STRUCTURE
GEOTECHNICAL REPORT

Proposed SN 041-0114

Existing SN 041-0020

IL Route 15 over Elk Horn Creek
FAP Route 821
Section 12B-2
Jefferson County

PTB 157 - Item 46
Contract No. 78458
Job No. D-99-018-15

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OF
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Michael T. Haley 9-10-18

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Project Description and Scope

This project involves the complete replacement of an existing bridge carrying Illinois Route 15 over Elk Horn Creek in Jefferson County. The project site is located in Section 35, Range 1E, Township 2S, in the 3rd Principal Meridian, about 4.4 miles east of the Washington County line. A *Location Map* is presented in Exhibit A.

The existing bridge at this location, SN 041-0020, was constructed in 1921 and reconstructed in 1970. It is a two span structure with precast channel beams supported on a hammerhead pier and closed abutments. The existing pier is founded on untreated timber piles while the abutments utilize spread footing foundations. Riprap was placed at the substructure to repair scour. The bridge measures 44'-0" back to back abutments and 33'-6" between the railings, with no skew.

Per the preliminary Type, Size & Location Plan (TSL), the proposed structure is a single span bridge with W33 rolled steel beams supported on integral abutments. The proposed structure will have a back-to-back abutment length of 66'-8", out-to-out width of 39'-2" and no skew. The roadway will be on a horizontal tangent alignment and on a vertically tangent section of roadway between two sag vertical curves. The proposed center of bridge will be constructed approximately 14 feet to the west of the existing center of bridge. The west abutment will be constructed on existing embankment with the profile raised by over two feet. The east abutment will be constructed in the existing channel on approximately two feet of fill beneath the proposed cap. The new abutment foundations will be located to avoid conflict with the existing foundations. Traffic will be maintained utilizing stage construction. The new structure is to be designed following LRFD Bridge Design Specifications.

See *Preliminary TSL* attached in Exhibit B for further information about the proposed structures.

Field Exploration

Subsurface Exploration and Testing

The site is located in a rural area west of Mt. Vernon with wooded areas located on both sides of the roadway. The structure crosses over Elk Horn Creek, which has a channel approximately 22 feet wide. Overhead power lines are running along IL Route 15 on the north side of the structure.

The subsurface investigation consisted of two borings (1-S and 2-S) drilled by IDOT District 9 personnel in May of 2015. 1-S was drilled near the proposed west abutment along the edge of the eastbound lane; 2-S was drilled east of the existing east abutment along the edge of the westbound lane. Boring locations can be found in Exhibit B.

Beginning at the ground surface, standard penetration tests (SPT) were conducted every 2.5 feet according to AASHTO T 206, using a Hollow Stem Auger. Borings 1-S and 2-S were terminated in hard clay shale at depths ranging from 63 to 70 feet.

Subsurface Conditions

While drilling, groundwater was encountered at an elevation between 431.2 and 435.7 with surface water elevation in Elk Horn Creek at 442.2.

Boring 1-S: Starting at ground surface, the boring data depicts medium brown silty clay to an elevation of 445.7, with a Q_u value of 0.8 tsf, an SPT (N) value of 3 blows per foot, and a moisture content of 22%. Soft brown silty clay loam is present down to elevation 440.7, with Q_u values from 0.3 to 0.4 tsf, SPT (N) values ranging from 1 to 2 blows per foot, and moisture contents ranging between 20% and 24%. Medium brown mottled gray clay is present down to elevation 435.7, with Q_u values of 0.7 tsf, SPT (N) values ranging from 1 to 3 blows per foot, and moisture contents ranging between 23% and 24%. Very loose sandy gravel with clay is present down to elevation 433.2, with a Q_u value of 0.4 tsf, an SPT (N) value of 3 blows per foot, and a moisture content of 16%. Soft brown mottled grey silty clay loam is present down to elevation 430.7, with a Q_u value of 0.4tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 23%. Loose sand with gravel and some clay is present down to elevation 428.2, an SPT (N) value of 6 blows per foot, and a moisture content of 19%. Stiff grey clay is present down to elevation 423.2, with Q_u values from 1.4 to 1.6 tsf, SPT (N) values of 4 blows per foot, and moisture contents ranging between 21% and 22%. Very stiff grey mottled brown clay is present down to elevation 420.7, with a Q_u value of 2.3 tsf, an SPT (N) value of 10 blows per foot, and a moisture content of 23%. Stiff grey clay is present down to elevation 415.7, with Q_u values from 1.6 to 1.9 tsf, SPT (N) values ranging from 3 to 4 blows per foot, and moisture contents ranging between 22% and 26%. Medium grey clay is present down to elevation 413.2, with a Q_u value of 0.8 tsf, an SPT (N) value of 2 blows per foot, and a moisture content of 25%. Stiff grey mottled brown clay is present down to elevation 410.7, with a Q_u value of 1.8 tsf, an SPT (N) value of 5 blows per foot, and a moisture content of 22%. Medium grey clay is present down to elevation 405.7, with a Q_u value of 0.8 tsf, an SPT (N) value of 3 blows per foot, and a moisture content of 21%. Stiff grey silty clay is present down to elevation 401.7, with a Q_u value of 1.1 tsf, an SPT (N) value of 2 blows per foot, and a moisture content of 20%. Very loose grey fine to medium sand is present down to elevation 390.7, with SPT (N) values ranging from 1 to 3 blows per foot, and a moisture content of 24%. Loose grey sand is present down to elevation 387.7, with an SPT (N) value of 9 blows per foot, and a moisture content of 12%. Hard grey clay shale was encountered at elevation 387.7 with SPT (N) values of over 100 blows per foot.

Boring 2-S: Starting at ground surface, the boring data depicts medium brown clay to silty clay to an elevation of 443.7, with Q_u values from 0.7 to 0.8 tsf, SPT (N) values ranging from 3 to 4 blows per foot, and moisture contents of 29%. Soft brown mottled grey clay to silty clay is present down to elevation 441.2, with a Q_u value of 0.4 tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 31%. Medium silty clay loam with a sand seam is present down to elevation 438.7, with a Q_u value of 0.6 tsf, an SPT (N) value of 4 blows per foot, and a moisture content of 24%. Very soft brown silty clay loam is present down to elevation 435.7, with a Q_u value of 0.2 tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 20%. Very stiff grey and brown clay to clay loam is present down to elevation 428.7, with Q_u values from 2.9 to 3.9 tsf, SPT (N) values ranging from 7 to 12 blows per foot, and moisture contents ranging between 15% and 16%. Stiff grey clay is present down to elevation 411.2, with Q_u values from 1.1 to 1.8 tsf, SPT (N) values ranging from 5 to 9 blows per foot, and moisture contents ranging between 17% and 21%. Medium grey clay is present down to elevation 406.2, with a Q_u

value of 0.8 tsf, an SPT (N) value of 4 blows per foot, and a moisture content of 21%. Stiff grey silty clay is present down to elevation 401.2, with a Q_u value of 1.1 tsf, an SPT (N) value of 5 blows per foot, and a moisture content of 24%. Medium to stiff grey sandy clay loam is present down to elevation 398.2, with a Q_u value of 1.0 tsf, an SPT (N) value of 7 blows per foot, and a moisture content of 20%. Very loose grey sand with gravel is present down to elevation 391.2, with an SPT (N) value of 2 blows per foot, and a moisture content of 20%. Hard grey clay shale was encountered at elevation 391.2 with SPT (N) values of over 100 blows per foot.

Further descriptions of the soil conditions encountered in the borings are presented in the *Soil Borings* attached in Exhibit D and the *Subsurface Data Profile* in Exhibit C.

Geotechnical Evaluations

Settlement

Per the preliminary TSL, it is estimated the profile will be raised between 2.1 to 2.3 feet at the abutments. The proposed west abutment will be located behind the existing west abutment on existing embankment, resulting in calculated settlement of less than 0.4 inches. Since the west abutment settlement is negligible, downdrag forces are not significant and no pre-coring will be required. The proposed east abutment will be located just in front of the existing east abutment with the bottom of cap on approximately 2 feet of fill. Without considering the presence of the existing east abutment, the calculated theoretical settlement is approximately 2.5”, which includes the entire mass of embankment behind the abutment. However, a majority of the embankment will be located behind the existing abutment with only a few feet wide strip of new embankment between the abutments bearing on un-compressed soil. Since the zone of influence from this new soil overlaps that of the existing abutment footing, the amount of settlement is considered insignificant, and therefore, downdrag forces are not considered significant and no pre-coring will be required.

Slope Stability

Preliminary stability analyses using Bishop’s method were performed for both abutments. According to AASHTO LRFD 11.6.2.3, the required resistance factor for slope stability is 0.65 which is equivalent to factor of safety of 1.54. The west abutment used a 8.14 foot high 2H:1V (at right angles) end slope model which rendered factor of safety of 2.38. The east abutment used a 9.17 foot high 2H:1V (at right angles) end slope model which rendered factor of safety of 1.80. The Seismic slope stability was also analyzed and yielded factors of safety of 1.65 and 1.22 at west and east abutments respectively. As per AASHTO LRFD 11.6.5.3, minimum required factor of safety under the effect of seismic loads is 1. The horizontal coefficient was calculated according to FHWA-NHI-11-032. The horizontal coefficient for both abutments is 0.175g. Slope stability analyses are presented in Exhibit G. No slope stability problems are expected.

Seismic Considerations

Based on the method described in the IDOT Design Guide LRFD Soil Site Class Definition, Soil Site Class E controls. The Design Spectral Acceleration at 1.0 sec (S_{D1}) is 0.427g and at 0.2 sec (S_{Ds}) is 0.849g. These values are based on a 1000 year design return period earthquake. According to AASHTO LRFD 3.10.6 the Seismic Performance Zone is 3 based on the 1.0 second Design Spectral Acceleration.

Liquefaction analysis was performed using the IDOT Liquefaction Analysis spreadsheet for each new boring at the proposed bridge. Boring 1-S at the proposed west abutment was found to contain potentially liquefiable loose sand layers between elevations 390.7 and 401.7. Boring 2-S behind the proposed east abutment was found to contain potentially liquefiable loose sand layers between elevations 391.2 and 398.2. Liquefaction calculations are presented in Exhibit E.

