REPORT TRANSMITTAL

February 17, 2022

To: **Greg Osborne, PE, LEED AP**
Vice President, Director of Civil Engineering
EPSTEIN
600 West Fulton Street
Chicago, Illinois 60661-1259
D +1-312-429-8272
C +1-312-330-8414

Re: **Structure Geotechnical Report**
Proposed IL Route 31 Bridge Replacement
IL Route 31 over US Route 20
Elgin, Illinois

Rubino Report No. G19.073_REV3

Via email: gosborne@epsteinglobal.com

Dear Mr. Osborne,

Rubino Engineering, Inc. (Rubino) is pleased to submit our Structure Geotechnical Report for the proposed IL Route 31 Bridge Replacement in Elgin, Illinois.

Report Description

Enclosed is the Structure Geotechnical Report including results of field and laboratory testing, as well as recommendations for foundation design and general site development.

Authorization and Correspondence History

- Rubino Proposal No. Q18.395g REV4 dated October 22, 2018; Authorized via subconsultant agreement, signed by Greg Osborne of A. Epstein and Sons International, Inc. (Epstein) on May 6, 2019
- This report has been revised to address comments from IDOT dated January 21, 2020 and June 17, 2020

Closing

Rubino appreciates the opportunity to provide geotechnical services for this project and we look forward to continued participation during the design and in future construction phases of this project.

If you have questions pertaining to this report, or if Rubino may be of further service, please contact our office at (847) 931-1555.

Respectfully submitted,
RUBINO ENGINEERING, INC.

Michelle A. Lipinski, PE
President

michelle.lipinski@rubinoeng.com
MAL/file/ Enclosures

Proposed IL Route 31 Bridge Replacement

SN 045-2106
F.A.U. Route 3887
Section BR-HB-3
Station 53+25.43

Elgin, Illinois

Rubino Project No. G19.073_REV3

Structure Geotechnical Report (SGR)

Drilling
Laboratory Testing
Geotechnical Analysis

Prepared By:
Aimee Ritchie, PE

Rubino Engineering Inc.

Michelle A. Lipinski, PE
President
IL No. 062-061241, Exp. 11/30/23

Prepared For:

A. Epstein and Sons International, Inc.

600 West Fulton Street

Chicago, Illinois 60661-1259

February 17, 2022

TABLE OF CONTENTS

PROJECT DESCRIPTION AND SCOPE

Rubino Engineering, Inc. (Rubino) understands that IDOT is planning to replace the bridge supporting IL 31 over US 20 in Elgin, Illinois. The bridge and ramp intersections will be reconstructed with left turn lanes added and increased lateral and vertical clearance on US 20 under IL 31. Pedestrian and bicyclist accommodations are proposed, including a 10-foot wide shared-use path on the west side of IL 31 and a 7-foot wide sidewalk on the east side. The bridge design will include an integral abutment at each end and a center pier between the lanes of US-20. The profile grade will be raised approximately 2 feet.

Purpose / Scope of Services

The purpose of this study was to explore the subsurface conditions at the site in order to prepare geotechnical recommendations for foundation design and general site development for the proposed bridge replacement. Rubino's scope of services included the following drilling program:

Table 1: Drilling Scope

BORING NUMBER	DEPTH (FEET BEG*)	LOCATION
B-01	75	South Abutment, East Side
B-02	70	Center Pier, West Side
B-03	75	North Abutment, West Side

*BEG = Below existing grade

Representative soil samples obtained during the field exploration program were transported to the laboratory for additional classification and laboratory testing.

This report briefly outlines the following:

- *Summary of client-provided project information and report basis*
- *Overview of encountered subsurface conditions*
    - *IDOT Format Boring Logs, Boring Location Plan, Site Vicinity Map*
- *Overview of field and laboratory tests performed including results*
- *Geotechnical recommendations pertaining to:*
    - *Subgrade preparation and cut / fill recommendations*
    - *Deep Foundations, including suitable foundation type(s), LRFD pile capacities, and estimated settlement*
    - *Seismic design site classification parameters*
- *Construction considerations, including temporary excavation and construction control of water*

An electronic copy of the report will be provided. The report will be addressed to Epstein.

Summary of Geotechnical Considerations

The main geotechnical design and construction considerations at this site are:

- **Free groundwater was observed** within the borings during drilling. See *Groundwater Conditions* section for more information.

- **Driven Pile Foundations** are recommended for this site. See *Deep Foundation Recommendations – Driven Metal Shell Piles and H-Piles* section for more detailed information.

    - Additional measures may need to be taken for driven piles into dense sand for integral abutments. See *Lateral Loads and Integral Abutments* section and the Bridge Manual for more information.

- **Shallow Foundations** are a possible option for support of the center pier. See *Shallow Foundation Recommendations – Center Pier* section for more detailed information.

Drilling, Field, and Laboratory Test Procedures

Epstein selected the number of borings and the boring depths. Rubino located the borings in the field by measuring distances from known fixed site features. Rubino and Wang Engineering Inc. (Wang) mobilized to the site on July 2, July 3, July 16, and July 17, 2019. The borings were advanced by Wang using a Diedrich D-50 with 3 ¼ inch inside-diameter hollow stem augers and automatic hammer. Soil samples were routinely obtained during the drilling process.

Selected soil samples were tested in the laboratory to determine material properties for this report. Drilling, sampling, and laboratory tests were accomplished in general accordance with AASHTO procedures. The following items are further described in the Appendix of this report.

- *Field Penetration Tests and Split-Barrel Sampling of Soils (AASHTO T 206)*
- *Field Water Level Measurements*
- *Laboratory Determination of Water (Moisture) Content of Soil by Mass (AASHTO T 265-15)*
- *Laboratory Organic Content by Loss on Ignition (AASHTO T 267-86)*

The laboratory testing program was conducted in general accordance with applicable AASHTO specifications. The results of these tests are to be found on the accompanying boring logs located in the Appendix.

SITE AND SUBSURFACE CONDITIONS

Site Location and Bridge Description

The IL Route 31 bridge over US Route 20 is located in Elgin, Illinois approximately four tenths of a mile west of the Fox River. The bridge is oriented north-south. The existing bridge structure was built in 1959 and consists of a simple span steel WF beam bridge with back to back abutments, out to out deck, and closed abutments on spread footings. The proposed bridge will consist of integral abutments that will encase the beam ends. The encased beam ends will be tied to the bottom part of the abutment with reinforcing.

The midpoint of the project site has an approximate latitude and longitude of 42.021951°N and 88.283405°W, respectively.

Groundwater Conditions

Groundwater was encountered in the borings during drilling operations. The following table summarizes groundwater observations from the field:

Table 2: Groundwater Observation Summary

Boring Number	Groundwater Elevation during drilling (Feet)	Groundwater Elevation upon auger removal (Feet)
B-01	703.2	716.7
B-02	703.7	702.2
B-03	702.6	N/A*

*Water was used during drilling operations in boring B-03 to combat heaving sands, therefore a groundwater elevation upon completion of the boring was not obtainable.

It should be noted that fluctuations in the groundwater level should be anticipated throughout the year depending on variations in climatological conditions and other factors not apparent at the time the borings were performed. The possibility of groundwater level fluctuation should be considered when developing the design and construction plans for the project. When bidding this project, the contractor should anticipate that groundwater will be present.

Undocumented Fill Discussion

Undocumented fill is defined as fill that has been placed without being documented as to its placed density and moisture content.

Deleterious materials could include, but are not limited to, bricks, asphalt, concrete, metal, wood, or other building debris.

Undocumented fill and possible fill materials were observed in the borings at depths ranging from about 4 ½ to 6 feet below existing grade. Undocumented fill was likely placed during original site development.

Deleterious materials, such as concrete were observed within the undocumented fill materials in boring B-03 during the drilling operations. Although deleterious materials were not encountered in all the undocumented fill materials, this does not eliminate the possibility that deleterious materials could be present within the undocumented fill materials at other locations along the project. The presence of deleterious materials could impact installation of the foundations during construction.

Topsoil Discussion

Topsoil materials as described in this report have not been analyzed for quality according to any minimum specifications. If topsoil is to be imported to or exported from this site, Rubino recommends that it meet the minimum specifications defined in **Section 1081.05** of the, “Standard Specifications for Road and Bridge Construction,” adopted by the Illinois Department of Transportation, April 1st, 2016.

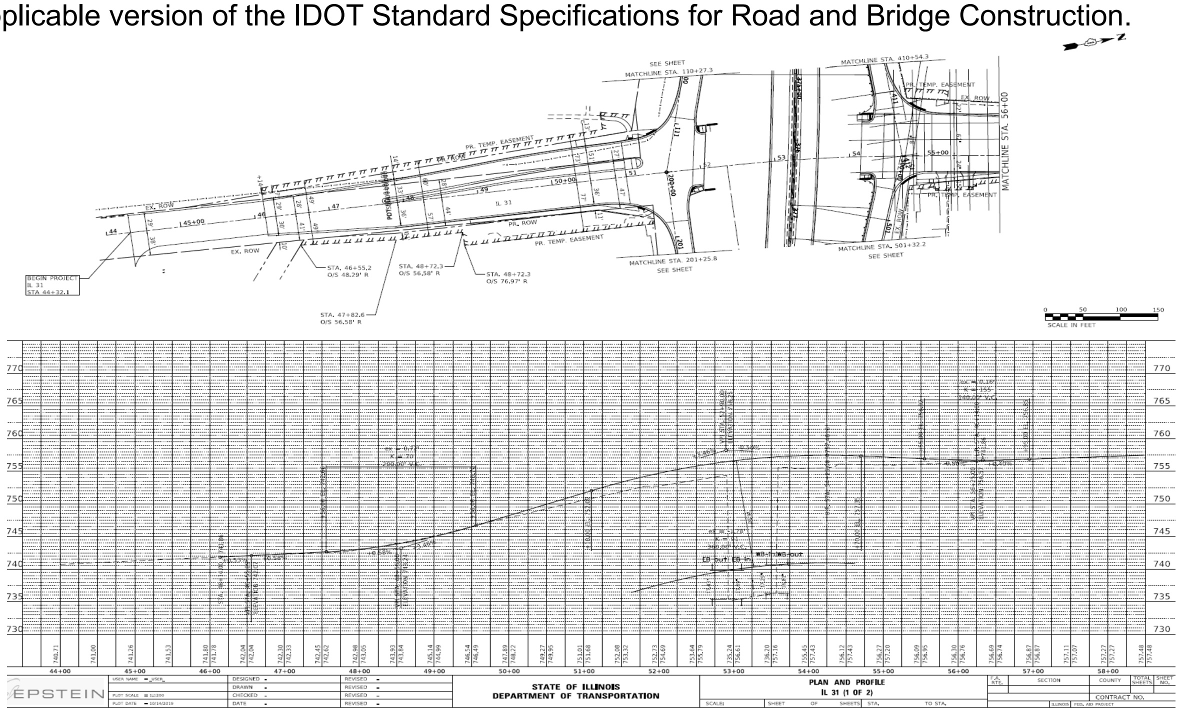
Rubino has reported topsoil thicknesses at boring B-01 based on visual observation of surficial soils. Topsoil thickness at this site is approximately 12 inches.

EVALUATION AND RECOMMENDATIONS

The geotechnical-related recommendations in this report are presented based on the subsurface conditions encountered and Rubino’s understanding of the project. Should changes in the project criteria occur, a review must be made by Rubino to determine if modifications to our recommendations will be necessary.

Fill Placement Settlement Analysis

Rubino understands that fill is planned to be placed to raise the profile grade of IL-31. Based on the strength of the soils in borings B-01 and B-03, Rubino anticipates settlement from fill placement to be less than 1 inch. Fill placement should be performed in accordance with the applicable version of the IDOT Standard Specifications for Road and Bridge Construction.



Deep Foundation Recommendations – Driven Metal Shell Piles and H-Piles

Due to the presence of granular soils encountered in the abutment borings, Rubino is recommending driven piles for the proposed bridge replacement abutments. Rubino is providing the following geotechnical recommendations for driven metal shell piles and H-Piles for each abutment.

The driven metal shell piles and H-Piles should be designed to be at least 3 diameters apart (center-to-center) from each other or group reduction factors will need to be employed in the design capacity of these members. Based on the subgrade information obtained during this investigation, vertical capacities of metal shell piles and H-Piles for each boring were calculated and can be found in the Appendix.

The capacities were derived using the IDOT Static Method of Estimating Pile Length Spreadsheet and the procedure outlined in the IDOT Design Guide AGMU 10.2 Geotechnical Pile Design.

The IDOT Static Method of Estimating Pile Length Spreadsheet calculates the factored resistance available in the boring using LRFD and the WSDOT Method for calculating pile capacities. The spreadsheet with inputs for each boring is included in the Appendix of this report. The following excerpt can be found in the above referenced Design Guide:

> *The Geotechnical Resistance Factor* (ϕ_G) shall be selected to represent the reliability of the construction method used to verify that the R_N has been developed. Our analysis using both national and local driving records and load tests indicated a ϕ_G of 0.55 should be used to compute R_F if the WSDOT formula is specified for construction verification. When more accurate construction verification methods are proposed, such as with static load test or a Pile Driving Analyzer (PDA), the resistance factor used may be increased to the values provided in the AASHTO specifications.

The WSDOT (IDOT) spreadsheets, with ranges of factored pile resistances, corresponding nominal required bearings, and estimated pile lengths, can be found in the Appendix.

The abutment and pier loads were provided by Epstein. Each of the abutments will experience a Total Factored Load of 2171 kips. Factored pier loads are provided in *Table 5.* The pile cutoff elevations were found on the approved TS&L, 749.68 feet and 751.70 feet for the South and North Abutments respectively. The pre-core elevations were used for the ground surface elevation against pile during driving, which were determined as the bottom of the abutment elevation, 747.68 feet and 748.70 feet for the South and North Abutments, respectively, minus 10 feet. The pre-core elevations are shown in *Table 3* and *Table 4* below. Recommended Maximum Nominal Required Bearing of the Pile is included as the last entry for each pile type if it is realized within the boring depth. In the case of *Table 3: South Abutment (B-01),* due to the very dense sand and gravel soils the Maximum Nominal Required Bearing of the Pile may be realized shallower than indicated in the table. Metal shell piles should have conical tips, and H-piles should have pile shoes. The estimated pile lengths for the recommended pile types can be found in the following tables.

