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Structural Geotechnical Report

Interstate 57 over Marcum Branch
FAI Route 57, Section (28-2)B-2
Franklin County, Illinois
PTB190-035
Existing Structures 028-0011 and 028-0012
Proposed Structures 028-0090 and 028-0091

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Structure Geotechnical Report
Interstate 57 Over Marcum Branch
FAI Route 57, Section (28-2)B-2
Proposed Structures 028-0090 and 028-0091
Franklin County, Illinois

1.0 Project Description and Proposed Structure Information

1.1 Introduction

This report summarizes the results of a geotechnical investigation performed for the design of replacement structures for the existing bridges carrying Interstate 57 over Marcum Branch adjacent to Rend Lake in Franklin County, Illinois. The purpose of this study was to provide a geotechnical assessment of the planned replacement structures, based on subsurface conditions encountered at two borings performed by the Illinois Department of Transportation (IDOT) in 2019, near the existing structures. Use was also made of boring information provided from the design and construction of the original structures, dated 1961. This report describes the exploration procedures used, presents the field and laboratory data, includes an assessment of the subsurface conditions in the area, and provides geotechnical recommendations for the construction.

1.2 Project Description

The project consists of the removal and replacement of the existing Interstate 57 bridges over Marcum Branch in Franklin County, Illinois. The general site area is shown on the attached Vicinity Map, Figure 1 in Appendix A. A plan that shows the approximate locations of the borings performed for this study, as well as the boring locations performed in 1961 is presented as the Type, Size, and Location Plan (TS&L), Figure 2 in Appendix A. Marcum Branch is oriented east and west beneath the existing I-57 overpass structures and flows in a western direction. The existing bridges are about 127.5-foot long, three-span concrete deck structures supported on steel beams. The end abutments and intermediate supports of each existing bridge are founded on steel piles. It is our understanding that the existing structures will be replaced with new two-span bridges using integral abutments. Based on the information provided, it appears that staged construction will be required to maintain traffic during construction.

1.3 Proposed Structure Information

The proposed structures will consist of two, two-span bridges with integral abutments. The abutments and center piers will be supported by driven piles. Each bridge structure will have a length of approximately 116 feet. It is our understanding that the roadway profile across the bridges will remain essentially unchanged, with little or no grade change for the embankments or end slopes.

2.0 Subsurface Exploration and Laboratory Testing

2.1 Subsurface Exploration

On April 10 and 11, 2019, IDOT conducted a subsurface exploration near the north and south abutments, consisting of two soil test borings, designated as Borings 1-S and 2-S along Interstate I-57. The approximate locations of the borings are indicated on the TS&L Plan, Figure 2.

The borings were advanced using hollow-stem auger drilling methods. Samples were obtained at 2.5- to 5-foot intervals thereafter to boring termination. Split-spoon samples were recovered using a 2-inch outside-diameter sampler, driven by a 140-pound hammer. The split-spoon samples were placed in containers for later testing in the laboratory. Millennia understands the District introduces fluids into the augers in lieu of switching to mud rotary methods when granular soils are encountered. The sampling sequence for each boring is summarized on the boring logs in Appendix B.

The underlying bedrock at Boring 1-S was cored for a depth of about 10 feet. The core samples recovered were measured in the field for percent recovery and RQD value. Photographs were taken of the rock core samples and are attached in Appendix B. Unconfined compressive strength test results from the recovered rock core samples are also presented along with the rock core photographs in Appendix B.

Unconfined compression tests were performed on selected split-spoon samples using a Rimac field testing machine. The resulting unconfined compressive strengths are reported on the boring logs.

Millennia has also included the boring log data (Borings 1 through 8) from the 1960’s plan set in Appendix B.

3.0 Subsurface Conditions

Details of the subsurface conditions encountered at the borings are shown on the boring logs. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at the boring locations on the dates shown; the reported conditions may differ at other locations and at other times.

3.1 Geology

The structure over Marcum Branch is located in north-central Franklin County on I-57 about 3.5 miles north of Benton, Illinois, and is in the southern part of the Pennsylvanian Bond Formation of interbedded, lithified marine sediments. This formation is characteristically hard, silty, carbonaceous, and argillaceous. The unit has the potential to contain high levels of coal in bedding planes underlaid by clays. Overburden consisting of glacial drift is typically less than 50 feet in thickness. These surficial deposits consist predominantly of clays and silts, while some sands and gravels are common in the creek channels and tributaries.

3.2 Generalized Subsurface Profile

The soils at the site are predominantly made up of cohesive materials, with occasional layers of more granular behaving material. The upper approximately 15 feet of material is most likely embankment material from the original road construction. The cohesive soils generally consist of silty clay, silty loam, clay loam, clay, and silt, with variable amounts of sand, sand seams, and gravel. Moisture contents vary from 12 to 28 percent. The standard penetration test (N) values range weight-of-hammer (0) to 8 blows per foot (bpf). Rimac unconfined compression test values on samples range from an estimated 0.3 to 3.7 tons per square foot (tsf).

Natural granular behaving soils consisting of sandy loam and sand were encountered at both borings at depths ranging from approximately 22.5 to 25.0 feet at Boring 1-S and from 17.0 to 22.5 feet at Boring 2-S. N-values in the granular soils vary from 0 to 6 bpf. Moisture contents of the granular soils vary from 21 to 35 percent, but may be unreliable considering groundwater was observed above the depth of this material.

Natural cohesive soils were observed beneath the sandy material to auger refusal on bedrock. The cohesive soils consist of silty clay, silty loam, silty clay loam and clay. N-values in the material vary from 0 to 8 bpf. Moisture contents range from 19 to 29 percent. Rimac values ranging from 0.6 to 1.6 tsf were recorded in the soil.

Bedrock consisting of either shale or sandstone was encountered at levels ranging from Elevation 377.7 to 376.4, approximately 44.0 to 45.0 feet below the natural ground surface. The bedrock was cored below a depth of approximately 44.0 feet at Boring 1-S. The bedrock is classified as hard, with coal seams and layers of clay shale. Core recoveries of 58 and 90 percent were observed, with corresponding rock quality designation (RQD) values of 29 and 33 percent. Unconfined compressive strength testing on selected samples of rock core yielded values that range from 2,405 to 8,890 pounds per square inch (psi).

Boring information performed for the original bridge structures in the 1960's indicates bedrock consisting of clay shale and sandstone was encountered at all of the borings, 1 through 8, at elevations ranging from about 366.8 to 380.0 feet. N-values obtained in the bedrock varies from 77 bpf to 100 blows for 1 inch of penetration. A softer coal seam was observed at many of the

borings, that varies in elevation from about Elevation 373 to 370. The coal seam thickness was measured to be approximately 6 inches to one foot.

The approximate elevations at which the top of bedrock was encountered for both this study and the study performed in the 1960's are summarized in Table 1 below:

Table 1
Bedrock Elevations (Approx.)

Boring No.	Approximate Top of Bedrock Elevation (ft.)
1-S	377.7
2-S	376.4
1*	366.8
2*	368.9
3*	370.4
4*	371.6
5*	374.7
6*	374.0
7*	376.8
8*	380.0

*= boring drilled for 1960's study

3.3 Groundwater

Groundwater was observed during the drilling of both borings, at depths of 4.0 feet (Elevation 417.7) and 18.5 feet (Elevation 402.9). The presence or absence of groundwater at a particular location does not necessarily indicate that groundwater will be present or absent at that location at other times. Groundwater levels may vary significantly over time due to the effect of seasonal variations in precipitation, water levels in the adjacent Marcum Branch, or other factors not evident at the time of exploration. The surface water elevation of the creek during the course of the field exploration was measured to be about Elevation 409.4 feet. Based on information provided by Oates, we understand the estimated water surface elevation (EWSE) is approximately 410.0 feet.

4.0 Geotechnical Evaluations

4.1 Earthwork and Slope Stability

Grade changes on the approach embankments will be minimal along the roadways. For lane shifts or constructability, it may require that the embankments be widened accordingly in the vicinity of the abutments. It is our understanding that no significant changes to the inclination of the end slopes are planned. As such, we do not anticipate any issues related to slope stability.

4.2 Settlement

The proposed grade changes will be minimal for the new bridge profile. Therefore, issues related to settlement are not anticipated. As such, effects from downdrag on pile foundations can be neglected for this site.

4.3 Mining Activity

A review of abandoned coal mines was made using the Illinois State Geological Survey (ISGS) website for mapped mines in Franklin County, Illinois. The nearest underground coal mine is approximately 0.75 miles southwest of the site, near the Marcum Branch South Public Use Area. The mine was noted as the Old Ben No. 24 Mine and was operated by the Old Ben Coal Corporation from 1965 to 1996 using room and pillar, room and pillar panel, and long wall mining methods. The depth of the coal seam mined was approximately 625 to 666 feet.

Because of the distance separating the mines from the site, it does not appear that the past coal mining activity will have an impact on the project. It should be noted that the ISGS includes a disclaimer with the published information stating that the location of features, including mine boundaries, may be offset by 500 feet or more. In addition, the plotted mine boundaries are not always based on a final mine map, and undocumented mines are occasionally discovered throughout the state.

4.4 Seismicity

Although several significant areas of seismic activity are present in the central United States, the site area is most directly affected by the Wabash Seismic Zone, located in south and east-central Illinois. An assessment of seismic criteria in accord with AASHTO 2009 Guide Specifications for LRFD Seismic Bridge Design has been performed for the site. The IDOT Spreadsheet “Seismic Site Class Determination” was used to determine a Soil Site Class D. We understand that IDOT utilizes the approximate fixity elevation as the point of reference. The United States Geological Survey (USGS) Design Maps Summary Report website was used with the Site Class D classification to provide acceleration coefficient values Sd_s of 0.753 g and Sd_1 of 0.320 g. The results of the Site Class determination are presented in Appendix C.

Based on published information and the IDOT Liquefaction Design Guide, liquefaction analyses are typically performed for the upper 60 feet of a soil profile, since the effects of liquefaction are unlikely to manifest below that depth. The sampled soils obtained in 2019 appear to be susceptible to liquefaction at depths ranging from 22.5 to 25.5 feet (Elev. 399 to 396) at Boring 1-S and from approximately 17.5 to 22.5 feet (Elev. 399 to 394) at Boring 2-S. The potential for liquefaction should not be ignored through this zone unless additional boring information indicates otherwise.

Additional isolated layers just above the bedrock surface were noted near 33 feet (Elev. 388.9) at Boring 1-S and 37.5 feet (Elev. 383.9) at Boring 2-S. The lower elevation material appears to have cohesive properties. In our opinion, the lower bound layer is unlikely to liquefy.

A general assessment of liquefaction potential at the 1960's borings (interior pier locations) near Borings #3, #4, #5 and #6 indicate isolated liquefiable layers from approximately Elev. 378 to 375. However, the plans contain text noting that wash methods were not used to advance the borings. Based on the overall cohesive profile presented on the boring cross sections and isolated sand layers, we believe that liquefaction is unlikely to occur at the center pier locations.

Considerations for lateral spread induced by liquefaction at or near the foundation locations at the abutments are not included within this report and are beyond the scope of work. While there is evidence of liquefaction-induced sand boils and settlements within and near the bootheel of Missouri and the New Madrid Seismic Zone, there is little evidence of historic lateral spreading. Thus, the risk for lateral spreading is considered to be low. If IDOT would like for this issue to be studied further, the task would require additional studies, including the possibility of on-site shear wave velocity testing and a site-specific spectral analysis.

4.5 Scour

Abutment slope protection should be included to protect against scour potential. Countermeasure options for scour at bridge locations could include webwalls to eliminate debris collection between columns, riprap, partially grouted riprap, geotextile sand containers, and sheet piling. Lining the abutment slopes with either Class A4 or A5 stone riprap appears to be appropriate scour protection for the new structures. Skin friction and lateral load design values for driven piles should be ignored in the scour zone. Based on information provided by Oates Associates, Inc., the design scour elevations for the 100-year and 200-year events for the bridges are shown in Table 2.

Table 2
Summary of Design Scour Elevations
Northbound and Southbound Structures

Event/Limit State	**Design Scour Elevations (ft.)**			**Item 113**
	North Abutment	Center Pier	South Abutment	
Q100	414.7	396.3	414.3	8
Q200	414.7	396.1	414.3	
Design	414.7	396.3	414.3	
Check	414.7	396.1	414.3	

5.0 Foundation Evaluations and Design Recommendations

5.1 Driven Pile Foundations

The bridge structures may be supported on driven pile foundations. Pile capacities and driving depths have been assessed using the IDOT pile design spreadsheet "Pile Capacity and Length Estimates," version 10/18/2011. Steel H-piles and metal shell piles are both considered to be feasible for this site. However, metal shell piles are not recommended because of the proximity of rock where a possibility of pile damage during driving may occur. Hard driving is anticipated to penetrate a sufficient distance into the shale or sandstone to achieve the maximum factored capacity, particularly for the heavier sections. Numerous available pile sections may be suitable, and final selection would be based on availability and structural requirements such as pile spacing, installation requirements, etc. Capacity reductions for liquefaction induced downdrag apply for the abutments at this site.

The four abutments have been assessed for selected pile sections. Copies of a typical input spreadsheet giving the input parameters for each substructure, and the corresponding summary sheets for the various pile types that are analyzed by the spreadsheet, are included in Appendix D. These tables provide the pile embedment length to develop various capacities, up to that approaching the factored design capacity of the pile. The tables were prepared for pile lengths corresponding to selected depths of the input stratigraphy. Data for key assumptions such as pile cutoff elevation and ground surface elevation against pile driving were provided to Millennia by Oates Associates, Inc.

Integral abutments are being considered for the new bridge structures. The pile selections were determined using the Integral Abutment Feasibility Analysis spreadsheet. The results indicate that all pile sections are feasible for these bridge structures.

The piles exhibited in the tables in Appendix D are the pile sections that are readily available in accordance with the IDOT Geotechnical Manual. The piles will achieve their nominal structural capacity within the shale or sandstone. Pile sections that are lighter than those given in the tables for a given pile dimension and location will have a similar capacity-elevation relation, but are expected to reach the maximum capacity at a higher elevation. Steel H-piles should be driven into rock to their maximum required bearing, as indicated on the IDOT pile design length spreadsheets. It should be noted that H-Piles driven into shale or sandstone may run shorter (or longer) than the IDOT pile design length spreadsheets estimate.

Table 3.1.
Estimated Pile Length Tables Northbound Structure – North Abutment
(Pile Cutoff Elevation: 416.73)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 8x36	286	157	42
HP 10x42	335	184	41
HP 10x57	454	250	43
HP 12x53	418	230	42
HP 12x63	497	273	42
HP 12x74	589	324	43
HP 12x84	664	365	44
HP 14x73	578	318	42
HP 14x89	705	388	43
HP 14x102	810	445	44
HP 14x117	929	511	45

Table 3.2.
Estimated Pile Length Tables Northbound Structure – Center Pier
(Pile Cutoff Elevation: 416.5)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 8x36	286	155	53
HP 10x42	335	182	52
HP 10x57	454	247	55
HP 12x53	418	227	52
HP 12x63	497	270	54
HP 12x74	589	321	55
HP 12x84	664	362	57
HP 14x73	578	314	53
HP 14x89	705	384	55
HP 14x102	810	442	57
HP 14x117	929	507	58

Table 3.3.
Estimated Pile Length Tables Northbound Structure – South Abutment
(Pile Cutoff Elevation: 416.33)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 8x36	286	157	55
HP 10x42	335	184	54
HP 10x57	454	250	56
HP 12x53	418	230	54
HP 12x63	497	273	55
HP 12x74	589	324	57
HP 12x84	664	365	58
HP 14x73	578	318	55
HP 14x89	705	388	57
HP 14x102	810	445	58
HP 14x117	929	511	60

Table 3.4.
Estimated Pile Length Tables Southbound Structure – North Abutment
(Pile Cutoff Elevation: 416.73)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 8x36	286	157	43
HP 10x42	335	184	42
HP 10x57	454	250	44
HP 12x53	418	230	43
HP 12x63	497	273	43
HP 12x74	589	324	44
HP 12x84	664	365	45
HP 14x73	578	318	43
HP 14x89	705	388	44
HP 14x102	810	445	45
HP 14x117	929	511	40

Table 3.5.
Estimated Pile Length Tables Southbound Structure – Center Pier
(Pile Cutoff Elevation: 416.5)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 8x36	286	156	52
HP 10x42	335	183	51
HP 10x57	454	248	54
HP 12x53	418	228	51
HP 12x63	497	272	53
HP 12x74	589	322	54
HP 12x84	664	364	56
HP 14x73	578	316	52
HP 14x89	705	386	54
HP 14x102	810	443	56
HP 14x117	929	509	58

Table 3.6.
Estimated Pile Length Tables Southbound Structure – South Abutment
(Pile Cutoff Elevation: 416.33)

Pile Type and Size	Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft.)
HP 8x36	286	157	52
HP 10x42	335	184	51
HP 10x57	454	250	54
HP 12x53	418	230	51
HP 12x63	497	273	52
HP 12x74	589	324	54
HP 12x84	664	365	55
HP 14x73	578	318	52
HP 14x89	705	388	54
HP 14x102	810	445	55
HP 14x117	929	511	57

5.2 Lateral Load Capacity Considerations

Lateral load resistance and induced lateral deflection are typically assessed using finite difference computer models based on the lateral modulus-of-subgrade reaction, such as LPILE. Recommendations for use in the design of foundations are presented on the following tables.

Recommended Design Values for Driven Pile Foundations

Table 4.1.
Parameters for Use in LPILE Analysis at Boring 1-S (2019)
Northbound and Southbound Northern Abutments

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Unaxial Compressrive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
422-414	Stiff Clay w/o Free Water	120	1,000	N/A	0.009	N/A	350
414-406	Stiff Clay w/ Free Water	58*	2,000	N/A	0.006	N/A	650
406-399	Soft Clay (Matlock)	58*	500	N/A	0.020	N/A	30
399-396	Sand (Reese)	58*	N/A	N/A	N/A	28	13
396-391	Stiff Clay w/ Free Water	53*	1,500	N/A	0.007	N/A	500
391-378	Stiff Clay w/ Free Water	53*	800	N/A	0.010	N/A	100
378-367	Strong Rock	145	N/A	4,000	N/A	N/A	N/A

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 4.2.
Parameters for Use in LPILE Analysis at Boring 2-S (2019)
Northbound and Southbound Southern Abutments

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Unaxial Compressrive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
421-419	Stiff Clay w/o Free Water	120	1,500	N/A	0.007	N/A	500
419-414	Soft Clay (Matlock)	120	300	N/A	0.020	N/A	30
414-409	Stiff Clay w/ Free Water	58*	750	N/A	0.010	N/A	100
409-406	Stiff Clay w/ Free Water	58*	2,000	N/A	0.006	N/A	650
406-404	Stiff Clay w/ Free Water	58*	750	N/A	0.010	N/A	100
404-399	Sand (Reese)	58*	N/A	N/A	N/A	28	13
399-394	Stiff Clay w/ Free Water	58*	750	N/A	0.010	N/A	100
394-389	Stiff Clay w/ Free Water	58*	1,250	N/A	0.008	N/A	425
389-384	Stiff Clay w/ Free Water	58*	700	N/A	0.010	N/A	100
384-376	Stiff Clay w/ Free Water	58*	1,000	N/A	0.009	N/A	350

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 4.3.
Parameters for Use in LPILE Analysis at Boring 3 (1961)
Northbound and Southbound Center Piers

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Unaxial Compressrive Strength (psi)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
401-396	SCOUR ZONE						
396-386	Stiff Clay w/ Free Water	58*	1,000	N/A	0.009	N/A	350
386-378	Stiff Clay w/ Free Water	58*	800	N/A	0.010	N/A	100
378-375	Sand (Reese)	58*	N/A	N/A	N/A	26	13
375-372	Sand (Reese)	58*	N/A	N/A	N/A	33	60
372-370	Stiff Clay w/ Free Water	63*	2,700	N/A	0.006	N/A	850
370-366	Stiff Clay w/ Free Water	135	5,000	N/A	0.004	N/A	1,300

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Piles should be maintained at a spacing no closer than three pile diameters, center-to-center, so that stress overlap at the bearing level can be avoided, to reduce lateral capacity interaction, and so that possible installation problems associated with one structural member do not impact the integrity of the adjacent member.

The LPile parameters provided above do not account for the temporary effects of liquefaction on the lateral capacity of the driven pile foundations. For lateral capacity reductions within the estimated liquefiable soils, the following tables should be referenced.

Table 5.1.
Parameters for Use in LPILE Analysis of Liquefiable Layers at Boring 1-S (2019)
Northbound and Southbound Northern Abutments

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
399-396	Soft Clay (Matlock)	58*	200	0.020	N/A	30

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

Table 5.2.
Parameters for Use in LPILE Analysis of Liquefiable Layers at Boring 2-S (2019)
Northbound and Southbound Southern Abutments

Elevation (ft)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K_{static} (pci)
404-399	Soft Clay (Matlock)	58*	175	0.020	N/A	30

pcf = pounds per cubic foot psf = pounds per square foot pci = pounds per cubic inch
*= submerged value

6.0 Construction Considerations

6.1 Temporary Sheeting and Soil Retention

The construction activities should be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction. Trenching, excavating, and bracing should be performed in accordance with Occupational Safety and Health Administration (OSHA) regulations, and other applicable regulatory agencies. In accordance with the OSHA excavation standards, the soil at the site is considered to be Type C, which requires a side slope for excavations no steeper than 1.5H:1.0V. However, worker safety and classification of the excavation soil is the responsibility of the contractor. The excavation side slopes for structure foundations may interfere with existing utilities. This will require a temporary soil retention system such as a cantilever sheet pile wall, sheeting, or other temporary support.

