STRUCTURE GEOTECHNICAL REPORT

Proposed SN 077-0041

Existing SN 077-0026

Shawnee College Road (County Highway 7) over I-57
FAI Route 57
Section (77-1-3)BR-1
Pulaski County

PTB 157 - Item 46
Contract No. 78454
Job No. D-99-014-15

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Project Description and Scope

This project involves the complete replacement of an existing bridge carrying Shawnee College Road (CH 7) over I-57 in Pulaski County. The project site is located on the border of Sections 19 and 25, split between Ranges 1W and 1E, Township 14S, in the 3rd Principal Meridian, about 4.3 miles south of the Union County line. A *Location Map* is presented in Exhibit A.

The existing bridge at this location, SN 077-0026, 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 existing plans call for concrete piles at the abutments driven to 32 ton capacity at an estimated length of 50 feet and Creosoted timber piles at the piers driven to 20 ton capacity at an estimated length of 30-35 feet. See *Existing Structure Pile Data* in Exhibit E for as-built information, which shows metal shell piles at much larger depths were used at most locations. Concrete slope walls are present within the outer spans of the bridge. The bridge measures 207'-0" back to back abutments and 33'-8" out to out, with a 6°-52'-40" right ahead skew.

Per the preliminary Type, Size & Location Plan (TSL), the proposed structure is a 2 span bridge with W36 rolled steel beams supported on integral abutments and a multi-column pier. The proposed structure will have a back-to-back abutment length of 196'-11", out-to-out width of 31'-2" and 6°-52'-40" 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 in front of the existing abutments, with the profile raised by up to one foot. Traffic will be maintained utilizing stage construction. The new abutment and pier foundations will be located to avoid conflict with the existing metal shell piles. The new structure is to be designed following LRFD Bridge Design Specifications.

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

Field Exploration

Subsurface Exploration and Testing

The site is located in the middle of a diamond interchange, with the town of Ullin west of the interchange. Several commercial properties are located to the west and private properties are located to the east, with the remaining areas predominantly fields and wooded areas. The structure crosses over I-57, which is approximately 118 feet wide from out to out of shoulders. No utilities were identified near the structure.

The subsurface investigation consisted of three borings (1-S, 2-S, and 3-S) drilled by IDOT District 9 personnel in June of 2015. 1-S was drilled in the median of I-57 just south of the bridge; 2-S was drilled in the embankment behind the west abutment; 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. Borings 1-S and 2-S were terminated in Limestone at depths ranging from 75 to 89 feet. Boring 3-S did not

reach limestone within 103 feet and was terminated in a very stiff clay layer. Rock cores were only retrieved at Boring 1-S.

Subsurface Conditions

While drilling, groundwater was encountered at an elevation between 320.1 and 330.5 within the embankments and at 335.3 within the I-57 median.

Boring 1-S: Starting at ground surface, the boring data depicts very stiff grey and brown clay to silty clay to an elevation of 335.3, with a Q_u value of 2.3 tsf, an SPT (N) value of 17 blows per foot, and a moisture content of 17%. Soft grey silty clay loam is present down to elevation 332.8, with a Q_u value of 0.3 tsf, an SPT (N) value of 4 blows per foot, and a moisture content of 25%. Stiff grey clay is present down to elevation 330.3, with a Q_u value of 1.8 tsf, an SPT (N) value of 5 blows per foot, and a moisture content of 27%. Soft to medium grey mottled brown silty clay is present down to elevation 325.3, with Q_u values from 0.4 to 0.7 tsf, SPT (N) values ranging from 1 to 3 blows per foot, and moisture contents ranging between 30% and 31%. Stiff grey mottled brown silty clay to clay is present down to elevation 322.8, with a Q_u value of 1.2 tsf, an SPT (N) value of 4 blows per foot, and a moisture content of 25%. Medium grey brown silty clay loam is present down to elevation 317.8, with Q_u values from 0.6 to 0.8 tsf, SPT (N) values ranging from 1 to 4 blows per foot, and moisture contents ranging between 31% and 35%. Stiff grey silt loam to silty clay loam is present down to elevation 315.3, with a Q_u value of 1.2 tsf, an SPT (N) value of 5 blows per foot, and a moisture content of 26%. Soft to medium grey silty clay to clay is present down to elevation 312.8, with a Q_u value of 0.5 tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 27%. Stiff grey clay is present down to elevation 302.8, with Q_u values from 1.2 to 1.7 tsf, SPT (N) values ranging from 3 to 4 blows per foot, and moisture contents ranging between 24% and 39%. Medium grey clay is present down to elevation 300.3, with a Q_u value of 0.9 tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 30%. Stiff to very stiff grey and brown clay is present down to elevation 280.3, with Q_u values from 1.1 to 2.9 tsf, SPT (N) values ranging from 2 to 13 blows per foot, and moisture contents ranging between 24% and 30%. Soft to medium grey clay is present down to elevation 270.3, with Q_u values from 0.4 to 0.8 tsf, SPT (N) values ranging from 1 to 3 blows per foot, and moisture contents of 27%. Stiff grey clay is present down to elevation 265.3, with a Q_u value of 1.2 tsf, an SPT (N) value of 3 blows per foot, and a moisture content of 27%. Very stiff grey and red brown clay with gravel is present down to elevation 252.3, with Q_u values from 2.5 to 3.1 tsf, SPT (N) values ranging from 14 to 17 blows per foot, and moisture contents ranging between 20% and 35%. Limestone was encountered at elevation 252.3 and the rock cores displayed an RQD value of 43% with sample recovery of 60%.

Boring 2-S: Starting at ground surface, the boring data depicts stiff to very stiff grey mottled brown clay to silty clay to an elevation of 333.0, with Q_u values from 1.1 to 3.9 tsf, SPT (N) values ranging from 3 to 18 blows per foot, and moisture contents ranging between 19% and 29%. Soft to medium grey mottled brown silty clay to clay is present down to elevation 325.5, with Q_u values from 0.3 to 1.0 tsf, SPT (N) values ranging from 1 to 4 blows per foot, and moisture contents ranging between 25% and 34%. Stiff grey silty clay loam is present down to elevation 323.0, with a Q_u value of 1.2 tsf, an SPT (N) value of 4 blows per foot, and a moisture content of 26%. Very soft grey silty clay loam is present down to elevation 318.0, with a Q_u value of 0.2 tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 30%. Medium grey silty clay is present down to

elevation 313.0, with a Q_u value of 0.7 tsf, an SPT (N) value of 2 blows per foot, and a moisture content of 26%. Stiff to very stiff grey and brown clay is present down to elevation 303.0, with Q_u values from 1.3 to 3.9 tsf, SPT (N) values ranging from 5 to 11 blows per foot, and moisture contents ranging between 22% and 24%. Stiff brown mottled grey clay with gravel is present down to elevation 298.0, with a Q_u value of 1.9 tsf, an SPT (N) value of 9 blows per foot, and a moisture content of 26%. Medium grey and brown silty clay to clay is present down to elevation 293.0, with a Q_u value of 0.7 tsf, an SPT (N) value of 3 blows per foot, and a moisture content of 29%. Soft to medium grey clay is present down to elevation 288.5, with a Q_u value of 0.5 tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 57%. Limestone was encountered at elevation 288.5.

Boring 3-S: Starting at ground surface, the boring data depicts stiff to very stiff grey mottled brown clay to an elevation of 340.0, with Q_u values from 1.5 to 3.1 tsf, SPT (N) values ranging from 5 to 16 blows per foot, and moisture contents ranging between 20% and 31%. Very stiff brown and grey silty clay loam is present down to elevation 337.5, with a Q_u value of 2.1 tsf, an SPT (N) value of 13 blows per foot, and a moisture content of 24%. Stiff to very stiff grey mottled brown silty clay to clay is present down to elevation 325.0, with Q_u values from 1.6 to 3.9 tsf, SPT (N) values ranging from 7 to 18 blows per foot, and moisture contents ranging between 20% and 22%. Medium grey silty clay to clay is present down to elevation 322.5, with a Q_u value of 0.7 tsf, an SPT (N) value of 4 blows per foot, and a moisture content of 26%. Stiff grey mottled brown clay is present down to elevation 320.0, with a Q_u value of 1.9 tsf, an SPT (N) value of 6 blows per foot, and a moisture content of 23%. Soft brown mottled grey silty clay is present down to elevation 315.0, with a Q_u value of 0.3 tsf, an SPT (N) value of 1 blow per foot, and a moisture content of 28%. Stiff brown and grey clay is present down to elevation 295.0, with Q_u values from 1.1 to 1.8 tsf, SPT (N) values ranging from 4 to 5 blows per foot, and moisture contents ranging between 24% and 30%. Very stiff grey and brown clay to silty clay loam is present down to elevation 280.0, with Q_u values from 2.1 to 2.8 tsf, SPT (N) values ranging from 3 to 11 blows per foot, and moisture contents ranging between 24% and 26%. Stiff grey clay to silty clay is present down to elevation 270.0, with a Q_u value of 1.9 tsf, an SPT (N) value of 6 blows per foot, and a moisture content of 25%. Soft grey clay with gravel is present down to elevation 260.0, with a Q_u value of 0.3 tsf, an SPT (N) value of 3 blows per foot, and a moisture content of 22%. Very stiff grey clay is present down to elevation 256.5, with a Q_u value of 2.1 tsf, an SPT (N) value of 5 blows per foot, and a moisture content of 33%.

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 0.84 to 0.98 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 22.95 foot high 2H:1V (at right angles) end slope model which rendered factor of safety of 2.04. The east abutment used a 20.81 foot high 2H:1V (at right angles) end slope model which rendered factor of safety of 4.03. The Seismic slope stability was also analyzed and yielded factors of safety of 0.70 and 1.29 at west and east abutments respectively. The horizontal coefficient was calculated according to FHWA-NHI-11-032. The horizontal coefficient for both abutments is 0.58g. As per AASHTO LRFD 11.6.5.3, minimum required factor of safety under the effect of seismic loads is 1. Per IDOT Geotechnical Manual Section 6.12.4.1, if the seismic slope stability factor of safety falls below 1.0, the vertical deformation at the back of slope shall be estimated using the Newmark procedure. IDOT considers a settlement of 6 inches or less at the bridge approach resulting from the design earthquake to be acceptable without corrective measures. Preliminary calculations per FHWA-NHI-11-032, section 6.2.3 yield an estimated displacement less than 6 inches, so no stability problems are expected. Slope stability analyses are presented in Exhibit H.

Seismic Considerations

Based on the method described in the IDOT Design Guide LRFD Soil Site Class Definition, Soil Site Class D controls. The Design Spectral Acceleration at 1.0 sec (S_{D1}) is 0.677g and at 0.2 sec (S_{Ds}) is 1.648g. These values are based on a 1000 year design return period earthquake. According to AASHTO LRFD 3.10.6 the Seismic Performance Zone is 4 based on the 1.0 second Design Spectral Acceleration.

Liquefaction analysis was performed using the IDOT Liquefaction Analysis spreadsheet for each new boring at the proposed bridge. Boring 1-S near the proposed pier was found to contain potentially liquefiable soft clay layers between elevations 305.3 and 322.8. Liquefiable layers at the West Abutment were only identified below the 60 foot depth limitation defined in the Liquefaction Analysis Design Guide; therefore liquefaction is not a concern at the West Abutment. No liquefiable layers were identified at the East Abutment. See Exhibit F.

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 Pulaski County indicates that no mining activity has been present at the project location. The nearest underground mine proximity region is located 7.5 miles northwest of the bridge location.

Foundation Recommendations

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

Strength I Load Combination

West Abutment	975 kips
Pier	2150 kips
East Abutment	950 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 HP 8x36 are permissible with an expansion length of 96.55'. Unless the abutment type is changed, spread footings and drilled shafts are not allowed for integral abutments as per the IDOT Bridge Manual.

Metal shell piles are recommended. Since the East Abutment boring does not encounter rock, the estimated length of H-pile at this location would likely be inaccurate since it extends below the limits of the boring. H-pile lengths are typically difficult to accurately estimate when used as friction piles. Metal shell piles will achieve adequate friction capacity above the rock layers.

Driven pile foundation design does not include a seismic case since no liquefiable soils are present within the upper 60 feet of the borings. Analyses have been performed using the Modified IDOT Static Method for estimating nominal pile resistance. Pile size calculations are presented in Exhibit G 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 358.27 at the west abutment and 356.11 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 077-0041 Strength Limit State	MS 12″x0.25″	165	91	30	328.27	0
		175	96	33	325.27	0
		176	97	35	323.27	0
		185	102	40	318.27	0
		203	112	45	313.27	0
		247	136	50	308.27	0
		275	151	55	303.27	0
		293	161	60	298.27	0
		304	167	65	293.27	0

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 077-0041 Strength Limit State	MS 14”x0.25”	150	83	18	340.27	0
		172	94	20	338.27	0
		173	95	23	335.27	0
		179	99	25	333.27	0
		182	100	28	330.27	0
		194	107	30	328.27	0
		206	113	35	323.27	0
		217	119	40	318.27	0
		239	131	45	313.27	0
		294	162	50	308.27	0
		324	178	55	303.27	0
		342	188	60	298.27	0
		355	195	65	293.27	0
	MS 14”x0.312”	150	83	18	340.27	0
		172	94	20	338.27	0
		173	95	23	335.27	0
		179	99	25	333.27	0
		182	100	28	330.27	0
		194	107	30	328.27	0
		206	113	35	323.27	0
		217	119	40	318.27	0
		239	131	45	313.27	0
		294	162	50	308.27	0
		324	178	55	303.27	0
		342	188	60	298.27	0
		355	195	65	293.27	0
	MS 16”x0.312”	144	79	15	343.27	0
		177	98	18	340.27	0
		200	110	23	335.27	0
		206	113	25	333.27	0
		209	115	28	330.27	0
		223	123	30	328.27	0
		236	130	35	323.27	0
		249	137	40	318.27	0
		276	152	45	313.27	0
		344	189	50	308.27	0
		374	206	55	303.27	0
		393	216	60	298.27	0
		407	224	65	293.27	0
	MS 16”x0.375”	144	79	15	343.27	0
		177	98	18	340.27	0
		200	110	23	335.27	0
		206	113	25	333.27	0
		209	115	28	330.27	0
		223	123	30	328.27	0
		236	130	35	323.27	0
		249	137	40	318.27	0
		276	152	45	313.27	0
		344	189	50	308.27	0
		374	206	55	303.27	0
		393	216	60	298.27	0
		407	224	65	293.27	0
		782	430	70	288.27	0.2

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)
West Abutment SN 077-0041 Strength Limit State	HP 10x42	180	99	50	308.27	0
		192	105	55	303.27	0
		199	109	60	298.27	0
		206	113	65	293.27	0
		326	179	70	288.27	0.2
		335	184	72	286.27	2.2
	HP 12x53	173	95	45	313.27	0
		226	124	50	308.27	0
		235	129	55	303.27	0
		241	132	60	298.27	0
		248	137	65	293.27	0
		390	215	70	288.27	0.2
		418	230	72	286.27	2.2
	HP 12x63	174	96	45	313.27	0
		228	125	50	308.27	0
		237	130	55	303.27	0
		243	134	60	298.27	0
		251	138	65	293.27	0
		400	220	70	288.27	0.2
		497	273	72	286.27	2.2
	HP 14x73	168	93	30	328.27	0
		171	94	35	323.27	0
		184	101	40	318.27	0
		208	115	45	313.27	0
		279	153	50	308.27	0
		284	156	55	303.27	0
		287	158	60	298.27	0
		296	163	65	293.27	0
		474	261	70	288.27	0.2
		578	318	72	286.27	2.2
	HP 14x89	170	94	30	328.27	0
		173	95	35	323.27	0
		187	103	40	318.27	0
		211	116	45	313.27	0
		283	156	50	308.27	0
		288	158	55	303.27	0
		291	160	60	298.27	0
		299	165	65	293.27	0
		486	267	70	288.27	0.2
		705	388	72	286.27	2.2
	HP 14x117	157	86	28	330.27	0
		174	96	30	328.27	0
		176	97	35	323.27	0
		191	105	40	318.27	0
		216	119	45	313.27	0
		290	160	50	308.27	0
		294	162	55	303.27	0
		297	163	60	298.27	0
		306	168	65	293.27	0
		505	278	70	288.27	0.2
		929	511	72	286.27	2.2