Table 3: Pile Capacity – South Abutment (B-01)

R_N Nominal Required Bearing, (kips)	R_F Factored Resistance Available, (kips)	Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)	Estimated Pile Pre-Core Elevation** (feet)
Metal Shell, 14 in. Φ, w / 0.312 in. walls*				
151	83	15	734.7	737.7
189	104	17	732.2	737.7
367	202	20	729.4	737.7
Max: 570	314	30	718.2	737.7
Metal Shell, 16 in. Φ, w / 0.375 in. walls*				
123	68	14	735.7	737.7
193	106	16	733.2	737.7
384	211	19	730.7	737.7
Max: 782	430	30	718.2	737.7
Steel H Pile 12 x 53*				
121	66	31	718.2	737.7
248	137	44	705.7	737.7
339	187	56	693.2	737.7
Max: 418	230	67	682.2	737.7
Steel H Pile 12 x 63*				
125	69	31	718.2	737.7
256	141	44	705.7	737.7
348	191	56	693.2	737.7
Steel H Pile 14 x 73*				
124	68	26	723.2	737.7
219	120	39	710.7	737.7
312	172	51	698.2	737.7
578	318	71	676.7	737.7

*Metal shell piles should have conical tips, H-piles should have pile shoes
**Bottom of abutment elevation minus 10 feet

Table 4: Pile Capacity – North Abutment (B-03)

R_N Nominal Required Bearing, (kips)	R_F Factored Resistance Available, (kips)	Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)	Estimated Pile Pre-Core Elevation** (feet)
Metal Shell, 14 in. Φ, w / 0.312 in. walls*				
184	101	24	727.6	739.7
207	114	29	722.6	739.7
219	120	32	720.1	739.7
Max: 570	314	35	716.6	739.7
Metal Shell, 16 in. Φ, w / 0.375 in. walls*				
118	65	14	737.6	739.7
212	116	24	727.6	739.7
253	139	32	720.1	739.7
Max: 782	430	38	714.1	739.7
Steel H Pile 12 x 53*				
112	62	34	717.6	739.7
225	124	47	705.1	739.7
326	179	59	692.6	739.7
Steel H Pile 12 x 63*				
116	64	34	717.6	739.7
231	127	47	705.1	739.7
333	183	59	692.6	739.7
Steel H Pile 14 x 73*				
137	76	34	717.6	739.7
237	131	44	707.6	739.7
336	185	52	700.1	739.7

*Metal shell piles should have conical tips, H-piles should have pile shoes
**Bottom of abutment elevation minus 10 feet

Based on the results of the field investigation, the total settlement per pile using the above capacities, is expected to be less than 1-inch.

Lateral Loads and Integral Abutments

For integral abutments, moving the joints beyond the abutment results in the bridge superstructure (deck and beams) exerting large lateral forces and deflection demands on the abutment foundations due to thermal expansion and contraction of the superstructure.

The soils at this site are considered too stiff for integral abutments. Therefore, piles shall be driven through 24-inch diameter (for metal shell piles) or 30-inch diameter (for H-Piles) precored holes extending to elevation 737.68 ft for South Abutment and 739.70 ft for North Abutment (see *Table 3* and *Table 4*) according to Article 512.09(c) of the Standard Specifications except that the void space outside of the pile shall be filled with bentonite according to the manufacturer's recommendations to achieve a Qu of 1.5 tsf.

Test Pile

Rubino recommends the utilization of at least one test pile in either abutment in order to obtain site specific pile bearing and length data. This data can be used in addition to the boring information, to supplement the estimated plan length. This recommendation has been made in accordance with the 2012 IDOT Bridge Manual Section 3.10.1.7.

Observation and Testing

Rubino should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. Rubino cannot accept responsibility for conditions that deviate from those described in this report, nor for the performance of the foundation system if not engaged to also provide construction observation and testing for this project. Driving resistance should be obtained during the pile driving operations in accordance with the observation requirements listed in this report.

The existing and proposed profile grades are anticipated to be the same and therefore, settlement analyses were not performed for the existing embankment.

Shallow Foundation Recommendations – Center Pier

Rubino evaluated the nominal bearing capacity of the soils at the anticipated frost bearing elevation of 727.28 feet based on the approved TS&L dated January 30, 2020. Factored pier loads were provided by Epstein and are included in *Table 5*.

The table below summarizes the bearing capacity recommendations for the center pier using the LRFD method.

Table 5: Shallow Foundation Bearing Capacity

Foundation Type	Anticipated Bearing Soil (Boring #)	Factored Pier Load (kips)	Friction Angle Utilized	AASHTO 2017 Resistance Factor	Factored Bearing Resistance (psf)
Continuous Spread Footing	Dense Sand, some gravel (B-02)	5,375	30	0.45	10,000

The nominal bearing resistance was calculated using Vesic's formula as shown below:

$$\boxed{q_{ult} = c'N_c s_c d_c i_c b_c g_c + \sigma'_{zD} N_q s_q d_q i_q b_q g_q + 0.5\gamma' B N_\gamma s_\gamma d_\gamma i_\gamma b_\gamma g_\gamma}$$

$s_c, s_q, s_\gamma =$ shape factors
$d_c, d_q, d_\gamma =$ depth factors
$i_c, i_q, i_\gamma =$ load inclination factors
$b_c, b_q, b_\gamma =$ base inclination factors
$g_c, g_q, g_\gamma =$ ground inclination factors

<u>Design – Resistance to Sliding</u>

To calculate the resistance to sliding, a friction angle of 30 degrees between the concrete foundation and the underlying soil with a corresponding friction coefficient of 0.58 (AASHTO 2007) can be used for design.

<u>Design – Shallow Foundation Settlement Estimate</u>

Based on the known subsurface conditions, laboratory testing, and past experience, Rubino anticipates that properly designed and constructed footings supported on the recommended, observed and documented natural soils that have been stabilized as recommended herein, or properly compacted structural fill should experience total settlement of less than 1 inch.

Rubino recommends that the bearing soils be tested with a dynamic cone penetrometer prior to placing concrete for foundations.

Seismic Considerations

The seismic site class was determined using the IDOT Spreadsheet "*Seismic Site Class Determination*" dated December 10, 2010. Based on the soils encountered and depth to bedrock, the project area is in Seismic Site Class D. The results of the "*Seismic Site Class Determination"* are shown in the Appendix G.

The USGS Unified Hazard Tool was used to calculate the PGA, S_s, and S_1 values for bedrock motion. Those values were then used to determine the Adjusted Maximum Considered Earthquake (MCE) Spectral Response Acceleration Parameters (S_{MS} and S_{M1}) in accordance with Section 3.10.2 of AASHTO *LRFD Bridge Design Specifications* (AASHTO, 2017). The MCE Spectral Response

Acceleration Parameters were then adjusted to determine the Design Spectral Acceleration Parameters at short period (S_{DS}) and 1-second period (S_{D1}). The Design Spectral Acceleration Parameters and Seismic Performance Zone Value (SPZ), in accordance with AASHTO *LRFD Bridge Design Specifications* (AASHTO, 2017) are shown in the table below.

Table 6: Seismic Design Parameters

SEISMIC PARAMETER	VALUE
Design Spectral Acceleration Coefficient at 0.2 sec. (S_{DS})	0.151g
Design Spectral Acceleration Coefficient at 1.0 sec (S_{D1})	0.085g
Seismic Performance Zone (SPZ)	1
Soil Site Class	D

Slope Stability

A review of the soil conditions, ground water levels, and proposed abutment and bridge geometry was performed to perform global wall stability. A model was developed based the cross section of the integral abutment and material found in boring B-03 at the location of the proposed northern abutment, shown below in Exhibit 1.

A computer program, Stedwin Version 2.88, was used to calculate the factor of safety (FOS) against a global stability failure using the Bishop's method of slices. Circular shear surfaces were evaluated. A search routine was employed to evaluate several circular shear surfaces to identify the most critical shear surfaces within constraints defined by the program user.

According to Section 6.5.1 of the Geotechnical Manual: Cut Slopes Stability, the minimum safety factor of 1.7 for global stability analysis can be utilized in lieu of resistance factors based on limitations of most commercial stability software where geotechnical parameters are based on limits information.

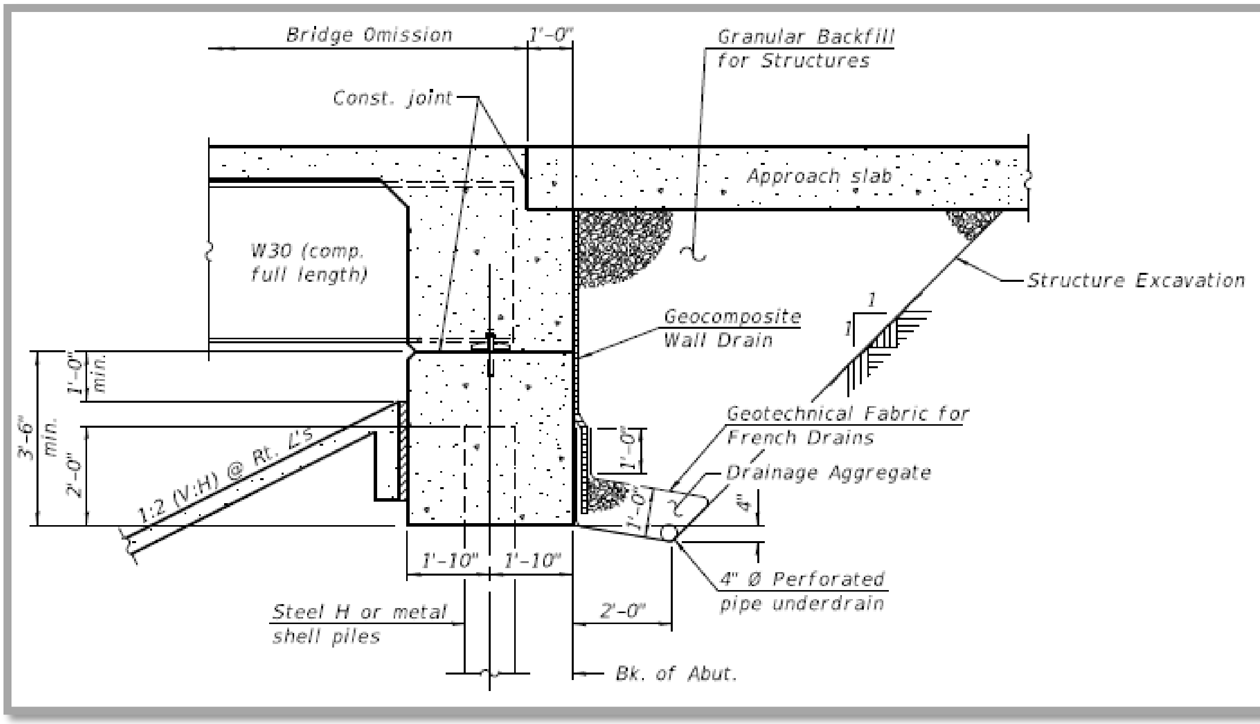


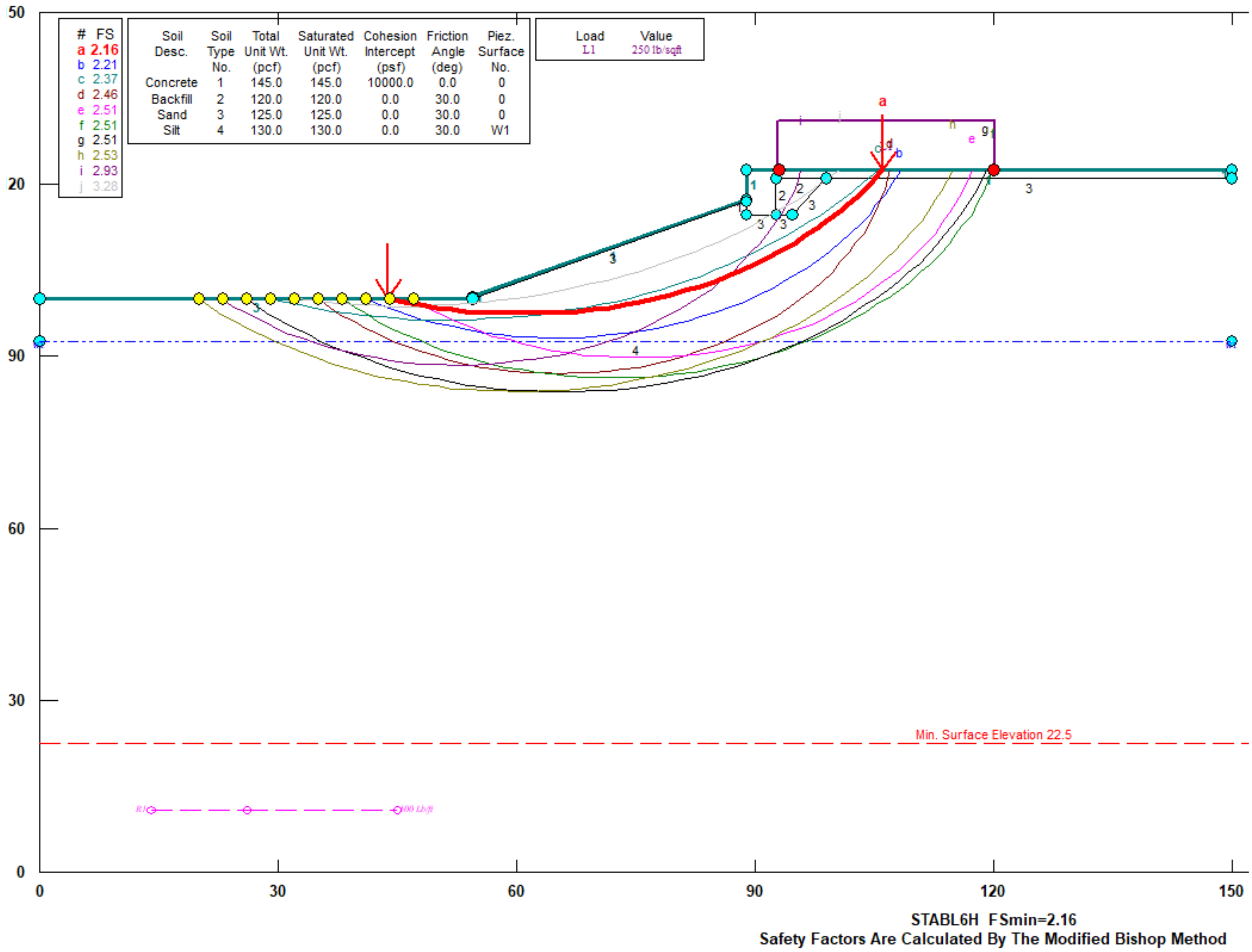
Exhibit 1) Cross-section through integral abutment

Soils within the cut slope were modeled based on adjacent boring, B-03, which is primarily sand with gravel. The stiff to very stiff, silt layer observed in boring B-03 was also incorporated into the stability model.