Traffic along I-57 will be maintained by utilizing staged construction. It appears as though a temporary sheet pile, which includes cantilever temporary sheet piling, will be feasible at the abutments. Cantilever sheet pile systems may be designed using IDOT Design Guide 3.13.1 – Temporary Sheet Piling Design. Temporary soil retention systems should be designed by an Illinois licensed structural engineer retained by the construction contractor.

6.2 Cofferdam

The following information is based on the understanding that the EWSE is approximately 410.0 for Marcum Branch and the fact that driven piles are planned to support the proposed bridge. Cofferdams will be required at the center pier piles. Per IDOT Bridge Manual Page 2-105, a Type 2 Cofferdam will be required at piles, due to more than 6 feet of water being anticipated at this location. Millennia recommends including a seal coat in the cofferdam design since loose or soft silty soils may be present near the proposed bottom of the cofferdam.

6.3 Subgrade Water Protection

Groundwater seepage should be anticipated for excavations extending more than a few feet below the roadway level along I-57 if construction occurs during periods when the water level approaches the design high water elevation. It is anticipated that excavations for the pile cap foundations may be adequately dewatered using sump and pump methods.

6.4 Driven Pile Installation

The driven piles are to be furnished and installed according to the requirements of Section 512 of the IDOT Standard Specifications, 2012. Millennia recommends that at least one test pile be driven at each substructure location, in accordance with Section 512.15. The piles should be fitted with reinforced tips to reduce the potential for damage during driving.

6.5 Subgrade, Fill, and Backfill

Earthwork activities including backfill and fill should be performed in accordance with Section 205 of the Standard Specifications.

7.0 Closing

This report has been prepared for the exclusive use of Oates Associates, Inc. and the Illinois Department of Transportation for use in the design and construction of the proposed I-57 over Marcum Branch bridge structures project in Franklin County, Illinois. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made to the professional advice and recommendations included herein. This report is not for use by parties other than those named or for purposes other than those stated herein. It may not contain sufficient information for the use of other parties or for other purposes.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed by Millennia to determine the applicability of the analyses and recommendations considering the changed conditions and time lapse. The report should also be reviewed by Millennia if changes occur in structure location, size, and type, or in the planned loads, elevations, grading plans, and project concepts.

These analyses and recommendations are based on data obtained from site reconnaissance, the borings performed for this study and other pertinent information presented herein. This report does not reflect any variations between, beyond, or below the borings. Should such variations become evident, it may be necessary to re-evaluate the recommendations of this report after performing on-site observation during the construction period and noting the characteristics of any such variation.

We appreciate this opportunity to be of service to you and would be pleased to discuss any aspect of this report with you at your convenience.

Sincerely,

Millennia Professional Services of Illinois, Ltd.

Jacob A. Schaeffer, P.E.
Project Manager

LICENSED PROFESSIONAL ENGINEER
JACOB ALLEN
SCHAEFFER
062.068357
12-16-2020
STATE OF ILLINOIS

6439 Plymouth Avenue, Suite W-129, St. Louis, Missouri 63133 314-531-3981

Appendix A:

Figure 1: Vicinity Map
Figure 2: TS&L Plan
Figure 3: Subsurface Profile

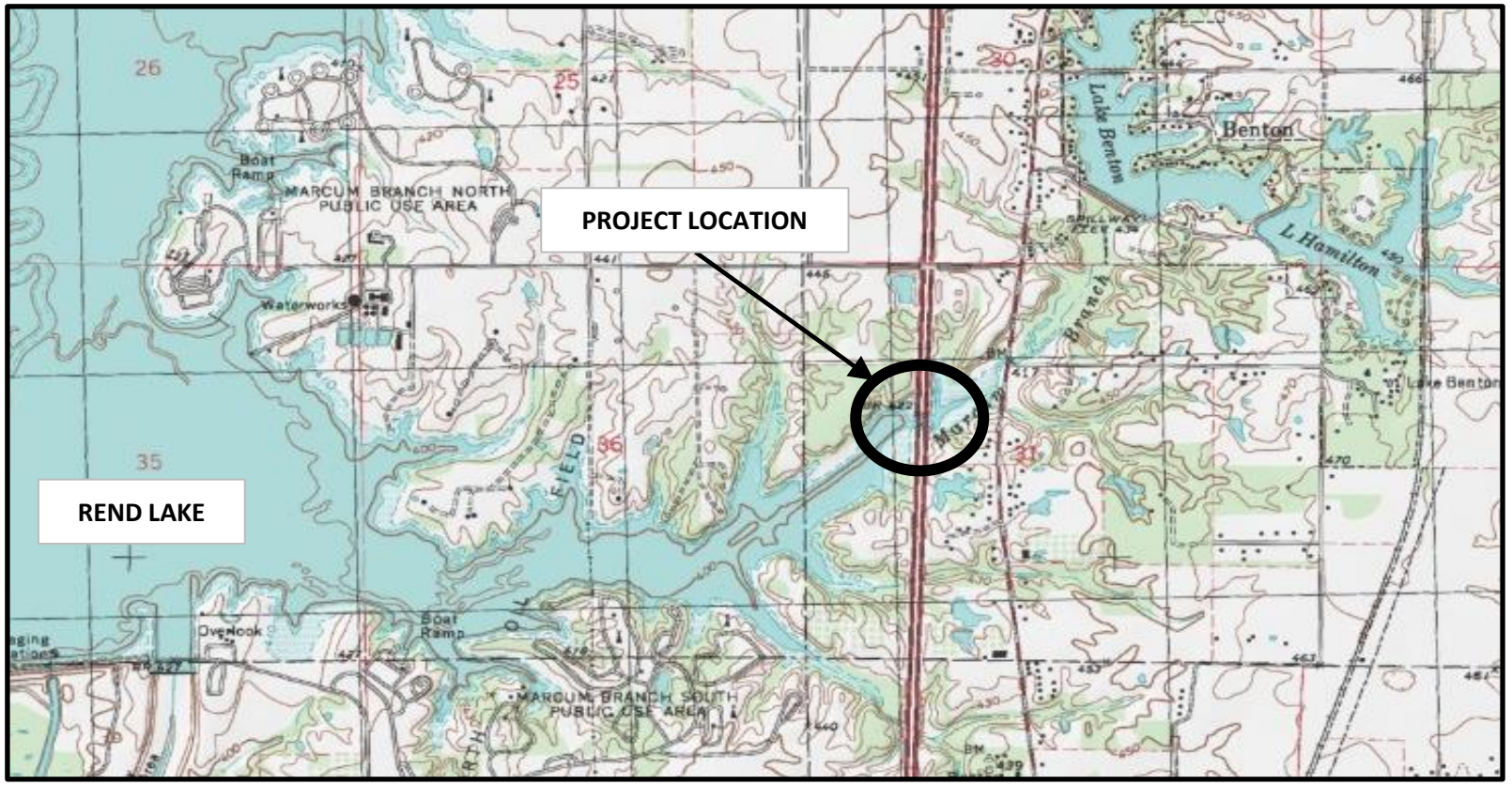
Millennia Professional Services

11 Executive Drive #12, Fairview Heights, IL

Phone: (618) 624-8610

Fax: (618) 624-8611

Project No.: MG19034.02



N

Image obtained from TopoQuest

*Not to scale

FIGURE 1: VICINITY MAP

Interstate 57 over Marcum Branch
Structure No. 028-0011 & 028-0012
Franklin County, IL

Drawn by:	B. Fisher	Checked by:	JAS
Project No.:	MG19034.02	Date:	12/1/2020

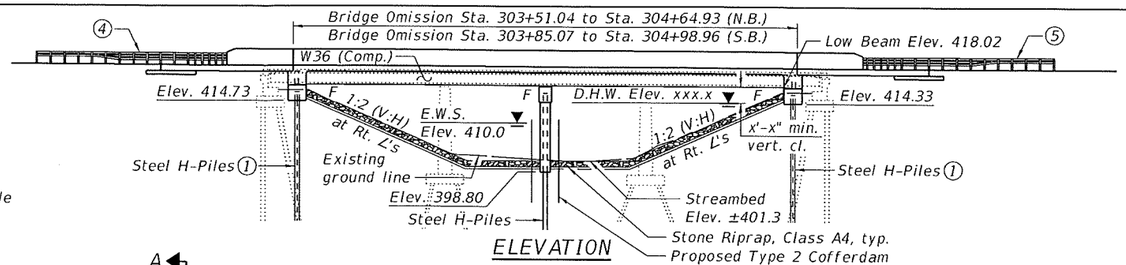
FIGURE 2: TS&L PLAN

Bench Mark: Chiseled square on the northwest wingwall of SN 028-0012, Sta. 303+40, 23' LT., Elev. 421.77.

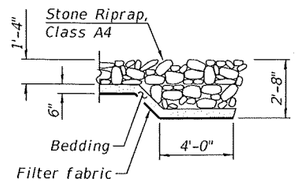
Existing Structure: SN 028-0011 (S.B.) and 028-0012 (N.B.) were originally built in 1962 as F.A.I. 57, Section 28-2B. The deck and bearings were replaced in 1993 for SN 028-0012 (N.B.) as Section (28-2B)D and 1994 for SN 028-0011 (S.B.) as Section (28-2B)D-1. The back to back abutment length is 127'-6" and the out to out deck width is 43'-2". Each structure consists of a three span steel 27WF superstructure supported by concrete stub abutments founded on steel H-piles and solid wall piers on steel H-pile supported footings. Structures to be removed and replaced.

Traffic Control: Two traffic lanes will be maintained in each direction by utilizing staged construction.

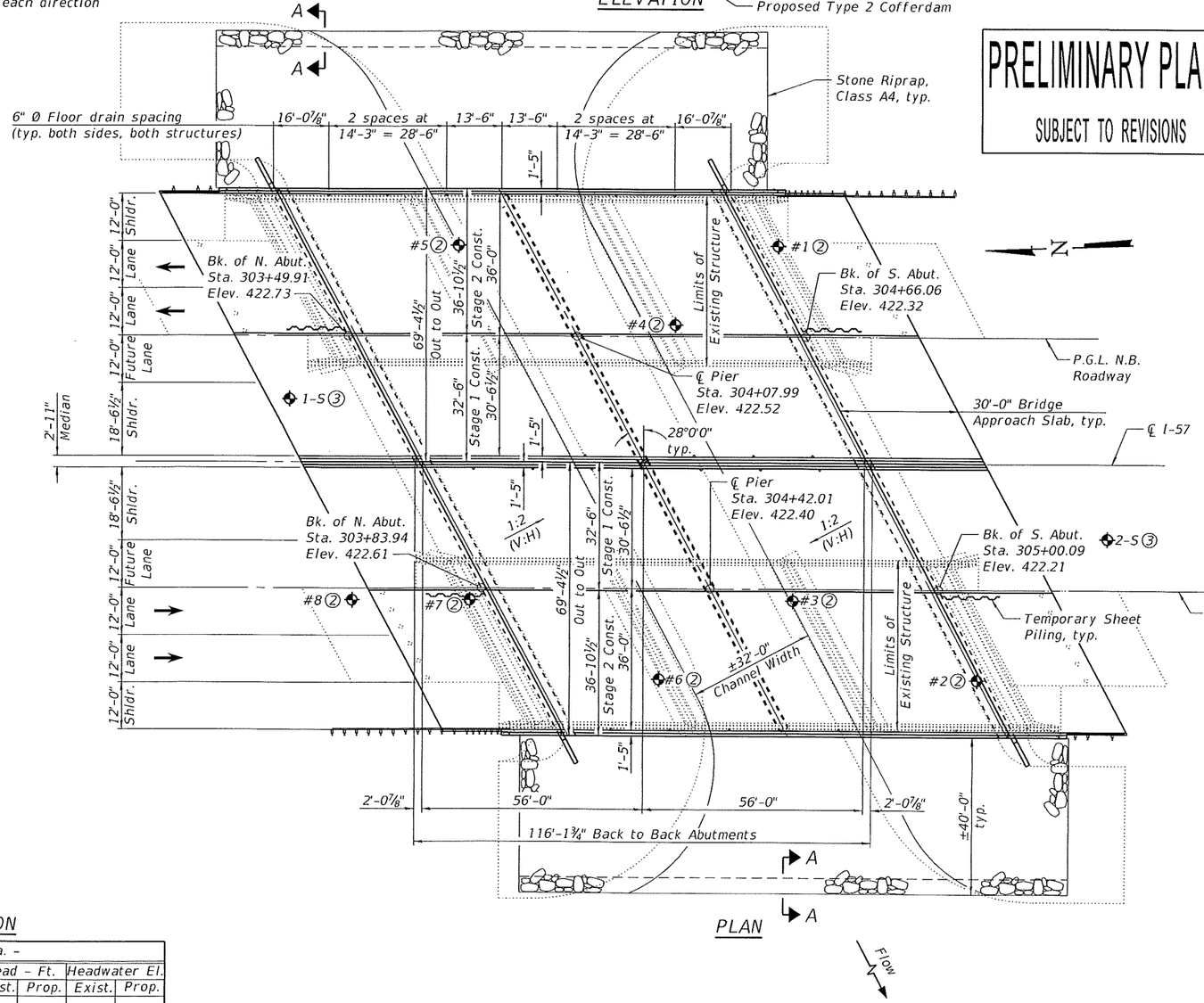
Salvage: None.



ELEVATION



SECTION A-A



PLAN

Notes:
① Space piles to miss existing battered piles.
② 1961 Boring
③ 2019 Boring
④ Traffic Barrier Terminal
Type 5, Std. 631026 (N.B. Structure)
Type 6, Std. 631031 (S.B. Structure)
⑤ Traffic Barrier Terminal
Type 5, Std. 631026 (S.B. Structure)
Type 6, Std. 631031 (N.B. Structure)

DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevations (ft.)			
	N. Abut.	Pier	S. Abut.	Item 113
Q100	414.7	X	414.3	X
Q200	414.7	X	414.3	
Design	414.7	X	414.3	
Check	414.7	X	414.3	

WATERWAY INFORMATION

Drainage Area = - Low Grade Elev. - @ Sta. -

Flood	Freq. Yr.	Q C.F.S.	Opening Ft² Exist.	Opening Ft² Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10								
Design									
Base	100								
Overtopping									
Max. Calc.	500								

PRELIMINARY PLANS
SUBJECT TO REVISIONS

HIGHWAY CLASSIFICATION

F.A.I. Rte. 57 - I-57
Functional Class: Interstate
ADT (one-way): 17,200 (2017) / 24,955 (2042)
ADTT (one-way): 5,425 (2017) / 7,873 (2042)
DHV (one-way): 2,245 (2042)
Design Speed: 70 m.p.h
Posted Speed: 70 m.p.h

LOADING HL-93

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

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

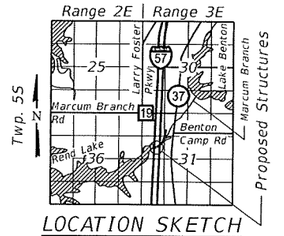
DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi
f'c = 4,000 psi (Superstructure Concrete)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)

SEISMIC DATA

Seismic Performance Zone (SPZ) = X
Design Spectral Acceleration at 1.0 sec. (SD1) = X
Design Spectral Acceleration at 0.2 sec. (SDS) = X
Soil Site Class = X



LOCATION SKETCH

GENERAL PLAN & ELEVATION
I-57 OVER MARCUM BRANCH
F.A.I. RTE. 57 - SEC. (28-2)B-2
FRANKLIN COUNTY
STA. 304+25.00
STRUCTURE NO. 028-0090 (S.B.)
STRUCTURE NO. 028-0091 (N.B.)

FILE NAME: H:\P\1812011820.002\BridgeTSL\Microstation\0280090_0091-78687-001-General Plan & Elevation.dgn

OATES ASSOCIATES
www.oatesassociates.com
ILLINOIS DESIGN FIRM LICENSE NO.: 184.001115

USER NAME = | PLOT SCALE = | PLOT DATE = 8/31/2020

DESIGNED - MAM | CHECKED - JAD | DRAWN - MAM | CHECKED - JAD

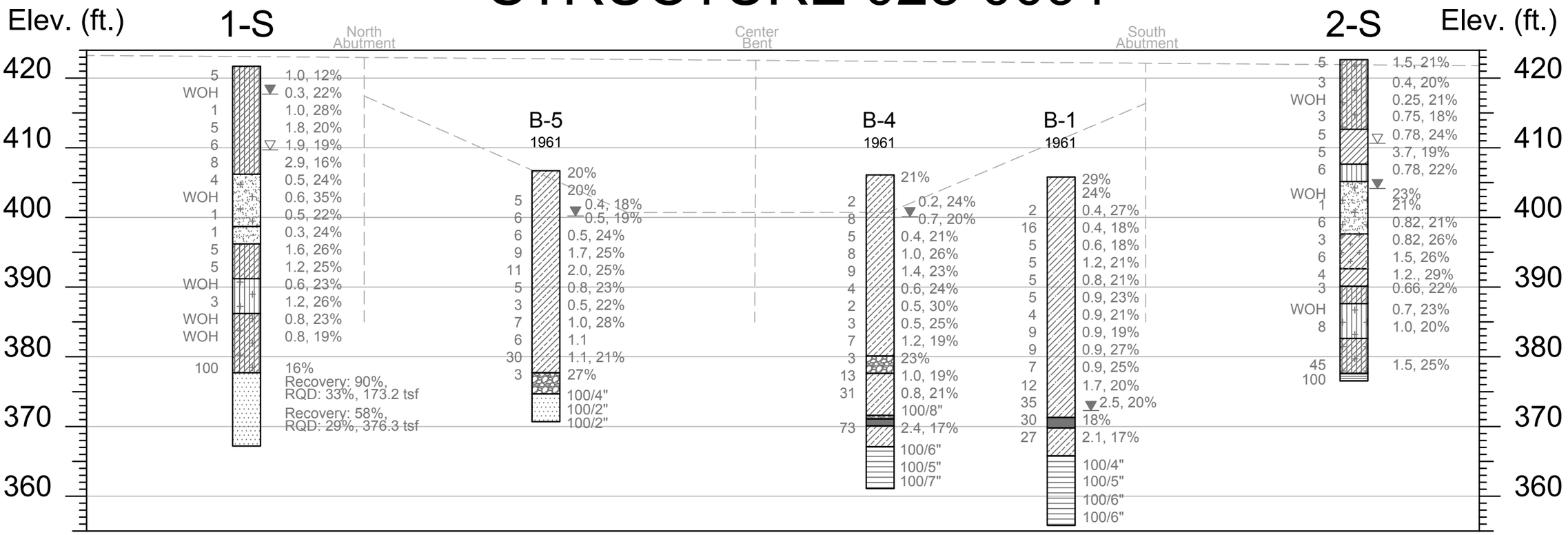
REVISED - | REVISED - | REVISED - | REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 2 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
57	(28-2)B-2	FRANKLIN		
		CONTRACT NO. 78687		
		ILLINOIS	FED. AID PROJECT	

STRUCTURE 028-0091



Note: Elevations are approximate. Actual conditions between borings are unknown, and are subject to change. Horizontal scale shown is only for reference. Locations and depths of existing structures are for reference only.

STRATIGRAPHY KEY:

CLAY	SAND	SILT
CLAY LOAM	SANDY LOAM	SILTY CLAY
CLAY SHALE	SANDSTONE	SILTY CLAY LOAM
COAL	SHALE	SILTY LOAM

1961: COHESIVE SOIL | GRANULAR SOIL

TRENDLINE KEY:

APPROXIMATE EXISTING STRUCTURE LOCATION

BORING DATA KEY:

Boring ID

N-Value (bpf) | Stratigraphy

Rimac Value (tsf) , Moisture Content (%)

Surface water elevation

Groundwater level encountered while drilling

SCALE: 1":15'

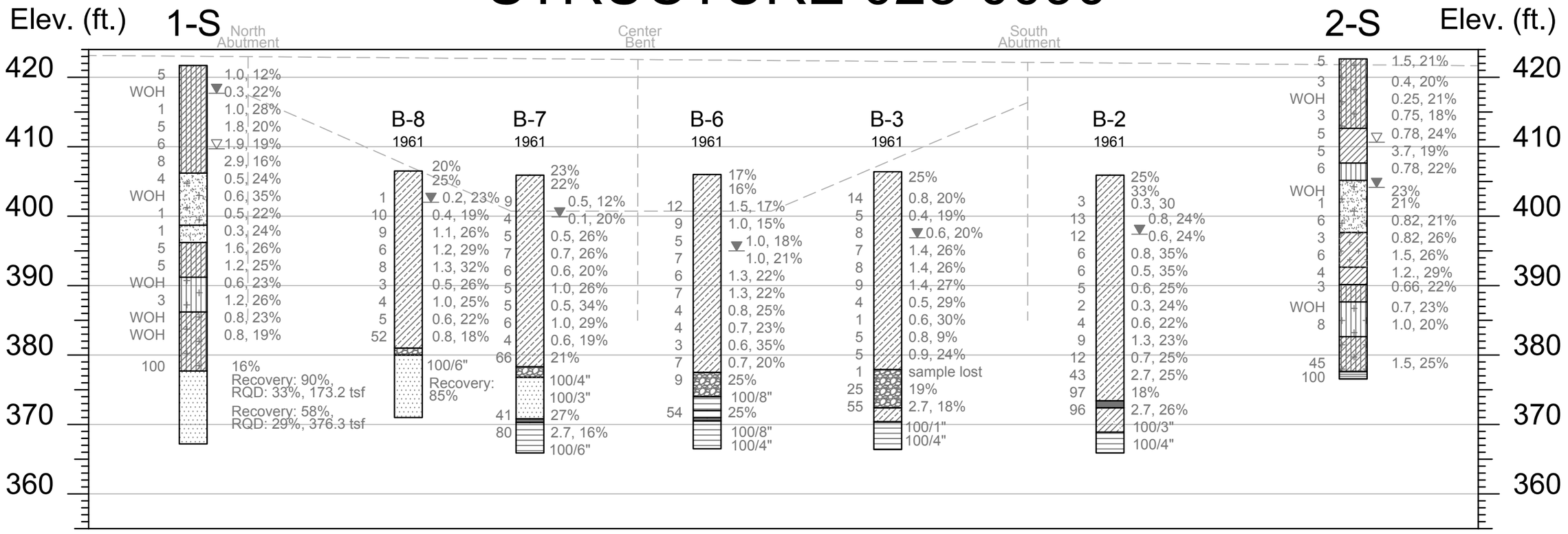
FIGURE 3.1:

NORTHBOUND SUBSURFACE PROFILE

PROJECT NAME:	PROJECT No.:	DRAWN BY:	CHECKED BY:
Interstate 57 Over Marcum Branch	MG19034.02	B. FISHER	J. SCHAEFFER
		12/1/2020	12/1/2020

MILLENNIA PROFESSIONAL SERVICES

STRUCTURE 028-0090



Note: Elevations are approximate. Actual conditions between borings are unknown, and are subject to change. Horizontal scale shown is only for reference. Locations and depths of existing structures are for reference only.