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 077-0041 Strength Limit State	MS 12″x0.25″	153	84	21	335.11	0
		174	96	24	332.11	0
		189	104	26	330.11	0
		196	108	29	327.11	0
		201	111	31	325.11	0
		218	120	36	320.11	0
		231	127	41	315.11	0
		251	138	46	310.11	0
		274	150	51	305.11	0
		300	165	56	300.11	0
		335	184	61	295.11	0
		367	202	66	290.11	0
	MS 14″x0.25″	151	83	19	337.11	0
		185	102	21	335.11	0
		209	115	24	332.11	0
		226	124	26	330.11	0
		232	128	29	327.11	0
		236	130	31	325.11	0
		255	140	36	320.11	0
		271	149	41	315.11	0
		295	162	46	310.11	0
		322	177	51	305.11	0
		353	194	56	300.11	0
		395	218	61	295.11	0
		433	238	66	290.11	0
	MS 14″x0.312″	151	83	19	337.11	0
		185	102	21	335.11	0
		209	115	24	332.11	0
		226	124	26	330.11	0
		232	128	29	327.11	0
		236	130	31	325.11	0
		255	140	36	320.11	0
		271	149	41	315.11	0
		295	162	46	310.11	0
		322	177	51	305.11	0
		353	194	56	300.11	0
		395	218	61	295.11	0
		433	238	66	290.11	0
		467	257	71	285.11	0
		499	274	76	280.11	0
		545	300	86	270.11	0
	MS 16″x0.312″	177	98	19	337.11	0
		219	120	21	335.11	0
		246	136	24	332.11	0
		264	145	26	330.11	0
		268	147	29	327.11	0
		271	149	31	325.11	0
		292	160	36	320.11	0
		312	172	41	315.11	0
		340	187	46	310.11	0
		370	204	51	305.11	0
		406	224	56	300.11	0
		457	252	61	295.11	0
		499	274	66	290.11	0
		537	296	71	285.11	0
		574	315	76	280.11	0
		623	343	86	270.11	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)
East Abutment SN 077-0041 Strength Limit State	MS 16”x0.375”	149	82	16	340.11	0
		177	98	19	337.11	0
		219	120	21	335.11	0
		246	136	24	332.11	0
		264	145	26	330.11	0
		268	147	29	327.11	0
		271	149	31	325.11	0
		292	160	36	320.11	0
		312	172	41	315.11	0
		340	187	46	310.11	0
		370	204	51	305.11	0
		406	224	56	300.11	0
		457	252	61	295.11	0
		499	274	66	290.11	0
		537	296	71	285.11	0
		574	315	76	280.11	0
		623	343	86	270.11	0
		666	367	96	260.11	0
		706	388	101	255.11	0
	HP 10x42	159	87	41	315.11	0
		174	95	46	310.11	0
		189	104	51	305.11	0
		208	114	56	300.11	0
		235	129	61	295.11	0
		256	141	66	290.11	0
		274	151	71	285.11	0
		292	161	76	280.11	0
		314	173	86	270.11	0
	HP 12x53	166	91	24	332.11	0
		167	92	31	325.11	0
		178	98	36	320.11	0
		194	107	41	315.11	0
		212	116	46	310.11	0
		230	127	51	305.11	0
		254	140	56	300.11	0
		289	159	61	295.11	0
		313	172	66	290.11	0
		335	184	71	285.11	0
		356	196	76	280.11	0
		378	208	86	270.11	0
		413	227	96	260.11	0
	HP 12x63	168	92	24	332.11	0
		168	93	31	325.11	0
		179	99	36	320.11	0
		195	107	41	315.11	0
		214	117	46	310.11	0
		232	128	51	305.11	0
		256	141	56	300.11	0
		292	161	61	295.11	0
		316	174	66	290.11	0
		338	186	71	285.11	0
		359	197	76	280.11	0
		381	210	86	270.11	0
		416	229	96	260.11	0
		440	242	101	255.11	0

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)
East Abutment SN 077-0041 Strength Limit State	HP 14x73	178	98	21	335.11	0
		200	110	31	325.11	0
		212	116	36	320.11	0
		233	128	41	315.11	0
		255	140	46	310.11	0
		277	152	51	305.11	0
		306	168	56	300.11	0
		351	193	61	295.11	0
		378	208	66	290.11	0
		403	221	71	285.11	0
		427	235	76	280.11	0
		449	247	86	270.11	0
		495	272	96	260.11	0
		523	288	101	255.11	0
	HP 14x89	181	99	21	335.11	0
		202	111	31	325.11	0
		214	118	36	320.11	0
		235	130	41	315.11	0
		258	142	46	310.11	0
		280	154	51	305.11	0
		310	170	56	300.11	0
		356	196	61	295.11	0
		382	210	66	290.11	0
		407	224	71	285.11	0
		432	238	76	280.11	0
		454	250	86	270.11	0
		501	276	96	260.11	0
		529	291	101	255.11	0
	HP 14x117	156	86	19	337.11	0
		186	102	21	335.11	0
		207	114	31	325.11	0
		219	120	36	320.11	0
		241	133	41	315.11	0
		264	145	46	310.11	0
		287	158	51	305.11	0
		317	174	56	300.11	0
		364	200	61	295.11	0
		391	215	66	290.11	0
		417	229	71	285.11	0
		442	243	76	280.11	0
		464	255	86	270.11	0
		512	282	96	260.11	0
		542	298	101	255.11	0

Table 2 (continued)

Piers

There are several options for the type of foundation at the pier: Spread footing bearing on soil, pile-supported footings, 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, the rock layer over 25 feet deep, and the potentially liquefiable soil layers, it is not recommended to use spread footings.

Pile Supported: Per the preliminary TSL, a multi-column pier with three rows of piles in the footing are anticipated. Pile size calculations are presented in Exhibit G and summarized in Tables 3 and 4. The estimated lengths include 2 ft embedment into the pier footing and are based on top of pile elevations of 334.89. Analyses have been performed using the Modified IDOT Static Method for estimating nominal pile resistance. Tables include strength limit state and extreme event, which includes liquefaction. R_n values in tables represent the maximum nominal required bearing.

Metal shell piles are recommended. H-pile lengths are typically difficult to accurately estimate when used as friction piles. Metal shell piles will achieve adequate friction capacity above the rock layers.

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 077-0041 Strength Limit State	MS 12″x0.25″	124	68	35	299.9	0
		159	87	40	294.9	0
		188	104	45	289.9	0
		209	115	50	284.9	0
		226	124	55	279.9	0
		237	130	60	274.9	0
		251	138	65	269.9	0
		288	158	70	264.9	0
		321	177	75	259.9	0
	MS 14″x0.25″	110	61	27	307.9	0
		128	70	30	304.9	0
		134	73	32	302.9	0
		146	81	35	299.9	0
		190	104	40	294.9	0
		223	123	45	289.9	0
		246	135	50	284.9	0
		264	145	55	279.9	0
		277	152	60	274.9	0
		295	162	65	269.9	0
		341	188	70	264.9	0
		379	208	75	259.9	0
	MS 14″x0.312″	110	61	27	307.9	0
		128	70	30	304.9	0
		134	73	32	302.9	0
		146	81	35	299.9	0
		190	104	40	294.9	0
		223	123	45	289.9	0
		246	135	50	284.9	0
		264	145	55	279.9	0
		277	152	60	274.9	0
		295	162	65	269.9	0
		341	188	70	264.9	0
		379	208	75	259.9	0

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)
Pier SN 077-0041 Strength Limit State	MS 16”x0.312”	116	64	25	309.9	0
		128	71	27	307.9	0
		149	82	30	304.9	0
		154	85	32	302.9	0
		170	93	35	299.9	0
		223	122	40	294.9	0
		259	143	45	289.9	0
		283	156	50	284.9	0
		304	167	55	279.9	0
		317	174	60	274.9	0
		340	187	65	269.9	0
		396	218	70	264.9	0
		438	241	75	259.9	0
	MS 16”x0.375”	116	64	25	309.9	0
		128	71	27	307.9	0
		149	82	30	304.9	0
		154	85	32	302.9	0
		170	93	35	299.9	0
		223	122	40	294.9	0
		259	143	45	289.9	0
		283	156	50	284.9	0
		304	167	55	279.9	0
		317	174	60	274.9	0
		340	187	65	269.9	0
		396	218	70	264.9	0
		438	241	75	259.9	0
		782	430	83	251.9	0.4
	HP 10x42	117	65	40	294.9	0
		134	74	45	289.9	0
		145	80	50	284.9	0
		154	85	55	279.9	0
		160	88	60	274.9	0
		173	95	65	269.9	0
		205	113	70	264.9	0
		225	124	75	259.9	0
		335	184	85	249.9	2.4
	HP 12x53	148	81	40	294.9	0
		166	91	45	289.9	0
		176	97	50	284.9	0
		187	103	55	279.9	0
		194	106	60	274.9	0
		211	116	65	269.9	0
		253	139	70	264.9	0
		276	152	75	259.9	0
		418	230	85	249.9	2.4
	HP 12x63	149	82	40	294.9	0
		168	92	45	289.9	0
		178	98	50	284.9	0
		189	104	55	279.9	0
		195	107	60	274.9	0
		213	117	65	269.9	0
		256	141	70	264.9	0
		279	153	75	259.9	0
		454	250	83	251.9	0.4
		497	273	85	249.9	2.4

Table 3 (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 SN 077-0041 Strength Limit State	HP 14x73	118	65	32	302.9	0
		132	72	35	299.9	0
		184	101	40	294.9	0
		203	112	45	289.9	0
		212	117	50	284.9	0
		224	123	55	279.9	0
		231	127	60	274.9	0
		254	139	65	269.9	0
		309	170	70	264.9	0
		335	184	75	259.9	0
		537	295	83	251.9	0.4
		578	318	85	249.9	2.4
	HP 14x89	120	66	32	302.9	0
		133	73	35	299.9	0
		186	102	40	294.9	0
		206	113	45	289.9	0
		215	118	50	284.9	0
		227	125	55	279.9	0
		233	128	60	274.9	0
		256	141	65	269.9	0
		313	172	70	264.9	0
		339	186	75	259.9	0
		550	302	83	251.9	0.4
		705	388	85	249.9	2.4
	HP 14x117	122	67	32	302.9	0
		137	75	35	299.9	0
		191	105	40	294.9	0
		211	116	45	289.9	0
		220	121	50	284.9	0
		232	128	55	279.9	0
		238	131	60	274.9	0
		262	144	65	269.9	0
		321	177	70	264.9	0
		347	191	75	259.9	0
		570	313	83	251.9	0.4
		929	511	85	249.9	2.4

Table 3 (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 SN 077-0041 Extreme Event (Liquefaction)	MS 12″x0.25″	188	58	45	289.9	0
		209	79	50	284.9	0
		226	96	55	279.9	0
		237	107	60	274.9	0
		251	121	65	269.9	0
		288	158	70	264.9	0
		321	191	75	259.9	0
	MS 14″x0.25″	190	38	40	294.9	0
		223	72	45	289.9	0
		246	94	50	284.9	0
		264	113	55	279.9	0
		277	125	60	274.9	0
		295	144	65	269.9	0
		341	189	70	264.9	0
		379	227	75	259.9	0

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 SN 077-0041 Extreme Event (Liquefaction)	MS 14”x0.312”	190	38	40	294.9	0
		223	72	45	289.9	0
		246	94	50	284.9	0
		264	113	55	279.9	0
		277	125	60	274.9	0
		295	144	65	269.9	0
		341	189	70	264.9	0
		379	227	75	259.9	0
	MS 16”x0.312”	223	49	40	294.9	0
		259	86	45	289.9	0
		283	110	50	284.9	0
		304	131	55	279.9	0
		317	144	60	274.9	0
		340	166	65	269.9	0
		396	222	70	264.9	0
		438	265	75	259.9	0
	MS 16”x0.375”	223	49	40	294.9	0
		259	86	45	289.9	0
		283	110	50	284.9	0
		304	131	55	279.9	0
		317	144	60	274.9	0
		340	166	65	269.9	0
		396	222	70	264.9	0
		438	265	75	259.9	0
		782	609	83	251.9	0.4
	HP 10x42	134	47	45	289.9	0
		145	57	50	284.9	0
		154	67	55	279.9	0
		160	73	60	274.9	0
		173	86	65	269.9	0
		205	118	70	264.9	0
		225	138	75	259.9	0
		335	248	85	249.9	2.4
	HP 12x53	166	61	45	289.9	0
		176	72	50	284.9	0
		187	83	55	279.9	0
		194	89	60	274.9	0
		211	106	65	269.9	0
		253	149	70	264.9	0
		276	171	75	259.9	0
		418	314	85	249.9	2.4
	HP 12x63	168	62	45	289.9	0
		178	72	50	284.9	0
		189	83	55	279.9	0
		195	90	60	274.9	0
		213	107	65	269.9	0
		256	150	70	264.9	0
		279	173	75	259.9	0
		454	348	83	251.9	0.4
		497	391	85	249.9	2.4

Table 4 (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 SN 077-0041 Extreme Event (Liquefaction)	HP 14x73	184	60	40	294.9	0
		203	79	45	289.9	0
		212	88	50	284.9	0
		224	100	55	279.9	0
		231	106	60	274.9	0
		254	129	65	269.9	0
		309	185	70	264.9	0
		335	211	75	259.9	0
		537	413	83	251.9	0.4
		578	454	85	249.9	2.4
	HP 14x89	186	61	40	294.9	0
		206	80	45	289.9	0
		215	89	50	284.9	0
		227	101	55	279.9	0
		233	108	60	274.9	0
		256	131	65	269.9	0
		313	188	70	264.9	0
		339	213	75	259.9	0
		550	424	83	251.9	0.4
		705	579	85	249.9	2.4
	HP 14x117	191	63	40	294.9	0
		211	83	45	289.9	0
		220	92	50	284.9	0
		232	104	55	279.9	0
		238	110	60	274.9	0
		262	134	65	269.9	0
		321	193	70	264.9	0
		347	219	75	259.9	0
		570	442	83	251.9	0.4
		929	929	85	249.9	2.4

Table 4 (continued)

Drilled Shafts: With the rock layers being very deep and highly variable, drilled shafts would be uneconomical at this location. If it is determined in the final design that the proposed piles do not develop sufficient resistance, drilled shafts set into rock are feasible.

Lateral Loading Analysis

Tables 5 thru 7 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 to Very Stiff Clay to Silty Clay	333.0	0.075	-	500	15	0.007
Soft to Medium Silty Clay to Clay	325.5	0.031	-	30	5	0.020
Stiff Silty Clay Loam	323.0	0.035	-	500	8	0.007
Very Soft Silty Clay Loam	318.0	0.024	-	30	1	0.020
Medium Silty Clay	313.0	0.032	-	100	5	0.010
Stiff to Very Stiff Clay	303.0	0.040	-	500	18	0.007
Stiff Clay with Gravel	298.0	0.039	-	500	13	0.007
Medium Silty Clay to Clay	293.0	0.032	-	100	5	0.010
Soft to Medium Clay	288.5	0.030	-	30	3	0.020
Limestone	287.5	0.048	44	-	-	-

Table 5 –West Abutment (2-S)

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Very Stiff Clay to Silty Clay	335.3	0.040	-	1000	16	0.005
Soft Silty Clay Loam	332.8	0.027	-	30	2	0.020
Stiff Clay	330.3	0.038	-	500	13	0.007
Soft to Medium Silty Clay	325.3	0.030	-	30	4	0.020
Stiff Silty Clay to Clay	322.8	0.035	-	500	8	0.007
Medium Silty Clay Loam	317.8	0.032	-	100	5	0.010
Stiff Silt Loam to Silty Clay Loam	315.3	0.035	-	500	8	0.007
Soft to Medium Silty Clay to Clay	312.8	0.030	-	30	3	0.020
Stiff Clay	302.8	0.036	-	500	9	0.007
Medium Clay	300.3	0.034	-	100	6	0.010
Stiff to Very Stiff Clay	280.3	0.038	-	500	13	0.007
Soft to Medium Clay	270.3	0.031	-	30	4	0.020
Stiff Clay	265.3	0.035	-	500	8	0.007
Very Stiff Clay with Gravel	252.3	0.041	-	1000	19	0.005
Limestone	250.8	0.048	44	-	-	-

Table 6 –Pier (1-S)

Soil Type	Elev. At Bottom of Layer	Effective Unit Wt. (pci)	Friction Angle (deg)	k (pci)	c (psi)	E50
Stiff to Very Stiff Clay	340.0	0.075	-	500	15	0.007
Very Stiff Silty Clay Loam	337.5	0.075	-	1000	15	0.005
Stiff to Very Stiff Silty Clay to Clay	325.0	0.078	-	500	21	0.007
Medium Silty Clay to Clay	322.5	0.068	-	100	5	0.010
Stiff Clay	320.0	0.039	-	500	13	0.007
Soft Silty Clay	315.0	0.027	-	30	2	0.020
Stiff Clay	295.0	0.036	-	500	10	0.007
Very Stiff Clay to Silty Clay Loam	280.0	0.040	-	1000	17	0.005
Stiff Clay to Silty Clay	270.0	0.039	-	500	13	0.007
Soft Clay with Gravel	260.0	0.027	-	30	2	0.020
Very Stiff Clay	255.0	0.039	-	1000	15	0.005

Table 7 –East Abutment (3-S)