Phreatic levels were linearly interpolated based on levels observed at the soil boring location and added to the respective approximate locations within the cross-section. Below is a table of materials properties used in the Global Wall Stability Analysis:

Table 7: Summary of Material Properties Used for Stability

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Concrete	1	145.0	145.0	10000.0	0.0	0
Backfill	2	120.0	120.0	0.0	30.0	0
Sand	3	125.0	125.0	0.0	30.0	0
Silt	4	130.0	130.0	0.0	30.0	W1



The results of the global stability analysis indicate calculated factors of safety meet or exceed the recommended minimums for each loading case. Below is a summary of the results of the global wall stability analysis.

Table 8: Summary of Slope Stability Analysis Results

LOADING CASE	RECOMMENDED MINIMUM FOS	CALCULATED FOS
End of Construction	1.7	2.16

CONSTRUCTION CONSIDERATIONS

Site Preparation

Rubino recommends that unsuitable soils or fill be removed from the site, as applicable. Unsuitable soils or fills include but are not limited to the following: organic soil, topsoil, vegetation, frozen soil, existing pavement sections, existing foundations, building debris, and existing curbs.

Operations should be monitored and documented by a representative of the geotechnical engineer at the time of construction.

Temporary Soil Retention System

Based on the TS&L, the project will be staged requiring soil retention to maintain traffic across the bridge during construction. Due to the retained height being greater than 20 feet at the back of the existing closed abutment and the presence of dense granular soils within the embedment, temporary sheet piling is not recommended. Rubino anticipates a soil retention system could be used and should be designed in accordance with the IDOT Bridge Design Manual, Section 3.13.1, Temporary Sheet Piling Design, Temporary Soil Retention Systems and Braced Excavations.

Recommendations for Additional Testing

Once the structural loads, site plan and grading plans are finalized, please notify Rubino so that we can review our recommendations for the direct use of the structure and development of the site. Changes in building location, foundation depth, and structural loading can affect the geotechnical recommendations for this site.

During construction, Rubino recommends that one of our representatives be onsite for typical **observations and documentation** of exposed subgrade for support of foundations, and pavements, including proofrolling and penetrometer testing.

CLOSING

The recommendations submitted are based on the available subsurface information obtained by Rubino Engineering, Inc. and design details furnished by A. Epstein and Sons International, Inc. for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, Rubino should be notified immediately to determine if changes in the foundation recommendations are required. If

Rubino is not retained to perform these functions, we will not be responsible for the impact of those conditions on the project.

The scope of services did not include an environmental assessment to determine the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater or air on, below, or around this site. Any statements in this report and/or on the boring logs regarding odors, colors, and/or unusual or suspicious items or conditions are strictly for informational purposes.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At this time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of A. Epstein and Sons International, Inc. and their consultants for the specific application to the proposed IL Route 31 Bridge Replacement in Elgin, Illinois.

Appendix A - Drilling, Field, and Laboratory Test Procedures

AASHTO T 206 Penetration Tests and Split-Barrel Sampling of Soils

During the sampling procedure, Standard Penetration Tests (SPT's) were performed at regular intervals to obtain the standard penetration (N-value) of the soil. The results of the standard penetration test are used to estimate the relative strength and compressibility of the soil profile components through empirical correlations to the soils' relative density and consistency. The split-barrel sampler obtains a soil sample for classification purposes and laboratory testing, as appropriate for the type of soil obtained.

Water Level Measurements

Water level observations were attempted during and upon completion of the drilling operation using a 100-foot tape measure. The depths of observed water levels in the boreholes are noted on the boring logs presented in the appendix of this report. In the borings where water is unable to be observed during the field activities, in relatively impervious soils, the accurate determination of the groundwater elevation may not be possible even after several days of observation. Seasonal variations, temperature and recent rainfall conditions may influence the levels of the groundwater table and volumes of water will depend on the permeability of the soils.

Ground Surface Elevations

Elevations of the soil borings were provided by Quigg Engineering, Inc. The depths indicated on the attached boring logs are relative to the existing ground surface for each individual boring at the time of the exploration. Copies of the boring logs are located in the Appendix of this report.

AASHTO T 265-15 Water (Moisture) Content of Soil by Mass (Laboratory)

The water content is an important index property used in expressing the phase relationship of solids, water, and air in a given volume of material and can be used to correlate soil behavior with its index properties. In fine grained cohesive soils, the behavior of a given soil type often depends on its natural water content. The water content of a cohesive soil along with its liquid and plastic limits as determined by Atterberg Limit testing are used to express the soil's relative consistency or liquidity index.

AASHTO T 267-86 Standard Test Method for Organic Soils using Loss on Ignition (Laboratory)

These test methods cover the measurement of moisture content, ash content, and organic matter in peats and other organic soils, such as organic clays, silts, and mucks. Ash content of a peat or organic soil sample is determined by igniting the oven-dried sample from the moisture content determination in a muffle furnace at 440°C (Method C) or 750°C (Method D). The substance remaining after ignition is the ash. The ash content is expressed as a percentage of the mass of the oven-dried sample. 2.4 Organic matter is determined by subtracting percent ash content from 100.

Appendix B – Site Vicinity Map & Boring Location Plan

rubino
ENGINEERING INC.

425 Shepard Drive
Elgin, Illinois 60123

Project Name: **IL 31 Bridge Replacement**
Project Location: IL 31 over US 20
Elgin, Illinois
Client: **A. Epstein and Sons International, Inc.**
Rubino Project # : G19.073

Site Vicinity Map

ENGINEERING INC.

425 Shepard Drive
Elgin, Illinois 60123

Project Name:	**IL 31 Bridge Replacement**
Project Location:	IL 31 over US 20 Elgin, Illinois
Client:	**A. Epstein and Sons International, Inc.**
Rubino Project # :	G19.073

Boring Location Plan

Appendix C – Approved TS&L

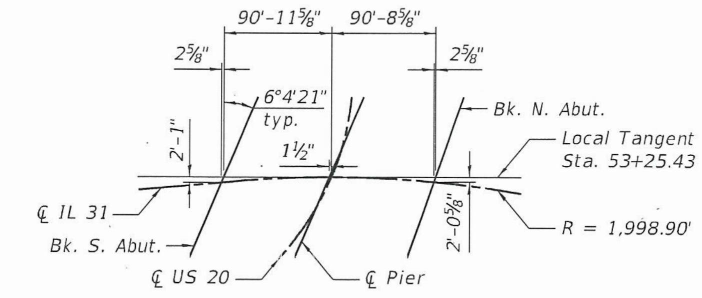
Benchmark: Cut ☐ on southwest corner of bridge headwall on east side of IL 31 over US 20. Elevation 756.31.

Existing Structure: S.N. 045-0017 was built in 1959 under project U-613(3). Structure consists of a simple span steel WF beam bridge with 71'-10⅛" back-to-back abutments, out-to-out deck width of 70'-0⅝", and closed abutments on spread footings. In 1975, wingwall parapets were removed and replaced. In 1988, deck was patched, joints were reconstructed, and longitudinal joint was removed. In 2003, sidewalks and bridge rail were removed and replaced, and beams were repaired and straightened. In 2011, joint seals at abutment joints were replaced, deck slab was repaired, protective shield was installed, and approaches were resurfaced. Traffic to be maintained utilizing staged construction. No salvage.

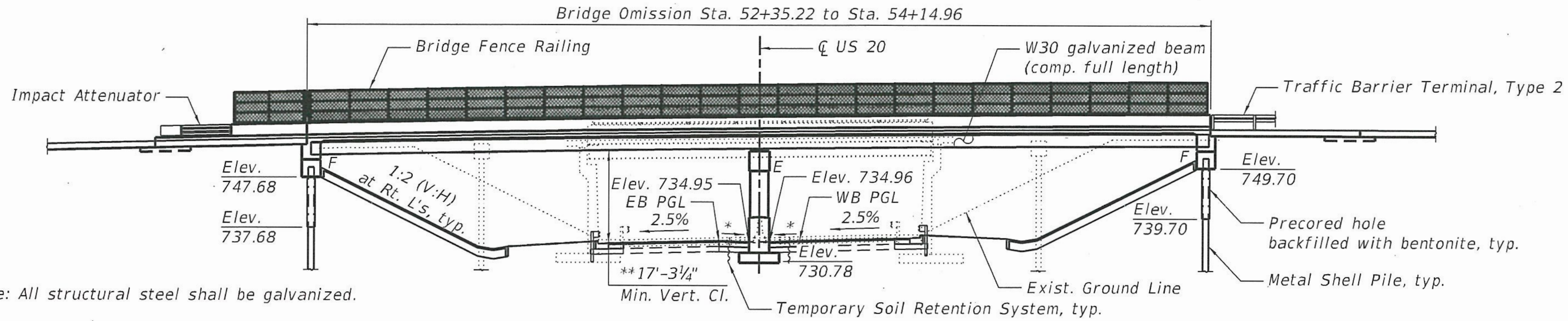
HIGHWAY CLASSIFICATION

FAU Rte. 3887 - IL 31
Functional Class: Minor Arterial
ADT: 16,600 (2017); 20,033 (2032)
ADTT: 1,328 (2017); 1,603 (2032)
DHV: 683
Design Speed: 35 m.p.h.
Posted Speed: 30 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

FAP Rte. 345 - US 20
Functional Class: Freeway
ADT: 42,800 (2017); 54,996 (2032)
ADTT: 3,852 (2017); 4,950 (2032)
DHV: 4,950
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50



OFFSET SKETCH



Note: All structural steel shall be galvanized.

*4.0%

**Future contract for US 20 widening improvements will reduce minimum vertical clearance to 16'-9¾"

ELEVATION

LOADING HL-93

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

APPROVED

FEB 20 2020

AS A BASIS FOR PREPARATION OF DETAILED PLANS

DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications, 8th Edition.

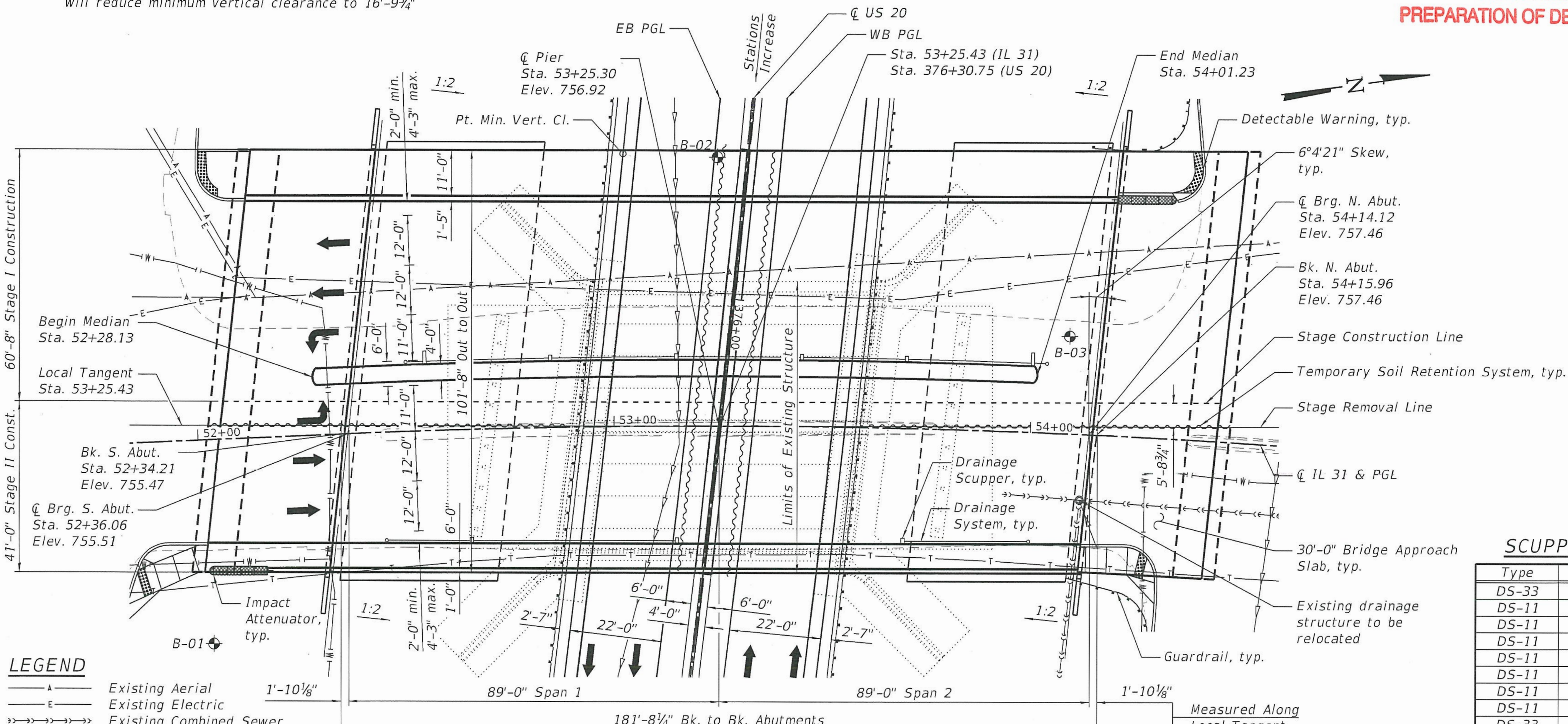
DESIGN STRESSES

FIELD UNITS

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

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.085g
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.135g
Soil Site Class = D



PLAN

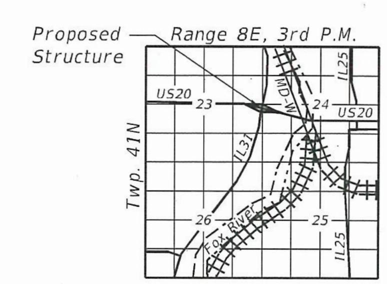
LEGEND

——A——	Existing Aerial
——E——	Existing Electric
»—»—»	Existing Combined Sewer
—▷—▷—	Existing Storm Sewer
——T——	Existing Telephone
——W——	Existing Water

SCUPPER LOCATION

Type	Station	Offset
DS-33	52+55	16.00' LT
DS-11	52+65	27.37' RT
DS-11	52+85	16.00' LT
DS-11	53+15	16.00' LT
DS-11	53+15	28.24' RT
DS-11	53+45	16.00' LT
DS-11	53+70	16.00' LT
DS-11	53+70	27.78' RT
DS-33	54+00	16.00' LT

Offset measured from curb at scupper to ℄ IL 31 & PGL.



