BACON | FARMER | WORKMAN

ENGINEERING & TESTING, INC.

STRUCTURE GEOTECHNICAL REPORT

IL 3 over Worthen Bayou
FAP Route 312
Section 130B-1
Existing Structure No. 039-0026
Proposed Structure No. 039-0083
Jackson County, Illinois

Prepared for:
Mr. Mike Cima, PE, SE
Director of Bridges & Structures
Quigg Engineering, Inc.
2351 S. Dirksen Parkway
Springfield, Illinois 62703

12/16/2024

CHRISTOPHER MATHEWS
062-067709
LICENSED
PROFESSIONAL
ENGINEER
STATE OF ILLINOIS

Exp. 11/30/2025

Submittal Date:

December 16, 2024

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.
521 WEST MAIN STREET | SUITE 200 | BELLEVILLE, IL 62220

December 16, 2024

Mr. Mike Cima, PE, SE
Director of Bridges & Structures
Quigg Engineering, Inc.
2351 S. Dirksen Parkway
Springfield, IL 62703

RE: ***Structure Geotechnical Report***
IL 3 over Worthen Bayou
Structure 039-0083
Jackson County, Illinois
BFW No: 23032

Dear Mr. Cima:

Bacon Farmer Workman Engineering & Testing, Inc. (BFW), is pleased to present the attached Structure Geotechnical Report for the referenced project. The foundation investigation was conducted in accordance with applicable IDOT and AASHTO Standards.

The attached report includes a review of pertinent project information, descriptions of site and subsurface conditions encountered, and our general recommendations for foundation design and construction of the proposed bridge.

Sincerely,

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

Shelby N. Livingstone, E.I.T.
Staff Engineer

Christopher L. Mathews, P.E.
Geotechnical Engineer/Project Manager

TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

1. PROJECT DESCRIPTION AND SCOPE

The purpose of this geotechnical study was to use the provided subsurface information to prepare geotechnical recommendations for the proposed bridge replacement.

The project consists of the removal and replacement of an existing 144'-6" three-span bridge on IL 3 over Worthen Bayou. The project site is located approximately 1.2 miles south of IL 149 in Jackson County, Illinois. The existing structure (SN 009-0026) was originally built in 1958 as SBI Route 150, section 130-BY.

The new structure (SN 039-0083) will be a two-lane 157'-6" two-span bridge with reinforced concrete decks on 42-inch web girders supported by integral abutments. Staged construction will be utilized during the replacement of the existing bridge. The structure will be designed according to the IDOT Bridge Manual and AASHTO LRFD Bridge Design Specifications. The site location is shown below in Figure 1.1. The TS&L prepared by Quigg Engineering, Inc. (QEI) is attached in Appendix A.

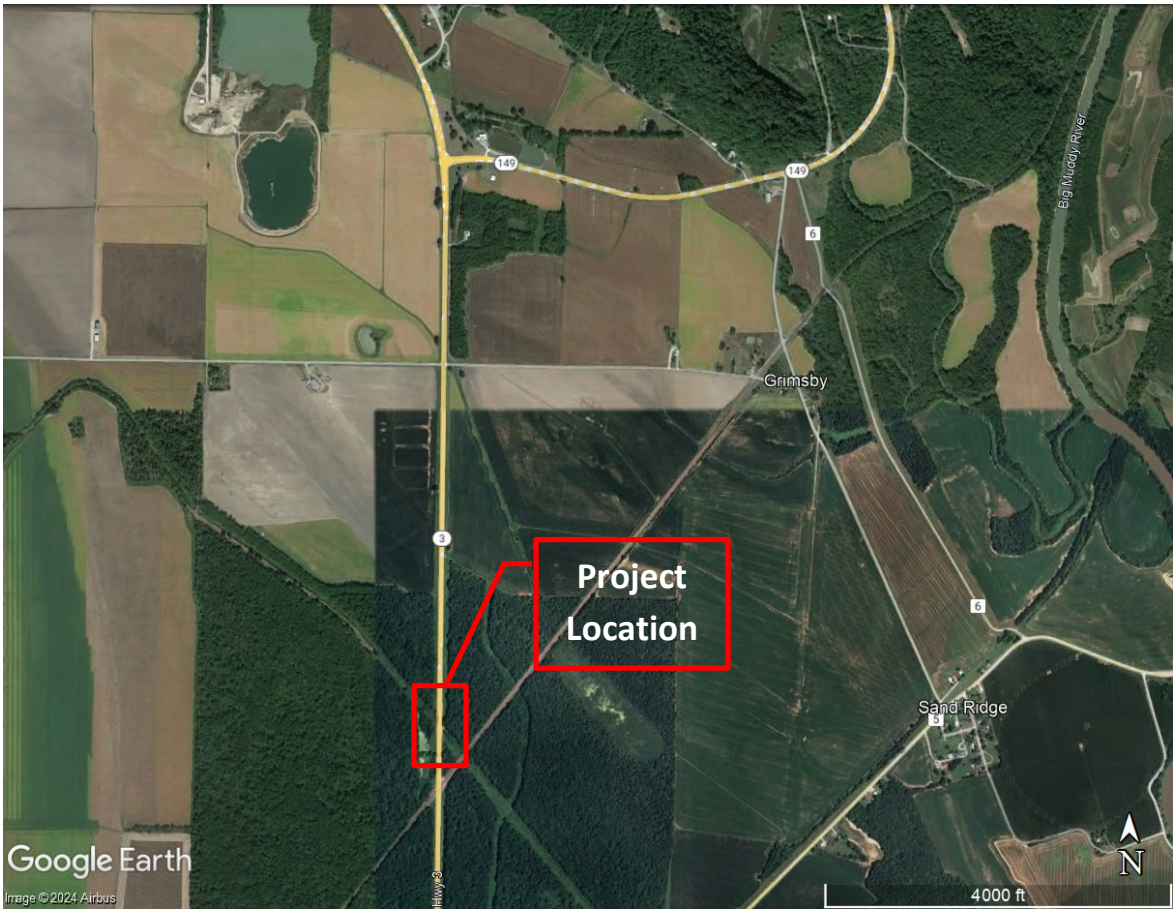


Figure 1.1. Project Location

2. FIELD EXPLORATION

The subsurface exploration was completed by IDOT in September 2022 and boring logs were provided to BFW in a letter dated October 25, 2022. Two borings labeled 1-S and 2-S were advanced in connection with this exploration, one boring near each of the existing north and south abutments. Based on the information included on the provided borings logs, the borings were advanced using 8-inch outside diameter hollow stem augers and SPT samples were collected with an auto hammer. An additional boring at the pier was completed by IDOT in October

2024 and the boring log was provided in a letter dated November 12, 2024. Three additional borings labeled 1 through 3 were completed by IDOT in 1958 and were provided in the October 25, 2022, letter. Table 2.1 summarizes the boring locations and depths. Additionally, the boring locations are shown on the provided draft TS&L in Appendix A.

Table 2.1 – Summary of Soil Testing Borings

Boring	Structure	Date of Drilling	Ground Surface Elevation (msl)	Depth (ft)	Station	Offset
1-S	South Abutment	September 2022	365.40	64.5	105+21	11' RT
2-S	North Abutment	September 2022	365.27	68.5	103+11	11' LT
3-S	Pier	October 2024	365.10	90.0	103+95	5.5' LT
1	South Abutment	January 1958	364.6	56.1	104+78	17' RT
2	North Abutment	January 1958	363.4	55.9	103+40	15' LT
3	Pier 1	January 1958	346.1	33.1	103+85	5' LT

2.1 *REGIONAL GEOLOGY*

According to the Illinois State Geological Survey's map titled *Bedrock Geology of Illinois,* this site is shown to be underlain by Pennsylvanian aged deposits of the Caseyville Formation. The Caseyville Formation is comprised of sandstone, shale, coal, and limestone. The sandstones are shown to be conglomeratic with the shale described as silty and carbonaceous in places.

2.2 *SUBSURFACE CONDITIONS*

The surface of borings 1-S and 2-S consisted of 4 to 4.5 inches of hot mix asphalt overlying 11 to 11.5 inches of concrete. Layers of clay, silty clay loam, and silty loam were encountered beneath the concrete extending to elevations 335 to 338. These cohesive to intermediate materials exhibited moisture contents of about 12 to 51 percent, unconfined compressive strengths of 0.2 to 1.65 tons per square foot (tsf), and SPT "N" values (blow counts) of 1 to 13 blows per foot (bpf), indicating a very soft to stiff consistency.

Sand and sandy loam otherwise predominated in borings 1-S and 2-S, extending to boring completion depths. Moisture contents of these materials ranged from 16 to 24 percent with SPT "N" values of 5 to 37 bpf, indicating a loose to dense density. Loose to medium dense sand also predominated for the entire depth of 1-S, extending to the depth of boring termination. Rock was not encountered in either boring.

Borings 1-3 encountered layers of clay and sandy clay extending to elevations 337 to 340. SPT "N" values of these materials ranged from 1 to 4 bpf, indicating a very soft to soft consistency. Layers of sand with varying amounts of gravel predominated beneath the clays, exhibiting SPT "N" values of 11 to over 50 bpf, indicating a firm to very dense density.

2.3 *GROUNDWATER*

Groundwater was encountered at 25 feet below ground surface in boring 2-S at the time of drilling activities. Groundwater was not encountered to a depth of 25 feet in boring 1-S, after which the boring was advanced using rotary wash drilling methods. The introduction of drilling mud into the borehole makes subsequent water level readings of dubious value. It should be noted that the ground water level is dependent upon seasonal and climatic variations and may be present at different depths in the future.

3. GEOTECHNICAL EVALUATIONS

Based on the results of the subsurface exploration, current site conditions observed, and laboratory results, and our review of the project plans, the following geotechnical evaluations were performed. The recommendations developed from these evaluations should be used in the design of the bridge structures.

3.1 *BASIS FOR RECOMMENDATIONS*

The following recommendations are based on data from this exploration and the stated project information. In our evaluations, we have utilized both subsurface data provided by IDOT and our experience with similar structures and subsurface conditions. If the structural information is incorrect or changed after our reporting, or if the subsurface conditions encountered during the construction vary from those reported, our recommendations should be reviewed based on the changed conditions.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized based on soil test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil-engineering services during the site preparation, excavation, and foundation construction phases of the proposed project. The geotechnical engineer should observe compliance with the design concepts, specifications, and recommendations, and allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.2 *SEISMIC CONSIDERATIONS*

3.2.1 Design Earthquake

The 2023 AASHTO Seismic Hazard, as referenced by the draft *IDOT 2024 Seismic Manual*, provides design accelerations consistent with an Upper-Level ground motion. This hazard provides accelerations consistent with a 1.5% probability of incipient column collapse in 75 years, or a collapse-based return period of 5,000 years. The design earthquake has a Moment Magnitude (Mw) of 7.8 and a Peak Ground Acceleration (PGA) of 0.33g as determined from data provided by the United States Geological Survey (USGS) National Seismic Hazard Mapping Project.

