STRUCTURE GEOTECHNICAL REPORT

Proposed SN 041-0113

Existing SN 041-0055

North Avenue (County Highway 42) over I-57
FAS Route 824
Section (41-1)BR-1
Jefferson County

PTB 178 - Item 19
Contract No. 78455
Job No. D-99-015-15

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Revised: 12/14/2017

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Project Description and Scope

This project involves the complete replacement of an existing bridge carrying North Avenue (CH 42) over I-57 in Jefferson County. The project site is located on the border of Sections 19 and 30, Range 3E, Township 4S, in the 3rd Principal Meridian at the Ina Interchange. A *Location Map* is presented in Exhibit A.

The existing bridge at this location, SN 041-0055, was constructed in 1965. It is a four span structure with continuous steel beams and concrete deck slab supported on hammerhead piers and open stub abutments. The piers and abutments are supported on steel piles. The existing plans call for the piles to be driven to refusal with an estimated 32-37 foot length at the abutments and 17-20 foot length at the piers. Concrete slope walls are present within the outer spans of the bridge. The bridge measures 223'-8" back to back abutments and 34'-0" out to out, with a 4°-30' right ahead skew.

Per the preliminary Type, Size & Location Plan (TSL), the proposed structure is a 2 span bridge with 48" web steel plate girders supported on integral abutments and a multi-column pier. The proposed structure will have a back-to-back abutment length of 213'-8", out-to-out width of 35'-2" and 4°-30' right ahead skew. The roadway will be on a horizontal tangent alignment and a crest vertical curve. The proposed abutments will be constructed on existing embankments, with the profile raised by over two feet. Traffic will be maintained utilizing stage construction. The new abutment and pier foundations will be located to avoid conflict with the existing steel piles. The new structures are 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 the middle of a diamond interchange. The town of Ina is directly to the east of the interchange while to the west is heavily wooded prior to reaching Rend Lake. The structure crosses over I-57, which is approximately 132 feet wide from out to out of shoulders. No utilities were identified near the structure.

The subsurface investigation consisted of three borings (1-S (2017), 2-S (2017), and 3-S (2017)) drilled by IDOT District 9 personnel in March of 2017. The original 1962 borings (1, 2, 3, 4, and 5) were also provided. 1-S was drilled in the embankment behind the west abutment; 2-S was drilled just inside the inside shoulder of NB I-57, east of the proposed pier; 3-S was drilled in the embankment behind the east abutment. 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. Boring depths range from 35 to 60 feet and were terminated in hard clay shale.

Subsurface Conditions

While drilling, groundwater was encountered at an elevation between 403.7and 405.9 for all 2017 borings.

Boring 1-S: Starting at ground surface, the boring data depicts stiff to very stiff grey and brown clay and silty clay to an elevation of 419.7, with Q_u values from 1.2 to 2.9 tsf, SPT (N) values ranging from 5 to 10 blows per foot, and moisture contents ranging between 19% and 28%. Stiff grey silty loam to silty clay loam is present down to elevation 417.7, with a Q_u value of 1.6 tsf, an SPT (N) value of 12 blows per foot, and a moisture content of 16%. Very stiff grey clay with layers of silt is present down to elevation 412.7, with Q_u values of 3.1 tsf, SPT (N) values ranging from 14 to 17 blows per foot, and moisture contents ranging between 23% and 25%. Medium grey silty clay to clay is present down to elevation 410.2, with a Q_u value of 0.8 tsf, an SPT (N) value of 6 blows per foot, and a moisture content of 28%. Stiff to very stiff grey and brown clay to silty clay is present down to elevation 405.2, with Q_u values from 1.5 to 2.1tsf, SPT (N) values ranging from 6 to 7 blows per foot, and moisture contents ranging between 22% and 23%. Medium to stiff yellow brown and grey clay with sand is present down to elevation 402.7, with a Q_u value of 1.0 tsf, an SPT (N) value of 5 blows per foot, and a moisture content of 27%. Very stiff to hard grey and brown clay to clay loam is present down to elevation 396.7, with Q_u values from 2.3 to 5.0 tsf, SPT (N) values ranging from 22 to 34 blows per foot, and moisture contents ranging between 13% and 24%. Hard black coal is present down to elevation 394.2, with an SPT (N) value of 72 blows per foot, and no moisture content readings. Hard grey clay shale and weathered clay shale is present down to elevation 379.7, with SPT (N) values of over 100 blows per foot and no moisture content readings.

Boring 2-S: Starting at ground surface, the boring data depicts stiff to very stiff grey and brown silty clay and clay to an elevation of 403.7, with Q_u values from 1.3 to 2.5 tsf, SPT (N) values ranging from 6 to 7 blows per foot, and moisture contents ranging between 17% and 28%. Soft brown sandy clay loam is present down to elevation 401.2, with a Q_u value of 0.4 tsf, an SPT (N) value of 3 blows per foot, and a moisture content of 18%. Very stiff yellow brown and grey clay to weathered shale is present down to elevation 393.2, with Q_u values of 2.4 to 2.8 tsf, SPT (N) values ranging from 16 to 23 blows per foot, and moisture contents ranging between 19% and 23%. Hard black coal and grey sandy clay shale is present down to elevation 383.2, with SPT (N) values of over 100 blows per foot and no moisture content readings.

Boring 3-S: Starting at ground surface, the boring data depicts stiff to very stiff grey and brown clay, silty clay and clay loam to an elevation of 405.9, with Q_u values from 1.1 to 2.5 tsf, SPT (N) values ranging from 5 to 11 blows per foot, and moisture contents ranging between 18% and 25%. Stiff brown sandy loam to sandy clay loam is present down to elevation 400.9, with Q_u values from 1.1 to 1.2 tsf, SPT (N) values ranging from 13 to 18 blows per foot, and moisture contents ranging between 19% and 21%. Very stiff brown and grey clay to weathered clay shale is present down to elevation 396.9, with a Q_u value of 3.1 tsf, an SPT (N) value of 32 blows per foot, and a moisture content of 20%. Hard grey clay shale and weathered clay shale is present down to elevation 380.4, with SPT (N) values of 69 to over 100 blows per foot and no moisture content readings.

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 2.06 to 2.08 feet at the abutments. The proposed abutments will be located just in front of the existing abutments on existing embankments, resulting in calculated settlement of less than 0.4 inches. Since the settlement is negligible, downdrag forces are not 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 20'-11" high 2H:1V (at right angles) end slope model which rendered factor of safety of 3.41. The east abutment used a 21'-5" high 2H:1V (at right angles) end slope model which rendered factor of safety of 2.96. The Seismic slope stability was also analyzed and yielded factors of safety of 2.33 and 2.00 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 all of the abutments is 0.15g. Slope stability analyses are presented in Exhibit G. No stability problems are expected.

Seismic Considerations

Based on the method described in the IDOT Design Guide LRFD Soil Site Class Definition, Soil Site Class C controls. The Design Spectral Acceleration at 1.0 sec (S_{D1}) is 0.229g and at 0.2 sec (S_{Ds}) is 0.633g. These values are based on a 1000 year design return period earthquake. According to AASHTO LRFD 3.10.6 the Seismic Performance Zone is 2 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. Calculations indicate no liquefiable soils at this location. See Exhibit E.

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 1.2 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., for both bridges. The Extreme Event I load combination was estimated to be 75% of Strength I.

Strength I Load Combination

West Abutment	770 kips
Pier	1920 kips
East Abutment	770 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 except metal shell and HP 8x36 are permissible with an effective expansion length of 123.19'. 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 does not include a seismic case since no liquefiable soils are present. 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 and 2. The estimated lengths include a 2 foot embedment into the abutment cap and are based on top of pile elevations of 435.33 at the west abutment and 435.80 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 50 ft for HP 8's, 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 SN 041-0113 Strength Limit State	HP 10x42	116	64	30	405.3	0
		138	76	35	400.3	0
		203	112	39	396.3	0.4
		335	184	42	393.3	3.4
	HP 12x53	112	62	23	412.3	0
		128	70	25	410.3	0
		142	78	30	405.3	0
		171	94	35	400.3	0
		243	134	39	396.3	0.4
		418	230	42	393.3	3.4
	HP 12x63	113	62	23	412.3	0
		129	71	25	410.3	0
		144	79	30	405.3	0
		173	95	35	400.3	0
		249	137	39	396.3	0.4
		497	273	44	391.3	5.4

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 SN 041-0113 Strength Limit State	HP 14x73	105	58	16	419.3	0
		130	71	18	417.3	0
		135	74	23	412.3	0
		156	86	25	410.3	0
		172	94	30	405.3	0
		209	115	35	400.3	0
		295	162	39	396.3	0.4
		578	318	43	392.3	4.4
	HP 14x89	106	58	16	419.3	0
		132	73	18	417.3	0
		137	75	23	412.3	0
		158	87	25	410.3	0
		174	96	30	405.3	0
		212	117	35	400.3	0
		301	166	39	396.3	0.4
		705	388	45	390.3	6.4

Table 1 (continued)

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 SN 041-0113 Strength Limit State	HP 10x42	117	64	32	403.8	0
		153	84	35	400.8	0
		183	100	39	396.8	0.1
		335	184	43	392.8	4.1
	HP 12x53	105	58	22	413.8	0
		124	68	25	410.8	0
		132	73	27	408.8	0
		134	74	30	405.8	0
		143	79	32	403.8	0
		194	106	35	400.8	0
		219	120	39	396.8	0.1
		418	230	43	392.8	4.1
	HP 12x63	106	58	22	413.8	0
		125	69	25	410.8	0
		133	73	27	408.8	0
		135	75	30	405.8	0
		145	80	32	403.8	0
		196	108	35	400.8	0
		224	123	39	396.8	0.1
		497	273	44	391.8	5.1

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 SN 041-0113 Strength Limit State	HP 14x73	103	57	15	420.8	0
		122	67	17	418.8	0
		124	68	20	415.8	0
		128	70	22	413.8	0
		152	84	25	410.8	0
		162	89	27	408.8	0
		173	95	32	403.8	0
		242	133	35	400.8	0
		265	146	39	396.8	0.1
		578	318	44	391.8	5.1
	HP 14x89	105	58	15	420.8	0
		123	68	17	418.8	0
		126	69	20	415.8	0
		129	71	22	413.8	0
		154	85	25	410.8	0
		164	90	27	408.8	0
		175	96	32	403.8	0
		246	135	35	400.8	0
		271	149	39	396.8	0.1
		705	388	46	389.8	7.1

Table 2 (continued)

Pier

There are several options for the type of foundation at the pier: Spread footing bearing on soil, pile-supported footing, encased pile bent, or drilled shaft foundation.