LOCATION SKETCH

GENERAL PLAN
IL 31 OVER US 20
FAU RTE. 3887
SECTION 8HB-2
KANE COUNTY
STATION 53+25.43
STRUCTURE NO. 045-2106

2/20/2020 9:38:48 AM
P:\Projects\18000\18184\DISCIPLINE\Civil\Working\Sheets\14-Bridge\D1_82G41_sht_TSL-01.dgn

EPSTEIN

USER NAME =	DESIGNED - CMS	REVISED -
	DRAWN - CMS	REVISED -
PLOT SCALE =	CHECKED - TCG	REVISED -
PLOT DATE =	DATE - 1/30/2020	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

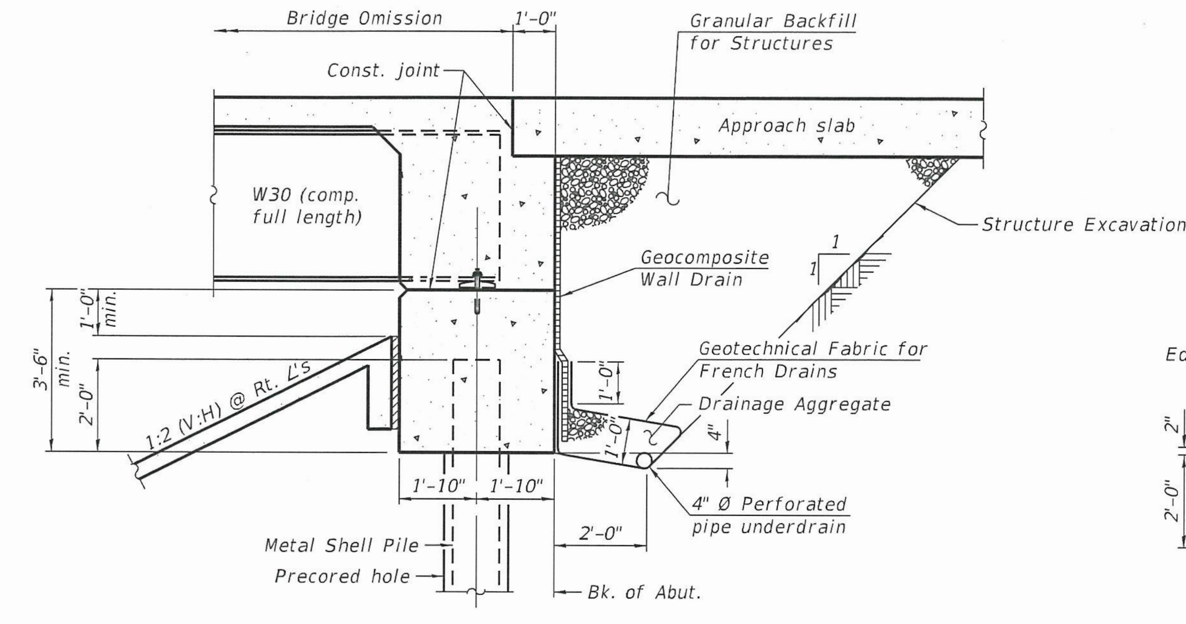
GENERAL PLAN AND ELEVATION

SCALE: SHEET 1 OF 2 SHEETS STA. TO STA.

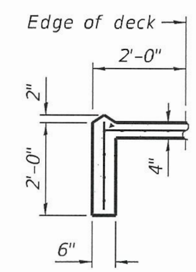
F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
3887	8HB-2	KANE	2	1

CONTRACT NO.

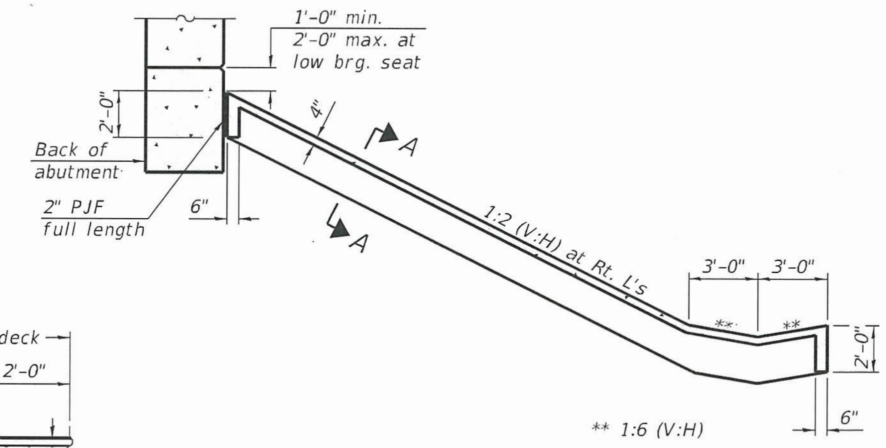
ILLINOIS FED. AID PROJECT



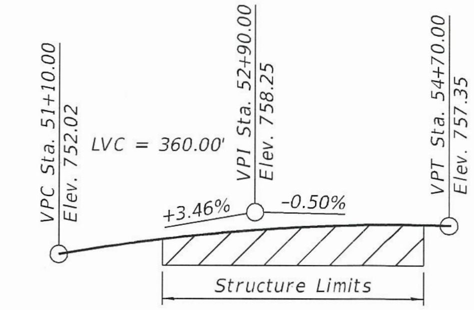
SECTION THRU INTEGRAL ABUTMENT
(Horiz. dim. @ Rt. ∠'s)



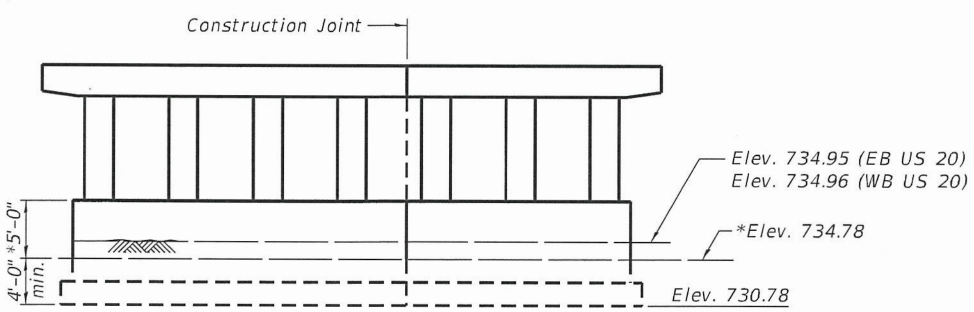
SECTION A-A



SECTION THRU CONCRETE SLOPEWALL



PROFILE GRADE IL 31

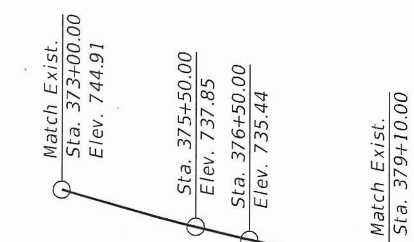


PIER SKETCH

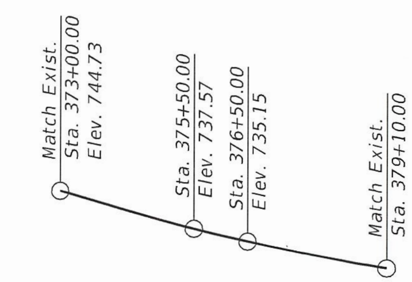
*Elevation based on future contract for US 20 widening improvements.

CURVE DATA
℄ IL 31
P.I. Sta. = 53+53.09
Δ = 6° 43' 39" RT
D = 2° 51' 59"
R = 1,998.90'
T = 117.49'
L = 234.71'
E = 3.45'
e = 0.020
T.R. = 78'
S.E. Run = 78'
P.C. Sta. = 52+35.60
P.T. Sta. = 54+70.31

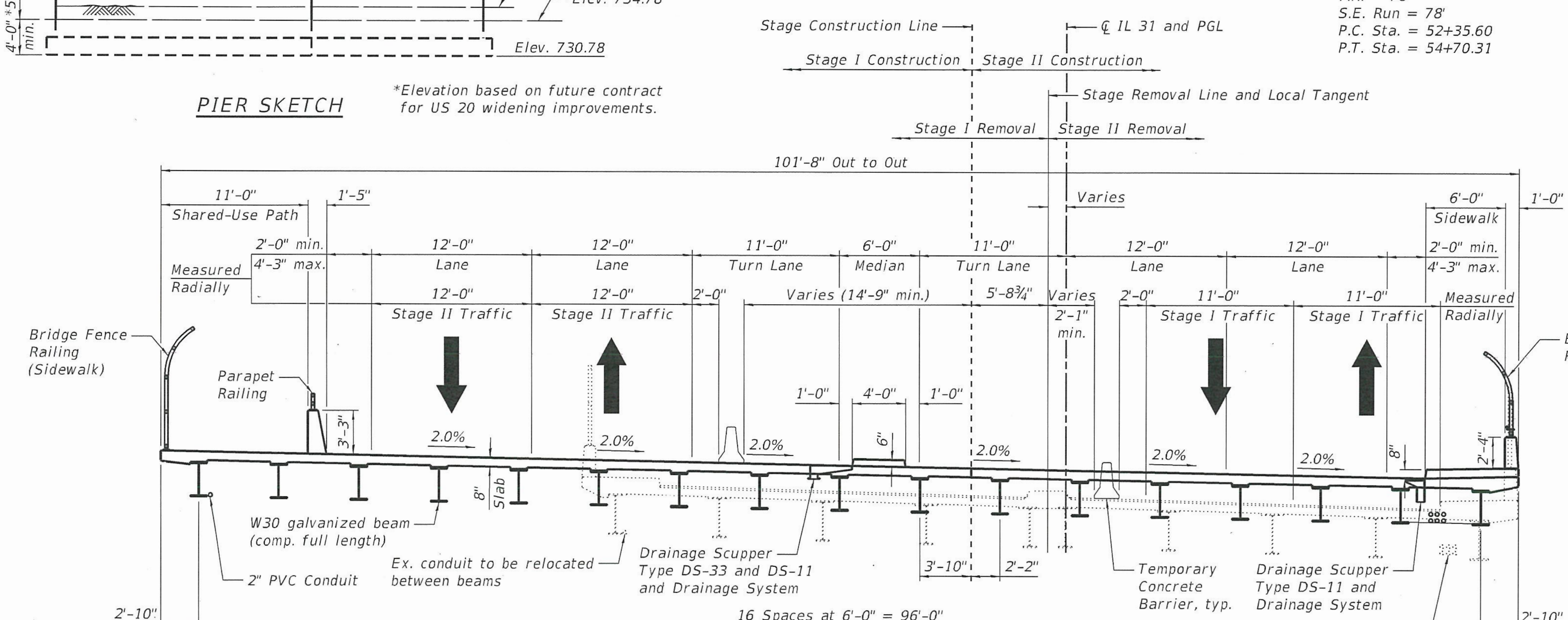
CURVE DATA
℄ US 20
P.I. Sta. = 372+64.68
Δ = 16° 21' 02" RT
D = 1° 14' 34"
R = 4,610.38'
T = 662.34'
L = 1,315.67'
E = 47.33'
e = 0.025
T.R. = 156'
S.E. Run = 195'
P.C. Sta. = 366+02.34
P.T. Sta. = 379+18.01



PROFILE GRADE WB US 20



PROFILE GRADE EB US 20



CROSS SECTION
(Looking North)

Note: All structural steel shall be galvanized.