Scour

With integral abutments protected by riprap, the design scour elevation is set at the bottom of abutment cap per IDOT Bridge Manual 2.3.6.3.2.

Approach Slab

Due to the profile raise, the approach slabs will rest on fill material where bearing capacities above the required 2 ksf should be expected.

Mining Activity

A review of the Illinois State Geological Survey (ISGS) “Directory of Coal Mines in Illinois” for Jefferson County indicates that no mining activity has been present at the project location. The nearest underground mine proximity region is located 3.8 miles southwest of the bridge location.

Foundation Recommendations

Following is the summary of preliminary factored vertical loads for the AASHTO LRFD Strength I load combination provided by ESCA Consultants, Inc. The Extreme Event I load combination was estimated to be 75% of Strength I.

Strength I Load Combination

West Abutment	788 kips
East Abutment	788 kips

Abutments

Due to IDOT’s strong desire for a jointless structure, integral abutments will be provided. Per IDOT Integral Abutment Pile Selection Design Guide, all pile types are permissible with an effective expansion length of 34.22’. Unless the abutment type is changed, spread footings and drilled shafts are not allowed for integral abutments as per the IDOT Bridge Manual.

Driven pile foundation design includes a seismic case since liquefiable soils are present within the upper 60 feet of the borings. The downdrag applied to the piles during the seismic design case limits the pile type to H-piles driven to end bearing in the shale layers. For this reason, only this scenario is provided in the below tables. Analyses have been performed using the Modified IDOT Static Method for estimating nominal pile resistance. Pile size calculations are presented in Exhibit F and summarized in Tables 1 thru 4. The estimated lengths include a 2 foot embedment into the abutment cap and are based on top of pile elevations of 446.48 at the west abutment and 446.80 at the east abutment. R_n values in tables represent the maximum nominal required bearing. Per IDOT Bridge Manual 3.10.1.6, the suggested upper limit for pile length is 75 ft for HP 10's and 100 ft for HP 12's.

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
West Abutment Strength Limit State	HP 10x42	335	184	63	383.5	4
	HP 12x53	418	230	63	383.5	4
	HP 12x63	497	273	65	381.5	6
	HP 14x73	578	318	64	382.5	5
	HP 14x89	705	388	65	381.5	6

Table 1

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
West Abutment Extreme Event (Liquefaction)	HP 10x42	335	132	63	383.5	4
	HP 12x53	418	174	63	383.5	4
	HP 12x63	497	251	65	381.5	6
	HP 14x73	578	288	64	382.5	5
	HP 14x89	705	413	65	381.5	6

Table 2

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
East Abutment Strength Limit State	HP 10x42	335	184	59	387.8	3
	HP 12x53	418	230	59	387.8	3
	HP 12x63	497	273	61	385.8	5
	HP 14x73	578	318	60	386.8	4
	HP 14x89	705	388	61	385.8	5

Table 3

Location	Pile Size	R_n Nominal Required Bearing (kips)	R_F Factored Resistance Available (kips)	Estimated Pile Length (ft)	Pile Tip Elev.	Estimated Embedment into rock (ft)
East Abutment Extreme Event (Liquefaction)	HP 10x42	335	68	59	387.8	3
	HP 12x53	418	97	59	387.8	3
	HP 12x63	497	174	61	385.8	5
	HP 14x73	578	198	60	386.8	4
	HP 14x89	705	321	61	385.8	5

Table 4

Lateral Loading Analysis

Tables 5 and 6 provide soil parameters for the LPile program (or other approved programs) for the structural engineer to perform the lateral analysis of the foundations. The effective unit weights provided are based on groundwater elevations of 435.70 at the west abutment and 431.20 at the east abutment.

Preliminary analysis has determined that adequate lateral resistance can be provided for the piles prior to reaching rock strata. Per Bridge Manual 3.10.1.10, if the lateral load on a pile exceeds 3 kips then a detailed soil structure interaction analysis shall be performed.

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Medium Silty Clay	445.7	0.069	-	100	5.56	0.010
Soft Silty Clay Loam	440.7	0.064	-	30	2.43	0.020
Medium Silty Clay	435.7	0.050	-	100	4.86	0.010
Very Loose Sandy Gravel w/ Clay	433.2	0.028	-	25	2.78	0.020
Soft Silty Clay Loam	430.7	0.028	-	30	2.78	0.020
Loose Sand w/ Gravel and Clay	428.2	0.033	29.4	20	-	-
Stiff Clay	423.2	0.037	-	500	10.42	0.007
Very Stiff Clay	420.7	0.040	-	1000	15.97	0.005
Stiff Clay	415.7	0.038	-	500	12.15	0.007
Medium Clay	413.2	0.033	-	100	5.56	0.010
Stiff Clay	410.7	0.038	-	500	12.50	0.007
Medium Clay	405.7	0.033	-	100	5.56	0.010
Stiff Silty Clay	401.7	0.035	-	500	7.64	0.007
Very Loose Fine to Medium Sand	390.7	0.027	25.9	20	-	-
Loose Sand	387.7	0.035	30.8	20	-	-
Hard Clay Shale	377.7	0.048	44.0	-	-	-

Table 5 –West Abutment (1-S)

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Medium Clay to Silty Clay	443.7	0.068	-	100	5.24	0.010
Soft Clay to Silty Clay	441.2	0.064	-	30	2.78	0.020
Medium Silty Clay Loam w/ Sand	438.7	0.067	-	100	4.17	0.010
Very Soft Silty Clay Loam	435.7	0.060	-	30	1.39	0.020
Very Stiff Clay to Clay Loam	428.7	0.053	-	1000	22.12	0.005
Stiff Clay	411.2	0.036	-	500	9.03	0.007
Medium Clay	406.2	0.033	-	100	5.56	0.010
Stiff Silty Clay	401.2	0.035	-	500	7.64	0.007
Medium to Stiff Sandy Clay Loam	398.2	0.034	-	100	6.94	0.010
Very Loose Sand w/ Gravel	391.2	0.028	26.2	20	-	-
Hard Clay Shale	380.7	0.048	44.0	-	-	-

Table 6 –East Abutment (2-S)

Construction Considerations

Stage Construction

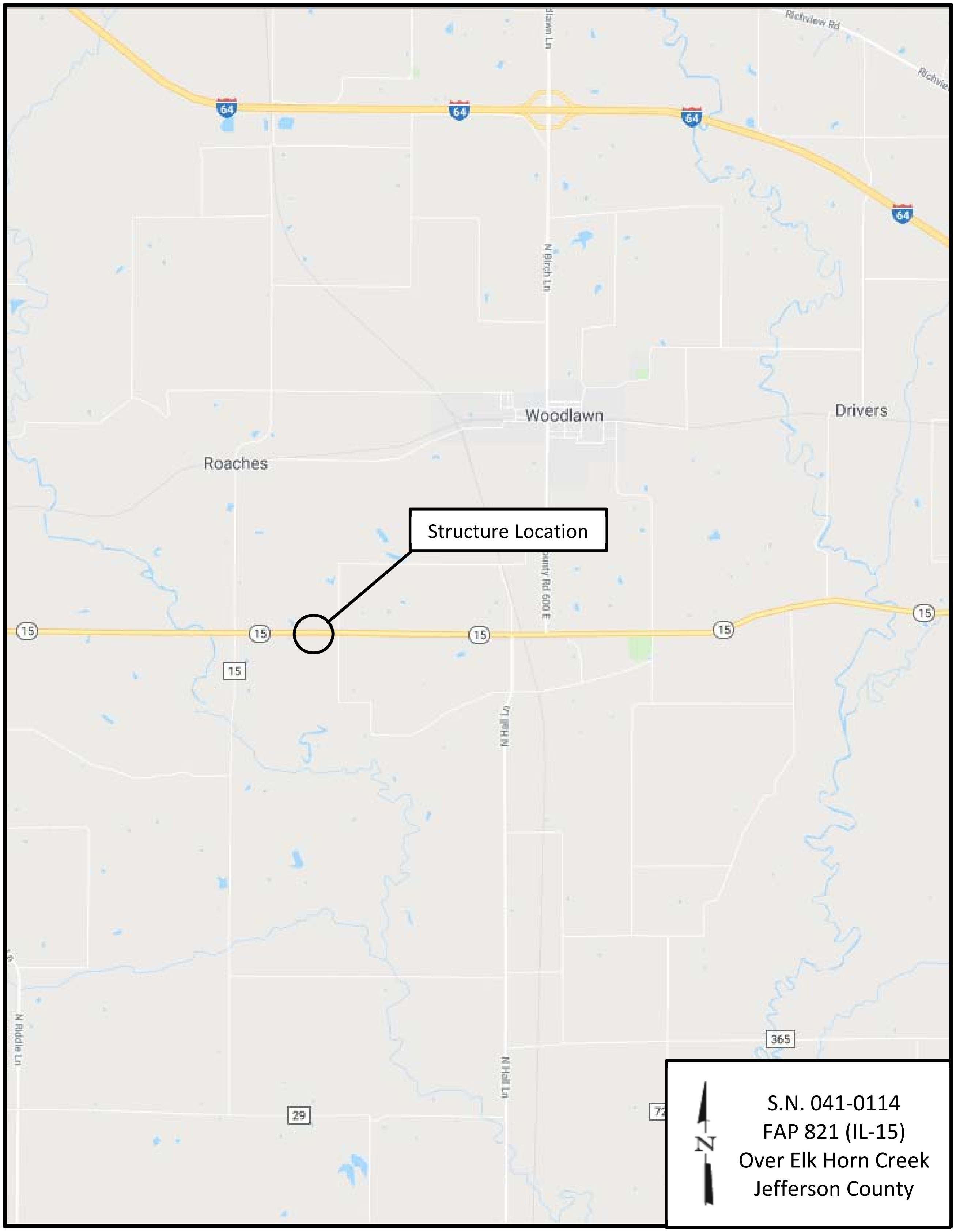
Traffic is expected to be maintained on Illinois Route 15 utilizing stage construction. A temporary soil support system will be required between the stage construction of the new bridge and the stage removal of the old bridge. Preliminary calculations show Temporary Sheet Piling is feasible for the cohesive material located within the expected embedment. The soil will generally be adequate for a 1V:1H excavation slope. However, if the intermittent very soft soil layers shown in the borings are encountered in the field, a 1V:1.5H excavation slope may be more appropriate.