Spread Footing on Soil: Due to the soil layers with Qu less than 2.0 tsf at the pier and the rock layer over 25 feet deep, it is not recommended to use spread footings.

Pile Supported: Per the preliminary TSL, a multi-column pier with two rows of piles in the footing are anticipated. Pile size calculations are presented in Exhibit F and summarized in Table 3. The estimated lengths include 1 ft embedment into the pier footing and are based on top of pile elevations of 415.00. Analyses have been performed using the Modified IDOT Static Method for estimating nominal pile resistance. Tables include strength limit state. R_n values in tables represent the maximum nominal required bearing.

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)
Pier SN 041-0113 Strength Limit State	HP 10x42	321	177	26	389.0	4.2
	HP 12x53	407	224	26	389.0	4.2
	HP 12x63	461	254	27	388.0	5.2
	HP 14x73	132	73	19	396.0	0
		171	94	22	393.0	0.2
		578	318	28	387.0	6.2
	HP 14x89	134	74	19	396.0	0
		176	97	22	393.0	0.2
		705	388	30	385.0	8.2

Table 3

Drilled Shafts: If it is determined in the final design that the proposed piles do not develop sufficient resistance, drill shafts set into rock are feasible, but would require rock cores for more accurate calculations.

Lateral Loading Analysis

Tables 4 thru 6 provide soil parameters for the LPile program (or other approved programs) for the structural engineer to perform the lateral analysis of the foundations.

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
Stiff Clay	432.7	0.074	-	500	12	0.007
Stiff Silty Clay to Clay	427.7	0.073	-	500	11	0.007
Stiff Clay	425.2	0.073	-	500	10	0.007
Very Stiff Clay to Silty Clay	419.7	0.077	-	1000	19	0.005
Stiff Silty Loam to Silty Clay Loam	417.7	0.074	-	500	11	0.007
Very Stiff Clay	412.7	0.078	-	1000	22	0.005
Medium Silty Clay to Clay	410.2	0.069	-	100	6	0.010
Stiff Clay to Silty Clay	407.7	0.073	-	500	10	0.007
Very Stiff Clay	405.2	0.075	-	1000	15	0.005
Medium to Stiff Clay with Sand	402.7	0.034	-	100	7	0.010
Hard Clay to Clay Loam	400.2	0.046	-	2000	35	0.004
Very Stiff Clay	396.7	0.040	-	1000	16	0.005

Table 4 –West Abutment (1-S)

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Very Stiff Silty Clay to Clay	413.7	0.077	-	1000	17	0.005
Stiff Clay	408.7	0.072	-	500	9	0.007
Very Stiff Clay	406.2	0.075	-	1000	15	0.005
Stiff Clay	403.7	0.036	-	500	10	0.007
Soft Sandy Clay Loam	401.2	0.028	-	30	3	0.020
Very Stiff Clay	398.7	0.041	-	1000	19	0.005
Very Stiff Clay to Weathered Clay Shale	393.2	0.040	-	1000	17	0.005

Table 5 –Pier (2-S)

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Stiff Clay	430.9	0.073	-	500	10	0.007
Very Stiff Clay	428.4	0.077	-	1000	17	0.005
Stiff Clay	425.9	0.074	-	500	11	0.007
Stiff Silty Clay Loam	423.4	0.073	-	500	10	0.007
Very Stiff Silty Clay to Clay	415.9	0.076	-	1000	15	0.005
Stiff Silty Clay to Clay	410.9	0.072	-	500	9	0.007
Stiff Clay	408.4	0.075	-	500	13	0.007
Stiff Clay to Clay Loam	405.9	0.038	-	500	12	0.007
Stiff Sandy Loam to Sandy Clay Loam	400.9	0.035	-	500	8	0.007
Very Stiff Clay to Weathered Clay Shale	396.9	0.042	-	1000	22	0.005

Table 6 –East Abutment (3-S)

Construction Considerations

Stage Construction

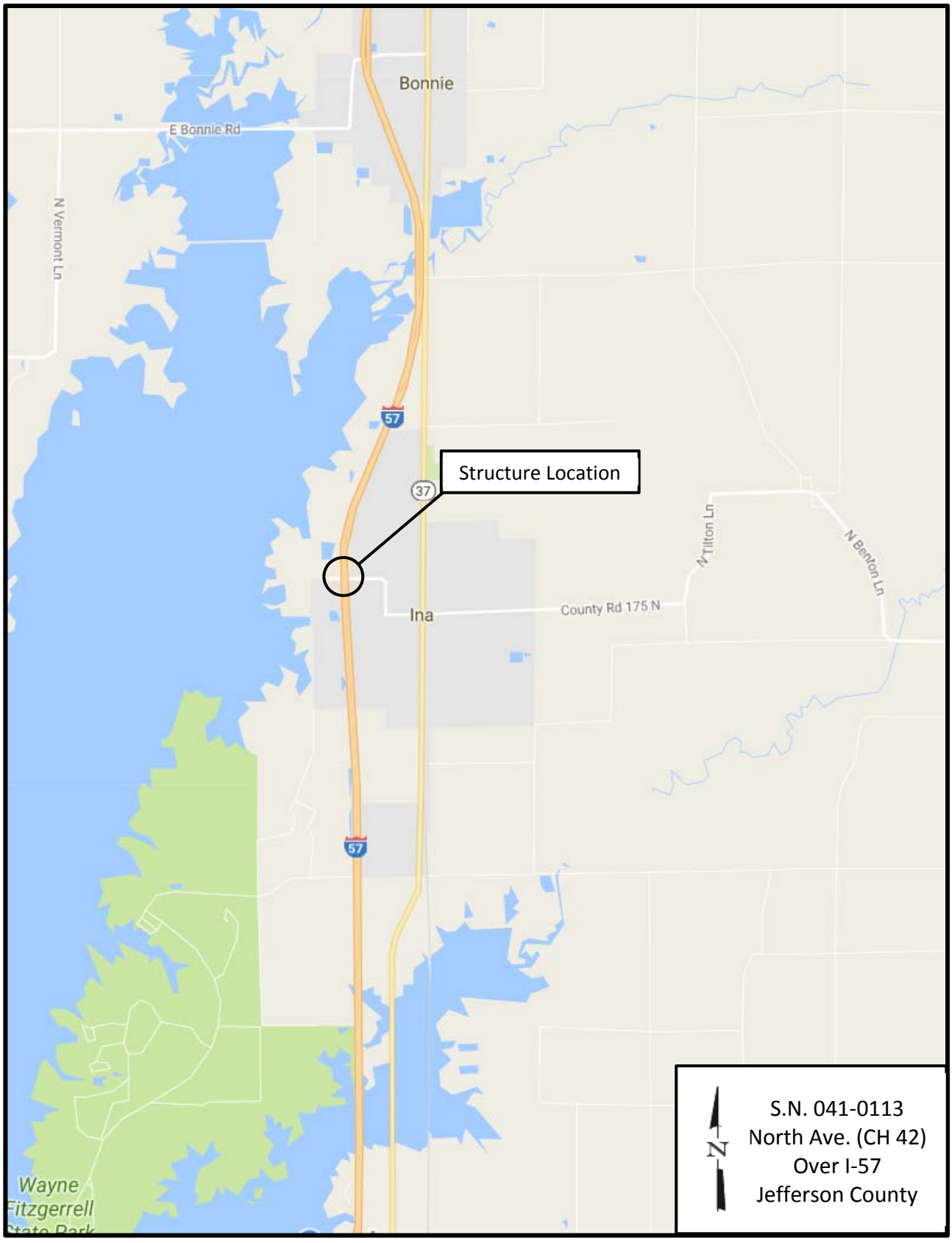
Traffic is expected to be maintained on North Avenue (CH 42) utilizing stage construction. A temporary soil support system will be required between the stage construction of the new bridge and the stage removal of the old bridge. Preliminary calculations show Temporary Sheet Piling is feasible for the 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 1.5V:1H excavation slope may be more appropriate.