3.2.2 Seismic Site Classification and Design Parameters

The seismic site classification for the site was determined based on the subsurface data collected and the procedures outlined in the draft *IDOT 2024 Seismic Manual*. Specifically, the procedures outlined in Section 3.2 of the manual were utilized to convert N values to shear wave velocity. The weighted averaged shear wave velocity of the upper 100 feet of the seismic soil column at each structure was then calculated. Based on the weighted average shear wave velocity profile in the upper 100 feet of the seismic soil column, Site Class DE should be used for seismic design. Site class calculations are included in Appendix C. Seismic design parameters are presented in Table 3.1.

Table 3.1 – Seismic Design Parameters

Seismic Design Parameters	
Performance Level	Operational
Latitude	37.74
Longitude	-89.46
Site Class	DE
S_{D1}	0.335
SDC	C

3.2.3 Liquefaction Analysis

The liquefaction potential analysis for the site was conducted using field and laboratory data and the techniques outlined in AGMU 10.1. The average seasonal groundwater elevation used in the analysis was estimated from the end of boring conditions and the seasonal weather conditions. Sands located above the groundwater table are not susceptible to liquefaction.

Based on our analyses, most of the soils have sufficient strength and/or a plasticity index that makes the threat of liquefaction minimal during the design earthquake. However, an isolated relatively thin (less than 5 feet) layer of loose sand encountered within boring 2-S (north abutment) may be susceptible to liquefaction during a design event. It is anticipated that the piles for the north abutment will extend through

the potentially liquefiable soils. Additionally, the unbraced length of the piles during liquefaction should not be a concern as the potentially liquefiable layers are relatively thin (less than 5 feet thick). While the amount of the seismically induced settlement is dependent on the magnitude and distance from the seismic event, we estimate that the impacts from the design earthquake will be negligible due to the isolated nature of the potentially liquefiable soils and liquefaction mitigation techniques are not required. The liquefaction analysis results are presented in Appendix D.

3.3 *ABUTMENT APPROACH SETTLEMENT*

Based on the provided draft TS&L prepared by QEI, minimal grade changes will be required. Accordingly, minimal abutment settlement will occur and the effects of downdrag do not need to be considered in the evaluation of pile capacity.

3.4 *BRIDGE APPROACH SLABS*

The bridge approach slabs should be designed to bear on existing embankment soils or newly placed low plasticity structural fill. In evaluating the bearing resistance of the slabs, we recommend using a modulus of subgrade reaction of 150 pounds per cubic inch per inch of deflection (pci).

3.5 *BRIDGE FOUNDATIONS*

The bridge foundations must be designed to provide sufficient capacity to resist dead and live loads, including seismic loads. The estimated axial substructure loads provided by QEI are summarized in Table 3.2.

Table 3.2 – Substructure Axial Loads

Substructure Location	Loading Condition	Axial Load (kips/pile),
North Abutment Est. 6 Piles	Service	258
	Strength-I	396
	Extreme Event-I	141
Pier Est. 16 Piles	Service	185
	Strength-I	267
	Extreme Event-I	156
South Abutment Est. 6 Piles	Service	278
	Strength-I	425
	Extreme Event-I	158

Based on the provided boring logs, piles designed to achieve their capacity via soil friction should be utilized for foundation support of the bridges. The structural capacity of driven piles is dependent upon the cross-sectional area of the pile and the allowable stress of the steel. The driven pile recommendations in this report assume the piles will conform to AASHTO M270 Grade 50 steel with a minimum yield stress of 50 kips per square inch (ksi). The piles should be spaced no closer than three pile diameters, center to center.

The IDOT Modified Static Method Excel spreadsheet was used to estimate the pile lengths at various axial geotechnical resistances for driven piles per AGMU Memo 10.2. Pile Design Tables for each substructure developed from the IDOT spreadsheet are appended to this letter. Per the *IDOT Geotechnical Manual*, a geotechnical resistance factor of 0.55 should be used for driven piles. During a seismic event, a geotechnical resistance factor of 1.0 may be used. Based on the results of the subsurface investigation no geotechnical

losses due to liquefaction or downdrag were included in the axial pile capacity calculations.

We recommend a minimum driven pile center-to-center spacing of three pile diameters, as recommended by the *IDOT Bridge Manual*. The maximum spacing shall be limited to 3.5 times the effective footing thickness plus 1 foot, but not to exceed 8 feet. Once the final spacing is determined, the piles should be evaluated for group effects.

We recommended one test pile be driven to verify design assumptions and evaluate the actual pile capacity in the field. Per section 8.10.5 of the *IDOT Geotechnical Manual*, the test pile should be driven at least 10 feet longer than the estimated plan length and driven to 110% of the nominal required bearing value as determined during driving by the "WSDOT" formula outlined in the *IDOT Bridge Manual*. The data from the test pile can then be used to verify the length of production piles. Additionally, construction verification should be performed during production pile driving by a qualified pile driving inspector using the WSDOT formula.

Table 3.3 provides the factored resistance available for 16" metal shell piles at their estimated maximum drivable length for each substructure. The *Pile Design Tables* showing additional pile types, capacities, and lengths can be found in Appendix E. Pile bearing vs. estimated length graphs for the pier are also included.

Table 3.3 – Pile Capacities

Substructure Location	Pile Type	Maximum Nominal Required Bearing (kips)	Factored Resistance Available (kips)	Estimated Pile Length (ft)
N. Abutment	Metal Shell 16"Φ w/.312" walls	654	360	59
	Metal Shell 16"Φ w/.375" walls	782	430	64
S. Abutment	Metal Shell 16"Φ w/.312" walls	654	360	59
	Metal Shell 16"Φ w/.375" walls	782	430	66
Pier	Metal Shell 16"Φ w/.312" walls	654	360	44
	Metal Shell 16"Φ w/.375" walls	782	430	58

3.5.1 Lateral Pile Response

The lateral response can be developed by modeling the soil/shaft interaction with the computer program LPILE. Discrete elements are used in LPILE to represent the shaft and non-linear soil using springs. The non-linear soil springs are commonly referred to as P-Y curves. Tables 3.4 to 3.6 summarize the approximate soil modulus parameters (k) for the LPILE analyses (Reference: LPILE User's Manual, Ensoft, Inc., 2019) at each substructure.

Table 3.4 – LPILE Parameters – South Abutment (Boring 1-S)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	340.30	120	1,000	0.01	--	--
Soft Clay	335.90	57.6	1,000	0.01	--	--
Sand	300.90	57.6	--	--	35	18

Table 3.5 – LPILE Parameters – North Abutment (Boring 2-S)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	340.30	120	1,000	0.01	--	--
Sand	298.27	57.6	--	--	35	18

Table 3.6 – LPILE Parameters – Pier 1 (Boring 3)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	338.0	57.6	1,000	0.01	--	--
Sand	313.0	57.6	--	--	38	50

3.6 *SLOPE STABILITY*

Based on the information shown on the provided draft TS&L, 2H:1V benched end slopes with riprap armoring will be utilized for the abutments. Based on minimal grade changes and slope heights, a slope stability analysis was not performed for the project.

3.7 *SCOUR CONSIDERATIONS*

We understand that scour protection will be provided at the bridge abutments via Class A4 stone riprap. Design scour elevation, as provided by QEI, are included in Table 3.7.

Table 3.7 – Scour Elevations

Event / Limit State	Design Scour Elevations (ft.)			Item 113
	N. Abut.	Pier	S. Abut.	
Q100	356.6	339.5	356.6	8
Q200	356.6	339.3	356.6	
Design	356.6	338.6	356.6	
Check	356.6	338.6	356.6	

4. CONSTRUCTION CONSIDERATIONS

Based on the provided draft TS&L, staged construction will be utilized, and a temporary soil retention system (TSRS) will be required. The IDOT *Temporary Soil Retention System* construction specification should be utilized for the design of the TSRS.

All work performed for the proposed project should conform to the requirements in the *IDOT Standard Specifications for Road and Bridge Construction* and any pertinent special provisions or policies. Any deviation from the requirements in the manuals above should be approved by the design engineer.

5. LIMITATIONS

This report has been prepared for the exclusive use of Quigg Engineering, Inc. and its subconsultants for the project and the Illinois Department of Transportation The recommendations provided in the report are specific to the

project described herein and are based on the information obtained from the soil boring locations provided by IDOT within the project limits. The analyses performed and the recommendations provided in this report are based on subsurface conditions determined at the location of the borings. The report may not reflect all variations that may occur between boring locations or at some other time, the nature and extent of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations provided herein considering the new conditions.