STRATIGRAPHY KEY:

CLAY	SAND	SILT
CLAY LOAM	SANDY LOAM	SILTY CLAY
CLAY SHALE	SANDSTONE	SILTY CLAY LOAM
COAL	SHALE	SILTY LOAM

1961: COHESIVE SOIL, GRANULAR SOIL

TRENDLINE KEY:

APPROXIMATE EXISTING STRUCTURE LOCATION

BORING DATA KEY:

Boring ID

N-Value (bpf) | Stratigraphy

Rimac Value (tsf) , Moisture Content (%)

Surface water elevation

Groundwater level encountered while drilling

SCALE: 1":15'

FIGURE 3.2:

SOUTHBOUND SUBSURFACE PROFILE

PROJECT NAME:	PROJECT No.:	DRAWN BY:	CHECKED BY:
Interstate 57 Over Marcum Branch	MG19034.02	B. FISHER	J. SCHAEFFER
		12/1/2020	12/1/2020

MILLENNIA PROFESSIONAL SERVICES

11 Executive Drive, Suite 12 Fairview Heights, Illinois 62208 618-624-8610

Appendix B:

Boring Logs

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Dave Piche	
From:	Keith Roberts	By: Aaron Hayes	AH
Subject:	Boring Logs	RG	
Date:	July 12, 2018 19		

FAI 57 (I-57) over Marcum Branch
Structure 028-0011 (Existing)
Structure 028-0012 (Existing)
Franklin County

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

Boring 1-S, near the north abutments, shows layers of potentially liquefiable soils at depths of 15.5 to 25.5 feet and 30.5 to 35.5 feet. Boring 2-S, near the south abutments, shows layers of potentially liquefiable soils at depths of 17.5 to 25 feet and 35 to 40 feet. A liquefaction analysis should be completed once the proposed structures' dimensions are determined.

Borings completed in 1961 before the existing structures were constructed have been attached for additional information regarding the depth to bedrock. Also attached is a General Plan and Elevation sheet from the 1961 plans showing the old boring locations.

Attachments
AWH:ah

cc: Materials Geotechnical Unit\Boring Logs using gINT\State Structures\Franklin

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 4/10/19

ROUTE I-57 DESCRIPTION Bridge over Marcum Branch LOGGED BY L. Estel

SECTION (28-2)B-2 LOCATION Mile Post 75.1, SEC. 31, TWP. 5S, RNG. 3E, PM

COUNTY Franklin DRILLING METHOD Hollow stem auger (8" O.D., 3.25" I.D.) HAMMER TYPE Auto SPT 140 lbs

STRUCT. NO. 028-0011 & -0012
Station 304+39

BORING NO. 1-S
Station 303+35
Offset 28.0ft LT of CL NB Lanes
Ground Surface Elev. 421.7 ft

Surface Water Elev. 409.4 ft
Stream Bed Elev. 405.8 ft

Groundwater Elev.:
▽ First Encounter 417.7 ft
▼ Upon Completion ft
▼ After Hrs. ft

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Stiff Brown, Moist SILTY CLAY with ORGANICS
	1			
	2	1	12	
418.70	3	E		
				Soft Brown, Moist to Wet SILTY CLAY with GRAVEL
	WOH			
-5	WOH	.3	22	
416.20	WOH	E		
				Stiff Brown, Moist SILTY CLAY
	WOH			
	WOH	1	28	
	1	B		
	1			
-10	2	1.8	20	
	3	B		
	1			
	3	1.9	19	
408.70	3	B		
	1			V. Stiff Brown, Moist SILTY CLAY
-15	4	2.9	16	
406.20	4	B		
	1			Soft Grey, Moist SANDY LOAM Lab #20: 5% Fine GRAVEL, 49% SAND, 35% SILT, and 10% CLAY
	2	.5	24	
403.70	2	B		
	WOH			
-20	WOH	.6	35	
				M. Stiff Grey, Moist to Wet SANDY LOAM with ORGANICS % Fines < #200: 40% (est.) *(continued)*
401.20	WOH	B		
				Soft Grey, Damp to Moist SANDY LOAM Lab #21: 69% SAND, 17% SILT, and 15% CLAY
	WOH			
	1	.5	22	
398.70	WOH	B		
	1			V. Loose Grey and Brown, Fine SAND
-25	1	.3	24	
396.20	WOH	B		
	1			Stiff Brown and Grey, Moist SILTY CLAY
	2	1.6	26	
393.70	3	B		
	1			Stiff Brown and Grey with specks of dark Brown, Moist SILTY CLAY
-30	2	1.2	25	
391.20	3	B		
	WOH			M. Stiff Grey, Damp to Moist SILTY LOAM % Fines < #200: 75% (est.), PI = 11 (est.), LL = 27 (est.) Based on historical data
	WOH	.6	23	
388.70	WOH	B		
	WOH			Stiff Grey, Moist SILTY LOAM with a CLAY layer % Fines < #200: 75% (est.), PI = 11 (est.), LL = 27 (est.) Based on historical data
-35	1	1.2	26	
386.20	2	B		
	WOH			M. Stiff Grey, Moist SILTY CLAY LOAM
	WOH	.8	23	
	WOH	B		
	WOH			
-40	WOH	.8	19	

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\MATERIALS GEOTECHNICAL UNIT\BORING LOGS USING GINT\STATE STRUCTURES\FRANKLIN\028-0011-12.GPJ Data Template D8TEMPLT.GDT Date Printed 7/12/19
Latitude 38.0469658 Longitude -88.9247182 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 4/10/19

ROUTE I-57 DESCRIPTION Bridge over Marcum Branch LOGGED BY L. Estel

SECTION (28-2)B-2 LOCATION Mile Post 75.1, SEC. 31, TWP. 5S, RNG. 3E, PM

COUNTY Franklin DRILLING METHOD Hollow stem auger (8" O.D., 3.25" I.D.) HAMMER TYPE Auto SPT 140 lbs

STRUCT. NO. 028-0011 & -0012
Station 304+39

BORING NO. 1-S
Station 303+35
Offset 28.0ft LT of CL NB Lanes
Ground Surface Elev. 421.7 ft

Surface Water Elev. 409.4 ft
Stream Bed Elev. 405.8 ft

Groundwater Elev.:
▽ First Encounter 417.7 ft
▼ Upon Completion ft
▼ After Hrs. ft

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
M. Stiff Grey, Moist SILTY CLAY LOAM *(continued)*	WOH	B	
377.70			
Hard Grey, Damp SANDSTONE	100		16
-45			
Bottom of hole @ 54.5 ft			
Elevation referenced to BM 14, Chiseled Square at NW corner of SN 028-0012; EL. 421.91			
To convert "N" values to "N60" multiply by 1.5			
Borehole continued with rock coring.			
-50			
-55			
-60			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\MATERIALS GEOTECHNICAL UNIT\BORING LOGS USING GINT\STATE STRUCTURES\FRANKLIN\028-0011-12.GPJ Data Template D&TEMPLT.GDT Date Printed 7/12/19
Latitude 38.0469658 Longitude -88.9247182 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

ROCK CORE LOG

Date 4/10/19

ROUTE I-57 DESCRIPTION Bridge over Marcum Branch LOGGED BY L. Estel

SECTION (28-2)B-2 LOCATION Mile Post 75.1, SEC. 31, TWP. 5S, RNG. 3E, PM

COUNTY Franklin CORING METHOD Conventional rotary with water

STRUCT. NO. 028-0011 & -0012
Station 304+39

BORING NO. 1-S
Station 303+35
Offset 28.0ft LT of CL NB Lanes
Ground Surface Elev. 421.7 ft

CORING BARREL TYPE & SIZE NV3 5FT NWJ

Core Diameter 2 in
Top of Rock Elev. 377.70 ft
Begin Core Elev. 377.20 ft

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Hard Grey, Dry SANDSTONE with COAL seams	-45	1	90	33	3.2	173.2
Hard Grey, Dry SANDSTONE with a COAL layer and Grey CLAY SHALE bottom	-50	1	58	29	4.8	376.3
	367.20					
Bottom of hole @ 54.5 ft Elevation referenced to BM 14, Chiseled Square at NW corner of SN 028-0012; EL. 421.91	-55					
	-60					

Color pictures of the cores Yes, in file
Cores will be stored for examination until 5 Years after Construction
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)
RQD is the ratio of the total length of sound core specimens >4" to total length of core run

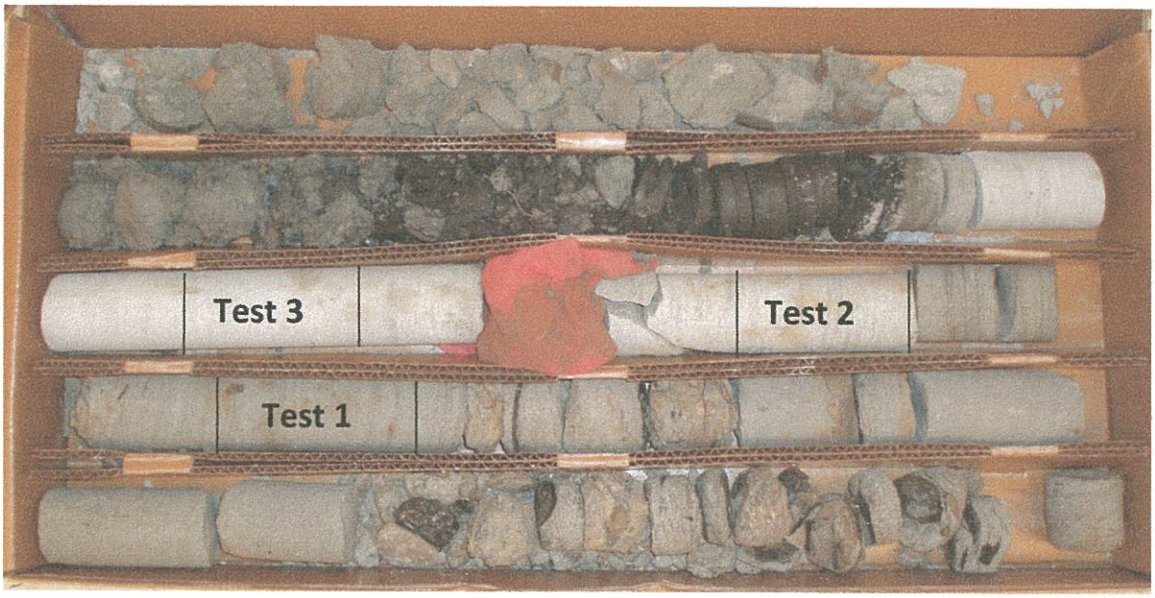
BBS, form 138 (Rev. 8-99)

ROCK CORE 028-0011-12.GPJ D6TEMPLT.GDT 7/12/19

Illinois Department of Transportation
District Nine Materials
Unconfined Compressive Strength

I -57
Structure 028-0011/12 (Boring 1-S)
Franklin County

54' 6" →



←44' 6"

Boring #	Specimen#	Depth	Unconfined Compression
1-S	1	48' 6"	2,405 psi
1-S	2	49' 0"	5,227 psi
1-S	3	50' 0"	8,890 psi

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 4/11/19

ROUTE I-57 DESCRIPTION Bridge over Marcum Branch LOGGED BY L. Estel

SECTION (28-2)B-2 LOCATION Mile Post 75.1, SEC. 31, TWP. 5S, RNG. 3E, PM

COUNTY Franklin DRILLING METHOD Hollow stem auger (8" O.D., 3.25" I.D.) HAMMER TYPE Auto SPT 140 lbs

STRUCT. NO. 028-0011 & -0012
Station 304+39

BORING NO. 2-S
Station 305+43
Offset 25.0ft LT of CL SB Lanes
Ground Surface Elev. 421.4 ft

Surface Water Elev. 409.4 ft
Stream Bed Elev. 405.8 ft

Groundwater Elev.:
▽ First Encounter 402.9 ft
▼ Upon Completion ft
▼ After Hrs. ft

DEPTH (ft)		BLOWS	UCS Qu (tsf)	MOIST (%)
	Stiff Brown, Moist SILTY CLAY LOAM	1 2 3	1.5 B	21
418.90				
	Soft Brown, Moist SILTY CLAY LOAM	WOH 1 2	.4 B	20
-5				
		WOH WOH WOH	.25 B	21
413.90				
	M. Stiff Brown, Moist SILTY CLAY LOAM with rotten WOOD	WOH 1 2	.75 B	18
411.40	-10			
	M. Stiff Blue/Grey, Moist CLAY	1 2 3	.78 B	24
408.90				
	V. Stiff Blue/Grey, Moist CLAY	1 2 3	3.7 B	19
406.40	-15			
	M. Stiff Blue/Grey, Moist SILT	WOH 3 3	.78 B	22
403.90				
	V. Loose Blue/Grey, Damp to ▽Wet SANDY LOAM Lab #25: 64% SAND, 28% SILT,	WOH		
401.40	-20			
	and 8% CLAY	WOH WOH		23
	V. Loose Grey to Brown, Damp to Wet SANDY LOAM 64% SAND, 28% SILT, and 8% CLAY (double sample)	WOH WOH 1		21
398.90				
	M. Stiff Brown, Moist SANDY LOAM % Fines < #200: 40% (est.)	1 2 4	.82 B	21
396.40	-25			
	M. Stiff Brown and mottled Grey, Moist CLAY LOAM	1 1 2	.82 B	26
393.90				
	Stiff Brown and mottled Grey, Moist CLAY LOAM	1 2 4	1.5 B	26
391.40	-30			
	Stiff Brown, Moist CLAY	WOH 1 3	1.2 B	29
388.90				
	M. Stiff Grey, Moist SILTY CLAY	WOH 1 2	.66 B	22
386.40	-35			
	M. Stiff Grey, Moist SILTY LOAM % Fines < #200: 75% (est.), PI = 11 (est.), LL = 27 (est.) Based on historical data	WOH WOH WOH	.7 B	23
383.90				
	Stiff Grey, Moist SILTY LOAM % Fines < #200: 75% (est.), PI = 11 (est.), LL = 27 (est.) Based on	1 4 4	1 B	20
381.40	-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

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Latitude 38.0465040 Longitude -88.9248211 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 4/11/19

ROUTE I-57 DESCRIPTION Bridge over Marcum Branch LOGGED BY L. Estel

SECTION (28-2)B-2 LOCATION Mile Post 75.1, SEC. 31, TWP. 5S, RNG. 3E, PM

COUNTY Franklin DRILLING METHOD Hollow stem auger (8" O.D., 3.25" I.D.) HAMMER TYPE Auto SPT 140 lbs

STRUCT. NO. 028-0011 & -0012
Station 304+39

BORING NO. 2-S
Station 305+43
Offset 25.0ft LT of CL SB Lanes
Ground Surface Elev. 421.4 ft

Surface Water Elev. 409.4 ft
Stream Bed Elev. 405.8 ft

Groundwater Elev.:
▽ First Encounter 402.9 ft
▼ Upon Completion ft
▼ After Hrs. ft

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				historical data
	4			Stiff Grey, Moist SILTY CLAY LOAM
-45	20	1.5	25	
376.40	25	S		Stiff Grey, Damp weathered CLAY SHALE
375.90	100			Hard dark Grey, Dry CLAYSHALE
-50				
-55				Bottom of hole @ 46 ft. 1 in.
				Elevation referenced to BM 14, Chiseled Square at NW corner of SN 028-0012; EL. 421.91
				To convert "N" values to "N60", multiply by 1.5
-60				

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name S:\MATERIALS GEOTECHNICAL UNIT\BORING LOGS USING GINT\STATE STRUCTURES\FRANKLIN\028-0011-12.GPJ Data Template D6TEMPLT.GDT Date Printed 7/12/19
Latitude 38.0465040 Longitude -88.9248211 Datum NAD83 Job Number

B.M. Concrete Monument 150 Ft. Lt. Sta. 310+50
Elev. 432.80

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS

COUNTY NO.	SECTION	COUNTY	SHEET NO.
F.A.I. 57	28-2B	FRANKLIN	25

SHEET NO. 1
11 SHEETS

FED. ROAD DIST. NO. 7 | ILLINOIS | FED. AID PROJECT: I-57-2(35)173

PILE DATA

Capacity - 18 Tons
Test Length - 30 Ft.
No. Reqd. - 64

Creosoted Pile by Bridge Contr.
Steel Piles (18BP54)
Steel Piles (18BP54)

ELEVATION

SECTION C-C

SECTION A-A

DETAIL "A"

DETAIL "B"

LOCATION SKETCH

PLAN

STATION 304+25
BUILT 19[illegible] BY
STATE OF ILLINOIS
F.A.I. RT. 57 SEC. 28-2B
F.A. PROJ. I-57-2(35)
LOADING H20-S16 & ALT

NAME PLATE
See Std. 2113

WATERWAY INFORMATION

Drainage Area 2283 Acres
Character Rolling, wooded cultivated
Required Opening: (30 yr. fld.) 375 Sq. Ft.
Proposed Opening: 375 Sq. Ft. bkwtr. El. 410 & 415

GENERAL NOTES

Class X Concrete shall be used throughout except in piers.

The Concrete floor Slab shall be finished in accordance with Art. 2.18 of the Standard Specifications.

The curb and slab outside of longitudinal construction joints, shown on cross section, shall be poured monolithically.

Slope wall shall be reinforced with welded wire fabric 6x6", mesh, 4 wire, weighing 84 lbs per 100 sq. ft.

Layout of slope walls may be varied to suit ground conditions in the field, as directed by the Engineer.

All rivets shall be 7/8", unless noted.

All holes for splices shall be sub-punched 13/16" and reamed to proper size: 1 3/8" dia. 7/8" rivets; 1 1/4" dia. 3/4" rivets.

All rockers, bolsters, bearing plates, lead plates, pintles and anchor bolts shall be fabricated and set in accordance with Article 2.11.2 of the Standard Specifications and are included in quantity of Structural Steel. Estimate weight of this steel is 13,500 Lbs.

Anchor bolts shall be set before riveting diaphragms over supports.

Expansion guards are included in quantity of Structural Steel. Estimate weight of this steel is 5,100 lbs.

All structural steel and Rail Handrail shall be inspected by the Illinois Div. of Highways before painting.

Except as otherwise provided, all structural steel and metal handrail shall receive one shop coat of red lead paint and two field coats of aluminum paint. See Art. 561.6 & 8.3 inclusive of the Standard Specifications.

All paint shall be furnished and applied by the Contractor.

Class A Concrete shall be used in piers.

The Contractor shall drive 4 test piles (one steel pile (18BP54) at North Abut. - East Structure, one steel pile (18BP54) at South Abut. - West Structure, one steel pile (18BP36) at Pier #2 - East Structure, one steel pile (18BP36) at Pier #1 - West Structure) in permanent locations as directed by the Engineer before ordering the remaining piles.