Foundation Construction

One test pile shall be provided at each abutment due to relatively inconsistent rock elevations reported in the borings. Pile shoes are not required for driving into clay shale layers.

Limitations

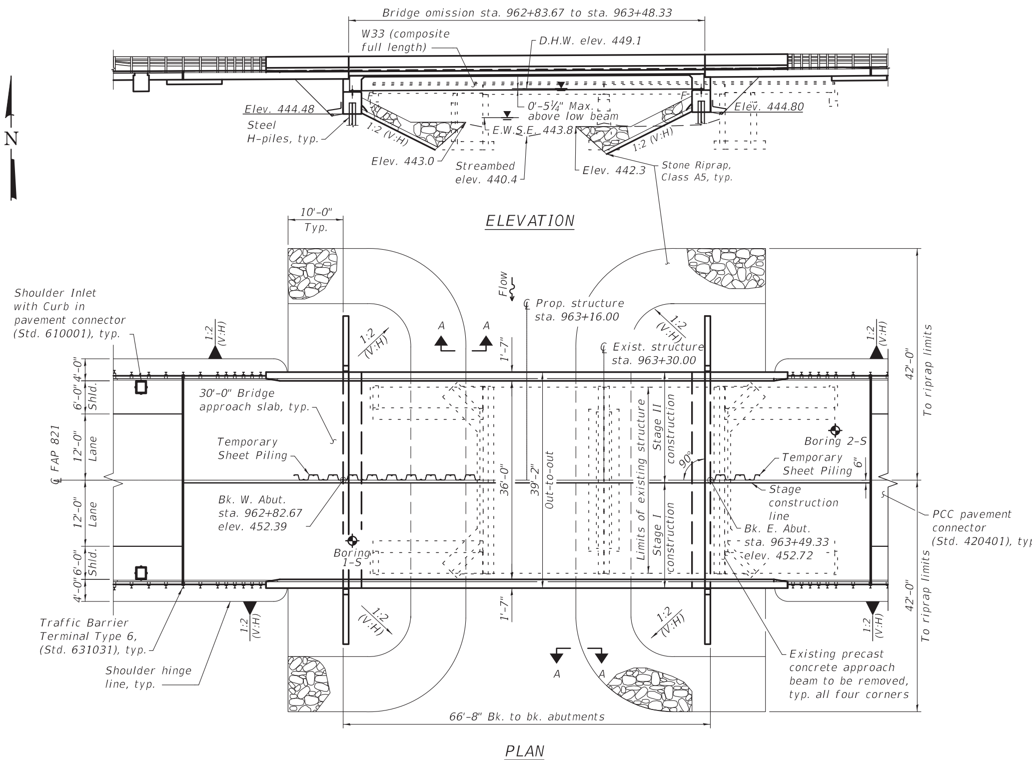
The recommendations provided herein are for the exclusive use of IDOT and ESCA Consultants, Inc. They are specific only to the project described, and are based on subsurface information obtained at boring locations within the bridge area, our understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. Lin Engineering, Ltd. should be contacted if conditions encountered during construction are not consistent with those described.

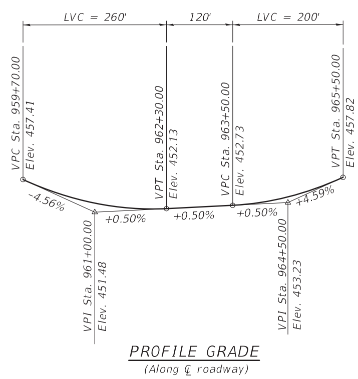

Woodlawn
Drivers
Roaches
Structure Location
N Birch Ln
N Hall Ln
N Riddle Ln
Richview Rd
64
15
29
365
S.N. 041-0114
FAP 821 (IL-15)
Over Elk Horn Creek
Jefferson County
N

BENCHMARK: BM1510. Cut square on N. end of RCCP along IL 15, sta. 967+50 @ 22' LT., elev. 460.15 (NAVD 88)

EXISTING STRUCTURE:
SN 041-0020 was originally built in 1921 as Route 15 Section 12A & 12B. The superstructure was replaced, the abutments and pier were widened/reconstructed, and the railing/guardrail was installed in 1970. The deck was resurfaced and the keyway was repaired in 2006. Riprap with bedding and filter fabric was placed in 2009 during the scour repair. The superstructure consists of two spans of nine 21" precast concrete channel beams. The spans are supported by a hammerhead pier on untreated timber piles and abutments on spread footings. The structure is not skewed. The back-to-back distance between the abutments is 44'-0", and the clear distance between the bridge rails is 33'-6". Traffic will be maintained using stage construction.

No salvage.





PROFILE GRADE
(Along ℄ roadway)

DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevations (ft.)		
	W. Abut.	E. Abut.	Item 113
Q100	444.5	444.8	8
Q200	444.5	444.8	
Design	444.5	444.8	
Check	444.5	444.8	

WATERWAY INFORMATION

Drainage Area = 1.9 Sq. Mi.
Exist. Overtopping Elev. 450.26 at Sta. 963+00
Prop. Overtopping Elev. 452.07 at Sta. 962+04

Flood	Freq. Yr.	Discharge (C.F.S.)	Waterway Opening (sq. ft.) Exist.	Waterway Opening (sq. ft.) Prop.	Natural H.W.E. (ft.)	Head (ft.) Exist.	Head (ft.) Prop.	Headwater Elev. (ft.) Exist.	Headwater Elev. (ft.) Prop.
	10	813	250	320	448.4	1.0	0.9	449.4	449.3
Design	50	1340	250	345	449.1	1.7	0.9	450.8	450.0
Base	100	1570	250	345	449.4	1.8	1.0	451.2	450.4
Scour Design Check	200	1830	250	345	449.6	2.1	1.2	451.7	450.8
Overtop Existing	30	1196	250	-	448.9	1.5	-	450.4	-
Overtop Proposed	-	-	-	-	-	-	-	-	-
Max. Calc.	500	2190	250	345	449.9	2.1	1.6	452.0	451.5

10 Year Velocity through Existing Bridge = 3.9 ft/s
10 Year Velocity through Proposed Bridge = 2.4 ft/s

HIGHWAY CLASSIFICATION

FAP Route 821 (IL 15)
Functional Class: Minor Arterial (Non-Urban)
ADT: 2730 (2018); 3330 (2038)
DHV: 265 (2038)
ADTT: 7.3%
Design Speed: 55 mph
Posted Speed: 55 mph
Two Way Traffic
Directional Distribution: 50:50

DESIGN SPECIFICATIONS

2017 AASHTO LRFD
Bridge Design Specifications
8th Edition

LOADING HL-93

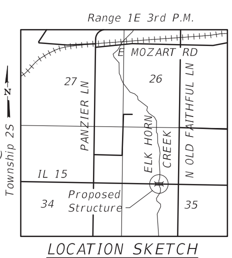
Allow 50 psf for future wearing surface

DESIGN STRESSES
FIELD UNITS

f'c = 3,500 psi (substructure)
f'c = 4,000 psi (superstructure)
fy = 60,000 psi (reinforcement)
fy = 50,000 psi (AASHTO M270 Grade 50)

SEISMIC DATA

Seismic Performance Zone (SPZ) = 3
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.440g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.849g
Soil Site Classification = E



LOCATION SKETCH

GENERAL PLAN & ELEVATION
IL 15 OVER ELK HORN CREEK
FAP ROUTE 821 - SECTION 12B-2
JEFFERSON COUNTY
STATION 963+16.00
STRUCTURE NO. 041-0114

ESCA CONSULTANTS, INC.
CIVIL & STRUCTURAL ENGINEERS

USER NAME = shl	DESIGNED - SHL	03/18	REVISED -	
ESCA PROJECT NO. 1035.10	CHECKED - RDP	03/18	REVISED -	
PLOT SCALE = 0:2 ':" / in.	DRAWN - SHL	03/18	REVISED -	
PLOT DATE = 4/2/2018	CHECKED - ELH	03/18	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
821	12B-2	JEFFERSON	1	2

