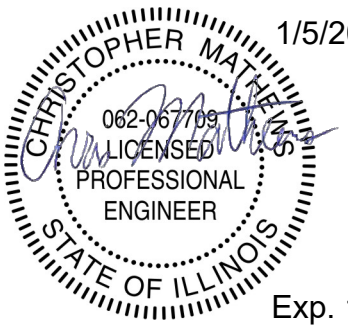
BACON | FARMER | WORKMAN

ENGINEERING & TESTING, INC.

STRUCTURE GEOTECHNICAL REPORT

Grapevine Trail over Clear Creek
Proposed SN: 002-3116
Existing SN: 002-3005
FAS RTE 945
Section 32B-F
Alexander County, Illinois



1/5/2026

Exp. 11/30/2027

Prepared for:
Nate Bullard, P.E.
County Engineer
Alexander County Highway Department
26799 IL-3
Olive Branch, Illinois 62969

Submittal Date:

January 5, 2026

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

January 5, 2026

Mr. Nate Bullard, P.E.
County Engineer
Alexander County Highway Department
26799 IL-3
Olive Branch, Illinois 62969

RE: ***Structure Geotechnical Report***
Grapevine Trail over Clear Creek
Structure 002-3116
Alexander County, Illinois
BFW No: 23038

Dear Mr. Bullard:

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 bridges.

Sincerely,

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

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

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

Attachment: Structure Geotechnical Report

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1. PROJECT DESCRIPTION AND SCOPE

The purpose of this geotechnical study is to explore the subsurface conditions present at the site and to determine pertinent engineering properties of the materials encountered.

Plans are for the removal and replacement of an existing six span bridge on Grapevine Trail over Clear Creek. This structure is located approximately 1.3 miles east of the town of McClure in Alexander County, Illinois. The existing structure is a 6-span, wide flange beam bridge built in 1954 as F.A.S. Rte. 945, Section 32B-F. The existing superstructure consists of continuous five-span WF 33 x 141 rolled beams with a reinforced concrete deck. The substructure consists of open reinforced concrete abutments and hammerhead piers on concrete piling. The existing structure abutment-abutment length measures 452'-6½" and the out-to-out deck width measures 29'-8".

The new structure will be a 4-span bridge with a reinforced concrete deck on continuous wide flange steel beams supported by integral abutments and solid wall piers. The planned structure abutment-abutment length is 443'-0" and its out-to-out deck width is 30'-10". The structure will be designed according to 2020 AASHTO LRFD Bridge Design Specifications, 9th Edition. See the *Preliminary GP&E* in Appendix B for more detail. The site location is shown in Figure 1.1.