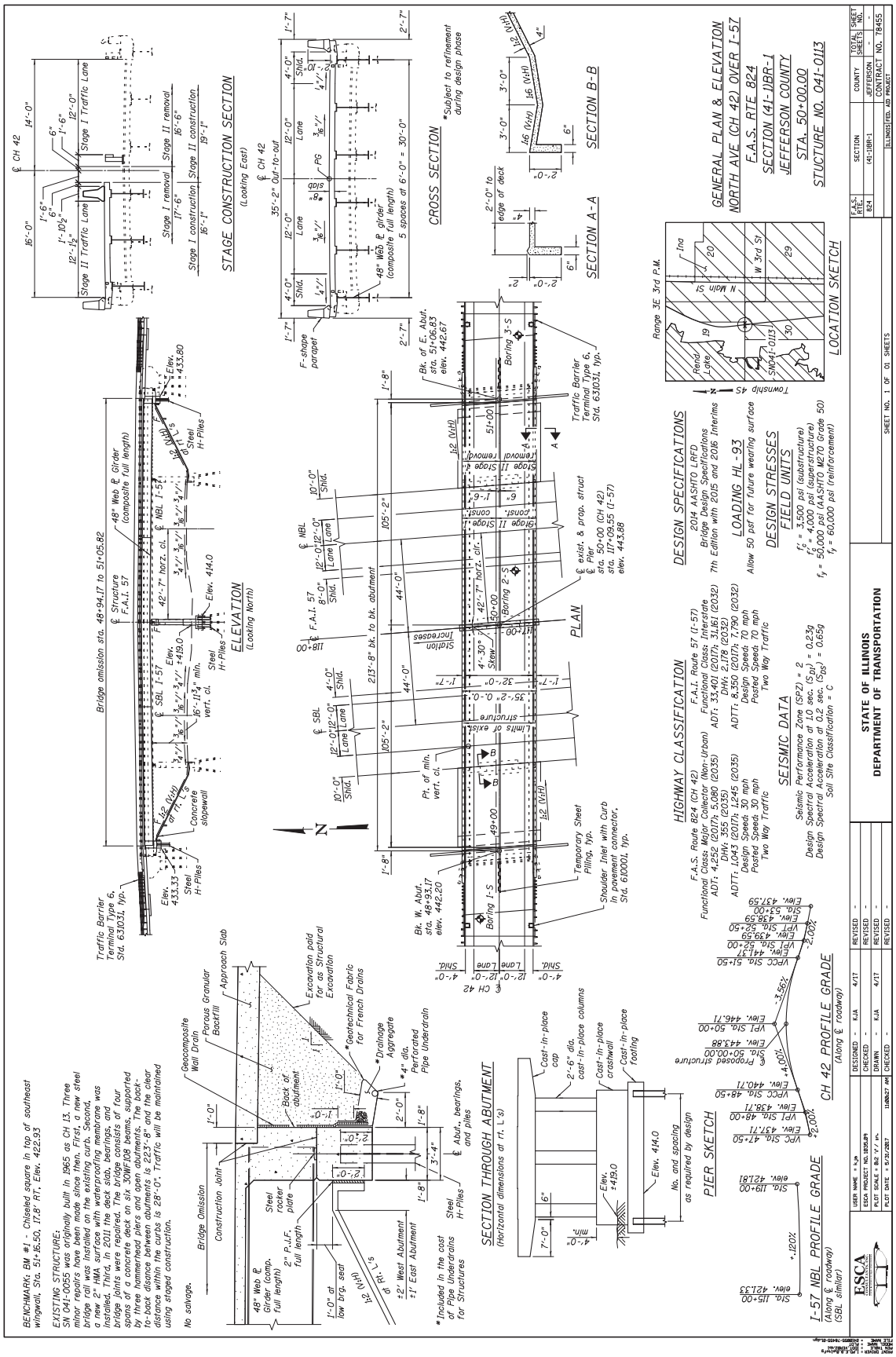
Foundation Construction

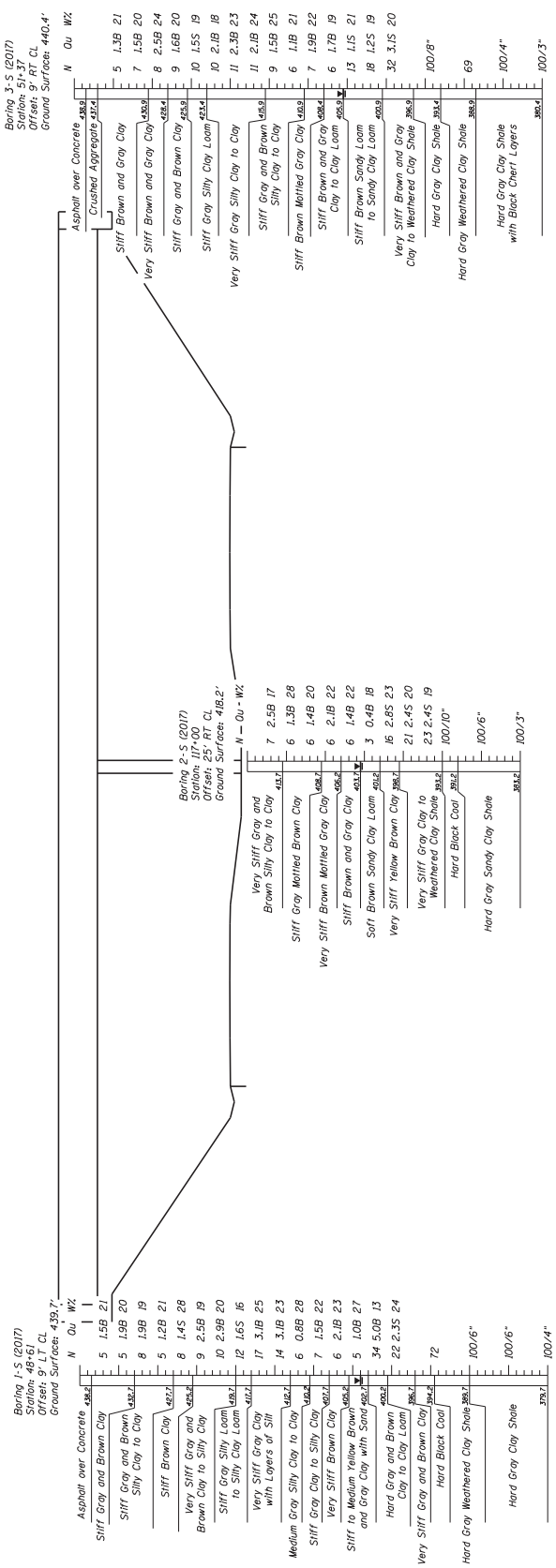
Since the soil borings consistently show the rock layers beginning near elevation 396, it is recommended to only provide one test pile for the proposed bridge if all of the piles will be driven to rock. Alternatively, it is recommended to provide one test pile per substructure unit if friction piles are used. Pile shoes are not required for driving into shale layers.

Limitations

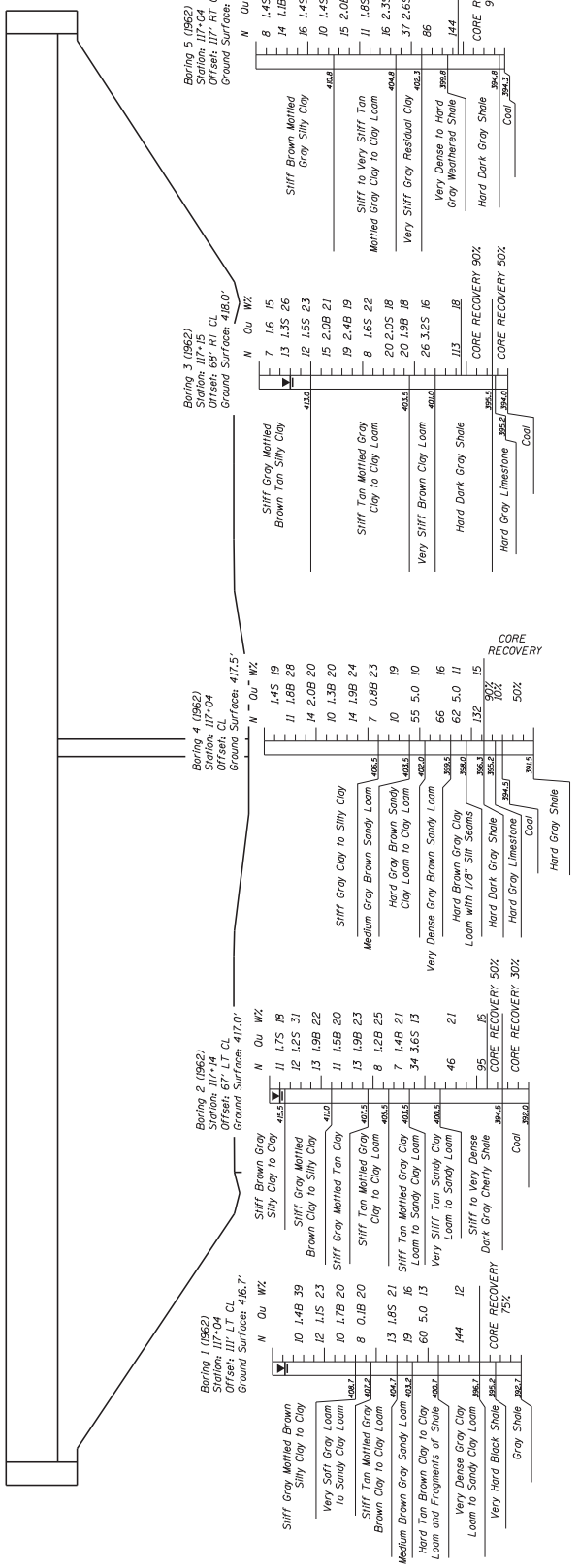
The recommendations provided herein are for the exclusive use of IDOT and ESCA Consultants, Inc. They are specific only to the project described, and are based on subsurface information obtained at boring locations within the bridge area, our understanding of the project as described herein, and geotechnical 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.


Bonnie
E Bonnie Rd
N Vermont Ln
57
37
Structure Location
Ina
County Rd 175 N
N Tilton Ln
N Benton Ln
57
Wayne
Fitzgerrell
S.N. 041-0113
North Ave. (CH 42)
Over I-57
Jefferson County
N


GENERAL PLAN & ELEVATION
NORTH AVE (CH 421) OVER I-57
F.A.S. RTE 824
SECTION (41-1)BR-1
JEFFERSON COUNTY
STA. 50+00.00
STUCTURE NO. 041-0113
LOCATION SKETCH
DESIGN SPECIFICATIONS
2014 AASHTO LRFD
Bridge Design Specifications
7th Edition with 2015 and 2016 Interims
LOADING HL-93
Allow 50 psf for future wearing surface
DESIGN STRESSES
FIELD UNITS
HIGHWAY CLASSIFICATION
SEISMIC DATA
STAGE CONSTRUCTION SECTION
(Looking East)
ELEVATION
(Looking North)
CROSS SECTION
*Subject to refinement during design phase
PLAN
SECTION A-A
SECTION B-B
SECTION THROUGH ABUTMENT
(Horizontal dimensions at ℄ L's)
PIER SKETCH
I-57 NBL PROFILE GRADE
(Along ℄ roadway)
(SBL similar)
CH 42 PROFILE GRADE
(Along ℄ roadway)
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
ESCA
LIN ENGINEERING, LTD.
Consulting Engineers
SHEET NO. 1 OF 01 SHEETS
ILLINOIS FED. AID PROJECT



2017 BORINGS
SUBSURFACE DATA PROFILE
NORTH AVE (CH 42) OVER I-57
F.A.S. RTE. 824
SEC. (41-1) BR-1
JEFFERSON COUNTY
STATION 50+00.00
STRUCTURE NO. 041-0113



1962 BORINGS
SUBSURFACE DATA PROFILE
NORTH AVE (CH 42) OVER I-57
F.A.S. RTE. 824
SEC. (41-1) BR-1
JEFFERSON COUNTY
STATION 50+00.00
STRUCTURE NO. 041-0113

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Dave Piche
From:	Rob Graeff	By: Rich Moberly
Subject:	*Boring Logs	
Date:	April 6, 2017	

SN 041-0055
Ina Interchange
FAS 824 (North Ave.) over FAI 57
Jefferson County

Foundation boring logs have been obtained for the above listed structure and are attached. Also attached are boring logs from 1962 which were obtained for the original construction of the interchange.