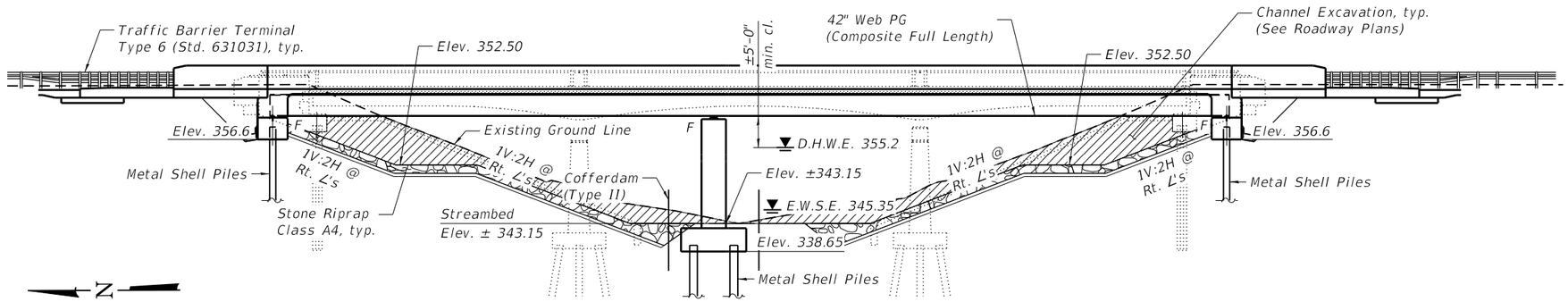
Appendix A

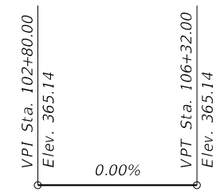
Draft TS&L

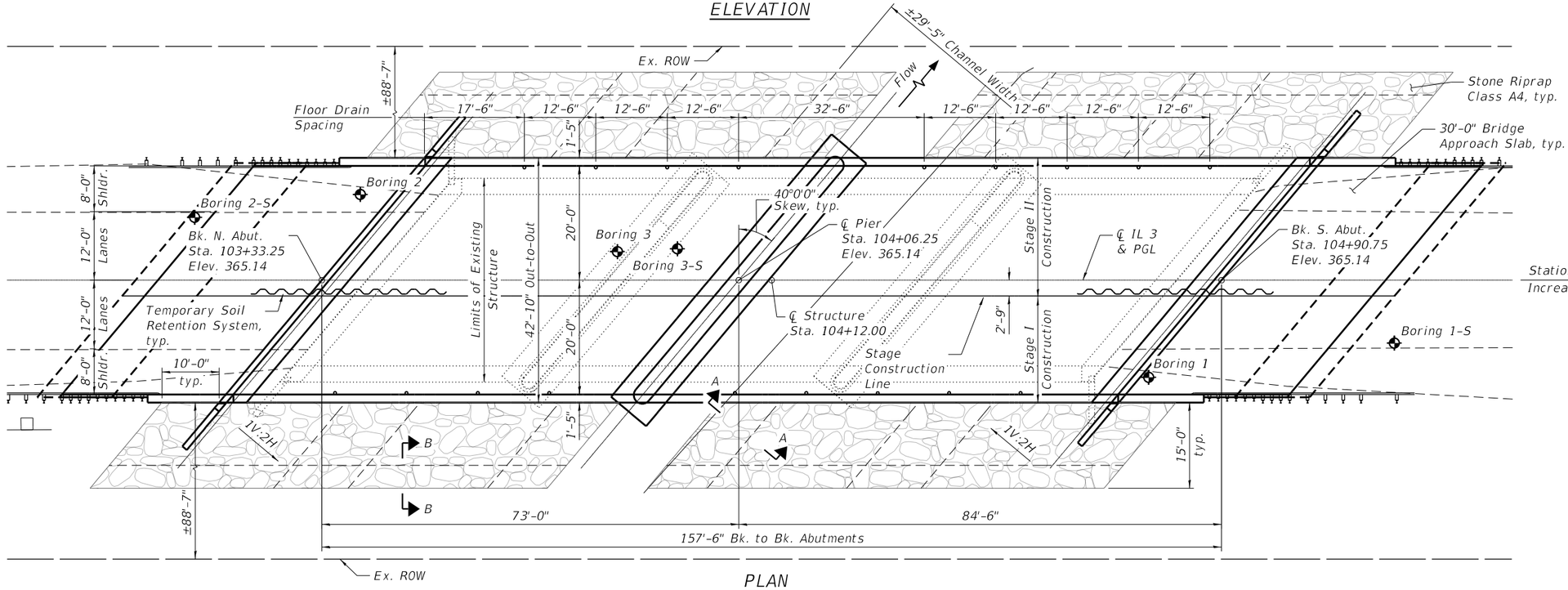
Benchmark: "□" Cut on top of NE Wingwall of SN 039-0026. Sta. 103+53.82, Offset 15.55' Lt., Elev. 365.72.

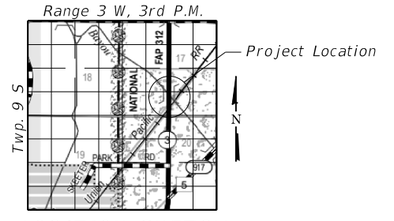
Existing Structure: SN 039-0026 was originally built in 1958 as SBI Route 150, Section 130 BY. The bridge is 144'-6" bk.-bk. of abutments and a 35'-8" out-out of deck. The superstructure consists of varying depth RC T-Beams on stub abutments and solid wall piers. The bridge has a 5" concrete wearing surface in place. The structure will be replaced using staged construction.

No Salvage.









LOADING HL-93

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

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

HIGHWAY CLASSIFICATION

F.A.P. Route. 312 - IL 3
Functional Class: Other Principal Arterial
ADT: 1,050 (2021); 1,061 (2046)
ADTT: 179 (2021); 181 (2046)
DHV: 120 (Two-Way)
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

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) *

* All structural steel shall be metallilized.

SEISMIC DATA

2023 AASHTO Seismic Hazard
Seismic Design Category (SDC) = C
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.335g
Soil Site Class = DE
Performance Level = Operational
Latitude = 37.74° N
Longitude = 89.46° W

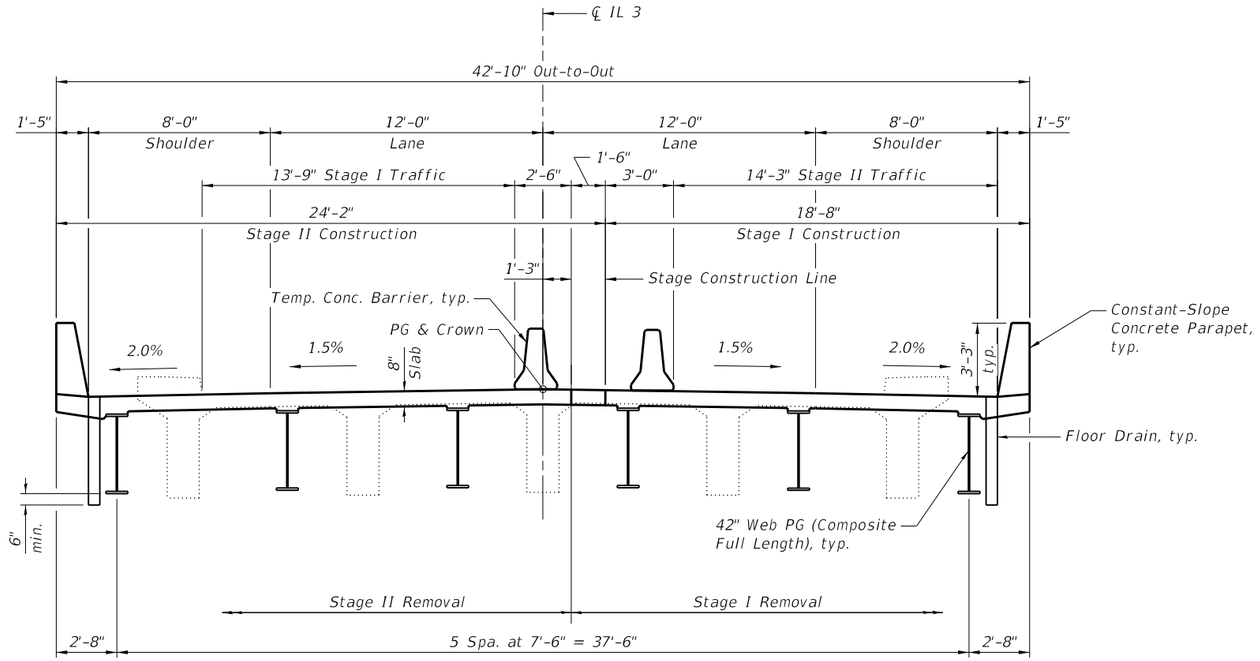
GENERAL PLAN & ELEVATION
IL 3 OVER WORTHEN BAYOU
F.A.P. ROUTE 312 - SECTION 130B-1
JACKSON COUNTY
STATION 104+12.00
STRUCTURE NO. 039-0083

QUIGG ENGINEERING INC	USER NAME = JCray	DESIGNED - RPW	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
	0390083-78967-TSL-001.dgn	CHECKED - KWB	REVISED -	
	PLOT SCALE = 21:8.0000 ':' / in.	DRAWN - JDC	REVISED -	
	PLOT DATE =	CHECKED - MDC	REVISED -	

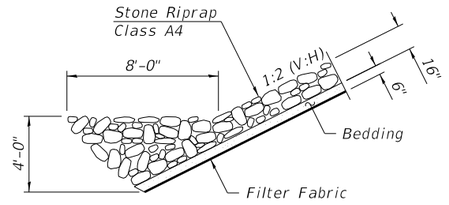
SHEET 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
312	130B-1	JACKSON		
		CONTRACT NO. 78967		
	ILLINOIS	FED. AID PROJECT		

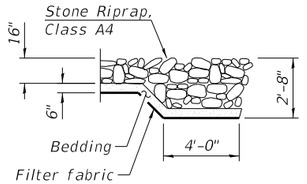
MODEL: Default
FILE NAME: S:\2021\21IL033 - PTB 199-38 D9 - QEI - Various LHWO-12 - IL-3 BR Replace 039-0026 PH1\CADD\CADD Sheets\0390083-78967-TSL-001.dgn
11/25/2024 11:54:28 AM



CROSS SECTION
(Looking South)



SECTION A-A



SECTION B-B

DESIGN SCOUR ELEVATION TABLE

Event / Limit State	Design Scour Elevations (ft.) N. Abut.	Pier	S. Abut.	Item 113
Q100	356.6	339.5	356.6	8
Q200	356.6	339.3	356.6	
Design	356.6	338.6	356.6	
Check	356.6	338.6	356.6	

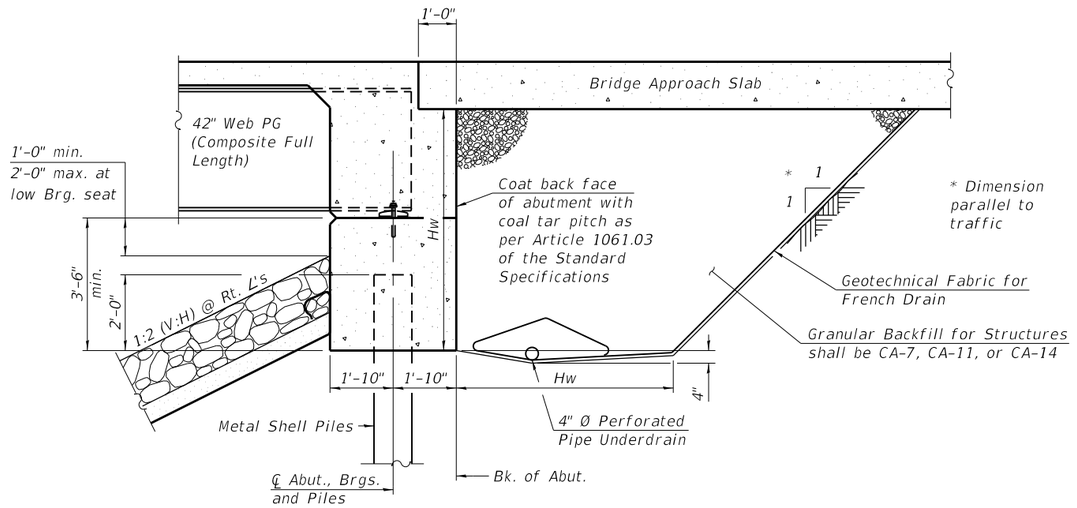
WATERWAY INFORMATION

Drainage Area = 13.7 sq. mi.

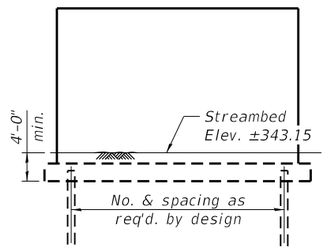
Existing Overtopping Elev. = 363.70 at Sta. 96+46
Proposed Overtopping Elev. = 363.70 at Sta. 96.46

Flood Event	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.
Ten-Year	10	706	508	532	355.1	0.2	0.2	355.3	355.3
Design	50	1,020	515	541	355.2	0.3	0.2	355.5	355.4
Base	100	1,140	515	541	355.2	0.3	0.2	355.5	355.4
Scour Check	200	1,270	522	550	355.3	0.3	0.2	355.6	355.5
Max. Calc.	500	1,450	529	559	355.4	0.3	0.3	355.7	355.7

10-Year Velocity through Existing Structure = 1.4 fps
10-Year Velocity through Proposed Structure = 1.3 fps



SECTION THRU INTEGRAL ABUTMENT
(Horiz. dim. at Rt. L's)



PIER SKETCH

DETAILS
IL 3 OVER WORTHEN BAYOU
F.A.P. ROUTE 312 - SECTION 130B-1
JACKSON COUNTY
STATION 104+12.00
STRUCTURE NO. 039-0083

Appendix B

Boring Logs

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Grant Deterding
From:	Douglas Helfrich	By: Aaron Hayes AH
Subject:	Boring Logs	
Date:	October 25, 2022	

IL 3 over Worthen Bayou
SN 039-0026 (Ex.)
Section: 130 BY (Ex.)
Jackson County

Foundation boring logs have been obtained for design of the replacement to the structure listed above and are attached.