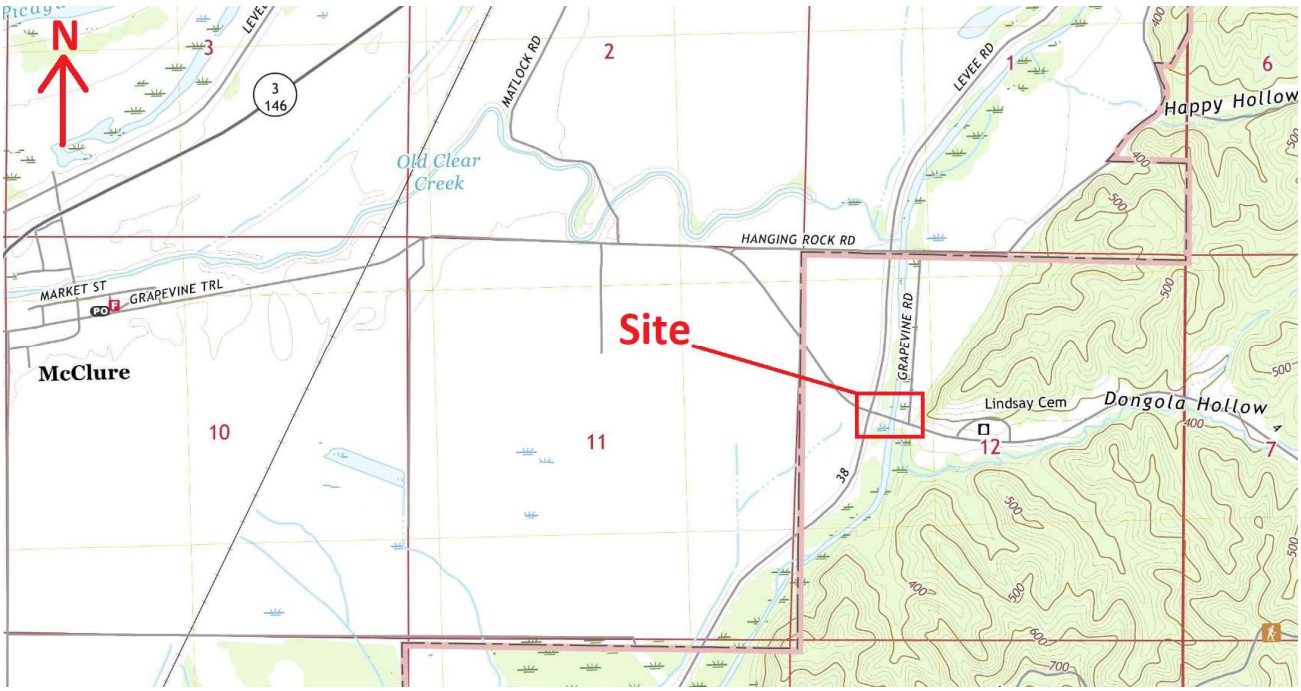

Figure 1.1. Project Location

2. FIELD EXPLORATION

2.1 *SUBSURFACE EXPLORATORY METHODS*

The procedures used by Bacon Farmer Workman Engineering & Testing, Inc. (BFW), Inc. for field and laboratory sampling and testing are in general accordance with American Society for Testing and Materials (ASTM) procedures, and established engineering practice. A total of five (5) test borings were advanced 54.3 to 114.7 feet below ground surface. Boring locations were located in the field by BFW personnel using a handheld GPS unit. As drilled boring locations were surveyed by BFW after the completion of drilling. See the *Preliminary*

GP&E and *Subsurface Boring Logs* in Appendices B and C, respectively. Table 2.1 summarizes the test boring locations.

Table 2.1 – Summary of Soil Testing Borings

Location	Structure	Ground Surface Elevation (msl)	Depth (ft)	Station	Offset (ft)
B-1	West Abutment	355.76	114.7	84+37.99	19.59 LT
B-2	Pier 1	334.58	87.3	85+78.46	28.88 RT
B-3	Pier 2	332.01	83.3	86+83.06	23.00 LT
B-4	Pier 3	332.33	78.1	88+23.44	26.42 RT
B-5	East Abutment	361.63	54.3	89+91.34	18.55 LT

A Diedrich D-50 rotary-drilling rig was used to advance the soil test borings and to obtain soil samples for laboratory evaluation. The test borings were advanced in accordance with geotechnical investigative procedures outlined by IDOT. Borings were backfilled with a cement grout mixture at the completion of the subsurface investigation.

Disturbed samples were retrieved during Standard Penetration Tests (SPT) [ASTM D-1586] using an automatic hammer assembly at various depths in the underlying stratum. The SPT consists of driving a 2-inch outside diameter split-barrel sampler (split-spoon) into the soil with a 140-pound weight falling freely through 30 inches. The sampler was driven in three (3) successive 6-inch increments, with the number of blows per increment being recorded. The number of blows required to advance the sampler the last 12 inches is termed the Standard Penetration Resistance (N). Relatively undisturbed Shelby tubes samples were collected at select location in-lieu of the SPTs for additional laboratory testing.

A project geologist observed and directed the drilling operations and visually classified soil samples obtained in accordance with Unified Soil Classification System (USCS) and ASTM D-2488 guidelines. Records of the conditions encountered, and visual soil classification were prepared and incorporated in *Subsurface Boring Logs* included in Appendix C.

The *Subsurface Boring Logs* represent BFW's interpretation of the conditions encountered within the soil test borings. It should be noted that strata changes may vary from those encountered within the soil test borings, transitions may be gradual or abrupt, and conditions may vary significantly at other locations. The groundwater information listed represents conditions at the time of drilling activities. Representative soil samples obtained from the borings were preserved in plastic bags, sealed, and taken to the laboratory for testing.

2.2 *LABORATORY TESTING PROCEDURES*

All samples were inspected in the laboratory to verify the field classifications. A laboratory testing program was undertaken to characterize and determine engineering properties of the soils encountered during the exploration. The following laboratory tests were performed on representative soil samples:

- Moisture content – ASTM D2216
- Unconfined Compression – ASTM D2166
- Grain Size Analysis – ASTM C136
- Grain Size Analysis with Hydrometer – ASTM D422

Based on the laboratory test results, the soils encountered were classified according to the IDOT IDH and AASHTO classification systems. The results of the laboratory testing program are included in Appendix D and are shown along with the field test results on the *Subsurface Boring Logs* in Appendix C.

2.3 *REGIONAL GEOLOGY*

According to the Illinois State Geological Survey's (ISGS) geologic map titled *Bedrock Geology of Illinois*, the project area is underlain by the Silurian-aged limestones and dolomites. Surficial materials are shown to consist of post-glacial river alluvial deposits. The site sits almost directly on the boundary of the Mississippi River flood plain and unglaciated terrain.