Construction Considerations

Stage Construction

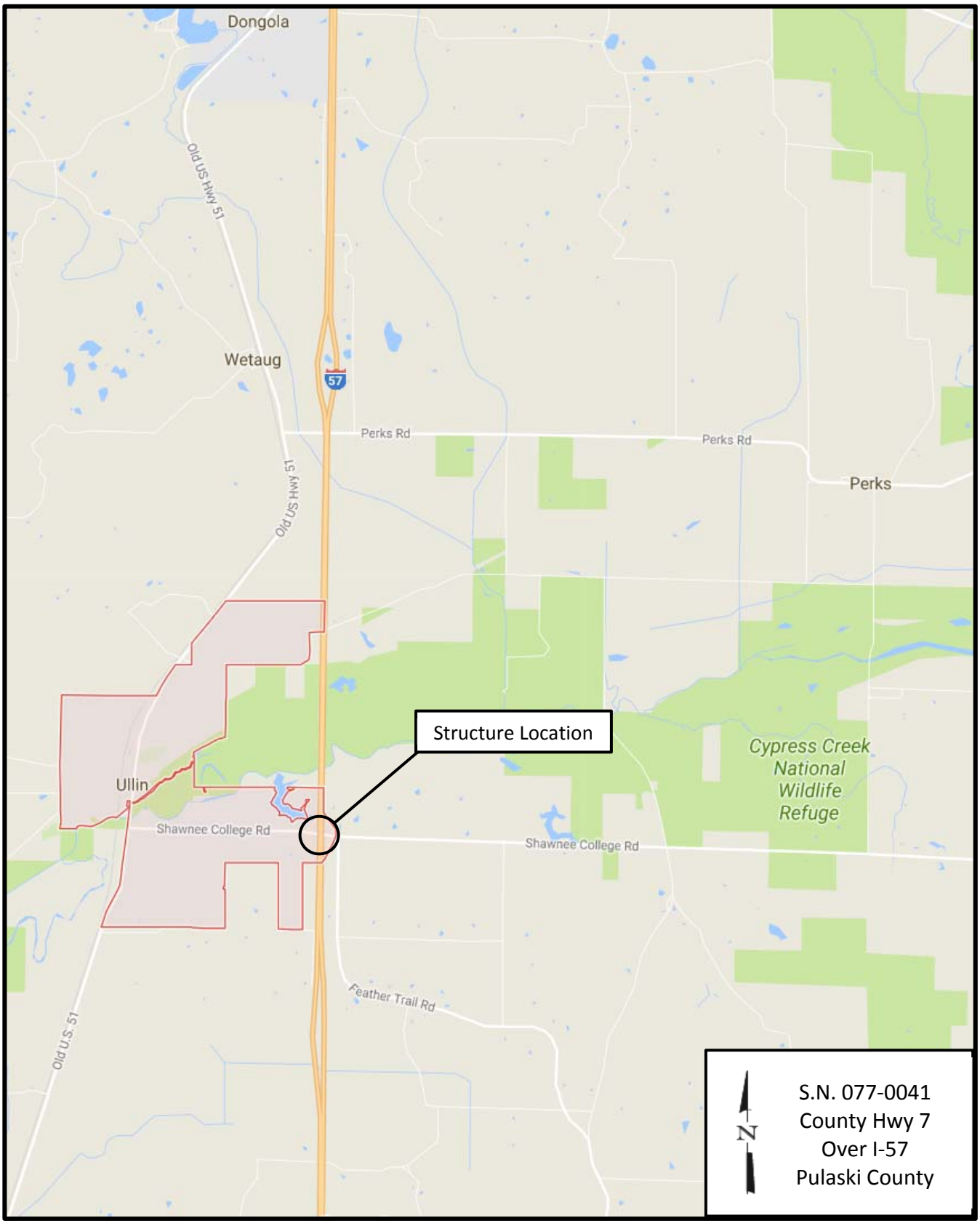
Traffic is expected to be maintained on Shawnee College Road (CH 7) utilizing stage construction. A temporary soil support system will be required between the stage construction of the new bridge and the stage removal of the old bridge. Preliminary calculations show Temporary Sheet Piling is feasible for the cohesive material located within the expected embedment. The soil will generally be adequate for a 1V:1H excavation slope. However, if the intermittent very soft soil layers shown in the borings are encountered in the field, a 1V:1.5H excavation slope may be more appropriate.

Foundation Construction

One test pile at each foundation unit should be provided regardless of pile type. Pile shoes will be required if H-piles are chosen.

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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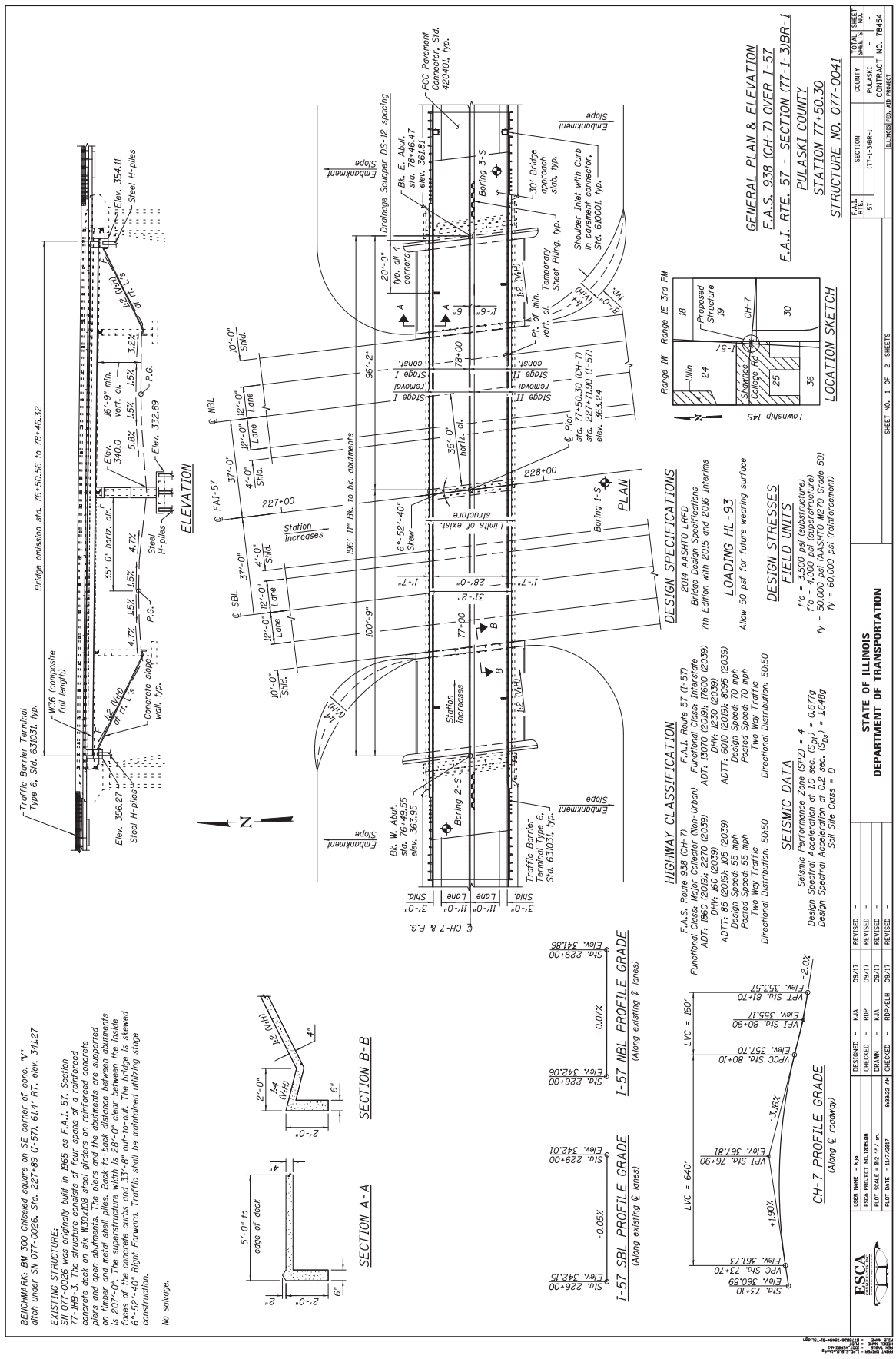
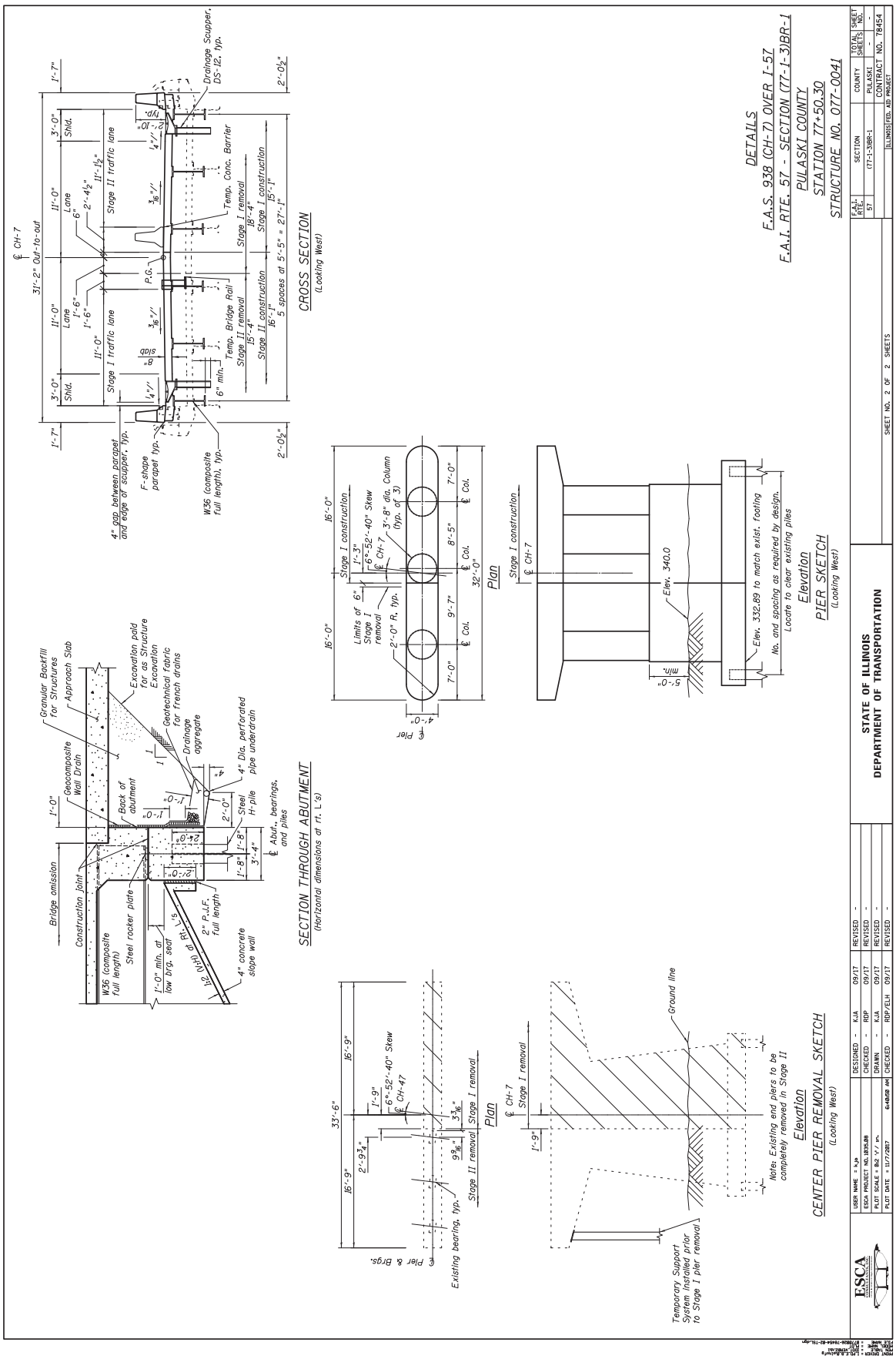
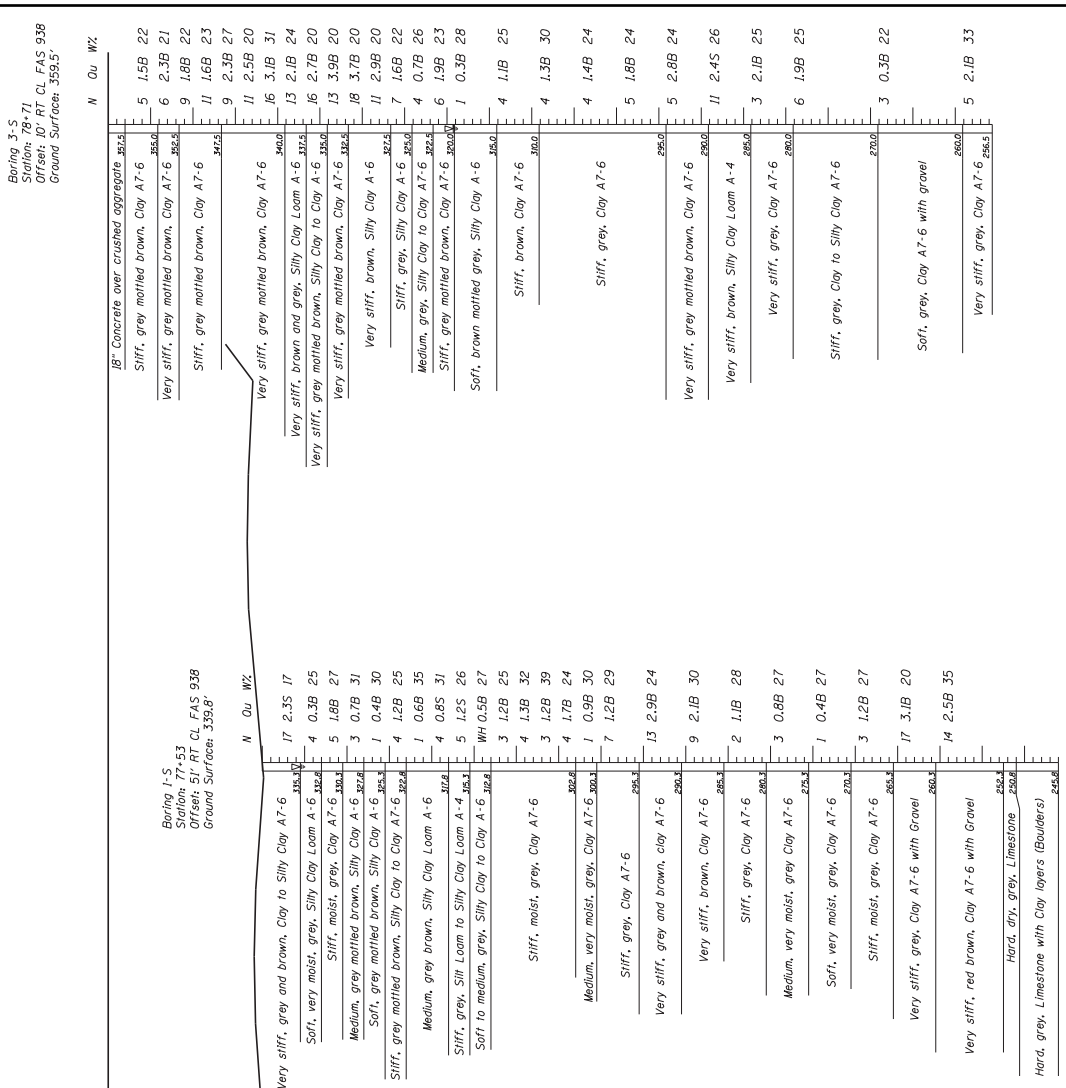
Old US Hwy 51
Wetaug
57
Perks Rd
Perks Rd
Perks
Old US Hwy 51
Structure Location
Ullin
Cypress Creek
National
Wildlife
Refuge
Shawnee College Rd
Shawnee College Rd
Feather Trail Rd
Old U.S. 51
N
S.N. 077-0041
County Hwy 7
Over I-57
Pulaski County


GENERAL PLAN & ELEVATION
F.A.S. 938 (CH-7) OVER I-57
F.A.I. RTE. 57 - SECTION (77-1-3)BR-1
PULASKI COUNTY
STATION 77+50.30
STRUCTURE NO. 077-0041
LOCATION SKETCH
ELEVATION
PLAN
SECTION A-A
SECTION B-B
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
f'c = 3,500 psi (substructure)
f'c = 4,000 psi (superstructure)
fy = 50,000 psi (AASHTO M270 Grade 50)
fy = 60,000 psi (reinforcement)
HIGHWAY CLASSIFICATION
SEISMIC DATA
I-57 SBL PROFILE GRADE
I-57 NBL PROFILE GRADE
CH-7 PROFILE GRADE
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
ESCA


DETAILS
F.A.S. 938 (CH-7) OVER I-57
F.A.I. RTE. 57 - SECTION (77-1-3)BR-1
PULASKI COUNTY
STATION 77+50.30
STRUCTURE NO. 077-0041
CROSS SECTION
(Looking West)
SECTION THROUGH ABUTMENT
(Horizontal dimensions at rt. L's)
Plan
Elevation
PIER SKETCH
(Looking West)
CENTER PIER REMOVAL SKETCH
(Looking West)
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
SHEET NO. 2 OF 2 SHEETS
ESCA