CONTRACT NO. 78458
ILLINOIS FED. AID PROJECT

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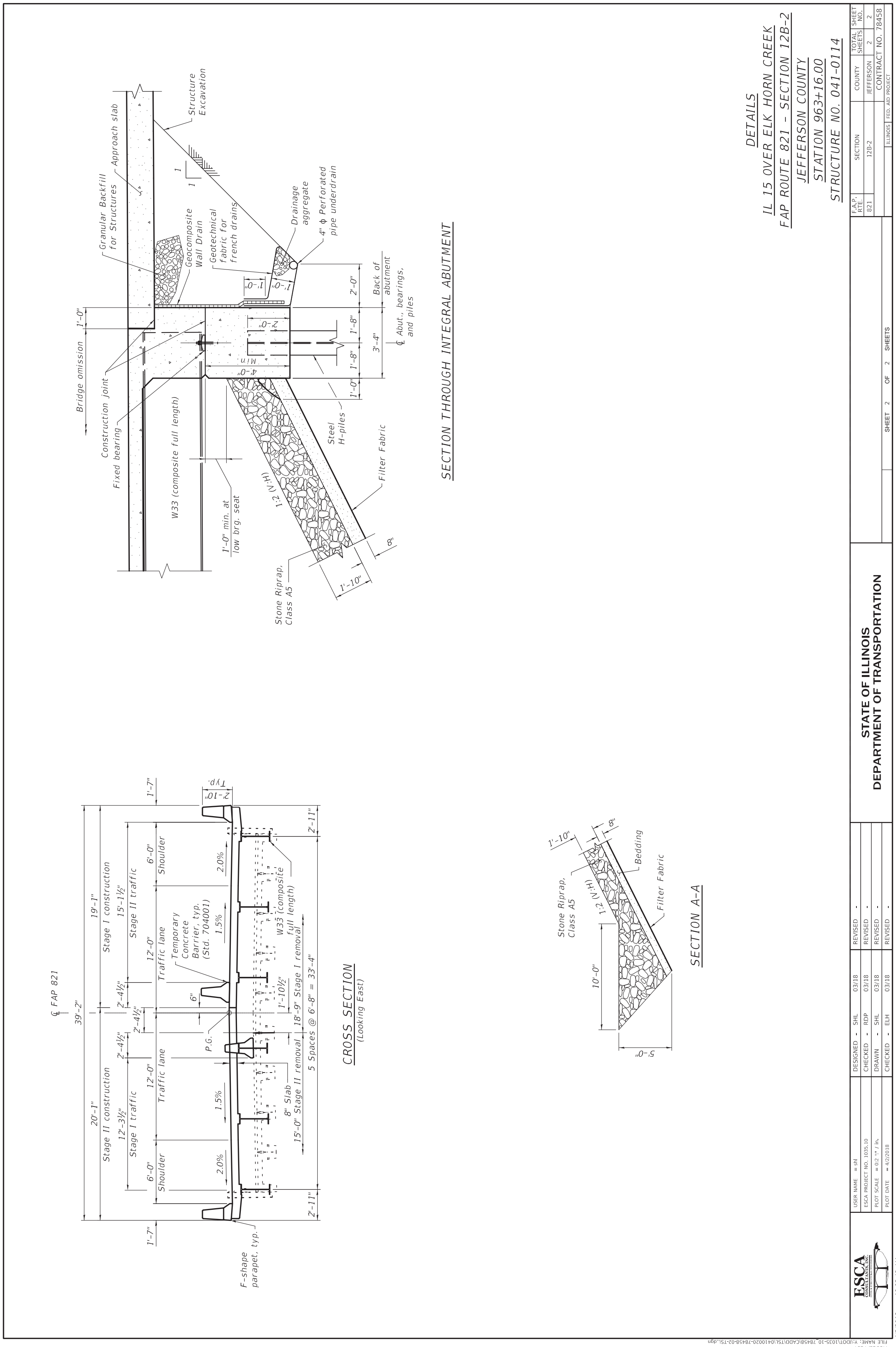
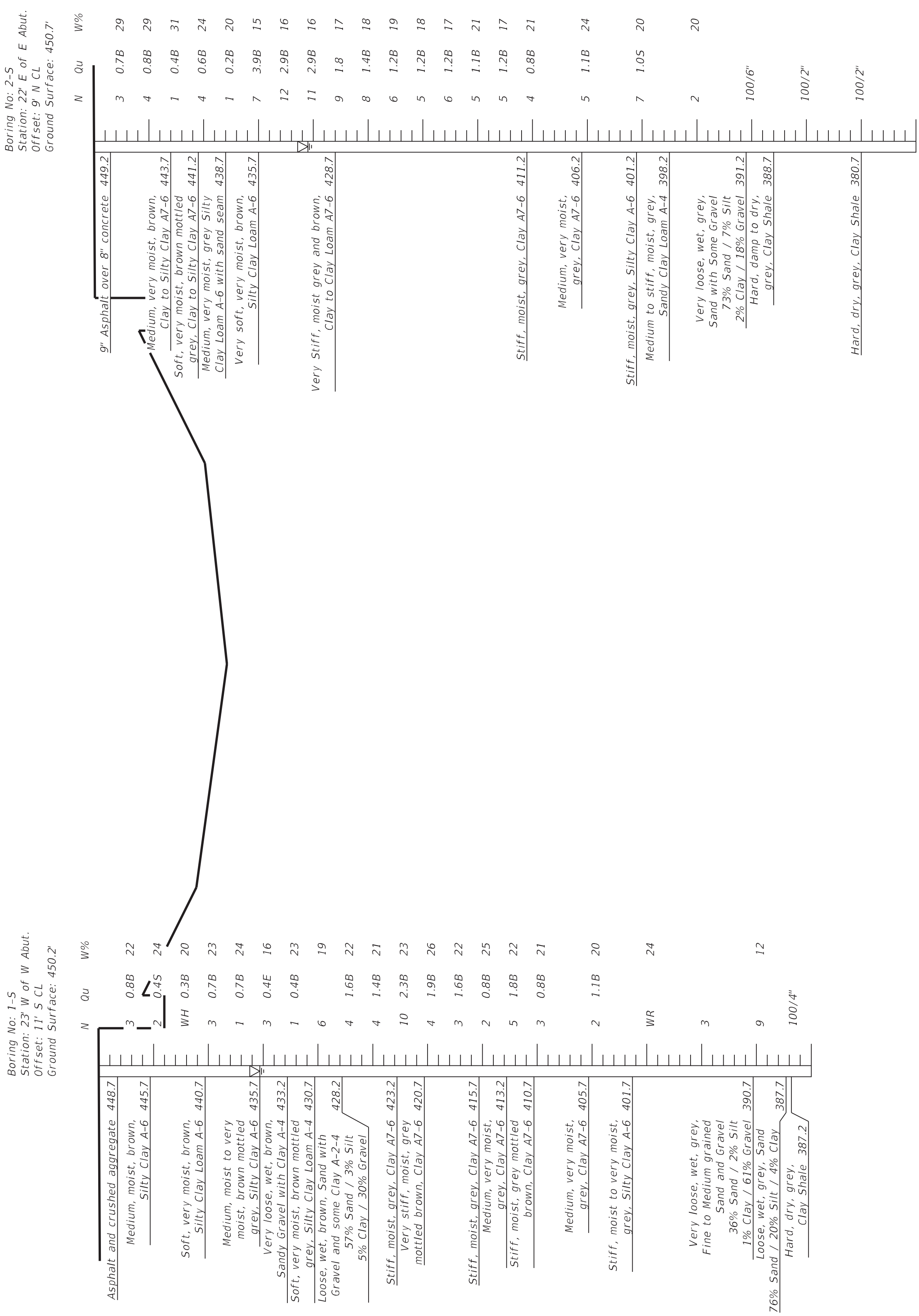

SECTION THROUGH INTEGRAL ABUTMENT
Bridge omission
1'-0"
Construction joint
Fixed bearing
Granular Backfill for Structures
Approach slab
Structure Excavation
Geocomposite Wall Drain
Geotechnical fabric for french drains
Drainage aggregate
4" ϕ Perforated pipe underdrain
Back of abutment
℄ Abut., bearings, and piles
Steel H-piles
Filter Fabric
W33 (composite full length)
1'-0" min. at low brg. seat
1:2 (V:H)
Stone Riprap, Class A5
1'-10"
8"
2'-0"
1'-8"
3'-4"
4'-0" Min.
CROSS SECTION
(Looking East)
℄ FAP 821
39'-2"
20'-1"
19'-1"
Stage II construction
Stage I construction
12'-3½"
15'-1½"
Stage I traffic
Stage II traffic
6'-0"
Shoulder
12'-0"
Traffic lane
2'-4½"
Temporary Concrete Barrier, typ. (Std. 704001)
2.0%
1.5%
P.G.
6"
8" Slab
15'-0" Stage II removal
18'-9" Stage I removal
1'-10½"
5 Spaces @ 6'-8" = 33'-4"
2'-11"
1'-7"
2'-10" Typ.
F-shape parapet, typ.
SECTION A-A
Stone Riprap, Class A5
1:2 (V:H)
10'-0"
5'-0"
1'-10"
8"
Bedding
Filter Fabric
DETAILS
IL 15 OVER ELK HORN CREEK
FAP ROUTE 821 - SECTION 12B-2
JEFFERSON COUNTY
STATION 963+16.00
STRUCTURE NO. 041-0114
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
SHEET 2 OF 2 SHEETS
DESIGNED - SHL 03/18
CHECKED - RDP 03/18
DRAWN - SHL 03/18
CHECKED - ELH 03/18
F.A.P. RTE. 821
SECTION 12B-2
COUNTY JEFFERSON
TOTAL SHEETS 2
SHEET NO. 2
CONTRACT NO. 78458
ESCA
4/2/2018 10:05:42 AM


Boring No: 2-S
Station: 22' E of E Abut.
Offset: 9' N CL
Ground Surface: 450.7'
N Qu W%
9" Asphalt over 8" concrete 449.2
Medium, very moist, brown, Clay to Silty Clay A7-6 443.7
Soft, very moist, brown mottled grey, Clay to Silty Clay A7-6 441.2
Medium, very moist, grey Silty Clay Loam A-6 with sand seam 438.7
Very soft, very moist, brown, Silty Clay Loam A-6 435.7
Very Stiff, moist grey and brown, Clay to Clay Loam A7-6 428.7
Stiff, moist, grey, Clay A7-6 411.2
Medium, very moist, grey, Clay A7-6 406.2
Stiff, moist, grey, Silty Clay A-6 401.2
Medium to stiff, moist, grey, Sandy Clay Loam A-4 398.2
Very loose, wet, grey, Sand with Some Gravel 73% Sand / 7% Silt 2% Clay / 18% Gravel 391.2
Hard, damp to dry, grey, Clay Shale 388.7
Hard, dry, grey, Clay Shale 380.7
3 0.7B 29
4 0.8B 29
1 0.4B 31
4 0.6B 24
1 0.2B 20
7 3.9B 15
12 2.9B 16
11 2.9B 16
9 1.8 17
8 1.4B 18
6 1.2B 19
5 1.2B 18
6 1.2B 17
5 1.1B 21
5 1.2B 17
4 0.8B 21
5 1.1B 24
7 1.0S 20
2 20
100/6"
100/2"
100/2"
Boring No: 1-S
Station: 23' W of W Abut.
Offset: 11' S CL
Ground Surface: 450.2'
N Qu W%
Asphalt and crushed aggregate 448.7
Medium, moist, brown, Silty Clay A-6 445.7
Soft, very moist, brown, Silty Clay Loam A-6 440.7
Medium, moist to very moist, brown mottled grey, Silty Clay A-6 435.7
Very loose, wet, brown, Sandy Gravel with Clay A-4 433.2
Soft, very moist, brown mottled grey, Silty Clay Loam A-4 430.7
Loose, wet, brown, Sand with Gravel and some Clay A-2-4 57% Sand / 3% Silt 5% Clay / 30% Gravel 428.2
Stiff, moist, grey, Clay A7-6 423.2
Very stiff, moist, grey mottled brown, Clay A7-6 420.7
Stiff, moist, grey, Clay A7-6 415.7
Medium, very moist, grey, Clay A7-6 413.2
Stiff, moist, grey mottled brown, Clay A7-6 410.7
Medium, very moist, grey, Clay A7-6 405.7
Stiff, moist to very moist, grey, Silty Clay A-6 401.7
Very loose, wet, grey, Fine to Medium grained Sand and Gravel 36% Sand / 2% Silt 1% Clay / 61% Gravel 390.7
Loose, wet, grey, Sand 76% Sand / 20% Silt / 4% Clay 387.7
Hard, dry, grey, Clay Shale 387.2
3 0.8B 22
2 0.4S 24
WH 0.3B 20
3 0.7B 23
1 0.7B 24
3 0.4E 16
1 0.4B 23
6 19
4 1.6B 22
4 1.4B 21
10 2.3B 23
4 1.9B 26
3 1.6B 22
2 0.8B 25
5 1.8B 22
3 0.8B 21
2 1.1B 20
WR 24
3
9 12
100/4"

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Dave Piche
From:	Rob Graeff	
Subject:	*Boring Logs	
Date:	March 3, 2016	

FAP 821 (IL 15) over Elk Horn Creek
Structure 041-0020
Jefferson County

Foundation boring logs have been obtained for the above listed structure and are attached.