2.4 *SUBSURFACE CONDITIONS*

Surficial materials at the boring locations consisted of approximately 3 inches of grass and topsoil, with the exception of B-1, which was advanced through surface material consisting of 6 inches of asphalt and 4 inches of gravel base. Existing fill materials from the adjacent levee were encountered at the two abutment borings (B-1 and B-5). These materials consist primarily of sandy clay, silty clay loam, and silt loam and extend to a depth of approximately 27 feet below ground surface (bgs). The natural soil profile generally consisted of clay and silt loam. These materials had a very soft consistency. The clay and silt loam gradually became sandier with depth and transitioned to a sand at approximately 39 feet bgs These sands were generally very fine to fine grained and exhibited a medium dense to very dense relative density. These sands extended to bedrock in borings B-1, B-2, and B-4. A silty clay and silt loam extended to bedrock in borings B-3 and B-5. Rock coring was performed at boring B-4 from 67.1 to 78.1 feet bgs and showed bedrock consisting of a light gray limestone. Auger refusal was encountered between 54.3 and 114.7 feet bgs in borings B-1, B-2, B-3, and B-5, likely due to limestone bedrock. Table 2.2 summarizes the bedrock/auger refusal depths and elevations encountered at the time of drilling.

Table 2.2 – Bedrock Depth and Elevation

Location	Ground Surface Elevation (msl)	Depth to Bedrock (ft)	Bedrock Elevation (msl)
B-1	355.76	114.7	241.06
B-2	334.58	87.3	247.28
B-3	332.01	83.3	248.71
B-4	332.33	67.1	265.23
B-5	361.63	54.3	307.33

2.5 *GROUNDWATER*

Groundwater was encountered during drilling in all five borings. 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. Table 2.3 summarizes the groundwater levels encountered while drilling.

Table 2.3 – Groundwater Elevation and Depth While Drilling

Location	Groundwater Elevation (msl)	Groundwater Depth (ft)
B-1	310.76	45.0
B-2	330.58	4.0
B-3	326.01	6.0
B-4	328.33	4.0
B-5	331.63	30.0

3. GEOTECHNICAL EVALUATIONS

Based on the results of the subsurface exploration, current site conditions observed, laboratory results, and our review of the preliminary 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 from this exploration 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

According to the *IDOT Geotechnical Manual*, bridge structures are required to be designed to an earthquake with a 7 percent Probability of Exceedance (PE) over a 75-year exposure period (i.e. a 1,000-year design earthquake). The 1,000-year design earthquake has a Moment Magnitude (Mw) of 7.5 and a Modified Peak Ground Acceleration (PGAM) of 0.66g 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, including Refraction MicroTremor (ReMi) surveys performed at each of the abutments. A ReMi survey is a geophysical test method that evaluates the shear wave velocity profile of the subsurface. Based on the results of the ReMi surveys, the average shear wave velocity of the upper 100 feet of the subsurface profile in indicative of a Site Class D, as shown in Appendix E. Seismic design parameters based on AASHTO 2009 are presented in Table 3.1.

Table 3.1 – Seismic Design Parameters

Seismic Design Parameters	
Site Class	D
F_A	1.02
F_V	1.79
F_{PGA}	1.00
S_S	1.19
S_1	0.31
PGA	0.66
A_s	0.66
S_{DS}	1.22
S_{D1}	0.55
SDC	D
Seismic Performance Zone	4

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, there is the potential for liquefaction of the silty and sandy soils below the groundwater table in borings B-2 (Pier 1) between a depth of 7.5 and 35 feet and B-4 (Pier 3) between 5 and 40 feet. It should be noted that additional isolated relatively thin (less than 5 feet) layers of potentially liquefiable soils were encountered in borings B-1 and B-5. While the amount of the seismically induced settlement is dependent on the magnitude and distance from the seismic event, we recommend down drag from the liquefaction induced settlements be considered in the foundation design for the bridges. Additionally, the unbraced length of the piles during liquefaction should be considered during lateral analysis of the piles. The liquefaction analysis results are presented in Appendix F.

3.3 *ABUTMENT APPROACH SETTLEMENT*

Based on the preliminary GP&E, minimal grade changes will be required. Accordingly, minimal abutment settlement will occur, and the effects of down drag due to settlement 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 square inch per inch of deflection (pci).