Boring 2-S
Station: 76+22
Offset: 9' LT CL FAS 938
Ground Surface: 362.5'
Boring 1-S
Station: 77+53
Offset: 51' RT CL FAS 938
Ground Surface: 339.8'
Boring 3-S
Station: 78+71
Offset: 10' RT CL FAS 938
Ground Surface: 359.5'
N Qu w%
15" Concrete over crushed aggregate 360.5
Stiff, grey mottled brown, clay A7-6 353.0
Stiff, brown, Silty Clay A-6 350.5
Very stiff, brown mottled grey, Clay A7-6 345.0
Stiff, brown mottled grey Clay A7-6 340.5
Very stiff, brown, Clay to Silty Clay A7-6 338.0
Very stiff, grey mottled brown, Clay A7-6 335.5
Stiff, grey mottled brown, Silty Clay A-6 333.0
Medium, grey mottled brown, Silty Clay A7-6 330.5
Soft, grey mottled brown, Clay A7-6 328.0
Medium to stiff, grey mottled brown, Silty Clay A-6 325.5
Stiff, grey, Silty Clay Loam A-4 323.0
Very soft, grey, Silty Clay Loam A-6 318.0
Medium, grey Silty Clay A-6 313.0
Stiff, grey and brown, Clay A7-6 308.0
Very stiff, brown mottled grey, Clay A7-6 303.0
Stiff, brown mottled grey, Clay A7-6 with some Gravel 298.0
Medium, grey and brown Silty Clay to Clay A7-6 293.0
Soft to medium, grey Clay A7-6 288.5
Hard, dry, grey, Limestone 287.5
100/1/2"
3 1.1B 27
4 1.3B 25
6 1.6B 26
7 1.7B 19
7 2.1B 21
16 3.9B 20
11 3.2B 22
9 1.9B 22
18 2.9B 21
9 2.9B 23
5 1.2B 29
2 0.7B 34
WH 0.3B 29
4 1.0B 25
4 1.2B 26
WH 0.2B 30
2 0.7B 26
5 1.3B 22
11 3.9B 24
9 1.9B 26
3 0.7B 29
1 0.5B 57
100/1/2"
Very stiff, grey and brown, Clay to Silty Clay A7-6 335.3
Soft, very moist, grey, Silty Clay Loam A-6 332.8
Stiff, moist, grey, Clay A7-6 330.3
Medium, grey mottled brown, Silty Clay A-6 327.8
Soft, grey mottled brown, Silty Clay A-6 325.5
Stiff, grey mottled brown, Silty Clay to Clay A7-6 322.8
Medium, grey brown, Silty Clay Loam A-6 317.8
Stiff, grey, Silt Loam to Silty Clay Loam A-4 315.1
Soft to medium, grey, Silty Clay to Clay A-6 312.8
Stiff, moist, grey, Clay A7-6 302.8
Medium, very moist, grey, Clay A7-6 300.1
Stiff, grey, Clay A7-6 295.3
Very stiff, grey and brown, clay A7-6 290.3
Very stiff, brown, Clay A7-6 285.5
Stiff, grey, Clay A7-6 280.3
Medium, very moist, grey Clay A7-6 275.5
Soft, very moist, grey, Clay A7-6 270.3
Stiff, moist, grey, Clay A7-6 265.8
Very stiff, grey, Clay A7-6 with Gravel 260.3
Very stiff, red brown, Clay A7-6 with Gravel 252.8
Hard, dry, grey, Limestone 250.8
Hard, grey, Limestone with Clay layers (Boulders) 245.8
17 2.3S 17
4 0.3B 25
5 1.8B 27
3 0.7B 31
1 0.4B 30
4 1.2B 25
1 0.6B 35
4 0.8S 31
5 1.2S 26
WH 0.5B 27
3 1.2B 25
4 1.3B 32
3 1.2B 39
4 1.7B 24
1 0.9B 30
7 1.2B 29
13 2.9B 24
9 2.1B 30
2 1.1B 28
3 0.8B 27
1 0.4B 27
3 1.2B 27
17 3.1B 20
14 2.5B 35
Very stiff, grey mottled brown, Clay A7-6 357.5
Stiff, grey mottled brown, Clay A7-6 355.0
Very stiff, grey mottled brown, Clay A7-6 352.5
Stiff, grey mottled brown, Clay A7-6 347.5
Very stiff, grey mottled brown, Clay A7-6 340.0
Very stiff, brown and grey, Silty Clay Loam A-6 337.5
Very stiff, grey mottled brown, Silty Clay to Clay A-6 335.0
Very stiff, grey mottled brown, Clay A7-6 332.5
Very stiff, brown, Silty Clay A-6 327.5
Stiff, grey, Silty Clay A-6 325.0
Medium, grey, Silty Clay to Clay A7-6 322.5
Stiff, grey mottled brown, Clay A7-6 320.0
Soft, brown mottled grey, Silty Clay A-6 315.0
Stiff, brown, Clay A7-6 310.0
Stiff, grey, Clay A7-6 295.0
Very stiff, grey mottled brown, Clay A7-6 290.0
Very stiff, brown, Silty Clay Loam A-4 285.0
Very stiff, grey, Clay A7-6 280.0
Stiff, grey, Clay to Silty Clay A7-6 270.0
Soft, grey, Clay A7-6 with gravel 260.0
Very stiff, grey, Clay A7-6 256.5
5 1.5B 22
6 2.3B 21
9 1.8B 22
11 1.6B 23
9 2.3B 27
11 2.5B 20
16 3.1B 31
13 2.1B 24
16 2.7B 20
13 3.9B 20
18 3.7B 20
11 2.9B 20
7 1.6B 22
4 0.7B 26
6 1.9B 23
1 0.3B 28
4 1.1B 25
4 1.3B 30
4 1.4B 24
5 1.8B 24
5 2.8B 24
11 2.4S 26
3 2.1B 25
6 1.9B 25
3 0.3B 22
5 2.1B 33

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Dave Piche
From:	Rob Graeff	
Subject:	*Boring Logs	
Date:	November 13, 2015	

FAS 938 (CH 7 – Shawnee College Road) over FAI 57
Structure 077-0026
Pulaski County

Foundation boring logs have been obtained for the above listed structure and are attached. Included are color photographs and compressive strengths for representative specimens.

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
RG:rg

cc: Soils File

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAS 938-CH 7 (Shawnee College Road) Over FAI 57

Route: FAS 938-CH 7 Structure Number: 077-0026 Date: 6/4/2015
Section 77-1HB-3 Bored By: R Moberly
County: Pulaski Location: Checked By: R Graeff

Boring No 1-S
Station 77+53
Offset 51' Rt CL FAS 938
Ground Surface 339.8 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 335.3
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	Description
				Very stiff, moist, grey and brown, Clay to Silty Clay A7-6
	2			
	7	2.3S	17	
	10			
335.3				
5.0	1			Soft, very moist, grey, Silty Clay Loam A-6
	2	0.3B	25	
	2			
332.8				
	1			Stiff, moist, grey, Clay A7-6
	2	1.8B	27	
	3			
330.3				
10.0	1			Medium, very moist, grey mottled brown, Silty Clay A-6
	1	0.7B	31	
	2			
327.8				
	WH			Soft, very moist, grey mottled brown, Silty Clay A-6
	WH	0.4B	30	
	1			
325.3				
15.0	1			Stiff, moist, grey mottled brown, Silty Clay to Clay A7-6
	2	1.2B	25	
	2			
322.8				
	WH			Medium, very moist, grey brown, Silty Clay Loam A-6
	WH	0.6B	35	
	1			
20.0	1			
	2	0.8S	31	
	2			
317.8				
	1			Stiff, moist to very moist, grey, Silt Loam to Silty Clay Loam A-4
	2	1.2S	26	
	3			
315.3				
25.0	WH			

DEPTH	BLOWS	Qu tsf	W%	Description
	WH	0.5B	27	Soft to medium, very moist, grey, Silty Clay to Clay A-6
	WH			
312.8				
	WH			Stiff, moist, grey, Clay A7-6
	1	1.2B	25	
	2			
30.0	1			
	2	1.3B	32	
	2			
	WH			
	1	1.2B	39	
	2			
35.0	1			
	2	1.7B	24	
	2			
302.8				
	WH			Medium, very moist, grey, Clay A7-6
	WH	0.9B	30	
	1			
300.3				
40.0	1			Stiff, moist, grey, Clay A7-6
	3	1.2B	29	
	4			
295.3				
45.0	2			Very stiff, moist, grey and brown, Clay A7-6
	5	2.9B	24	
	8			
50.0	1			

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

Sheet 2 of 2

Route: FAS 938-CH 7
Section: 77-1HB-3
County: Pulaski
Date: 6/4/2015

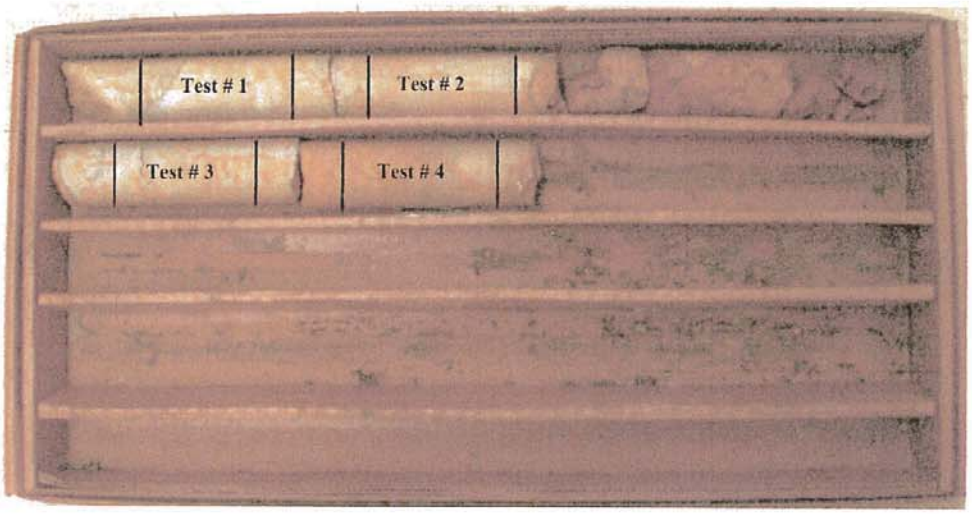
Boring No: 1-S
Station: 77+53
Offset: 51' Rt CL FAS 938
Ground Surface: 339.8 Ft

	DEPTH	BLOWS	Qu tsf	W%
Very stiff, moist, brown, Clay A7-6		4 5	2.1B	30
	285.3			
Stiff, moist to very moist, grey, Clay A7-6	55.0	WH 1 1	1.1B	28
	280.3			
Medium, very moist, grey, Clay A7-6	60.0	1 1 2	0.8B	27
	275.3			
Soft, very moist, grey, Clay A7-6	65.0	WH WH 1	0.4B	27
	270.3			
Stiff, moist, grey, Clay A7-6	70.0	WH 2 1	1.2B	27
	75.0	6		
Very stiff, moist, grey, Clay A7-6 with Gravel		8 9	3.1B	20
	260.3			
Very stiff, moist, red brown, Clay A7-6 with Gravel	80.0	3 7 7	2.5B	35
	85.0			
	252.3			
Hard, dry, grey, Limestone				
Refusal at 89.0 feet	250.8			
Cored 89.0 to 94.0 feet	90.0			
60% Recovery; 43% RQD				
Hard, dry, grey, Limestone with Clay layers (Boulders??)				
	245.8			
Bottom of hole = 94.0 feet				
	95.0			
Free water observed at 4.5 feet				
Elevation referenced to BM 300; Elevation = 341.3 feet				
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
To convert "N" values to "N60" multiply by 1.25	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
Unconfined Compressive Strength

FAS 938 – CH 7
Structure 077-0026 (Boring 1-S)
Pulaski County



Boring #	Specimen#	Depth	Unconfined Compression
1-S	1	89' 5"	7,075 psi
1-S	2	90'5"	7,652 psi
1-S	3	91'5"	5,812 psi
1-S	4	92'5"	10,641 psi

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 2

FAS 938-CH 7 (Shawnee College Road) Over FAI 57

Route: FAS 938-CH 7 Structure Number: 077-0026 Date: 6/9/2015
Section 77-1HB-3 Bored By: R Moberly
County: Pulaski Location: Checked By: R Graeff

Boring No 2-S
Station 76+22
Offset 9' LT CL FAS 938
Ground Surface 362.5 Ft

Surf Wat Elev:
Ground Water Elevation when Drilling 330.5
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
15" Concrete over crushed aggregate				Very stiff, moist, grey mottled brown, Clay A7-6	4 5	2.9B	23
360.5				335.5			
Stiff, moist, grey mottled brown, Clay A7-6	1 1 2	1.1B	27	Stiff, moist, grey mottled brown, Silty Clay A-6	1 2 3	1.2B	29
				333.0			
5.0	1 2 2	1.3B	25	Medium, very moist, grey mottled brown, Silty Clay A7-6	30.0 WH 1 1	0.7B	34
				330.5			
	1 3 3	1.6B	26	Soft, very moist to wet, grey mottled brown, Clay A7-6	WH WH WH	0.3B	29
353.0				328.0			
Stiff, moist, brown, Silty Clay A-6 10.0	2 3 4	1.7B	19	Medium to stiff, moist to very moist, grey mottled brown, Silty Clay A-6	35.0 1 2 2	1.0B	25
350.5				325.5			
Very stiff, moist, brown mottled grey, Clay A7-6	1 3 4	2.1B	21	Stiff, moist to very moist, grey, Silty Clay Loam A-4	1 2 2	1.2B	26
				323.0			
15.0	2 7 9	3.9B	20	Very soft, very moist, grey, Silty Clay Loam A-6	40.0 WH WH WH	0.2B	30
	1 5 6	3.2B	22				
343.0				318.0			
Stiff, moist, brown mottled grey, Clay A7-6 20.0	2 4 5	1.9B	22	Medium, very moist, grey, Silty Clay A-6	45.0 WH 1 1	0.7B	26
340.5							
Very stiff, moist, brown, Clay to Silty Clay A7-6	2 8 10	2.9B	21				
338.0				313.0			
25.0	2			50.0	1		

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

Sheet 2 of 2

Route: FAS 938-CH 7
Section: 77-1HB-3
County: Pulaski
Date: 6/9/2015

Boring No: 2-S
Station: 76+22
Offset: 9' LT CL FAS 938
Ground Surface: 362.5 Ft

	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, grey and brown, Clay A7-6		2 3	1.3B	22
	308.0			
Very stiff, moist, brown mottled grey, Clay A7-6	55.0	2 5 6	3.9B	24
	303.0			
Stiff, moist, brown mottled grey, Clay A7-6 with some Gravel	60.0	1 3 6	1.9B	26
	298.0			
Medium, very moist, grey and brown, Silty Clay to Clay A7-6	65.0	1 1 2	0.7B	29
	293.0			
Soft to medium, very moist, grey, Clay A7-6	70.0	WH WH 1	0.5B	57
	288.5			
Hard, dry, grey, Limestone		100/1/2"		
	287.5 75.0	Refusal		

Bottom of hole = 74.8 feet

Free water observed at 32.0 feet

Elevation referenced to BM 300; Elevation = 341.3 feet

Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)

To convert "N" values to "N60" multiply by 1.25

DEPTH	BLOWS	Qu tsf	W%
80.0			
85.0			
90.0			
95.0			
100.0			

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 3

FAS 938-CH 7 (Shawnee College Road) Over FAI 57

Route: FAS 938-CH 7 Structure Number: 077-0026 Date: 6/11/2015
Section 77-1HB-3 Bored By: R Moberly
County: Pulaski Location: Checked By: R Graeff

Boring No 3-S
Station 78+71
Offset 10' RT CL FAS 938
Ground Surface 359.5 Ft

Surf Wat Elev:
Ground Water Elevation
when Drilling 320.1
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
18" Concrete over crushed aggregate				Very stiff, moist, grey mottled brown, Clay A7-6	5	3.9B	20
357.5				332.5	8		
Stiff, moist, grey mottled brown, Clay A7-6	1			Very stiff, moist, brown, Silty Clay A-6	4		
	2	1.5B	22		8	3.7B	20
	3				10		
355.0							
5.0 Very stiff, moist, grey mottled brown, Clay A7-6	1			30.0	1		
	2	2.3B	21		4	2.9B	20
	4				7		
352.5				327.5			
Stiff, moist, grey mottled brown, Clay A7-6	1			Stiff, moist, grey, Silty Clay A-6	2		
	4	1.8B	22		3	1.6B	22
	5				4		
				325.0			
10.0	2			35.0 Medium, very moist, grey, Silty Clay to Clay A7-6	1		
	5	1.6B	23		2	0.7B	26
	6				2		
347.5				322.5			
Very stiff, moist, grey mottled brown, Clay A7-6	2			Stiff, moist, grey mottled brown, Clay A7-6	1		
	4	2.3B	27		3	1.9B	23
	5				3		
				320.0			
15.0	1			40.0 Soft, very moist to wet, brown mottled grey, Silty Clay A-6	WH		
	4	2.5B	20		WH	0.3B	28
	7				1		
	2						
	6	3.1B	31				
	10						
340.0				315.0			
Very stiff, moist, brown and grey, Silty Clay Loam A-6	20.0 2			Stiff, moist to very moist, brown, Clay A7-6	45.0 1		
	5	2.1B	24		2	1.1B	25
	8				2		
337.5							
Very stiff, moist, grey mottled brown, Silty Clay to Clay A-6	2						
	6	2.7B	20				
	10						
335.0				310.0			
25.0	1			50.0	1		

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

Sheet 2 of 3

Route: FAS 938-CH 7
Section: 77-1HB-3
County: Pulaski
Date: 6/11/2015

Boring No: 3-S
Station: 78+71
Offset: 10' RT CL FAS 938
Ground Surface: 359.5 Ft

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, grey, Clay A7-6	2 2	1.3B	30	Very stiff, moist, grey, Clay A7-6	1 2	2.1B	25
55.0	1			280.0			
	2 2	1.4B	24	Stiff, moist, grey, Clay to Silty Clay A7-6	1 2 4	1.9B	25
60.0	1			80.0			
	2 3	1.8B	24	85.0			
295.0				270.0			
Very stiff, moist, grey mottled brown, Clay A7-6	65.0 1 2 3	2.8B	24	Soft, very moist, grey, Clay A7-6 with gravel	90.0 1 1 2	0.3B	22
290.0							
Very stiff, moist, brown, Silty Clay Loam A-4	70.0 3 4 7	2.4S	26	95.0			
285.0				260.0			
	75.0 WH				100.0 1		

