STRUCTURE GEOTECHNICAL REPORT

Proposed SN 097-0082

Existing SN 097-0013

US 45 over Bear Creek
FAP Route 332
Section 28B-1
White County

PTB 182 - Item 16
Contract No. 78682
Job No. D-99-005-17

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Date Prepared: 4/21/2022
Revised: 2/16/2022

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Project Description and Scope

This project involves the complete replacement of an existing bridge carrying US 45 over Bear Creek in White County. The project site is located in Section 5, Range 8E, Township 7S, in the 3rd Principal Meridian, two and a half miles south of Norris City. A *Location Map* is presented in Exhibit A.

The existing bridge at this location, SN 097-0013, was originally constructed in 1924 and the superstructure was replaced in 1954. It is a two-span structure with a rolled steel beam superstructure supported on a concrete wall pier and stub abutments. The pier and abutments are supported on timber piles. The approaches rest on bents added in 1954 supported by precast concrete piles. The 1954 plans call for the precast concrete piles to be driven to 25-ton capacity with estimated lengths of 35 ft at both approaches. The bridge measures 88'-2" back-to-back abutments and 36'-4" out to out, with no skew.

Per the preliminary Type, Size & Location Plan (TSL), the proposed structure is a 3-span bridge with W27 rolled steel beams supported on integral abutments and pile bent piers with encasement walls. The proposed structure will have a back-to-back abutment length of 143'-8", out-to-out width of 34'-10" and no skew. The roadway will be on horizontal and vertical tangent alignments. The proposed abutments will be constructed on existing embankments due to increased bridge length. The proposed profile will be less than 1 foot higher than the existing profile. US 45 will be closed during construction and traffic will be detoured. The new abutment and pier foundations will be located to avoid conflict with the existing substructure units. 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 structure.

Field Exploration

Subsurface Exploration and Testing

The site is located in a rural area. Wooded areas surround the site at all 4 quadrants, with farmland just beyond to the east and southwest. The structure crosses over Bear Creek, which has a channel width varying from 13 to 24 feet. Overhead power lines run parallel to the road on the east, but are offset from the bridge by about 100 feet. There are no other known utilities near the structure.

The subsurface investigation consisted of two borings (1-S and 2-S) drilled by IDOT District 9 personnel in October of 2018. 1-S was drilled in the embankment behind the south abutment; 2-S was drilled in the embankment behind the north abutment. Boring locations can be found in the Preliminary TSL 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 54.7 to 55.5 feet and were terminated in dense sandstone.

Subsurface Conditions

While drilling, groundwater was encountered at elevations 340.6 and 355.6. Groundwater elevations at completion and after 24 hours were not recorded.

The borings showed 38 feet of cohesive soils with Q_u values between 0.0-3.1 tsf. Below these layers was sand with SPT (N) blow counts ranged from 5 blows per foot to 100 blows in 3 inches. Both borings terminated in sandstone.

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, the estimated profile raise at the north and south abutments is 0.86 feet and 0.43 feet, respectively. The proposed abutments will be located behind the existing abutments on existing embankments, resulting in a maximum calculated settlement of 0.2 inches. Since the settlement is less than 0.4 inches, 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 11.6.3.7, the required resistance factor for slope stability is 0.65 which is equivalent to factor of safety of 1.54. The slope stability models rendered a worst-case factor of safety of 1.82. As per IDOT Geotechnical Manual 6.12.4.1, the minimum required factor of safety under the effect of seismic loads is 1. The seismic slope stability yielded a worst-case factor of safety of 1.31. The horizontal coefficient was calculated according to FHWA-NHI-11-032. The horizontal coefficient for 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 0.233g and at 0.2 sec (S_{Ds}) is 0.646g. 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 boring at the proposed bridge. No liquefaction was found within the first 60 ft of the soil borings. Liquefaction calculations are presented in Exhibit E.

Scour

With integral abutments protected by riprap, the design scour elevation is set at the bottom of the abutment cap per IDOT Bridge Manual 2.3.6.3.2 See Table 1 for the Scour Elevation Table.

Event/Limit State	Design Scour Elevations (ft.)				
	N. Abut.	Pier 1	Pier 2	S. Abut.	Item 113
Q100	373.4	359.2	359.8	373.0	5
Q200	373.4	357.4	358.1	373.0	
Design	373.4	359.2	359.8	373.0	
Check	373.4	357.4	358.1	373.0	

Table 1

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

Abutments	800 kips
Piers	1110 kips

Abutments

Due to IDOT's strong desire for a jointless structure, integral abutments will be provided. Per IDOT ABD Memoranda 19.8, all pile types are permissible for an effective expansion length of 70.1'. 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 2 and 3. Metal shell piles are not included due to risk of damage driving through dense layers. The estimated lengths include a 2-foot embedment into the abutment cap and are based on top of pile elevations of 374.95 at the south abutment and 375.38 at the north abutment. R_n values in the 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)
North Abutment SN 097-0082 Strength Limit State	HP 10x42	96	53	34	341.38	-
		126	69	40	335.38	-
		182	100	42	333.38	-
		239	132	45	330.38	-
		296	163	47	328.38	-
		335	184	49	326.38	0

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)
North Abutment SN 097-0082 Strength Limit State	HP 12x53	117	65	34	341.38	-
		151	83	40	335.38	-
		219	120	42	333.38	-
		287	158	45	330.38	-
		354	195	47	328.38	-
		418	230	49	326.38	0
	HP 12x63	120	66	34	341.38	-
		158	87	40	335.38	-
		227	125	42	333.38	-
		295	162	45	330.38	-
		364	200	47	328.38	-
		413	227	49	326.38	0
		497	273	50	325.38	1
	HP 14x73	95	52	32	343.38	-
		142	78	34	341.38	-
		187	103	40	335.38	-
		268	147	42	333.38	-
		350	192	45	330.38	-
		431	237	47	328.38	-
		489	269	49	326.38	0
		578	318	50	325.38	1
	HP 14x89	96	53	32	343.38	-
		145	80	34	341.38	-
		196	108	40	335.38	-
		278	153	42	333.38	-
		360	198	45	330.38	-
		442	243	47	328.38	-
		500	275	49	326.38	0
		705	388	51	324.38	2
	HP 14x102	97	53	32	343.38	-
		147	81	34	341.38	-
		203	112	40	335.38	-
		286	157	42	333.38	-
		368	202	45	330.38	-
		450	248	47	328.38	-
		507	279	49	326.38	0
		810	445	51	324.38	2
	HP 14x117	98	54	32	343.38	-
		149	82	34	341.38	-
		212	117	40	335.38	-
		295	162	42	333.38	-
		378	208	45	330.38	-
		461	254	47	328.38	-
		517	284	49	326.38	0
		929	511	52	323.38	3

Table 2 (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)
South Abutment SN 097-0082 Strength Limit State	HP 10x42	96	53	36	338.95	-
		138	76	39	335.95	-
		143	79	41	333.95	-
		169	93	44	330.95	-
		226	124	46	328.95	-
		290	159	49	325.95	0
		335	184	50	324.95	1
	HP 12x53	117	64	36	338.95	-
		166	91	39	335.95	-
		175	96	41	333.95	-
		203	112	44	330.95	-
		271	149	46	328.95	-
		347	191	49	325.95	0
		418	230	50	324.95	1
	HP 12x63	118	65	36	338.95	-
		169	93	39	335.95	-
		179	98	41	333.95	-
		211	116	44	330.95	-
		279	154	46	328.95	-
		356	196	49	325.95	0
		497	273	51	323.95	2
	HP 14x73	125	69	26	348.95	-
		136	75	29	345.95	-
		139	76	31	343.95	-
		139	77	34	340.95	-
		140	77	36	338.95	-
		201	110	39	335.95	-
		212	116	41	333.95	-
		249	137	44	330.95	-
		330	182	46	328.95	-
		421	232	49	325.95	0
		578	318	51	323.95	2
	HP 14x89	109	60	24	350.95	-
		126	69	26	348.95	-
		138	76	29	345.95	-
		140	77	31	343.95	-
		141	77	34	340.95	-
		142	78	36	338.95	-
		205	113	39	335.95	-
		216	119	41	333.95	-
		259	142	44	330.95	-
		341	188	46	328.95	-
		431	237	49	325.95	0
		705	388	51	323.95	2
	HP 14x102	110	61	24	350.95	-
		128	70	26	348.95	-
		140	77	29	345.95	-
		142	78	31	343.95	-
		142	78	34	340.95	-
		143	79	36	338.95	-
		207	114	39	335.95	-
		218	120	41	333.95	-
		266	146	44	330.95	-
		349	192	46	328.95	-
		438	241	49	325.95	0
		810	445	52	322.95	3

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)
South Abutment SN 097-0082 Strength Limit State	HP 14x117	111	61	24	350.95	-
		130	71	26	348.95	-
		142	78	29	345.95	-
		144	79	31	343.95	-
		144	79	34	340.95	-
		145	80	36	338.95	-
		211	116	39	335.95	-
		222	122	41	333.95	-
		276	152	44	330.95	-
		359	197	46	328.95	-
		447	246	49	325.95	0
		929	511	53	322.95	4

Table 3 (continued)

Piers

There are multiple options for the type of foundation at the piers: Spread footing bearing on soil, pile-supported foundation, or drilled shaft foundation.

Spread Footing on Soil: Due to the weaker soil layers with an unconfined compressive strength of less than 2.0 tsf at the elevation of the pier footing and the rock layer over 40 feet deep, spread footings are not recommended.