TOTAL BILL OF MATERIAL

ITEM		Super.	Sub.	Total
Channel Excavation	Cu. Yds.		2,190	2,190
Earth Excavation	Cu. Yds.		27,100	27,100
Class A Excavation	Cu. Yds.		310	310
Class B Excavation	Cu. Yds.		590	590
Class X Concrete	Cu. Yds.	2554	2070	4614
Structural Steel	Lbs.	130460		130460
Steel Reinforcement	Lin. Ft.	300		300
Reinforcement Bars	Lbs.	63410	32860	96270
Creosoted Piles	Lin. Ft.		480	480
Steel Piles (18BP54)	Lin. Ft.		2108	2108
Test Piles Steel (18BP54)	Ea.		2	2
Steel Piles (18BP36)	Lin. Ft.		2397	2397
Test Piles Steel (18BP36)	Ea.		2	2
Name Plates	Ea.	1		1
Slope Wall 6"	Sq. Yds.		3050	3050
Class A Concrete	Cu. Yds.		482.2	362.2
Protective Coat	Sq. Yds.	1848		1848

DESIGN STRESSES

fc = 1400 psi Super. & Sub.
Yc = 75 pcf
fs = 20000 psi Reinf.
fs = 22000 psi Struct. (A-36 Steel)
Allowable ℄ Deflection 1/1000
n = 10

LOADING H20-S16-44 & ALTERNATE

DESIGNED [illegible]
CHECKED D. Kelly
DRAWN C.A. Barnard
CHECKED JEK

EXAMINED Nov. 10 1961
PASSED [illegible]
APPROVED [illegible]

GENERAL PLAN & ELEVATION
PROJ. I-57-2(35)173
MARCUM BRANCH
FAI RT. 57 SEC. 28-2B
FRANKLIN COUNTY
STA. 304+25

Revised - 12-22-61 - W.H.K. - In ELEVATION, at location of conc. abutment, and in TOTAL BILL OF MATERIAL, revised designation of "Name Material" to "Steel Material".
Revised - 1-18-62 D.K.C. In Total Bill of Mat'l, Quantity of Reinf. Bars changed From 89,680 to 63,410 (Super.) & From 34,460 to 32,860 (Sub. Total)

F.A.I. 57 | 28-2B | FRANKLIN | 22 | 14
SHEET NO. 10 — 11 SHEETS

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS

Boring No. 1 — Station 304+59 — Offset 55' Lt.

Description	Elevation	N	Qu t/sq ft	Type Failure	w (%)
Ground Surface	405.8 / 0				
Medium and moist brown silty clay loam A-4(8)	405.3	Augered Sample			19
Medium and wet brown mottled grey silty clay loam A-6(9-10)		Augered Sample			24
	-5				
	399.8	2	0.4	B	27
Soft and wet brown mottled grey and black clay loam A-6(7-8)					
	397.3	16	0.4	S	18
Medium and wet grey mottled brown clay loam to clay A-6(11-12)	-10				
	394.8	5	0.6	B	18
Stiff and very moist grey mottled brown silty clay to clay A-6(12-13)					
	392.3	5	1.2	B	21
Medium and very moist grey mottled brown clay loam A-6(9)	-15				
	389.8	5	0.8	B	21
Medium and moist grey silty loam A-4(8)		5	0.9	B	23
	-20				
	384.8	4	0.9	B	21
Medium and moist grey clay loam A-6(7-8)	382.1	9	0.9	S	19
Medium and moist black silty clay A-6(9-10)	-25				
	380.3	9	0.9	B	27
Medium and wet grey sandy clay loam	379.8		-	-	26
Medium and moist grey silty clay A-6(11-12)					
	377.3	7	0.9	B	25
Stiff and moist grey clay loam A-6(4-5)	-30	12	1.7	S	20
	374.3				
Very stiff and wet grey sandy clay loam		35	250	P	20
	371.3				
Moist black very soft coal	-35				
	369.8	38	-	-	18
Very stiff and slightly moist grey clay - near clay shale		77	2.13	S	17
	366.8				
	-40				
Medium and dry to slightly moist grey to dark grey clay shale		100 Blows in 4 inches			
	-45	100 Blows in 5 inches			
		100 Blows in 6 inches			
	355.8 / -50	100 Blows in 6 inches			

Bottom of Hole = 50.0 feet

Entire hole augered to obtain samples. No washing procedure required.

During drilling operations, it appeared that free water was encountered at 13.5 feet.

Surface Water El. None
Groundwater El. at Completion 396.8
After 24 Hours 401.8

Boring No. 2 — Station 305+10 — Offset 55 ft. Rt.

Description	Elevation	N	Qu t/sq ft	Type Failure	w (%)
Ground Surface	405.9 / 0				
Medium and slightly moist brown silty clay loam A-6(8)		Augered Sample			25
	402.4				
Medium and wet brown silty clay loam A-6(8)	400.9	Augered Sample			33
Soft and wet brown mottled grey sandy clay loam	-5	3	0.3	S	30
	398.9				
Medium and very moist brown mottled grey clay loam A-6(5-6)	397.4	13	0.8	S	24
Medium and wet brown clay loam A-6(7-8)	-10				
	394.9	12	0.6	S	24
Medium and very moist grey mottled brown clay A-7-6(14)		6	0.8	S	35
	-15	6	0.5	S	35
	388.9				
Medium and moist blue grey clay A-7-6(14)		5	0.6	B	25
	385.9 / -20				
Soft and very moist blue grey clay loam A-6(6-7)		2	0.3	B	24
	383.9				
Medium and moist grey silty clay loam A-4(8)		4	0.8	B	22
	-25				
	380.4	9	1.1	B	22
Medium and wet grey sandy clay loam			-	-	23
		12	0.7	P	25
	376.4				
Very stiff and very moist grey-streaked with black sandy clay loam	-30	43	2.7	P	25
	373.4				
Medium and slightly moist black soft coal	372.4	97	-	-	18
Very stiff and slightly moist grey-clay - near clay shale	-35	96	2.7	S	16
	368.9				
Medium and slightly moist grey clay shale		100 Blows in 3 inches			
	365.9 / -40	100 Blows in 4 inches			

Bottom of Hole = 40.0 feet

Entire hole augered to obtain samples. No washing procedure required. During drilling operation, it appeared that free water was encountered at 8.5 feet

Surface Water El. None
Groundwater El. at Completion 400.9
After 24 Hours 401.9

Boring No. 3 — Station 304+63 — Offset 35' Rt.

Description	Elevation	N	Qu t/sq ft	Type Failure	w (%)
Ground Surface	406.4 / 0				
Medium and moist brown silty clay loam A-4(8)		25	Augered Sample		
	401.9				
Medium and moist brown mottled grey clay loam A-6(6-7)	-5	14	0.8	S	20
	399.4				
Soft to medium and very moist to wet brown mottled grey clay loam A-6(6-7)		5	0.4	B	19
	-10	8	0.6	B	20
	394.4				
Stiff and very moist grey mottled brown silty clay A-6(11-12)		7	1.4	B	24
	-15	8	1.4	S	26
	388.9				
Stiff and very moist blue to grey clay A-7-6(14-15)		9	1.4	S	27
	386.4 / -20				
Soft and very moist to wet blue to grey clay A-7-6(14-15)		4	0.5	B	29
	382.9	1	0.4	B	30
Medium and moist blue to grey silty clay A-6(11-12)	-25				
		5	0.8	B	9
	377.9	5	0.9	B	24
Very loose and wet grey medium graded fine sand	-30				
	375.4	1	Lost Sample		
Medium and wet grey poorly graded coarse sand		25	-	-	19
	372.4				
Very stiff and moist grey clay - near clay shale	-35				
	370.4	55	2.7	S	18
Medium and dry to slightly moist grey clay shale		100 Blows in 1 inches			
	366.4 / -40	100 Blows in 4 inches			

Bottom of Hole = 40.0 feet

Entire hole augered to obtain samples. No washing procedure required.
During drilling operations, it appeared that free water was encountered at 9.5 feet

Surface Water El. None
Groundwater El. at Completion 398.4
After 24 Hours 401.4

Boring No. 4 — Station 304+33 — Offset 35' Lt.

Description	Elevation	N	Qu t/sq ft	Type Failure	w (%)
Ground Surface	406.1 / 0				
Medium and moist brown silty clay loam A-4(8)		21	Augered Sample		
	401.6				
Very soft and wet brown mottled grey clay loam A-6(7-8)	-5	2	0.2	B	24
	398.6				
Medium and very moist brown mottled grey clay loam A-6(7-8)		8	0.7	S	20
	396.1 / -10				
Soft and wet grey clay loam to clay A-6(10-11)		5	0.4	S	21
	394.6				
Stiff and moist brown silty clay A-6(10)	393.1	8	1.5	B	25
Medium and very moist grey silty clay A-6(10-11)			0.5	B	26
	391.1 / -15				
Stiff and moist brown mottled grey silty clay loam A-6(9-10)		9	1.4	S	23
	389.1				
Medium and very moist blue grey clay loam A-6(7-8)	387.6	4	0.6	B	24
Medium and very moist blue grey clay A-7-6(14-15)	-20				
	385.1	2	0.5	B	30
Medium and very moist blue grey silty clay A-6(9-10)	382.6	3	0.5	B	25
Stiff and moist blue grey clay loam A-6(8-9)	-25				
	380.1	7	1.2	B	19
Very loose and wet grey poorly graded fine sand					
	377.6	3	-	-	23
Stiff and very moist grey sandy clay loam	-30	13	1.0	S	19
		31	0.8	P	21
Medium and very moist grey poorly graded fine sand	371.6				
	371.1 / -35	100 Blows in 8 inches			
Medium and slightly moist black soft coal	370.1				
Very stiff and slightly moist grey clay - near clay shale		73	2.0	S	17
	367.1				
	-40	100 Blows in 6 inches			
Medium and dry to slightly moist clay shale		100 Blows in 5 inches			
	361.1 / -45	100 Blows in 7 inches			

Bottom of Hole = 45.0 feet

Entire hole augered to obtain samples. No washing procedure required.

During drilling operations, it appeared, that free water was encountered at 6.0 feet

*Sides of the hole caved in and was unable to get water elevation at completion.

Surface Water El. None
Groundwater El. at Completion *
After 72 Hours 404.1

N = Standard Penetration Test Blows per foot to drive 2" O.D. Split Spoon Sampler with 140# hammer falling 30"
Qu = Unconfined Compressive Strength t/sf
W = Water Content - percentage of oven dry weight %
Type Failure:
B = Bugle Failure
S = Shear Failure
P = Penetrometer value

DESIGNED	Robert Jander
CHECKED	JEK A.D.
DRAWN	P.J.
CHECKED	JEK

Nov. 10 1961
EXAMINED W.E. Bowman
PASSED E.H. Stuart
APPROVED [illegible]

BORING DATA
MARCUM BRANCH
F.A.I. RT. 57 SEC. 28-2B
FRANKLIN COUNTY
STA. 304+25

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS

DISTRICT	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
FAI RTE 57	28-2B	FRANKLIN	22	15

SHEET NO. //
//SHEETS

Boring No. 5
Station 303+78
Offset 151 Lt.

Elevation	N	Qu (T.S.F.)	Type Failure	w (%)
Ground Surface 406.7	0			
Medium and moist brown silty clay loam A-4(8)	20		Augered Sample	
401.7	-20		Augered Sample	
Medium and very moist brown silty loam A-4(8)				
400.7	-20		Augered Sample	
Soft to medium and wet brown clay loam A-6(5-6)	4	0.4	P	18
397.7	6	0.5	S	19
Medium and very moist brown mottled grey clay loam A-6(9-10)	-10			
393.2	6	0.9	S	24
Stiff and moist grey mottled brown and black silty clay A-6(11-12)				
	9	1.7	S	21
	-15			
390.2	11	2.0	S	21
Medium and moist blue grey silty loam A-4(8)				
	5	0.8	S	23
	-20			
386.2				
Soft and moist blue grey clay loam A-6(7-8)	3	0.5	S	22
383.7				
Stiff and moist grey silty clay A-6(9-10)	7	1.0	S	28
	-25			
	6	1.1	S	-
	-30			
377.7	50	3.0	S	21
Very loose and wet grey poorly graded fine sand	-30			
	3	-	-	27
374.7				
Medium and wet white medium grained sandstone		100 Blows in 4 inches		
373.7	-35	100 Blows in 2 inches		
Medium and wet white to grey medium grained sandstone 370.7		100 Blows in 2 inches		

Bottom of Hole = 36.0 feet

Drive hole augered to obtain samples. No washing procedure required.

During drilling operations, it appeared that free water was encountered at 6.5 feet

Surface Water El. None
Groundwater El. at Completion 403.7
After 24 Hours 404.7

Boring No. 6
Station 304+29
Offset 151 Rt.

Elevation	N	Qu (T.S.F.)	Type Failure	w (%)
Ground Surface 406.0	0			
Medium and moist brown silty clay loam A-6(6-7)	17		Augered Sample	
404.0				
Medium and tan clay loam A-6(6-7)	16		Augered Sample	
401.5	-5			
Stiff and moist brown mottled grey clay loam A-6(8-9)	12	1.4	P	17
397.5				
Stiff and very moist brown mottled grey clay loam A-6(7-8)	9	1.0	S	15
	-10			
395.0	11	1.0	S	18
Stiff and moist grey mottled brown silty clay A-6(10-11)				
392.5	7	1.0	S	21
Stiff and moist grey mottled brown and black silty clay	-15			
	6	1.2	S	22
388.0	7	-	-	-
Stiff and moist blue grey silty clay A-6(10-11)	387.5	1.2	S	22
	-20			
Medium and moist blue grey clay A-7-6(14-15)	4	0.8	S	28
385.0				
Medium and moist blue grey silty clay A-6(11-12)	382.5	4	0.7	S	23
Medium and moist grey silty clay A-6(11-12)	-25			
	7	0.6	S	24
377.5	7	0.7	S	20
Loose and wet grey poorly poorly graded fine sand	-30			
	9	-	-	21
374.0				
Medium to soft and slightly moist dark grey clay shale		100 Blows in 8 inches		
372.0				
Loose and wet grey poorly graded fine sand 371.0	-35			
Very soft and wet black soft coal 370.5	54	-	-	10
Hard and slightly moist grey clay near clay shale				
366.5		100 Blows in 8 inches		
Medium and dry to slightly moist grey clay shale				
365.5	-40	100 Blows in 4 inches		

Bottom of Hole = 39.5 feet

During drilling operations, it appeared that free water was encountered at 11.0 feet

Hole was washed to obtain sample between 31.0 feet and 32.0 feet

Surface Water El. None
Groundwater El. at Completion 398.0
After 24 Hours 403.0

Boring No. 7
Station 303+51
Offset 152 Rt.

Elevation	N	Qu (T.S.F.)	Type Failure	w (%)
Ground Surface 406.0	0			
Medium and moist brown silty clay loam A-4(8)	23		Augered Sample	
Medium and moist tan silty loam A-4(8)	22		Augered Sample	
401.0	-5			
Medium and moist brown clay loam A-6(6-7)	9	0.4	S	12
397.8				
Soft and wet brown mottled grey clay loam A-6(10)				
396.3	1	0.4	S	30
Medium and very moist brown mottled grey silty clay A-6(11)	-10			
391.8	4	0.4	S	26
Medium and very moist grey mottled brown silty clay A-6(11-12)				
	7	0.8	S	25
390.8	-15			
Medium and moist dark grey clay loam A-6(6-7)	6	0.6	S	20
388.1				
Medium and moist blue grey silty clay A-6(12-13)	1	1.0	S	26
385.8	-20			
Medium and moist dark grey clay A-7-6(14-15)	4	0.6	S	16
383.3				
Medium and moist dark grey silty clay A-6(12-13)	6	1.0	S	29
	-25			
	4	0.6	S	19
378.3				
Very loose and wet grey poorly graded fine sand	66	-	-	21
376.8				
Medium and wet grey fine grained sandstone	-30	100 Blows in 4 inches		
		100 Blows in 3 inches		
Medium and wet well graded medium fine sand 372.8	-35			
Medium and wet black soft coal 370.3	41	-	-	27
		-	-	26
Stiff to very stiff and dry to slightly moist clay to clay shale				
	90	2.7	S	16
361.8	-40	100 Blows in 5 inches		

Bottom of Hole = 40.0 feet

During drilling operations, it appeared that free water was encountered at 6.0 feet
Hole was washed to obtain sample between 28.5 feet and 29.5 feet

Surface Water El. None
Groundwater El. at Completion 400.8
After 24 Hours 404.8

Boring No. 8
Station 303+31
Offset 151 Rt.

Elevation	N	Qu (T.S.F.)	Type Failure	w (%)
Ground Surface 406.0	0			
Medium and slightly moist brown silty clay loam A-4(8)	20		Augered Sample	
Medium and moist brown silty clay loam A-4(8)	23		Augered Sample	
402.0				
Soft and wet brown sandy clay loam	-5			
	3	0.4	P	23
398.0				
Stiff and moist brown mottled grey and black silty clay A-6(10-11)	10	0.4	S	19
	-10			
395.5	9	1.2	S	26
Stiff and moist grey mottled brown silty clay A-6(10-11)				
	6	1.2	S	27
	-15			
390.5	8	1.2	S	21
Soft and moist blue grey silty clay loam A-6(9-10)				
388.0	3	0.3	S	24
Medium and moist blue grey silty clay loam A-6(9-10)	-20			
385.5	4	1.0	S	24
Medium and moist grey silty clay A-6(10-11)				
	3	1.0	S	22
381.0	-25			
Medium and moist blue poorly graded fine sand 380.0	4	0.2	P	18
Soft and moist light blue fine grained sandstone	100 Blows in 6 inches			
376.0	-30			
Soft and moist grey fine sandstone with occasional soft coal seam				
371.0	-35			

Bottom of Hole = 35.5 feet

Except for coring, entire hole augered to obtain samples. No washing procedure required.

During drilling operations, it appeared that free water was encountered at 4.5 feet

*Filled hole upon completion of drilling operation.

Cored from 27.5 feet to 35.5 feet, 65% Recovery

Surface Water El. None
Groundwater El. at Completion 400.5*
After — Hours

DESIGNED	Robert Sanders	Nov. 10 1961
CHECKED	J. Billing	
DRAWN		
CHECKED	J.R.	
EXAMINED		
PASSED		
APPROVED		

BORING DATA
MARCUM BRANCH
F.A.I. RT. 57 SEC. 28-2B
FRANKLIN COUNTY
STA. 304+25

11 Executive Drive, Suite 12 Fairview Heights, Illinois 62208 618-624-8610

Appendix C:

Seismic Site Class and Liquefaction Spreadsheets

SEISMIC SITE CLASS DETERMINATION

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified on 12/10/10

PROJECT TITLE=====I-57 over Marcum Branch Northbound

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	414.7	ft.
Pile or Shaft Dia.	12	inches
Boring Number	1-S	
Top of Boring Elev.	421.7	ft.
Approximate Fixity Elev.	408.7	ft.

Individual Site Class Definition:

N (bar): 5 (Blows/ft.) Soil Site Class E
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.01 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	418.7	3.00	5	1.00	
	416.2	2.50	1	0.30	
	413.7	2.50	1	1.00	
	411.2	2.50	5	1.80	
	408.7	2.50	6	1.90	B
2.5	406.2	2.50	8	2.90	B
5.0	403.7	2.50	4	0.50	
7.5	401.2	2.50	1	0.60	
10.0	398.7	2.50	1	0.50	B
12.5	396.2	2.50	1		B
15.0	393.7	2.50	5	1.60	
17.5	391.2	2.50	5	1.20	B
20.0	388.7	2.50	1	0.60	
22.5	386.2	2.50	3	1.20	B
25.0	383.7	2.50	1	0.80	
27.0	381.7	2.00	1	0.80	
29.0	379.7	2.00	1	0.80	
31.0	377.7	2.00	1	0.80	B
100.0	308.7	69.00	100	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	398.8	ft.
Pile or Shaft Dia.	12	inches
Boring Number	#5	
Top of Boring Elev.	406.7	ft.
Approximate Fixity Elev.	392.8	ft.

Individual Site Class Definition:

N (bar): 24 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 71 (Blows/ft.) Soil Site Class C
s_u (bar): 2.79 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	404.7	2.00	17		B
	402.2	2.50	16		B
	399.7	2.50	12	1.50	
	397.7	2.00	7	1.00	B
	395.7	2.00	5	1.00	B
	393.2	2.50	7	1.00	B
2.1	390.7	2.50	6	1.30	
4.1	388.7	2.00	7	1.30	B
7.1	385.7	3.00	4	0.80	B
9.6	383.2	2.50	4	0.70	B
12.1	380.7	2.50	3	0.60	
14.6	378.2	2.50	7	0.70	B
18.1	374.7	3.50	9		B
100.0	292.8	81.90	100	5.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)	398.8	ft.
Pile or Shaft Dia.	12	inches
Boring Number	#4	
Top of Boring Elev.	406.1	ft.
Approximate Fixity Elev.	392.8	ft.

Individual Site Class Definition:

N (bar): 19 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.31 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	403.6	2.50	21		
	401.6	2.00	21		B
	399.6	2.00	2	0.20	
	398.6	1.00	2	0.20	B
	396.1	2.50	8	0.70	B
	394.6	1.50	5	0.40	B
	393.1	1.50	8	1.50	B
1.7	391.1	2.00	8	0.50	B
3.7	389.1	2.00	9	1.40	B
5.2	387.6	1.50	4	0.60	B
7.7	385.1	2.50	2	0.50	B
10.2	382.6	2.50	3	0.50	B
12.7	380.1	2.50	7	1.20	B
15.2	377.6	2.50	3		B
17.2	375.6	2.00	13	1.00	
19.2	373.6	2.00	13	1.00	
21.2	371.6	2.00	31	0.80	B
22.7	370.1	1.50	100		
25.2	367.6	2.50	73	2.90	B
100.0	292.8	74.80	100	5.00	R

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)	414.3	ft.
Pile or Shaft Dia.	12	inches
Boring Number	2-S	
Top of Boring Elev.	421.4	ft.
Approximate Fixity Elev.	408.3	ft.