APPROVED
FEB 20 2020
AS A BASIS FOR PREPARATION OF DETAILED PLANS

DETAILS
IL 31 OVER US 20
FAU RTE. 3887
SECTION 8HB-2
KANE COUNTY
STATION 53+25.43
STRUCTURE NO. 045-2106

2/20/2020 3:02:12 PM
P:\Projects\18000\18184\DISCIPLINE\Civil\Working\Sheets\14-Bridge\01_62G41_sht_TSL-02.dgn

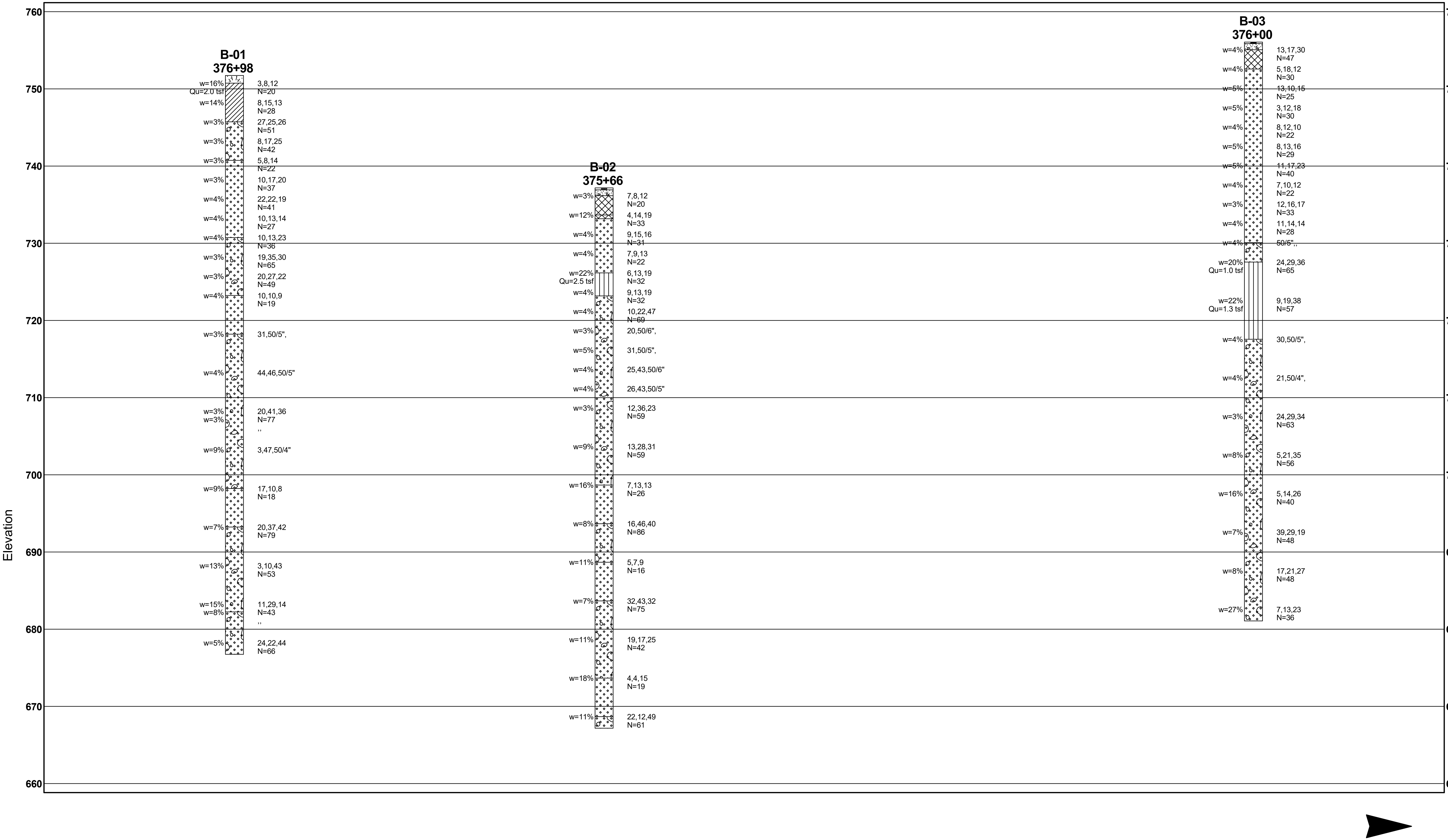
EPSTEIN

USER NAME =	DESIGNED - CMS	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
PLOT SCALE =	DRAWN - CMS	REVISED -	
	CHECKED - TCG	REVISED -	
PLOT DATE =	DATE - 1/30/2020	REVISED -	

STRUCTURAL DETAILS
SCALE: | SHEET 2 OF 2 SHEETS | STA. | TO STA.

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
3887	8HB-2	KANE	2	2
		CONTRACT NO.		
	ILLINOIS	FED. AID PROJECT		

Appendix D – Subsurface Data Profile Plot



rubino ENGINEERING INC.

Rubino Engineering, Inc.
425 Shepard Drive
Elgin, IL 60123
Telephone: 847-931-1555
Fax: 847-931-1560

Soil Profile

Rubino Job No.:	G19.073
Project & location:	Elgin, Illinois
Route:	FAU 3887 (IL 31)
County:	Kane
Section:	BR-HB-3

Appendix E – Boring Logs

RUBINO ENGINEERING INC.

SOIL BORING LOG

Date 7/16/19

ROUTE FAU 3887 (IL 31) **DESCRIPTION** IL 31 over US 20 **LOGGED BY** J. Ignarski

SECTION BR-HB-3 **LOCATION** SE 1/4 SEC, 23, TWP, 41N, RNG, 8E, 3RD PM
Latitude: 42.02158717, Longitude: -88.28334724

COUNTY Kane **DRILLING METHOD** 3 ½ inch Hollow Stem Auger **HAMMER TYPE** Automatic SPT

STRUCT. NO. 045-2106
Station

BORING NO. B-01
Station 376+98
Offset 115RT
Ground Surface Elev. 751.74 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 48.5 ft ▼
Upon Completion 35 ft ∇
After ____ **Hrs.** Filled ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
TOPSOIL; brown silty clay with roots	750.74				
Stiff, brown to gray silty CLAY, trace sand and gravel, Possible fill — Dry			3 / 8 / 12	2.0 P	16
		-5	8 / 15 / 13		14
	745.74				
Dense to very dense, brown and gray SAND and gravel — Dry			27 / 25 / 26		3
		-10	8 / 17 / 25		3
	740.74				
Medium dense to dense, brown SAND and gravel — Dry			5 / 8 / 14		3
		-15	10 / 17 / 20		3
			22 / 22 / 19		4
		-20	10 / 13 / 14		4
	730.74				
Dense to very dense, brown SAND and gravel — Dry			10 / 13 / 23		4
		-25	19 / 35 / 30		3
			20 / 27 / 22		3
	723.24				
Medium dense, brown SAND and gravel — Moist		-30	10 / 10 / 9		4
	718.24				
Very dense, brown SAND and gravel — Moist		∇ -35	31 / 50/5"		3
		-40	44 / 46 / 50/5"		4

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 7/16/19

ROUTE FAU 3887 (IL 31) **DESCRIPTION** IL 31 over US 20 **LOGGED BY** J. Ignarski

SECTION BR-HB-3 **LOCATION** SE 1/4 SEC, 23, TWP, 41N, RNG, 8E, 3RD PM
Latitude: 42.02158717, Longitude: -88.28334724

COUNTY Kane **DRILLING METHOD** 3 ½ inch Hollow Stem Auger **HAMMER TYPE** Automatic SPT

STRUCT. NO. 045-2106
Station

BORING NO. B-01
Station 376+98
Offset 115RT
Ground Surface Elev. 751.74 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 48.5 ft ▼
Upon Completion 35 ft ▽
After ____ **Hrs.** Filled ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Very dense, brown SAND and gravel Moist *(continued)*				
No Gravel		20		3
		41		3
	-45	36		
Wet ▼		3		9
		47		
	-50	50/4"		
698.24				
Medium dense, brown SAND little gravel Wet		17		9
		10		
	-55	8		
693.24				
Dense to very dense, brown SAND and gravel		20		7
		37		
	-60	42		
Dense to very dense, brown SAND and gravel *(continued)*				
Trace Gravel		3		13
		10		
	-65	43		
No Gravel		11		15
Very dense, brown SAND and gravel Saturated		29		8
	-70	14		
And Gravel		24		5
		22		
676.74	-75	44		
End of boring at approximately 75 feet below existing grade.				
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 7/2/19

ROUTE FAU 3887 (IL 31) **DESCRIPTION** US 20 at IL 31 **LOGGED BY** J. Ignarski

SECTION BR-HB-3 **LOCATION** SE 1/4 SEC, 23, TWP, 41N, RNG, 8E, 3RD PM
Latitude: 42.02195923 , Longitude: -88.28371459

COUNTY Kane **DRILLING METHOD** 3 ½ inch Hollow Stem Auger **HAMMER TYPE** Automatic SPT

STRUCT. NO. 045-2106
Station

BORING NO. B-02
Station 375+66
Offset 7RT
Ground Surface Elev. 737.17 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 33.5 ft ▼
Upon Completion 35 ft ▽
After ______ **Hrs.** Filled ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Approximately 3 inches of ASPHALT	736.92				
Approximately 9 inches of CONCRETE	736.17				
FILL; brown sand and gravel, Dry			7 8 12		3
	733.67				
FILL; brown and gray silty clay	733.17				
Medium dense to dense, brown SAND some gravel, Dry		-5	4 14 19		12
			9 15 16		4
		-10	7 9 13		4
	726.17				
Very stiff, brown SILT, Moist			6 13 19	2.5 P	22
	723.17				
Dense to very dense, brown SAND, Damp		-15	9 13 19		4
Some Gravel			10 22 47		4
And Gravel		-20	20 50/6"		3

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Dense to very dense, brown SAND, Damp *(continued)*					
			31 50/5"		5
		-25	25 43 50/6"		4
			26 43 50/5"		4
Wet		-30	12 36 23		3
		▼ ▽ -35	13 28 31		9
	698.67				
Medium dense, brown SAND some gravel, Saturated		-40	7 13 13		16

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 7/2/19

ROUTE FAU 3887 (IL 31) **DESCRIPTION** US 20 at IL 31 **LOGGED BY** J. Ignarski

SECTION BR-HB-3 **LOCATION** SE 1/4 SEC, 23, TWP, 41N, RNG, 8E, 3RD PM
Latitude: 42.02195923 , Longitude: -88.28371459

COUNTY Kane **DRILLING METHOD** 3 ½ inch Hollow Stem Auger **HAMMER TYPE** Automatic SPT

STRUCT. NO. 045-2106
Station

BORING NO. B-02
Station 375+66
Offset 7RT
Ground Surface Elev. 737.17 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 33.5 ft ▼
Upon Completion 35 ft ▽
After ___ **Hrs.** Filled ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Medium dense, brown SAND some gravel Saturated *(continued)*				
693.67				
Very dense, brown SAND little gravel Wet		16		8
		46		
	-45	40		
688.67				
Medium dense, brown SAND and gravel Wet		5		11
		7		
	-50	9		
683.67				
Dense to very dense, brown SAND and gravel Wet		32		7
		43		
	-55	32		
Trace Gravel		19		11
		17		
	-60	25		

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Dense to very dense, brown SAND and gravel Wet *(continued)*				
673.67				
Medium dense, brown SAND trace gravel Wet		4		18
		4		
	-65	15		
668.67				
Very dense, brown SAND and gravel Wet		22		11
		12		
667.17	-70	49		
End of boring at approximately 70 feet below existing grade.				
	-75			
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 7/17/19

ROUTE FAU 3887 (IL 31) **DESCRIPTION** IL 31 over US 20 **LOGGED BY** J. Ignarski

SECTION BR-HB-3 **LOCATION** SE 1/4 SEC, 23, TWP, 41N, RNG, 8E, 3RD PM
Latitude: 42.02217372 , Longitude: -88.28351539

COUNTY Kane **DRILLING METHOD** 3 ½ inch Hollow Stem Auger **HAMMER TYPE** Automatic SPT

STRUCT. NO. 045-2106
Station

BORING NO. B-03
Station 376+00
Offset 81LT
Ground Surface Elev. 756.07 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 53.5 ft ▼
Upon Completion Washed ft
After 24 **Hrs.** Caved @ 4 ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Approximately 2½ inches of ASPHALT	755.86				
Approximately 9½ inches of CONCRETE	755.07				
FILL; brown sand and gravel with concrete, Dry			13 17 30		4
	752.57				
Medium dense to dense, brown SAND and gravel, Damp		-5	5 18 12		4
			13 10 15		5
		-10	3 12 18		5
			8 12 10		4
		-15	8 13 16		5
			11 17 23		5
		-20	7 10 12		4

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Medium dense to dense, brown SAND and gravel, Damp *(continued)*					
			12 16 17		3
		-25	11 14 14		4
	730.07				
Very dense, brown SAND and gravel, Moist			50/5"		4
	727.57				
Stiff, brown SILT, Wet		-30	24 29 36	1.0 P	20
		-35	9 19 38	1.3 S	22
	717.57				
Dense to very dense, brown SAND and gravel		-40	30 50/5"		4

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

rubino ENGINEERING INC.

SOIL BORING LOG

Date 7/17/19

ROUTE FAU 3887 (IL 31) **DESCRIPTION** IL 31 over US 20 **LOGGED BY** J. Ignarski

SECTION BR-HB-3 **LOCATION** SE 1/4 SEC, 23, TWP, 41N, RNG, 8E, 3RD PM
Latitude: 42.02217372 , Longitude: -88.28351539

COUNTY Kane **DRILLING METHOD** 3 ½ inch Hollow Stem Auger **HAMMER TYPE** Automatic SPT

STRUCT. NO. 045-2106
Station

BORING NO. B-03
Station 376+00
Offset 81LT
Ground Surface Elev. 756.07 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 53.5 ft ▼
Upon Completion Washed ft
After 24 **Hrs.** Caved @ 4 ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Dense to very dense, brown SAND and gravel *(continued)* Wet				
		21		4
	-45	50/4"		
		24		3
		29		
	-50	34		
▼ Heaving Sands, Flushed Augers		5		8
		21		
Some gravel Saturated	-55	35		
Little gravel Heaving Sands		5		16
		14		
	-60	26		

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Dense to very dense, brown SAND and gravel *(continued)*				
Heaving Sands		39		7
		29		
	-65	19		
Heaving Sands		17		8
		21		
	-70	27		
		7		27
		13		
681.07	-75	23		
End of boring at approximately 75 feet below existing grade.				
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Appendix F – Pile Length / Pile Type Capacity Charts

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

Illinois Department of Transportation

SUBSTRUCTURE==================================== South Abutment
REFERENCE BORING ================================ B-01
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 749.68 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 737.68 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 ============== 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 64.06 KIPS