Rock was not encountered in the two new borings completed for this project. Boring 1-S, near the south abutment, was drilled to a depth that will achieve a minimum nominal driven bearing capacity for a 14 in. diameter metal shell pile of 570 kips. Boring 2-S, near the north abutment, was drilled to a depth that will achieve a minimum nominal driven bearing capacity 550 kips. Boring 1-S shows a potentially liquefiable layer at a depth of 27.5 to 29.5 ft. Boring 2-S shows a potentially liquefiable layer at a depth of 24.5 to 32 ft. A liquefaction analysis should be completed once the proposed structure's final dimensions are determined.

Borings completed in 1958 before the existing structure was constructed have been attached for additional subsurface information. Also attached is a General Plan and Elevation sheet for the existing structure.

Attachments
AWH:ah

C: Soils File
S:\Materials Geotechnical Unit\gINT\PROJECTS\Projects File\Jackson\Structures

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 9/27/22

ROUTE IL 3 **DESCRIPTION** Bridge over Worthen Bayou **LOGGED BY** L. Estel

SECTION 130 BY (Ex.) **LOCATION** 1.2 mi S. of IL 149/3 Int. (Near S. Abut.), **SEC.** 17, **TWP.** 9S, **RNG.** 3W, **PM**

COUNTY Jackson **DRILLING METHOD** HSA (8" OD, 3.25" ID)/Mud Rotary **HAMMER TYPE** Auto SPT 140 lbs HE 86.5%

STRUCT. NO. 039-0026
Station 104+12

BORING NO. 1-S
Station 105+21
Offset 11.0ft Rt
Ground Surface Elev. 365.4 ft

Surface Water Elev. 345.2 ft
Stream Bed Elev. 345 ft

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

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Cored Pavement, 4.5 in. HMA over 11.5 in. CONCRETE
				364.10
				Stiff Grey, Moist SILTY CLAY LOAM
	3			
	5	1.45	21	
	5	S		
				360.90
-5	WOH			Medium Stiff Grey, Moist CLAY
	WOH	0.65	38	
	1	B		
	WOH			
	1	0.8	45	
	2	S		
-10	1			
	2	0.8	41	
	2	S		
	WOH			
	1	0.95	47	
	3	B		
				350.90
-15	1			Stiff Grey, Moist CLAY
	2	1.4	38	
	3	B		
				348.40
	1			Stiff Brownish Grey, Moist CLAY
	2	1.4	41	
	3	B		
-20	1			

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
	2	1.3	40	Stiff Brownish Grey, Moist CLAY *(continued)*
	4	S		
				343.40
	1			Medium Stiff Grey with specks of Brown, Moist CLAY
	2	0.85	29	
	3	B		
-25	WOH			
	1	0.7	31	Mud rotary drilling method begun at 25 ft
	2	B		Medium Stiff Grey with specks of Brown, Moist CLAY
	2			
				337.90
	2	0.2	29	Very Soft Grey, Moist SILTY LOAM
	2	B		
				335.90
-30	6			Medium Dense Brown and Grey, Moist fine SAND
	10		24	
	10			3% f. Gravel & c. SAND, 26% m. SAND, 65% f. SAND, 5% SILT, 2% CLAY, Non-plastic (Lab 49)
	6			
	11		24	
	11			
-35				
	5			
	7		24	
	8			
-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)

File Name S:\MATERIALS GEOTECHNICAL UNIT\GINT\PROJECTS\PROJECTS FILE\JACKSON 039\STRUCTURES\039-0026 IL 3 OVER WORTHEN BAYOU.GPJ Data Template D6TEMPLT.GDT Date Printed 10/25/22
Latitude 37.7393683 Longitude -89.4634841 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 9/27/22

ROUTE IL 3 **DESCRIPTION** Bridge over Worthen Bayou **LOGGED BY** L. Estel

SECTION 130 BY (Ex.) **LOCATION** 1.2 mi S. of IL 149/3 Int. (Near S. Abut.), **SEC.** 17, **TWP.** 9S, **RNG.** 3W, **PM**

COUNTY Jackson **DRILLING METHOD** HSA (8" OD, 3.25" ID)/Mud Rotary **HAMMER TYPE** Auto SPT 140 lbs HE 86.5%

STRUCT. NO. 039-0026
Station 104+12

BORING NO. 1-S
Station 105+21
Offset 11.0ft Rt
Ground Surface Elev. 365.4 ft

Surface Water Elev. 345.2 ft
Stream Bed Elev. 345 ft

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

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Medium Dense Brown and Grey, Moist fine SAND
				3% f. Gravel & c. SAND, 26% m. SAND, 65% f. SAND, 5% SILT, 2% CLAY, Non-plastic (Lab 49) *(continued)*
322.40				
	6			Dense Brown and Grey, Moist m. SAND with Pebbles
	15		16	
	16			19% f. Gravel & c. SAND, 48% m. SAND, 28% f. SAND, 4% SILT, 1% CLAY, Non-plastic (Lab 52)
-45				
	8			
	17		16	
	20			
-50				
312.40				
	9			Medium Dense Brown and Grey, Moist m. SAND with Pebbles
	14		16	
	15			19% f. Gravel & c. SAND, 48% m. SAND, 28% f. SAND, 4% SILT, 1% CLAY, Non-plastic (Lab 52)
-55				
	8			
	9		16	
	12			
-60				

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Medium Dense Brown and Grey, Moist m. SAND with Pebbles
				19% f. Gravel & c. SAND, 48% m. SAND, 28% f. SAND, 4% SILT, 1% CLAY, Non-plastic (Lab 52) *(continued)*
	7			
	10		16	
300.90	12			
-65				
				Bottom of hole @ 64.5 ft
				Hollow stem auger sampling from 0 to 25 ft
				Mud rotary drilling operation from 25 to 64.5 ft
-70				
				Free water undetermined
				To convert "N" values to "N60", multipy by 1.44, Hammer efficiency = 86.5%
				Ground surface elevation referenced to BM 039-0026; Cut square on NE wingwall at Pier; EL 365.72
-75				
-80				

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)

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 9/28/22

ROUTE IL 3 **DESCRIPTION** Bridge over Worthen Bayou **LOGGED BY** L. Estel

SECTION 130 BY (Ex.) **LOCATION** 1.2 mi S. of IL 149/3 Int. (Near N. Abut.), **SEC.** 17, **TWP.** 9S, **RNG.** 3W, **PM**

COUNTY Jackson **DRILLING METHOD** HSA (8" OD, 3.25" ID)/Mud Rotary **HAMMER TYPE** Auto SPT 140 lbs HE 86.5%

STRUCT. NO. 039-0026
Station 104+12

BORING NO. 2-S
Station 103+11
Offset 11.0ft Lt
Ground Surface Elev. 365.27 ft

Surface Water Elev. 345.2 ft
Stream Bed Elev. 345 ft

Groundwater Elev.:
▽ **First Encounter** 340.3 ft
▽ **Upon Completion** ft
▼ **After** Hrs. ft

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Cored Pavement, 4 in. HMA over 11 in. CONCRETE
				363.97
				Soft Grey, Moist SILTY LOAM
	2			
	6 7	0.25 P	12	
				360.77
-5	1			Medium Stiff Grey, Moist CLAY
	1 2	0.9 B	46	
	1			
	1 1	0.55 B	51	
				355.77
-10	WOH			Soft Grey, Moist CLAY
	1 1	0.4 B	26	
				353.27
	1			Stiff Dark Grey, Moist CLAY
	2 3	1.45 B	45	
-15	1			
	2 4	1.65 S	38	
	1			
	3 4	1.65 B	40	
				345.77
-20	1			
	2 4	1.35 B	40	Stiff Grey with mottled Brown and Black, Moist CLAY *(continued)*
				343.27
	WOH			Soft Grey and Brown, Moist CLAY
	1 2	0.4 B	28	
				340.77
-25	WOH			Soft Grey, Moist to Very Moist ▽ SILTY LOAM
	1 1	0.15 B	29	
				338.27
	WOH			Mud rotary drilling method begun at 27 ft
	2 4		21	Loose Brown, Moist SANDY LOAM
				3% m. SAND, 67% f. SAND, 25% SILT, 5% CLAY, Non-Plastic (Lab
-30	WOH			50)
	1 4		21	
				333.27
	7			Medium Dense Grey, Moist SAND with PEBBLES
	12 16		19	
				18% f. GRAVEL & c. SAND, 31% m. SAND, 46% f. SAND, 3% SILT, 1% CLAY, Non-Plastic (Lab
-35				51)
	4			
	9 9		19	
-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)

File Name S:\MATERIALS GEOTECHNICAL UNIT\GINT\PROJECTS\PROJECTS FILE\JACKSON 039\STRUCTURES\039-0026 IL 3 OVER WORTHEN BAYOU.GPJ Data Template D6TEMPLT.GDT Date Printed 10/25/22
Latitude 37.7399551 Longitude -89.4633966 Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 9

SOIL BORING LOG

Date 9/28/22

ROUTE IL 3 **DESCRIPTION** Bridge over Worthen Bayou **LOGGED BY** L. Estel

SECTION 130 BY (Ex.) **LOCATION** 1.2 mi S. of IL 149/3 Int. (Near N. Abut.), **SEC.** 17, **TWP.** 9S, **RNG.** 3W, **PM**

COUNTY Jackson **DRILLING METHOD** HSA (8" OD, 3.25" ID)/Mud Rotary **HAMMER TYPE** Auto SPT 140 lbs HE 86.5%

STRUCT. NO. 039-0026
Station 104+12

BORING NO. 2-S
Station 103+11
Offset 11.0ft Lt
Ground Surface Elev. 365.27 ft

Surface Water Elev. 345.2 ft
Stream Bed Elev. 345 ft

Groundwater Elev.:
▽ **First Encounter** 340.3 ft
▽ **Upon Completion** ft
▼ **After** Hrs. ft

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Medium Dense Grey, Moist SAND with PEBBLES 18% f. GRAVEL & c. SAND, 31% m. SAND, 46% f. SAND, 3% SILT, 1% CLAY, Non-Plastic (Lab 51) *(continued)*
322.27				
	6			Medium Dense Grey, Moist SAND with PEBBLES 18% f. GRAVEL & c. SAND, 31% m. SAND, 46% f. SAND, 3% SILT, 1 % CLAY, Non-Plastic (Lab 51)
	9 12		19	
-45				
	6			
	9 13		19	
-50				
	9			
	14 16		19	
-55				
	6			
	13 16		19	
-60				

DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)	Description
				Medium Dense Grey, Moist SAND with PEBBLES 18% f. GRAVEL & c. SAND, 31% m. SAND, 46% f. SAND, 3% SILT, 1 % CLAY, Non-Plastic (Lab 51) *(continued)*
	5			
	9 12		19	
-65				
298.27				
	6			
	11 14		19	
-70				Bottom of hole @ 68.5 ft Hollow stem auger sampling from 0 to 27 ft Mud rotary drilling operation from 27 to 68.5 ft Free water encountered @ 25 ft To convert "N" values to "N60", multipy by 1.44, Hammer efficiency =86.5% Ground surface elevation referenced to BM 039-0026; Cut square on NE wingwall at Pier; EL 365.72
-75				
-80				

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\GINT\PROJECTS\PROJECTS FILE\JACKSON 039\STRUCTURES\039-0026 IL 3 OVER WORTHEN BAYOU.GPJ Data Template D6TEMPLT.GDT Date Printed 10/25/22
Latitude 37.7399551 Longitude -89.4633966 Datum NAD83 Job Number

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: Ehren Kirby
From:	Aaron Hayes AH	By: Kyle Markel
Subject:	Boring Logs	
Date:	November 12, 2024	

IL 3 over Worthen Bayou
SN 039-0026 (Ex.)
Section: 130 BY (Ex.)
Jackson County

As requested, an additional boring log has been obtained for design of the replacement to the structure listed above and is attached.