Pile Supported: Using a pile bent with a single line of piles is appropriate for the bridge size and type. Analyses have been performed using the Modified IDOT Static Method for estimating nominal pile resistance and account for geotechnical losses due to scour. Pile size calculations are presented in Exhibit F and summarized in Tables 5 and 6. Metal shell piles are not included due to risk of damage driving through dense layers. The estimated lengths include 2 ft embedment into the pier cap and are based on top of pile elevations of 376.48 and 376.33 for piers 1 and 2 respectively. R_n values in tables represent the maximum nominal required bearing.

Drilled Shafts: With the rock layers being very deep, drilled shafts would be uneconomical at this location.

Estimated Top of Rock Elevations	
Pier 1	Pier 2
326.1	325.6

Table 4

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 1 SN 097-0082 Strength Limit State (Scour)	HP 10x42	163	87	43	333.48	-
		219	118	46	330.48	-
		276	149	48	328.48	-
		318	172	50	326.48	0
		335	181	51	325.48	1

Table 5

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 1 SN 097-0082 Strength Limit State (Scour)	HP 12x53	128	67	41	335.48	-
		196	104	43	333.48	-
		263	141	46	330.48	-
		331	178	48	328.48	-
		380	205	50	326.48	0
		418	227	51	325.48	1
	HP 12x63	134	70	41	335.48	-
		203	108	43	333.48	-
		272	146	46	330.48	-
		340	184	48	328.48	-
		389	211	50	326.48	0
		497	270	51	325.48	1
	HP 14x73	159	83	41	335.48	-
		240	128	43	333.48	-
		321	173	46	330.48	-
		403	217	48	328.48	-
		461	249	50	326.48	0
		578	314	51	325.48	1
	HP 14x89	168	88	41	335.48	-
		250	133	43	333.48	-
		332	178	46	330.48	-
		414	223	48	328.48	-
		471	255	50	326.48	0
		705	383	52	324.48	2
	HP 14x102	175	92	41	335.48	-
		257	137	43	333.48	-
		340	182	46	330.48	-
		422	228	48	328.48	-
		478	259	50	326.48	0
		810	441	53	323.48	3
	HP 14x117	120	62	35	341.48	-
		183	97	41	335.48	-
		267	142	43	333.48	-
		350	188	46	330.48	-
		433	234	48	328.48	-
		488	264	50	326.48	0
		929	507	54	322.48	4

Table 5 (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)
Pier 2 SN 097-0082 Strength Limit State (Scour)	HP 10x42	147	79	45	331.33	-
		204	110	48	328.33	-
		261	141	50	326.33	0
		335	182	52	324.33	1
	HP 12x53	149	79	43	333.33	-
		177	95	45	331.33	-
		245	132	48	328.33	-
		313	169	50	326.33	0
		418	228	52	324.33	1

Table 6

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 2 SN 097-0082 Strength Limit State (Scour)	HP 12x63	153	81	43	333.33	-
		184	99	45	331.33	-
		253	137	48	328.33	-
		322	174	50	326.33	0
		497	271	53	323.33	2
	HP 14x73	170	90	40	336.33	-
		181	96	43	333.33	-
		218	117	45	331.33	-
		299	162	48	328.33	-
		381	206	50	326.33	0
		578	315	53	323.33	2
	HP 14x89	173	92	40	336.33	-
		184	98	43	333.33	-
		228	122	45	331.33	-
		310	167	48	328.33	-
		392	212	50	326.33	0
		705	385	54	322.33	3
	HP 14x102	176	94	40	336.33	-
		187	100	43	333.33	-
		235	126	45	331.33	-
		317	172	48	328.33	-
		400	217	50	326.33	0
		810	442	54	322.33	3
	HP 14x117	123	65	38	338.33	-
		179	96	40	336.33	-
		190	102	43	333.33	-
		244	131	45	331.33	-
		327	177	48	328.33	-
		410	223	50	326.33	0
		929	508	55	321.33	4

Table 6 (continued)

Lateral Loading Analysis

Tables 7 and 8 provide soil parameters for the LPile program (or other approved programs) for the structural engineer to perform the lateral analysis of the foundations.

Given the depth to rock, piles will be able to develop sufficient fixity above the rock line. 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 Silty Clay	373.6	0.071	-	500	8	0.007
Soft Silty Clay	368.6	0.063	-	30	2	0.020
Very Soft Silty Clay	366.1	0.055	-	30	0	0.020
Stiff Clay	358.6	0.073	-	500	11	0.007
Very Stiff Clay	353.6	0.077	-	1000	19	0.005
Stiff Clay	343.6	0.073	-	500	10	0.007
Stiff Silty Clay with Sand	341.1	0.071	-	500	8	0.007
Loose Sand	336.1	0.032	28.8	20	-	-
Dense Sand	331.1	0.042	37.6	125	-	-
Very Dense Coarse Sand	325.6	0.048	44.0	125	-	-
Sandstone	-	0.048	44.0	-	-	-

Table 7 –South Abutment & Pier 2 (1-S)

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Stiff Silty Clay	373.6	0.072	-	500	8	0.007
Medium Clay	371.1	0.069	-	100	6	0.010
Soft Clay	368.6	0.064	-	30	3	0.020
Very Soft Clay	363.6	0.060	-	30	1	0.020
Stiff Clay	361.1	0.074	-	500	13	0.007
Medium Clay	358.6	0.068	-	100	5	0.010
Very Stiff Clay	356.1	0.042	-	1000	22	0.005
Soft Clay	353.6	0.028	-	30	3	0.020
Medium Clay	351.1	0.031	-	100	4	0.010
Medium Clay	347.6	0.033	-	100	6	0.010
Stiff Clay	343.6	0.036	-	500	10	0.007
Soft Clay to Clay Loam	341.1	0.028	-	30	3	0.020
Medium Sand	335.6	0.039	34.0	60	-	-
Very Dense Coarse Sand w/ Clay and Sandstone	326.1	0.048	44.0	125	-	-
Sandstone	-	0.048	44.0	-	-	-

Table 8 –North Abutment & Pier 1 (2-S)

Construction Considerations

Foundation Construction

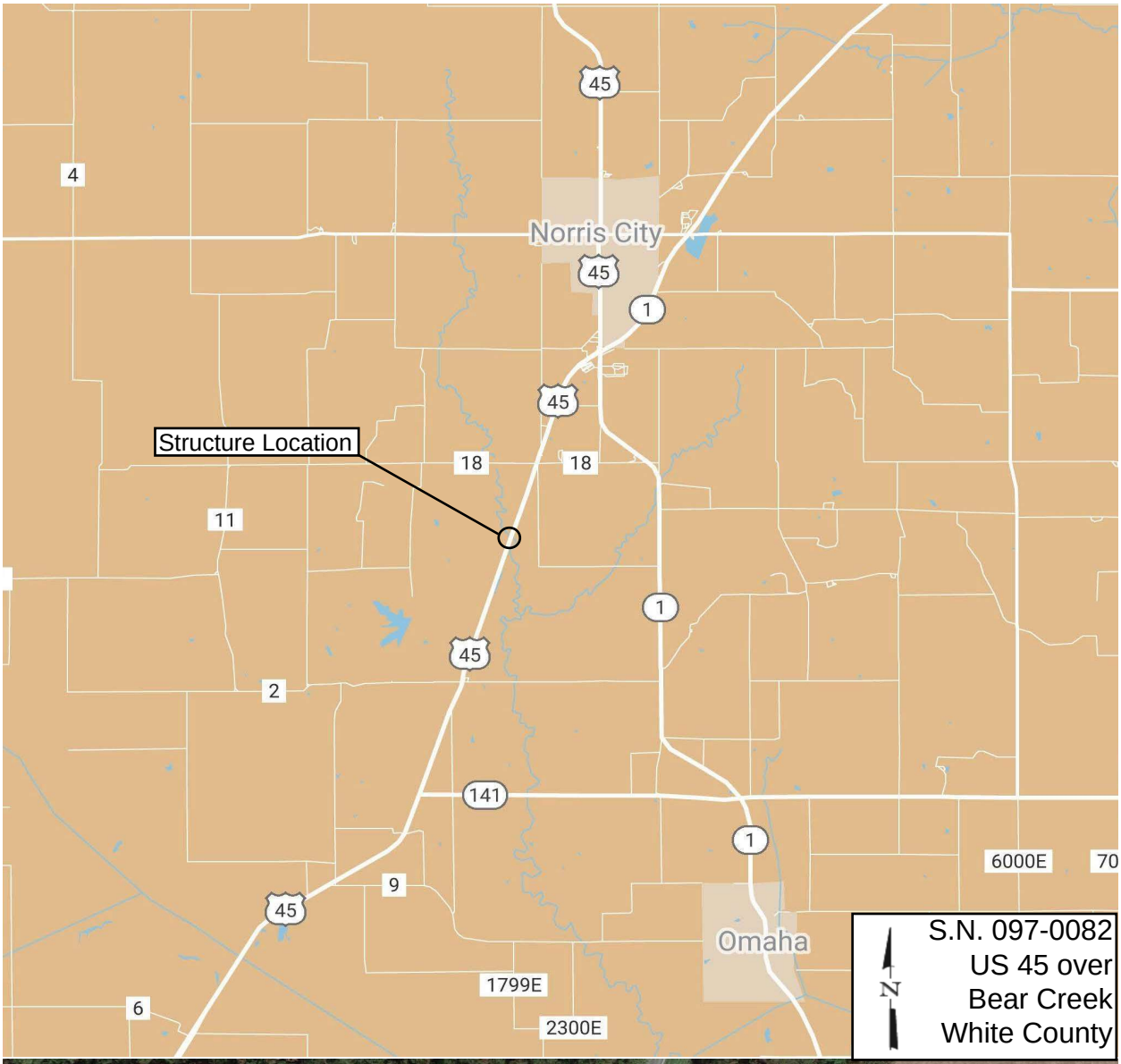
Since the soil borings consistently show the rock layers beginning near elevation 326, it is recommended to only provide one test pile for the proposed bridge if all of the piles will be driven to rock. Alternatively, it is recommended to provide one test pile per substructure unit if friction piles are used. Pile shoes are recommended for driving into sandstone layers.