PILE TYPE AND SIZE ============= Metal Shell 14"Φ w/.312" walls
Pile Perimeter============================== 3.665 FT.
Pile End Bearing Area========================== 1.069 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
570 KIPS	**367** KIPS	**202** KIPS	**20** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
735.74	1.94		37	Medium Sand	28.4		***98.0***	98	0	0	54	14
734.74	1.00		41	Medium Sand	17.5	69.5	***150.9***	151	0	0	83	15
733.24	1.50		41	Medium Sand	26.2	105.0	***156.9***	157	0	0	86	16
732.24	1.00		27	Medium Sand	9.2	84.7	***189.4***	189	0	0	104	17
730.74	1.50		27	Medium Sand	13.8	108.1	***305.8***	306	0	0	168	19
729.74	1.00		46	Medium Sand	21.6	210.7	***367.2***	367	0	0	202	20
728.24	1.50		46	Medium Sand	32.3	250.5	***586.5***	~~586~~	~~0~~	~~0~~	~~323~~	~~21~~
725.74	2.50		65	Medium Sand	101.2	437.4	***580.0***	~~580~~	~~0~~	~~0~~	~~319~~	~~24~~
723.24	2.50		49	Medium Sand	60.7	329.7	***438.8***	439	0	0	241	26
720.74	2.50		19	Medium Sand	16.0	127.9	***454.8***	455	0	0	250	29
718.24	2.50		19	Medium Sand	16.0	127.9	***679.5***	~~679~~	~~0~~	~~0~~	~~374~~	~~31~~
715.74	2.50		50	Medium Sand	63.1	336.5	***742.5***	~~743~~	~~0~~	~~0~~	~~408~~	~~34~~
713.24	2.50		50	Medium Sand	63.1	336.5	***805.6***	~~806~~	~~0~~	~~0~~	~~443~~	~~36~~
710.74	2.50		50	Medium Sand	63.1	336.5	***868.6***	~~869~~	~~0~~	~~0~~	~~478~~	~~39~~
708.24	2.50		50	Medium Sand	63.1	336.5	***1113.4***	~~1113~~	~~0~~	~~0~~	~~612~~	~~41~~
705.74	2.50		77	Medium Sand	132.0	518.2	***1245.4***	~~1245~~	~~0~~	~~0~~	~~685~~	~~44~~
703.24	2.50		77	Medium Sand	132.0	518.2	***1195.8***	~~1196~~	~~0~~	~~0~~	~~658~~	~~46~~
700.74	2.50		50	Medium Sand	63.1	336.5	***1258.8***	~~1259~~	~~0~~	~~0~~	~~692~~	~~49~~
698.24	2.50		50	Medium Sand	63.1	336.5	***1106.5***	~~1107~~	~~0~~	~~0~~	~~609~~	~~51~~
695.74	2.50		18	Medium Sand	15.2	121.1	***1121.7***	~~1122~~	~~0~~	~~0~~	~~617~~	~~54~~
693.24	2.50		18	Medium Sand	15.2	121.1	***1547.4***	~~1547~~	~~0~~	~~0~~	~~851~~	~~56~~
690.74	2.50		79	Medium Sand	137.2	531.6	***1684.5***	~~1685~~	~~0~~	~~0~~	~~926~~	~~59~~
688.24	2.50		79	Medium Sand	137.2	531.6	***1646.7***	~~1647~~	~~0~~	~~0~~	~~906~~	~~61~~
685.74	2.50		53	Medium Sand	70.5	356.7	***1717.3***	~~1717~~	~~0~~	~~0~~	~~945~~	~~64~~
683.24	2.50		53	Medium Sand	70.5	356.7	***1720.5***	~~1721~~	~~0~~	~~0~~	~~946~~	~~66~~
680.74	2.50		43	Medium Sand	47.6	289.4	***1768.2***	~~1768~~	~~0~~	~~0~~	~~972~~	~~69~~
679.74	1.00		43	Medium Sand	19.0	289.4	***1787.2***	~~1787~~	~~0~~	~~0~~	~~983~~	~~70~~
678.74	1.00		43	Medium Sand	19.0	289.4	***1806.2***	~~1806~~	~~0~~	~~0~~	~~993~~	~~71~~
678.24	0.50		43	Medium Sand	9.5	289.4	***1970.5***	~~1971~~	~~0~~	~~0~~	~~1084~~	~~71~~
676.74	1.50		66	Medium Sand		444.1						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== South Abutment
REFERENCE BORING ================================ B-01
LRFD or ASD or SEISMIC ============================= LRFD
PILE CUTOFF ELEV. ================================= 749.68 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 737.68 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 ============== 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts =========== 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts =========== 64.06 KIPS

PILE TYPE AND SIZE ============= Metal Shell 16"Φ w/.375" walls
Plugged Pile Perimeter========================= 4.189 FT.
Plugged Pile End Bearing Area=================== 1.396 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
782 KIPS	541 KIPS	297 KIPS	29 FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL 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.)
735.74	1.94		37	Medium Sand	32.5		123.3	123	0	0	68	14
734.74	1.00		41	Medium Sand	20.0	90.8	189.6	190	0	0	104	15
733.24	1.50		41	Medium Sand	30.0	137.1	193.1	193	0	0	106	16
732.24	1.00		27	Medium Sand	10.5	110.7	234.2	234	0	0	129	17
730.74	1.50		27	Medium Sand	15.8	141.2	383.9	384	0	0	211	19
729.74	1.00		46	Medium Sand	24.6	275.2	460.6	461	0	0	253	20
728.24	1.50		46	Medium Sand	36.9	327.1	741.7	742	0	0	408	21
725.74	2.50		65	Medium Sand	115.7	571.3	716.7	717	0	0	394	24
723.24	2.50		49	Medium Sand	69.3	430.7	522.4	522	0	0	287	26
720.74	2.50		19	Medium Sand	18.3	167.0	540.7	541	0	0	297	29
718.24	2.50		19	Medium Sand	18.3	167.0	831.5	~~831~~	~~0~~	~~0~~	~~457~~	~~31~~
715.74	2.50		50	Medium Sand	72.1	439.5	903.5	~~904~~	~~0~~	~~0~~	~~497~~	~~34~~
713.24	2.50		50	Medium Sand	72.1	439.5	975.6	~~976~~	~~0~~	~~0~~	~~537~~	~~36~~
710.74	2.50		50	Medium Sand	72.1	439.5	1047.7	~~1048~~	~~0~~	~~0~~	~~576~~	~~39~~
708.24	2.50		50	Medium Sand	72.1	439.5	1357.0	~~1357~~	~~0~~	~~0~~	~~746~~	~~41~~
705.74	2.50		77	Medium Sand	150.9	676.8	1507.9	~~1508~~	~~0~~	~~0~~	~~829~~	~~44~~
703.24	2.50		77	Medium Sand	150.9	676.8	1421.5	~~1422~~	~~0~~	~~0~~	~~782~~	~~46~~
700.74	2.50		50	Medium Sand	72.1	439.5	1493.6	~~1494~~	~~0~~	~~0~~	~~821~~	~~49~~
698.24	2.50		50	Medium Sand	72.1	439.5	1284.4	~~1284~~	~~0~~	~~0~~	~~706~~	~~51~~
695.74	2.50		18	Medium Sand	17.4	158.2	1301.7	~~1302~~	~~0~~	~~0~~	~~716~~	~~54~~
693.24	2.50		18	Medium Sand	17.4	158.2	1855.2	~~1855~~	~~0~~	~~0~~	~~1020~~	~~56~~
690.74	2.50		79	Medium Sand	156.8	694.4	2012.0	~~2012~~	~~0~~	~~0~~	~~1107~~	~~59~~
688.24	2.50		79	Medium Sand	156.8	694.4	1940.2	~~1940~~	~~0~~	~~0~~	~~1067~~	~~61~~
685.74	2.50		53	Medium Sand	80.6	465.8	2020.9	~~2021~~	~~0~~	~~0~~	~~1111~~	~~64~~
683.24	2.50		53	Medium Sand	80.6	465.8	2013.6	~~2014~~	~~0~~	~~0~~	~~1107~~	~~66~~
680.74	2.50		43	Medium Sand	54.4	377.9	2068.0	~~2068~~	~~0~~	~~0~~	~~1137~~	~~69~~
679.74	1.00		43	Medium Sand	21.8	377.9	2089.8	~~2090~~	~~0~~	~~0~~	~~1149~~	~~70~~
678.74	1.00		43	Medium Sand	21.8	377.9	2111.5	~~2112~~	~~0~~	~~0~~	~~1161~~	~~71~~
678.24	0.50		43	Medium Sand	10.9	377.9	2324.6	~~2325~~	~~0~~	~~0~~	~~1279~~	~~71~~
676.74	1.50		66	Medium Sand		580.1						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

Illinois Department of Transportation

SUBSTRUCTURE===================================== South Abutment
REFERENCE BORING ================================= B-01
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 749.68 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 737.68 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 ============== 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts =========== 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts =========== 64.06 KIPS

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

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**406** KIPS	**223** KIPS	**61** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
735.74	1.94		37	Medium Sand	6.1		35.6	8.9		***12.1***	12	0	0	7	14
734.74	1.00		41	Medium Sand	3.7	29.5	54.4	5.5	3.2	***19.3***	19	0	0	11	15
733.24	1.50		41	Medium Sand	5.6	44.6	51.4	8.2	4.9	***26.5***	27	0	0	15	16
732.24	1.00		27	Medium Sand	2.0	36.0	63.3	2.9	3.9	***30.5***	31	0	0	17	17
730.74	1.50		27	Medium Sand	3.0	45.9	109.9	4.3	5.0	***39.6***	40	0	0	22	19
729.74	1.00		46	Medium Sand	4.6	89.5	131.4	6.7	9.8	***48.2***	48	0	0	27	20
728.24	1.50		46	Medium Sand	6.9	106.4	191.2	10.1	11.6	***64.1***	64	0	0	35	21
725.74	2.50		65	Medium Sand	21.7	159.2	173.6	31.7	17.4	***91.5***	92	0	0	50	24
723.24	2.50		49	Medium Sand	13.0	120.0	113.1	19.0	13.1	***102.5***	102	0	0	56	26
720.74	2.50		19	Medium Sand	3.4	46.5	116.6	5.0	5.1	***107.5***	107	0	0	59	29
718.24	2.50		19	Medium Sand	3.4	46.5	196.0	5.0	5.1	***120.8***	121	0	0	66	31
715.74	2.50		50	Medium Sand	13.5	122.5	209.5	19.7	13.4	***140.6***	141	0	0	77	34
713.24	2.50		50	Medium Sand	13.5	122.5	223.0	19.7	13.4	***160.3***	160	0	0	88	36
710.74	2.50		50	Medium Sand	13.5	122.5	236.5	19.7	13.4	***180.1***	180	0	0	99	39
708.24	2.50		50	Medium Sand	13.5	122.5	316.1	19.7	13.4	***207.0***	207	0	0	114	41
705.74	2.50		77	Medium Sand	28.3	188.6	344.4	41.3	20.6	***248.4***	248	0	0	137	44
703.24	2.50		77	Medium Sand	28.3	188.6	306.5	41.3	20.6	***282.5***	282	0	0	155	46
700.74	2.50		50	Medium Sand	13.5	122.5	320.0	19.7	13.4	***302.2***	302	0	0	166	49
698.24	2.50		50	Medium Sand	13.5	122.5	***255.1***	19.7	13.4	313.4	255	0	0	140	51
695.74	2.50		18	Medium Sand	3.3	44.1	***258.4***	4.8	4.8	318.2	258	0	0	142	54
693.24	2.50		18	Medium Sand	3.3	44.1	411.1	4.8	4.8	***339.3***	339	0	0	187	56
690.74	2.50		79	Medium Sand	29.4	193.5	440.5	43.0	21.2	***382.2***	382	0	0	210	59
688.24	2.50		79	Medium Sand	29.4	193.5	***406.1***	43.0	21.2	418.2	406	0	0	223	61
685.74	2.50		53	Medium Sand	15.1	129.8	***421.2***	22.1	14.2	440.3	~~421~~	~~0~~	~~0~~	~~232~~	~~64~~
683.24	2.50		53	Medium Sand	15.1	129.8	***411.9***	22.1	14.2	459.7	412	0	0	227	66
680.74	2.50		43	Medium Sand	10.2	105.3	***422.1***	14.9	11.5	474.6	~~422~~	~~0~~	~~0~~	~~232~~	~~69~~
679.74	1.00		43	Medium Sand	4.1	105.3	***426.1***	6.0	11.5	480.6	~~426~~	~~0~~	~~0~~	~~234~~	~~70~~
678.74	1.00		43	Medium Sand	4.1	105.3	***430.2***	6.0	11.5	486.5	~~430~~	~~0~~	~~0~~	~~237~~	~~71~~
678.24	0.50		43	Medium Sand	2.0	105.3	***488.6***	3.0	11.5	495.7	~~489~~	~~0~~	~~0~~	~~269~~	~~71~~
676.74	1.50		66	Medium Sand		161.7			17.7						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

Illinois Department of Transportation

SUBSTRUCTURE==================================== South Abutment
REFERENCE BORING ================================ B-01
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 749.68 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 737.68 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 ============= 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts =========== 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts =========== 64.06 KIPS

PILE TYPE AND SIZE ============= Steel HP 12 X 63
Plugged Pile Perimeter========================= 4.000 FT. Unplugged Pile Perimeter============= 5.883 FT.
Plugged Pile End Bearing Area=================== 1.000 SQFT. Unplugged Pile End Bearing Area======= 0.128 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
497 KIPS	**494** KIPS	**272** KIPS	*** Below Boring