Rock was not encountered in the new boring. Boring 3-S, near the location of Pier 1 of the proposed structure, was drilled to an elevation of 275.10. This boring shows potentially liquefiable layers at depths of 33.5 to 36 ft, 38.5 to 41 ft, and 53.5 to 56 ft. A liquefaction analysis should be completed at this location.

Attachments
KPM:kpm

C: Soils File
S:\Materials Geotechnical Unit\gINT\PROJECTS\Projects File\Jackson\Structures

Illinois Department of Transportation
Division of Highways
Terracon

SOIL BORING LOG

Date 10/4/24

ROUTE IL 3 **DESCRIPTION** Bridge over Worthen Bayou **LOGGED BY** KEG

SECTION 130B-1 **LOCATION** 1.2 mi S. of IL 149/3 Int. (Near Pier), **SEC.** 17, **TWP.** 9S, **RNG.** 3W,
Latitude 37.73967, **Longitude** -89.463473

COUNTY Jackson **DRILLING METHOD** MUD ROTARY **HAMMER TYPE** Auto SPT 140 lb

STRUCT. NO. 039-0026 (EX) 039-0083 (PR)
Station 104+12.00
BORING NO. 3-S
Station 103+95.00
Offset 5.5 ft LT
Ground Surface Elev. 365.10 ft

Surface Water Elev. ft
Stream Bed Elev. ft
Groundwater Elev.:
First Encounter ft
Upon Completion ft
After Hrs. ft

DEPTH (ft)	Description	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	12" Concrete Pavement			
	364.10			
	Blind drill down through the bridge deck to the bottom of Worthen Bayou at El 343.1			
-5				
-10				
-15				
-20				
	Blind drill down through the bridge deck to the bottom of Worthen Bayou at El 343.1 *(continued)*			
	343.10			
	Rotary down to first sample at 28.5'			
-25				
	336.60			
	SAND - Gray, fine to coarse, loose to medium dense	13		
		31	-	18
-30	Poor Recovery due to rock in casing	-		
		6		
		9	-	28
		9		
	becomes dark gray, medium dense, w/organics	5		
		5	-	28
-35		5		
	becomes fine and dense	10		
		13	-	18
		17		
	becomes medium dense	6		
		9	-	26
-40		14		

SOIL BORING 24-1008.03 IL 3 OVER WORTHEN BAYOU.GPJ IL_DOT.GDT 11/11/24

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)

Illinois Department of Transportation
Division of Highways
Terracon

SOIL BORING LOG

Date 10/4/24

ROUTE IL 3 **DESCRIPTION** Bridge over Worthen Bayou **LOGGED BY** KEG

SECTION 130B-1 **LOCATION** 1.2 mi S. of IL 149/3 Int. (Near Pier), **SEC.** 17, **TWP.** 9S, **RNG.** 3W,
Latitude , **Longitude**

COUNTY Jackson **DRILLING METHOD** MUD ROTARY **HAMMER TYPE** Auto SPT 140 lb

STRUCT. NO. 039-0026 (EX) 039-0083 (PR)
Station 104+12.00

BORING NO. 3-S
Station 103+95.00
Offset 5.5 ft LT
Ground Surface Elev. 365.10 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter ft
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SAND - Gray, fine to coarse, loose to medium dense *(continued)*	8		
becomes coarse	12 14	-	14
	7		
with pebbles	7 11	-	16
-45			
	9		
	12 14	-	15
	9		
	15 17	-	18
-50			
	11		
	12 12	-	23
	5		
	7 8	-	19
-55			
	7		
	11 12	-	22
	8		
4% gravel, 95.9% sand, 0.1% fines	9 12	-	17
-60			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SAND - Gray, fine to coarse, loose to medium dense *(continued)*			
	6		
	9 11	-	23
-65			
	7		
	9 13	-	25
-70			
	10		
	16 14	-	25
-75			
	10		
	10 20	-	25
-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)

BBS, form 137 (Rev. 8-99)

SOIL BORING 24-1008.03 IL 3 OVER WORTHEN BAYOU.GPJ IL_DOT.GDT 11/11/24

Illinois Department of Transportation
Division of Highways
Terracon

SOIL BORING LOG

Date 10/4/24

ROUTE IL 3 **DESCRIPTION** Bridge over Worthen Bayou **LOGGED BY** KEG

SECTION 130B-1 **LOCATION** 1.2 mi S. of IL 149/3 Int. (Near Pier), **SEC.** 17, **TWP.** 9S, **RNG.** 3W,
Latitude , **Longitude**

COUNTY Jackson **DRILLING METHOD** MUD ROTARY **HAMMER TYPE** Auto SPT 140 lb

STRUCT. NO. 039-0026 (EX) 039-0083 (PR)
Station 104+12.00

BORING NO. 3-S
Station 103+95.00
Offset 5.5 ft LT
Ground Surface Elev. 365.10 ft

Surface Water Elev. _____ ft
Stream Bed Elev. _____ ft

Groundwater Elev.:
First Encounter _____ ft
Upon Completion _____ ft
After _____ **Hrs.** _____ ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SAND - Gray, fine to coarse, loose to medium dense *(continued)*			
	10		
	10	-	19
-85	14		
becomes dense	12		
	25	-	24
275.10 -90	10		
End of Boring			
-95			
Elevation referenced to BM 039-0026, EL. 365.72			
Hammer Efficiency: 89.3%			
End of Boring -100			

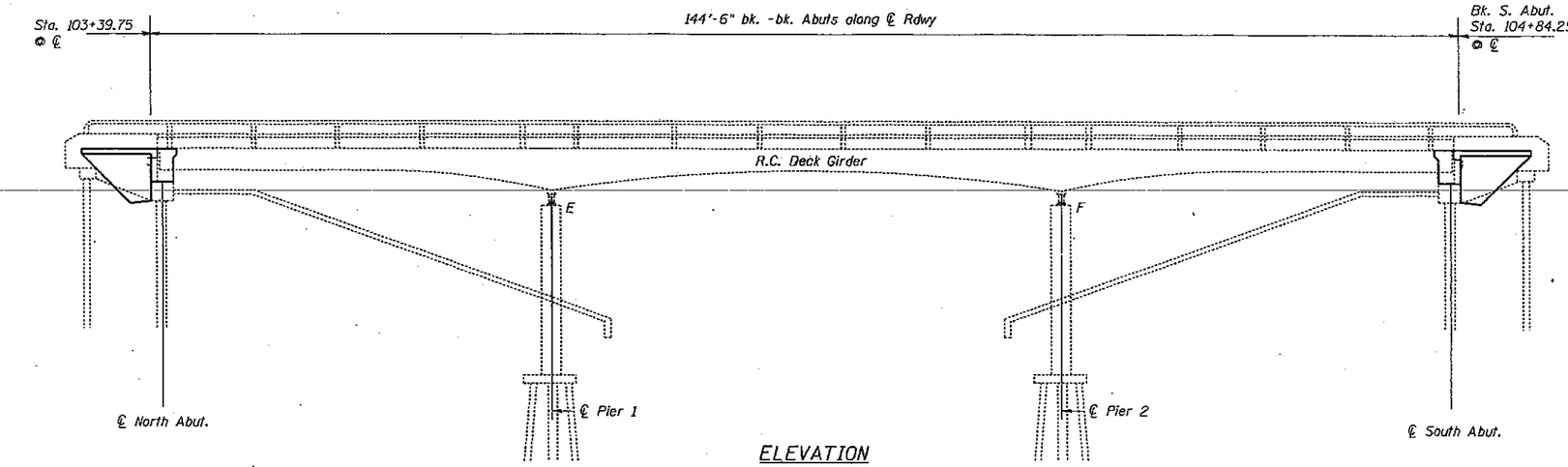
SOIL BORING 24-1008.03 IL 3 OVER WORTHEN BAYOU.GPJ IL_DOT.GDT 11/11/24

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)

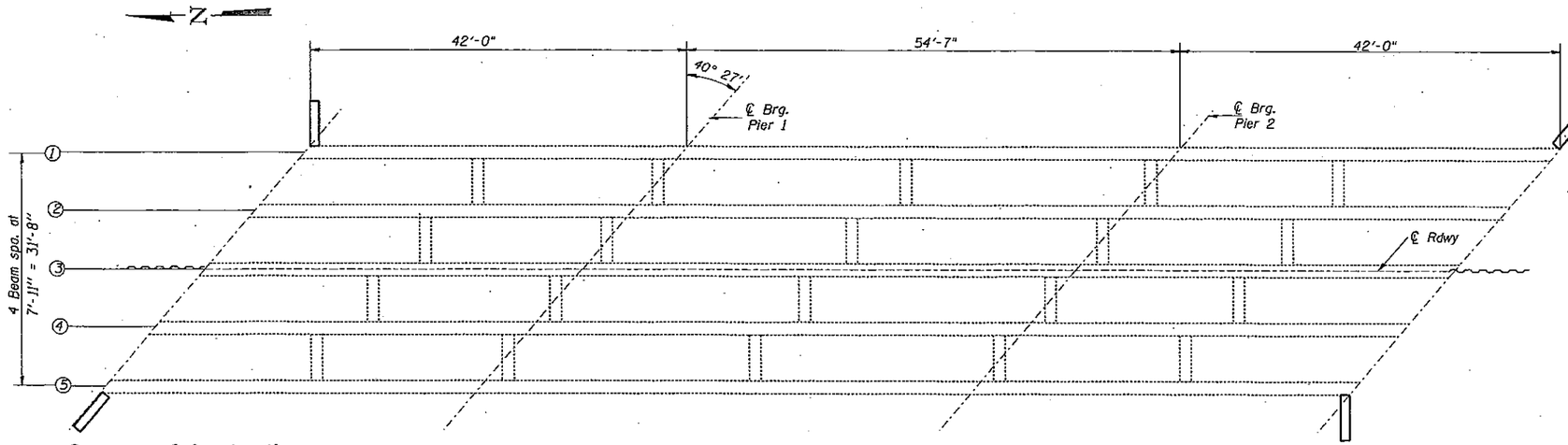
F. A. P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
312	*	JACKSON	14	3
STA.		TO STA.		
FED. ROAD DIST. NO.	ILLINOIS	FED. AID PROJECT		