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

Sheet 3 of 3

Route: FAS 938-CH 7
Section: 77-1HB-3
County: Pulaski
Date: 6/11/2015

Boring No: 3-S
Station: 78+71
Offset: 10' RT CL FAS 938
Ground Surface: 359.5 Ft

DEPTH	BLOWS	Qu tsf	W%
	2	2.1B	33
	3		
105.0			
110.0			
115.0			
120.0			
125.0			

Very stiff, moist, grey, Clay A7-6

++++++++++++++++++++++
65.1 tons ESF at 103.0 feet
++++++++++++++++++++++

Augered without sampling to determine depth to bedrock or Limestone boulders

Boring abandoned at 124.5 feet when loose Sand was encountere and drill rods fell through augers for about 3 feet. 235.0

DEPTH	BLOWS	Qu tsf	W%
130.0			
135.0			
140.0			
145.0			
150.0			

Bottom of hole = 124.5 feet

Free water observed at 39.5 feet

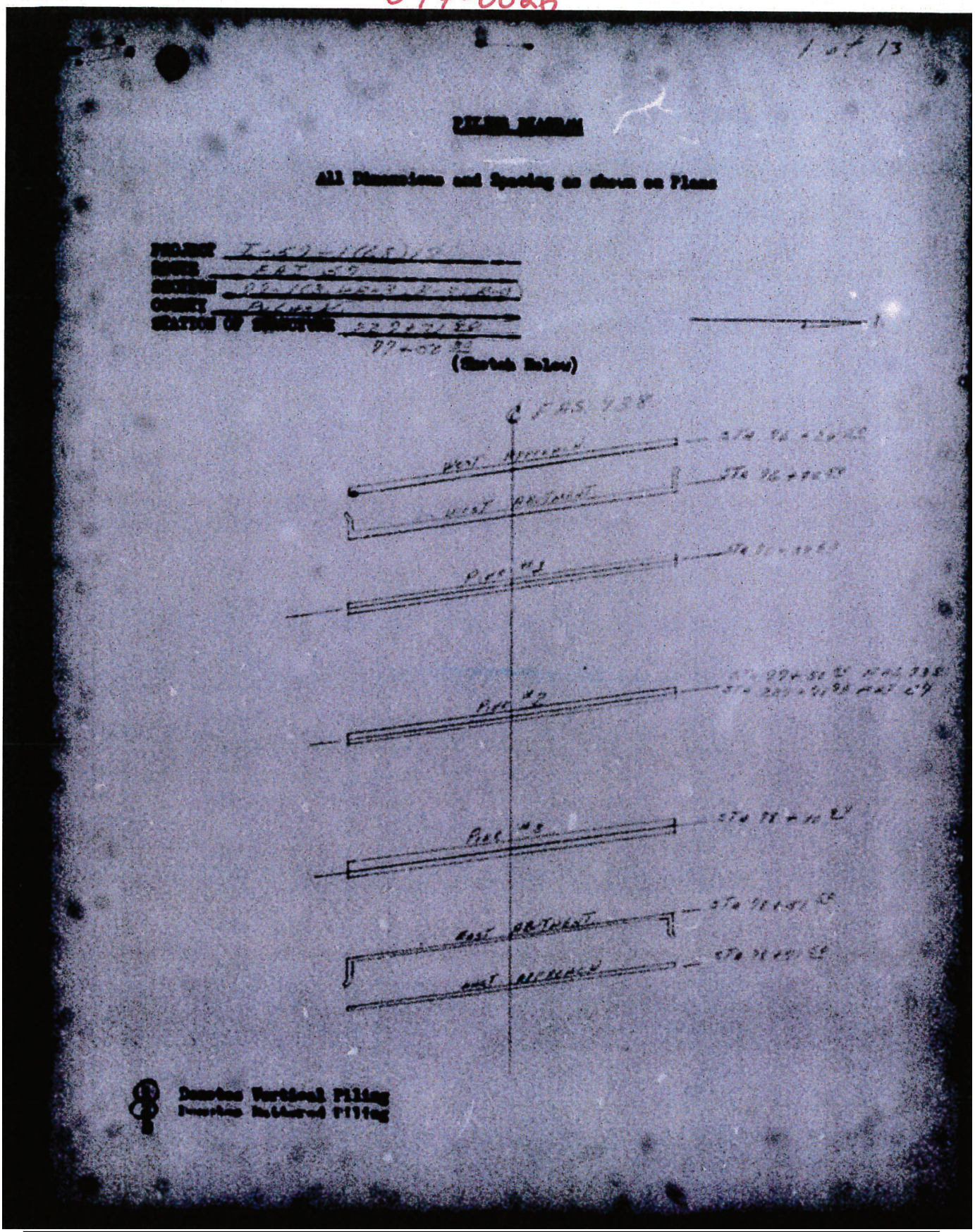
Elevation referenced to BM 300; Elevation = 341.3 feet

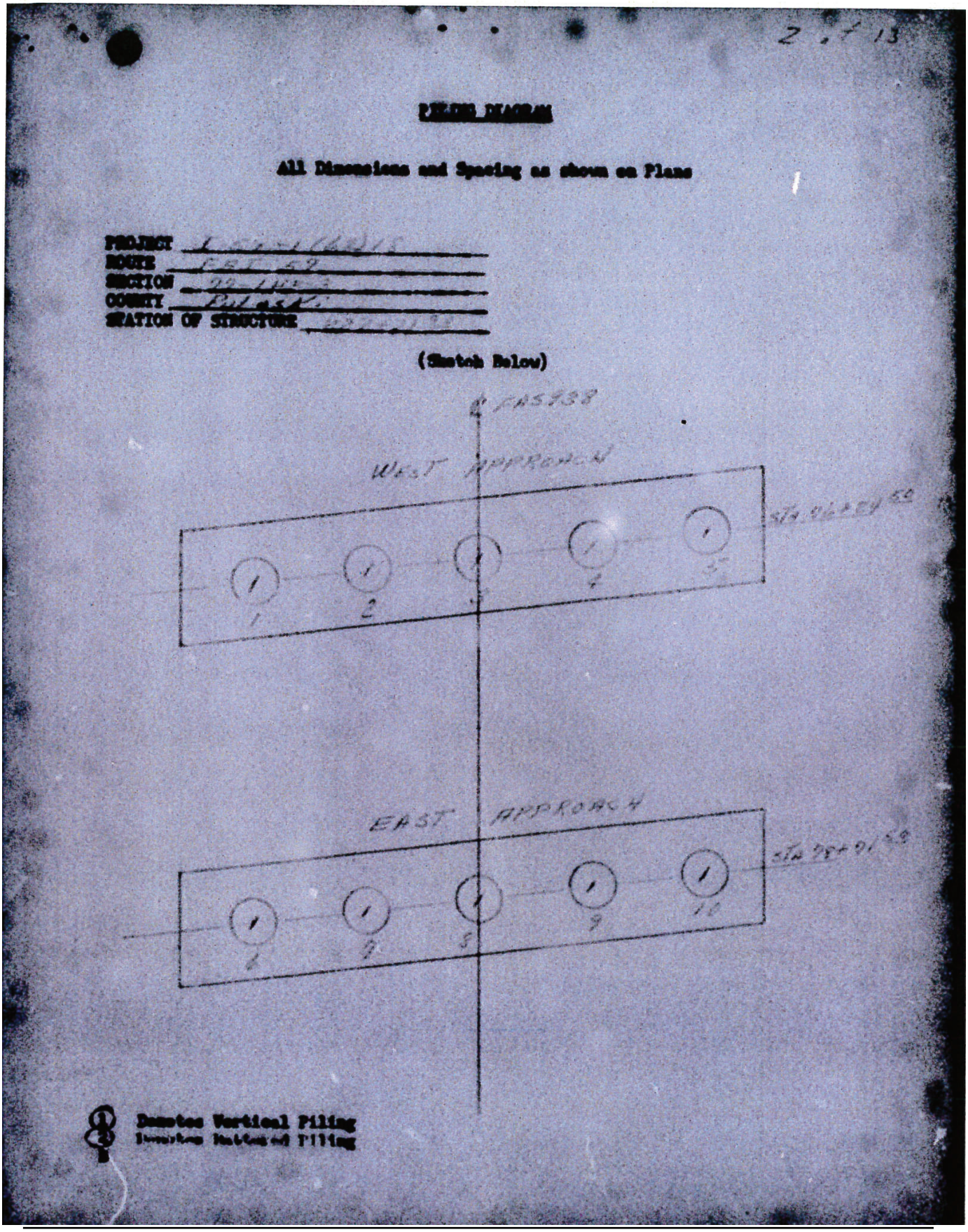
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)

To convert "N" values to "N60" multiply by 1.25

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

077-0026


1 of 13
All Dimensions and Spacing as shown on Plans
(Sketch Below)
Drawing Vertical Piling
Drawing Battered Piling


2 of 13
PILING DIAGRAM
All Dimensions and Spacing as shown on Plans
PROJECT
ROUTE
SECTION
COUNTY
STATION OF STRUCTURE
(Sketch Below)
WEST APPROACH
EAST APPROACH
Denotes Vertical Piling

Location [illegible]

Type of Pile [illegible]

PROJECT [illegible]
ROUTE [illegible]
SECTION [illegible]
COUNTY [illegible]

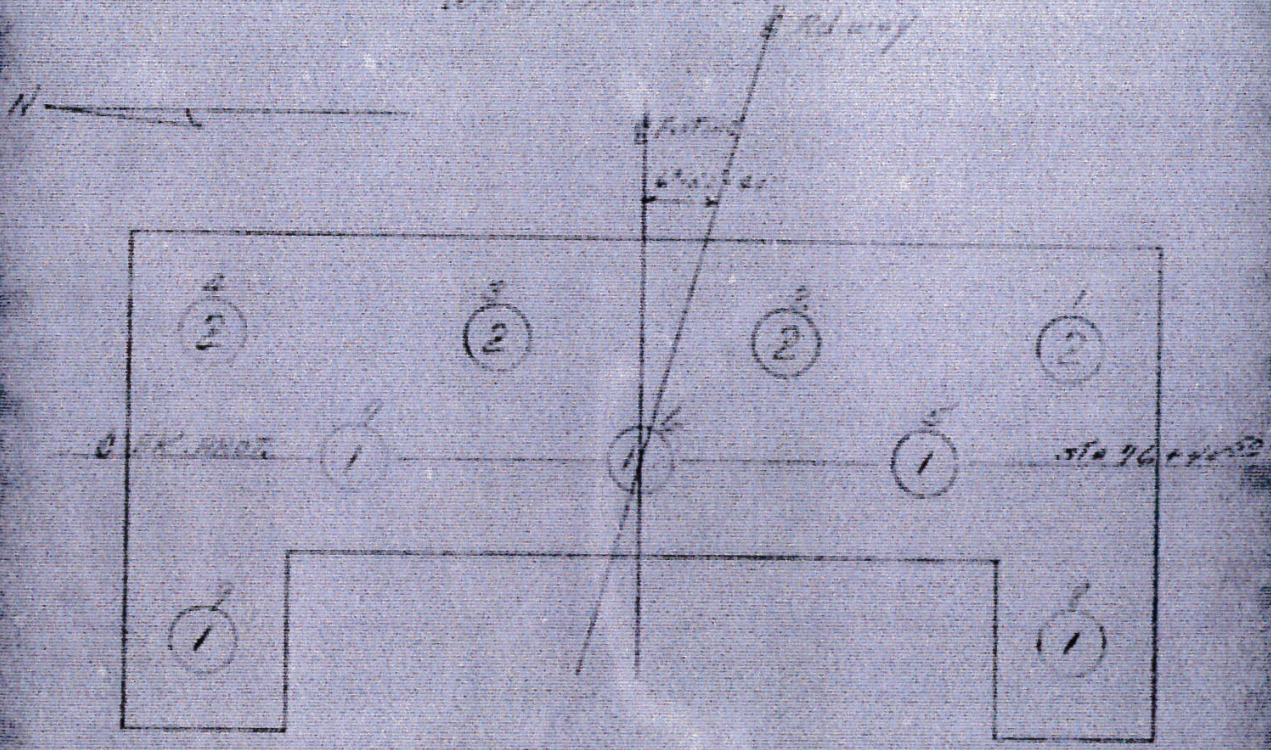
Pile Number	Ordered Length	Furnished Length	Driven Length	Cutoff	Bearing (Tons)
West Approach					
1	25^{0}	25^{0}	20^{6}	4^{6}	[illegible]
2	25^{0}	25^{0}	[illegible]	[illegible]	[illegible]
3	25^{0}	25^{0}	[illegible]	6^{0}	[illegible]
4	25^{0}	25^{0}	[illegible]	[illegible]	[illegible]
5	25^{0}	25^{0}	[illegible]	[illegible]	Refusal
Sub-Total	125^{0}	125^{0}	[illegible]	[illegible]	
East Approach					
6	25^{0}	25^{0}	25^{0}	0^{0}	[illegible]
7	25^{0}	25^{0}	25^{0}	0^{0}	[illegible]
8	25^{0}	25^{0}	[illegible]	[illegible]	Refusal
9	25^{0}	25^{0}	[illegible]	[illegible]	[illegible]
10	25^{0}	25^{0}	25^{0}	0^{0}	[illegible]
Sub-Total	125^{0}	125^{0}	[illegible]	[illegible]	
Totals	250^{0}	250^{0}	[illegible]	[illegible]	

PILING DIAGRAM

All Dimensions and Spacing as shown on Plans

PROJECT _____
ROUTE _____
SECTION _____
COUNTY _____
STATION OF STRUCTURE _____

(Sketch Below)



Denotes Vertical Piling
Denotes Battered Piling

[illegible]

Location [illegible]

Type of Pile [illegible]

PROJECT [illegible]
ROUTE [illegible]
SECTION [illegible]
COUNTY [illegible]

Pile Number	Ordered Length	Furnished Length	Driven Length	Cutoff	Bearing (Tons)
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

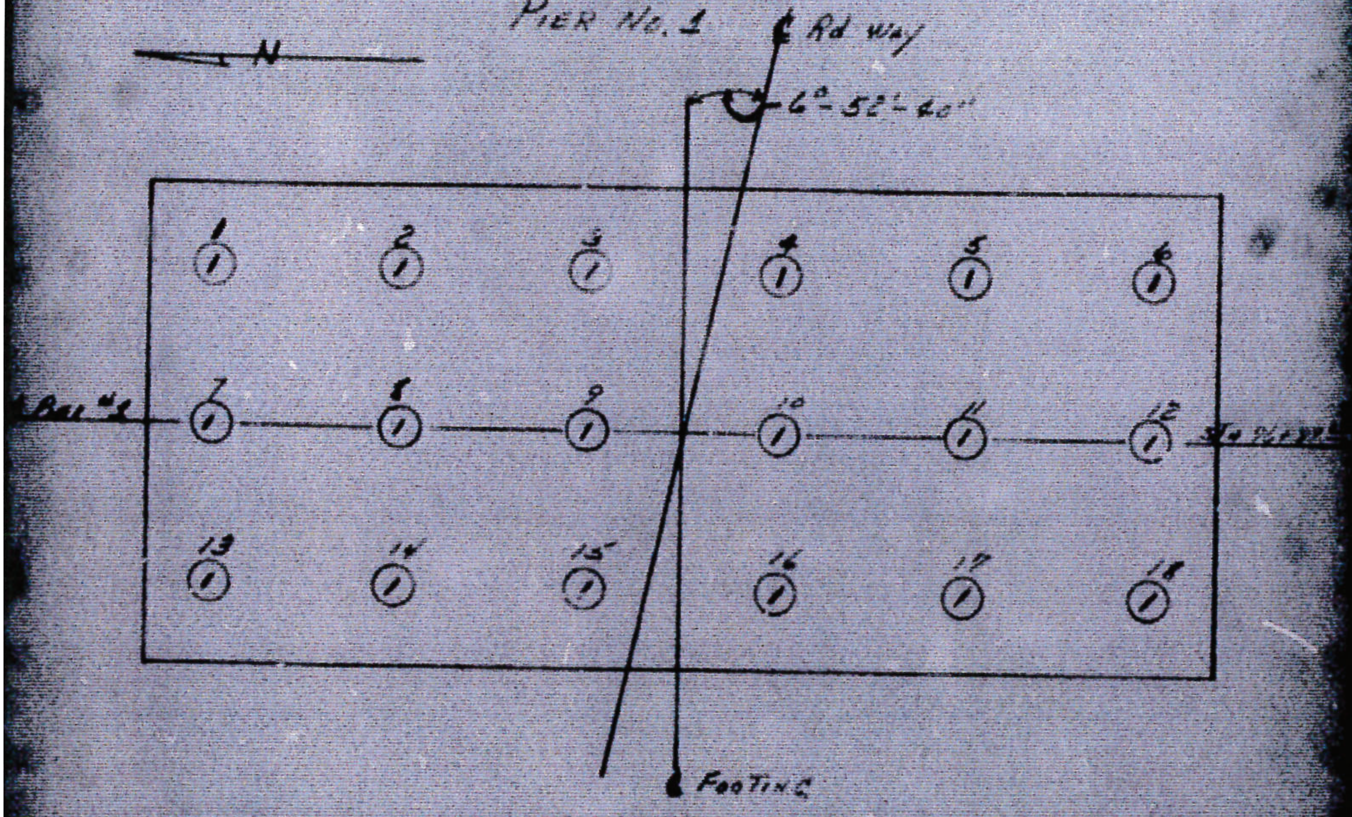
Page 2 of 11

PILING DIAGRAM

All Dimensions and Spacing as shown on Plans

PROJECT I-57-1(28)18
ROUTE F.A.I. 57
SECTION 77-1HB-[illegible]
COUNTY [illegible]
STATION OF STRUCTURE 227+96.90

(Sketch Below)