Liquefaction Analysis
Liquefaction calculations indicate no liquefiable soils at this structure location.

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

FAS 824 (North Ave) Over FAI 57

Route: FAS 824 Structure Number: 041-0055 Date: 3/28/2017

Section 41-1HB-1 Bored By: R Moberly

County: Jefferson Location: Ina Interchange Checked By: R Moberly

Boring No 1-S (2017)
Station 48+61
Offset 9' Lt CL
Ground Surface 439.7 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 403.7
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Asphalt over Concrete	Cored			Very stiff, moist, grey, Clay A7-6	6	3.1B	23
438.2				with layers of Silt	8		
Stiff, moist, grey and brown,	2			412.7			
Clay A7-6	2	1.5B	21	Medium, very moist, grey, Silty	1		
	3			Clay to Clay A-6	3	0.8B	28
5.0	1			410.2	3		
	2	1.9B	20	Stiff, moist, grey, Clay to Silty	1		
	3			30.0 Clay A7-6	4	1.5B	22
432.7				407.7	3		
Stiff, moist, grey and brown,	2			Very stiff, moist, brown, Clay	1		
Silty Clay to Clay A7-6	3	1.9B	19	A7-6	3	2.1B	23
	5				3		
10.0	1			405.2			
	2	1.2B	21	Stiff to medium, moist to very	1		
	3			35.0 moist, yellow brown and grey,	2	1.0B	27
427.7				Clay A7--6 with Sand	3		
Stiff, moist, brown, Clay A7-6	1			402.7			
	3	1.4S	28	Hard, damp, grey and brown,	5		
	5			Clay to Clay Loam A-6	14	5.0B	13
425.2				400.2	20		
Very stiff, moist, grey and brown,	1			Very stiff, moist, grey and brown,	4		
15.0 Clay to Silty Clay A7-6	4	2.5B	19	40.0 Clay A7-6	8	2.3S	24
	5				14		
	1			396.7			
	4	2.9B	20	Hard, dry, black Coal			
	6						
419.7							
20.0	1			45.0	17		
Stiff, damp to moist, grey, Silty	4	1.6S	16	394.2	40		
Loam to Silty Clay Loam A-4	8			Hard, moist, grey, Weathered	32		
417.7				Clay Shale			
Very stiff, moist, grey, Clay A7-6	1						
with layers of Silt	6	3.1B	25				
	11						
25.0	1			389.7	50.0	12	

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: FAS 824
Section: 41-1HB-1
County: Jefferson
Date: 3/28/2017

Boring No: 1-S (2017)
Station: 48+61
Offset: 9' Lt CL
Ground Surface: 439.7 Ft

	DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Hard, dry, grey, Clay Shale		100/6"						
		100/6"						
	55.0				80.0			
379.7	60.0	100/4"			85.0			
Bottom of hole = 59.8 feet								
Free water observed at 36.0 feet								
Elevation referenced to BM at SE wingwall; Elevation = 442.9 feet	65.0				90.0			
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)								
To convert "N" values to "N60" multiply by 1.25								
	70.0				95.0			
	75.0				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 1

FAS 824 (North Ave) Over FAI 57

Route: FAS 824 Structure Number: 041-0055 Date: 3/29/2017

Section 41-1HB-1 Bored By: R Moberly

County: Jefferson Location: Ina Interchange Checked By: R Moberly

Boring No 2-S (2017)
Station 117+00
Offset 25' Rt CL
Ground Surface 418.2 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 403.7
At Completion
At: Hrs:

	DEPTH	BLOWS	Qu tsf	W%
Very stiff, moist, grey and brown, Silty Clay to Clay A7-6				
		2		
		3	2.5B	17
		4		
413.7				
Stiff, moist, grey mottled brown, Clay A7-6	5.0	1		
		3	1.3B	28
		3		
		1		
		3	1.4B	20
		3		
408.7				
Very stiff, moist, brown mottled grey, Clay A7-6	10.0	1		
		3	2.1B	22
		3		
406.2				
Stiff, moist, brown and grey, Clay A7-6		1		
		3	1.4B	22
		3		
403.7				
Soft, very moist to wet, brown, Sandy Clay Loam A-4	15.0	1		
		1	0.4B	18
		2		
401.2				
Very stiff, moist, yellow brown, Clay A7-6		2		
		6	2.8S	23
		10		
398.7				
Very stiff, damp, grey, Clay to Weathered Clay Shale	20.0	2		
		8	2.4S	20
		13		
		2		
		9	2.4S	19
		14		
393.2	25.0	11		

	DEPTH	BLOWS	Qu tsf	W%
Hard, dry, black, Coal		100/10"		
391.2				
Hard, dry, grey, Sandy Clay Shale				
	30.0	100/6"		
383.2	35.0	100/3"		
Bottom of hole = 34.8 feet				
Free water observed at 14.5 feet				
Elevation referenced to BM at SE wingwall; Elevation = 442.9 feet				
	40.0			
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
To convert "N" values to "N60" multiply by 1.25				
	45.0			
	50.0			

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

FAS 824 (North Ave) Over FAI 57

Route: FAS 824 Structure Number: 041-0055 Date: 3/28/2017

Section 41-1HB-1 Bored By: R Moberly

County: Jefferson Location: Ina Interchange Checked By: R Moberly

Boring No 3-S (2017)
Station 51+37
Offset 9' Rt CL
Ground Surface 440.4 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 405.9
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Asphalt over Concrete				Stiff, moist, grey and brown, Silty	4	1.5B	25
438.9				Clay to Clay A7-6	5		
Crushed aggregate							
437.4					1		
Stiff, moist, brown and grey,					3	1.1B	21
Clay A7-6					3		
				410.9			
5.0	1			Stiff, moist, brown mottled grey, 30.0	1		
	2	1.3B	21	Clay A7-6	3	1.9B	22
	3				4		
				408.4			
	1			Stiff, moist, brown and grey, Clay	1		
	3	1.5B	20	to Clay Loam A7-6	3	1.7B	19
	4				3		
430.9				405.9			
Very stiff, moist, brown and grey, 10.0	1			Stiff, moist to very moist, brown, 35.0	3		
Clay A7-6	3	2.5B	24	Sandy Loam to Sandy Clay Loam	6	1.1S	21
	5			A-4	7		
428.4							
Stiff, moist, grey and brown,	1				2		
Clay A7-6	4	1.6B	20		8	1.2S	19
	5				10		
425.9				400.9			
Stiff, moist, grey, Silty Clay Loam 15.0	2			Very stiff, moist, brown and grey, 40.0	4		
A-4	4	1.5S	19	Clay to Weathered Clay Shale	10	3.1S	20
	6			A7-6	22		
423.4							
Very stiff, moist, grey, Silty Clay to	2						
Clay A-6	4	2.1B	18				
	6			396.9			
				Hard, dry, grey, Clay Shale			
20.0	2			45.0	15		
	5	2.3B	23		100/8"		
	6						
				393.4			
	2						
	4	2.1B	24	Hard, damp, grey, Weathered			
	7			Clay Shale			
415.9							
25.0	1			50.0	12		

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: FAS 824
Section: 41-1HB-1
County: Jefferson
Date: 3/28/2017

Boring No: 3-S (2017)
Station: 51+37
Offset: 9' Rt CL
Ground Surface: 440.4 Ft

	DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Hard, damp, grey, Weathered Clay Shale		29 40						
388.9								
Hard, dry, grey, Clay Shale with black Chert layers								
	55.0	100/4"			80.0			
380.4	60.0	100/3"			85.0			
Bottom of hole = 59.8 feet Free water observed at 34.5 feet Elevation referenced to BM at SE wingwall; Elevation = 442.9 feet Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.) To convert "N" values to "N60" multiply by 1.25	65.0				90.0			
	70.0				95.0			
	75.0				100.0			

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

M NO. B.D. 137 REV. 9-60 041-0055 Sh. 1 of 5 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT I-57-2(32)81 BRIDGE SA Route 13 Date March 9, 1962
ROUTE FAI 57 over FAI Rt. 57 Bored By J. R. Wall & F.Beck
SEC. 41-1HB-1 STA. 117+09.55 Checked By J. J. Klay
COUNTY Jefferson
Boring No. 1
Station 117+04
Offset 111' Lt.Sur.℄
Surface Water El. ____
Groundwater El. at Completion 415.5
After ___ Hours ____