Cofferdams

Considering the Estimated Water Surface Elevation (EWSE) of 367.8, Pier 1 can be constructed using conventional water diversion determined by the Contractor. Since the bottom of Pier 2 is below the EWSE by less than six feet and within the channel, a Type 1 cofferdam may be necessary for construction.

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.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Structure Location
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S.N. 097-0082
US 45 over
Bear Creek
White County
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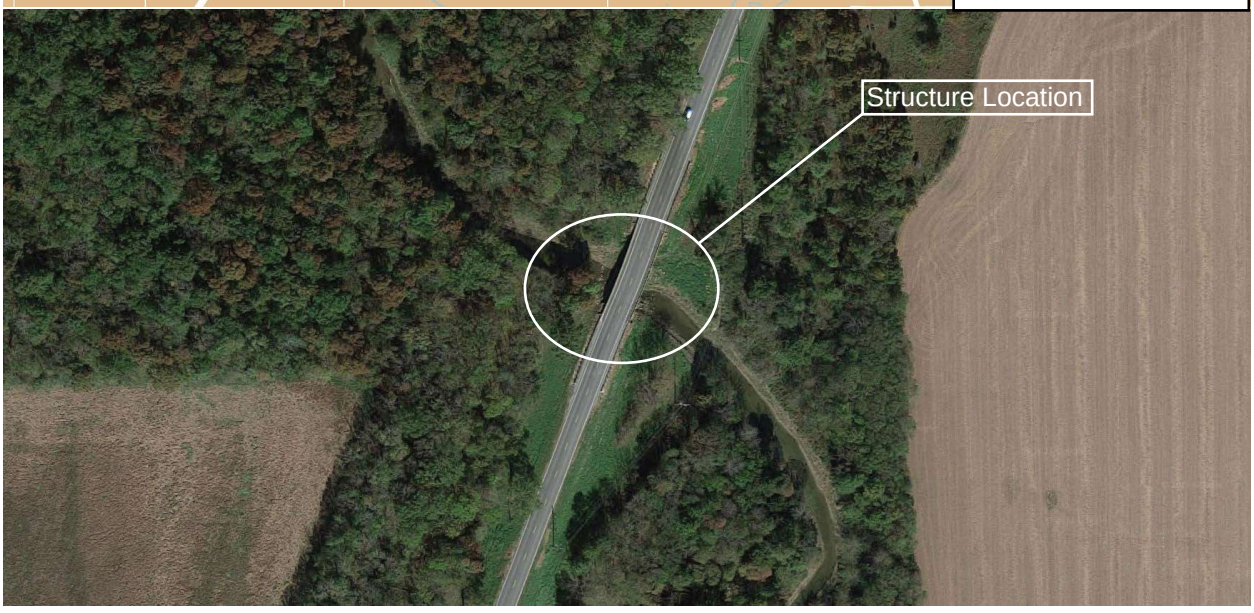
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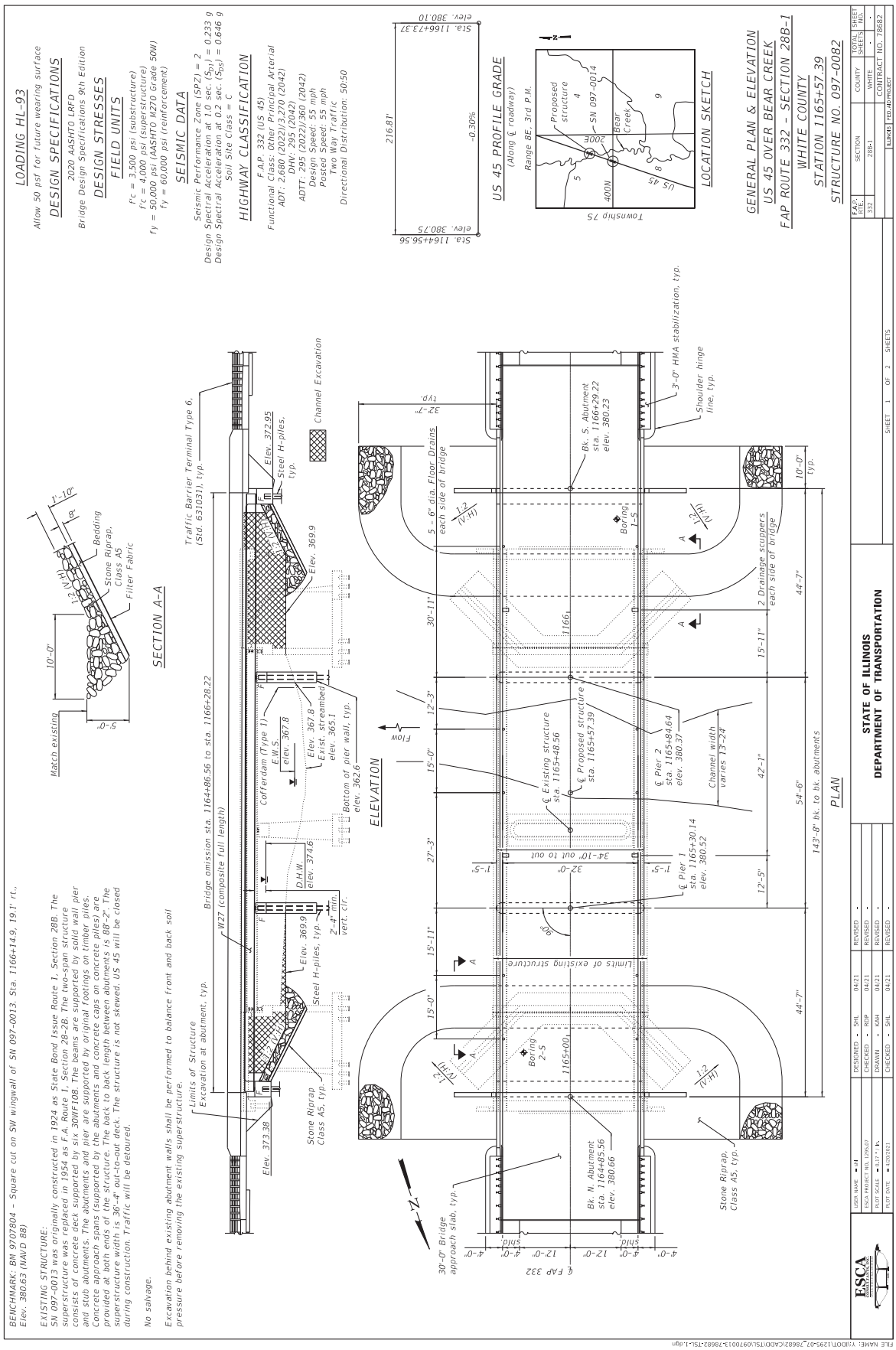
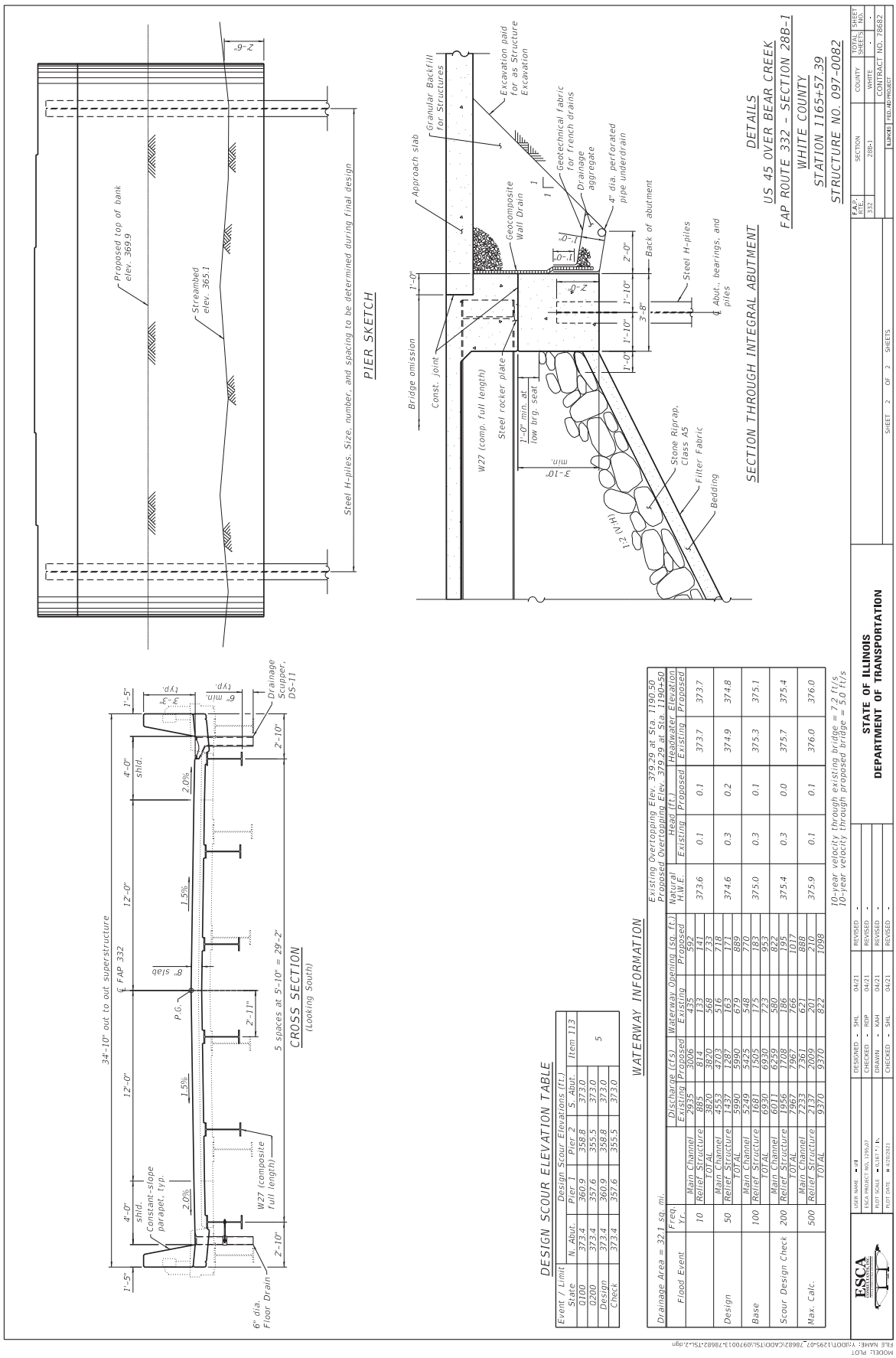