Liquefaction Analysis
A review of the borings indicates the presence of potentially liquefiable soils. The extent of these layers should be addressed in the Structure Geotechnical Report.

Slope Stability
At the time of this report, a preliminary TSL is not available. Therefore, we are unable to provide any slope stability calculations for the proposed endslope configuration. This office should be contacted to complete the slope stability calculations when a proposed endslope configuration is determined.

Structure Geotechnical Report
Due to a current shortage of staffing, the District Nine Geotechnical Unit is unable to complete the required Structure Geotechnical Report. Any additional foundation recommendations should be evaluated by a competent consultant.

Attachments
RM:rm

cc: Soils File

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAP 821 (IL 15) Over Elk Horn Creek

Route: FAP 821 (IL 15) Structure Number: 041-0020 Date: 5/12/2015
Section 12,B,BR Bored By: R Moberly
County: Jefferson Location: 4.4 miles East of Washington Co. Checked By: R Moberly

Boring No 1-S
Station 23' W of W Abut
Offset 11' S CL
Ground Surface 450.2 Ft

Surf Wat Elev: 442.2
Ground Water Elevation
when Drilling 435.7
At Completion
At: Hrs:

Description	DEPTH	BLOWS	Qu tsf	W%
Asphalt and crushed aggregate				
448.7				
Medium, moist, brown, Silty Clay A-6		1		
		1	0.8B	22
		2		
445.7				
Soft, very moist, brown, Silty Clay Loam A-6	5.0	1		
		1	0.4S	24
		1		
		WH		
		WH	0.3B	20
		WH		
440.7				
Medium, moist to very moist, brown mottled grey, Silty Clay A-6	10.0	WH		
		1	0.7B	23
		2		
		WH		
		WH	0.7B	24
		1		
435.7				
Very loose, wet, brown, Sandy Gravel with Clay A-4	15.0	1		
		2	0.4E	16
		1		
433.2				
Soft, very moist, brown mottled grey, Silty Clay Loam A-4		WH		
		1	0.4B	23
		WH		
430.7				
Loose, wet, brown, Sand with Gravel and some Clay A-2-4 57% Sand / 3% Silt 5% Clay / 30% Gravel	20.0	1		
		3		19
		3		
428.2				
Stiff, moist, grey, Clay A7-6		1		
		2	1.6B	22
		2		
	25.0	1		

Description	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, grey, Clay A7-6		2	1.4B	21
		2		
423.2				
Very stiff, moist, grey mottled brown, Clay A7-6		2		
		4	2.3B	23
		6		
420.7				
Stiff, moist, grey, Clay A7-6	30.0	1		
		2	1.9B	26
		2		
		1		
		1	1.6B	22
		2		
415.7				
Medium, very moist, grey, Clay A7-6	35.0	1		
		1	0.8B	25
		1		
413.2				
Stiff, moist, grey mottled brown, Clay A7-6		1		
		2	1.8B	22
		3		
410.7				
Medium, very moist, grey, Clay A7-6	40.0	1		
		1	0.8B	21
		2		
405.7				
Stiff, moist to very moist, grey, Silty Clay A-6	45.0	WH		
		1	1.1B	20
		1		
401.7				
Very loose, wet, grey, Fine to Medium grained Sand				
	50.0	WR		

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

Sheet 2 of 2

Route: FAP 821 (IL 15)
Date: 5/12/2015
Section: 12,B,BR
County: Jefferson

Boring No: 1-S
Station: 23' W of W Abut
Offset: 11' S CL
Ground Surface: 450.2 Ft

Description	DEPTH	BLOWS	Qu tsf	W%
Very loose, wet, grey, Fine to Medium grained Sand and Gravel 36% Sand / 2% Silt 1% Clay / 61% Gravel		WR WH		24
(No sample recovered)	55.0	1 1 2		
390.7				
Loose, wet, grey, Sand 76% Sand / 20% Silt 4% Clay	60.0	1 3 6		12
387.7		8		
Hard, dry, grey, Clay Shale 387.2		100/4"		
	65.0			
Bottom of hole = 62.8 feet				
Free water observed at 14.5 feet				
Elevation referenced to BM 4100202; Elevation= 450.2 feet				
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
	70.0			
To convert "N" values to "N60" multiply by 1.25				
	75.0			

	DEPTH	BLOWS	Qu tsf	W%
	80.0			
	85.0			
	90.0			
	95.0			
	100.0			

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
Sheet 1 of 2

FAP 821 (IL 15) Over Elk Horn Creek

Route: FAP 821 (IL 15)	Structure Number: 041-0020		Date: 5/21/2015
Section 12,B,BR			Bored By: R Moberly
County: Jefferson	Location: 4.4 miles East of Washington Co.		Checked By: R Moberly

Boring No	2-S
Station	22' E of E Abut
Offset	9' N CL
Ground Surface	450.7 Ft
Surf Wat Elev:	442.2
Ground Water Elevation when Drilling	431.2
At Completion	
At: Hrs:	

Description	Elev.	DEPTH	BLOWS	Qu tsf	W%
9" Asphalt over 8" concrete	449.2				
Medium, very moist, brown, Clay to Silty Clay A7-6			1 2 1	0.7B	29
		5.0	1 2 2	0.8B	29
	443.7				
Soft, very moist, brown mottled grey, Clay to Silty Clay A7-6			WH WH 1	0.4B	31
	441.2				
Medium, very moist, grey, Silty Clay Loam A-6 with sand seam		10.0	1 2 2	0.6B	24
	438.7				
Very soft, very moist, brown, Silty Clay Loam A-6			WH WH 1	0.2B	20
	435.7	15.0			
Very stiff, moist, grey and brown, Clay to Clay Loam A7-6			WH 2 5	3.9B	15
			2 5 7	2.9B	16
		20.0	2 5 6	2.9B	16
	428.7				
Stiff, moist, grey, Clay A7-6			2 4 5	1.8B	17
		25.0	1		

Description	Elev.	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, grey, Clay A7-6			3 5	1.4B	18
			1 2 4	1.2B	19
		30.0	1 2 3	1.2B	18
			1 3 3	1.2B	17
		35.0	1 2 3	1.1B	21
			1 2 3	1.2B	17
	411.2				
Medium, very moist, grey, Clay A7-6		40.0	1 2 2	0.8B	21
	406.2				
Stiff, moist, grey, Silty Clay A-6		45.0	1 2 3	1.1B	24
	401.2				
		50.0	1		

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

Sheet 2 of 2

Route: FAP 821 (IL 15)
Date: 5/21/2015
Section: 12,B,BR
County: Jefferson

Boring No: 2-S
Station: 22' E of E Abut
Offset: 9' N CL
Ground Surface: 450.7 Ft

Description	DEPTH	BLOWS	Qu tsf	W%
Medium to stiff, moist, grey, Sandy Clay Loam A-4		3	1.0S	20
		4		
398.2				
Very loose, wet, grey, Sand with Some Gravel 73% Sand / 7% Silt 2% Clay / 18% Gravel				
	55.0	1		
		1		20
		1		
391.2				
Hard, damp to dry, grey, Clay Shale	60.0	20		
		100/6"		
388.7				
Hard, dry, grey, Clay Shale				
	65.0	100/2"		
Hard, dry, grey, Clay Shale 380.7	70.0	100/2"		
Bottom of hole = 69.7 feet				
	75.0			

Description	DEPTH	BLOWS	Qu tsf	W%
Bottom of hole = 69.7 feet				
Free water observed at 19.5 feet				
Elevation referenced to BM 4100202; Elevation = 450.2 feet	80.0			
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
To convert "N" values to "N60" multiply by 1.25				
	85.0			
	90.0			
	95.0			
	100.0			

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

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==================================== 1-S
ELEVATION OF BORING GROUND SURFACE ========================= 448.70 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 13.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 8.20 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.520
EARTHQUAKE MOMENT MAGNITUDE =============================== 5.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== -4.22 FT. (Cut Depth)
HAMMER EFFICIENCY== 73 %
BOREHOLE DIAMETER== 8 IN.
SAMPLING METHOD== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.897**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **275** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.63
Source-To-Site Distance, R (km) = 12.71
Ground Motion Prediction Equations = CEUS
PGA = **0.362**