* CONT. MAINT. FY2002-1

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION



ELEVATION



FRAMING PLAN

Sequence of Construction

1. Remove Stage I Bit. Wearing Surface
2. Perform Stage I Repairs and Overlay
3. Remove Stage II Bit. Wearing Surface
4. Perform Stage II Repairs and Overlay

DESIGNED	T. Wayne Halstead
CHECKED	Mike Stephenson
DRAWN	T. Wayne Halstead
CHECKED	TWH MAS CMW

Design Stresses

(Exist. Construction)
fc = 1400 psi (Super)
fc = 1000 psi (Sub)
fs = 20,000 psi (Reinf.)
n = 10

(New Construction)
fc' = 3,500 psi (Concrete)
fy = 60,000 psi (Reinforcement)

GENERAL NOTES

Plan dimensions and details relative to existing structure have been taken from existing plans and are subject to nominal construction variations. It shall be the Contractor's responsibility to verify such dimensions and details in the field and make necessary approved adjustments prior to construction or ordering of materials. Such variations shall not be cause for additional compensation for a change in the scope of the work, however, the Contractor will be paid for the quantity actually furnished at the unit price bid for the work.

Reinforcement bars shall conform to the requirements of AASHTO M-31, M-42 or M-53 Grade 60.

Factors used for estimating plan quantities are as follows and shall not be used for the basis of final quantities.

All Bituminous Concrete 2.0;6 Tons/Cu. Yd.
Bituminous Material (Prime Coat) .09 Gal/Sq. Yd.

Butt Joints shall not be cut until staged bridge work is done.

Existing reinforcement bars extending into the removal area shall be cleaned, straightened and incorporated into new construction. Any reinforcement bars that are damaged during Concrete Removal shall be replaced with an approved bar splicer or achorage system. Cost included with Concrete Removal.

The existing slopewall shall be removed and replaced in-kind as directed by the Engineer in order to install the new dog ear wingwalls. The cost to be included with Concrete Superstructure.

Protective coat shall be applied to the Concrete Wearing Surface in accordance with Article 503.19 of the Standard Specifications. The seasonal exception shall not apply. The rate of application for each coat on saw cut grooved areas shall be 25 Sq. Yds. per gallon of mixture.

Slope wall shall be reinforced with welded wire fabric, 6" x 6" – W4.0, weighing 58 lbs. per 100 sq. ft.

Mechanical Splicers and all reinforcement within the Bridge Approach Pavement, Specials, shall be included in the cost of Bridge Approach Pavement, Special,

TOTAL BILL OF MATERIAL

ITEM	UNIT	QUANTITY
Concrete Removal	Cu. Yd.	38.3
Concrete Superstructure	Cu. Yd.	42.9
Bridge Deck Grooving	Sq. Yd.	441
Reinforcement Bars, Epoxy Coated	Pound	12770
Steel Bridge Rail	Foot	290
Deck Slab Repair (Partial Depth)	Sq. Yd.	33
Bar Splicers	Each	245
Temporary Sheet Piling	Sq. Ft.	242
Concrete Wearing Surface	Sq. Yd.	473
Structure Excavation	Cu. Yd.	159.6
Porous Granular Embankment	Cu. Yd.	159.6
Conc. Bridge Deck Scarification (1/2")	Sq. Yd.	449
Bit. Concrete Removal (Deck)	Sq. Yd.	473
Protective Coat	Sq. Yd.	473

General Plan & Elevation
IL Rte. 3 over Worthen Bayou
Jackson County
Structure No. 039-0026
Sta. 104+12.00

Rev.

Form No. B.O.137

FOUNDATION BORINGS

Project

Route SSI 150

Section 130 BY

County Jackson

Will bearing piles be required.

Can trestle piles be driven.

Bridge over Northen Bayou

Station 104+12

Borings made by Gordon R. Benson

Sheet 1 of 5 Sheets

Date Jan 58

Boring No. 1

Blows per cu foot	Elevation	Elevation	Blows per cu foot	
		344.5		Boring located at Staion 104+78, 17 Ft Rt Center-line.
		343.5		
		343.0		
	364.6	342.0		Surface of Ground.
		341.0	2	Stiff dark mottled clay.
	363.0	340.0		
	362.0	339.5		Qu-1.56
17	361.0	338.5	17	
				Stiff dark gray clear clay.
	359.5			Qu-1.72
17	358.5			
		338.5		
	357.0			Qu-1.64
33		333.5	26	
	356.0			
	355.5			
	354.5			Qu-1.56
3	353.5			Stiff blue clear clay.
		329.5		
4	352.0		13	Qu-1.84
	351.0	328.5		
	350.5	327.5		
	349.5			Qu-2.53
3	348.5			Very stiff blue clear clay.
		324.5		
	347.0		33	Qu-2.12
3	346.0	323.5		
	345.5			

Stiff blue mottled slightly sandy clay. Qu-1.52

Medium mottled very sandy clay. Qu-0.60

Medium brown uniform fine sand.

Dense dark gray well graded subangular gravel.

039-0026

Form No. B.O.137

FOUNDATION BORINGS

Project

Route SSI 150

Section 130 BY

County Jackson

Will bearing piles be required.

Can trestle piles be driven.

Bridge over Northen Bayou

Station 104+12

Borings made by Gordon R. Benson

Sheet 2 of 5 Sheets

Date Jan 58

Boring No. 1 Cont.

Blows per cu foot	Elevation	Elevation	Blows per cu foot	
		319.5		
44		318.5		
				Dense gray well graded subangular sand.
		314.5		
40		313.5		
		309.5		
48		308.5		

Form No. B. D. 137

FOUNDATION BORINGS

Project _____ Bridge over Wolfpen Bayou

Route SBI 150 Station 104+12

Section 130 BY Borings made by Francis Piefer

County Jackson

Will bearing piles be required. _____

Can trestle piles be driven. _____

Boring No. 2

Sheet 3 of 5 Sheets

Date Jan 58

Will bearing piles be required. _____

Can trestle piles be driven. _____

	Blows per cu foot	Elevation	Elevation	Blows per cu foot	
Boring located at Station 103+40, 15 Ft Lt Center-line. Surface of Ground.					
Stiff gravelly clay fill.		363.4	341.0	3	Very stiff blue clay fill.
		362.5	340.0		Qu-1.64
			339.5		
Qu-1.48	1	361.0	338.5	2	Medium very sandy mottled clay.
		360.0	337.5		
			337.0		
Stiff dark gray clay.		358.5	336.0		Medium brown fine sand.
Qu-1.56	1	357.5	335.0	14	
			334.5		
Qu-1.72	2	356.0	333.5		
		355.0	332.5	44	Dense brown fine sand.
		354.5			
Qu-1.80	3	353.5	330.5		
		352.5			
Stiff blue-gray clay fill.		351.0	328.5	12	
Qu-1.88	3	350.0	327.5		
Qu-1.80	3	348.5			Medium gray fine sand.
		347.5			
		346.5			
		346.0	323.5		
Qu-2.45	3	345.0	322.5	11	
Very stiff blue clay fill.					
Qu-2.04	2	343.5			
		342.5			

Form No. B. D. 137

FOUNDATION BORINGS

Project _____ Bridge over Wolfpen Bayou

Route SBI 150 Station 104+12

Section 130 BY Borings made by Francis Piefer

County Jackson

Will bearing piles be required. _____

Can trestle piles be driven. _____

Boring No. 2

Sheet 4 of 5 Sheets

Date Jan 58

Will bearing piles be required. _____

Can trestle piles be driven. _____

	Blows per cu foot	Elevation	Elevation	Blows per cu foot	
		319.5			
Dense gray sand and gravel	38	318.5			
		317.5			
		316.5			
	80	313.5			
		312.5			
Very dense gray sand and gravel.					
	85	308.5			
		307.5			

Form No. B. D. 137

FOUNDATION BORINGS

Project

Route SFI 150

Section 130 BV

County Jackson

Will bearing piles be required.

Can trestle piles be driven.

Bridge over Walthen Bayou

Station 104+10

Borings made by Francis Fiefer

Sheet 5 of 5 Sheets

Date Sept. 58

Boring No. 3

Will bearing piles be required.

Can trestle piles be driven.

Blows per 6" foot	Elevation	Elevation	Blows per 6" foot
Boring located at Station 103+85, 5 Ft Lt Center-line.			Dense gray fine sand.
		326.0	
Surface of ground.	346.1	324.0	55
		323.0	
Medium gray sandy clay.			Very dense gray fine sand, and occasional small gravel.
		319.0	88
		318.0	
3	340.0		
	339.0		
	338.0		
		314.0	62
		313.0	
32	334.0		
Dense gray fine sand.	333.0		
34	329.0		
	328.0		

Appendix C

Seismic Site Classification

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

Project:	IL 3 over Worthen Bayou
BFW Project No:	23032
Structure:	S Abutment
Boring:	1-S
Boring El:	365.4
GWT Depth:	25.1
GWT El:	340.3
Base of Substructure El:	356.6
Pile or Shaft Dia.	16
Hammer Efficiency:	86%
Approximate Fixity El.	348.6

$V_{s,100}$ Calculations

Depth	Thickness	Vs,avg	d_i/Vs
12.7	12.7	495.66	0.0256224
100	87.3	604.81	0.1443425