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.)
735.74	1.94		37	Medium Sand	6.1		36.2	9.0		***12.9***	13	0	0	7	14
734.74	1.00		41	Medium Sand	3.8	30.0	55.3	5.6	3.8	***20.4***	20	0	0	11	15
733.24	1.50		41	Medium Sand	5.7	45.4	52.2	8.3	5.8	***27.6***	28	0	0	15	16
732.24	1.00		27	Medium Sand	2.0	36.6	64.3	2.9	4.7	***31.8***	32	0	0	17	17
730.74	1.50		27	Medium Sand	3.0	46.7	111.5	4.4	6.0	***41.9***	42	0	0	23	19
729.74	1.00		46	Medium Sand	4.7	91.0	133.4	6.8	11.6	***50.9***	51	0	0	28	20
728.24	1.50		46	Medium Sand	7.0	108.2	194.1	10.3	13.8	***68.0***	68	0	0	37	21
725.74	2.50		65	Medium Sand	21.9	161.9	176.1	32.2	20.7	***95.1***	95	0	0	52	24
723.24	2.50		49	Medium Sand	13.1	122.1	114.5	19.3	15.6	***104.8***	105	0	0	58	26
720.74	2.50		19	Medium Sand	3.5	47.3	118.0	5.1	6.0	***109.9***	110	0	0	60	29
718.24	2.50		19	Medium Sand	3.5	47.3	198.6	5.1	6.0	***124.9***	125	0	0	69	31
715.74	2.50		50	Medium Sand	13.6	124.6	212.3	20.0	15.9	***144.9***	145	0	0	80	34
713.24	2.50		50	Medium Sand	13.6	124.6	225.9	20.0	15.9	***164.9***	165	0	0	91	36
710.74	2.50		50	Medium Sand	13.6	124.6	239.5	20.0	15.9	***185.0***	185	0	0	102	39
708.24	2.50		50	Medium Sand	13.6	124.6	320.4	20.0	15.9	***213.6***	214	0	0	117	41
705.74	2.50		77	Medium Sand	28.5	191.8	348.9	41.9	24.5	***255.5***	256	0	0	141	44
703.24	2.50		77	Medium Sand	28.5	191.8	310.1	41.9	24.5	***288.9***	289	0	0	159	46
700.74	2.50		50	Medium Sand	13.6	124.6	323.8	20.0	15.9	***308.9***	309	0	0	170	49
698.24	2.50		50	Medium Sand	13.6	124.6	***257.7***	20.0	15.9	318.7	258	0	0	142	51
695.74	2.50		18	Medium Sand	3.3	44.8	***260.9***	4.8	5.7	323.6	261	0	0	144	54
693.24	2.50		18	Medium Sand	3.3	44.8	416.2	4.8	5.7	***347.8***	348	0	0	191	56
690.74	2.50		79	Medium Sand	29.6	196.8	445.8	43.6	25.2	***391.4***	391	0	0	215	59
688.24	2.50		79	Medium Sand	29.6	196.8	***410.7***	43.6	25.2	426.7	411	0	0	226	61
685.74	2.50		53	Medium Sand	15.2	132.0	***425.9***	22.4	16.9	449.1	426	0	0	234	64
683.24	2.50		53	Medium Sand	15.2	132.0	***416.2***	22.4	16.9	468.3	416	0	0	229	66
680.74	2.50		43	Medium Sand	10.3	107.1	***426.5***	15.1	13.7	483.4	426	0	0	235	69
679.74	1.00		43	Medium Sand	4.1	107.1	***430.6***	6.0	13.7	489.5	431	0	0	237	70
678.74	1.00		43	Medium Sand	4.1	107.1	***434.7***	6.0	13.7	495.5	435	0	0	239	71
678.24	0.50		43	Medium Sand	2.1	107.1	***494.1***	3.0	13.7	505.9	494	0	0	272	71
676.74	1.50		66	Medium Sand		164.4			21.0						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== South Abutment
REFERENCE BORING ================================ B-01
LRFD or ASD or SEISMIC ============================= LRFD
PILE CUTOFF ELEV. ================================= 749.68 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 737.68 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 ============== 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 64.06 KIPS

PILE TYPE AND SIZE ============= Steel HP 14 X 73
Plugged Pile Perimeter========================== 4.700 FT. Unplugged Pile Perimeter============== 6.975 FT.
Plugged Pile End Bearing Area==================== 1.379 SQFT. Unplugged Pile End Bearing Area======== 0.149 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
578 KIPS	**533** KIPS	**293** KIPS	**71** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
735.74	1.94		37	Medium Sand	7.2		42.7	10.7		***14.5***	15	0	0	8	14
734.74	1.00		41	Medium Sand	4.4	35.5	65.3	6.6	3.8	***23.1***	23	0	0	13	15
733.24	1.50		41	Medium Sand	6.7	53.6	61.6	9.9	5.8	***31.8***	32	0	0	18	16
732.24	1.00		27	Medium Sand	2.3	43.3	75.8	3.5	4.7	***36.6***	37	0	0	20	17
730.74	1.50		27	Medium Sand	3.5	55.2	131.7	5.2	5.9	***47.4***	47	0	0	26	19
729.74	1.00		46	Medium Sand	5.5	107.5	157.5	8.1	11.6	***57.7***	58	0	0	32	20
728.24	1.50		46	Medium Sand	8.2	127.9	261.1	12.2	13.8	***80.2***	80	0	0	44	21
725.74	2.50		65	Medium Sand	25.7	223.3	231.8	38.1	24.1	***112.4***	112	0	0	62	24
723.24	2.50		49	Medium Sand	15.4	168.3	144.2	22.8	18.1	***124.1***	124	0	0	68	26
720.74	2.50		19	Medium Sand	4.1	65.3	148.2	6.0	7.0	***130.2***	130	0	0	72	29
718.24	2.50		19	Medium Sand	4.1	65.3	258.8	6.0	7.0	***147.7***	148	0	0	81	31
715.74	2.50		50	Medium Sand	16.0	171.8	274.8	23.7	18.5	***171.4***	171	0	0	94	34
713.24	2.50		50	Medium Sand	16.0	171.8	290.8	23.7	18.5	***195.2***	195	0	0	107	36
710.74	2.50		50	Medium Sand	16.0	171.8	306.8	23.7	18.5	***218.9***	219	0	0	120	39
708.24	2.50		50	Medium Sand	16.0	171.8	415.6	23.7	18.5	***252.7***	253	0	0	139	41
705.74	2.50		77	Medium Sand	33.5	264.5	449.1	49.7	28.5	***302.4***	302	0	0	166	44
703.24	2.50		77	Medium Sand	33.5	264.5	389.8	49.7	28.5	***342.1***	342	0	0	188	46
700.74	2.50		50	Medium Sand	16.0	171.8	405.8	23.7	18.5	***365.9***	366	0	0	201	49
698.24	2.50		50	Medium Sand	16.0	171.8	***311.9***	23.7	18.5	377.8	312	0	0	172	51
695.74	2.50		18	Medium Sand	3.9	61.8	***315.7***	5.7	6.7	383.5	316	0	0	174	54
693.24	2.50		18	Medium Sand	3.9	61.8	529.2	5.7	6.7	***411.8***	412	0	0	226	56
690.74	2.50		79	Medium Sand	34.8	271.4	564.0	51.7	29.2	***463.4***	463	0	0	255	59
688.24	2.50		79	Medium Sand	34.8	271.4	509.4	51.7	29.2	***505.5***	505	0	0	278	61
685.74	2.50		53	Medium Sand	17.9	182.1	***527.4***	26.6	19.6	532.0	527	0	0	290	64
683.24	2.50		53	Medium Sand	17.9	182.1	***510.9***	26.6	19.6	554.9	511	0	0	281	66
680.74	2.50		43	Medium Sand	12.1	147.7	***523.0***	17.9	15.9	572.8	523	0	0	288	69
679.74	1.00		43	Medium Sand	4.8	147.7	***527.8***	7.2	15.9	580.0	528	0	0	290	70
678.74	1.00		43	Medium Sand	4.8	147.7	***532.6***	7.2	15.9	587.2	533	0	0	293	71
678.24	0.50		43	Medium Sand	2.4	147.7	614.1	3.6	15.9	**599.3**	~~599~~	~~0~~	~~0~~	~~330~~	~~71~~
676.74	1.50		66	Medium Sand		226.7			24.4						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

Illinois Department of Transportation

SUBSTRUCTURE==================================== North Abutment
REFERENCE BORING ================================ B-03
LRFD or ASD or SEISMIC ============================= LRFD
PILE CUTOFF ELEV. ================================= 751.70 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 739.70 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 ============= 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts =========== 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts =========== 64.06 KIPS

PILE TYPE AND SIZE ============= Metal Shell 14"Φ w/.312" walls
Pile Perimeter============================= 3.665 FT.
Pile End Bearing Area========================== 1.069 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
570 KIPS	**553** KIPS	**304** KIPS	**34** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL 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.)
737.57	2.13		40	Medium Sand	35.7		***94.4***	94	0	0	52	14
735.07	2.50		22	Medium Sand	18.6	58.8	***189.9***	190	0	0	104	17
732.57	2.50		33	Medium Sand	30.5	135.7	***240.2***	240	0	0	132	19
730.07	2.50		28	Medium Sand	24.1	155.5	***445.3***	445	0	0	245	22
727.57	2.50		50	Medium Sand	63.1	336.5	***183.6***	184	0	0	101	24
725.07	2.50	1.00	65		10.2	11.7	***193.8***	194	0	0	107	27
722.57	2.50	1.00	65		10.2	11.7	***206.9***	207	0	0	114	29
720.07	2.50	1.25	57		12.1	14.7	***219.1***	219	0	0	120	32
717.57	2.50	1.25	57		12.1	14.7	***553.0***	553	0	0	304	34
715.07	2.50		50	Medium Sand	63.1	336.5	***616.0***	~~616~~	~~0~~	~~0~~	~~339~~	~~37~~
712.57	2.50		50	Medium Sand	63.1	336.5	***679.1***	~~679~~	~~0~~	~~0~~	~~373~~	~~39~~
710.07	2.50		50	Medium Sand	63.1	336.5	***742.1***	~~742~~	~~0~~	~~0~~	~~408~~	~~42~~
707.57	2.50		50	Medium Sand	63.1	336.5	***892.7***	~~893~~	~~0~~	~~0~~	~~491~~	~~44~~
705.07	2.50		63	Medium Sand	96.1	424.0	***988.8***	~~989~~	~~0~~	~~0~~	~~544~~	~~47~~
702.57	2.50		63	Medium Sand	96.1	424.0	***1037.8***	~~1038~~	~~0~~	~~0~~	~~571~~	~~49~~
700.07	2.50		56	Medium Sand	78.1	376.8	***1115.9***	~~1116~~	~~0~~	~~0~~	~~614~~	~~52~~
697.57	2.50		56	Medium Sand	78.1	376.8	***1086.4***	~~1086~~	~~0~~	~~0~~	~~597~~	~~54~~
695.07	2.50		40	Medium Sand	41.9	269.2	***1128.2***	~~1128~~	~~0~~	~~0~~	~~621~~	~~57~~
692.57	2.50		40	Medium Sand	41.9	269.2	***1223.9***	~~1224~~	~~0~~	~~0~~	~~673~~	~~59~~
690.07	2.50		48	Medium Sand	58.3	323.0	***1282.3***	~~1282~~	~~0~~	~~0~~	~~705~~	~~62~~
687.57	2.50		48	Medium Sand	58.3	323.0	***1340.6***	~~1341~~	~~0~~	~~0~~	~~737~~	~~64~~
685.07	2.50		48	Medium Sand	58.3	323.0	***1399.0***	~~1399~~	~~0~~	~~0~~	~~769~~	~~67~~
682.57	2.50		48	Medium Sand	58.3	323.0	***1376.6***	~~1377~~	~~0~~	~~0~~	~~757~~	~~69~~
681.07	1.50		36	Medium Sand		242.3						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

Illinois Department of Transportation

SUBSTRUCTURE==================================== North Abutment
REFERENCE BORING ================================ B-03
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================== 751.70 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 739.70 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 ============== 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts =========== 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts =========== 64.06 KIPS

PILE TYPE AND SIZE ============= Metal Shell 16"Φ w/.375" walls
Plugged Pile Perimeter========================= 4.189 FT.
Plugged Pile End Bearing Area=================== 1.396 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
782 KIPS	**759** KIPS	**417** KIPS	**37** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL 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.)
737.57	2.13		40	Medium Sand	40.8		***117.5***	118	0	0	65	14
735.07	2.50		22	Medium Sand	21.2	76.7	***239.2***	239	0	0	132	17
732.57	2.50		33	Medium Sand	34.9	177.3	***300.0***	300	0	0	165	19
730.07	2.50		28	Medium Sand	27.6	203.1	***563.9***	564	0	0	310	22
727.57	2.50		50	Medium Sand	72.1	439.5	***211.8***	212	0	0	116	24
725.07	2.50	1.00	65		11.6	15.3	***223.4***	223	0	0	123	27
722.57	2.50	1.00	65		11.6	15.3	***238.9***	239	0	0	131	29
720.07	2.50	1.25	57		13.8	19.1	***252.7***	253	0	0	139	32
717.57	2.50	1.25	57		13.8	19.1	***686.9***	687	0	0	378	34
715.07	2.50		50	Medium Sand	72.1	439.5	***759.0***	759	0	0	417	37
712.57	2.50		50	Medium Sand	72.1	439.5	***831.0***	~~831~~	~~0~~	~~0~~	~~457~~	~~39~~
710.07	2.50		50	Medium Sand	72.1	439.5	***903.1***	~~903~~	~~0~~	~~0~~	~~497~~	~~42~~
707.57	2.50		50	Medium Sand	72.1	439.5	***1089.4***	~~1089~~	~~0~~	~~0~~	~~599~~	~~44~~
705.07	2.50		63	Medium Sand	109.8	553.7	***1199.2***	~~1199~~	~~0~~	~~0~~	~~660~~	~~47~~
702.57	2.50		63	Medium Sand	109.8	553.7	***1247.5***	~~1248~~	~~0~~	~~0~~	~~686~~	~~49~~
700.07	2.50		56	Medium Sand	89.3	492.2	***1336.8***	~~1337~~	~~0~~	~~0~~	~~735~~	~~52~~
697.57	2.50		56	Medium Sand	89.3	492.2	***1285.5***	~~1285~~	~~0~~	~~0~~	~~707~~	~~54~~
695.07	2.50		40	Medium Sand	47.8	351.6	***1333.3***	~~1333~~	~~0~~	~~0~~	~~733~~	~~57~~
692.57	2.50		40	Medium Sand	47.8	351.6	***1451.5***	~~1451~~	~~0~~	~~0~~	~~798~~	~~59~~
690.07	2.50		48	Medium Sand	66.7	421.9	***1518.2***	~~1518~~	~~0~~	~~0~~	~~835~~	~~62~~
687.57	2.50		48	Medium Sand	66.7	421.9	***1584.9***	~~1585~~	~~0~~	~~0~~	~~872~~	~~64~~
685.07	2.50		48	Medium Sand	66.7	421.9	***1651.5***	~~1652~~	~~0~~	~~0~~	~~908~~	~~67~~
682.57	2.50		48	Medium Sand	66.7	421.9	***1612.8***	~~1613~~	~~0~~	~~0~~	~~887~~	~~69~~
681.07	1.50		36	Medium Sand		316.4						

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

Illinois Department of Transportation

SUBSTRUCTURE==================================== North Abutment
REFERENCE BORING ================================ B-03
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 751.70 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 739.70 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ================= ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
418 KIPS	**352** KIPS	**194** KIPS	*** Below Boring

TOTAL FACTORED SUBSTRUCTURE LOAD ============= 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts =========== 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts =========== 64.06 KIPS