LOADING HL-93
Allow 50 psf for future wearing surface
DESIGN SPECIFICATIONS
2020 AASHTO LRFD
Bridge Design Specifications 9th Edition
DESIGN STRESSES
FIELD UNITS
f'c = 3,500 psi (substructure)
f'c = 4,000 psi (superstructure)
fy = 50,000 psi (AASHTO M270 Grade 50W)
fy = 60,000 psi (reinforcement)
SEISMIC DATA
Seismic Performance Zone (SPZ) = 2
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.233 g
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.646 g
Soil Site Class = C
HIGHWAY CLASSIFICATION
F.A.P. 332 (US 45)
Functional Class: Other Principal Arterial
ADT: 2,680 (2022)/3,270 (2042)
DHV: 295 (2042)
ADTT: 295 (2022)/360 (2042)
Design Speed: 55 mph
Posted Speed: 55 mph
Two Way Traffic
Directional Distribution: 50:50
US 45 PROFILE GRADE
(Along ℄ roadway)
Range 8E, 3rd P.M.
Sta. 1164+56.56
elev. 380.75
-0.30%
216.81'
Sta. 1166+73.37
elev. 380.10
LOCATION SKETCH
Township 7S
Proposed structure 4
SN 097-0014
Bear Creek
US 45
200ft
400N
GENERAL PLAN & ELEVATION
US 45 OVER BEAR CREEK
FAP ROUTE 332 - SECTION 28B-1
WHITE COUNTY
STATION 1165+57.39
STRUCTURE NO. 097-0082
F.A.P. RTE. 332
SECTION 28B-1
COUNTY WHITE
TOTAL SHEETS -
SHEET NO. -
CONTRACT NO. 76882
ILLINOIS FED. AID PROJECT
SHEET 1 OF 2 SHEETS
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
PLAN
ELEVATION
SECTION A-A
BENCHMARK: BM 970804 - Square cut on SW wingwall of SW 097-0013. Sta. 1166+14.9, 19.1' rt., Elev. 380.63 (NAVD 88)
EXISTING STRUCTURE:
SN 097-0013 was originally constructed in 1924 as State Bond Issue Route 1, Section 28B. The superstructure was replaced in 1954 as F.A. Route 1, Section 28-2B. The two-span structure consists of concrete deck supported by six 30WF108. The beams are supported by solid wall pier and stub abutments. The abutments and pier are supported by original footings on timber piles. Concrete approach spans (supported by the abutments and concrete caps on concrete piles) are provided at both ends of the structure. The back to back length between abutments is 68'-2". The superstructure width is 36'-4" out to out of deck. The structure is not skewed. US 45 will be closed during construction. Traffic will be detoured.
No salvage.
Excavation behind existing abutment walls shall be performed to balance front and back soil pressure before removing the existing superstructure.
Bridge omission sta. 1164+86.56 to sta. 1166+28.22
Limits of Structure Excavation at abutment, typ.
W27 (composite full length)
Traffic Barrier Terminal Type 6. (Std. 631031), typ.
Elev. 372.95
Steel H-piles, typ.
Channel Excavation
Elev. 369.9
Cofferdam (Type 1)
E.W.S. elev. 367.8
Elev. 367.8
Exist. streambed elev. 365.1
Bottom of pier wall, typ. elev. 362.6
D.H.W. elev. 374.6
Elev. 369.9
Steel H-piles, typ.
2'-4" min. vert. clr.
Elev. 373.38
Stone Riprap Class A5, typ.
Match existing
10'-0"
1'-10"
1:2 (V:H)
Bedding
Stone Riprap, Class A5
Filter Fabric
5'-0"
Flow
Limits of existing structure
Bk. N. Abutment sta. 1164+85.56 elev. 380.66
Boring 2-S
1165+00
Boring 1-S
Bk. S. Abutment sta. 1166+29.22 elev. 380.23
℄ Existing structure sta. 1165+86.56
℄ Proposed structure sta. 1165+57.39
℄ Pier 2 sta. 1165+84.64 elev. 380.37
℄ Pier 1 sta. 1165+30.14 elev. 380.52
℄ FAP 332
30'-0" Bridge approach slab, typ.
Stone Riprap, Class A5, typ.
5 - 6" dia. Floor Drains each side of bridge
2 Drainage scuppers each side of bridge
3'-0" HMA stabilization, typ.
Shoulder hinge line, typ.
Channel width varies 13'-24"
34'-10" out to out
32'-0"
143'-8" bk. to bk. abutments
68°
1166
DESIGNED - SHL 04/21
CHECKED - RDP 04/21
DRAWN - KAH 04/21
CHECKED - SHL 04/21
REVISED -
USER NAME = M
ESCA PROJECT NO. 1295.07
PLOT SCALE = 0.1' / IN.
PLOT DATE = 4/20/2021
MODEL: PLOT
FILE NAME: Y:\DOT\1295-07_76882\CADD\TSL\097-0013-76882-TSL-1.dgn
4/20/2021 4:51:29 PM



Event / Limit State	Design Scour Elevations (ft.)			
	N. Abut.	Pier 1	Pier 2	S. Abut.
Q100	373.4	360.9	358.8	373.0
Q200	373.4	357.6	355.5	373.0
Design	373.4	360.9	358.8	373.0
Check	373.4	357.6	355.5	373.0

Item 113: 5

Drainage Area = 32.1 sq. mi.

Existing Overtopping Elev. 379.29 at Sta. 1190+50
Proposed Overtopping Elev. 379.29 at Sta. 1190+50

Flood Event	Freq. Yr.		Discharge (cfs)		Waterway Opening (sq. ft.)		Natural H.W.E.	Headwater Elevation			
			Existing	Proposed	Existing	Proposed		Head (ft.)		Existing	Proposed
								Existing	Proposed		
Design	10	Main Channel	2935	3006	435	592	373.6	0.1	0.1	373.7	373.7
		Relief Structure	885	814	133	141					
		TOTAL	3820	3820	568	733					
	50	Main Channel	4553	4703	516	718	374.6	0.3	0.2	374.9	374.8
		Relief Structure	1737	1787	163	171					
		TOTAL	5990	5990	679	889					
Base	100	Main Channel	5249	5425	548	770	375.0	0.3	0.1	375.3	375.1
		Relief Structure	1681	1505	175	183					
		TOTAL	6930	6930	723	953					
Scour Design Check	200	Main Channel	6011	6259	580	822	375.4	0.3	0.0	375.7	375.4
		Relief Structure	1956	1708	186	195					
		TOTAL	7967	7967	766	1017					
Max. Calc.	500	Main Channel	7733	7761	761	887	375.9	0.1	0.1	376.0	376.0
		Relief Structure	2137	2009	201	210					
		TOTAL	9370	9370	822	1098					

10-year velocity through existing bridge = 7.2 ft/s
10-year velocity through proposed bridge = 5.0 ft/s

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
332	28B-1	WHITE	-	-
		CONTRACT NO. 78882		
ILLINOIS FED. AID PROJECT				