ELEV. OF SAMPLE (FT.)	BORING DATA: BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	CONDITIONS DURING DRILLING: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	CONDITIONS DURING EARTHQUAKE: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
445.7	3	3	0.8		11	40	22	0.119	0.357	5.567	5.567	0.076								
443.2	5.5	2	0.4		11	40	24	0.111	0.635	3.388	3.388	0.061	0.111	0.142	0.142	1.500	**0.173**	0.956	**0.323**	**N.L. (1)**
440.7	8	1	0.3		11	40	20	0.108	0.905	1.599	1.599	0.051	0.108	0.412	0.412	1.388	**0.135**	0.867	**0.293**	**N.L. (1)**
438.2	10.5	3	0.7		11	40	23	0.117	1.197	4.749	4.749	0.070	0.117	0.705	0.705	1.246	**0.166**	0.778	**0.263**	**N.L. (1)**
435.7	13	1	0.7		11	40	24	0.117	1.490	1.544	1.544	0.051	0.179	1.152	1.188	1.130	**0.109**	0.691	**0.241**	**N.L. (2)**
433.2	15.5	3	0.4		10	40	16	0.049	1.612	4.656	4.656	0.070	0.049	1.275	1.467	1.107	**0.146**	0.610	**0.237**	**N.L. (2)**
430.7	18	1	0.4		10	40	23	0.049	1.735	1.546	1.546	0.051	0.049	1.397	1.745	1.087	**0.105**	0.535	**0.226**	**N.L. (2)**
428.2	20.5	6					19	0.057	1.877	9.132	9.132	0.106	0.057	1.540	2.044	1.075	**0.215**	0.469	**0.211**	**1.019 (C)**
425.7	23	4	1.6		11	41	22	0.065	2.040	5.945	5.945	0.079	0.065	1.702	2.362	1.046	**0.157**	0.412	**0.193**	**N.L. (2)**
423.2	25.5	4	1.4		11	41	21	0.063	2.197	5.799	5.799	0.078	0.063	1.860	2.676	1.027	**0.152**	0.363	**0.177**	**N.L. (2)**
420.7	28	10	2.3		11	41	23	0.069	2.370	14.078	14.078	0.151	0.069	2.032	3.004	1.011	**0.289**	0.323	**0.161**	**N.L. (2)**
418.2	30.5	4	1.9		11	41	26	0.067	2.537	5.472	5.472	0.076	0.067	2.200	3.328	0.993	**0.142**	0.290	**0.148**	**N.L. (2)**
415.7	33	3	1.6		11	41	22	0.065	2.700	3.993	3.993	0.065	0.065	2.362	3.646	0.979	**0.120**	0.263	**0.137**	**N.L. (2)**
413.2	35.5	2	0.8		11	41	25	0.057	2.842	2.601	2.601	0.056	0.057	2.505	3.945	0.967	**0.103**	0.242	**0.129**	**N.L. (2)**
410.7	38	5	1.8		11	41	22	0.066	3.007	6.329	6.329	0.082	0.066	2.670	4.266	0.953	**0.149**	0.225	**0.121**	**N.L. (2)**
405.7	43	3	0.8		11	41	21	0.057	3.292	3.633	3.633	0.062	0.057	2.955	4.863	0.936	**0.111**	0.201	**0.112**	**N.L. (2)**
401.7	47	2	1.1		11	40	20	0.060	3.532	2.336	2.336	0.055	0.060	3.195	5.352	0.921	**0.095**	0.189	**0.107**	**N.L. (2)**
396.2	52.5	1					24	0.043	3.769	1.130	1.130	0.050	0.043	3.431	5.932	0.908	**0.085**	0.178	**0.104**	**0.817 (C)**
390.7	58	3						0.051	4.049	3.254	3.254	0.060	0.051	3.712	6.556	0.894	**0.102**	0.172	**0.103**	**0.990 (C)**
388.7	60	9					12	0.060	4.169	9.592	9.592	0.110	0.060	3.832	6.801	0.873	**0.181**	0.170	**0.102**	**1.775 (C)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ==================================== 2-S
ELEVATION OF BORING GROUND SURFACE ========================= 449.20 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ====================== 18.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ================== 13.02 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.520
EARTHQUAKE MOMENT MAGNITUDE =============================== 5.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE =============== -4.40 FT. (Cut Depth)
HAMMER EFFICIENCY== 73 %
BOREHOLE DIAMETER== 8 IN.
SAMPLING METHOD== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.897**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **349** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.63
Source-To-Site Distance, R (km) = 12.71
Ground Motion Prediction Equations = CEUS
PGA = **0.362**

ELEV. OF SAMPLE (FT.)	BORING DATA: BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	CONDITIONS DURING DRILLING: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	CONDITIONS DURING EARTHQUAKE: EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
446.7	2.5	3	0.7				29	0.117	0.293	5.694	5.694	0.077								
443.7	5.5	4	0.8				29	0.119	0.650	6.743	6.743	0.086	0.119	0.131	0.131	1.500	**0.244**	0.976	**0.330**	**N.L. (1)**
441.2	8	1	0.4		11	41	31	0.111	0.927	1.589	1.589	0.051	0.111	0.408	0.408	1.390	**0.135**	0.918	**0.310**	**N.L. (1)**
438.7	10.5	4	0.6		11	40	24	0.116	1.217	6.299	6.299	0.082	0.116	0.698	0.698	1.260	**0.196**	0.855	**0.289**	**N.L. (1)**
435.7	13.5	1	0.2		11	40	20	0.104	1.529	1.541	1.541	0.051	0.104	1.010	1.010	1.160	**0.112**	0.775	**0.262**	**N.L. (1)**
433.7	15.5	7	3.9		11	41	15	0.138	1.805	10.382	10.382	0.117	0.138	1.286	1.286	1.124	**0.248**	0.721	**0.244**	**N.L. (1)**
431.2	18	12	2.9		11	41	16	0.134	2.140	17.241	17.241	0.183	0.196	1.776	1.813	1.050	**0.365**	0.654	**0.226**	**N.L. (2)**
428.7	20.5	11	2.9		11	41	16	0.072	2.320	15.294	15.294	0.163	0.072	1.956	2.149	1.021	**0.316**	0.591	**0.219**	**N.L. (2)**
426.2	23	9	1.8		11	41	17	0.066	2.485	12.192	12.192	0.133	0.066	2.121	2.470	1.000	**0.252**	0.532	**0.209**	**N.L. (2)**
423.7	25.5	8	1.4		11	41	18	0.063	2.643	10.601	10.601	0.118	0.063	2.279	2.783	0.983	**0.221**	0.479	**0.198**	**N.L. (2)**
421.2	28	6	1.2		11	41	19	0.061	2.795	7.774	7.774	0.094	0.061	2.431	3.092	0.971	**0.173**	0.433	**0.186**	**N.L. (2)**
418.7	30.5	5	1.2		11	41	18	0.061	2.948	6.329	6.329	0.082	0.061	2.584	3.400	0.960	**0.150**	0.393	**0.175**	**N.L. (2)**
416.2	33	6	1.2		11	41	17	0.061	3.100	7.420	7.420	0.091	0.061	2.736	3.709	0.947	**0.164**	0.360	**0.165**	**N.L. (2)**
413.7	35.5	5	1.1		11	41	21	0.060	3.250	6.044	6.044	0.080	0.060	2.886	4.015	0.938	**0.142**	0.333	**0.157**	**N.L. (2)**
411.2	38	5	1.2		11	41	17	0.061	3.403	5.908	5.908	0.079	0.061	3.039	4.323	0.929	**0.139**	0.311	**0.150**	**N.L. (2)**
406.2	43	4	0.8		11	41	21	0.057	3.688	4.537	4.537	0.069	0.057	3.324	4.920	0.914	**0.119**	0.279	**0.140**	**N.L. (2)**
401.2	48	5	1.1		11	40	24	0.060	3.988	5.438	5.438	0.075	0.060	3.624	5.532	0.897	**0.128**	0.259	**0.134**	**N.L. (2)**
398.2	51	7	1		10	40	20	0.059	4.165	7.432	7.432	0.091	0.059	3.801	5.896	0.882	**0.153**	0.251	**0.132**	**N.L. (2)**
391.2	58	2					20	0.048	4.501	2.030	2.030	0.053	0.048	4.137	6.669	0.875	**0.088**	0.239	**0.130**	0.677 **(C)**
389.2	60	100						0.083	4.667	######	117.268	0.852	0.083	4.303	6.960	0.753	**1.217**	0.237	**0.130**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE====================================== West Abut.
REFERENCE BORING ================================= 1-S
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================== 446.48 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 444.48 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 788 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 39.17 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 160.94 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 60.35 KIPS

PILE TYPE AND SIZE ============= Steel HP 12 X 53
Plugged Pile Perimeter========================== 3.967 FT.
Plugged Pile End Bearing Area==================== 0.983 SQFT.
Unplugged Pile Perimeter=============== 5.800 FT.
Unplugged Pile End Bearing Area========= 0.108 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**418** KIPS	**230** KIPS	**63** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
443.20	1.28	0.40			1.6		5.7	2.4		**2.8**	3	0	0	2	3
440.70	2.50	0.30			2.4	4.1	13.7	3.5	0.5	**6.9**	7	0	0	4	6
438.20	2.50	0.70			5.2	9.6	18.9	7.6	1.1	**14.6**	15	0	0	8	8
435.70	2.50	0.70			5.2	9.6	**20.0**	7.6	1.1	21.7	20	0	0	11	11
433.20	2.50	0.40			3.1	5.5	**23.1**	4.6	0.6	26.3	23	0	0	13	13
430.70	2.50	0.40			3.1	5.5	35.4	4.6	0.6	**31.9**	32	0	0	18	16
428.20	2.50		6	Sandy Gravel	1.4	14.7	44.2	2.0	1.6	**34.8**	35	0	0	19	18
425.70	2.50	1.60			10.0	22.0	51.4	14.6	2.4	**49.1**	49	0	0	27	21
423.20	2.50	1.40			9.1	19.3	72.9	13.3	2.1	**63.7**	64	0	0	35	23
420.70	2.50	2.30			12.6	31.7	**80.0**	18.5	3.5	81.6	80	0	0	44	26
418.20	2.50	1.90			11.2	26.2	**87.1**	16.3	2.9	97.5	87	0	0	48	28
415.70	2.50	1.60			10.0	22.0	**86.0**	14.6	2.4	110.8	86	0	0	47	31
413.20	2.50	0.80			5.9	11.0	**105.6**	8.6	1.2	120.9	106	0	0	58	33
410.70	2.50	1.80			10.8	24.8	**102.6**	15.8	2.7	135.2	103	0	0	56	36
405.70	5.00	0.80			11.7	11.0	**118.5**	17.1	1.2	152.7	118	0	0	65	41
401.70	4.00	1.10			12.2	15.2	**117.9**	17.8	1.7	169.1	118	0	0	65	45
396.20	5.50		1	Medium Sand	0.4	2.4	**123.2**	0.6	0.3	170.3	123	0	0	68	50
390.70	5.50		3	Medium Sand	1.2	7.3	**133.6**	1.7	0.8	173.0	134	0	0	73	56
387.70	3.00		9	Very Fine Silty Sand	1.7	16.5	241.2	2.4	1.8	**187.0**	187	0	0	103	59
386.70	1.00			Shale	49.4	122.5	290.7	72.3	13.4	**259.3**	259	0	0	143	59.8
385.70	1.00			Shale	49.4	122.5	340.1	72.3	13.4	**331.5**	332	0	0	182	60.8
384.70	1.00			Shale	49.4	122.5	**389.5**	72.3	13.4	403.8	389	0	0	214	61.8
383.70	1.00			Shale	49.4	122.5	**438.9**	72.3	13.4	476.0	~~439~~	~~0~~	~~0~~	~~241~~	~~62.8~~
382.70	1.00			Shale	49.4	122.5	**488.3**	72.3	13.4	548.3	~~488~~	~~0~~	~~0~~	~~269~~	~~63.8~~
381.70	1.00			Shale		122.5			13.4						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE===================================== West Abut.
REFERENCE BORING ================================ 1-S
LRFD or ASD or SEISMIC ============================== SEISMIC
PILE CUTOFF ELEV. ================================== 446.48 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 444.48 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD =============== 390.70 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 401.70 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ================= 591 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 39.17 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 120.70 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 45.26 KIPS