Elevation	Z	t/s.f. J O	w (%)	Description
416.7				Ground Surface
				Stiff, grey mottled brown, SILTY CLAY to CLAY
	10	1.4 B	39	
-5	12	1.1 S	23	
	10	1.7 B	20	
408.7				
	8	0.1 B	20	Very soft, wet, grey, LOAM to SANDY CLAY LOAM
407.2				
-10				Stiff, tan mottled grey brown, CLAY to CLAY LOAM
404.7	13	1.8 S	21	
				Medium, brown grey, water bearing, SANDY LOAM
403.2	19		16	
				Hard, tan brown, CLAY to CLAY LOAM and fragments of SHALE
-15	60	5.0 *	13	
				Penetrometer value
400.7				
				Very dense, grey, CLAY LOAM to SANDY CLAY LOAM
	144		12	
396.7 -20				
395.9				
395.2	CORE			SHALE, very hard, black
				SHALE, grey core recovery 75%
392.7	CORE			Extent of Exploration
				**Very hard, grey, LIMESTONE Core recovery 50%
-25				
-30				
-35				
-40				
-45				

Standard Penetration Test - ws per foot to drive 2" I. Split Spoon Sampler 12" with # hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

ORM NO. B.D. 137 REV. 9-60 041-0055 Sh. 2 of 5

BRIDGE FOUNDATION BORING LOG

PROJECT I-57-2(32)81 BRIDGE SA Route 13 Date March 13, 1962
ROUTE FAI 57 over FAI Route 57 Bored By J. R. Wall / F. H. Beck
SEC. 41-1HB-1 STA. 117+09.55 Checked By J. J. Klay
COUNTY Jefferson

Boring No. 2
Station 117+14
Offset 67' Lt.Sur. ℄

Surface Water El. ____
Groundwater El. at Completion 416.0
After ___ Hours ____

Elevation	Z	t/s.f. J	t/s.f. O	w (%)
Ground Surface 417.00				
Stiff, brown grey, SILTY CLAY to CLAY	11	1.7	S	18
415.5				
Stiff, grey mottled brown, CLAY to SILTY CLAY	12	1.2	S	31
-5	13	1.9	B	22
411.0				
Stiff, grey mottled tan, CLAY	11	1.5	B	20
	13	1.9	B	23
407.5 -10				
Stiff, tan mottled grey, CLAY to CLAY LOAM	8	1.2	B	25
405.5				
Stiff, tan mottled grey, CLAY LOAM to SANDY CLAY LOAM	7	1.4	B	21
403.5				
Very stiff, tan, SANDY CLAY LOAM to	34	3.6	S	13
-15 SANDY LOAM				
400.5				
Stiff to very dense, dark grey, very damp, CHERTY SHALE	46			21
core recovery 50% -20				
	95			16
394.5	CORE			

Elevation	Z	t/s.f. J	t/s.f. O
394.5			
COAL	CORE		
core recovery 30%			
392.5			
392.0-25 Extent of Exploration			
*Dark grey SHALE core recovery 60%			
-30			
-35			
-40			
-45			

I - Standard Penetration Test - llows per foot to drive 2" I.D, Split Spoon Sampler 12" with 40# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of over dry weight %

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

M NO. B D 137 REV. 9-60 041-0055 Sh. 3 of 5 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT I-57-2(32)81 BRIDGE SA Route 13 Over FAI Route 57 Date March 13, 1962
ROUTE FAI 57 Bored By J. R. Wall / F. H. Beck
SEC. 41-1HB-1 STA. 117+09.55 Checked By J. J. Klay
COUNTY Jefferson
Boring No. 3
Station 117+15
Offset 68' Rt. Sur. ℄
Surface Water El. ____
Groundwater El. at Completion 415.0
After ___ Hours ____

Elevation	Z	t/s.f. J O	w (%)
Ground Surface 418.00			
penetrometer value	7	1.6 *	15
tiff, grey mottled brown tan, ILTY CLAY	13	1.3 S	26
413.0 -5	12	1.5 S	23
tiff, tan mottled grey, LAY to CLAY LOAM	15	2.0 B	21
	19	2.4 B	19
-10	8	1.6 S	22
	20	2.0 S	18
403.5	20	1.9 B	18
-15			
ery stiff, brown, LAY LOAM	26	3.2 S	16
401.0			
ard, dark grey, HALE			
	113		18
ore recovery 90% -20	CORE		
395.5			

Elevation	Z	t/s.f. J O	w (%)
Hard, grey, LIMESTONE core recovery 50% 395.2	CORE		
COAL core recovery 50% 394.0			
Extent of Exploration			
-25			
-30			
-35			
-40			
-45			

- Standard Penetration Test - ows per foot to drive 2" D. Split Spoon Sampler 12" with 0# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight-%.

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

RM NO. B.D. 137 REV. 9-60 041-0055 Sh. 4 of 5 Sh

BRIDGE FOUNDATION BORING LOG

PROJECT I-57-2(32)81 BRIDGE SA Route 13 Date March 15, 1962
ROUTE FAI 57 over FAI Rt. 57 Bored By J. R. Wall / F. H. Beck
SEC. 41-1HB-1 STA. 117+09.55 Checked By J. J. Klay
COUNTY Jefferson

Boring No. 4
Station 117+04
Offset ℄ Survey

Surface Water El. ____
Groundwater El. at Completion ____
After ____ Hours ____

Elevation	Z	t/s.f.	(%)	
Ground Surface 417.50				
Stiff, grey, CLAY to SILTY CLAY		1.4 S	19	
	11	1.8 B	28	
-5	14	2.0 B	20	
	10	1.3 B	20	
	14	1.9 B	24	
-10 406.5	7	0.8 B	23	
Medium, grey brown, water bearing SANDY LOAM	10		19	
403.5				
Hard, grey brown, SANDY CLAY LOAM to CLAY LOAM -15 402.0	55	5.0*	10	
Very dense, grey brown, SANDY LOAM	66		16	
399.5				
Hard, brown grey, CLAY LOAM & 1/8" SILT SEAMS	62	5.0*	11	
398.0 -20				
Hard, dark grey, SHALE	132		15	
396.3				
Hard, grey LIMESTONE core recovery 90% 395.2	CORE			

Elevation	Z	t/s.f.	(%)	
395.2				
COAL - core recovery 10% 394.5				
Hard, grey, SHALE Core recovery 50% -25	CORE			
391.5				
Extent of Exploration				
-30				
-35				
-40				
-45				

*Penetrometer value

I - Standard Penetration Test - blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight-%.

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

IM NO. B.D. 137 REV 9-60 041-0055 Sh. 5 of 5 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT I-57-2(32)81 BRIDGE SA Route 13 Date March 16, 1962
ROUTE FAI 57 over FAI Rt. 57 Bored By J. R. Wall & F. H. Beck
SEC. 41-1HB-1 STA. 117+09.55 Checked By J. J. Klay
COUNTY Jefferson
Boring No. 5
Station 117+04
Offset 111' Rt. Sur. ℄

Surface Water El. ____
Groundwater El. at Completion ____
After ___ Hours ____

Elevation	Z	t/s.f. J O	w (%)	Description
418.30				Ground Surface
	8	1.4 S	14	Stiff, brown mottled grey, SILTY CLAY
	14	1.1 B	26	
-5	16	1.4 S	19	
	10	1.4 S	24	
410.8				
	15	2.0 B	21	Stiff to very stiff, tan mottled grey, CLAY to CLAY LOAM
-10				
	11	1.8 S	19	
	16	2.3 S	20	
404.8				
	37	2.6 S	19	Very stiff, grey, residual CLAY
-15				
402.3				
	86		18	Very dense to hard, grey, weathered SHALE
399.8				
	144		16	Hard, dark grey, SHALE
-20				
	CORE			Core recovery 95%

Elevation	Z	t/s.f. J O	w (%)	Description
				Hard, dark grey SHALE
394.8				
394.3	CORE			COAL-core recovery 95%
				Extent of Exploration
-25				
-30				
-35				
-40				
-45				

- Standard Penetration Test - ows per foot to drive 2" D. Split Spoon Sampler 12" with)# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT — Modified 5/24/10

REFERENCE BORING NUMBER ========== 1-S (2017)
ELEVATION OF BORING GROUND SURFACE ========== 438.20 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 34.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 38.50 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.337
EARTHQUAKE MOMENT MAGNITUDE ========== 5.8
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 4.00 FT. (Fill Height)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.776**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **487** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.8
Source-To-Site Distance, R (km) = 16.75
Ground Motion Prediction Equations = CEUS
PGA = **0.300**