SHEET 2 OF 2 SHEETS

DESIGNED - SHL 04/21
CHECKED - RDP 04/21
DRAWN - KAH 04/21
CHECKED - SHL 04/21
REVISED -
REVISED -
REVISED -

USER NAME = M
ESCA PROJECT NO. 19507
PLOT SCALE = 0.667 ' / IN.
PLOT DATE = 4/20/2021

MODELS: PLOT
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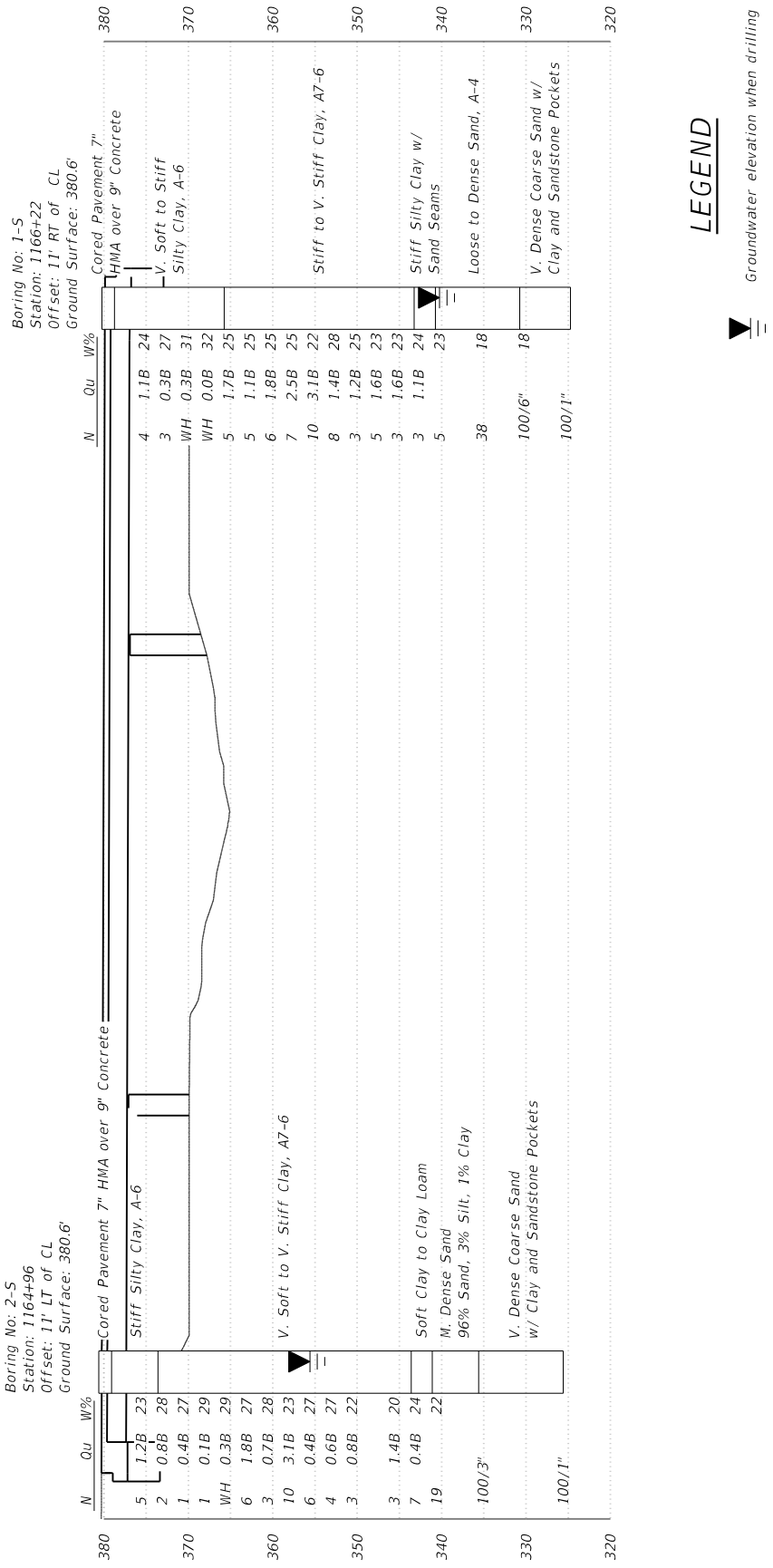
Boring No: 1-S
Station: 1166+22
Offset: 11' RT of CL
Ground Surface: 380.6'
Cored Pavement 7"
HMA over 9" Concrete
V. Soft to Stiff
Silty Clay, A-6
Stiff to V. Stiff Clay, A7-6
Stiff Silty Clay w/
Sand Seams
Loose to Dense Sand, A-4
V. Dense Coarse Sand w/
Clay and Sandstone Pockets
Boring No: 2-S
Station: 1164+96
Offset: 11' LT of CL
Ground Surface: 380.6'
Cored Pavement 7" HMA over 9" Concrete
Stiff Silty Clay, A-6
V. Soft to V. Stiff Clay, A7-6
Soft Clay to Clay Loam
M. Dense Sand
96% Sand, 3% Silt, 1% Clay
V. Dense Coarse Sand
w/ Clay and Sandstone Pockets
N Qu W%
LEGEND
Groundwater elevation when drilling

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAP 332 (US 45) Over Bear Creek
Route: US 45 Structure Number: 097-0013 Date: 10/3/2018
Section 28B-1 Bored By: L Estel
County: White Location: 2 miles South of IL 1/US 45 Checked By: A Hayes

Boring No 1-S
Station 1166+22
Offset 11' RT of CL
Ground Surface 380.6 Ft

Surf Wat Elev: 366.8
Ground Water Elevation
when Drilling 340.6
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	Soil Description
				Cored Pavement 7" HMA over 9" CONCRETE
379.1				
				Grey, Moist SILTY CLAY A-6 (No sample, noted auger cuttings)
376.1				
5.0	1			
	2	1.1B	24	Stiff Grey and Mottled Brown, Moist SILTY CLAY A-6
	2			
373.6				
	WH			
	1	0.3B	27	Soft Grey, Moist SILTY CLAY A-6
	2			
10.0	WH			
	WH	0.3B	31	
	WH			
368.6				
	WH			
	WH	0.0B	32	V. Soft Grey, Wet SILTY CLAY A-6
	WH			
366.1				
15.0	1			
	2	1.7B	25	Stiff Grey and Mottled Brown, Moist CLAY A7-6
	3			
	1			
	2	1.1B	25	
	3			
20.0	1			
	3	1.8B	25	
	3			
358.6				
	1			
	3	2.5B	25	V. Stiff Grey and Mottled Brown, Moist CLAY A7-6
	4			
25.0	2			
	4	3.1B	22	
	6			
353.6				
	2			
	3	1.4B	28	Stiff Grey and Mottled Brown, Moist CLAY A7-6
	5			
30.0	WH			
	1	1.2B	25	
	2			
	1			
	2	1.6B	23	
	3			
35.0	WH			
	1	1.6B	23	
	2			
343.6				
	WH			
	1	1.1B	24	Stiff Dark Grey, Moist SILTY CLAY with SAND seams
	2			
341.1				
40.0	1			
	2		23	Loose Grey, Wet SAND A-4 85% Sand 10% Silt 5% Clay
	3			
336.1				
45.0	5			
	12		18	Dense Grey/Brown, Moist Well-Graded SAND A-4
	26			
331.1				
50.0	100/6"		18	V. Dense Grey, Moist Coarse

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: US 45
Section: 28B-1
County: White
Date: 10/3/2018

Boring No: 1-S
Station: 1166+22
Offset: 11' RT of CL
Ground Surface: 380.6 Ft

DEPTH	BLOWS	Qu tsf	W%		DEPTH	BLOWS	Qu tsf	W%
SAND with CLAY and SANDSTONE pockets								
325.6 55.0					80.0			
V. Dense Grey, SAND with Weathered SANDSTONE and SANDSTONE pockets	100/1"			Bottom of hole at 55.5 feet Free water observed at 40.0 feet Elevation referenced to BM 9707804 on SN 097-0013; Chiseled Square on SW Wingwall Elev. = 380.63				
60.0				Borehole advanced with hollow stem auger (8" O.D., 3.25" I.D.) To convert "N" values to "N60" multiply by 1.5	85.0			
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)

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAP 332 (US 45) Over Bear Creek
Route: US 45 Structure Number: 097-0013 Date: 10/3/2018
Section 28B-1 Bored By: L Estel
County: White Location: 2 miles South of IL 1/US 45 Checked By: A Hayes

Boring No 2-S
Station 1164+96
Offset 11' LT of CL
Ground Surface 380.6 Ft

Surf Wat Elev: 366.8
Ground Water Elevation
when Drilling 355.6
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	Material
				Cored Pavement 7" HMA over 9" CONCRETE
379.1				
				Brown, Moist SILTY CLAY A-6 (No sample, noted auger cuttings)
376.1				
5.0	1			
	3	1.2B	23	Stiff Grey and Mottled Brown, Moist SILTY CLAY A-6
	2			
373.6				
	WH			
	1	0.8B	28	M. Stiff Grey, Moist CLAY A7-6
	1			
371.1				
10.0	WH			
	WH	0.4B	27	Soft Grey, Moist CLAY A7-6
	1			
368.6				
	WH			
	WH	0.1B	29	V. Soft Grey, V. Moist CLAY A7-6
	1			
15.0	WH			
	WH	0.3B	29	
	WH			
363.6				
	1			
	3	1.8B	27	Stiff Grey, Moist CLAY A7-6
	3			
361.1				
20.0	WH			
	1	0.7B	28	M. Stiff Grey and Mottled Brown, Moist CLAY A7-6
	2			
358.6				
	1			
	4	3.1B	23	V. Stiff Brown and Mottled Grey, Moist CLAY A7-6
	6			
356.1				
25.0	2			

DEPTH	BLOWS	Qu tsf	W%	Material
	3	0.4B	27	Soft to M. Stiff Brown, V. Moist CLAY A7-6
	3			
	1			
	2	0.6B	27	
	2			
351.1				
30.0	1			
	1	0.8B	22	M. Stiff Brown, Moist CLAY A7-6
	2			
347.6				
35.0	1			
	1	1.4B	20	Stiff Brown, Moist CLAY A7-6
	2			
343.6				
	WH			
	1	0.4B	24	Soft Grey, Moist CLAY to CLAY LOAM
	6			
341.1				
40.0	3			
	9		22	M. Dense Grey, Wet SAND 96% Sand 3% Silt 1% Clay
	10			
335.6	45.0			
	100/3"			V. Dense Grey, Moist Coarse SAND with CLAY and SANDSTONE pockets
330.6	50.0			

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: US 45
Section: 28B-1
County: White
Date: 10/3/2018