Weighted Average $V_{s,100}$ (ft/sec) =	**588**
Site Class =	**DE**

Seismic Soil Column Depth (ft)	Bottom of Sample Elevation	Sample Thickness (ft)	Sample Depth (ft)	N	Soil Type	Age (H or P)	N60	Ageing Factor (H)	Ageing Factor (P)	Vertical Effective Stress (psf)	Vertical Effective Stress (kPA)	Vs (m/s)	Vs (ft/s)
	360.90	4.50	4.50	10	Clay	H	14.40	0.88	1.00	562.50	26.93	103.29	338.88
	358.40	2.50	7.00	1	Clay	H	1.44	0.88	1.00	875.00	41.90	80.44	263.91
	355.90	2.50	9.50	3	Clay	H	4.32	0.88	1.00	1187.50	56.86	106.91	350.76
	353.40	2.50	12.00	4	Clay	H	5.76	0.88	1.00	1500.00	71.82	120.98	396.93
	350.90	2.50	14.50	4	Clay	H	5.76	0.88	1.00	1812.50	86.78	128.54	421.71
0.20	348.40	2.50	17.00	5	Clay	H	7.20	0.88	1.00	2125.00	101.75	140.48	460.88
2.70	345.90	2.50	19.50	5	Clay	H	7.20	0.88	1.00	2437.50	116.71	146.78	481.57
5.20	343.40	2.50	22.00	6	Clay	H	8.64	0.88	1.00	2750.00	131.67	157.36	516.28
7.70	340.90	2.50	24.50	5	Clay	H	7.20	0.88	1.00	3062.50	146.63	157.91	518.06
10.20	338.40	2.50	27.00	3	Clay	H	4.32	0.88	1.00	3219.00	154.13	147.10	482.61
12.70	335.90	2.50	29.50	4	Clay	H	5.76	0.88	1.00	3375.50	161.62	156.84	514.55
15.70	332.90	3.00	32.50	20	Sand	H	28.80	0.90	1.00	3533.30	169.18	166.40	545.95
20.70	327.90	5.00	37.50	22	Sand	H	31.68	0.90	1.00	3796.30	181.77	172.27	565.18
26.20	322.40	5.50	43.00	15	Sand	H	21.60	0.90	1.00	4085.60	195.62	162.91	534.47
30.20	318.40	4.00	47.00	31	Sand	H	44.64	0.90	1.00	4296.00	205.69	189.17	620.64
36.20	312.40	6.00	53.00	37	Sand	H	53.28	0.90	1.00	4611.60	220.80	198.85	652.41
40.20	308.40	4.00	57.00	29	Sand	H	41.76	0.90	1.00	4822.00	230.88	191.82	629.32
46.20	302.40	6.00	63.00	21	Sand	H	30.24	0.90	1.00	5137.60	245.99	183.06	600.58
47.70	300.90	1.50	64.50	22	Sand	H	31.68	0.90	1.00	5216.50	249.77	185.33	608.04
100.00	248.60	52.30	116.80	25	Sand	H	36.00	0.90	1.00	7967.48	381.49	209.32	686.73

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

Project:	IL 3 over Worthen Bayou
BFW Project No:	23032
Structure:	N Abutment
Boring:	2-S
Boring El:	365.3
GWT Depth:	25.1
GWT El:	340.2
Base of Substructure El:	356.6
Pile or Shaft Dia.	16
Hammer Efficiency:	86%
Approximate Fixity El.	348.6

$V_{s,100}$ Calculations

Depth	Thickness	Vs,avg	d_i/Vs
10	10	485.41	0.0206013
23	13	423.58	0.0306909
100	77	611.09	0.1260052

Weighted Average $V_{s,100}$ (ft/sec) =	**564**
Site Class =	**DE**

Seismic Soil Column Depth (ft)	Bottom of Sample Elevation	Sample Thickness (ft)	Sample Depth (ft)	N	Soil Type	Age (H or P)	N60	Ageing Factor (H)	Ageing Factor (P)	Vertical Effective Stress (psf)	Vertical Effective Stress (kPA)	Vs (m/s)	Vs (ft/s)
	360.80	4.50	4.50	12	Clay	H	17.28	0.88	1.00	562.50	26.93	106.54	349.55
	358.30	2.50	7.00	3	Clay	H	4.32	0.88	1.00	875.00	41.90	96.96	318.10
	355.80	2.50	9.50	2	Clay	H	2.88	0.88	1.00	1187.50	56.86	99.79	327.39
	353.30	2.50	12.00	2	Clay	H	2.88	0.88	1.00	1500.00	71.82	107.54	352.81
	350.80	2.50	14.50	5	Clay	H	7.20	0.88	1.00	1812.50	86.78	133.51	438.01
0.30	348.30	2.50	17.00	6	Clay	H	8.64	0.88	1.00	2125.00	101.75	144.90	475.39
2.80	345.80	2.50	19.50	7	Clay	H	10.08	0.88	1.00	2437.50	116.71	155.42	509.92
5.30	343.30	2.50	22.00	6	Clay	H	8.64	0.88	1.00	2750.00	131.67	157.36	516.28
7.80	340.80	2.50	24.50	3	Clay	H	4.32	0.88	1.00	3062.50	146.63	144.77	474.97
10.30	338.30	2.50	27.00	2	Clay	H	2.88	0.88	1.00	3219.00	154.13	137.30	450.46
12.80	335.80	2.50	29.50	6	Sand	H	8.64	0.90	1.00	3350.50	160.42	130.77	429.04
15.30	333.30	2.50	32.00	5	Sand	H	7.20	0.90	1.00	3482.00	166.72	127.44	418.12
20.30	328.30	5.00	37.00	28	Sand	H	40.32	0.90	1.00	3745.00	179.31	179.78	589.83
26.30	322.30	6.00	43.00	18	Sand	H	25.92	0.90	1.00	4060.60	194.42	168.41	552.52
30.30	318.30	4.00	47.00	21	Sand	H	30.24	0.90	1.00	4271.00	204.50	175.44	575.60
36.30	312.30	6.00	53.00	22	Sand	H	31.68	0.90	1.00	4586.60	219.61	179.93	590.31
40.30	308.30	4.00	57.00	30	Sand	H	43.20	0.90	1.00	4797.00	229.68	192.83	632.63
46.30	302.30	6.00	63.00	29	Sand	H	41.76	0.90	1.00	5112.60	244.79	194.42	637.85
50.30	298.30	4.00	67.00	21	Sand	H	30.24	0.90	1.00	5323.00	254.87	184.56	605.50
52.80	295.80	2.50	69.50	25	Sand	H	36.00	0.90	1.00	5454.50	261.16	191.85	629.41
100.00	248.60	47.20	116.70	25	Sand	H	36.00	0.90	1.00	7937.22	380.04	209.13	686.13

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

Project:	IL 3 over Worthen Bayou
BFW Project No:	23032
Structure:	Pier
Boring:	3
Boring El:	343.1
GWT Depth:	20
GWT El:	323.1
Base of Substructure El:	338.65
Pile or Shaft Dia.	16
Hammer Efficiency:	86%
Approximate Fixity El.	330.65

$V_{s,100}$ Calculations

Depth	Thickness	Vs,avg	d_i/Vs
100	100	519.93	0.1923339

Weighted Average $V_{s,100}$ (ft/sec) =	**520**
Site Class =	**DE**

Seismic Soil Column Depth (ft)	Bottom of Sample Elevation	Sample Thickness (ft)	Sample Depth (ft)	N	Soil Type	Age (H or P)	N60	Ageing Factor (H)	Ageing Factor (P)	Vertical Effective Stress (psf)	Vertical Effective Stress (kPA)	Vs (m/s)	Vs (ft/s)
	335.10	8.00	8.00	18	Sand	H	25.92	0.90	1.00	920.00	44.05	119.69	392.69
	332.60	2.50	10.50	18	Sand	H	25.92	0.90	1.00	1207.50	57.82	127.42	418.03
0.55	330.10	2.50	13.00	10	Sand	H	14.40	0.90	1.00	1495.00	71.58	119.69	392.68
3.05	327.60	2.50	15.50	30	Sand	H	43.20	0.90	1.00	1782.50	85.35	153.56	503.81
5.55	325.10	2.50	18.00	23	Sand	H	33.12	0.90	1.00	2070.00	99.11	151.11	495.76
8.05	322.60	2.50	20.50	26	Sand	H	37.44	0.90	1.00	2201.50	105.41	156.88	514.69
10.55	320.10	2.50	23.00	18	Sand	H	25.92	0.90	1.00	2333.00	111.70	148.26	486.40
13.05	317.60	2.50	25.50	26	Sand	H	37.44	0.90	1.00	2464.50	118.00	161.00	528.22
15.55	315.10	2.50	28.00	32	Sand	H	46.08	0.90	1.00	2596.00	124.30	169.50	556.09
18.05	312.60	2.50	30.50	15	Sand	H	21.60	0.90	1.00	2727.50	130.59	148.45	487.03
20.55	310.10	2.50	33.00	23	Sand	H	33.12	0.90	1.00	2859.00	136.89	162.76	533.99
23.05	307.60	2.50	35.50	21	Sand	H	30.24	0.90	1.00	2990.50	143.19	161.63	530.29
25.55	305.10	2.50	38.00	20	Sand	H	28.80	0.90	1.00	3122.00	149.48	161.73	530.63
30.55	300.10	5.00	43.00	23	Sand	H	33.12	0.90	1.00	3385.00	162.07	169.21	555.14
35.55	295.10	5.00	48.00	30	Sand	H	43.20	0.90	1.00	3648.00	174.67	181.06	594.02
40.55	290.10	5.00	53.00	30	Sand	H	43.20	0.90	1.00	3911.00	187.26	183.98	603.61
45.55	285.10	5.00	58.00	24	Sand	H	34.56	0.90	1.00	4174.00	199.85	179.00	587.27
55.55	275.10	10.00	68.00	35	Sand	H	50.40	0.90	1.00	4700.00	225.04	197.63	648.38

Appendix D

Liquefaction Analysis

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== 1-S
ELEVATION OF BORING GROUND SURFACE ========== 365.40 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 25.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 25.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.182
EARTHQUAKE MOMENT MAGNITUDE ========== 7.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 87 %
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

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

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **404** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.58
Source-To-Site Distance, R (km) = 101.03
Ground Motion Prediction Equations = NMSZ
PGA = **0.155**