3.5 *INTEGRAL ABUTMENT FEASIBILITY ANALYSIS*

Integral abutments are preferred to eliminate joints in the bridge decks, decreasing maintenance costs and increasing service life. The proposed structure length and soil strength within 10 feet of the bottom of the abutment typically fits in the range of applicability for integral abutments. The results of the Integral Abutment Feasibility Analysis are included in Appendix G. The designer shall verify integral abutment feasibility analysis with final configuration.

3.6 *BRIDGE FOUNDATIONS*

The bridge foundations must be designed to provide sufficient capacity to resist dead and live loads, including seismic loads. Based on the depth to bedrock and the potential for liquefaction, we recommend steel H-piles end-bearing on bedrock be utilized for foundation support of the bridges.

3.6.1 Driven Piles

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 H-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.

To develop capacity and resist down drag loads the H-piles will need to be driven to practical refusal on bedrock. Based on the refusal depths encountered in the borings, we estimate that the piles will bear at an elevation ranging between 241 and 249 msl at the west abutment and Piers 1 and 2, at about elevation 265 at Pier 3, and at about elevation 307 at the east abutment. 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. Per the IDOT Geotechnical Manual, a geotechnical resistance factor of 0.55 should be used for driven piles. For H-piles end bearing on rock, the factored resistance available is simply the structural nominal compressive resistance of the pile section factored with the appropriate geotechnical resistance factor. Pile sizes with estimated lengths and capacities can be found in Appendix H.

During a seismic event, a geotechnical resistance factor of 1.0 may be used. Based on the piles end bearing on bedrock, geotechnical losses due to liquefaction do not need to be included in the axial pile capacity calculations. However, downdrag loads due to liquefaction were considered in the provided axial capacities for the seismic condition in borings where significant liquefaction was encountered. Pile tables for the seismic condition at these borings locations are included in Appendix H.

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.

3.6.2 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. When pile design details and load information are refined in the development of the structure plans, LPILE analyses, if warranted, can be performed. A summary of the approximate soil modulus parameters (k) for the LPILE analyses (Reference: LPILE User's Manual, Ensoft, Inc., 2019) can be found in Appendix I.

3.7 *SLOPE STABILITY*

According to the information shown on the preliminary GP&E plans, 2H:1V end slopes will be utilized for the abutments. Based on minimal to no grade changes and a similar configuration to the existing end slopes, a slope stability analysis was not performed for the project.

4. CONSTRUCTION CONSIDERATIONS

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 the Alexander County Highway Department 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 within the project limits. The analyses have been 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