IF(P22="","",IF(B22>=(K$7+K$12-K$9),"N.L. (1)",IF(OR(G22>=12,AND(H22>0,I22>0,I2

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
435.45	2.75	5	1.5				21	0.126	0.347	9.313	9.313	0.107	0.126	0.827	0.827	1.239	**0.236**	0.942	**0.206**	**N.L. (1)**
432.7	5.5	5	1.9				20	0.129	0.701	8.295	8.295	0.098	0.129	1.181	1.181	1.138	**0.199**	0.909	**0.199**	**N.L. (1)**
430.2	8	8	1.9				19	0.129	1.024	12.418	12.418	0.135	0.129	1.504	1.504	1.088	**0.261**	0.875	**0.192**	**N.L. (1)**
427.7	10.5	5	1.2				21	0.124	1.334	7.637	7.637	0.093	0.124	1.814	1.814	1.034	**0.171**	0.837	**0.183**	**N.L. (1)**
425.2	13	8	1.4				28	0.125	1.646	11.888	11.888	0.130	0.125	2.126	2.126	0.999	**0.231**	0.795	**0.174**	**N.L. (1)**
422.45	15.75	9	2.5				19	0.133	2.012	12.779	12.779	0.138	0.133	2.492	2.492	0.961	**0.236**	0.747	**0.164**	**N.L. (1)**
419.7	18.5	10	2.9				20	0.134	2.381	13.482	13.482	0.145	0.134	2.861	2.861	0.927	**0.239**	0.698	**0.153**	**N.L. (1)**
417.7	20.5	12	1.6				16	0.127	2.635	15.708	15.708	0.167	0.127	3.115	3.115	0.902	**0.268**	0.663	**0.145**	**N.L. (1)**
415.2	23	17	3.1				25	0.135	2.972	21.831	21.831	0.240	0.135	3.452	3.452	0.862	**0.367**	0.621	**0.136**	**N.L. (1)**
412.7	25.5	14	3.1				23	0.135	3.310	16.610	16.610	0.177	0.135	3.790	3.790	0.853	**0.268**	0.582	**0.128**	**N.L. (1)**
410.2	28	6	0.8				28	0.119	3.607	6.747	6.747	0.086	0.119	4.087	4.087	0.871	**0.132**	0.548	**0.120**	**N.L. (1)**
407.7	30.5	7	1.5				22	0.126	3.922	7.525	7.525	0.092	0.126	4.402	4.402	0.854	**0.140**	0.518	**0.113**	**N.L. (1)**
405.2	33	6	2.1				23	0.130	4.247	6.166	6.166	0.081	0.130	4.727	4.727	0.847	**0.122**	0.492	**0.108**	**N.L. (1)**
402.7	35.5	5	1	36	11	41	27	0.059	4.395	5.047	11.056	0.123	0.059	4.875	4.937	0.820	**0.179**	0.470	**0.104**	**N.L. (2)**
400.2	38	34	5				13	0.079	4.592	37.196	37.196	-0.042	0.079	5.072	5.290	0.705	**-0.053**	0.452	**0.103**	**N.L. (3)**
396.7	41.5	22	2.3	36	11	41	24	0.069	4.834	21.787	31.145	0.576	0.069	5.314	5.750	0.716	**0.733**	0.433	**0.103**	**N.L. (2)**
394.2	44	72						0.079	5.031	79.476	79.476	0.562	0.079	5.511	6.104	0.682	**0.681**	0.422	**0.102**	**N.L. (3)**
389.7	48.5	100						0.083	5.405	105.673	105.673	0.764	0.083	5.885	6.758	0.665	**0.902**	0.409	**0.103**	**N.L. (3)**
384.7	53.5	100						0.083	5.820	100.819	100.819	0.727	0.083	6.300	7.485	0.647	**0.835**	0.399	**0.104**	**N.L. (3)**
379.7	58.5	100						0.083	6.235	96.281	96.281	0.692	0.083	6.715	8.212	0.631	**0.775**	0.393	**0.105**	**N.L. (3)**
378.2	60	100						0.083	6.359	94.975	94.975	0.682	0.083	6.839	8.430	0.626	**0.758**	0.392	**0.106**	**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

7/31/2017

09 - Liquefaction 1-S

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT — Modified 5/24/10

REFERENCE BORING NUMBER ========== 2-S (2017)
ELEVATION OF BORING GROUND SURFACE ========== 418.20 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 14.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 14.50 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.337
EARTHQUAKE MOMENT MAGNITUDE ========== 5.8
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.776**

AVG. SHEAR WAVE VELOCITY (top 40')
$V'_{s,40'}$ = **667** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.8
Source-To-Site Distance, R (km) = 16.75
Ground Motion Prediction Equations = CEUS
PGA = **0.300**

IF(P22="","",IF(B22>=(K$7+K$12-K$9),"N.L. (1)",IF(OR(G22>=12,AND(H22>0,I22>0,I2

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	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
413.7	4.5	7	2.5				17	0.133	0.599	12.035	12.035	0.132	0.133	0.599	0.599	1.362	**0.318**	0.993	**0.218**	**N.L. (1)**
411.2	7	6	1.3				28	0.125	0.911	9.349	9.349	0.107	0.125	0.911	0.911	1.212	**0.231**	0.988	**0.216**	**N.L. (1)**
408.7	9.5	6	1.4				20	0.125	1.224	9.195	9.195	0.106	0.125	1.224	1.224	1.133	**0.213**	0.981	**0.215**	**N.L. (1)**
406.2	12	6	2.1				22	0.130	1.549	8.966	8.966	0.104	0.130	1.549	1.549	1.073	**0.199**	0.973	**0.213**	**N.L. (1)**
403.7	14.5	6	1.4				22	0.125	1.861	8.675	8.675	0.102	0.125	1.861	1.861	1.030	**0.186**	0.962	**0.211**	**N.L. (1)**
401.2	17	3	0.4	36	10	40	18	0.049	1.984	4.343	10.211	0.115	0.049	1.984	2.140	1.016	**0.207**	0.949	**0.224**	**N.L. (2)**
398.7	19.5	16	2.8	36	11	41	23	0.072	2.164	23.937	33.725	3.879	0.072	2.164	2.476	0.992	**6.838**	0.934	**0.234**	**N.L. (2)**
395.95	22.25	21	2.4				20	0.070	2.356	31.744	31.744	0.674	0.070	2.356	2.840	0.962	**1.151**	0.913	**0.241**	**N.L. (3)**
393.2	25	23	2.4				19	0.070	2.549	34.110	34.110	-8.824	0.070	2.549	3.204	0.932	**-14.609**	0.889	**0.245**	**N.L. (3)**
391.2	27	100						0.083	2.715	155.094	155.094	1.136	0.083	2.715	3.495	0.906	**1.827**	0.869	**0.245**	**N.L. (3)**
387.2	31	100						0.083	3.047	147.077	147.077	1.076	0.083	3.047	4.076	0.865	**1.653**	0.825	**0.242**	**N.L. (3)**
383.2	35	100						0.083	3.379	139.664	139.664	1.020	0.083	3.379	4.658	0.830	**1.504**	0.777	**0.235**	**N.L. (3)**
358.2	60	100						0.083	5.454	105.728	105.728	0.764	0.083	5.454	8.293	0.685	**0.930**	0.575	**0.191**	**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

7/31/2017 — 09 - Liquefaction 2-S

LIQUEFACTION ANALYSIS

I.D.O.T. Bureau of Bridges and Structures FOUNDATIONS AND GEOTECHNICAL UNIT — Modified 5/24/10

REFERENCE BORING NUMBER ========== 3-S (2017)
ELEVATION OF BORING GROUND SURFACE ========== 437.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 31.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 36.80 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.337
EARTHQUAKE MOMENT MAGNITUDE ========== 5.8
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 5.30 FT. (Fill Height)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.776**

AVG. SHEAR WAVE VELOCITY (top 40')
$V'_{s,40'}$ = **510** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 5.8
Source-To-Site Distance, R (km) = 16.75
Ground Motion Prediction Equations = CEUS
PGA = **0.300**

IF(P22="","",IF(B22>=(K$7+K$12-K$9),"N.L. (1)",IF(OR(G22>=12,AND(H22>0,I22>0,I

	BORING DATA							CONDITIONS DURING DRILLING					CONDITIONS DURING EARTHQUAKE							
ELEV. OF SAMPLE (FT.)	BORING SAMPLE DEPTH (FT.)	SPT N VALUE (BLOWS)	UNCONF. COMPR. STR., Q_u (TSF.)	% FINES < #200 (%)	PLAST. INDEX PI	LIQUID LIMIT LL	MOIST. CONTENT w_c (%)	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	CORR. SPT N VALUE $(N_1)_{60}$	EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$	CRR RESIST. MAG 7.5 $CRR_{7.5}$	EFFECTIVE UNIT WT. (KCF.)	EFFECTIVE VERT. STRESS (KSF.)	TOTAL VERT. STRESS (KSF.)	OVER-BURDEN CORR. FACT. (Ks)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
434.15	3.25	5	1.3				21	0.125	0.406	9.124	9.124	0.105	0.125	1.042	1.042	1.174	**0.220**	0.934	**0.205**	**N.L. (1)**
430.9	6.5	7	1.5				20	0.126	0.816	11.217	11.217	0.124	0.126	1.452	1.452	1.095	**0.241**	0.897	**0.196**	**N.L. (1)**
428.4	9	8	2.5				24	0.133	1.148	12.345	12.345	0.134	0.133	1.784	1.784	1.043	**0.249**	0.864	**0.189**	**N.L. (1)**
425.9	11.5	9	1.6				20	0.127	1.466	13.649	13.649	0.147	0.127	2.102	2.102	1.002	**0.261**	0.826	**0.181**	**N.L. (1)**
423.4	14	10	1.5				19	0.126	1.781	14.728	14.728	0.157	0.126	2.417	2.417	0.966	**0.270**	0.786	**0.172**	**N.L. (1)**
420.9	16.5	10	2.1				18	0.130	2.106	14.029	14.029	0.150	0.130	2.742	2.742	0.936	**0.250**	0.744	**0.163**	**N.L. (1)**
418.4	19	11	2.3				23	0.132	2.436	14.761	14.761	0.158	0.132	3.072	3.072	0.908	**0.254**	0.702	**0.154**	**N.L. (1)**
415.9	21.5	11	2.1				24	0.130	2.761	14.030	14.030	0.150	0.130	3.397	3.397	0.886	**0.237**	0.661	**0.145**	**N.L. (1)**
413.4	24	9	1.5				25	0.126	3.076	10.953	10.953	0.122	0.126	3.712	3.712	0.875	**0.189**	0.621	**0.136**	**N.L. (1)**
410.9	26.5	6	1.1				21	0.123	3.383	6.977	6.977	0.087	0.123	4.019	4.019	0.873	**0.136**	0.585	**0.128**	**N.L. (1)**
408.4	29	7	1.9				22	0.129	3.706	7.764	7.764	0.094	0.129	4.342	4.342	0.856	**0.143**	0.553	**0.121**	**N.L. (1)**
405.9	31.5	6	1.7				19	0.128	4.026	6.359	6.359	0.083	0.128	4.662	4.662	0.848	**0.124**	0.525	**0.115**	**N.L. (1)**
403.4	34	13	1.1	36	10	40	21	0.060	4.176	13.522	21.226	0.231	0.060	4.812	4.968	0.781	**0.321**	0.501	**0.113**	**N.L. (2)**
400.9	36.5	18	1.2	36	10	40	19	0.061	4.328	18.738	27.486	0.353	0.061	4.964	5.276	0.748	**0.469**	0.482	**0.112**	**N.L. (2)**
396.9	40.5	32	3.1				20	0.073	4.620	34.577	34.577	-1.481	0.073	5.256	5.818	0.705	**-1.855**	0.457	**0.111**	**N.L. (3)**
393.4	44	100						0.083	4.911	112.165	112.165	0.813	0.083	5.547	6.327	0.681	**0.983**	0.442	**0.110**	**N.L. (3)**
388.9	48.5	69						0.079	5.266	74.205	74.205	0.520	0.079	5.902	6.963	0.664	**0.613**	0.428	**0.111**	**N.L. (3)**
384.65	52.75	100						0.083	5.619	103.245	103.245	0.745	0.083	6.255	7.581	0.649	**0.859**	0.419	**0.111**	**N.L. (3)**
380.4	57	100						0.083	5.972	99.197	99.197	0.715	0.083	6.608	8.199	0.635	**0.805**	0.413	**0.112**	**N.L. (3)**
377.4	60	100						0.083	6.221	96.473	96.473	0.694	0.083	6.857	8.635	0.625	**0.770**	0.403	**0.111**	**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