Individual Site Class Definition:

N (bar): 8 (Blows/ft.) Soil Site Class E
N_{ch} (bar): 13 (Blows/ft.) Soil Site Class E <----Controls
s_u (bar): 2.38 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	418.9	2.50	5	1.50	B
	416.4	2.50	3	0.40	
	413.9	2.50	1	0.25	B
	411.4	2.50	3	0.75	B
	408.9	2.50	5	0.78	B
1.9	406.4	2.50	5	3.70	B
4.4	403.9	2.50	6	0.78	B
6.9	401.4	2.50	1		
9.4	398.9	2.50	1		B
11.9	396.4	2.50	6	0.82	B
14.4	393.9	2.50	3	0.82	
16.9	391.4	2.50	6	1.50	B
19.4	388.9	2.50	4	1.20	B
21.9	386.4	2.50	3	0.66	B
24.4	383.9	2.50	1	0.70	B
26.9	381.4	2.50	8	1.00	B
29.4	378.9	2.50	8	1.50	
31.9	376.4	2.50	8	1.50	B
100.0	308.3	68.10	100	5.00	R

Global Site Class Definition: Substructures 1 through 4

N (bar): 14 (Blows/ft.) Soil Site Class E
N_{ch} (bar): 40 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 2.37 (ksf) Soil Site Class C

SEISMIC SITE CLASS DETERMINATION

I.D.O.T. BBS FOUNDATIONS AND GEOTECHNICAL UNIT

Modified on 12/10/10

PROJECT TITLE=====I-57 over Marcum Branch Southbound

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	414.7	ft.
Pile or Shaft Dia.	12	inches
Boring Number	1-S	
Top of Boring Elev.	421.7	ft.
Approximate Fixity Elev.	408.7	ft.

Individual Site Class Definition:

N (bar): 5 (Blows/ft.) Soil Site Class E
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.01 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	418.7	3.00	5	1.00	
	416.2	2.50	1	0.30	
	413.7	2.50	1	1.00	
	411.2	2.50	5	1.80	
	408.7	2.50	6	1.90	B
2.5	406.2	2.50	8	2.90	B
5.0	403.7	2.50	4	0.50	
7.5	401.2	2.50	1	0.60	
10.0	398.7	2.50	1	0.50	B
12.5	396.2	2.50	1		B
15.0	393.7	2.50	5	1.60	
17.5	391.2	2.50	5	1.20	B
20.0	388.7	2.50	1	0.60	
22.5	386.2	2.50	3	1.20	B
25.0	383.7	2.50	1	0.80	
27.0	381.7	2.00	1	0.80	
29.0	379.7	2.00	1	0.80	
31.0	377.7	2.00	1	0.80	B
100.0	308.7	69.00	100	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	398.8	ft.
Pile or Shaft Dia.	12	inches
Boring Number	#6	
Top of Boring Elev.	406	ft.
Approximate Fixity Elev.	392.8	ft.

Individual Site Class Definition:

N (bar): 23 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 71 (Blows/ft.) Soil Site Class C
s_u (bar): 2.76 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	404.0	2.00	17		B
	401.5	2.50	16		B
	399.0	2.50	12	1.50	
	397.0	2.00	7	1.00	B
	395.0	2.00	5	1.00	B
0.3	392.5	2.50	7	1.00	B
2.8	390.0	2.50	6	1.30	
4.8	388.0	2.00	7	1.30	B
7.8	385.0	3.00	4	0.80	B
10.3	382.5	2.50	4	0.70	B
12.8	380.0	2.50	3	0.60	
15.3	377.5	2.50	7	0.70	B
18.8	374.0	3.50	9		B
100.0	292.8	81.20	100	5.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)	398.8	ft.
Pile or Shaft Dia.	12	inches
Boring Number	#3	
Top of Boring Elev.	406.4	ft.
Approximate Fixity Elev.	392.8	ft.

Individual Site Class Definition:

N (bar): 16 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 24 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 2.86 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	403.9	2.50	25		
	401.9	2.00	25		B
	399.4	2.50	14	0.80	B
	396.9	2.50	5	0.40	
	394.4	2.50	8	0.60	B
0.9	391.9	2.50	7	1.40	
3.9	388.9	3.00	8	1.40	B
6.4	386.4	2.50	9	1.40	B
8.4	384.4	2.00	4	0.50	
9.9	382.9	1.50	1	0.60	B
12.4	380.4	2.50	5	0.80	
14.9	377.9	2.50	5	0.90	B
17.4	375.4	2.50	1		B
20.4	372.4	3.00	25		B
22.4	370.4	2.00	55	2.70	B
100.0	292.8	77.60	100	5.00	R

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)	414.3	ft.
Pile or Shaft Dia.	12	inches
Boring Number	2-S	
Top of Boring Elev.	421.4	ft.
Approximate Fixity Elev.	408.3	ft.

Individual Site Class Definition:

N (bar): 8 (Blows/ft.) Soil Site Class E
N_{ch} (bar): 13 (Blows/ft.) Soil Site Class E <----Controls
s_u (bar): 2.38 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	418.9	2.50	5	1.50	B
	416.4	2.50	3	0.40	
	413.9	2.50	1	0.25	B
	411.4	2.50	3	0.75	B
	408.9	2.50	5	0.78	B
1.9	406.4	2.50	5	3.70	B
4.4	403.9	2.50	6	0.78	B
6.9	401.4	2.50	1		
9.4	398.9	2.50	1		B
11.9	396.4	2.50	6	0.82	B
14.4	393.9	2.50	3	0.82	
16.9	391.4	2.50	6	1.50	B
19.4	388.9	2.50	4	1.20	B
21.9	386.4	2.50	3	0.66	B
24.4	383.9	2.50	1	0.70	B
26.9	381.4	2.50	8	1.00	B
29.4	378.9	2.50	8	1.50	
31.9	376.4	2.50	8	1.50	B
100.0	308.3	68.10	100	5.00	R

Global Site Class Definition: Substructures 1 through 4

N (bar): 13 (Blows/ft.) Soil Site Class E
N_{ch} (bar): 34 (Blows/ft.) Soil Site Class D <----Controls
s_u (bar): 2.5 (ksf) Soil Site Class C

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 1-S
ELEVATION OF BORING GROUND SURFACE ========== 421.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 10.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 10.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.194
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 93 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **234** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 90
Ground Motion Prediction Equations = NMSZ
PGA = **0.159**

	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
418.9	2.5	5	1				12	0.122	0.305	12.037	12.037	0.132	0.122	0.305	0.305	1.500	**0.197**	0.923	**0.116**	**N.L. (1)**
416.4	5	1	0.3				22	0.108	0.575	2.199	2.199	0.054	0.108	0.575	0.575	1.298	**0.070**	0.848	**0.107**	**N.L. (1)**
413.9	7.5	1	1				28	0.122	0.880	2.016	2.016	0.053	0.122	0.880	0.880	1.192	**0.063**	0.776	**0.098**	**N.L. (1)**
411.4	10	5	1.8				20	0.128	1.200	9.953	9.953	0.113	0.128	1.200	1.200	1.141	**0.129**	0.710	**0.090**	**N.L. (1)**
408.9	12.5	6	1.9		12	35	19	0.067	1.368	12.063	12.063	0.132	0.067	1.368	1.524	1.113	**0.147**	0.652	**0.092**	**N.L. (2)**
406.4	15	8	2.9		12	35	16	0.072	1.548	15.969	15.969	0.170	0.072	1.548	1.860	1.088	**0.185**	0.600	**0.091**	**N.L. (2)**
403.9	17.5	4	0.5	45	0	0	24	0.051	1.675	7.953	14.543	0.156	0.051	1.675	2.143	1.063	**0.165**	0.557	**0.090**	**1.833 (C)**
401.4	20	1	0.6	40	0	0	35	0.053	1.808	1.964	7.357	0.091	0.053	1.808	2.432	1.035	**0.094**	0.520	**0.088**	**1.068 (C)**
398.9	22.5	1		32			22	0.043	1.915	1.942	7.103	0.089	0.043	1.915	2.695	1.022	**0.090**	0.491	**0.087**	**1.034 (C)**
396.4	25	1					24	0.043	2.023	1.914	1.914	0.052	0.043	2.023	2.959	1.009	**0.053**	0.466	**0.086**	**0.616 (C)**
393.9	27.5	5	1.6		12	35	26	0.065	2.185	9.307	9.307	0.107	0.065	2.185	3.277	0.993	**0.106**	0.447	**0.084**	**N.L. (2)**
391.4	30	5	1.2		12	35	25	0.061	2.338	9.063	9.063	0.105	0.061	2.338	3.586	0.978	**0.103**	0.431	**0.083**	**N.L. (2)**
388.9	32.5	1	0.6	75	11	27	23	0.053	2.470	1.772	7.126	0.089	0.053	2.470	3.874	0.968	**0.086**	0.419	**0.083**	**1.036 (C)**
386.4	35	3	1.2	75	11	27	26	0.061	2.623	5.178	11.213	0.124	0.061	2.623	4.183	0.950	**0.118**	0.409	**0.082**	**1.439 (C)**
383.9	37.5	1	0.8		12	30	23	0.057	2.765	1.685	1.685	0.051	0.057	2.765	4.481	0.948	**0.049**	0.402	**0.082**	**N.L. (2)**
381.4	40	1	0.8		12	30	19	0.057	2.908	1.646	1.646	0.051	0.057	2.908	4.780	0.939	**0.048**	0.396	**0.082**	**N.L. (2)**
377.4	44	100						0.083	3.240	######	184.187	1.353	0.083	3.240	5.361	0.844	**1.142**	0.389	**0.081**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 2-S
ELEVATION OF BORING GROUND SURFACE ========== 421.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 10.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 10.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.194
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 93 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **282** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 90
Ground Motion Prediction Equations = NMSZ
PGA = **0.159**

	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
418.9	2.5	5	1.5				21	0.126	0.315	11.995	11.995	0.131	0.126	0.315	0.315	1.500	**0.197**	0.939	**0.118**	**N.L. (1)**
416.4	5	3	0.4				20	0.111	0.593	6.560	6.560	0.084	0.111	0.593	0.593	1.307	**0.110**	0.876	**0.110**	**N.L. (1)**
413.9	7.5	1	0.25				21	0.107	0.860	2.028	2.028	0.053	0.107	0.860	0.860	1.198	**0.064**	0.813	**0.102**	**N.L. (1)**
411.4	10	3	0.75				18	0.118	1.155	6.045	6.045	0.080	0.118	1.155	1.155	1.134	**0.091**	0.752	**0.095**	**N.L. (1)**
408.9	12.5	5	0.78		12	35	24	0.056	1.295	10.242	10.242	0.115	0.056	1.295	1.451	1.122	**0.129**	0.695	**0.098**	**N.L. (2)**
406.4	15	5	3.7		12	35	19	0.075	1.483	10.142	10.142	0.114	0.075	1.483	1.795	1.087	**0.124**	0.644	**0.098**	**N.L. (2)**
403.9	17.5	6	0.78		7	30	22	0.056	1.623	12.079	12.079	0.132	0.056	1.623	2.091	1.068	**0.141**	0.599	**0.097**	**N.L. (2)**
401.4	20	1		36			23	0.043	1.730	2.000	7.400	0.091	0.043	1.730	2.354	1.045	**0.095**	0.560	**0.096**	**0.990 (C)**
398.9	22.5	1		36			21	0.043	1.838	1.977	7.372	0.091	0.043	1.838	2.618	1.031	**0.094**	0.527	**0.095**	**0.989 (C)**
396.4	25	6	0.82	40	0	0	21	0.057	1.980	11.594	18.913	0.202	0.057	1.980	2.916	1.020	**0.206**	0.500	**0.093**	**2.215 (D)**
393.9	27.5	3	0.82		12	35	26	0.057	2.123	5.659	5.659	0.077	0.057	2.123	3.215	1.000	**0.077**	0.477	**0.091**	**N.L. (2)**
391.4	30	6	1.5		12	35	26	0.064	2.283	10.999	10.999	0.122	0.064	2.283	3.531	0.983	**0.120**	0.460	**0.090**	**N.L. (2)**
388.9	32.5	4	1.2		12	35	29	0.061	2.435	7.138	7.138	0.089	0.061	2.435	3.839	0.971	**0.086**	0.445	**0.089**	**N.L. (2)**
386.4	35	3	0.66		12	35	22	0.054	2.570	5.231	5.231	0.074	0.054	2.570	4.130	0.962	**0.071**	0.434	**0.088**	**N.L. (2)**
383.9	37.5	1	0.7	75	11	27	23	0.055	2.708	1.703	7.044	0.088	0.055	2.708	4.424	0.949	**0.084**	0.425	**0.088**	**0.955 (C)**
381.4	40	8	1	75	11	27	20	0.059	2.855	13.295	20.954	0.228	0.059	2.855	4.727	0.915	**0.208**	0.418	**0.087**	**N.L. (2)**
376.4	45	45	1.5				25	0.064	3.175	83.908	83.908	0.597	0.064	3.175	5.359	0.851	**0.508**	0.408	**0.087**	**N.L. (3)**
375.4	46	100						0.083	3.258	######	183.986	1.351	0.083	3.258	5.504	0.842	**1.138**	0.407	**0.087**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== #3
ELEVATION OF BORING GROUND SURFACE ========== 406.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.194
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 60 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **438** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 90
Ground Motion Prediction Equations = NMSZ
PGA = **0.159**

	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
403.4	3	25						0.069	0.207	47.524	47.524	0.273	0.069	0.207	0.394	1.500	**0.410**	0.974	**0.234**	**N.L. (3)**
400.4	6	14	0.8		12	35	20	0.057	0.378	23.581	23.581	0.266	0.057	0.378	0.752	1.500	**0.399**	0.942	**0.236**	**N.L. (2)**
397.9	8.5	5	0.4		12	35	19	0.049	0.501	7.567	7.567	0.092	0.049	0.501	1.031	1.366	**0.126**	0.911	**0.237**	**N.L. (2)**
395.4	11	8	0.6		12	35	20	0.053	0.633	12.596	12.596	0.137	0.053	0.633	1.319	1.349	**0.184**	0.877	**0.230**	**N.L. (2)**
392.9	13.5	7	1.4		12	35	24	0.063	0.791	10.831	10.831	0.121	0.063	0.791	1.633	1.263	**0.152**	0.840	**0.219**	**N.L. (2)**
390.4	16	8	1.4		12	35	26	0.063	0.948	12.291	12.291	0.134	0.063	0.948	1.946	1.219	**0.163**	0.801	**0.207**	**N.L. (2)**
387.9	18.5	9	1.4		12	35	27	0.063	1.106	13.640	13.640	0.147	0.063	1.106	2.260	1.180	**0.173**	0.762	**0.196**	**N.L. (2)**
385.4	21	4	0.5		12	35	29	0.051	1.233	5.874	5.874	0.079	0.051	1.233	2.543	1.118	**0.088**	0.723	**0.188**	**N.L. (2)**
382.9	23.5	1	0.6		12	35	30	0.053	1.366	1.435	1.435	0.051	0.053	1.366	2.832	1.092	**0.055**	0.686	**0.179**	**N.L. (2)**
380.4	26	5	0.8		12	35	9	0.057	1.508	6.981	6.981	0.088	0.057	1.508	3.130	1.075	**0.094**	0.652	**0.171**	**N.L. (2)**
377.9	28.5	5	0.9		12	35	24	0.058	1.653	6.780	6.780	0.086	0.058	1.653	3.431	1.054	**0.091**	0.622	**0.163**	**N.L. (2)**
375.4	31	1						0.043	1.761	1.328	1.328	0.050	0.043	1.761	3.695	1.038	**0.052**	0.596	**0.158**	**0.329 (C)**
372.9	33.5	25					19	0.069	1.933	36.732	36.732	-0.099	0.069	1.933	4.023	1.037	**-0.102**	0.574	**0.151**	**N.L. (3)**
370.4	36	55	2.7				18	0.071	2.111	80.442	80.442	0.569	0.071	2.111	4.357	1.002	**0.570**	0.555	**0.144**	**N.L. (3)**
367.9	38.5	100						0.083	2.318	######	140.457	1.026	0.083	2.318	4.720	0.965	**0.990**	0.539	**0.139**	**N.L. (3)**
365.4	41	100						0.083	2.526	######	135.110	0.986	0.083	2.526	5.084	0.932	**0.919**	0.527	**0.134**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== #4
ELEVATION OF BORING GROUND SURFACE ========== 406.10 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.194
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 60 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **449** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 90
Ground Motion Prediction Equations = NMSZ
PGA = **0.159**

	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
403.6	2.5	21						0.068	0.170	40.029	40.029	0.126	0.068	0.170	0.326	1.500	**0.189**	0.980	**0.237**	**N.L. (3)**
400.1	6	2	0.2		12	35	24	0.042	0.317	3.093	3.093	0.059	0.042	0.317	0.691	1.462	**0.086**	0.947	**0.260**	**N.L. (2)**
397.6	8.5	8	0.7		12	35	20	0.055	0.455	12.566	12.566	0.136	0.055	0.455	0.985	1.464	**0.200**	0.918	**0.251**	**N.L. (2)**
395.1	11	5	0.4		12	35	21	0.049	0.577	7.888	7.888	0.095	0.049	0.577	1.263	1.329	**0.126**	0.886	**0.245**	**N.L. (2)**
392.6	13.5	8	1.5		12	35	25	0.064	0.737	12.737	12.737	0.138	0.064	0.737	1.579	1.300	**0.180**	0.851	**0.230**	**N.L. (2)**
390.1	16	9	1.4		12	35	23	0.063	0.895	14.236	14.236	0.152	0.063	0.895	1.893	1.249	**0.190**	0.813	**0.217**	**N.L. (2)**
388.1	18	4	0.6		12	35	24	0.053	1.001	6.133	6.133	0.081	0.053	1.001	2.124	1.168	**0.094**	0.783	**0.209**	**N.L. (2)**
385.1	21	2	0.5		12	35	30	0.051	1.154	3.000	3.000	0.058	0.051	1.154	2.464	1.129	**0.066**	0.737	**0.199**	**N.L. (2)**
383.1	23	3	0.5		12	35	25	0.051	1.256	4.421	4.421	0.068	0.051	1.256	2.691	1.110	**0.075**	0.708	**0.191**	**N.L. (2)**
380.1	26	7	1.2		12	35	19	0.061	1.439	9.943	9.943	0.113	0.061	1.439	3.061	1.094	**0.123**	0.667	**0.179**	**N.L. (2)**
377.6	28.5	3					23	0.051	1.566	4.154	4.154	0.066	0.051	1.566	3.344	1.062	**0.070**	0.636	**0.171**	**0.409 (C)**
375.1	31	13	1		5	20	19	0.059	1.714	18.134	18.134	0.193	0.059	1.714	3.648	1.062	**0.205**	0.609	**0.164**	**1.250 (D)**
372.6	33.5	31	0.8				21	0.057	1.856	47.799	47.799	0.277	0.057	1.856	3.946	1.055	**0.292**	0.586	**0.157**	**N.L. (3)**
370.6	35.5	100						0.083	2.022	######	148.995	1.090	0.083	2.022	4.237	1.019	**1.111**	0.570	**0.151**	**N.L. (3)**
367.6	38.5	73						0.079	2.259	######	103.793	0.750	0.079	2.259	4.661	0.975	**0.731**	0.551	**0.143**	**N.L. (3)**
366.1	40	100						0.083	2.384	######	138.841	1.014	0.083	2.384	4.880	0.954	**0.968**	0.542	**0.140**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== #5
ELEVATION OF BORING GROUND SURFACE ========== 406.70 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.194
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 60 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

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

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 90
Ground Motion Prediction Equations = NMSZ
PGA = **0.159**

	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
404.2	2.5	20						0.067	0.168	38.123	38.123	0.035	0.067	0.168	0.324	1.500	**0.053**	0.986	**0.240**	**N.L. (3)**
401.7	5	20						0.067	0.335	36.329	36.329	-0.165	0.067	0.335	0.647	1.500	**-0.248**	0.968	**0.236**	**N.L. (3)**
400.2	6.5	6	0.4		12	35	18	0.049	0.409	8.992	8.992	0.104	0.049	0.409	0.814	1.449	**0.151**	0.956	**0.240**	**N.L. (2)**
398.7	8	6	0.5		12	35	19	0.051	0.485	8.979	8.979	0.104	0.051	0.485	0.984	1.394	**0.145**	0.943	**0.241**	**N.L. (2)**
395.2	11.5	6	0.5		12	35	24	0.051	0.664	9.310	9.310	0.107	0.051	0.664	1.381	1.302	**0.139**	0.907	**0.238**	**N.L. (2)**
392.7	14	9	1.7		12	35	25	0.065	0.826	14.192	14.192	0.152	0.065	0.826	1.700	1.275	**0.194**	0.878	**0.228**	**N.L. (2)**
390.7	16	11	2		11	27	25	0.067	0.960	17.444	17.444	0.186	0.067	0.960	1.958	1.246	**0.231**	0.852	**0.219**	**1.055 (D)**
387.7	19	5	0.8		11	27	23	0.057	1.131	7.452	7.452	0.091	0.057	1.131	2.317	1.145	**0.105**	0.812	**0.210**	**0.500 (C)**
385.2	21.5	3	0.5		12	35	22	0.051	1.259	4.387	4.387	0.068	0.051	1.259	2.600	1.110	**0.075**	0.777	**0.202**	**N.L. (2)**
382.7	24	7	1		12	35	28	0.059	1.406	9.961	9.961	0.113	0.059	1.406	2.904	1.100	**0.124**	0.742	**0.193**	**N.L. (2)**
380.2	26.5	6	1.1		12	35	28	0.060	1.556	8.290	8.290	0.098	0.060	1.556	3.210	1.071	**0.105**	0.709	**0.184**	**N.L. (2)**
377.7	29	10	1.1		12	35	21	0.060	1.706	13.524	13.524	0.146	0.060	1.706	3.516	1.057	**0.154**	0.678	**0.176**	**N.L. (2)**
374.7	32	3					27	0.051	1.859	3.903	3.903	0.064	0.051	1.859	3.856	1.027	**0.066**	0.645	**0.169**	**0.391 (C)**
373.2	33.5	100						0.083	1.984	######	149.848	1.096	0.083	1.984	4.074	1.027	**1.126**	0.630	**0.163**	**N.L. (3)**
371.7	35	100						0.083	2.108	######	146.143	1.069	0.083	2.108	4.292	1.002	**1.071**	0.617	**0.158**	**N.L. (3)**
370.7	36	100						0.083	2.191	######	143.771	1.051	0.083	2.191	4.437	0.987	**1.037**	0.609	**0.155**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== #6
ELEVATION OF BORING GROUND SURFACE ========== 406.00 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 0.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 0.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ===== 0.194
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 60 %
BOREHOLE DIAMETER========== 8 IN.
SAMPLING METHOD========== Sampler w/out Liners