Aerial Photograph

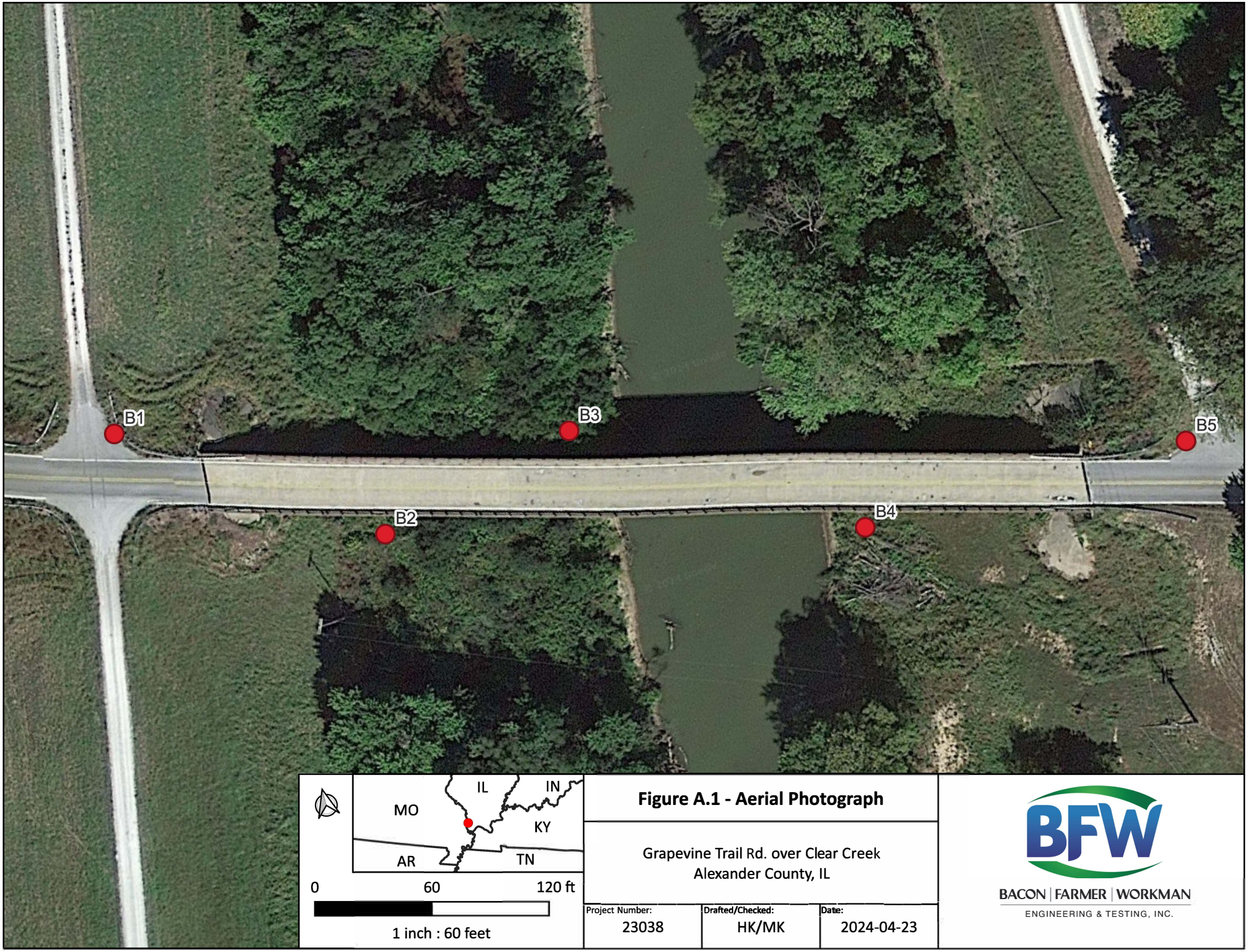

Figure A.1 - Aerial Photograph

Grapevine Trail Rd. over Clear Creek
Alexander County, IL

Project Number:	Drafted/Checked:	Date:
23038	HK/MK	2024-04-23

BFW
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ENGINEERING & TESTING, INC.

Appendix B

Preliminary GP&E

Bench Mark: Elevation ☐

Existing Structure: S.N. 002-3005 was originally built in 1959 as F.A.S Rte. 945, Section 32B-F. The existing superstructure consists of continous five-span WF 33x141 rolled beams with a reinforced concrete deck. The substructure is consists open reinforced concrete abutments and hammehead piers. All substructure units are on concrete piling. The bk. to bk. of abutment length measures 452'-6 1/2" and the out-to-out deck width measures 29'-8". The structure is to be removed and replaced. Traffic to be detoured during construction.