Boring No: 2-S
Station: 1164+96
Offset: 11' LT of CL
Ground Surface: 380.6 Ft

DEPTH	BLOWS	Qu tsf	W%		DEPTH	BLOWS	Qu tsf	W%
326.1				Bottom of hole = 54.7 feet				
V. Dense Grey, SAND with Weathered SANDSTONE and SANDSTONE pockets	55.0	100/1"		Free water observed at 24.5 feet Elevation referenced to BM 9707804 on SN 097-0013; Chiseled Square on SW Wingwall Elev. = 380.63	80.0			
	60.0			Borehole advanced with hollow stem auger (8" O.D., 3.25" I.D.) To convert "N" values to "N60" multiply by 1.5	85.0			
	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)

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 2-S / N. Abut.
ELEVATION OF BORING GROUND SURFACE ========== 380.60 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 25.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 17.78 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.318
EARTHQUAKE MOMENT MAGNITUDE ========== 7.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== -7.22 FT. (Cut Depth)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.982**

AVG. SHEAR WAVE VELOCITY (top 40')
$V'_{s,40'}$ = **346** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.58
Source-To-Site Distance, R (km) = 162.15
Ground Motion Prediction Equations = NMSZ
PGA = **0.097**

	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
373.6	7	5	1.2					0.124	0.868	7.889	7.889	0.095								
371.1	9.5	2	0.8					0.119	1.166	3.113	3.113	0.059	0.119	0.271	0.271	1.500	**0.087**	0.960	**0.199**	**N.L. (1)**
368.6	12	2	0.4					0.111	1.443	3.068	3.068	0.059	0.111	0.549	0.549	1.310	**0.076**	0.913	**0.189**	**N.L. (1)**
366.1	14.5	2	0.1					0.098	1.688	3.010	3.010	0.058	0.098	0.794	0.794	1.217	**0.070**	0.862	**0.178**	**N.L. (1)**
363.6	17	1	0.3					0.108	1.958	1.456	1.456	0.051	0.108	1.064	1.064	1.148	**0.057**	0.810	**0.167**	**N.L. (1)**
361.1	19.5	6	1.8					0.128	2.278	8.321	8.321	0.099	0.128	1.384	1.384	1.099	**0.106**	0.757	**0.157**	**N.L. (1)**
358.6	22	3	0.7					0.117	2.571	3.978	3.978	0.065	0.117	1.676	1.676	1.048	**0.067**	0.707	**0.146**	**N.L. (1)**
356.1	24.5	10	3.1					0.135	2.908	12.566	12.566	0.136	0.135	2.014	2.014	1.013	**0.136**	0.659	**0.136**	**N.L. (1)**
353.6	27	6	0.4	36	11	41	27	0.049	3.031	7.428	13.913	0.149	0.049	2.136	2.261	0.998	**0.146**	0.616	**0.135**	**N.L. (2)**
351.1	29.5	4	0.6	36	11	41	27	0.053	3.163	4.863	10.836	0.121	0.053	2.269	2.550	0.984	**0.116**	0.578	**0.134**	**N.L. (2)**
347.6	33	3	0.8	36	11	41	22	0.057	3.363	3.545	9.254	0.107	0.057	2.468	2.968	0.966	**0.101**	0.534	**0.133**	**N.L. (2)**
343.6	37	3	1.4	36	11	41	20	0.063	3.615	3.418	9.102	0.105	0.063	2.720	3.469	0.945	**0.098**	0.494	**0.130**	**N.L. (2)**
341.1	39.5	7	0.4	36	11	41	24	0.049	3.737	7.845	14.414	0.154	0.049	2.843	3.748	0.927	**0.140**	0.476	**0.130**	**N.L. (2)**
335.6	45	19						0.067	4.106	20.850	20.850	0.226	0.067	3.211	4.459	0.883	**0.196**	0.446	**0.128**	**1.531 (D)**
326.1	54.5	100						0.083	4.894	######	113.432	0.823	0.083	4.000	5.841	0.776	**0.627**	0.421	**0.127**	**N.L. (3)**
313.38	67.22	100						0.083	5.950	99.623	99.623	0.718	0.083	5.056	7.690	0.706	**0.498**	0.409	**0.129**	**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

Printed 4/16/2021 Page 1 of 1 BBS 146 (11/01/16)

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 1-S (S. Abut.)
ELEVATION OF BORING GROUND SURFACE ========== 380.60 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 40.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 32.35 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.318
EARTHQUAKE MOMENT MAGNITUDE ========== 7.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== -7.65 FT. (Cut Depth)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.982**

AVG. SHEAR WAVE VELOCITY (top 40')
$V'_{s,40'}$ = **342** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.58
Source-To-Site Distance, R (km) = 162.15
Ground Motion Prediction Equations = NMSZ
PGA = **0.097**

	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
373.6	7	4	1.1					0.123	0.861	6.324	6.324	0.082								
371.1	9.5	3	0.3					0.108	1.131	4.713	4.713	0.070	0.108	0.200	0.200	1.500	**0.103**	0.967	**0.200**	**N.L. (1)**
368.6	12	1	0.3					0.108	1.401	1.550	1.550	0.051	0.108	0.470	0.470	1.352	**0.068**	0.920	**0.190**	**N.L. (1)**
366.1	14.5	1	0					0.000	1.401	1.614	1.614	0.051	0.000	0.470	0.470	1.352	**0.068**	0.869	**0.180**	**N.L. (1)**
363.6	17	5	1.7					0.128	1.721	7.683	7.683	0.093	0.128	0.790	0.790	1.239	**0.113**	0.816	**0.169**	**N.L. (1)**
361.1	19.5	5	1.1					0.123	2.029	7.312	7.312	0.090	0.123	1.097	1.097	1.152	**0.102**	0.763	**0.158**	**N.L. (1)**
358.6	22	6	1.8					0.128	2.349	8.318	8.318	0.099	0.128	1.417	1.417	1.093	**0.106**	0.711	**0.147**	**N.L. (1)**
356.1	24.5	7	2.5					0.133	2.681	9.178	9.178	0.106	0.133	1.750	1.750	1.044	**0.109**	0.663	**0.137**	**N.L. (1)**
353.6	27	10	3.1					0.135	3.019	12.406	12.406	0.135	0.135	2.087	2.087	1.004	**0.133**	0.619	**0.128**	**N.L. (1)**
351.1	29.5	8	1.4					0.125	3.331	9.448	9.448	0.108	0.125	2.400	2.400	0.972	**0.103**	0.580	**0.120**	**N.L. (1)**
348.6	32	3	1.2					0.124	3.641	3.380	3.380	0.061	0.124	2.710	2.710	0.952	**0.057**	0.547	**0.113**	**N.L. (1)**
346.1	34.5	5	1.6					0.127	3.959	5.378	5.378	0.075	0.127	3.027	3.027	0.930	**0.068**	0.518	**0.107**	**N.L. (1)**
343.6	37	3	1.6					0.127	4.276	3.087	3.087	0.059	0.127	3.345	3.345	0.913	**0.053**	0.495	**0.102**	**N.L. (1)**
341.1	39.5	3	1.1					0.123	4.584	2.963	2.963	0.058	0.123	3.652	3.652	0.897	**0.051**	0.476	**0.098**	**N.L. (1)**
336.1	44.5	5		36	10	40		0.055	4.859	4.781	10.738	0.120	0.055	3.927	4.208	0.865	**0.102**	0.448	**0.099**	**1.030 (C)**
331.1	49.5	38		36	10	40		0.073	5.224	38.855	51.626	0.321	0.073	4.292	4.885	0.754	**0.238**	0.430	**0.101**	**N.L. (3)**
325.6	55	100						0.083	5.680	######	102.619	0.741	0.083	4.749	5.685	0.724	**0.527**	0.418	**0.103**	**N.L. (3)**
312.95	67.65	100						0.083	6.730	91.242	91.242	0.653	0.083	5.799	7.524	0.669	**0.429**	0.407	**0.109**	**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