7/31/2017

09 - Liquefaction 3-S

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== W. Abut.
REFERENCE BORING ========== 1-S (2017)
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 435.33 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 433.33 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 ========== 770 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.28 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ========== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 174.60 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 65.48 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	**42** 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.)
432.70	0.63	1.90			2.8		29.0	4.1		***7.0***	7	0	0	4	3
430.20	2.50	1.90			11.2	26.2	30.5	16.3	2.9	***22.3***	22	0	0	12	5
427.70	2.50	1.20			8.1	16.5	41.4	11.9	1.8	***34.4***	34	0	0	19	8
425.20	2.50	1.40			9.1	19.3	65.7	13.3	2.1	***49.4***	49	0	0	27	10
422.45	2.75	2.50			14.7	34.5	85.9	21.5	3.8	***71.5***	71	0	0	39	13
419.70	2.75	2.90			16.3	40.0	***84.2***	23.8	4.4	93.3	84	0	0	46	16
417.70	2.00	1.60			8.0	22.0	112.9	11.7	2.4	***107.3***	107	0	0	59	18
415.20	2.50	3.10	17		15.5	42.7	***128.4***	22.7	4.7	130.0	128	0	0	71	20
412.70	2.50	3.10	14		15.5	42.7	***112.3***	22.7	4.7	149.2	112	0	0	62	23
410.20	2.50	0.80			5.9	11.0	***127.8***	8.6	1.2	158.8	128	0	0	70	25
407.70	2.50	1.50			9.5	20.7	***145.6***	13.9	2.3	173.7	146	0	0	80	28
405.20	2.50	2.10			11.9	28.9	***142.3***	17.4	3.2	189.4	142	0	0	78	30
402.70	2.50	1.00			7.0	13.8	***198.1***	10.3	1.5	205.1	198	0	0	109	33
400.20	2.50		34	Hard Till	3.7	62.5	***171.0***	5.4	6.8	207.1	171	0	0	94	35
396.70	3.50	2.30			17.7	31.7	279.5	25.9	3.5	***242.9***	243	0	0	134	39
395.70	1.00			Shale	49.4	122.5	328.9	72.3	13.4	***315.2***	315	0	0	173	39.6
394.70	1.00			Shale	49.4	122.5	***378.3***	72.3	13.4	387.4	378	0	0	208	40.6
393.70	1.00			Shale	49.4	122.5	***427.7***	72.3	13.4	459.7	~~428~~	~~0~~	~~0~~	~~235~~	~~41.6~~
392.70	1.00			Shale	49.4	122.5	***477.1***	72.3	13.4	531.9	~~477~~	~~0~~	~~0~~	~~262~~	~~42.6~~
391.70	1.00			Shale	49.4	122.5	***526.5***	72.3	13.4	604.2	~~527~~	~~0~~	~~0~~	~~290~~	~~43.6~~
390.70	1.00			Shale	49.4	122.5	***575.9***	72.3	13.4	676.4	~~576~~	~~0~~	~~0~~	~~317~~	~~44.6~~
389.70	1.00			Shale	49.4	122.5	***625.4***	72.3	13.4	748.7	~~625~~	~~0~~	~~0~~	~~344~~	~~45.6~~
388.70	1.00			Shale	49.4	122.5	***674.8***	72.3	13.4	820.9	~~675~~	~~0~~	~~0~~	~~371~~	~~46.6~~
387.70	1.00			Shale	49.4	122.5	***724.2***	72.3	13.4	893.2	~~724~~	~~0~~	~~0~~	~~398~~	~~47.6~~
386.70	1.00			Shale	49.4	122.5	***773.6***	72.3	13.4	965.4	~~774~~	~~0~~	~~0~~	~~425~~	~~48.6~~
385.70	1.00			Shale	49.4	122.5	***823.0***	72.3	13.4	1037.7	~~823~~	~~0~~	~~0~~	~~453~~	~~49.6~~
384.70	1.00			Shale	49.4	122.5	***872.4***	72.3	13.4	1109.9	~~872~~	~~0~~	~~0~~	~~480~~	~~50.6~~
383.70	1.00			Shale	49.4	122.5	***921.8***	72.3	13.4	1182.2	~~922~~	~~0~~	~~0~~	~~507~~	~~51.6~~
382.70	1.00			Shale	49.4	122.5	***971.3***	72.3	13.4	1254.4	~~971~~	~~0~~	~~0~~	~~534~~	~~52.6~~
381.70	1.00			Shale	49.4	122.5	***1020.7***	72.3	13.4	1326.7	~~1021~~	~~0~~	~~0~~	~~561~~	~~53.6~~
380.70	1.00			Shale	49.4	122.5	***1070.1***	72.3	13.4	1398.9	~~1070~~	~~0~~	~~0~~	~~589~~	~~54.6~~
379.70	1.00			Shale		122.5			13.4						

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LIN ENGINEERING, LTD.
Consulting Engineers

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Pier
REFERENCE BORING ========== 2-S (2017)
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 415.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 414.00 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

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	**407** KIPS	**224** KIPS	**26** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1920 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.28 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ========== 2
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 217.69 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 81.63 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.

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.)
413.70	0.30	2.50			1.6		19.5	2.3		***4.3***	4	0	0	2	1
411.20	2.50	1.30			8.6	17.9	29.5	12.6	2.0	***17.1***	17	0	0	9	4
408.70	2.50	1.40			9.1	19.3	48.3	13.3	2.1	***31.4***	31	0	0	17	6
406.20	2.50	2.10			11.9	28.9	50.5	17.4	3.2	***47.8***	48	0	0	26	9
403.70	2.50	1.40			9.1	19.3	***45.8***	13.3	2.1	59.6	46	0	0	25	11
401.20	2.50	0.40			3.1	5.5	82.1	4.6	0.6	***67.8***	68	0	0	37	14
398.70	2.50	2.80			14.4	38.6	91.0	21.1	4.2	***88.3***	88	0	0	49	16
395.95	2.75	2.40			14.3	33.1	***105.3***	20.9	3.6	109.2	105	0	0	58	19
393.20	2.75	2.40			14.3	33.1	209.0	20.9	3.6	***139.9***	140	0	0	77	22
392.20	1.00			Shale	49.4	122.5	258.4	72.3	13.4	***212.1***	212	0	0	117	22.8
391.20	1.00			Shale	49.4	122.5	307.8	72.3	13.4	***284.4***	284	0	0	156	23.8
390.20	1.00			Shale	49.4	122.5	357.2	72.3	13.4	***356.6***	357	0	0	196	24.8
389.20	1.00			Shale	49.4	122.5	***406.7***	72.3	13.4	428.9	407	0	0	224	25.8
388.20	1.00			Shale	49.4	122.5	***456.1***	72.3	13.4	501.1	~~456~~	~~0~~	~~0~~	~~251~~	~~26.8~~
387.20	1.00			Shale	49.4	122.5	***505.5***	72.3	13.4	573.4	~~505~~	~~0~~	~~0~~	~~278~~	~~27.8~~
386.20	1.00			Shale	49.4	122.5	***554.9***	72.3	13.4	645.6	~~555~~	~~0~~	~~0~~	~~305~~	~~28.8~~
385.20	1.00			Shale	49.4	122.5	***604.3***	72.3	13.4	717.9	~~604~~	~~0~~	~~0~~	~~332~~	~~29.8~~
384.20	1.00			Shale	49.4	122.5	***653.7***	72.3	13.4	790.1	~~654~~	~~0~~	~~0~~	~~360~~	~~30.8~~
383.20	1.00			Shale		122.5			13.4						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== E. Abut.
REFERENCE BORING ========== 3-S (2017)
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 435.80 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 433.80 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

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	**43** FT.

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 770 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.28 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ========== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 174.60 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 65.48 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.

