoned
- Surface coal mine - abandoned
- Indefinite underground coal mine boundary - abandoned
- Underground industrial mine and surrounding buffer region
- .481 Coal mine index number (polygon label, point label)
- Opening type unknown
- Uncertain location
- Active surface opple
- Abandoned surface opple
- Active shaft
- Abandoned shaft
- Active slope
- Abandoned slope
- Active drift
- Abandoned drift
- Underground industrial mine entrance or general location

Map Explanation

This map accompanies the coal mines directory for this county. Please consult the directory for an explanation of the coal mine information shown on this map. Buffer regions for industrial mineral mines were incorporated into this map due to limited information regarding these mines. The size of the buffer region is dependent on the uncertainty or inaccuracy of the mine location. For more information regarding industrial mineral mines please contact the ISGS Industrial Minerals Section.

The maps and digital files used for this study were compiled from data obtained from a variety of public and private sources and have varying degrees of completeness and accuracy. They present reasonable interpretations of the geology of the area and are based on available data. These data were compiled and digitized at a scale of 1:62,500. Locations of some features may be offset by 500 feet or more due to errors in the original source maps, the compilation process, digitizing, or a combination of these factors.

These data are not intended for use in site-specific screening or decision-making. Data included in this map are suitable for use at a scale of 1:100,000.

Disclaimer