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== N. Abutment
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 375.38 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 373.38 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 ========== 800 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 34.83 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 183.75 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 68.91 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 Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring.
418 KIPS	**418** KIPS	**230** KIPS	**49** 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.)
371.10	2.28	0.80			5.3		10.9	7.8		***8.4***	8	0	0	5	4
368.60	2.50	0.40			3.1	5.5	***9.9***	4.6	0.6	12.6	10	0	0	5	7
366.10	2.50	0.10			0.8	1.4	***13.5***	1.2	0.2	14.1	13	0	0	7	9
363.60	2.50	0.30			2.4	4.1	36.5	3.5	0.5	***19.8***	20	0	0	11	12
361.10	2.50	1.80			10.8	24.8	***32.1***	15.8	2.7	34.0	32	0	0	18	14
358.60	2.50	0.70			5.2	9.6	70.4	7.6	1.1	***45.2***	45	0	0	25	17
356.10	2.50	3.10	10		15.5	42.7	***48.8***	22.7	4.7	63.9	49	0	0	27	19
353.60	2.50	0.40			3.1	5.5	***54.7***	4.6	0.6	68.8	55	0	0	30	22
351.10	2.50	0.60			4.6	8.3	***62.0***	6.7	0.9	75.7	62	0	0	34	24
347.60	3.50	0.80			8.2	11.0	***78.5***	12.0	1.2	88.6	78	0	0	43	28
343.60	4.00	1.40			14.6	19.3	***79.2***	21.3	2.1	108.4	79	0	0	44	32
341.10	2.50	0.40			3.1	5.5	123.4	4.6	0.6	***117.5***	117	0	0	65	34
335.60	5.50		19	Clean Coarse Sand	8.3	46.5	330.1	12.1	5.1	***151.3***	151	0	0	83	40
333.10	2.50		100	Clean Coarse Sand	46.3	245.0	376.4	67.7	26.8	***219.0***	219	0	0	120	42
330.60	2.50		100	Clean Coarse Sand	46.3	245.0	422.7	67.7	26.8	***286.7***	287	0	0	158	45
328.10	2.50		100	Clean Coarse Sand	46.3	245.0	469.0	67.7	26.8	***354.3***	354	0	0	195	47
326.10	2.00		100	Clean Coarse Sand	37.0	245.0	460.1	54.2	26.8	***403.5***	403	0	0	222	49
325.90	0.20			Sandstone	16.5	199.1	476.6	24.1	21.8	***427.6***	~~428~~	~~0~~	~~0~~	~~235~~	~~49.5~~
324.90	1.00			Sandstone	82.4	199.1	558.9	120.4	21.8	***548.0***	~~548~~	~~0~~	~~0~~	~~301~~	~~50.5~~
323.90	1.00			Sandstone	82.4	199.1	***641.3***	120.4	21.8	668.4	~~641~~	~~0~~	~~0~~	~~353~~	~~51.5~~
322.90	1.00			Sandstone		199.1			21.8						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Pier 1
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 376.48 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 362.60 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 359.20 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1100 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 251.43 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 94.29 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 Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring.
418 KIPS	**418** KIPS	**227** KIPS	**51** 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.)
361.10	1.50	1.80			6.5		16.1	9.5		***10.5***	11	4	0	2	15
358.60	2.50	0.70			5.2	9.6	54.4	7.6	1.1	***21.8***	22	4	0	8	18
356.10	2.50	3.10	10		15.5	42.7	***32.7***	22.7	4.7	40.4	33	4	0	14	20
353.60	2.50	0.40			3.1	5.5	***38.6***	4.6	0.6	45.3	39	4	0	18	23
351.10	2.50	0.60			4.6	8.3	***46.0***	6.7	0.9	52.3	46	4	0	22	25
347.60	3.50	0.80			8.2	11.0	***62.4***	12.0	1.2	65.2	62	4	0	31	29
343.60	4.00	1.40			14.6	19.3	***63.2***	21.3	2.1	84.9	63	4	0	31	33
341.10	2.50	0.40			3.1	5.5	107.4	4.6	0.6	***94.0***	94	4	0	48	35
335.60	5.50		19	Clean Coarse Sand	8.3	46.5	314.1	12.1	5.1	***127.8***	128	4	0	67	41
333.10	2.50		100	Clean Coarse Sand	46.3	245.0	360.4	67.7	26.8	***195.5***	196	4	0	104	43
330.60	2.50		100	Clean Coarse Sand	46.3	245.0	406.7	67.7	26.8	***263.2***	263	4	0	141	46
328.10	2.50		100	Clean Coarse Sand	46.3	245.0	453.0	67.7	26.8	***330.9***	331	4	0	178	48
326.10	2.00		100	Clean Coarse Sand	37.0	245.0	444.1	54.2	26.8	***380.0***	380	4	0	205	50
325.10	1.00			Sandstone	82.4	199.1	526.4	120.4	21.8	***500.4***	~~500~~	~~4~~	~~0~~	~~272~~	~~51.4~~
324.10	1.00			Sandstone	82.4	199.1	***608.8***	120.4	21.8	620.9	~~609~~	~~4~~	~~0~~	~~331~~	~~52.4~~
323.10	1.00			Sandstone	82.4	199.1	***691.1***	120.4	21.8	741.3	~~691~~	~~4~~	~~0~~	~~377~~	~~53.4~~
322.10	1.00			Sandstone	82.4	199.1	***773.5***	120.4	21.8	861.7	~~773~~	~~4~~	~~0~~	~~422~~	~~54.4~~
321.10	1.00			Sandstone		199.1			21.8						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Pier 2
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 376.33 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 362.60 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 359.80 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== 1100 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 35.00 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 251.43 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 94.29 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	**228** KIPS	**52** 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.)
361.10	1.50	1.10			4.6		29.4	6.7		***9.4***	9	3	0	3	15
358.60	2.50	1.80			10.8	24.8	49.8	15.8	2.7	***26.2***	26	3	0	12	18
356.10	2.50	2.50			13.4	34.5	71.4	19.5	3.8	***46.6***	47	3	0	23	20
353.60	2.50	3.10	10		15.5	42.7	***63.5***	22.7	4.7	66.8	64	3	0	32	23
351.10	2.50	1.40			9.1	19.3	***69.9***	13.3	2.1	79.8	70	3	0	36	25
348.60	2.50	1.20			8.1	16.5	***83.5***	11.9	1.8	92.3	84	3	0	43	28
346.10	2.50	1.60			10.0	22.0	***93.5***	14.6	2.4	106.9	93	3	0	49	30
343.60	2.50	1.60			10.0	22.0	***96.6***	14.6	2.4	120.7	97	3	0	51	33
341.10	2.50	1.10			7.6	15.2	***98.2***	11.1	1.7	131.1	98	3	0	51	35
338.60	2.50		5	Very Fine Silty Sand	0.8	9.2	***99.0***	1.1	1.0	132.3	99	3	0	52	38
336.10	2.50		5	Very Fine Silty Sand	0.8	9.2	160.4	1.1	1.0	***140.0***	140	3	0	75	40
333.60	2.50		38	Very Fine Silty Sand	6.2	69.8	166.5	9.0	7.6	***149.1***	149	3	0	79	43
331.10	2.50		38	Very Fine Silty Sand	6.2	69.8	347.9	9.0	7.6	***177.3***	177	3	0	95	45
328.60	2.50		100	Clean Coarse Sand	46.3	245.0	394.2	67.7	26.8	***245.0***	245	3	0	132	48
326.10	2.50		100	Clean Coarse Sand	46.3	245.0	440.5	67.7	26.8	***312.6***	313	3	0	169	50
325.60	0.50		100	Clean Coarse Sand	9.3	245.0	403.8	13.5	26.8	***321.2***	321	3	0	174	51
324.60	1.00			Sandstone	82.4	199.1	486.2	120.4	21.8	***441.6***	~~442~~	~~3~~	~~0~~	~~240~~	~~51.7~~
323.60	1.00			Sandstone	82.4	199.1	568.5	120.4	21.8	***562.0***	~~562~~	~~3~~	~~0~~	~~307~~	~~52.7~~
322.60	1.00			Sandstone	82.4	199.1	***650.9***	120.4	21.8	682.4	~~651~~	~~3~~	~~0~~	~~355~~	~~53.7~~
321.60	1.00			Sandstone	82.4	199.1	***733.2***	120.4	21.8	802.8	~~733~~	~~3~~	~~0~~	~~401~~	~~54.7~~
320.60	1.00			Sandstone	82.4	199.1	***815.6***	120.4	21.8	923.3	~~816~~	~~3~~	~~0~~	~~446~~	~~55.7~~
319.60	1.00			Sandstone	82.4	199.1	***897.9***	120.4	21.8	1043.7	~~898~~	~~3~~	~~0~~	~~491~~	~~56.7~~
318.60	1.00			Sandstone		199.1			21.8						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== S Abutment
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 374.95 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 372.95 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 ========== 800 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 34.83 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 183.75 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 68.91 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 Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring.
418 KIPS	**418** KIPS	**230** KIPS	**50** 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.)
371.10	1.85	0.30			1.8		5.9	2.6		***3.1***	3	0	0	2	4
368.60	2.50	0.30			2.4	4.1	***4.2***	3.5	0.5	6.1	4	0	0	2	6
366.10	2.50	0.00			0.0	0.0	27.6	0.0	0.0	***8.7***	9	0	0	5	9
363.60	2.50	1.70			10.4	23.4	29.7	15.2	2.6	***23.0***	23	0	0	13	11
361.10	2.50	1.10			7.6	15.2	47.0	11.1	1.7	***35.1***	35	0	0	19	14
358.60	2.50	1.80			10.8	24.8	67.4	15.8	2.7	***51.9***	52	0	0	29	16
356.10	2.50	2.50			13.4	34.5	89.0	19.5	3.8	***72.4***	72	0	0	40	19
353.60	2.50	3.10	10		15.5	42.7	***81.1***	22.7	4.7	92.5	81	0	0	45	21
351.10	2.50	1.40			9.1	19.3	***87.5***	13.3	2.1	105.5	87	0	0	48	24
348.60	2.50	1.20			8.1	16.5	***101.1***	11.9	1.8	118.0	101	0	0	56	26
346.10	2.50	1.60			10.0	22.0	***111.1***	14.6	2.4	132.6	111	0	0	61	29
343.60	2.50	1.60			10.0	22.0	***114.2***	14.6	2.4	146.4	114	0	0	63	31
341.10	2.50	1.10			7.6	15.2	***115.8***	11.1	1.7	156.9	116	0	0	64	34
338.60	2.50		5	Very Fine Silty Sand	0.8	9.2	***116.6***	1.1	1.0	158.0	117	0	0	64	36
336.10	2.50		5	Very Fine Silty Sand	0.8	9.2	178.0	1.1	1.0	***165.8***	166	0	0	91	39
333.60	2.50		38	Very Fine Silty Sand	6.2	69.8	184.1	9.0	7.6	***174.8***	175	0	0	96	41
331.10	2.50		38	Very Fine Silty Sand	6.2	69.8	365.5	9.0	7.6	***203.0***	203	0	0	112	44
328.60	2.50		100	Clean Coarse Sand	46.3	245.0	411.8	67.7	26.8	***270.7***	271	0	0	149	46
326.10	2.50		100	Clean Coarse Sand	46.3	245.0	458.1	67.7	26.8	***338.4***	338	0	0	186	49
325.60	0.50		100	Clean Coarse Sand	9.3	245.0	421.4	13.5	26.8	***346.9***	347	0	0	191	49
324.60	1.00			Sandstone	82.4	199.1	503.8	120.4	21.8	***467.3***	~~467~~	~~0~~	~~0~~	~~257~~	~~50.4~~
323.60	1.00			Sandstone	82.4	199.1	***586.1***	120.4	21.8	587.7	~~586~~	~~0~~	~~0~~	~~322~~	~~51.4~~
322.60	1.00			Sandstone	82.4	199.1	***668.5***	120.4	21.8	708.2	~~668~~	~~0~~	~~0~~	~~368~~	~~52.4~~
321.60	1.00			Sandstone	82.4	199.1	***750.8***	120.4	21.8	828.6	~~751~~	~~0~~	~~0~~	~~413~~	~~53.4~~
320.60	1.00			Sandstone	82.4	199.1	***833.2***	120.4	21.8	949.0	~~833~~	~~0~~	~~0~~	~~458~~	~~54.4~~
319.60	1.00			Sandstone	82.4	199.1	***915.5***	120.4	21.8	1069.4	~~916~~	~~0~~	~~0~~	~~504~~	~~55.4~~
318.60	1.00			Sandstone		199.1			21.8						