EQ MAGNITUDE SCALING FACTOR
(MSF) = **1.000**

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **524** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 90
Ground Motion Prediction Equations = NMSZ
PGA = **0.159**

	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
404	2	17						0.066	0.132	32.130	32.130	0.768	0.066	0.132	0.257	1.500	**1.152**	0.992	**0.243**	**N.L. (3)**
402	4	16						0.065	0.262	29.038	29.038	0.412	0.065	0.262	0.512	1.500	**0.618**	0.982	**0.242**	**N.L. (3)**
400	6	12	1.5		12	35	17	0.064	0.390	19.591	19.591	0.210	0.064	0.390	0.764	1.500	**0.316**	0.971	**0.240**	**N.L. (2)**
398	8	9	1		12	35	15	0.059	0.508	13.823	13.823	0.148	0.059	0.508	1.007	1.440	**0.214**	0.958	**0.240**	**N.L. (2)**
395	11	5	1		12	35	18	0.059	0.685	7.625	7.625	0.093	0.059	0.685	1.371	1.277	**0.119**	0.935	**0.236**	**N.L. (2)**
393	13	7	1		12	35	21	0.059	0.803	10.703	10.703	0.119	0.059	0.803	1.614	1.257	**0.150**	0.917	**0.232**	**N.L. (2)**
390	16	6	1.3		12	35	22	0.062	0.989	9.055	9.055	0.105	0.062	0.989	1.987	1.188	**0.125**	0.886	**0.225**	**N.L. (2)**
388	18	7	1.3		12	35	22	0.062	1.113	10.403	10.403	0.117	0.062	1.113	2.236	1.163	**0.136**	0.864	**0.219**	**N.L. (2)**
385	21	4	0.8		12	35	28	0.057	1.284	5.796	5.796	0.078	0.057	1.284	2.594	1.108	**0.087**	0.827	**0.211**	**N.L. (2)**
383	23	4	0.7		12	35	23	0.055	1.394	5.688	5.688	0.077	0.055	1.394	2.829	1.090	**0.084**	0.802	**0.205**	**N.L. (2)**
380	26	3	0.6		12	35	35	0.053	1.553	4.142	4.142	0.066	0.053	1.553	3.175	1.064	**0.070**	0.763	**0.197**	**N.L. (2)**
377.5	28.5	7	0.7		12	35	20	0.055	1.691	9.409	9.409	0.108	0.055	1.691	3.469	1.053	**0.114**	0.732	**0.190**	**N.L. (2)**
375	31	9					25	0.060	1.841	11.738	11.738	0.129	0.060	1.841	3.775	1.035	**0.133**	0.703	**0.182**	**0.731 (D)**
373	33	100						0.083	2.007	######	148.982	1.090	0.083	2.007	4.066	1.022	**1.114**	0.682	**0.174**	**N.L. (3)**
370	36	54						0.076	2.235	76.930	76.930	0.542	0.076	2.235	4.481	0.979	**0.530**	0.653	**0.165**	**N.L. (3)**
368	38	100						0.083	2.401	######	138.029	1.008	0.083	2.401	4.772	0.952	**0.959**	0.637	**0.160**	**N.L. (3)**
366	40	100						0.083	2.567	######	133.869	0.977	0.083	2.567	5.063	0.926	**0.905**	0.622	**0.155**	**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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Appendix D:

Pile Capacity Summaries

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== North Abutment (NB)
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 416.73 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 414.73 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 ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ==========
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 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
454 KIPS	**454** KIPS	**250** KIPS	**43** FT.

PILE TYPE AND SIZE ========== Steel HP 10 X 57
Plugged Pile Perimeter========== 3.365 FT. Unplugged Pile Perimeter========== 4.883 FT.
Plugged Pile End Bearing Area========== 0.708 SQFT. Unplugged Pile End Bearing Area========== 0.117 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.)
412.73	2.00	1.00			4.8		22.6	6.9		***9.9***	10	0	0	5	4
410.73	2.00	1.80			7.3	17.9	30.9	10.6	2.9	***20.7***	21	0	0	11	6
408.73	2.00	1.90			7.6	18.8	48.4	11.0	3.1	***33.3***	33	0	0	18	8
406.23	2.50	2.90			12.6	28.8	***37.2***	18.2	4.7	47.6	37	0	0	20	11
403.73	2.50	0.50			3.3	5.0	***41.5***	4.8	0.8	52.5	41	0	0	23	13
401.23	2.50	0.60			3.9	6.0	***44.3***	5.6	1.0	58.0	44	0	0	24	16
398.73	2.50	0.50			3.3	5.0	***46.2***	4.8	0.8	62.5	46	0	0	25	18
396.23	2.50		2	Fine Sand	0.3	3.5	***58.8***	0.4	0.6	65.0	59	0	0	32	21
393.73	2.50	1.60			8.5	15.9	***63.3***	12.3	2.6	76.6	63	0	0	35	23
391.23	2.50	1.20			6.9	11.9	***64.3***	10.0	2.0	85.6	64	0	0	35	26
388.73	2.50	0.60			3.9	6.0	***74.1***	5.6	1.0	92.2	74	0	0	41	28
386.23	2.50	1.20			6.9	11.9	***77.0***	10.0	2.0	101.5	77	0	0	42	31
383.73	2.50	0.80			5.0	7.9	***82.0***	7.2	1.3	108.7	82	0	0	45	33
381.23	2.50	0.80			5.0	7.9	***86.9***	7.2	1.3	116.0	87	0	0	48	36
378.73	2.50	0.80			5.0	7.9	***91.9***	7.2	1.3	123.2	92	0	0	51	38
377.73	1.00	0.80			2.0	7.9	229.2	2.9	1.3	***148.4***	148	0	0	82	39
376.73	1.00			Sandstone	69.9	143.2	299.1	101.4	23.6	***249.8***	250	0	0	137	40
375.73	1.00			Sandstone	69.9	143.2	368.9	101.4	23.6	***351.1***	351	0	0	193	41
374.73	1.00			Sandstone	69.9	143.2	***438.8***	101.4	23.6	452.5	439	0	0	241	42
373.73	1.00			Sandstone	69.9	143.2	***508.7***	101.4	23.6	553.9	~~509~~	~~0~~	~~0~~	~~280~~	~~43~~
372.73	1.00			Sandstone	69.9	143.2	***578.5***	101.4	23.6	655.3	~~579~~	~~0~~	~~0~~	~~318~~	~~44~~
371.73	1.00			Sandstone	69.9	143.2	***648.4***	101.4	23.6	756.7	~~648~~	~~0~~	~~0~~	~~357~~	~~45~~
370.73	1.00			Sandstone		143.2			23.6						

Pile Design Table for North Abutment (NB) utilizing Boring #1-S

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
22	12	4
34	19	6
51	28	11
57	31	13
62	34	16
72	40	18
78	43	21
86	48	23
91	50	26
102	56	28
109	60	31
116	64	33
123	68	36
131	72	38
Metal Shell 14"Φ w/.25" walls		
29	16	4
43	24	6
61	33	11
68	37	13
73	40	16
86	47	18
93	51	21
103	57	23
108	59	26
121	67	28
128	71	31
137	75	33
145	80	36
154	85	38
Metal Shell 14"Φ w/.312" walls		
29	16	4
43	24	6
61	33	11
68	37	13
73	40	16
86	47	18
93	51	21
103	57	23
108	59	26
121	67	28
128	71	31
137	75	33
145	80	36
154	85	38
Metal Shell 16"Φ w/.312" walls		
37	20	4
53	29	6
70	39	11
78	43	13
84	46	16
101	55	18
109	60	21
120	66	23
124	68	26
141	77	28
148	81	31
158	87	33
167	92	36
177	97	38
Metal Shell 16"Φ w/.375" walls		
37	20	4
53	29	6
70	39	11
78	43	13
84	46	16
101	55	18
109	60	21
120	66	23
124	68	26
141	77	28
148	81	31
158	87	33
167	92	36
177	97	38
Steel HP 8 X 36		
7	4	4
16	9	6
26	14	8
29	16	11
32	18	13
35	19	16
36	20	18
45	25	21
49	27	23
51	28	26
57	32	28
60	33	31
64	35	33
68	38	36
72	40	38
114	63	39
286	157	42

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
9	5	4
20	11	6
32	18	8
36	20	11
41	22	13
43	24	16
45	25	18
57	32	21
62	34	23
63	35	26
72	40	28
75	41	31
80	44	33
85	47	36
90	49	38
142	78	39
335	184	41
Steel HP 10 X 57		
10	5	4
21	11	6
33	18	8
37	20	11
41	23	13
44	24	16
46	25	18
59	32	21
63	35	23
64	35	26
74	41	28
77	42	31
82	45	33
87	48	36
92	51	38
148	82	39
454	250	43
Steel HP 12 X 53		
11	6	4
24	13	6
38	21	8
45	25	11
50	28	13
53	29	16
55	30	18
73	40	21
77	42	26
90	49	28
92	51	31
98	54	33
104	57	36
110	61	38
170	93	39
418	230	42
Steel HP 12 X 63		
12	6	4
25	14	6
40	22	8
45	25	11
51	28	13
54	30	16
56	31	18
73	40	21
78	43	26
91	50	28
93	51	31
99	55	33
105	58	36
111	61	38
176	97	39
497	273	42
Steel HP 12 X 74		
12	7	4
25	14	6
41	22	8
46	25	11
51	28	13
55	30	16
56	31	18
75	41	21
79	43	26
92	51	28
95	52	31
101	55	33
107	59	36
113	62	38
182	100	39
589	324	43

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
13	7	4
26	14	6
42	23	8
47	26	11
52	29	13
55	30	16
57	31	18
76	42	21
80	44	26
93	51	28
96	53	31
102	56	33
108	59	36
114	63	38
186	102	39
664	365	44
Steel HP 14 X 73		
14	8	4
29	16	6
47	26	8
55	30	11
61	34	13
65	36	16
66	37	18
91	50	21
93	51	26
110	61	28
112	62	31
119	65	33
126	69	36
133	73	38
208	115	39
578	318	42
Steel HP 14 X 89		
15	8	4
30	17	6
49	27	8
55	30	11
62	34	13
65	36	16
67	37	18
92	51	21
94	52	26
111	61	28
113	62	31
120	66	33
127	70	36
134	74	38
216	119	39
705	388	43
Steel HP 14 X 102		
15	8	4
31	17	6
50	27	8
56	31	11
63	35	13
66	36	16
68	37	18
94	51	21
95	52	26
113	62	28
115	63	31
122	67	33
129	71	36
136	75	38
222	122	39
810	445	44
Steel HP 14 X 117		
16	9	4
32	18	6
51	28	8
57	31	11
64	35	13
67	37	16
69	38	18
95	52	21
96	53	26
114	63	28
116	64	31
123	68	33
130	72	36
138	76	38
230	127	39
929	511	45
Precast 14"x 14"		
37	20	4
55	30	6
77	43	11
86	47	13
93	51	16
110	60	18
119	65	21
131	72	23
137	75	26
154	85	28
163	90	31
174	96	33
185	102	36
196	108	38

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== North Abutment (NB)
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 416.73 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 414.73 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 396.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 399.00 ft

TOTAL SEISMIC SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ==========
Approx. Seismic Loading Applied per pile spaced at 8 ft. Cts ======= KIPS
Approx. Seismic Loading Applied per pile spaced at 3 ft. Cts ======= 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
929 KIPS	**929** KIPS	**804** KIPS	**45** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 117
Pile Perimeter========== 4.850 FT. Unplugged Pile Perimeter========== 7.117 FT.
Pile End Bearing Area========== 1.469 SQFT. Unplugged Pile End Bearing Area========= 0.239 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 SIDE RESIST. (KIPS)	ULTIMATE END BRG. RESIST. (KIPS)	ULTIMATE 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.)
412.73	2.00	1.00			6.9		44.0	10.1		***16.1***	16	7	8	2	4
410.73	2.00	1.80			10.5	37.1	56.6	15.5	6.0	***32.0***	32	17	19	-5	6
408.73	2.00	1.90			10.9	39.1	88.1	16.0	6.4	***51.3***	51	28	31	-8	8
406.23	2.50	2.90			18.1	59.7	***56.8***	26.6	9.7	69.9	57	46	51	-41	11
403.73	2.50	0.50			4.7	10.3	***63.6***	6.9	1.7	77.1	64	51	56	-44	13
401.23	2.50	0.60			5.6	12.4	***67.1***	8.2	2.0	85.0	67	57	63	-52	16
398.73	2.50	0.50			4.7	10.3	***68.8***	6.9	1.7	91.4	69	62	63	-55	18
396.23	2.50		2	Fine Sand	0.4	7.3	***94.9***	0.6	1.2	96.2	95	62	63	-30	21
393.73	2.50	1.60			12.2	32.9	***98.8***	17.9	5.4	112.8	99	62	63	-26	23
391.23	2.50	1.20			9.9	24.7	***96.4***	14.6	4.0	125.3	96	62	63	-28	26
388.73	2.50	0.60			5.6	12.4	***114.3***	8.2	2.0	135.5	114	62	63	-10	28
386.23	2.50	1.20			9.9	24.7	***116.0***	14.6	4.0	148.7	116	62	63	-8	31
383.73	2.50	0.80			7.2	16.5	***123.2***	10.5	2.7	159.3	123	62	63	-1	33
381.23	2.50	0.80			7.2	16.5	***130.3***	10.5	2.7	169.8	130	62	63	6	36
378.73	2.50	0.80			7.2	16.5	***137.5***	10.5	2.7	180.3	138	62	63	13	38
377.73	1.00	0.80			2.9	16.5	421.3	4.2	2.7	***230.2***	230	62	63	106	39
376.73	1.00			Sandstone	100.7	297.4	522.0	147.8	48.4	***377.9***	378	62	63	253	40
375.73	1.00			Sandstone	100.7	297.4	622.7	147.8	48.4	***525.7***	526	62	63	401	41
374.73	1.00			Sandstone	100.7	297.4	723.4	147.8	48.4	***673.4***	673	62	63	549	42
373.73	1.00			Sandstone	100.7	297.4	824.1	147.8	48.4	***821.2***	821	62	63	697	43
372.73	1.00			Sandstone	100.7	297.4	***924.8***	147.8	48.4	968.9	925	62	63	800	44
371.73	1.00			Sandstone	100.7	297.4	***1025.5***	147.8	48.4	1116.7	~~1025~~	~~62~~	~~63~~	~~901~~	~~45~~
370.73	1.00			Sandstone		297.4			48.4						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== North Abutment (SB)
REFERENCE BORING ========== 1-S and #7
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 416.73 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 414.73 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 ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ==========
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 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
335 KIPS	**335** KIPS	**184** KIPS	**42** FT.

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area========= 0.086 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.)
412.73	2.00	1.00			4.7		21.9	6.9		***9.1***	9	0	0	5	4
410.73	2.00	1.80			7.2	17.2	30.0	10.6	2.2	***19.8***	20	0	0	11	6
408.73	2.00	1.90			7.4	18.1	47.0	10.9	2.3	***31.9***	32	0	0	18	8
406.23	2.50	2.90			12.3	27.7	***36.4***	18.1	3.5	47.2	36	0	0	20	11
403.73	2.50	0.50			3.2	4.8	***40.6***	4.7	0.6	52.0	41	0	0	22	13
401.30	2.43	0.60			3.7	5.7	***43.3***	5.4	0.7	57.3	43	0	0	24	15
399.80	1.50	0.50			1.9	4.8	***44.3***	2.8	0.6	60.0	44	0	0	24	17
396.30	3.50	0.40			3.7	3.8	***47.9***	5.4	0.5	65.4	48	0	0	26	20
395.30	1.00	0.40			1.0	3.8	***49.9***	1.5	0.5	67.1	50	0	0	27	21
392.80	2.50	0.50			3.2	4.8	***55.1***	4.7	0.6	72.1	55	0	0	30	24
390.80	2.00	0.70			3.5	6.7	***57.6***	5.1	0.8	77.1	58	0	0	32	26
388.30	2.50	0.60			3.8	5.7	***65.2***	5.6	0.7	83.1	65	0	0	36	28
385.80	2.50	1.00			5.9	9.5	***66.3***	8.6	1.2	91.2	66	0	0	36	31
383.30	2.50	0.50			3.2	4.8	***74.3***	4.7	0.6	96.5	74	0	0	41	33
380.80	2.50	1.00			5.9	9.5	***76.3***	8.6	1.2	104.6	76	0	0	42	36
378.30	2.50	0.60			3.8	5.7	186.3	5.6	0.7	***123.7***	124	0	0	68	38
376.80	1.50		66	Fine Sand	9.1	111.9	221.2	13.4	14.2	***140.3***	140	0	0	77	40
375.80	1.00			Sandstone	68.5	137.7	289.7	100.9	17.4	***241.2***	241	0	0	133	40.9
374.80	1.00			Sandstone	68.5	137.7	358.2	100.9	17.4	***342.1***	~~342~~	~~0~~	~~0~~	~~188~~	~~41.9~~
373.80	1.00			Sandstone	68.5	137.7	***426.7***	100.9	17.4	442.9	~~427~~	~~0~~	~~0~~	~~235~~	~~42.9~~
372.80	1.00			Sandstone	68.5	137.7	***495.3***	100.9	17.4	543.8	~~495~~	~~0~~	~~0~~	~~272~~	~~43.9~~
371.80	1.00			Sandstone	68.5	137.7	***563.8***	100.9	17.4	644.7	~~564~~	~~0~~	~~0~~	~~310~~	~~44.9~~
370.80	1.00			Sandstone	68.5	137.7	***546.7***	100.9	17.4	734.7	~~547~~	~~0~~	~~0~~	~~301~~	~~45.9~~
370.30	0.50		41	Hard Till	0.8	52.1	***597.1***	1.2	6.6	742.1	~~597~~	~~0~~	~~0~~	~~328~~	~~46~~
369.30	1.00		80	Hard Till	4.7	101.7	***601.7***	6.9	12.9	749.0	~~602~~	~~0~~	~~0~~	~~331~~	~~47~~
368.30	1.00		80	Hard Till	4.7	101.7	***606.4***	6.9	12.9	755.9	~~606~~	~~0~~	~~0~~	~~334~~	~~48~~
367.30	1.00		80	Hard Till	4.7	101.7	***611.1***	6.9	12.9	762.8	~~611~~	~~0~~	~~0~~	~~336~~	~~49~~
366.30	1.00		80	Hard Till	4.7	101.7	***598.9***	6.9	12.9	767.6	~~599~~	~~0~~	~~0~~	~~329~~	~~50~~
365.30	1.00			Shale	41.1	84.8	***640.0***	60.5	10.7	828.1	~~640~~	~~0~~	~~0~~	~~352~~	~~51.4~~
364.30	1.00			Shale	41.1	84.8	***681.1***	60.5	10.7	888.6	~~681~~	~~0~~	~~0~~	~~375~~	~~52.4~~
363.30	1.00			Shale		84.8			10.7						

Pile Design Table for North Abutment (SB) utilizing Boring #1-S and #7

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
22	12	4
34	19	6
51	28	11
57	31	13
62	34	15
64	35	17
69	38	20
72	39	21
78	43	24
82	45	26
92	50	28
96	53	31
105	58	33
110	61	36
Metal Shell 14"Φ w/.25" walls		
29	16	4
43	24	6
61	33	11
68	37	13
73	40	15
75	41	17
81	45	20
84	46	21
92	51	24
97	53	26
108	60	28
113	62	31
124	68	33
130	71	36
Metal Shell 14"Φ w/.312" walls		
29	16	4
43	24	6
61	33	11
68	37	13
73	40	15
75	41	17
81	45	20
84	46	21
92	51	24
97	53	26
108	60	28
113	62	31
124	68	33
130	71	36
Metal Shell 16"Φ w/.312" walls		
37	20	4
53	29	6
70	39	11
78	43	13
84	46	15
87	48	17
94	52	20
97	54	21
107	59	24
112	62	26
126	69	28
130	71	31
144	79	33
149	82	36
Metal Shell 16"Φ w/.375" walls		
37	20	4
53	29	6
70	39	11
78	43	13
84	46	15
87	48	17
94	52	20
97	54	21
107	59	24
112	62	26
126	69	28
130	71	31
144	79	33
149	82	36
728	400	38
Steel HP 8 X 36		
7	4	4
16	9	6
26	14	8
29	16	11
32	18	13
35	19	15
36	20	17
39	21	20
40	22	21
44	24	24
46	25	26
52	28	28
53	29	31
59	33	33
61	34	36
100	55	38
113	62	40
286	157	43