Denotes Vertical Piling
Denotes Battered Piling

Location Pier No. 1

Type of Pile Creosoted Timber

PROJECT I-57-1(16)18
ROUTE FAI 57
SECTION 77-1HB-3
COUNTY Pulaski

Pile Number	Ordered Length	Furnished Length	Driven Length	Cutoff	Bearing (Tons)
1	45.0	45.0	44^{2}	0^{1}	22^{5}
2		45.0	43^{8}	1^{2}	22^{9}
3		45.0	43^{1}	1^{9}	25^{2}
4		45.0	42^{7}	2^{3}	20^{4}
5		45.0	44^{2}	0^{3}	20^{4}
6		45.0	44^{1}	0^{9}	21^{3}
7		45.0	44^{3}	0^{2}	23^{7}
8		45.0	42^{9}	2^{1}	21^{5}
9		45.0	44^{9}	0^{1}	20^{4}
10		45.0	42^{8}	2^{2}	21^{3}
11		45.0	44^{8}	0^{2}	20^{4}
12		45.0	44^{5}	0^{5}	22^{1}
13		45.0	44^{5}	0^{5}	21^{3}
14		45.0	42^{3}	2^{7}	25^{3}
15		45.0	41^{4}	3^{6}	23^{7}
16		45.0	44^{8}	0^{8}	24^{4}
17		45.0	42^{8}	2^{2}	22^{9}
18		45.0	44^{2}	1^{0}	25^{8}
Totals	810.0	810.0	786^{7}	23^{3}	

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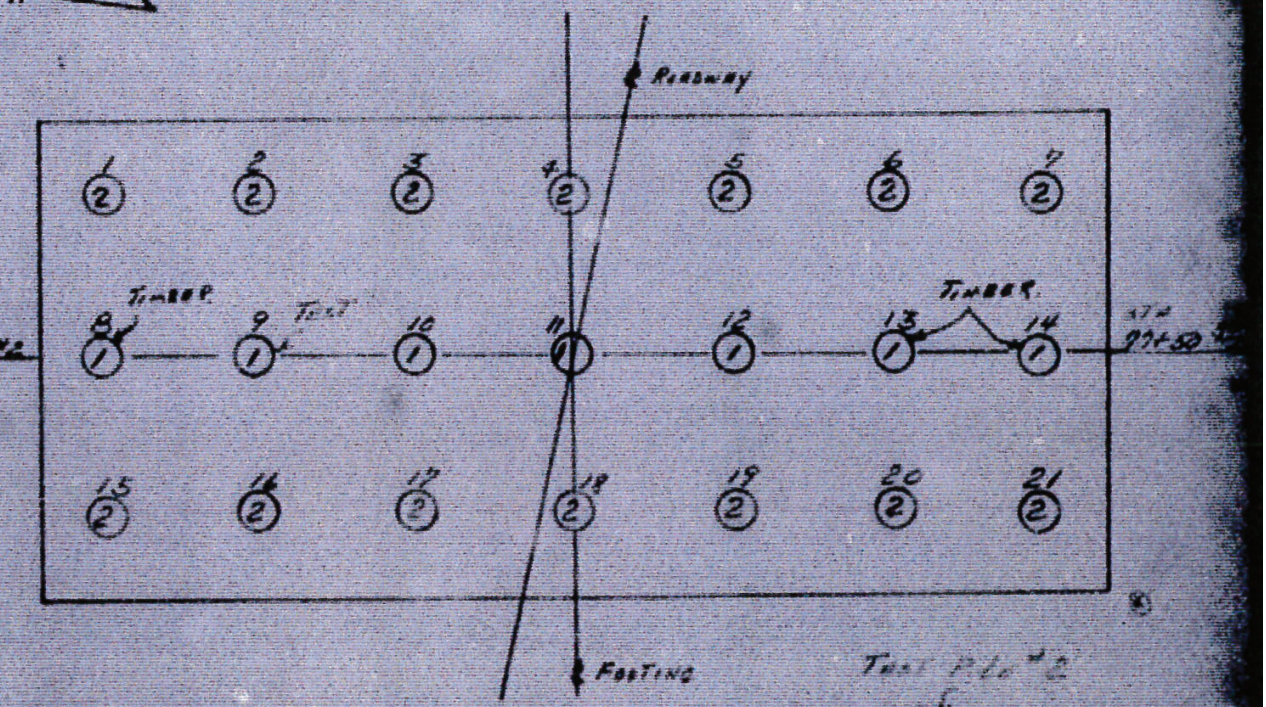
PILING DIAGRAM

All Dimensions and Spacing as shown on Plans

PROJECT I-57-1(68)18
ROUTE Ext 57
SECTION 27-1HR-2
COUNTY Pulaski
STATION OF STRUCTURE 227+21.20

(Sketch Below)

PIER No. 2



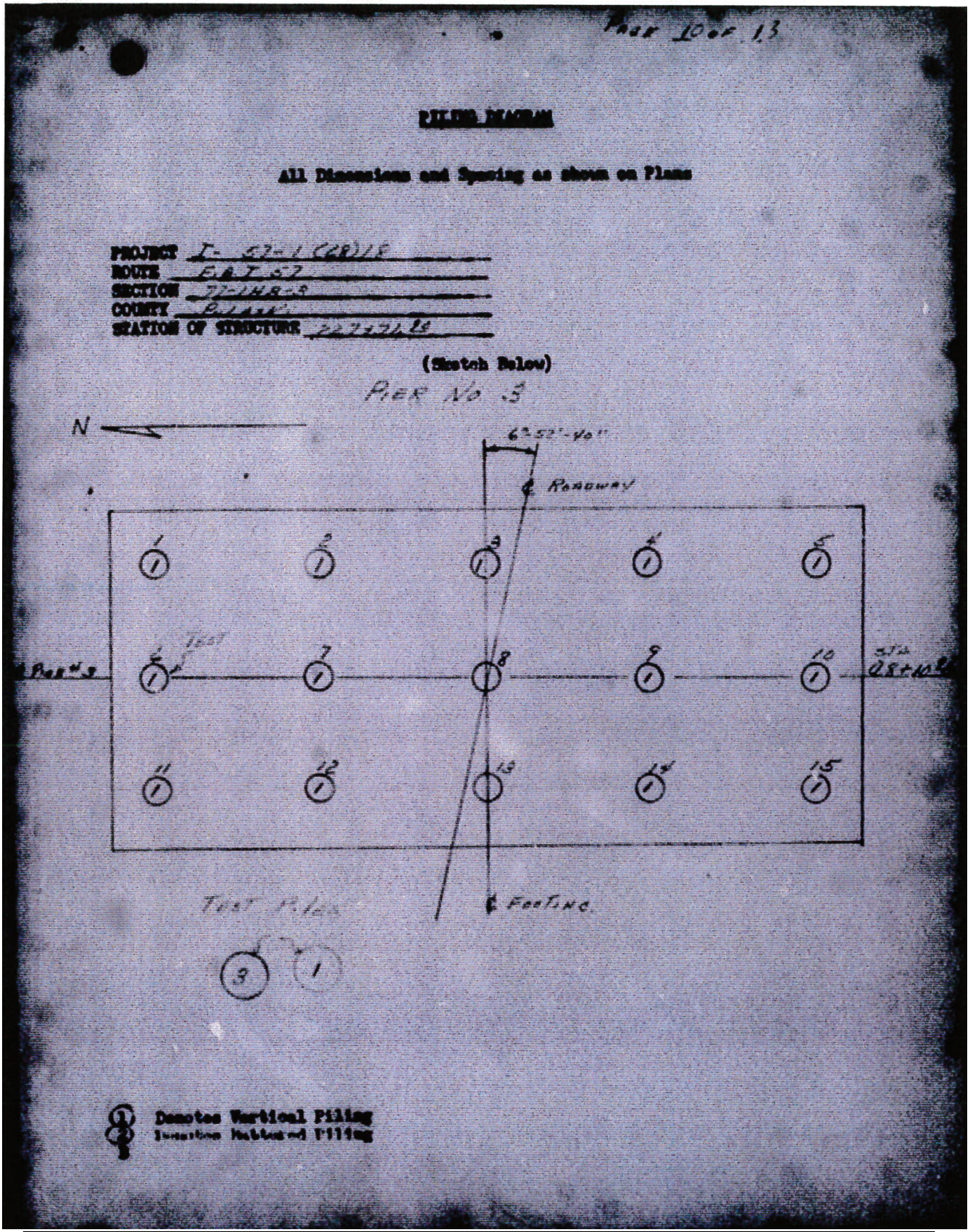
Denotes Vertical Piling
Denotes Battered Piling

Location Pier #2

Type of Pile Metal Shell + Treated Timber.

PROJECT I-57-1(60)18
ROUTE F.A.I. 57
SECTION [illegible]
COUNTY [illegible]

Pile Number	Ordered Length	Furnished Length	Driven Length	Cutoff	Bearing (Tons)
Metal Shell 1	60.0	62.0	61.2	0.8	Refusal
2	60.0	60.0	59.0	1.0	26.5
3	60.0	60.0	58.7	1.3	26.9
4	60.0	60.0	59.2	0.8	25.0
5	60.0	60.0	59.6	0.4	24.3
6	60.0	70.0	70.0	0.0	Refusal
7	60.0	70.0	67.3	2.7	Refusal
9	Test				
10	60.0	60.0	55.9	4.1	Refusal
11	60.0	60.0	56.2	3.8	Refusal
12	60.0	60.0	56.0	4.0	Refusal
15	60.0	60.0	58.7	1.3	Refusal
16	60.0	60.0	58.0	2.0	Refusal
17	60.0	60.0	55.9	4.1	Refusal
18	60.0	58.0	57.0	1.0	Refusal
19	60.0	58.0	55.4	2.6	Refusal
20	60.0	60.0	55.8	4.2	Refusal
Metal Shell 21	60.0	58.0	56.2	1.8	Refusal
Total Metal Shell	1020.0	1036.0	1000.1	35.9	
Timber					
8	45.0	45.0	45.0	0.0	6.3
13	45.0	45.0	45.0	0.0	16.7
14	45.0	45.0	45.0	0.0	17.7
Total Timber Alum	135.0	135.0	135.0	0.0	



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PILING DIAGRAM

All Dimensions and Spacing as shown on Plans

PROJECT I-57-1(28)18
ROUTE EAST 57
SECTION 77-1HR-3
COUNTY Platte
STATION OF STRUCTURE 227+74.18

(Sketch Below)

PIER NO 3

Test Pile

Denotes Vertical Piling
Inclined Piling

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Location Pier No. 5

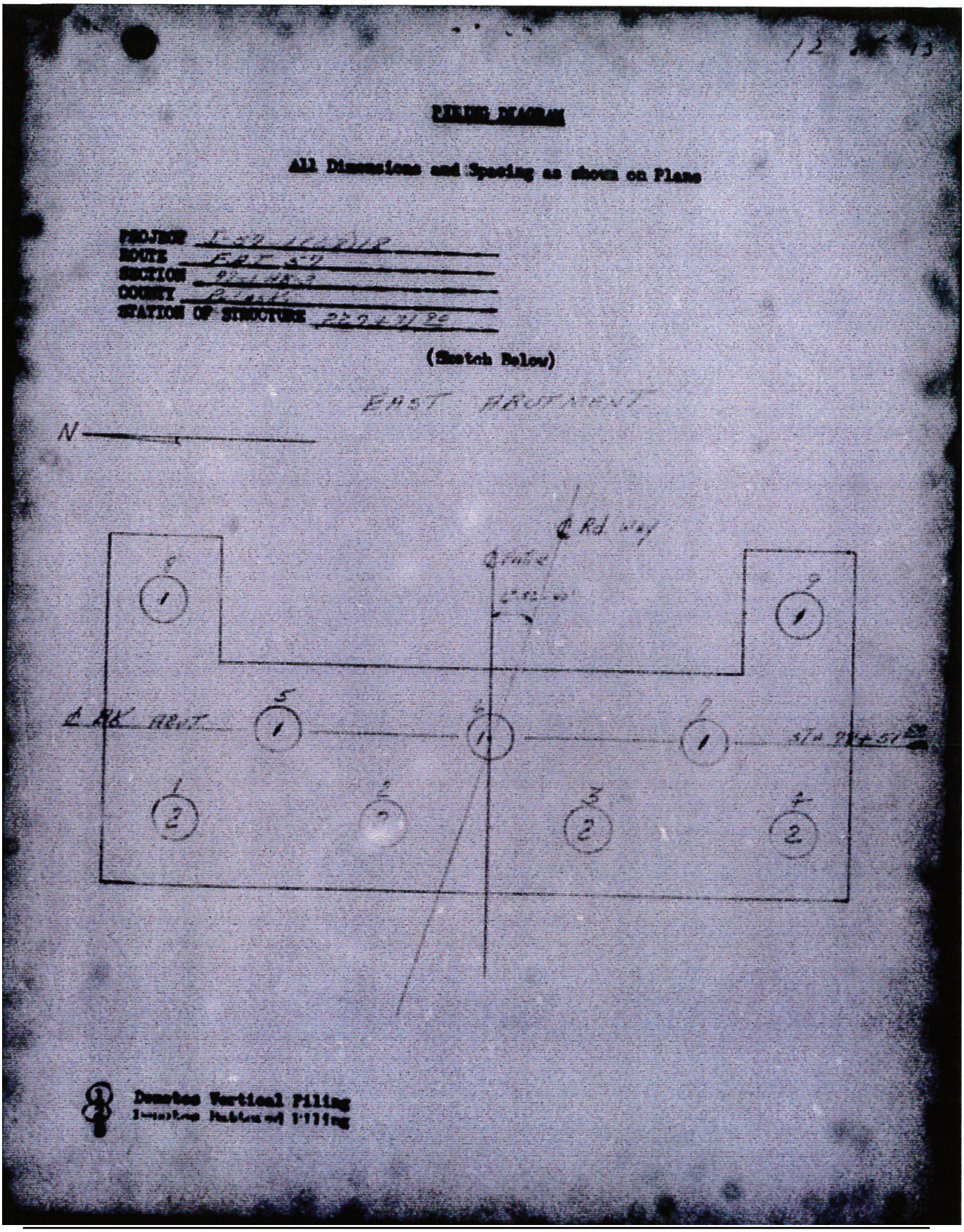
Type of Pile Metal Shell

PROJECT I-82-1(42)12
ROUTE I-82-E2
SECTION 77-1HR-2
COUNTY Yakima

25 Ton Required

Pile Number	Ordered Length	Furnished Length	Driven Length	Cutoff	Bearing (Tons)
1	80.0	80.0	75.5	4.5	31.0
2	80.0	80.0	74.6	5.4	32.8
3	80.0	80.0	74.9	5.1	33.4
4	80.0	80.0	77.3	2.7	30.3
5	80.0	80.0	72.3	7.7	29.7
6	Test #	22.1	22.1	—	—
7	80.0	80.0	74.6	5.4	35.7
8	80.0	80.0	74.4	5.6	31.9
9	80.0	80.0	76.8	3.2	30.3
10	80.0	80.0	74.0	6.0	27.8
11	80.0	80.0	75.9	4.1	31.0
12	80.0	80.0	77.3	2.7	30.3
13	80.0	80.0	75.3	4.7	30.3
14	80.0	80.0	75.9	4.1	31.9
15	80.0	80.0	77.	2.8	30.3
Totals	1120.0	1142.1	1078.1	64.0	
Timber test #1			2.0 *		16.2
" " #2		+10.0	13.9 *		15.3
Total		10.0	16.7		

* Driven below cut off


All Dimensions and Spacing as shown on Plans
PROJECT
ROUTE
SECTION
COUNTY
STATION OF STRUCTURE
(Sketch Below)
EAST ABUTMENT
N
℄ Rd Way
℄ Brg
Dempsey Vertical Piling

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Location East Abutment

Type of Pile Metal Shell

PROJECT [illegible]
ROUTE [illegible]
SECTION [illegible]
COUNTY [illegible]

Pile Number	Ordered Length	Furnished Length	Driven Length	Cutoff	Bearing (Tons)
1	95'	95'	90'	4'	93'
2	95'	* 96'	[illegible]	6'	37'
3	95'	95'	92'	3'	35'
4	95'	95'	89'	5'	41'
5	Test *	40'	[illegible]	8'	Test
6	95'	95'	91'	4'	[illegible]
7	95'	95'	91'	3'	41'
8	95'	95'	89'	6'	39'
9	95'	95'	87'	7'	42'
	760'	801'	757'	13'	

* No weld Required

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 1-S
ELEVATION OF BORING GROUND SURFACE ========== 339.80 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 4.50 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 4.50 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 1.385
EARTHQUAKE MOMENT MAGNITUDE ========== 7.7
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) = **0.959**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **284** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.66
Source-To-Site Distance, R (km) = 12.62
Ground Motion Prediction Equations = NMSZ
PGA = **1.385**