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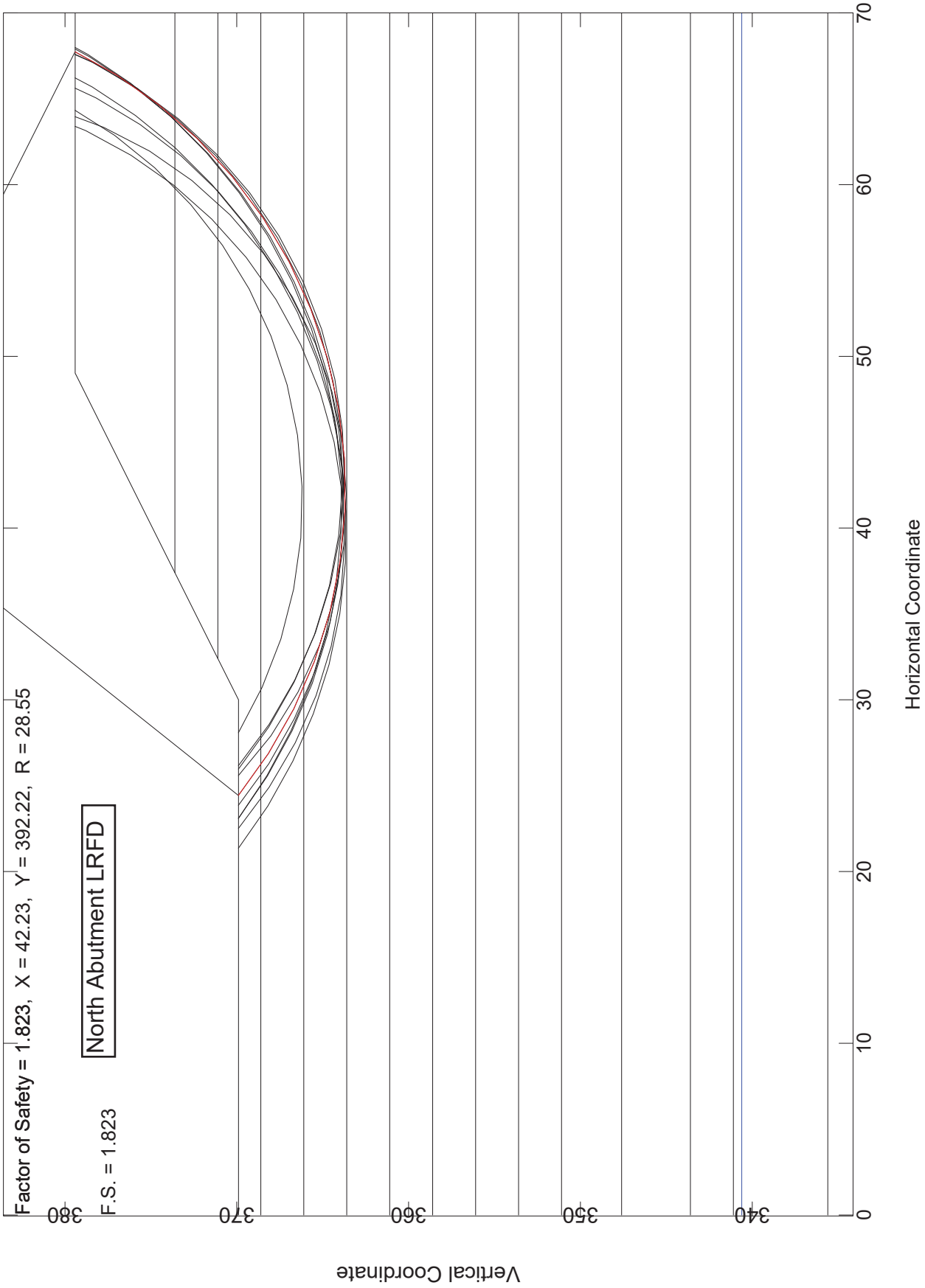
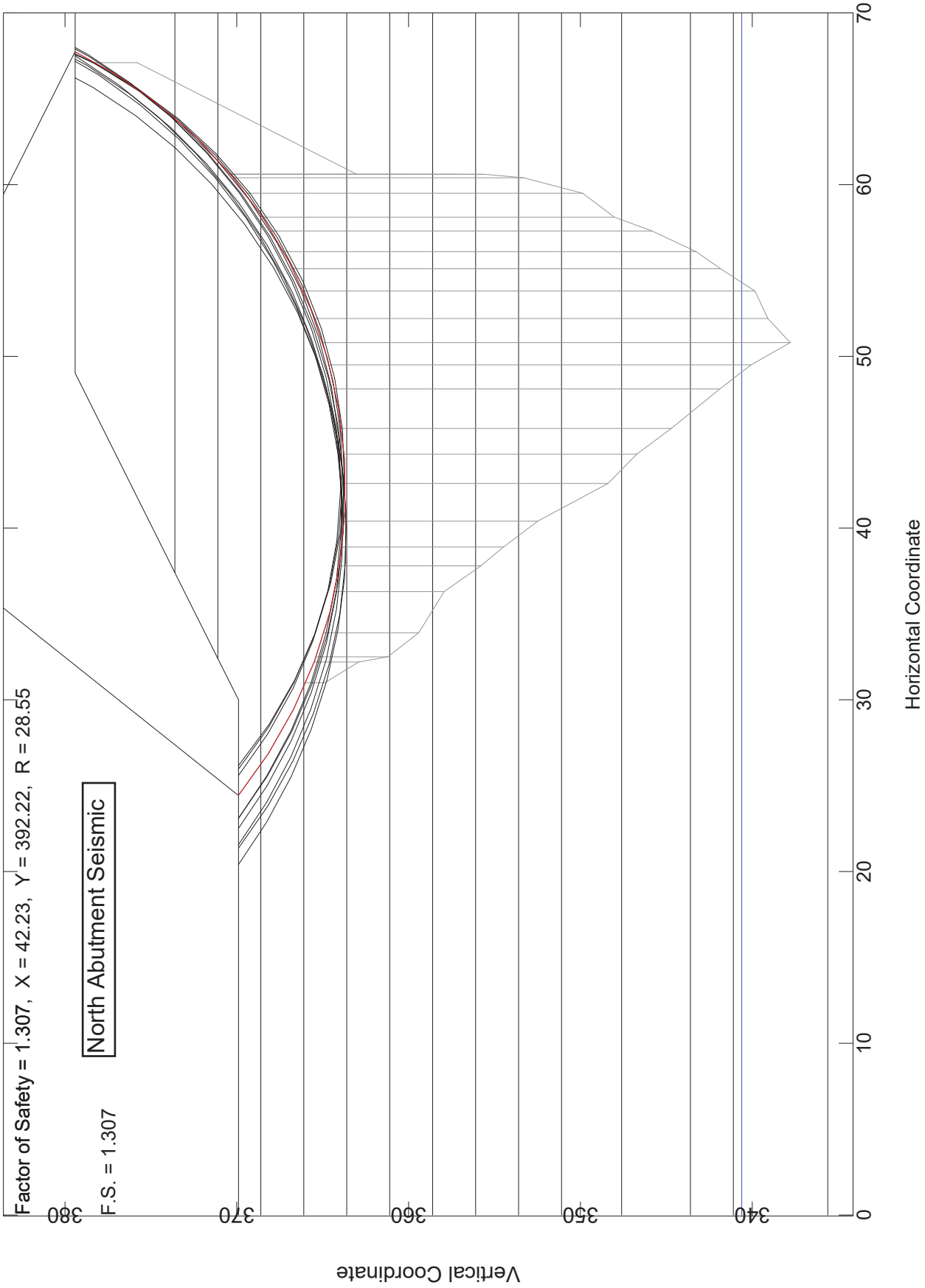

Factor of Safety = 1.823, X = 42.23, Y = 392.22, R = 28.55
F.S. = 1.823
North Abutment LRFD
Vertical Coordinate
Horizontal Coordinate
380
370
360
350
340
0
10
20
30
40
50
60
70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North Abutment Seismic
F.S. = 1.307
Vertical Coordinate
Horizontal Coordinate
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370
360
350
340
0
10
20
30
40
50
60
70