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
9	5	4
20	11	6
32	18	8
36	20	11
41	22	13
43	24	15
44	24	17
48	26	20
50	27	21
55	30	24
58	32	26
65	36	28
66	36	31
74	41	33
76	42	36
124	68	38
140	77	40
335	184	42
Steel HP 10 X 57		
10	5	4
21	11	6
33	18	8
37	20	11
41	23	13
44	24	15
45	25	17
49	27	20
51	28	21
56	31	24
59	32	26
67	37	28
68	37	31
76	42	33
78	43	36
129	71	38
147	81	40
454	250	44
Steel HP 12 X 53		
11	6	4
24	13	6
38	21	8
45	25	11
50	28	13
53	29	15
54	30	17
59	32	20
61	34	21
68	37	24
71	39	26
81	44	28
81	44	31
92	50	33
93	51	36
148	82	38
168	93	40
418	230	43
Steel HP 12 X 63		
12	6	4
25	14	6
40	22	8
45	25	11
51	28	13
54	30	15
55	30	17
59	32	20
62	34	21
68	38	24
71	39	26
81	45	28
82	45	31
92	51	33
94	52	36
154	84	38
175	96	40
497	273	43
Steel HP 12 X 74		
12	7	4
25	14	6
41	22	8
46	25	11
51	28	13
54	30	15
55	30	17
60	33	20
63	34	21
69	38	24
72	40	26
83	45	28
83	45	31
94	52	33
95	52	36
158	87	38
180	99	40
589	324	44

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
13	7	4
26	14	6
42	23	8
47	26	11
52	29	13
55	30	15
56	31	17
61	33	20
63	35	21
70	39	24
73	40	26
84	46	31
95	52	33
97	53	36
162	89	38
185	102	40
664	365	45
Steel HP 14 X 73		
14	8	4
29	16	6
47	26	8
55	30	11
61	34	13
65	35	15
65	36	17
71	39	20
74	41	21
82	45	24
85	47	26
97	53	31
112	61	33
112	62	36
182	100	38
207	114	40
578	318	43
Steel HP 14 X 89		
15	8	4
30	17	6
49	27	8
55	30	11
62	34	13
65	36	15
66	36	17
71	39	20
75	41	21
83	46	24
86	48	26
98	54	31
113	62	33
113	62	36
188	104	38
215	118	40
705	388	44
Steel HP 14 X 102		
15	8	4
31	17	6
50	27	8
56	31	11
63	35	13
66	36	15
67	37	17
72	40	20
76	42	21
84	46	24
88	48	26
100	55	31
114	63	33
115	63	36
193	106	38
221	121	40
810	445	45
Steel HP 14 X 117		
16	9	4
32	18	6
51	28	8
57	31	11
64	35	13
67	37	15
68	37	17
73	40	20
77	42	21
86	47	24
89	49	26
101	55	31
116	64	33
116	64	36
200	110	38
228	126	40
Precast 14"x 14"		
37	20	4
55	30	6
77	43	11
86	47	13
93	51	15
96	53	17
104	57	20
107	59	21
118	65	24
124	68	26
138	76	28
144	79	31
158	87	33
165	91	36

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Center Pier - Northbound
REFERENCE BORING ========== #4
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 416.50 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 398.80 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 396.10 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ==========
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 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
335 KIPS	**335** KIPS	**182** KIPS	**52** FT.

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area========= 0.086 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.)
396.10	2.70	0.70			4.7		8.5	6.9		***7.4***	7	3	0	1	20
394.60	1.50	0.40			1.6	3.8	20.6	2.3	0.5	***11.0***	11	3	0	3	22
393.10	1.50	1.50			4.8	14.3	***15.8***	7.0	1.8	16.8	16	3	0	6	23
391.10	2.00	0.50			2.6	4.8	26.9	3.8	0.6	***21.7***	22	3	0	9	25
389.10	2.00	1.40			6.1	13.3	***25.4***	8.9	1.7	29.7	25	3	0	11	27
387.60	1.50	0.60			2.3	5.7	***26.7***	3.3	0.7	32.9	27	3	0	12	29
385.10	2.50	0.50			3.2	4.8	***29.9***	4.7	0.6	37.6	30	3	0	14	31
382.60	2.50	0.50			3.2	4.8	***39.8***	4.7	0.6	43.2	40	3	0	19	34
380.20	2.40	1.20			6.5	11.4	***39.9***	9.6	1.4	51.9	40	3	0	19	36
377.60	2.60		3	Fine Sand	0.4	5.1	***44.8***	0.6	0.6	53.2	45	3	0	22	39
375.10	2.50	1.00			5.9	9.5	***48.8***	8.6	1.2	61.5	49	3	0	24	41
371.60	3.50	0.80			6.8	7.6	132.7	10.0	1.0	***81.3***	81	3	0	42	45
370.60	1.00			Shale	41.1	84.8	181.9	60.5	10.7	***142.9***	143	3	0	76	45.9
369.60	1.00		73	Hard Till	4.0	92.8	185.9	5.8	11.7	***148.7***	149	3	0	79	47
368.60	1.00		73	Hard Till	4.0	92.8	181.8	5.8	11.7	***153.6***	154	3	0	82	48
367.60	1.00			Shale	41.1	84.8	222.9	60.5	10.7	***214.1***	214	3	0	115	48.9
366.60	1.00			Shale	41.1	84.8	***264.0***	60.5	10.7	274.6	264	3	0	143	49.9
365.60	1.00			Shale	41.1	84.8	***305.1***	60.5	10.7	335.1	305	3	0	165	50.9
364.60	1.00			Shale	41.1	84.8	***346.2***	60.5	10.7	395.6	~~346~~	~~3~~	~~0~~	~~188~~	~~51.9~~
363.60	1.00			Shale	41.1	84.8	***387.3***	60.5	10.7	456.2	~~387~~	~~3~~	~~0~~	~~210~~	~~52.9~~
362.60	1.00			Shale	41.1	84.8	***428.4***	60.5	10.7	516.7	~~428~~	~~3~~	~~0~~	~~233~~	~~53.9~~
361.60	1.00			Shale	41.1	84.8	***469.5***	60.5	10.7	577.2	~~470~~	~~3~~	~~0~~	~~256~~	~~54.9~~
360.60	1.00			Shale	41.1	84.8	***510.6***	60.5	10.7	637.7	~~511~~	~~3~~	~~0~~	~~278~~	~~55.9~~
359.60	1.00			Shale	41.1	84.8	***551.7***	60.5	10.7	698.3	~~552~~	~~3~~	~~0~~	~~301~~	~~56.9~~
358.60	1.00			Shale	41.1	84.8	***592.9***	60.5	10.7	758.8	~~593~~	~~3~~	~~0~~	~~323~~	~~57.9~~
357.60	1.00			Shale		84.8			10.7						

Pile Design Table for Center Pier - Northbound utilizing Boring ##4

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
10	2	20
21	8	23
32	14	25
34	15	27
37	16	29
42	19	31
53	25	34
63	31	39
70	34	41
320	172	45
Metal Shell 14"Φ w/.25" walls		
13	3	20
25	9	23
40	18	25
41	18	27
44	20	29
50	23	31
63	30	34
75	37	39
83	41	41
422	227	45
Metal Shell 14"Φ w/.312" walls		
13	3	20
25	9	23
40	18	25
41	18	27
44	20	29
50	23	31
63	30	34
75	37	39
83	41	41
422	227	45
Metal Shell 16"Φ w/.312" walls		
15	3	20
30	11	23
48	21	27
51	23	29
58	27	31
75	36	34
87	43	39
96	48	41
537	290	45
Metal Shell 16"Φ w/.375" walls		
15	3	20
30	11	23
48	21	27
51	23	29
58	27	31
75	36	34
87	43	39
96	48	41
537	290	45
Steel HP 8 X 36		
6	1	20
9	3	22
12	5	23
17	8	25
20	9	27
21	9	29
24	11	31
31	15	34
32	15	36
35	17	39
39	19	41
66	34	45
120	64	47
124	66	48
286	155	53

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
7	1	20
11	3	22
16	6	23
22	9	25
25	11	27
27	12	29
30	14	31
40	19	34
40	19	36
45	22	39
49	24	41
81	42	45
149	79	47
154	82	48
335	182	52
Steel HP 10 X 57		
8	2	20
12	4	22
16	6	23
22	10	25
26	12	27
27	12	29
31	14	31
41	20	34
41	20	36
46	23	39
50	25	41
86	44	45
154	82	47
158	84	48
454	247	55
Steel HP 12 X 53		
9	2	20
13	4	22
20	8	23
26	11	25
32	14	27
33	15	29
37	17	31
49	24	36
56	28	39
60	30	41
98	51	45
178	95	47
184	98	48
418	227	52
Steel HP 12 X 63		
9	2	20
14	4	22
20	8	23
27	12	25
32	15	27
34	15	29
37	17	31
50	24	36
57	28	39
61	30	41
101	53	45
183	98	47
189	101	48
497	270	54
Steel HP 12 X 74		
9	2	20
14	5	22
21	8	23
27	12	25
33	15	27
34	16	29
38	18	31
50	25	36
58	29	39
62	31	41
105	54	45
187	100	47
193	103	48
589	321	55

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
9	2	20
15	5	22
21	8	23
28	12	25
33	15	27
35	16	29
39	18	31
51	25	36
59	29	39
63	31	41
108	56	45
191	102	47
196	105	48
664	362	57
Steel HP 14 X 73		
11	2	20
16	5	22
24	10	23
32	14	25
40	18	27
41	19	29
45	21	31
60	29	36
70	35	39
74	37	41
120	62	45
217	116	47
224	119	48
578	314	53
Steel HP 14 X 89		
11	2	20
17	6	22
25	10	23
33	14	25
40	18	27
41	19	29
46	22	31
61	30	36
71	35	39
75	38	41
125	65	45
223	119	47
229	122	48
705	384	55
Steel HP 14 X 102		
11	2	20
18	6	22
25	10	23
33	14	25
41	19	27
42	19	29
47	22	31
61	30	36
71	36	39
76	38	41
129	67	45
227	121	47
233	125	48
810	442	57
Steel HP 14 X 117		
11	3	20
19	6	22
25	10	23
34	15	25
41	19	27
43	20	29
47	22	31
62	30	36
72	36	39
77	39	41
133	69	45
233	124	47
239	128	48
929	507	58
Precast 14"x 14"		
16	3	20
32	12	23
51	22	25
52	23	27
56	25	29
63	29	31
81	39	34
95	47	39
105	52	41

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== Center Pier - Southbound
REFERENCE BORING ========== #3
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 416.50 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 398.80 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 396.10 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ==========
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 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
589 KIPS	**589** KIPS	**322** KIPS	**54** FT.

PILE TYPE AND SIZE ========== Steel HP 12 X 74
Plugged Pile Perimeter========== 4.050 FT. Unplugged Pile Perimeter========== 5.908 FT.
Plugged Pile End Bearing Area========== 1.025 SQFT. Unplugged Pile End Bearing Area========== 0.151 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.)
396.40	2.40	0.40			3.1		11.7	4.5		***5.8***	6	2	0	1	20
394.40	2.00	0.60			3.7	8.6	26.9	5.4	1.3	***12.9***	13	2	0	5	22
391.40	3.00	1.40			11.1	20.1	38.1	16.3	3.0	***29.2***	29	2	0	14	25
388.90	2.50	1.40			9.3	20.1	47.3	13.5	3.0	***42.7***	43	2	0	22	28
386.90	2.00	1.40			7.4	20.1	***41.8***	10.8	3.0	51.6	42	2	0	21	30
384.90	2.00	0.50			3.2	7.2	***46.4***	4.6	1.1	56.5	46	2	0	24	32
382.90	2.00	0.60			3.7	8.6	***53.0***	5.4	1.3	62.3	53	2	0	27	34
380.90	2.00	0.80			4.8	11.5	***59.3***	7.0	1.7	69.5	59	2	0	31	36
377.90	3.00	0.90			7.9	12.9	***56.8***	11.6	1.9	79.5	57	2	0	30	39
375.40	2.50		1	Fine Sand	0.2	2.6	118.3	0.3	0.4	***88.8***	89	2	0	47	41
372.40	3.00		25	Fine Sand	5.2	63.9	165.0	7.6	9.4	***102.5***	103	2	0	55	44
370.40	2.00		55	Hard Till	6.0	105.4	193.3	8.8	15.6	***114.6***	115	2	0	61	46
369.40	1.00			Shale	50.5	127.7	243.8	73.6	18.9	***188.2***	188	2	0	102	47.1
368.40	1.00			Shale	50.5	127.7	294.2	73.6	18.9	***261.8***	262	2	0	142	48.1
367.40	1.00			Shale	50.5	127.7	344.7	73.6	18.9	***335.4***	335	2	0	183	49.1
366.40	1.00			Shale	50.5	127.7	***395.1***	73.6	18.9	409.0	395	2	0	216	50.1
365.40	1.00			Shale	50.5	127.7	***445.6***	73.6	18.9	482.6	446	2	0	243	51.1
364.40	1.00			Shale	50.5	127.7	***496.0***	73.6	18.9	556.2	496	2	0	271	52.1
363.40	1.00			Shale	50.5	127.7	***546.5***	73.6	18.9	629.8	546	2	0	299	53.1
362.40	1.00			Shale	50.5	127.7	***596.9***	73.6	18.9	703.4	~~597~~	~~2~~	~~0~~	~~327~~	~~54.1~~
361.40	1.00			Shale	50.5	127.7	***647.4***	73.6	18.9	777.0	~~647~~	~~2~~	~~0~~	~~354~~	~~55.1~~
360.40	1.00			Shale	50.5	127.7	***697.8***	73.6	18.9	850.6	~~698~~	~~2~~	~~0~~	~~382~~	~~56.1~~
359.40	1.00			Shale	50.5	127.7	***748.3***	73.6	18.9	924.2	~~748~~	~~2~~	~~0~~	~~410~~	~~57.1~~
358.40	1.00			Shale	50.5	127.7	***798.7***	73.6	18.9	997.8	~~799~~	~~2~~	~~0~~	~~438~~	~~58.1~~
357.40	1.00			Shale		127.7			18.9						

Pile Design Table for Center Pier - Southbound utilizing Boring ##3

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
9	3	20
20	9	22
34	17	25
45	23	28
46	23	30
51	26	32
57	29	34
64	33	36
71	37	39
190	103	41
291	158	44
358	195	46
Metal Shell 14"Φ w/.25" walls		
11	4	20
26	12	22
42	21	25
55	28	30
61	31	32
68	35	34
76	39	36
84	44	39
246	133	41
379	206	44
Metal Shell 14"Φ w/.312" walls		
11	4	20
26	12	22
42	21	25
55	28	30
61	31	32
68	35	34
76	39	36
84	44	39
246	133	41
379	206	44
465	254	46
Metal Shell 16"Φ w/.312" walls		
14	5	20
32	15	22
51	25	25
64	32	30
70	36	32
80	41	34
89	46	36
97	50	39
308	167	41
478	260	44
587	320	46
Metal Shell 16"Φ w/.375" walls		
14	5	20
32	15	22
51	25	25
64	32	30
70	36	32
80	41	34
89	46	36
97	50	39
308	167	41
478	260	44
587	320	46
Steel HP 8 X 36		
4	1	20
8	3	22
19	9	25
26	13	30
29	15	32
33	17	34
37	19	36
37	19	39
57	30	41
65	35	44
72	39	46
286	156	52

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
4	1	20
10	4	22
23	11	25
33	17	30
37	19	32
41	21	34
46	24	39
71	37	41
80	43	44
89	48	46
335	183	51
Steel HP 10 X 57		
5	1	20
10	4	22
24	12	25
34	17	30
37	19	32
42	22	34
47	24	39
73	39	41
84	45	44
94	50	46
454	248	54
Steel HP 12 X 53		
5	1	20
12	5	22
28	14	25
41	21	30
45	23	32
52	27	34
56	29	39
85	45	41
96	51	44
107	57	46
418	228	51
Steel HP 12 X 63		
6	1	20
12	5	22
29	14	25
41	21	30
46	23	32
52	27	34
56	29	39
87	46	41
100	53	44
111	60	46
497	272	53
Steel HP 12 X 74		
6	1	20
13	5	22
29	14	25
42	21	30
46	24	32
53	27	34
57	30	39
89	47	41
103	55	44
115	61	46
589	322	54

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
6	2	20
13	6	22
30	15	25
42	22	30
47	24	32
54	28	34
58	30	39
90	48	41
105	56	44
118	63	46
664	364	56
Steel HP 14 X 73		
7	2	20
15	6	22
34	17	25
50	25	28
50	25	30
55	29	32
64	33	34
66	35	39
103	55	41
118	63	44
132	70	46
578	316	52
Steel HP 14 X 89		
7	2	20
15	6	22
35	17	25
51	26	30
56	29	32
65	33	34
67	35	39
106	56	41
122	65	44
137	73	46
705	386	54
Steel HP 14 X 102		
7	2	20
16	7	22
35	17	25
51	26	30
57	29	32
65	34	34
68	35	39
108	57	41
125	67	44
140	75	46
810	443	56
Steel HP 14 X 117		
7	2	20
17	7	22
36	18	25
52	26	30
58	30	32
66	34	34
69	36	39
111	59	41
129	69	44
145	78	46
929	509	58
Precast 14"x 14"		
15	5	20
33	15	22
53	26	25
70	35	30
77	39	32
87	45	34
97	50	36
106	55	39

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== South Abutment (NB)
REFERENCE BORING ========== 2-S and #1
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 416.33 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 414.33 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ==========
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 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
929 KIPS	**929** KIPS	**511** KIPS	**60** FT.

PILE TYPE AND SIZE ========== Steel HP 14 X 117
Pile Perimeter========== 4.850 FT. Unplugged Pile Perimeter========== 7.117 FT.
Pile End Bearing Area========== 1.469 SQFT. Unplugged Pile End Bearing Area========= 0.239 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 SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
413.90	0.43	0.25			0.4		15.9	0.6		***3.1***	3	0	0	2	2
411.40	2.50	0.75			6.8	15.4	23.3	9.9	2.5	***13.2***	13	0	0	7	5
408.90	2.50	0.78			7.0	16.1	90.4	10.3	2.6	***33.2***	33	0	0	18	7
406.40	2.50	3.70	5		21.7	76.2	***51.9***	31.8	12.4	55.2	52	0	0	29	10
403.90	2.50	0.78			7.0	16.1	***51.1***	10.3	2.6	64.2	51	0	0	28	12
401.40	2.50	0.40			3.8	8.2	***55.0***	5.6	1.3	69.9	55	0	0	30	15
399.60	1.80	0.40			2.8	8.2	***57.7***	4.1	1.3	74.0	58	0	0	32	17
397.60	2.00	0.40			3.1	8.2	***64.9***	4.5	1.3	79.1	65	0	0	36	19
394.80	2.80	0.60			6.2	12.4	***83.5***	9.2	2.0	90.3	84	0	0	46	22
392.30	2.50	1.20			9.9	24.7	***85.2***	14.6	4.0	103.6	85	0	0	47	24
389.80	2.50	0.80			7.2	16.5	***94.4***	10.5	2.7	114.4	94	0	0	52	27
387.30	2.50	0.90			7.9	18.5	***102.3***	11.6	3.0	126.0	102	0	0	56	29
384.80	2.50	0.90			7.9	18.5	***110.2***	11.6	3.0	137.6	110	0	0	61	32
382.30	2.50	0.90			7.9	18.5	***118.2***	11.6	3.0	149.2	118	0	0	65	34
379.80	2.50	0.90			7.9	18.5	***126.1***	11.6	3.0	160.8	126	0	0	69	37
377.30	2.50	0.90			7.9	18.5	***150.4***	11.6	3.0	175.1	150	0	0	83	39
374.30	3.00	1.70			15.2	35.0	226.8	22.4	5.7	***207.4***	207	0	0	114	42
371.30	3.00		35	Very Fine Silty Sand	8.2	96.1	***182.7***	12.0	15.6	210.8	183	0	0	100	45
368.80	2.50	2.13			14.7	43.9	***197.4***	21.6	7.1	232.4	197	0	0	109	48
367.80	1.00	2.13			5.9	43.9	***203.3***	8.6	7.1	241.0	203	0	0	112	49
366.80	1.00	2.13			5.9	43.9	348.3	8.6	7.1	***272.3***	272	0	0	150	50
365.80	1.00			Shale	60.4	183.0	408.7	88.7	29.8	***360.9***	361	0	0	199	50.5
364.80	1.00			Shale	60.4	183.0	469.1	88.7	29.8	***449.6***	450	0	0	247	51.5
363.80	1.00			Shale	60.4	183.0	***529.6***	88.7	29.8	538.2	530	0	0	291	52.5
362.80	1.00			Shale	60.4	183.0	***590.0***	88.7	29.8	626.9	590	0	0	324	53.5
361.80	1.00			Shale	60.4	183.0	***650.4***	88.7	29.8	715.5	650	0	0	358	54.5
360.80	1.00			Shale	60.4	183.0	***710.8***	88.7	29.8	804.2	711	0	0	391	55.5
359.80	1.00			Shale	60.4	183.0	***771.2***	88.7	29.8	892.8	771	0	0	424	56.5
358.80	1.00			Shale	60.4	183.0	***831.6***	88.7	29.8	981.5	832	0	0	457	57.5
357.80	1.00			Shale	60.4	183.0	***892.1***	88.7	29.8	1070.2	892	0	0	491	58.5
356.80	1.00			Shale	60.4	183.0	***952.5***	88.7	29.8	1158.8	~~952~~	~~0~~	~~0~~	~~524~~	~~59.5~~
355.80	1.00			Shale		183.0			29.8						