No Salvage

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

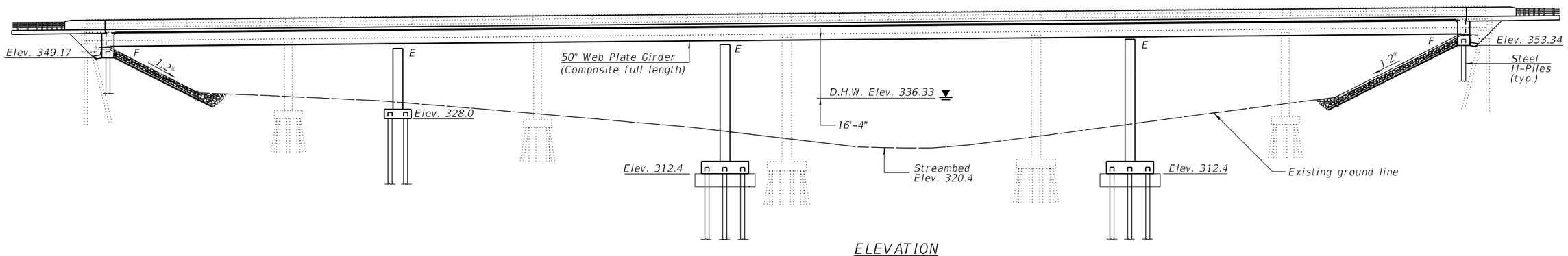
LOADING HL-93

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

DESIGN STRESSES

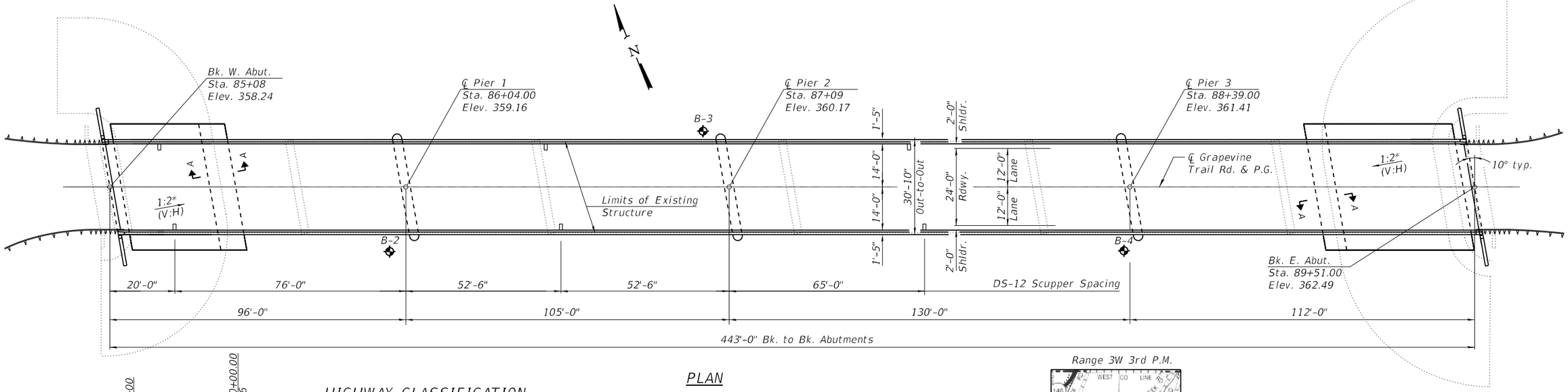
FIELD UNITS

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

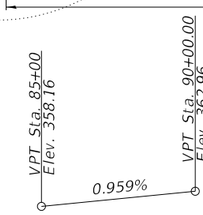


ELEVATION

*At right L's to front face of abutment



PLAN



PROFILE GRADE

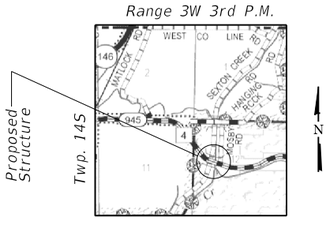
(along centerline Grapevine Trail Rd.)

HIGHWAY CLASSIFICATION

F.A.S. Rte. 945 - Grapevine Trail Rd.
Functional Class: Major Collector (Rural)
ADT: 1100 (2022); 1263 (2046)
ADTT: 176 (2022); 202 (2046)
DHV: 126 (2041)
Design Speed: 55 m.p.h.
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution: 50:50

SEISMIC DATA

Seismic Performance Zone (SPZ) = 4
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.561g
Design Spectral Acceleration at 0.2 sec. (SDS) = 0.961g
Soil Site Class = D



LOCATION SKETCH

GENERAL PLAN & ELEVATION
GRAPEVINE TRAIL RD. OVER CLEAR CREEK
F.A.S. RTE. 945 - SEC. 32B-F
ALEXANDER COUNTY
STATION 87+29
S.N. 002-3116

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.
403 NORTH COURT STREET
MARION, ILLINOIS 62959
PHONE - 618.997.9186

USER NAME = ____	DESIGNED - TAC	REVISED - ____	
	CHECKED -	REVISED - ____	
PLOT SCALE = ____	DRAWN - TAC	REVISED - ____	
PLOT DATE = ____	CHECKED -	REVISED - ____	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN & ELEVATION
STRUCTURE NO. 002-3116
SHEET 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
945	32B-F	Alexander	__	__
			CONTRACT NO.	
	ILLINOIS	FED. AID PROJECT		

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Appendix C

Subsurface Boring Logs

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/13/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** West Abutment, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3146699, **Longitude** -89.3951516

COUNTY Alexander **DRILLING METHOD** HSA/MUD ROTARY **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-1
Station 84+37.99
Offset 19.6 ft LT
Ground Surface Elev. 355.76 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 310.8 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
				Asphalt - 6 inches 355.26
				Gravel Base - 4 inches 354.86
				EXISTING FILL: Gray sandy clay
	3			
	4 1		22	
-5				
				348.51
				EXISTING FILL: Gray silty clay loam
	3			
	3 3		23	
-10				
	2			
	2 2		23	
	2			
				342.26
	2 3		25	
				EXISTING FILL: Gray silt
-15				
	2			
	2 2		25	
	2			
	2 2		25	
-20				

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	0			EXISTING FILL: Gray silt *(continued)*
	0 0		28	
				333.76
				EXISTING FILL: Gray clay
	2			
	2 2		28	
-25				
	0			
	0 0		28	
				328.76
				CLAY: Brownish gray to gray
	0			
	0 2		29	
-30				
	0			
	0 0		29	
-35				
-40				

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
Bacon Farmer Workman Engineering & Testing, Inc.