PILE TYPE AND SIZE ============= Steel HP 12 X 53
Plugged Pile Perimeter========================== 3.967 FT. Unplugged Pile Perimeter============== 5.800 FT.
Plugged Pile End Bearing Area==================== 0.983 SQFT. Unplugged Pile End Bearing Area======== 0.108 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**389** KIPS	**145** KIPS	**62** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE PLUGGED SIDE RESIST. (KIPS)	ULTIMATE PLUGGED END BRG. RESIST. (KIPS)	ULTIMATE PLUGGED TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
443.20	1.28	0.40			1.6		5.7	2.4		***2.8***	3	2	2	-1	3
440.70	2.50	0.30			2.4	4.1	13.7	3.5	0.5	***6.9***	7	4	4	-2	6
438.20	2.50	0.70			5.2	9.6	18.9	7.6	1.1	***14.6***	15	9	10	-5	8
435.70	2.50	0.70			5.2	9.6	***20.0***	7.6	1.1	21.7	20	14	16	-10	11
433.20	2.50	0.40			3.1	5.5	***23.1***	4.6	0.6	26.3	23	18	19	-14	13
430.70	2.50	0.40			3.1	5.5	35.4	4.6	0.6	***31.9***	32	21	23	-12	16
428.20	2.50		6	Sandy Gravel	1.4	14.7	44.2	2.0	1.6	***34.8***	35	22	24	-12	18
425.70	2.50	1.60			10.0	22.0	51.4	14.6	2.4	***49.1***	49	32	35	-18	21
423.20	2.50	1.40			9.1	19.3	72.9	13.3	2.1	***63.7***	64	41	45	-23	23
420.70	2.50	2.30			12.6	31.7	***80.0***	18.5	3.5	81.6	80	54	59	-33	26
418.20	2.50	1.90			11.2	26.2	***87.1***	16.3	2.9	97.5	87	65	72	-50	28
415.70	2.50	1.60			10.0	22.0	***86.0***	14.6	2.4	110.8	86	75	83	-72	31
413.20	2.50	0.80			5.9	11.0	***105.6***	8.6	1.2	120.9	106	81	89	-64	33
410.70	2.50	1.80			10.8	24.8	***102.6***	15.8	2.7	135.2	103	92	101	-90	36
405.70	5.00	0.80			11.7	11.0	***118.5***	17.1	1.2	152.7	118	103	114	-99	41
401.70	4.00	1.10			12.2	15.2	***117.9***	17.8	1.7	169.1	118	115	127	-125	45
396.20	5.50		1	Medium Sand	0.4	2.4	***123.2***	0.6	0.3	170.3	123	116	127	-120	50
390.70	5.50		3	Medium Sand	1.2	7.3	***133.6***	1.7	0.8	173.0	134	117	127	-111	56
387.70	3.00		9	Very Fine Silty Sand	1.7	16.5	241.2	2.4	1.8	***187.0***	187	117	127	-57	59
386.70	1.00			Shale	49.4	122.5	290.7	72.3	13.4	***259.3***	259	117	127	15	59.8
385.70	1.00			Shale	49.4	122.5	340.1	72.3	13.4	***331.5***	332	117	127	87	60.8
384.70	1.00			Shale	49.4	122.5	***389.5***	72.3	13.4	403.8	389	117	127	145	61.8
383.70	1.00			Shale	49.4	122.5	***438.9***	72.3	13.4	476.0	~~439~~	~~117~~	~~127~~	~~194~~	~~62.8~~
382.70	1.00			Shale	49.4	122.5	***488.3***	72.3	13.4	548.3	~~488~~	~~117~~	~~127~~	~~244~~	~~63.8~~
381.70	1.00			Shale		122.5			13.4						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE===================================== East Abut.
REFERENCE BORING ================================= 2-S
LRFD or ASD or SEISMIC =============================== LRFD
PILE CUTOFF ELEV. =================================== 446.80 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 444.80 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 788 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 39.17 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 160.94 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 60.35 KIPS

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**418** KIPS	**230** KIPS	**59** FT.

PILE TYPE AND SIZE ============= Steel HP 12 X 53
Plugged Pile Perimeter========================== 3.967 FT. Unplugged Pile Perimeter============== 5.800 FT.
Plugged Pile End Bearing Area==================== 0.983 SQFT. Unplugged Pile End Bearing Area======== 0.108 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
443.70	1.10	0.80			2.6		8.1	3.8		***4.4***	4	0	0	2	3
441.20	2.50	0.40			3.1	5.5	14.0	4.6	0.6	***9.3***	9	0	0	5	6
438.70	2.50	0.60			4.6	8.3	***13.0***	6.7	0.9	15.3	13	0	0	7	8
435.70	3.00	0.20			2.0	2.8	66.0	2.9	0.3	***23.8***	24	0	0	13	11
433.70	2.00	3.90	7		14.7	53.7	66.9	21.6	5.9	***43.8***	44	0	0	24	13
431.20	2.50	2.90			14.8	40.0	81.8	21.7	4.4	***65.5***	65	0	0	36	16
428.70	2.50	2.90			14.8	40.0	***81.4***	21.7	4.4	85.5	81	0	0	45	18
426.20	2.50	1.80			10.8	24.8	***86.7***	15.8	2.7	100.6	87	0	0	48	21
423.70	2.50	1.40			9.1	19.3	***93.0***	13.3	2.1	113.6	93	0	0	51	23
421.20	2.50	1.20			8.1	16.5	***101.1***	11.9	1.8	125.5	101	0	0	56	26
418.70	2.50	1.20			8.1	16.5	***109.3***	11.9	1.8	137.4	109	0	0	60	28
416.20	2.50	1.20			8.1	16.5	***116.0***	11.9	1.8	149.1	116	0	0	64	31
413.70	2.50	1.10			7.6	15.2	***125.0***	11.1	1.7	160.4	125	0	0	69	33
411.20	2.50	1.20			8.1	16.5	***127.6***	11.9	1.8	171.7	128	0	0	70	36
406.20	5.00	0.80			11.7	11.0	***143.5***	17.1	1.2	189.3	143	0	0	79	41
401.20	5.00	1.10			15.2	15.2	***157.3***	22.2	1.7	211.3	157	0	0	87	46
398.20	3.00	1.00			8.5	13.8	***156.9***	12.4	1.5	222.7	157	0	0	86	49
391.20	7.00		2	Sandy Gravel	1.3	4.9	275.7	1.9	0.5	***237.5***	237	0	0	131	56
390.20	1.00			Shale	49.4	122.5	325.2	72.3	13.4	***309.7***	310	0	0	170	56.6
389.20	1.00			Shale	49.4	122.5	***374.6***	72.3	13.4	382.0	375	0	0	206	57.6
388.20	1.00			Shale	49.4	122.5	***424.0***	72.3	13.4	454.2	~~424~~	~~0~~	~~0~~	~~233~~	~~58.6~~
387.20	1.00			Shale	49.4	122.5	***473.4***	72.3	13.4	526.5	~~473~~	~~0~~	~~0~~	~~260~~	~~59.6~~
386.20	1.00			Shale		122.5			13.4						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE====================================== East Abut.
REFERENCE BORING ================================= 2-S
LRFD or ASD or SEISMIC =============================== SEISMIC
PILE CUTOFF ELEV. ==================================== 446.80 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 444.80 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD =============== 391.20 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 398.20 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ================= 591 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 39.17 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 120.70 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 45.26 KIPS

PILE TYPE AND SIZE ============= Steel HP 12 X 53
Plugged Pile Perimeter=========================== 3.967 FT. Unplugged Pile Perimeter=============== 5.800 FT.
Plugged Pile End Bearing Area==================== 0.983 SQFT. Unplugged Pile End Bearing Area======== 0.108 SQFT.

MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**375** KIPS	**54** KIPS	**58** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE PLUGGED SIDE RESIST. (KIPS)	ULTIMATE PLUGGED END BRG. RESIST. (KIPS)	ULTIMATE PLUGGED TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
443.70	1.10	0.80			2.6		8.1	3.8		***4.4***	4	3	3	-1	3
441.20	2.50	0.40			3.1	5.5	14.0	4.6	0.6	***9.3***	9	6	6	-3	6
438.70	2.50	0.60			4.6	8.3	***13.0***	6.7	0.9	15.3	13	10	11	-9	8
435.70	3.00	0.20			2.0	2.8	66.0	2.9	0.3	***23.8***	24	12	13	-2	11
433.70	2.00	3.90	7		14.7	53.7	66.9	21.6	5.9	***43.8***	44	27	30	-13	13
431.20	2.50	2.90			14.8	40.0	81.8	21.7	4.4	***65.5***	65	42	46	-22	16
428.70	2.50	2.90			14.8	40.0	***81.4***	21.7	4.4	85.5	81	57	62	-38	18
426.20	2.50	1.80			10.8	24.8	***86.7***	15.8	2.7	100.6	87	67	74	-55	21
423.70	2.50	1.40			9.1	19.3	***93.0***	13.3	2.1	113.6	93	76	84	-68	23
421.20	2.50	1.20			8.1	16.5	***101.1***	11.9	1.8	125.5	101	85	93	-77	26
418.70	2.50	1.20			8.1	16.5	***109.3***	11.9	1.8	137.4	109	93	102	-86	28
416.20	2.50	1.20			8.1	16.5	***116.0***	11.9	1.8	149.1	116	101	111	-96	31
413.70	2.50	1.10			7.6	15.2	***125.0***	11.1	1.7	160.4	125	108	120	-103	33
411.20	2.50	1.20			8.1	16.5	***127.6***	11.9	1.8	171.7	128	117	129	-118	36
406.20	5.00	0.80			11.7	11.0	***143.5***	17.1	1.2	189.3	143	128	141	-126	41
401.20	5.00	1.10			15.2	15.2	***157.3***	22.2	1.7	211.3	157	143	158	-144	46
398.20	3.00	1.00			8.5	13.8	***156.9***	12.4	1.5	222.7	157	152	168	-163	49
391.20	7.00		2	Sandy Gravel	1.3	4.9	275.7	1.9	0.5	***237.5***	237	153	168	-83	56
390.20	1.00			Shale	49.4	122.5	325.2	72.3	13.4	***309.7***	310	153	168	-11	56.6
389.20	1.00			Shale	49.4	122.5	***374.6***	72.3	13.4	382.0	375	153	168	54	57.6
388.20	1.00			Shale	49.4	122.5	***424.0***	72.3	13.4	454.2	~~424~~	~~153~~	~~168~~	~~103~~	~~58.6~~
387.20	1.00			Shale	49.4	122.5	***473.4***	72.3	13.4	526.5	~~473~~	~~153~~	~~168~~	~~153~~	~~59.6~~
386.20	1.00			Shale		122.5			13.4						

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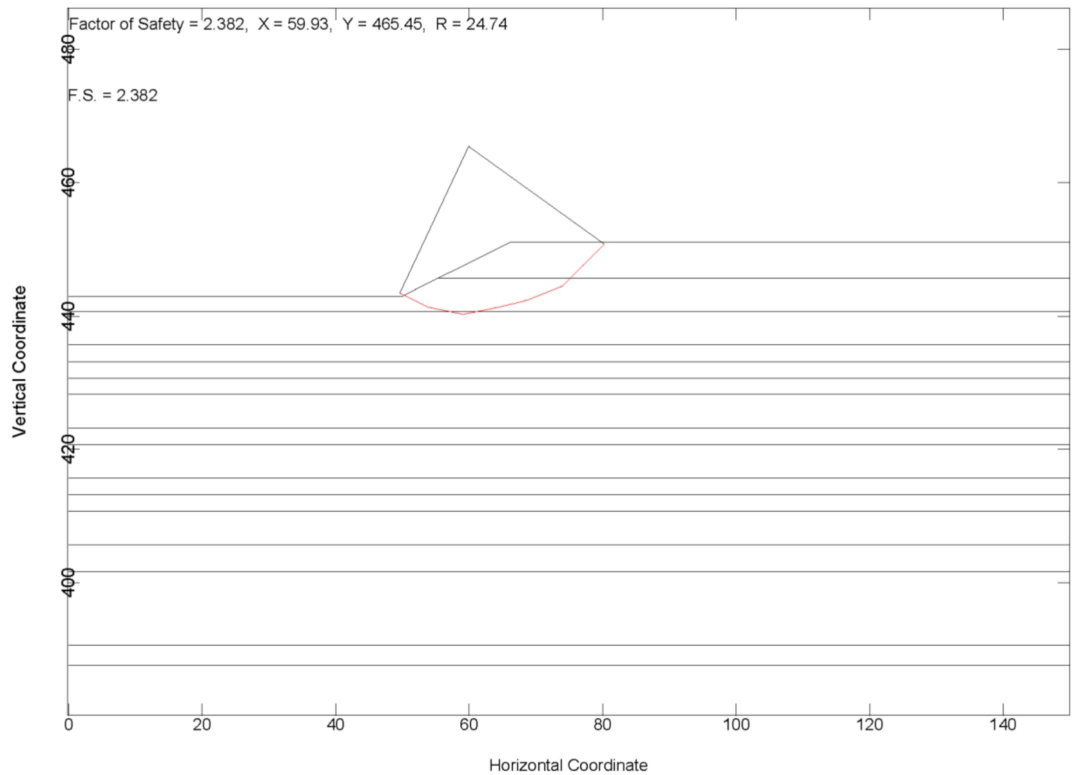
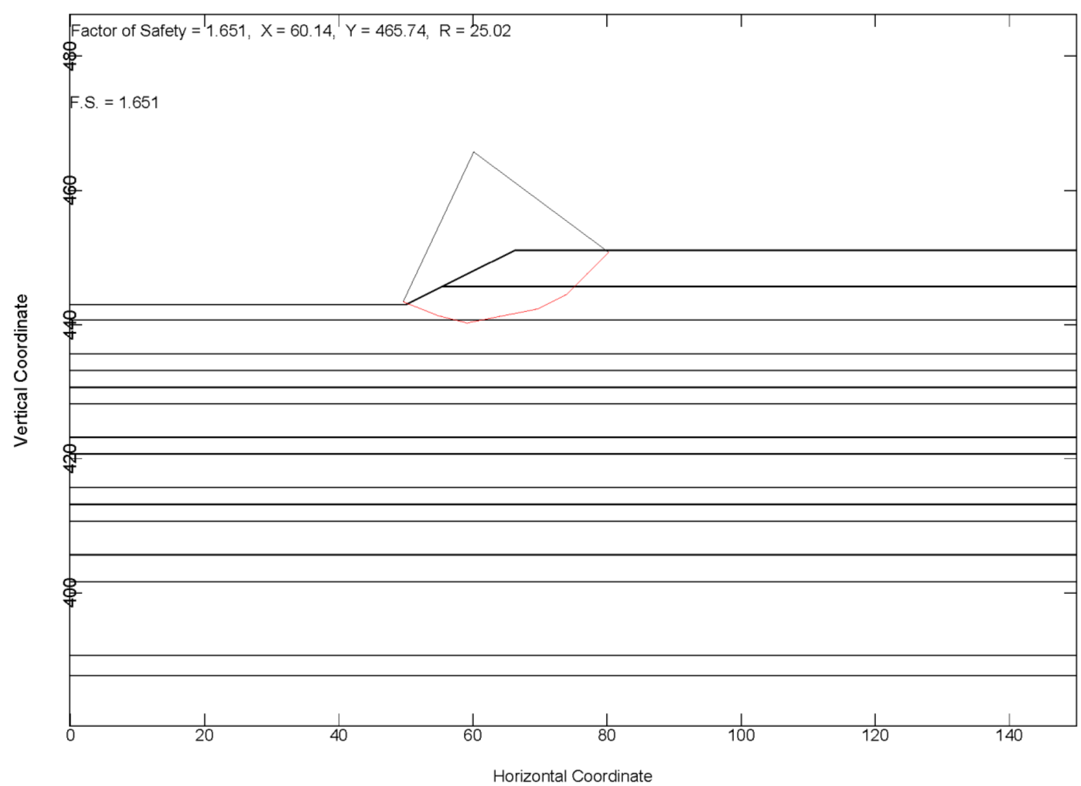
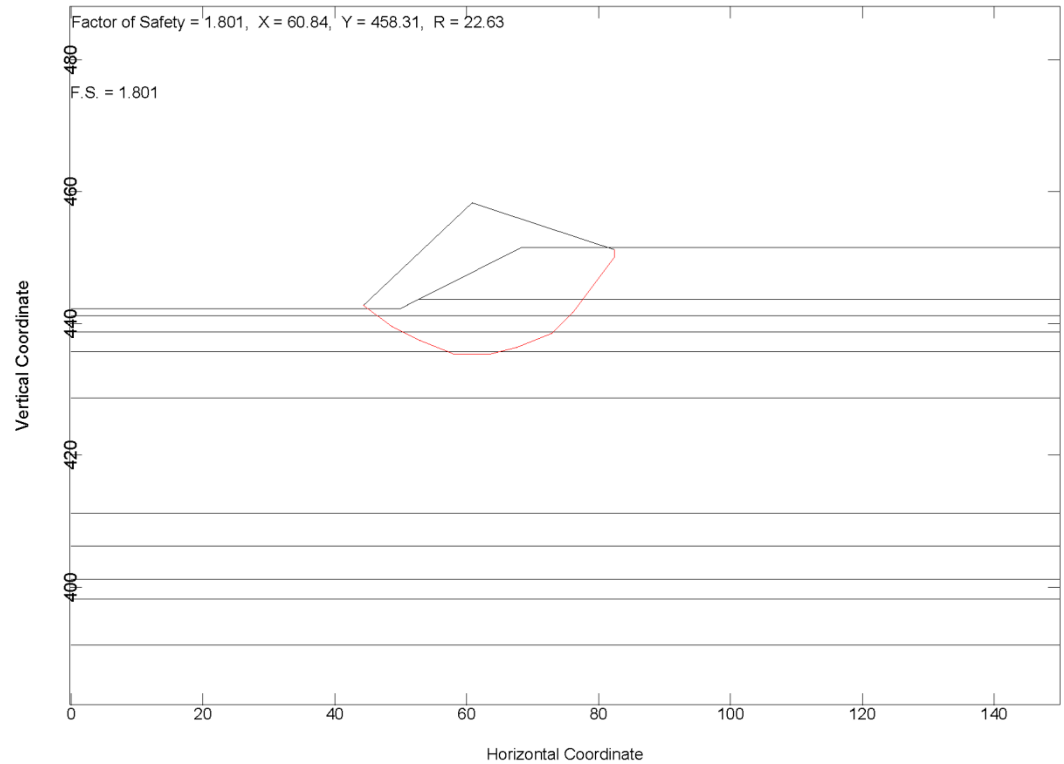
West Abutment (LRFD)



West Abutment (Seismic)



East Abutment (LRFD)



East Abutment (Seismic)