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.)
430.90	2.90	1.50			11.1		45.5	16.2		***19.9***	20	0	0	11	5
428.40	2.50	2.50			13.4	34.5	46.5	19.5	3.8	***38.1***	38	0	0	21	7
425.90	2.50	1.60			10.0	22.0	55.1	14.6	2.4	***52.5***	53	0	0	29	10
423.40	2.50	1.50			9.5	20.7	72.9	13.9	2.3	***67.4***	67	0	0	37	12
420.90	2.50	2.10			11.9	28.9	87.5	17.4	3.2	***85.1***	85	0	0	47	15
418.40	2.50	2.30			12.6	31.7	***97.4***	18.5	3.5	103.3	97	0	0	54	17
415.90	2.50	2.10			11.9	28.9	***101.0***	17.4	3.2	119.8	101	0	0	56	20
413.40	2.50	1.50			9.5	20.7	***105.1***	13.9	2.3	133.1	105	0	0	58	22
410.90	2.50	1.10			7.6	15.2	***123.7***	11.1	1.7	145.4	124	0	0	68	25
408.40	2.50	1.90			11.2	26.2	***132.1***	16.3	2.9	161.5	132	0	0	73	27
405.90	2.50	1.70			10.4	23.4	***134.2***	15.2	2.6	175.8	134	0	0	74	30
403.40	2.50	1.10			7.6	15.2	***143.2***	11.1	1.7	187.0	143	0	0	79	32
400.90	2.50	1.20			8.1	16.5	***193.6***	11.9	1.8	203.5	194	0	0	106	35
396.90	4.00		32	Hard Till	5.5	58.8	262.8	8.1	6.4	***218.6***	219	0	0	120	39
395.90	1.00			Shale	49.4	122.5	312.2	72.3	13.4	***290.8***	291	0	0	160	39.9
394.90	1.00			Shale	49.4	122.5	***361.6***	72.3	13.4	363.1	362	0	0	199	40.9
393.90	1.00			Shale	49.4	122.5	***411.1***	72.3	13.4	435.3	411	0	0	226	41.9
392.90	1.00			Shale	49.4	122.5	***460.5***	72.3	13.4	507.6	~~460~~	~~0~~	~~0~~	~~253~~	~~42.9~~
391.90	1.00			Shale	49.4	122.5	***509.9***	72.3	13.4	579.8	~~510~~	~~0~~	~~0~~	~~280~~	~~43.9~~
390.90	1.00			Shale	49.4	122.5	***559.3***	72.3	13.4	652.1	~~559~~	~~0~~	~~0~~	~~308~~	~~44.9~~
389.90	1.00			Shale	49.4	122.5	***608.7***	72.3	13.4	724.3	~~609~~	~~0~~	~~0~~	~~335~~	~~45.9~~
388.90	1.00			Shale	49.4	122.5	***658.1***	72.3	13.4	796.6	~~658~~	~~0~~	~~0~~	~~362~~	~~46.9~~
387.90	1.00			Shale	49.4	122.5	***707.5***	72.3	13.4	868.8	~~708~~	~~0~~	~~0~~	~~389~~	~~47.9~~
386.90	1.00			Shale	49.4	122.5	***757.0***	72.3	13.4	941.1	~~757~~	~~0~~	~~0~~	~~416~~	~~48.9~~
385.90	1.00			Shale	49.4	122.5	***806.4***	72.3	13.4	1013.3	~~806~~	~~0~~	~~0~~	~~444~~	~~49.9~~
384.90	1.00			Shale	49.4	122.5	***855.8***	72.3	13.4	1085.6	~~856~~	~~0~~	~~0~~	~~471~~	~~50.9~~
383.90	1.00			Shale	49.4	122.5	***905.2***	72.3	13.4	1157.8	~~905~~	~~0~~	~~0~~	~~498~~	~~51.9~~
382.90	1.00			Shale	49.4	122.5	***954.6***	72.3	13.4	1230.1	~~955~~	~~0~~	~~0~~	~~525~~	~~52.9~~
381.90	1.00			Shale	49.4	122.5	***1004.0***	72.3	13.4	1302.4	~~1004~~	~~0~~	~~0~~	~~552~~	~~53.9~~
380.90	1.00			Shale	49.4	122.5	***1053.4***	72.3	13.4	1374.6	~~1053~~	~~0~~	~~0~~	~~579~~	~~54.9~~
380.40	0.50			Shale		122.5			13.4						

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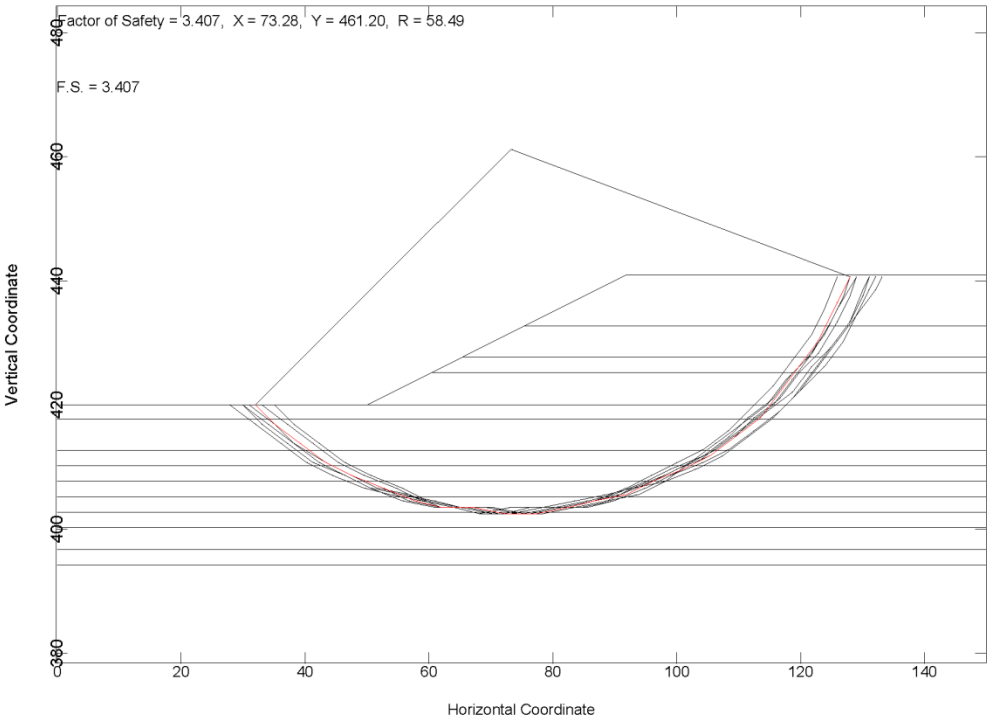
W. Abutment (LRFD)



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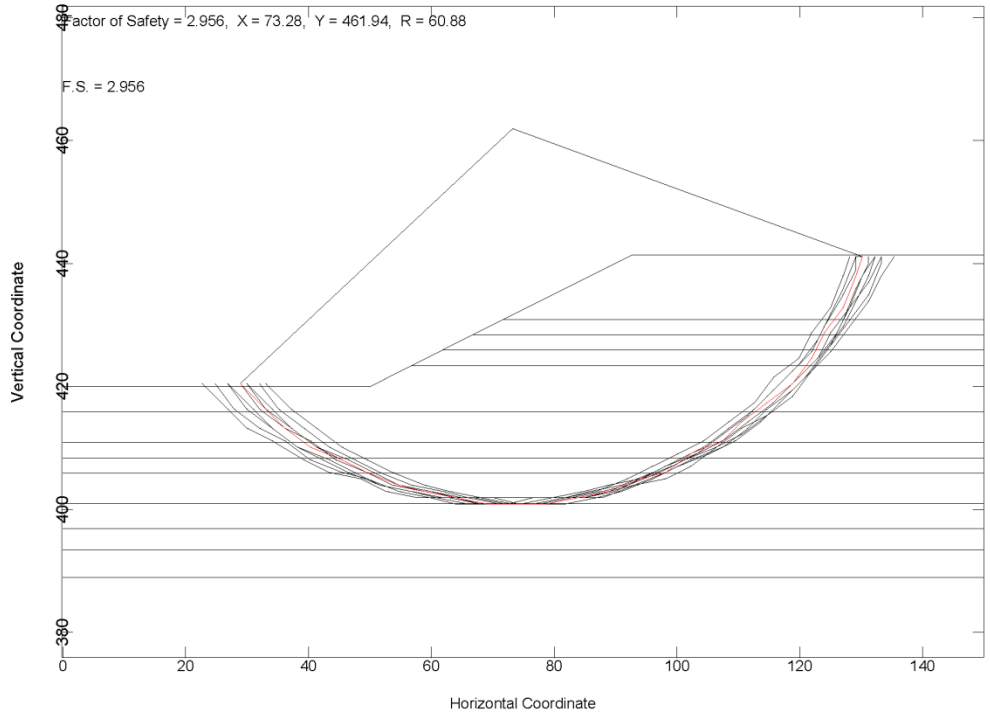
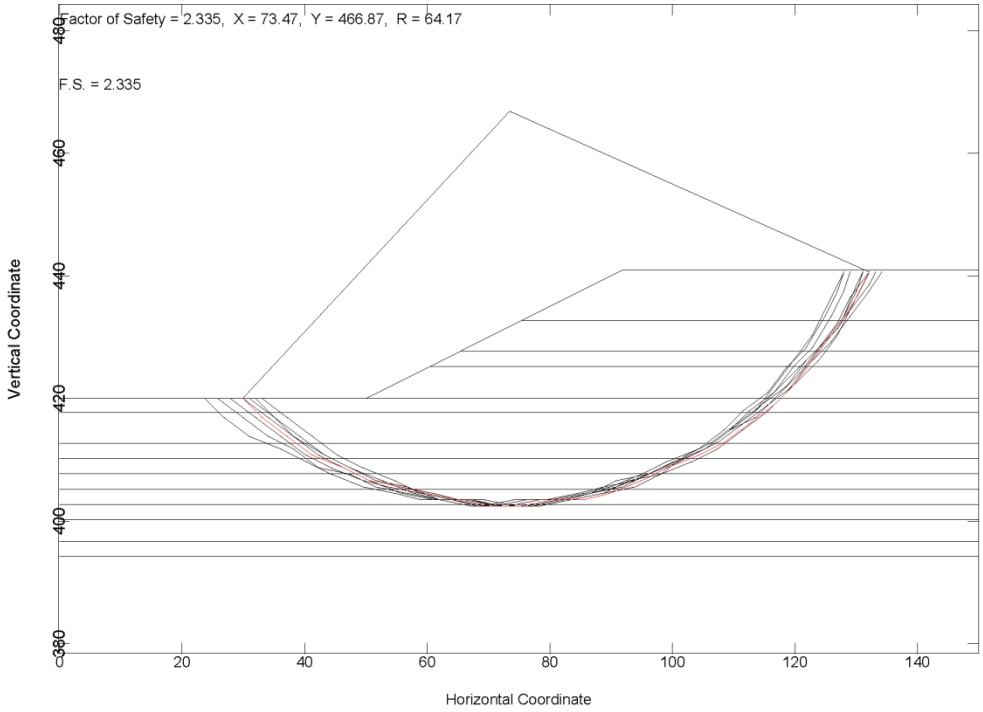


W. Abutment (Seismic)



E. Abutment (Seismic)