	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
362.9	2.5	10	1.45		8	25	21	0.126	0.315	20.516	20.516	0.222	0.126	0.315	0.315	1.500	**0.327**	0.972	**0.115**	**N.L. (1)**
360.4	5	1	0.65		15	25	38	0.117	0.608	1.760	1.760	0.052	0.117	0.608	0.608	1.284	**0.065**	0.940	**0.111**	**N.L. (1)**
357.9	7.5	3	0.8		15	25	45	0.119	0.905	4.856	4.856	0.071	0.119	0.905	0.905	1.186	**0.083**	0.904	**0.107**	**N.L. (1)**
355.4	10	4	0.8		15	25	41	0.119	1.203	6.436	6.436	0.083	0.119	1.203	1.203	1.126	**0.092**	0.865	**0.103**	**N.L. (1)**
352.9	12.5	4	0.95		15	25	47	0.121	1.505	6.283	6.283	0.082	0.121	1.505	1.505	1.074	**0.086**	0.824	**0.098**	**N.L. (1)**
350.4	15	5	1.4		15	25	38	0.125	1.818	7.573	7.573	0.092	0.125	1.818	1.818	1.034	**0.094**	0.781	**0.093**	**N.L. (1)**
347.9	17.5	5	1.4		15	25	41	0.125	2.130	7.257	7.257	0.090	0.125	2.130	2.130	0.999	**0.088**	0.739	**0.088**	**N.L. (1)**
345.4	20	6	1.3		15	25	40	0.125	2.443	8.318	8.318	0.099	0.125	2.443	2.443	0.969	**0.094**	0.699	**0.083**	**N.L. (1)**
342.9	22.5	5	0.85		15	25	29	0.120	2.743	6.625	6.625	0.085	0.120	2.743	2.743	0.947	**0.079**	0.661	**0.078**	**N.L. (1)**
340.4	25	3	0.7		15	25	31	0.117	3.035	3.802	3.802	0.064	0.117	3.035	3.035	0.931	**0.058**	0.627	**0.074**	**N.L. (1)**
337.9	27.5	4	0.2		8	35	29	0.042	3.140	5.010	5.010	0.072	0.042	3.140	3.296	0.924	**0.065**	0.598	**0.074**	**N.L. (2)**
335.4	30	20						0.067	3.308	25.780	25.780	0.308	0.067	3.308	3.620	0.863	**0.261**	0.572	**0.074**	**N.L. (3)**
332.4	33	22						0.068	3.512	27.776	27.776	0.362	0.068	3.512	4.011	0.841	**0.299**	0.547	**0.074**	**N.L. (3)**
327.4	38	15						0.065	3.837	17.169	17.169	0.183	0.065	3.837	4.648	0.849	**0.152**	0.516	**0.074**	**2.054 (D)**
321.9	43.5	31						0.071	4.227	36.801	36.801	-0.089	0.071	4.227	5.381	0.759	**-0.066**	0.495	**0.075**	**N.L. (3)**
317.9	47.5	37						0.073	4.519	43.355	43.355	0.209	0.073	4.519	5.923	0.739	**0.152**	0.485	**0.075**	**N.L. (3)**
311.9	53.5	29						0.071	4.945	30.554	30.554	0.512	0.071	4.945	6.723	0.737	**0.371**	0.475	**0.077**	**N.L. (3)**
307.9	57.5	21						0.068	5.217	20.407	20.407	0.221	0.068	5.217	7.245	0.766	**0.166**	0.472	**0.078**	**2.128 (D)**
301.9	63.5	22						0.068	5.625	20.327	20.327	0.220	0.068	5.625	8.027	0.749	**0.161**	0.468	**0.079**	**2.038 (D)**

* 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 ========== 365.27 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 25.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 25.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.182
EARTHQUAKE MOMENT MAGNITUDE ========== 7.6
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 87 %
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

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

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **399** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.58
Source-To-Site Distance, R (km) = 101.03
Ground Motion Prediction Equations = NMSZ
PGA = **0.155**

	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
362.77	2.5	12	0.25					0.107	0.268	25.809	25.809	0.309	0.107	0.268	0.268	1.500	**0.455**	0.971	**0.115**	**N.L. (1)**
360.27	5	3	0.9		15	25	12	0.120	0.568	5.348	5.348	0.075	0.120	0.568	0.568	1.306	**0.096**	0.938	**0.111**	**N.L. (1)**
357.77	7.5	2	0.55		15	25	46	0.115	0.855	3.285	3.285	0.060	0.115	0.855	0.855	1.199	**0.071**	0.902	**0.107**	**N.L. (1)**
355.27	10	2	0.4		15	25	51	0.111	1.133	3.279	3.279	0.060	0.111	1.133	1.133	1.134	**0.067**	0.861	**0.102**	**N.L. (1)**
352.77	12.5	5	1.45		15	25	26	0.126	1.448	7.967	7.967	0.096	0.126	1.448	1.448	1.087	**0.102**	0.819	**0.097**	**N.L. (1)**
350.27	15	6	1.65		15	25	45	0.127	1.765	9.198	9.198	0.106	0.127	1.765	1.765	1.042	**0.109**	0.776	**0.092**	**N.L. (1)**
347.77	17.5	7	1.65		15	25	38	0.127	2.083	10.265	10.265	0.115	0.127	2.083	2.083	1.004	**0.114**	0.734	**0.087**	**N.L. (1)**
345.27	20	6	1.35		15	25	40	0.125	2.395	8.398	8.398	0.099	0.125	2.395	2.395	0.973	**0.095**	0.693	**0.082**	**N.L. (1)**
342.77	22.5	3	0.4		15	25	40	0.111	2.673	4.028	4.028	0.065	0.111	2.673	2.673	0.955	**0.061**	0.655	**0.078**	**N.L. (1)**
340.27	25	2	0.15		8	35	28	0.101	2.925	2.586	2.586	0.056	0.101	2.925	2.925	0.938	**0.052**	0.622	**0.074**	**N.L. (1)**
337.77	27.5	6						0.057	3.068	7.612	7.612	0.093	0.057	3.068	3.224	0.923	**0.084**	0.592	**0.074**	**1.135 (C)**
335.27	30	5						0.055	3.205	6.224	6.224	0.081	0.055	3.205	3.517	0.918	**0.073**	0.567	**0.074**	**0.986 (C)**
332.77	32.5	28						0.070	3.380	37.684	37.684	0.003	0.070	3.380	3.848	0.830	**0.002**	0.546	**0.074**	**N.L. (3)**
327.77	37.5	18						0.066	3.710	21.472	21.472	0.235	0.066	3.710	4.490	0.844	**0.194**	0.515	**0.074**	**2.622 (D)**
321.77	43.5	21						0.068	4.118	23.949	23.949	0.273	0.068	4.118	5.272	0.809	**0.217**	0.491	**0.074**	**2.932 (D)**
317.77	47.5	22						0.068	4.390	24.225	24.225	0.277	0.068	4.390	5.794	0.792	**0.216**	0.481	**0.075**	**2.880 (D)**
311.77	53.5	30						0.071	4.816	32.420	32.420	0.868	0.071	4.816	6.594	0.737	**0.629**	0.472	**0.077**	**N.L. (3)**
307.77	57.5	29						0.071	5.100	29.902	29.902	0.461	0.071	5.100	7.128	0.732	**0.331**	0.469	**0.078**	**N.L. (3)**
301.77	63.5	21						0.068	5.508	19.616	19.616	0.211	0.068	5.508	7.910	0.757	**0.157**	0.465	**0.079**	**1.987 (D)**
297.77	67.5	25						0.069	5.784	22.952	22.952	0.256	0.069	5.784	8.436	0.731	**0.184**	0.458	**0.079**	**2.329 (D)**

* 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

Appendix E

Pile Design Tables

Pile Design Table for S. Abutment utilizing Boring #1-S

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
165	91	25
270	148	30
343	189	36
354	195	40
366	202	46
Metal Shell 14"Φ w/.25" walls		
207	114	25
345	190	30
436	240	36
441	242	40
448	246	46
Metal Shell 14"Φ w/.312" walls		
207	114	25
345	190	30
436	240	36
441	242	40
448	246	46
483	266	50
527	290	56
Metal Shell 16"Φ w/.312" walls		
86	47	17
253	139	25
430	236	30
535	294	46
576	317	50
627	345	56
Metal Shell 16"Φ w/.375" walls		
86	47	17
253	139	25
430	236	30
535	294	46
576	317	50
627	345	56
751	413	62
Steel HP 8 X 36		
150	83	77

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
195	107	77
Steel HP 10 X 57		
200	110	77
Steel HP 12 X 53		
212	117	72
247	136	77
Steel HP 12 X 63		
214	118	72
251	138	77
Steel HP 12 X 74		
201	111	62
218	120	72
256	141	77

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
204	112	62
221	122	72
259	142	77
Steel HP 14 X 73		
215	118	56
235	129	62
258	142	67
264	145	72
299	165	77
Steel HP 14 X 89		
201	111	50
218	120	56
240	132	62
262	144	67
268	147	72
305	167	77
Steel HP 14 X 102		
203	112	50
220	121	56
242	133	62
265	146	67
272	149	72
308	169	77
Steel HP 14 X 117		
207	114	50
224	123	56
247	136	62
270	148	67
275	151	72
313	172	77
Precast 14"x 14"		
95	52	17

Pile Design Table for N. Abutment utilizing Boring #2-S

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
173	95	25
214	118	30
249	137	35
321	176	40
361	199	45
365	201	50
Metal Shell 14"Φ w/.25" walls		
96	53	20
220	121	25
270	149	30
312	172	35
403	222	40
446	245	50
Metal Shell 14"Φ w/.312" walls		
96	53	20
220	121	25
270	149	30
312	172	35
403	222	40
446	245	50
509	280	55
531	292	60
Metal Shell 16"Φ w/.312" walls		
114	63	20
271	149	25
332	182	30
381	210	35
494	272	40
533	293	50
609	335	55
630	347	60
Metal Shell 16"Φ w/.375" walls		
114	63	20
271	149	25
332	182	30
381	210	35
494	272	40
533	293	50
609	335	55
630	347	60
763	419	67
Steel HP 8 X 36		
149	82	82

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
166	91	77
193	106	82
Steel HP 10 X 57		
170	94	77
198	109	82
Steel HP 12 X 53		
167	92	60
191	105	67
210	115	77
244	134	82
Steel HP 12 X 63		
169	93	60
195	107	67
212	117	77
249	137	82
Steel HP 12 X 74		
172	95	60
198	109	67
215	119	77
252	139	82

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
175	96	60
200	110	67
219	120	77
255	140	82
Steel HP 14 X 73		
178	98	50
193	106	55
208	114	60
231	127	67
254	140	72
261	144	77
295	162	82
Steel HP 14 X 89		
181	100	50
197	108	55
211	116	60
235	130	67
258	142	72
265	146	77
300	165	82
Steel HP 14 X 102		
183	101	50
199	109	55
213	117	60
238	131	67
261	144	72
269	148	77
304	167	82
Steel HP 14 X 117		
186	103	50
202	111	55
217	119	60
242	133	67
266	146	72
272	150	77
309	170	82
Precast 14"x 14"		
122	67	20

Pile Design Table for Pier 1 utilizing Boring #3

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
183	100	16
236	130	19
251	138	26
302	166	29
311	171	31
322	177	34
364	200	39
Metal Shell 14"Φ w/.25" walls		
84	46	6
221	122	11
230	127	16
301	165	19
307	169	26
375	206	29
382	210	31
395	217	34
445	245	39
Metal Shell 14"Φ w/.312" walls		
84	46	6
221	122	11
230	127	16
301	165	19
307	169	26
375	206	29
382	210	31
395	217	34
445	245	39
540	297	44
Metal Shell 16"Φ w/.312" walls		
104	57	6
278	153	11
283	156	16
367	202	26
453	249	29
460	253	31
474	260	34
533	293	39
650	358	44
Metal Shell 16"Φ w/.375" walls		
104	57	6
278	153	11
283	156	16
367	202	26
453	249	29
460	253	31
474	260	34
533	293	39
650	358	44
719	395	49
735	404	54
Steel HP 8 X 36		
112	62	59

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
139	77	59
Steel HP 10 X 57		
143	79	59
Steel HP 12 X 53		
167	92	59
Steel HP 12 X 63		
171	94	59
Steel HP 12 X 74		
174	96	59

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
176	97	59
Steel HP 14 X 73		
182	100	54
202	111	59
Steel HP 14 X 89		
185	102	54
207	114	59
Steel HP 14 X 102		
187	103	54
210	115	59
Steel HP 14 X 117		
171	94	49
191	105	54
214	118	59
Precast 14"x 14"		
107	59	6