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Date 12/13/23

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STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-1
Station 84+37.99
Offset 19.6 ft LT
Ground Surface Elev. 355.76 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 310.8 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
CLAY: Brownish gray to gray *(continued)*	0		
	0 3		36
▼-45	2		
	2 2		42
307.26			
SAND: Brownish gray to gray, fine grained			
-50	0		
	0 4		43
302.26			
SANDY CLAY: Gray to dark gray			
-55	0		
	0 2		31
297.26			
SANDY CLAY LOAM: Gray to dark gray			
-60			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SANDY CLAY LOAM: Gray to dark gray *(continued)*	4		
	8 12		25
-65	5		
	4 5		30
287.26			
SAND: Gray, very fine to fine grained			
-70	14		
	13 21		21
-75	12		
	10 12		9
-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)

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing, Inc.

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Date 12/13/23

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Station 87+29

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Station 84+37.99
Offset 19.6 ft LT
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Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 310.8 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	SAND: Gray, very fine to fine grained *(continued)*		
	16		
	19		26
	23		
-85			
	20		
	24		23
	31		
-90			
	13		
	20		19
	23		
262.26			
	SAND: Gray, fine to coarse grained, some gravel		
-95			
	18		
	14		23
	12		
-100			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	SAND: Gray, fine to coarse grained, some gravel *(continued)*		
	9		
	10		17
	10		
-105			
	6		
	9		15
	12		
-110			
	10		
	12		21
	12		
241.06			
-115	End of Boring		
	50		
-120			

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
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/14/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 1, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3144177, **Longitude** -89.3947571

COUNTY Alexander **DRILLING METHOD** HSA/MUD ROTARY **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-2
Station 85+78.46
Offset 28.9 ft RT
Ground Surface Elev. 334.58 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 330.6 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	2			Grass and Topsoil - 3" 334.33
	2 4	0.8	24	SILTY CLAY LOAM: Brown to gray
	2			
	2 2	1.5	27	▼
-5	0			
	3 3	0.8	27	
	0			327.58 SILTY LOAM: Gray
	0 0	0.0	33	
-10	0			
	0 0	0.5	30	
	0			
	0 0	0.0	33	320.08 SILTY: Gray
-15	0			
	0 0	0.0	43	
	0			
	0 0	0.0	47	
-20				
	0			SILTY: Gray *(continued)*
	0 0	0.0	44	
	0			
	0 0	0.0	38	
-25	0			
	0 0	0.0	52	
	0			
	0 0	0.0	44	305.08 LOAMY SAND: Gray, very fine grained, silty
-30	0			
	0 0		29	
				301.08 CLAY: Gray
-35	0			
	0 0		40	
				296.08 LOAMY SAND: Gray, very fine grained, silty
-40				

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
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/14/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 1, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3144177, **Longitude** -89.3947571

COUNTY Alexander **DRILLING METHOD** HSA/MUD ROTARY **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-2
Station 85+78.46
Offset 28.9 ft RT
Ground Surface Elev. 334.58 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 330.6 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
LOAMY SAND: Gray, very fine grained, silty *(continued)*	8		
	8		27
	4		
291.08			
SAND: Gray, fine grained			
-45			
	5		
	6		23
	7		
-50			
	12		
	14		27
	16		
-55			
	10		
	11		26
	14		
-60			

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
SAND: Gray, fine grained *(continued)*	9		
	11		28
	11		
271.08			
LOAMY SAND: Gray, very fine grained, clayey			
-65			
	6		
	8		32
	11		
-70			
	3		
	3		31
	3		
261.08			
SAND: Gray, very fine to coarse, trace gravel			
-75			
	23		
	25		22
	27		
-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)

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/14/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 1, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3144177, **Longitude** -89.3947571

COUNTY Alexander **DRILLING METHOD** HSA/MUD ROTARY **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-2
Station 85+78.46
Offset 28.9 ft RT
Ground Surface Elev. 334.58 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 330.6 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	10		
SAND: Gray, very fine to coarse, trace gravel *(continued)*	14 19		29
-85	15		
	20 23		17
247.58			
247.28 LIMESTONE: Light gray, with fine sand	50		
End of Boring			
-90			
-95			
-100			

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
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/19/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 2, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3144697, **Longitude** -89.3943918

COUNTY Alexander **DRILLING METHOD** HSA/MUD ROTARY **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-3
Station 86+83.06
Offset 23.0 ft LT
Ground Surface Elev. 332.01 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 326.0 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
	0			Topsoil - 2 inches 331.81
	0 0	0.3	29	SILTY LOAM: Gray to brown
				330.01 SILT: Gray to brown
	4			
	6 6		24	
				327.51 SANDY CLAY: Gray-brown, trace gravel
-5	4			
▼	7 3		20	
				325.01 CLAY: Gray, trace black organics
	0			
	0 0	0.0	30	
-10	0			
	0 0		35	
	0			
	0 0		31	
-15	0			
	0 3	0.0	49	
	0			
	0 0	0.3	48	
-20				