Pile Design Table for South Abutment (NB) utilizing Boring #2-S and #1

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
7	4	2
14	8	5
43	24	10
47	26	12
51	28	15
54	29	17
58	32	19
70	38	22
77	42	24
85	47	27
93	51	29
101	55	32
109	60	34
117	64	37
132	72	39
178	98	45
192	106	48
198	109	49
Metal Shell 14"Φ w/.25" walls		
9	5	2
18	10	5
52	28	10
55	30	12
60	33	15
63	35	17
69	38	19
84	46	22
91	50	24
100	55	27
110	60	29
119	65	32
128	71	34
138	76	37
156	86	39
211	116	45
228	125	48
235	129	49
Metal Shell 14"Φ w/.312" walls		
9	5	2
18	10	5
52	28	10
55	30	12
60	33	15
63	35	17
69	38	19
84	46	22
91	50	24
100	55	27
110	60	29
119	65	32
128	71	34
138	76	37
156	86	39
211	116	45
228	125	48
235	129	49
554	304	50
Metal Shell 16"Φ w/.312" walls		
12	7	2
22	12	5
60	33	10
64	35	12
69	38	15
73	40	17
80	44	19
98	54	22
105	58	24
116	64	27
127	70	29
138	76	32
148	82	34
159	88	37
182	100	39
245	135	45
265	146	48
273	150	49
Metal Shell 16"Φ w/.375" walls		
12	7	2
22	12	5
60	33	10
64	35	12
69	38	15
73	40	17
80	44	19
98	54	22
105	58	24
116	64	27
127	70	29
138	76	32
148	82	34
159	88	37
182	100	39
245	135	45
265	146	48
273	150	49
688	378	50
Steel HP 8 X 36		
1	1	2
7	4	5
15	8	7
25	14	10
26	15	12
29	16	15
30	17	17
33	18	19
40	22	22
43	24	24
48	26	27
52	29	29
57	31	32
61	34	34
65	36	37
75	41	39
91	50	45
99	54	48
102	56	49
142	78	50
286	157	55

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
1	1	2
8	4	5
19	10	7
32	18	10
33	18	12
36	20	15
37	21	17
41	23	19
51	28	22
54	30	24
60	33	27
66	36	29
71	39	32
76	42	34
82	45	37
95	52	39
115	63	45
125	69	48
129	71	49
176	97	50
335	184	54
Steel HP 10 X 57		
2	1	2
9	5	5
20	11	7
33	18	10
34	19	12
36	20	15
38	21	17
42	23	19
53	29	22
56	31	24
62	34	27
67	37	29
73	40	32
78	43	34
84	46	37
97	53	39
117	65	45
128	70	48
132	72	49
181	100	50
454	250	56
Steel HP 12 X 53		
2	1	2
10	5	5
23	12	7
40	22	10
41	22	12
44	24	15
46	25	17
51	28	19
65	36	22
67	37	24
74	41	27
81	45	29
87	48	32
94	52	34
100	55	37
118	65	39
143	79	45
155	85	48
160	88	49
211	116	50
418	230	54
Steel HP 12 X 63		
2	1	2
10	6	5
24	13	7
41	22	10
41	23	12
44	24	15
46	26	17
52	28	19
65	36	22
68	37	24
75	41	27
82	45	29
88	49	32
95	52	34
101	56	37
119	65	39
144	79	45
156	86	48
161	89	49
216	119	50
497	273	55
Steel HP 12 X 74		
2	1	2
10	6	5
25	14	7
41	23	10
42	23	12
45	25	15
47	26	17
53	29	19
66	36	22
69	38	24
76	42	27
83	46	29
90	49	32
96	53	34
103	56	37
121	66	39
147	81	45
159	87	48
164	90	49
220	121	50
589	324	57

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
2	1	2
11	6	5
26	14	7
42	23	10
42	23	12
45	25	15
48	26	17
53	29	19
67	37	22
70	38	24
77	43	27
84	46	29
91	50	32
97	54	34
104	57	37
123	67	39
149	82	45
161	89	48
166	91	49
224	123	50
664	365	58
Steel HP 14 X 73		
2	1	2
12	7	5
28	15	7
49	27	12
53	29	15
56	31	17
63	34	19
80	44	22
82	45	24
91	50	27
99	54	29
106	58	32
114	63	34
122	67	37
145	80	39
176	97	45
190	104	48
196	108	49
256	141	50
578	318	55
Steel HP 14 X 89		
3	1	2
12	7	5
30	17	7
50	27	12
54	30	15
56	31	17
63	35	19
81	45	22
83	46	24
92	51	27
100	55	29
108	59	32
115	63	34
123	68	37
147	81	39
178	98	45
192	106	48
198	109	49
262	144	50
705	388	57
Steel HP 14 X 102		
3	2	2
13	7	5
31	17	7
50	28	12
54	30	15
57	31	17
64	35	19
82	45	22
84	46	24
93	51	27
101	56	29
109	60	32
117	64	34
125	69	37
149	82	39
180	99	45
195	107	48
201	110	49
266	147	50
810	445	58
Steel HP 14 X 117		
3	2	2
13	7	5
33	18	7
51	28	12
55	30	15
58	32	17
65	36	19
84	46	22
85	47	24
94	52	27
102	56	29
110	61	32
118	65	34
126	69	37
150	83	39
183	100	45
197	109	48
203	112	49
272	150	50
929	511	60
Precast 14"x 14"		
12	7	2
22	12	5
66	36	10
71	39	12
76	42	15
81	44	17
88	48	19
106	59	22
115	64	24
128	70	27
140	77	29
152	83	32
163	90	34
175	96	37
199	110	39

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== South Abutment (SB)
REFERENCE BORING ========== 2-S and #2
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 416.33 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 414.33 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ==========
Approx. Factored Loading Applied per pile at 8 ft. Cts ========== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ========== 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
286 KIPS	**286** KIPS	**157** KIPS	**52** FT.

PILE TYPE AND SIZE ========== Steel HP 8 X 36
Plugged Pile Perimeter========== 2.695 FT. Unplugged Pile Perimeter========== 3.892 FT.
Plugged Pile End Bearing Area========== 0.454 SQFT. Unplugged Pile End Bearing Area========= 0.074 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
413.90	0.43	0.25			0.2		5.0	0.3		***1.1***	1	0	0	1	2
411.40	2.50	0.75			3.8	4.8	9.0	5.4	0.8	***6.6***	7	0	0	4	5
408.90	2.50	0.78			3.9	5.0	31.4	5.6	0.8	***15.2***	15	0	0	8	7
406.40	2.50	3.70	5		12.0	23.5	***24.9***	17.4	3.8	29.6	25	0	0	14	10
403.90	2.50	0.78			3.9	5.0	***24.7***	5.6	0.8	34.5	25	0	0	14	12
400.90	3.00		1	Very Fine Silty Sand	0.1	0.8	***25.9***	0.2	0.1	34.9	26	0	0	14	15
398.90	2.00	0.30			1.3	1.9	***30.3***	1.9	0.3	37.3	30	0	0	17	17
397.40	1.50	0.80			2.4	5.1	***31.5***	3.4	0.8	40.5	31	0	0	17	19
394.90	2.50	0.60			3.1	3.8	***35.8***	4.5	0.6	45.2	36	0	0	20	21
391.90	3.00	0.80			4.8	5.1	***38.7***	6.9	0.8	51.8	39	0	0	21	24
388.90	3.00	0.50			3.2	3.2	***42.5***	4.6	0.5	56.4	42	0	0	23	27
385.90	3.00	0.60			3.7	3.8	***44.3***	5.4	0.6	61.5	44	0	0	24	30
383.90	2.00	0.30			1.3	1.9	***47.5***	1.9	0.3	63.7	48	0	0	26	32
381.90	2.00	0.60			2.5	3.8	***54.4***	3.6	0.6	68.0	54	0	0	30	34
380.40	1.50	1.30			3.5	8.3	***54.1***	5.1	1.3	72.5	54	0	0	30	36
378.40	2.00	0.70			2.8	4.5	***57.0***	4.1	0.7	76.6	57	0	0	31	38
376.40	2.00	0.70			2.8	4.5	***72.5***	4.1	0.7	82.7	73	0	0	40	40
373.40	3.00	2.70			11.5	17.2	149.1	16.6	2.8	***109.8***	110	0	0	60	43
372.40	1.00		97	Hard Till	5.5	82.3	153.7	7.9	13.3	***117.6***	118	0	0	65	44
371.40	1.00		96	Hard Till	5.4	81.4	159.1	7.8	13.2	***125.4***	125	0	0	69	45
370.40	1.00		96	Hard Till	5.4	81.4	164.5	7.8	13.2	***133.2***	133	0	0	73	46
369.90	0.50		96	Hard Till	2.7	81.4	167.2	3.9	13.2	***137.0***	137	0	0	75	46
368.90	1.00		96	Hard Till	5.4	81.4	147.7	7.8	13.2	***140.8***	141	0	0	77	47
367.90	1.00			Shale	33.6	56.5	***181.2***	48.5	9.2	189.2	181	0	0	100	48.4
366.90	1.00			Shale	33.6	56.5	***214.8***	48.5	9.2	237.7	215	0	0	118	49.4
365.90	1.00			Shale	33.6	56.5	***248.4***	48.5	9.2	286.2	248	0	0	137	50.4
364.90	1.00			Shale	33.6	56.5	***282.0***	48.5	9.2	334.7	282	0	0	155	51.4
363.90	1.00			Shale	33.6	56.5	***315.5***	48.5	9.2	383.2	~~316~~	~~0~~	~~0~~	~~174~~	~~52.4~~
362.90	1.00			Shale	33.6	56.5	***349.1***	48.5	9.2	431.6	~~349~~	~~0~~	~~0~~	~~192~~	~~53.4~~
361.90	1.00			Shale	33.6	56.5	***382.7***	48.5	9.2	480.1	~~383~~	~~0~~	~~0~~	~~210~~	~~54.4~~
360.90	1.00			Shale	33.6	56.5	***416.3***	48.5	9.2	528.6	~~416~~	~~0~~	~~0~~	~~229~~	~~55.4~~
359.90	1.00			Shale	33.6	56.5	***449.8***	48.5	9.2	577.1	~~450~~	~~0~~	~~0~~	~~247~~	~~56.4~~
358.90	1.00			Shale	33.6	56.5	***483.4***	48.5	9.2	625.6	~~483~~	~~0~~	~~0~~	~~266~~	~~57.4~~
357.90	1.00			Shale		56.5			9.2						

Pile Design Table for South Abutment (SB) utilizing Boring #2-S and #2

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
7	4	2
14	8	5
43	24	10
47	26	15
53	29	17
56	31	19
63	35	21
70	38	24
76	42	27
80	44	30
85	47	32
96	53	34
97	53	36
102	56	38
125	69	40
Metal Shell 14"Φ w/.25" walls		
9	5	2
18	10	5
52	28	10
55	30	15
64	35	17
66	37	19
75	41	21
82	45	24
90	49	27
94	52	30
101	55	32
114	63	34
115	63	36
121	66	38
150	83	40
Metal Shell 14"Φ w/.312" walls		
9	5	2
18	10	5
52	28	10
55	30	15
64	35	17
66	37	19
75	41	21
82	45	24
90	49	27
94	52	30
101	55	32
114	63	34
115	63	36
121	66	38
150	83	40
Metal Shell 16"Φ w/.312" walls		
12	7	2
22	12	5
60	33	10
64	35	15
74	41	17
77	42	19
88	48	21
95	52	24
104	57	27
108	60	30
116	64	32
132	73	36
139	77	38
177	97	40
Metal Shell 16"Φ w/.375" walls		
12	7	2
22	12	5
60	33	10
64	35	15
74	41	17
77	42	19
88	48	21
95	52	24
104	57	27
108	60	30
116	64	32
132	73	36
139	77	38
177	97	40
Steel HP 8 X 36		
1	1	2
7	4	5
15	8	7
25	14	12
26	14	15
30	17	17
31	17	19
36	20	21
39	21	24
42	23	27
44	24	30
48	26	32
54	30	36
57	31	38
73	40	40
110	60	43
118	65	44
125	69	45
133	73	46
137	75	46
141	77	47
286	157	52

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
1	1	2
8	4	5
19	10	7
30	17	12
32	18	15
39	21	17
40	22	19
45	25	21
48	27	24
53	29	27
55	30	30
59	33	32
68	37	36
71	39	38
94	51	40
136	75	43
146	80	44
156	86	45
165	91	46
170	94	46
175	96	47
335	184	51
Steel HP 10 X 57		
2	1	2
9	5	5
20	11	7
31	17	12
33	18	15
39	22	17
40	22	19
46	25	21
49	27	24
54	30	27
56	31	30
60	33	32
69	38	36
73	40	38
96	53	40
142	78	43
152	84	44
162	89	45
171	94	46
176	97	46
180	99	47
454	250	54
Steel HP 12 X 53		
2	1	2
10	5	5
23	12	7
37	20	12
39	22	15
48	27	17
49	27	19
56	31	21
59	33	24
65	36	27
67	37	30
73	40	32
83	46	36
87	48	38
119	65	40
163	90	43
175	96	44
187	103	45
198	109	46
204	112	46
210	115	47
418	230	51
Steel HP 12 X 63		
2	1	2
10	6	5
24	13	7
37	20	12
40	22	15
49	27	17
49	27	19
57	31	21
60	33	24
66	36	27
67	37	30
73	40	32
84	46	36
88	48	38
120	66	40
169	93	43
181	99	44
193	106	45
204	112	46
210	116	46
215	118	47
497	273	52
Steel HP 12 X 74		
2	1	2
10	6	5
25	14	7
38	21	12
40	22	15
49	27	17
50	28	19
58	32	21
61	33	24
67	37	27
68	37	30
74	41	32
85	47	36
89	49	38
122	67	40
174	96	43
186	102	44
197	109	45
209	115	46
215	118	46
219	120	47
589	324	54

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
2	1	2
11	6	5
26	14	7
38	21	12
41	22	15
50	28	17
51	28	19
59	32	21
61	34	24
68	37	27
69	38	30
75	41	32
86	47	36
90	50	38
124	68	40
178	98	43
190	105	44
202	111	45
214	118	46
220	121	46
222	122	47
664	365	55
Steel HP 14 X 73		
2	1	2
12	7	5
28	15	7
44	24	12
48	26	15
60	33	17
60	33	19
69	38	21
72	39	24
79	43	27
80	44	30
88	48	32
100	55	36
105	58	38
149	82	40
200	110	43
214	118	44
228	125	45
242	133	46
249	137	46
254	140	47
578	318	52
Steel HP 14 X 89		
3	1	2
12	7	5
30	17	7
45	25	12
48	26	15
60	33	17
61	33	19
70	38	21
72	40	24
80	44	27
81	44	30
89	49	32
101	56	36
106	59	38
151	83	40
207	114	43
221	122	44
235	129	45
249	137	46
256	141	46
260	143	47
705	388	54
Steel HP 14 X 102		
3	2	2
13	7	5
31	17	7
45	25	12
49	27	15
61	34	17
61	34	19
71	39	21
73	40	24
81	45	27
82	45	30
90	49	32
103	56	36
108	59	38
153	84	40
213	117	43
227	125	44
241	132	45
255	140	46
262	144	46
265	146	47
810	445	55
Steel HP 14 X 117		
3	2	2
13	7	5
33	18	7
46	25	12
49	27	15
62	34	17
62	34	19
72	39	21
74	41	24
82	45	27
82	45	30
91	50	32
104	57	36
109	60	38
155	85	40
220	121	43
234	129	44
248	136	45
262	144	46
269	148	46
270	149	47
929	511	57
Precast 14"x 14"		
12	7	2
22	12	5
66	36	10
70	39	15
81	45	17
85	47	19
96	53	21
104	57	24
115	63	27
120	66	30
128	70	32
145	80	34
146	80	36
154	84	38
191	105	40

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE========== South Abutment (SB)
REFERENCE BORING ========== 2-S and #2
LRFD or ASD or SEISMIC ========== SEISMIC
PILE CUTOFF ELEV. ========== 416.33 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 414.33 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== Liquef.
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========== 399.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== 404.00 ft

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

PILE TYPE AND SIZE ========== Steel HP 8 X 36
Plugged Pile Perimeter========== 2.695 FT. Unplugged Pile Perimeter========== 3.892 FT.
Plugged Pile End Bearing Area========== 0.454 SQFT. Unplugged Pile End Bearing Area========= 0.074 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Seismic Resistance Available in Boring	Maximum Pile Driveable Length in Boring
286 KIPS	**286** KIPS	**240** KIPS	**52** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	ULTIMATE PLUGGED SIDE RESIST. (KIPS)	ULTIMATE PLUGGED END BRG. RESIST. (KIPS)	ULTIMATE PLUGGED TOTAL RESIST. (KIPS)	ULTIMATE UNPLUGGED SIDE RESIST. (KIPS)	ULTIMATE UNPLUGGED END BRG. RESIST. (KIPS)	ULTIMATE UNPLUGGED TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	NOMINAL GEOTECH. LOSS FROM LIQUEF. & DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	SEISMIC RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
413.90	0.43	0.25			0.2		5.0	0.3		***1.1***	1	0	0	1	2
411.40	2.50	0.75			3.8	4.8	9.0	5.4	0.8	***6.6***	7	4	4	-2	5
408.90	2.50	0.78			3.9	5.0	31.4	5.6	0.8	***15.2***	15	8	9	-1	7
406.40	2.50	3.70	5		12.0	23.5	***24.9***	17.4	3.8	29.6	25	20	22	-17	10
403.90	2.50	0.78			3.9	5.0	***24.7***	5.6	0.8	34.5	25	24	22	-21	12
400.90	3.00		1	Very Fine Silty Sand	0.1	0.8	***25.9***	0.2	0.1	34.9	26	24	22	-20	15
398.90	2.00	0.30			1.3	1.9	***30.3***	1.9	0.3	37.3	30	24	22	-16	17
397.40	1.50	0.80			2.4	5.1	***31.5***	3.4	0.8	40.5	31	24	22	-14	19
394.90	2.50	0.60			3.1	3.8	***35.8***	4.5	0.6	45.2	36	24	22	-10	21
391.90	3.00	0.80			4.8	5.1	***38.7***	6.9	0.8	51.8	39	24	22	-7	24
388.90	3.00	0.50			3.2	3.2	***42.5***	4.6	0.5	56.4	42	24	22	-3	27
385.90	3.00	0.60			3.7	3.8	***44.3***	5.4	0.6	61.5	44	24	22	-2	30
383.90	2.00	0.30			1.3	1.9	***47.5***	1.9	0.3	63.7	48	24	22	2	32
381.90	2.00	0.60			2.5	3.8	***54.4***	3.6	0.6	68.0	54	24	22	9	34
380.40	1.50	1.30			3.5	8.3	***54.1***	5.1	1.3	72.5	54	24	22	8	36
378.40	2.00	0.70			2.8	4.5	***57.0***	4.1	0.7	76.6	57	24	22	11	38
376.40	2.00	0.70			2.8	4.5	***72.5***	4.1	0.7	82.7	73	24	22	27	40
373.40	3.00	2.70			11.5	17.2	149.1	16.6	2.8	***109.8***	110	24	22	64	43
372.40	1.00		97	Hard Till	5.5	82.3	153.7	7.9	13.3	***117.6***	118	24	22	72	44
371.40	1.00		96	Hard Till	5.4	81.4	159.1	7.8	13.2	***125.4***	125	24	22	79	45
370.40	1.00		96	Hard Till	5.4	81.4	164.5	7.8	13.2	***133.2***	133	24	22	87	46
369.90	0.50		96	Hard Till	2.7	81.4	167.2	3.9	13.2	***137.0***	137	24	22	91	46
368.90	1.00		96	Hard Till	5.4	81.4	147.7	7.8	13.2	***140.8***	141	24	22	95	47
367.90	1.00			Shale	33.6	56.5	***181.2***	48.5	9.2	189.2	181	24	22	135	48.4
366.90	1.00			Shale	33.6	56.5	***214.8***	48.5	9.2	237.7	215	24	22	169	49.4
365.90	1.00			Shale	33.6	56.5	***248.4***	48.5	9.2	286.2	248	24	22	202	50.4
364.90	1.00			Shale	33.6	56.5	***282.0***	48.5	9.2	334.7	282	24	22	236	51.4
363.90	1.00			Shale	33.6	56.5	***315.5***	48.5	9.2	383.2	~~316~~	~~24~~	~~22~~	~~270~~	~~52.4~~
362.90	1.00			Shale	33.6	56.5	***349.1***	48.5	9.2	431.6	~~349~~	~~24~~	~~22~~	~~303~~	~~53.4~~
361.90	1.00			Shale	33.6	56.5	***382.7***	48.5	9.2	480.1	~~383~~	~~24~~	~~22~~	~~337~~	~~54.4~~
360.90	1.00			Shale	33.6	56.5	***416.3***	48.5	9.2	528.6	~~416~~	~~24~~	~~22~~	~~370~~	~~55.4~~
359.90	1.00			Shale	33.6	56.5	***449.8***	48.5	9.2	577.1	~~450~~	~~24~~	~~22~~	~~404~~	~~56.4~~
358.90	1.00			Shale	33.6	56.5	***483.4***	48.5	9.2	625.6	~~483~~	~~24~~	~~22~~	~~437~~	~~57.4~~
357.90	1.00			Shale		56.5			9.2						