	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. (K_S)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
335.3	4.5	17	2.3				17	0.132	0.594	33.214	33.214	1.514	0.132	0.594	0.594	1.500	**2.178**	0.841	**0.757**	**N.L. (1)**
332.8	7	4	0.3		11	40	25	0.046	0.709	6.620	6.620	0.085	0.046	0.709	0.865	1.259	**0.102**	0.751	**0.824**	**N.L. (2)**
330.3	9.5	5	1.8		11	41	27	0.066	0.874	8.446	8.446	0.100	0.066	0.874	1.186	1.217	**0.116**	0.663	**0.810**	**N.L. (2)**
327.8	12	3	0.7		11	40	31	0.055	1.012	5.160	5.160	0.073	0.055	1.012	1.480	1.161	**0.082**	0.580	**0.764**	**N.L. (2)**
325.3	14.5	1	0.4		11	40	30	0.049	1.134	1.732	1.732	0.052	0.049	1.134	1.758	1.133	**0.056**	0.504	**0.704**	**N.L. (2)**
322.8	17	4	1.2		11	41	25	0.061	1.287	6.844	6.844	0.086	0.061	1.287	2.067	1.112	**0.092**	0.437	**0.632**	**N.L. (2)**
320.3	19.5	1	0.6		11	40	35	0.053	1.419	1.687	1.687	0.052	0.053	1.419	2.355	1.084	**0.054**	0.379	**0.567**	**0.095** (C)
317.8	22	4	0.8		11	40	31	0.057	1.562	6.608	6.608	0.085	0.057	1.562	2.654	1.066	**0.086**	0.330	**0.505**	**N.L. (2)**
315.3	24.5	5	1.2		10	40	26	0.061	1.714	8.045	8.045	0.096	0.061	1.714	2.962	1.048	**0.097**	0.289	**0.450**	**N.L. (2)**
312.8	27	1	0.5		11	40	27	0.051	1.842	1.574	1.574	0.051	0.051	1.842	3.246	1.029	**0.050**	0.255	**0.405**	**N.L. (2)**
310.3	29.5	3	1.2		11	41	25	0.061	1.994	4.587	4.587	0.069	0.061	1.994	3.554	1.012	**0.067**	0.228	**0.366**	**N.L. (2)**
307.8	32	4	1.3		11	41	32	0.062	2.149	5.940	5.940	0.079	0.062	2.149	3.865	0.997	**0.076**	0.206	**0.334**	**N.L. (2)**
305.3	34.5	3	1.2		11	41	39	0.061	2.302	4.330	4.330	0.067	0.061	2.302	4.174	0.984	**0.063**	0.189	**0.309**	**0.204** (C)
302.8	37	4	1.7		11	41	24	0.065	2.464	5.605	5.605	0.077	0.065	2.464	4.492	0.970	**0.071**	0.176	**0.288**	**N.L. (2)**
300.3	39.5	1	0.9		11	41	30	0.058	2.609	1.366	1.366	0.050	0.058	2.609	4.793	0.959	**0.046**	0.165	**0.273**	**N.L. (2)**
295.3	44.5	7	1.2		11	41	29	0.061	2.914	9.079	9.079	0.105	0.061	2.914	5.410	0.931	**0.094**	0.150	**0.251**	**N.L. (2)**
290.3	49.5	13	2.9		11	41	24	0.072	3.274	15.956	15.956	0.170	0.072	3.274	6.082	0.890	**0.145**	0.141	**0.236**	**N.L. (2)**
285.3	54.5	9	2.1		11	41	30	0.068	3.614	10.434	10.434	0.117	0.068	3.614	6.734	0.883	**0.099**	0.135	**0.227**	**N.L. (2)**
280.3	59.5	2	1.1		11	41	28	0.060	3.914	2.215	2.215	0.054	0.060	3.914	7.346	0.885	**0.046**	0.132	**0.223**	**N.L. (2)**
279.8	60	3	0.8		11	41	27	0.057	3.943	3.309	3.309	0.060	0.057	3.943	7.406	0.883	**0.051**	0.132	**0.223**	**N.L. (2)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 2-S
ELEVATION OF BORING GROUND SURFACE ========== 360.50 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 30.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 33.45 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 1.385
EARTHQUAKE MOMENT MAGNITUDE ========== 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 3.45 FT. (Fill Height)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.959**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **392** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.66
Source-To-Site Distance, R (km) = 12.62
Ground Motion Prediction Equations = NMSZ
PGA = **1.385**

	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. (K_S)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
358	2.5	3	1.1				27	0.123	0.308	5.664	5.664	0.077	0.123	0.722	0.722	1.246	**0.092**	0.887	**0.799**	**N.L. (1)**
355.5	5	4	1.3				25	0.125	0.620	6.806	6.806	0.086	0.125	1.034	1.034	1.164	**0.096**	0.831	**0.748**	**N.L. (1)**
353	7.5	6	1.6				26	0.127	0.938	9.339	9.339	0.107	0.127	1.352	1.352	1.108	**0.114**	0.770	**0.694**	**N.L. (1)**
350.5	10	7	1.7				19	0.128	1.258	10.772	10.772	0.120	0.128	1.672	1.672	1.058	**0.122**	0.708	**0.637**	**N.L. (1)**
348	12.5	7	2.1				21	0.130	1.583	10.471	10.471	0.117	0.130	1.997	1.997	1.014	**0.114**	0.646	**0.581**	**N.L. (1)**
345.5	15	16	3.9				20	0.138	1.928	24.335	24.335	0.279	0.138	2.342	2.342	0.969	**0.260**	0.585	**0.527**	**N.L. (1)**
343	17.5	11	3.2				22	0.136	2.268	15.143	15.143	0.161	0.136	2.682	2.682	0.940	**0.146**	0.529	**0.476**	**N.L. (1)**
340.5	20	9	1.9				22	0.129	2.590	11.761	11.761	0.129	0.129	3.004	3.004	0.919	**0.114**	0.477	**0.430**	**N.L. (1)**
338	22.5	18	2.9				21	0.134	2.925	23.463	23.463	0.264	0.134	3.339	3.339	0.866	**0.220**	0.432	**0.389**	**N.L. (1)**
335.5	25	9	2.9				23	0.134	3.260	10.641	10.641	0.119	0.134	3.674	3.674	0.879	**0.100**	0.393	**0.354**	**N.L. (1)**
333	27.5	5	1.2				29	0.124	3.570	5.650	5.650	0.077	0.124	3.984	3.984	0.879	**0.065**	0.360	**0.324**	**N.L. (1)**
330.5	30	2	0.7				34	0.117	3.863	2.168	2.168	0.054	0.117	4.277	4.277	0.869	**0.045**	0.333	**0.300**	**N.L. (1)**
328	32.5	1	0.3		11	41	29	0.046	3.978	1.069	1.069	0.049	0.046	4.392	4.548	0.864	**0.041**	0.311	**0.290**	**N.L. (2)**
325.5	35	4	1		11	40	25	0.059	4.125	4.198	4.198	0.066	0.059	4.539	4.851	0.859	**0.055**	0.293	**0.281**	**N.L. (2)**
323	37.5	4	1.2		10	40	26	0.061	4.278	4.117	4.117	0.066	0.061	4.692	5.160	0.853	**0.054**	0.278	**0.275**	**N.L. (2)**
318	42.5	1	0.2		11	40	30	0.042	4.488	1.005	1.005	0.049	0.042	4.902	5.682	0.846	**0.040**	0.258	**0.269**	**N.L. (2)**
313	47.5	2	0.7		11	40	26	0.055	4.763	1.944	1.944	0.053	0.055	5.177	6.269	0.836	**0.042**	0.245	**0.267**	**N.L. (2)**
308	52.5	5	1.3		11	41	22	0.062	5.073	4.681	4.681	0.070	0.062	5.487	6.891	0.827	**0.055**	0.237	**0.268**	**N.L. (2)**
303	57.5	11	3.9		11	41	24	0.076	5.453	9.834	9.834	0.112	0.076	5.867	7.583	0.791	**0.085**	0.233	**0.271**	**N.L. (2)**
300.5	60	9	1.9		11	41	26	0.067	5.620	7.887	7.887	0.095	0.067	6.034	7.906	0.796	**0.073**	0.231	**0.273**	**N.L. (2)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 3-S
ELEVATION OF BORING GROUND SURFACE ========== 357.50 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 37.40 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 41.70 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 1.385
EARTHQUAKE MOMENT MAGNITUDE ========== 7.7
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 4.30 FT. (Fill Height)
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **0.959**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **537** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.66
Source-To-Site Distance, R (km) = 12.62
Ground Motion Prediction Equations = NMSZ
PGA = **1.385**

	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. (K_S)	CORR. RESIST. $CRR_{7.5}$ CRR	SOIL MASS PART. FACTOR (r_d)	EQ INDUCED CSR	FACTOR OF SAFETY * CRR/CSR
355	2.5	5	1.5				22	0.126	0.315	9.415	9.415	0.108	0.126	0.831	0.831	1.238	**0.128**	0.956	**0.861**	**N.L. (1)**
352.5	5	6	2.3				21	0.132	0.645	10.129	10.129	0.114	0.132	1.161	1.161	1.150	**0.126**	0.933	**0.840**	**N.L. (1)**
350	7.5	9	1.8				22	0.128	0.965	14.146	14.146	0.152	0.128	1.481	1.481	1.097	**0.159**	0.906	**0.815**	**N.L. (1)**
347.5	10	11	1.6				23	0.127	1.283	17.338	17.338	0.184	0.127	1.799	1.799	1.047	**0.185**	0.874	**0.786**	**N.L. (1)**
345	12.5	9	2.3				27	0.132	1.613	13.378	13.378	0.144	0.132	2.129	2.129	0.999	**0.138**	0.837	**0.754**	**N.L. (1)**
342.5	15	11	2.5				20	0.133	1.945	15.914	15.914	0.169	0.133	2.461	2.461	0.961	**0.156**	0.797	**0.717**	**N.L. (1)**
340	17.5	16	3.1				31	0.135	2.283	22.910	22.910	0.256	0.135	2.799	2.799	0.917	**0.225**	0.754	**0.678**	**N.L. (1)**
337.5	20	13	2.1				24	0.130	2.608	17.202	17.202	0.183	0.130	3.124	3.124	0.898	**0.158**	0.709	**0.638**	**N.L. (1)**
335	22.5	16	2.7				20	0.134	2.943	20.474	20.474	0.221	0.134	3.459	3.459	0.865	**0.184**	0.663	**0.597**	**N.L. (1)**
332.5	25	13	3.9				20	0.138	3.288	15.353	15.353	0.164	0.138	3.804	3.804	0.857	**0.134**	0.619	**0.557**	**N.L. (1)**
330	27.5	18	3.7				20	0.138	3.633	20.793	20.793	0.226	0.138	4.149	4.149	0.818	**0.177**	0.577	**0.520**	**N.L. (1)**
327.5	30	11	2.9				20	0.134	3.968	11.733	11.733	0.129	0.134	4.484	4.484	0.834	**0.103**	0.539	**0.485**	**N.L. (1)**
325	32.5	7	1.6				22	0.127	4.285	7.149	7.149	0.089	0.127	4.801	4.801	0.840	**0.072**	0.505	**0.455**	**N.L. (1)**
322.5	35	4	0.7				26	0.117	4.578	3.931	3.931	0.064	0.117	5.094	5.094	0.839	**0.052**	0.476	**0.429**	**N.L. (1)**
320	37.5	6	1.9		11	41	23	0.067	4.745	5.780	5.780	0.078	0.067	5.261	5.267	0.830	**0.062**	0.451	**0.407**	**N.L. (2)**
315	42.5	1	0.3		11	40	28	0.046	4.975	0.939	0.939	0.049	0.046	5.491	5.809	0.827	**0.039**	0.414	**0.394**	**N.L. (2)**
310	47.5	4	1.1		11	41	25	0.060	5.275	3.632	3.632	0.062	0.060	5.791	6.421	0.818	**0.049**	0.389	**0.388**	**N.L. (2)**
305	52.5	4	1.3		11	41	30	0.062	5.585	3.508	3.508	0.062	0.062	6.101	7.043	0.809	**0.048**	0.373	**0.388**	**N.L. (2)**
300	57.5	4	1.4		11	41	24	0.063	5.900	3.387	3.387	0.061	0.063	6.416	7.670	0.801	**0.047**	0.364	**0.391**	**N.L. (2)**
297.5	60	5	1.8		11	41	24	0.066	6.065	4.155	4.155	0.066	0.066	6.581	7.991	0.797	**0.050**	0.360	**0.394**	**N.L. (2)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Pier
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 334.89 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 332.89 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 ========== 2150 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 31.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 3
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 182.01 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 68.25 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	**83** 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			NOMINAL UNPLUG'D			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.)
					SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)	SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)					
332.80	0.09	0.30			0.1		24.9	0.1		***2.8***	3	0	0	2	2
330.30	2.50	1.80			10.8	24.8	20.5	15.8	2.7	***17.0***	17	0	0	9	5
327.80	2.50	0.70			5.2	9.6	***21.6***	7.6	1.1	24.1	22	0	0	12	7
325.30	2.50	0.40			3.1	5.5	35.8	4.6	0.6	***29.9***	30	0	0	16	10
322.80	2.50	1.20			8.1	16.5	***35.6***	11.9	1.8	40.9	36	0	0	20	12
320.30	2.50	0.60			4.6	8.3	***42.9***	6.7	0.9	47.9	43	0	0	24	15
317.80	2.50	0.80			5.9	11.0	***54.3***	8.6	1.2	57.0	54	0	0	30	17
315.30	2.50	1.20			8.1	16.5	***52.8***	11.9	1.8	67.9	53	0	0	29	20
312.80	2.50	0.50			3.9	6.9	***66.3***	5.7	0.8	74.6	66	0	0	36	22
310.30	2.50	1.20			8.1	16.5	***75.8***	11.9	1.8	86.6	76	0	0	42	25
307.80	2.50	1.30			8.6	17.9	***83.1***	12.6	2.0	99.1	83	0	0	46	27
305.30	2.50	1.20			8.1	16.5	***98.1***	11.9	1.8	111.7	98	0	0	54	30
302.80	2.50	1.70			10.4	23.4	***97.4***	15.2	2.6	125.7	97	0	0	54	32
300.30	2.50	0.90			6.5	12.4	***108.0***	9.5	1.4	135.6	108	0	0	59	35
295.30	5.00	1.20			16.3	16.5	***147.7***	23.8	1.8	161.9	148	0	0	81	40
290.30	5.00	2.90			29.6	40.0	***166.3***	43.3	4.4	204.0	166	0	0	91	45
285.30	5.00	2.10			23.8	28.9	***176.3***	34.8	3.2	237.3	176	0	0	97	50
280.30	5.00	1.10			15.2	15.2	***187.4***	22.2	1.7	259.1	187	0	0	103	55
275.30	5.00	0.80			11.7	11.0	***193.6***	17.1	1.2	275.6	194	0	0	106	60
270.30	5.00	0.40			6.3	5.5	***210.9***	9.2	0.6	286.0	211	0	0	116	65
265.30	5.00	1.20			16.3	16.5	***253.4***	23.8	1.8	312.7	253	0	0	139	70
260.30	5.00	3.10	17		31.1	42.7	***276.2***	45.4	4.7	357.2	276	0	0	152	75
252.30	8.00	2.50			42.7	34.5	529.4	62.5	3.8	***442.7***	~~443~~	~~0~~	~~0~~	~~243~~	~~83~~
251.30	1.00			Limestone	98.8	245.0	628.3	144.5	26.8	***587.2***	~~587~~	~~0~~	~~0~~	~~323~~	~~83.6~~
250.80	0.50			Limestone		245.0			26.8						