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

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
737.57	2.13		40	Medium Sand	7.6		32.6	11.2		***13.9***	14	0	0	8	14
735.07	2.50		22	Medium Sand	4.0	25.0	69.3	5.8	2.7	***23.3***	23	0	0	13	17
732.57	2.50		33	Medium Sand	6.5	57.6	84.2	9.5	6.3	***33.8***	34	0	0	19	19
730.07	2.50		28	Medium Sand	5.2	66.1	145.8	7.6	7.2	***47.5***	47	0	0	26	22
727.57	2.50		50	Medium Sand	13.5	122.5	***50.6***	19.7	13.4	55.3	51	0	0	28	24
725.07	2.50	1.00	65		7.0	13.8	***57.6***	10.3	1.5	65.6	58	0	0	32	27
722.57	2.50	1.00	65		7.0	13.8	***68.1***	10.3	1.5	76.3	68	0	0	37	29
720.07	2.50	1.25	57		8.4	17.2	***76.5***	12.3	1.9	88.6	77	0	0	42	32
717.57	2.50	1.25	57		8.4	17.2	190.2	12.3	1.9	***112.3***	112	0	0	62	34
715.07	2.50		50	Medium Sand	13.5	122.5	203.7	19.7	13.4	***132.1***	132	0	0	73	37
712.57	2.50		50	Medium Sand	13.5	122.5	217.2	19.7	13.4	***151.8***	152	0	0	84	39
710.07	2.50		50	Medium Sand	13.5	122.5	230.7	19.7	13.4	***171.6***	172	0	0	94	42
707.57	2.50		50	Medium Sand	13.5	122.5	276.0	19.7	13.4	***194.8***	195	0	0	107	44
705.07	2.50		63	Medium Sand	20.6	154.3	296.6	30.1	16.9	***224.9***	225	0	0	124	47
702.57	2.50		63	Medium Sand	20.6	154.3	300.0	30.1	16.9	***253.1***	253	0	0	139	49
700.07	2.50		56	Medium Sand	16.7	137.2	316.8	24.5	15.0	***277.6***	278	0	0	153	52
697.57	2.50		56	Medium Sand	16.7	137.2	***294.3***	24.5	15.0	297.8	294	0	0	162	54
695.07	2.50		40	Medium Sand	9.0	98.0	***303.3***	13.1	10.7	310.9	303	0	0	167	57
692.57	2.50		40	Medium Sand	9.0	98.0	331.8	13.1	10.7	***326.1***	326	0	0	179	59
690.07	2.50		48	Medium Sand	12.5	117.6	***344.3***	18.3	12.9	344.4	344	0	0	189	62
687.57	2.50		48	Medium Sand	12.5	117.6	***356.8***	18.3	12.9	362.7	357	0	0	196	64
685.07	2.50		48	Medium Sand	12.5	117.6	***369.3***	18.3	12.9	380.9	369	0	0	203	67
682.57	2.50		48	Medium Sand	12.5	117.6	***352.4***	18.3	12.9	396.0	352	0	0	194	69
681.07	1.50		36	Medium Sand		88.2			9.7						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== North Abutment
REFERENCE BORING ================================ B-03
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 751.70 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 739.70 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 ============== 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 64.06 KIPS

PILE TYPE AND SIZE ============= Steel HP 12 X 63
Plugged Pile Perimeter========================= 4.000 FT. Unplugged Pile Perimeter============= 5.883 FT.
Plugged Pile End Bearing Area=================== 1.000 SQFT. Unplugged Pile End Bearing Area======== 0.128 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
497 KIPS	**356** KIPS	**196** KIPS	*** Below Boring

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.)
737.57	2.13		40	Medium Sand	7.7		33.1	11.3		***14.6***	15	0	0	8	14
735.07	2.50		22	Medium Sand	4.0	25.4	70.3	5.9	3.2	***24.7***	25	0	0	14	17
732.57	2.50		33	Medium Sand	6.6	58.6	85.5	9.7	7.5	***35.5***	35	0	0	20	19
730.07	2.50		28	Medium Sand	5.2	67.2	148.1	7.7	8.6	***50.5***	50	0	0	28	22
727.57	2.50		50	Medium Sand	13.6	124.6	***51.1***	20.0	15.9	56.4	51	0	0	28	24
725.07	2.50	1.00	65		7.1	14.0	***58.2***	10.5	1.8	66.8	58	0	0	32	27
722.57	2.50	1.00	65		7.1	14.0	***68.9***	10.5	1.8	77.7	69	0	0	38	29
720.07	2.50	1.25	57		8.4	17.5	***77.3***	12.4	2.2	90.2	77	0	0	43	32
717.57	2.50	1.25	57		8.4	17.5	192.8	12.4	2.2	***116.3***	116	0	0	64	34
715.07	2.50		50	Medium Sand	13.6	124.6	206.4	20.0	15.9	***136.3***	136	0	0	75	37
712.57	2.50		50	Medium Sand	13.6	124.6	220.0	20.0	15.9	***156.3***	156	0	0	86	39
710.07	2.50		50	Medium Sand	13.6	124.6	233.6	20.0	15.9	***176.4***	176	0	0	97	42
707.57	2.50		50	Medium Sand	13.6	124.6	279.6	20.0	15.9	***200.5***	201	0	0	110	44
705.07	2.50		63	Medium Sand	20.8	156.9	300.4	30.5	20.1	***231.1***	231	0	0	127	47
702.57	2.50		63	Medium Sand	20.8	156.9	303.7	30.5	20.1	***259.4***	259	0	0	143	49
700.07	2.50		56	Medium Sand	16.9	139.5	320.6	24.8	17.8	***284.2***	284	0	0	156	52
697.57	2.50		56	Medium Sand	16.9	139.5	***297.6***	24.8	17.8	303.9	298	0	0	164	54
695.07	2.50		40	Medium Sand	9.0	99.7	***306.6***	13.3	12.7	317.2	307	0	0	169	57
692.57	2.50		40	Medium Sand	9.0	99.7	335.6	13.3	12.7	***333.0***	333	0	0	183	59
690.07	2.50		48	Medium Sand	12.6	119.6	***348.2***	18.5	15.3	351.6	348	0	0	192	62
687.57	2.50		48	Medium Sand	12.6	119.6	***360.8***	18.5	15.3	370.1	361	0	0	198	64
685.07	2.50		48	Medium Sand	12.6	119.6	***373.4***	18.5	15.3	388.6	373	0	0	205	67
682.57	2.50		48	Medium Sand	12.6	119.6	***356.1***	18.5	15.3	403.4	356	0	0	196	69
681.07	1.50		36	Medium Sand		89.7			11.5						

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== North Abutment
REFERENCE BORING ================================ B-03
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================= 751.70 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 739.70 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 ============== 2171 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========= 101.67 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ====== 1
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 170.83 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 64.06 KIPS

PILE TYPE AND SIZE ============= Steel HP 14 X 73
Plugged Pile Perimeter========================== 4.700 FT. Unplugged Pile Perimeter============== 6.975 FT.
Plugged Pile End Bearing Area==================== 1.379 SQFT. Unplugged Pile End Bearing Area======== 0.149 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
578 KIPS	**437** KIPS	**240** KIPS	*** Below Boring

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.)
737.57	2.13		40	Medium Sand	9.1		39.0	13.4		***16.7***	17	0	0	9	14
735.07	2.50		22	Medium Sand	4.7	30.0	83.0	7.0	3.2	***27.9***	28	0	0	15	17
732.57	2.50		33	Medium Sand	7.7	69.3	100.9	11.5	7.5	***40.5***	40	0	0	22	19
730.07	2.50		28	Medium Sand	6.1	79.4	199.4	9.1	8.6	***59.5***	60	0	0	33	22
727.57	2.50		50	Medium Sand	16.0	171.8	***62.9***	23.7	18.5	66.8	63	0	0	35	24
725.07	2.50	1.00	65		8.3	19.3	***71.3***	12.4	2.1	79.2	71	0	0	39	27
722.57	2.50	1.00	65		8.3	19.3	***84.5***	12.4	2.1	92.1	84	0	0	46	29
720.07	2.50	1.25	57		9.9	24.2	***94.4***	14.7	2.6	106.8	94	0	0	52	32
717.57	2.50	1.25	57		9.9	24.2	251.9	14.7	2.6	***137.5***	137	0	0	76	34
715.07	2.50		50	Medium Sand	16.0	171.8	267.9	23.7	18.5	***161.2***	161	0	0	89	37
712.57	2.50		50	Medium Sand	16.0	171.8	283.9	23.7	18.5	***185.0***	185	0	0	102	39
710.07	2.50		50	Medium Sand	16.0	171.8	299.9	23.7	18.5	***208.7***	209	0	0	115	42
707.57	2.50		50	Medium Sand	16.0	171.8	360.6	23.7	18.5	***237.3***	237	0	0	131	44
705.07	2.50		63	Medium Sand	24.4	216.4	385.0	36.2	23.3	***273.5***	273	0	0	150	47
702.57	2.50		63	Medium Sand	24.4	216.4	385.3	36.2	23.3	***307.1***	307	0	0	169	49
700.07	2.50		56	Medium Sand	19.8	192.4	405.2	29.4	20.7	***336.5***	336	0	0	185	52
697.57	2.50		56	Medium Sand	19.8	192.4	370.0	29.4	20.7	***360.0***	360	0	0	198	54
695.07	2.50		40	Medium Sand	10.6	137.4	380.6	15.8	14.8	***375.8***	376	0	0	207	57
692.57	2.50		40	Medium Sand	10.6	137.4	418.7	15.8	14.8	***394.5***	394	0	0	217	59
690.07	2.50		48	Medium Sand	14.8	164.9	433.5	22.0	17.8	***416.5***	416	0	0	229	62
687.57	2.50		48	Medium Sand	14.8	164.9	448.4	22.0	17.8	***438.4***	438	0	0	241	64
685.07	2.50		48	Medium Sand	14.8	164.9	463.2	22.0	17.8	***460.4***	460	0	0	253	67
682.57	2.50		48	Medium Sand	14.8	164.9	***436.7***	22.0	17.8	477.9	437	0	0	240	69
681.07	1.50		36	Medium Sand		123.7			13.3						

Appendix G – Seismic Site Class Determination

SEISMIC SITE CLASS DETERMINATION

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

Modified on 12/10/10

PROJECT TITLE===== G19.073 IL 31 Bridge Replacement

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	747.68	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-01	
Top of Boring Elev.	751.7	ft.
Approximate Fixity Elev.	741.68	ft.

Individual Site Class Definition:

N (bar):	38	(Blows/ft.)	Soil Site Class D <----Controls
N_{ch} (bar):	38	(Blows/ft.)	Soil Site Class D
s_u (bar):		(ksf)	NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	748.2	2.50	20	2.00	B
	745.7	2.50	28		B
	743.2	2.50	51		B
1.0	740.7	2.50	42		B
3.5	738.2	2.50	22		B
6.0	735.7	2.50	37		B
8.5	733.2	2.50	41		B
11.0	730.7	2.50	27		B
13.5	728.2	2.50	36		B
16.0	725.7	2.50	65		B
18.5	723.2	2.50	49		B
23.5	718.2	5.00	19		B
28.5	713.2	5.00	50		B
33.5	708.2	5.00	50		B
38.5	703.2	5.00	77		B
43.5	698.2	5.00	50		B
48.5	693.2	5.00	18		B
53.5	688.2	5.00	79		B
58.5	683.2	5.00	53		B
63.5	678.2	5.00	43		B
65.0	676.7	1.50	66		B

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	730.78	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-02	
Top of Boring Elev.	737.2	ft.
Approximate Fixity Elev.	724.78	ft.

Individual Site Class Definition:

N (bar):	37	(Blows/ft.)	Soil Site Class D <----Controls
N_{ch} (bar):	37	(Blows/ft.)	Soil Site Class D
s_u (bar):		(ksf)	NA, H < 0.1*H (Soil)

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	733.7	2.50	20		B
	731.2	2.50	33		B
	728.7	2.50	31		B
	726.2	2.50	21		B
1.1	723.7	2.50	32	2.50	B
3.6	721.2	2.50	32		B
6.1	718.7	2.50	69		B
8.6	716.2	2.50	50		B
11.1	713.7	2.50	50		B
13.6	711.2	2.50	50		B
16.1	708.7	2.50	50		B
21.1	703.7	5.00	59		B
26.1	698.7	5.00	59		B
31.1	693.7	5.00	26		B
36.1	688.7	5.00	86		B
41.1	683.7	5.00	16		B
46.1	678.7	5.00	75		B
51.1	673.7	5.00	42		B
56.1	668.7	5.00	19		B
57.6	667.2	1.50	61		B

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)	749.7	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-03	
Top of Boring Elev.	756.1	ft.
Approximate Fixity Elev.	743.7	ft.

Individual Site Class Definition:

N (bar):	44	(Blows/ft.)	Soil Site Class D <----Controls
N_{ch} (bar):	41	(Blows/ft.)	Soil Site Class D
s_u (bar):	1.13	(ksf)	Soil Site Class D

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	752.6	2.50	47		B
	750.1	2.50	30		B
	747.6	2.50	25		B
	745.1	2.50	30		B
1.1	742.6	2.50	22		B
3.6	740.1	2.50	29		B
6.1	737.6	2.50	40		B
8.6	735.1	2.50	22		B
11.1	732.6	2.50	33		B
13.6	730.1	2.50	28		B
16.1	727.6	2.50	50		B
21.1	722.6	5.00	65	1.00	B
26.1	717.6	5.00	57	1.30	B
31.1	712.6	5.00	50		B
36.1	707.6	5.00	50		B
41.1	702.6	5.00	63		B
46.1	697.6	5.00	56		B
51.1	692.6	5.00	40		B
56.1	687.6	5.00	48		B
61.1	682.6	5.00	48		B
62.6	681.1	1.50	36		B

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)		ft.
Pile or Shaft Dia.		inches
Boring Number		
Top of Boring Elev.		ft.
Approximate Fixity Elev.		ft.

Individual Site Class Definition:

N (bar):		(Blows/ft.)	NA
N_{ch} (bar):		(Blows/ft.)	NA
s_u (bar):		(ksf)	NA

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary

Global Site Class Definition: Substructures 1 through 3

N (bar):	40	(Blows/ft.)	Soil Site Class D <----Controls
N_{ch} (bar):	39	(Blows/ft.)	Soil Site Class D
s_u (bar):		(ksf)	NA, H < 0.1*H (Total)