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Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Pier
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 334.89 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 332.89 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 305.30 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 322.80 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== 1610 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 31.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 3
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= 136.30 KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 51.11 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 Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**418** KIPS	**314** KIPS	**83** 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	ULTIMATE PLUGGED SIDE RESIST. (KIPS)	ULTIMATE PLUGGED END BRG. RESIST. (KIPS)	ULTIMATE PLUGGED TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
332.80	0.09	0.30			0.1		24.9	0.1		***2.8***	3	0	0	3	2
330.30	2.50	1.80			10.8	24.8	20.5	15.8	2.7	***17.0***	17	11	12	-6	5
327.80	2.50	0.70			5.2	9.6	***21.6***	7.6	1.1	24.1	22	16	18	-12	7
325.30	2.50	0.40			3.1	5.5	35.8	4.6	0.6	***29.9***	30	19	21	-11	10
322.80	2.50	1.20			8.1	16.5	***35.6***	11.9	1.8	40.9	36	27	30	-22	12
320.30	2.50	0.60			4.6	8.3	***42.9***	6.7	0.9	47.9	43	32	30	-19	15
317.80	2.50	0.80			5.9	11.0	***54.3***	8.6	1.2	57.0	54	38	30	-14	17
315.30	2.50	1.20			8.1	16.5	***52.8***	11.9	1.8	67.9	53	46	30	-23	20
312.80	2.50	0.50			3.9	6.9	***66.3***	5.7	0.8	74.6	66	50	30	-14	22
310.30	2.50	1.20			8.1	16.5	***75.8***	11.9	1.8	86.6	76	58	30	-12	25
307.80	2.50	1.30			8.6	17.9	***83.1***	12.6	2.0	99.1	83	67	30	-14	27
305.30	2.50	1.20			8.1	16.5	***98.1***	11.9	1.8	111.7	98	75	30	-7	30
302.80	2.50	1.70			10.4	23.4	***97.4***	15.2	2.6	125.7	97	75	30	-7	32
300.30	2.50	0.90			6.5	12.4	***108.0***	9.5	1.4	135.6	108	75	30	3	35
295.30	5.00	1.20			16.3	16.5	***147.7***	23.8	1.8	161.9	148	75	30	43	40
290.30	5.00	2.90			29.6	40.0	***166.3***	43.3	4.4	204.0	166	75	30	61	45
285.30	5.00	2.10			23.8	28.9	***176.3***	34.8	3.2	237.3	176	75	30	72	50
280.30	5.00	1.10			15.2	15.2	***187.4***	22.2	1.7	259.1	187	75	30	83	55
275.30	5.00	0.80			11.7	11.0	***193.6***	17.1	1.2	275.6	194	75	30	89	60
270.30	5.00	0.40			6.3	5.5	***210.9***	9.2	0.6	286.0	211	75	30	106	65
265.30	5.00	1.20			16.3	16.5	***253.4***	23.8	1.8	312.7	253	75	30	149	70
260.30	5.00	3.10	17		31.1	42.7	***276.2***	45.4	4.7	357.2	276	75	30	171	75
252.30	8.00	2.50			42.7	34.5	529.4	62.5	3.8	***442.7***	~~443~~	~~75~~	~~30~~	~~338~~	~~83~~
251.30	1.00			Limestone	98.8	245.0	628.3	144.5	26.8	***587.2***	~~587~~	~~75~~	~~30~~	~~482~~	~~83.6~~
250.80	0.50			Limestone		245.0			26.8						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== West Abutment
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 358.27 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 356.27 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 ========== 975 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 31.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 247.62 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 92.86 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	**71** 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			NOMINAL UNPLUG'D			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.)
					SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)	SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)					
355.50	0.77	1.30			2.7		24.7	3.9		***6.3***	6	0	0	3	3
353.00	2.50	1.60			10.0	22.0	36.1	14.6	2.4	***21.0***	21	0	0	12	5
350.50	2.50	1.70			10.4	23.4	51.9	15.2	2.6	***36.8***	37	0	0	20	8
348.00	2.50	2.10			11.9	28.9	88.7	17.4	3.2	***56.9***	57	0	0	31	10
345.50	2.50	3.90	16		18.4	53.7	97.5	27.0	5.9	***82.8***	83	0	0	46	13
343.00	2.50	3.20	11		15.9	44.1	***95.4***	23.2	4.8	104.1	95	0	0	52	15
340.50	2.50	1.90			11.2	26.2	***120.4***	16.3	2.9	122.0	120	0	0	66	18
338.00	2.50	2.90			14.8	40.0	***135.2***	21.7	4.4	143.6	135	0	0	74	20
335.50	2.50	2.90			14.8	40.0	***126.6***	21.7	4.4	162.7	127	0	0	70	23
333.00	2.50	1.20			8.1	16.5	***127.8***	11.9	1.8	173.8	128	0	0	70	25
330.50	2.50	0.70			5.2	9.6	***127.5***	7.6	1.1	180.9	128	0	0	70	28
328.00	2.50	0.30			2.4	4.1	***139.6***	3.5	0.5	185.4	140	0	0	77	30
325.50	2.50	1.00			7.0	13.8	***149.4***	10.3	1.5	196.0	149	0	0	82	33
323.00	2.50	1.20			8.1	16.5	***143.7***	11.9	1.8	206.4	144	0	0	79	35
318.00	5.00	0.20			3.3	2.8	***153.9***	4.8	0.3	211.9	154	0	0	85	40
313.00	5.00	0.70			10.4	9.6	***172.6***	15.3	1.1	228.1	173	0	0	95	45
308.00	5.00	1.30			17.2	17.9	***225.6***	25.2	2.0	257.2	226	0	0	124	50
303.00	5.00	3.90	11		36.9	53.7	***235.0***	53.9	5.9	308.1	235	0	0	129	55
298.00	5.00	1.90			22.3	26.2	***240.8***	32.7	2.9	339.0	241	0	0	132	60
293.00	5.00	0.70			10.4	9.6	***248.5***	15.3	1.1	354.0	248	0	0	137	65
288.50	4.50	0.50			7.0	6.9	493.5	10.2	0.8	***390.2***	390	0	0	215	70
287.50	1.00			Limestone	98.8	245.0	592.3	144.5	26.8	***534.7***	~~535~~	~~0~~	~~0~~	~~294~~	~~70.8~~
286.50	1.00			Limestone		245.0			26.8						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== East Abutment
REFERENCE BORING ========== 3-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 356.11 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 354.11 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 ========== 950 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 31.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== 241.27 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 90.48 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	**413** KIPS	**227** KIPS	**96** 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			NOMINAL UNPLUG'D			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.)
					SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)	SIDE RESIST. (KIPS)	END BRG. RESIST. (KIPS)	TOTAL RESIST. (KIPS)					
352.50	1.61	2.30			8.1		32.9	11.9		***14.6***	15	0	0	8	4
350.00	2.50	1.80			10.8	24.8	41.0	15.8	2.7	***30.1***	30	0	0	17	6
347.50	2.50	1.60			10.0	22.0	60.6	14.6	2.4	***45.7***	46	0	0	25	9
345.00	2.50	2.30			12.6	31.7	76.0	18.5	3.5	***64.5***	64	0	0	35	11
342.50	2.50	2.50			13.4	34.5	97.6	19.5	3.8	***84.9***	85	0	0	47	14
340.00	2.50	3.10	16		15.5	42.7	***99.4***	22.7	4.7	106.1	99	0	0	55	16
337.50	2.50	2.10			11.9	28.9	***119.5***	17.4	3.2	124.4	120	0	0	66	19
335.00	2.50	2.70			14.1	37.2	150.1	20.6	4.1	***146.8***	147	0	0	81	21
332.50	2.50	3.90	13		18.4	53.7	***165.8***	27.0	5.9	173.5	166	0	0	91	24
330.00	2.50	3.70	18		17.7	51.0	***172.5***	25.9	5.6	198.2	173	0	0	95	26
327.50	2.50	2.90			14.8	40.0	***169.4***	21.7	4.4	217.9	169	0	0	93	29
325.00	2.50	1.60			10.0	22.0	***167.0***	14.6	2.4	231.1	167	0	0	92	31
322.50	2.50	0.70			5.2	9.6	***188.7***	7.6	1.1	240.5	189	0	0	104	34
320.00	2.50	1.90			11.2	26.2	***177.9***	16.3	2.9	254.5	178	0	0	98	36
315.00	5.00	0.30			4.8	4.1	***193.7***	7.0	0.5	262.7	194	0	0	107	41
310.00	5.00	1.10			15.2	15.2	***211.6***	22.2	1.7	285.2	212	0	0	116	46
305.00	5.00	1.30			17.2	17.9	***230.3***	25.2	2.0	310.6	230	0	0	127	51
300.00	5.00	1.40			18.2	19.3	***254.0***	26.6	2.1	337.8	254	0	0	140	56
295.00	5.00	1.80			21.6	24.8	***289.3***	31.5	2.7	370.8	289	0	0	159	61
290.00	5.00	2.80			28.9	38.6	***312.7***	42.2	4.2	412.5	313	0	0	172	66
285.00	5.00	2.40			26.0	33.1	***334.5***	38.0	3.6	450.0	335	0	0	184	71
280.00	5.00	2.10			23.8	28.9	***355.6***	34.8	3.2	484.5	356	0	0	196	76
270.00	10.00	1.90			44.7	26.2	***378.2***	65.3	2.9	547.5	378	0	0	208	86
260.00	10.00	0.30			9.6	4.1	***412.7***	14.0	0.5	564.2	413	0	0	227	96
255.00	5.00	2.10			23.8	28.9	***436.5***	34.8	3.2	599.0	~~436~~	~~0~~	~~0~~	~~240~~	~~101~~
250.00	5.00	2.10				28.9			3.2						

Slope Stability Soil Parameters SN 077-0041

West Abutment (LRFD)			
Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
1	129.6	2164	-
2	115.8	667	-
3	123.6	1200	-
4	104.3	200	-
5	117.5	700	-
6	131.5	2600	-
7	129.1	1900	-
8	117.5	700	-
9	113.8	500	-
10	144.9	-	44

West Abutment (Seismic)			
Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
1	129.6	2164	-
2	115.8	667	-
3	123.6	1200	-
4	104.3	200	-
5	117.5	700	-
6	131.5	2600	-
7	129.1	1900	-
8	117.5	700	-
9	113.8	500	-
10	144.9	-	44

West Abutment

			X	Y
PGL @ Back/Abut:	363.95			
Approach Slab Thickness:	1.25	Bottom of Slope Coordinates:	50.00	341.00
Bottom of Approach Slab:	362.7			
		Top of Slope Coordinates:	93.40	362.7
Ditch at Bottom of Slope:	341.00			
		Bottom Initiation Pt Range (X):	6.6	50.0
Slope Height:	21.70			
Horizontal Slope Length:	43.4	Top Termination Pt Range (X):	93.40	136.8

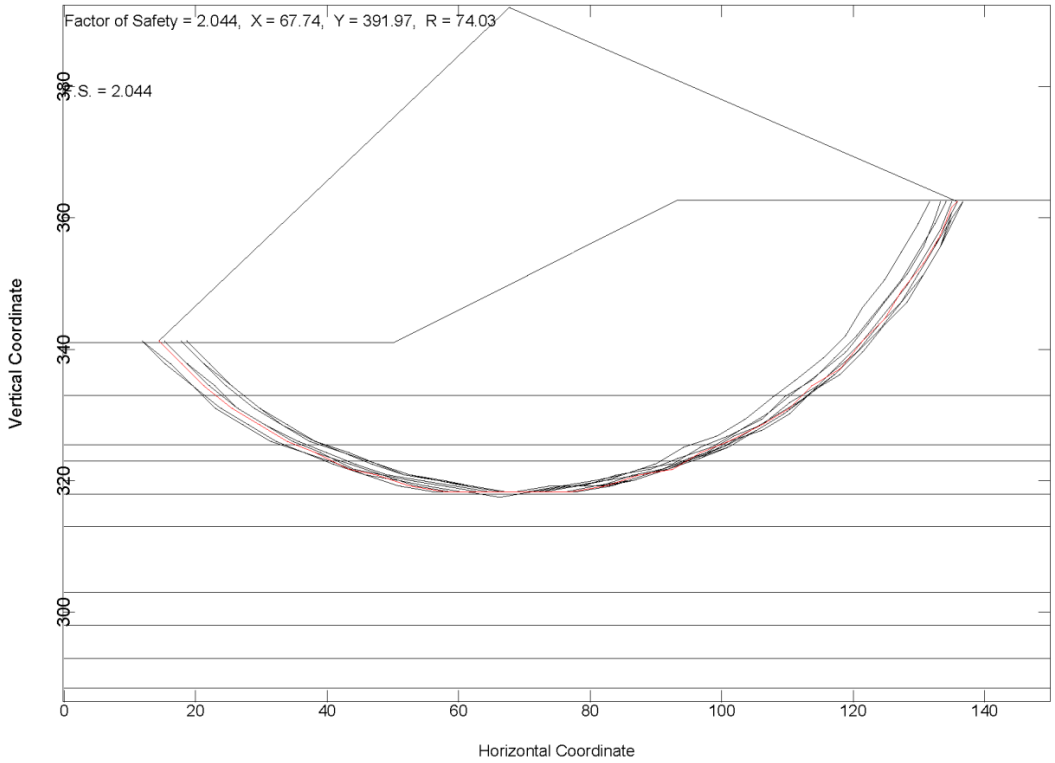
East Abutment (LRFD)			
Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
1	129.6	2157	-
2	130.4	2100	-
3	134.8	2960	-
4	117.5	700	-
5	129.1	1900	-
6	108.4	300	-
7	125.3	1400	-
8	132.1	2434	-
9	129.1	1900	-
10	108.4	300	-
11	130.4	2100	-

Eastbound, East Abutment (Seismic)			
Layer Number	Unit Weight (lbs/ft^3)	Cohesion (lbs/ft^2)	Friction Angle (deg.)
1	129.6	2157	-
2	130.4	2100	-
3	134.8	2960	-
4	117.5	700	-
5	129.1	1900	-
6	108.4	300	-
7	125.3	1400	-
8	132.1	2434	-
9	129.1	1900	-
10	108.4	300	-
11	130.4	2100	-

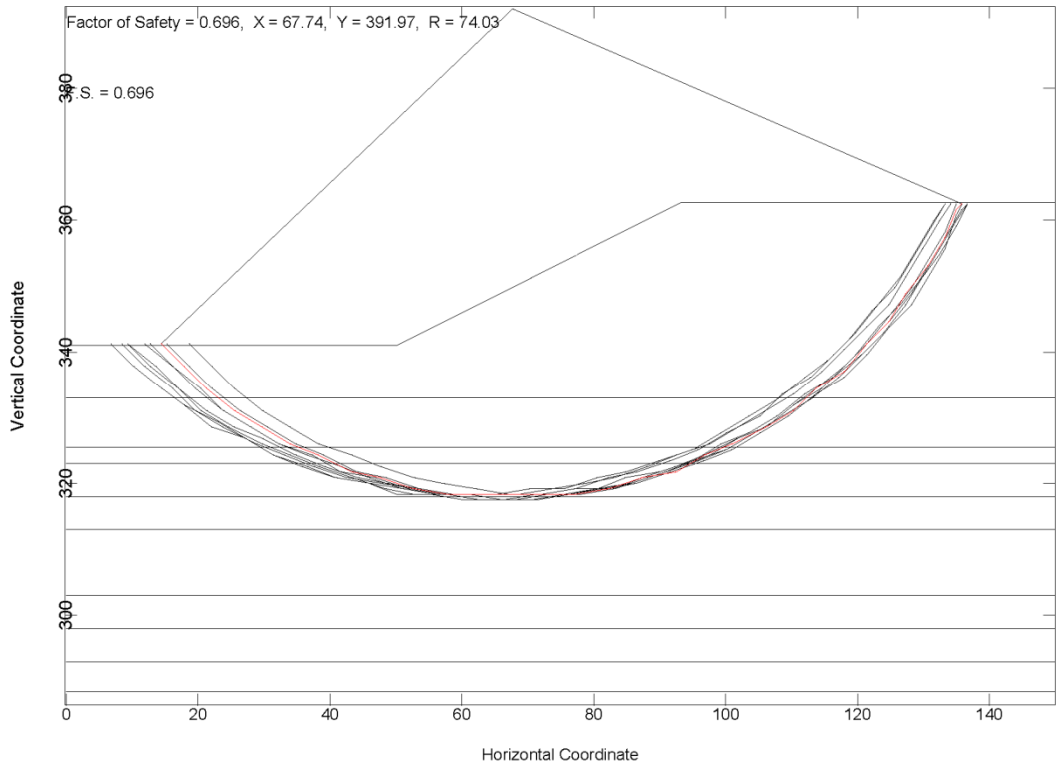
East Abutment

			X	Y
PGL @ Back/Abut:	361.8			
Approach Slab Thickness:	1.25	Bottom of Slope Coordinates:	50.00	341.00
Bottom of Approach Slab:	360.55			
		Top of Slope Coordinates:	89.10	360.55
Ditch at Bottom of Slope:	341.00			
		Bottom Initiation Pt Range (X):	10.9	50.0
Slope Height:	19.55			
Horizontal Slope Length:	39.1	Top Termination Pt Range (X):	89.10	128.2

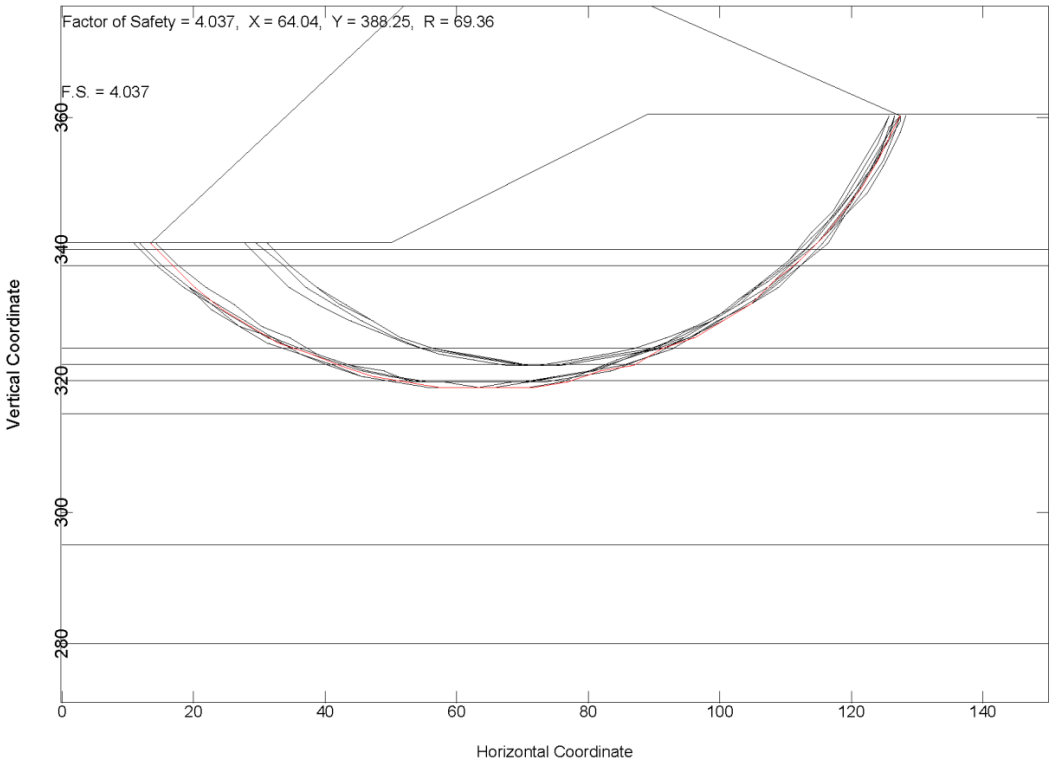
West Abutment (LRFD)



West Abutment (Seismic)



East Abutment (LRFD)



East Abutment (Seismic)