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
	0			CLAY: Gray, trace black organics *(continued)*
	0 0		48	
	0			
	0 0		49	
-25				
	0			
	0 0		41	
	0			
	0 2		34	
-30				
	1			
	2 1	0.3	38	
-35				
	0			
	0 4	0.0	46	
-40				

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
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/19/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 2, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3144697, **Longitude** -89.3943918

COUNTY Alexander **DRILLING METHOD** HSA/MUD ROTARY **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-3
Station 86+83.06
Offset 23.0 ft LT
Ground Surface Elev. 332.01 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 326.0 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
	3			CLAY: Gray, trace black organics *(continued)*
	1	0.0	46	
	1			
288.51				
				LOAMY SAND: Gray
-45				
	4			
	10		23	
	12			
283.51				
				SAND: Gray, very fine grained
-50				
	10			
	14		28	
	17			
-55				
	14			
	17		24	
	18			
-60				
	12			SAND: Gray, very fine grained *(continued)*
	14		28	
	14			
268.51				
				LOAMY SAND: Gray
-65				
	5			
	7		30	
	8			
263.51				
				SILTY LOAM: Gray, with very fine sand
-70				
	4			
	4		39	
	6			
-75				
	4			
	6		42	
	7			
253.51				
				SILTY CLAY: Gray, trace sand
-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)

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/19/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 2, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3144697, **Longitude** -89.3943918

COUNTY Alexander **DRILLING METHOD** HSA/MUD ROTARY **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-3
Station 86+83.06
Offset 23.0 ft LT
Ground Surface Elev. 332.01 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 326.0 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	
SILTY CLAY: Gray, trace sand *(continued)*	3			
	3			
	4			
248.71				
End of Boring	50			
-85				
-90				
-95				
-100				

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
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/21/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 3, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3142109, **Longitude** -89.3939533

COUNTY Alexander **DRILLING METHOD** CASING **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-4
Station 88+23.44
Offset 26.4 ft RT
Ground Surface Elev. 332.33 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 328.3 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	
332.13				Topsoil and Vegetation - 2 inches
	3			
	6 9		25	SILTY LOAM: Brown, with gravel (Possibly Existing Fill)
330.33				
				SILT: Gray
			29	▼
-5	0			
	0 3	0.3	28	
	0			
	0 0	0.0	31	
-10	0			
	0 0	0.0	34	
	0			
	0 0	0.0	36	
-15	0			Trace decayed plant material
	0 0	0.0	35	
	0			
	0 0	0.0	49	
312.83				
-20				CLAY: Gray, high plastic

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	
	0			CLAY: Gray, high plastic *(continued)*
	0 0	0.0	52	
310.33				
	0			SILTY LOAM: Gray
	0 0	0.0	38	
-25	0			
	0 0	0.0	55	
	0			
	0 0	0.0	44	
-30	0			
	0 0	0.0	36	
-35	0			
	6 2	0.0	40	Becomes sandy
-40				

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
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/21/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** Pier 3, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3142109, **Longitude** -89.3939533

COUNTY Alexander **DRILLING METHOD** CASING **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-4
Station 88+23.44
Offset 26.4 ft RT
Ground Surface Elev. 332.33 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 328.3 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Material
	0			SILTY LOAM: Gray *(continued)*
	0 0	0.0	60	
287.83				
-45				CLAY: Gray
	0			
	0 0	0.0	64	
-50				
	0			
	0 0	0.0	29	
278.83				
				SANDY CLAY: Gray, trace silt
-55				
	2			
	3 7	0.5	33	
273.83				
				SANDY CLAY LOAM: Gray
-60				
	3			SANDY CLAY LOAM: Gray *(continued)*
271.33				
	3 1		30	CLAY: Gray
-65				
266.83	6			
	8 35			SAND: Gray, very fine grained, some broken limestone
				Borehole continued with rock coring.
-70				
-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)

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/21/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** East Abutment, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3141794, **Longitude** -89.3933694

COUNTY Alexander **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-5
Station 89+91.34
Offset 18.6 ft LT
Ground Surface Elev. 361.63 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 331.6 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	4			Topsoil and Grass - 3 inches (361.38)
	8		26	EXISTING FILL: Gray-brown silty clay, some gravel
	8			
	4			
	5	4.5	20	
	5			
				(357.13)
-5				EXISTING FILL: Gray to brown silty loam
			25	
	4			
	6	1.0	23	
	4			
-10				
	3			
	3	1.0	31	
	5			
	3			
	4	4.5	36	
	6			
-15				
	4			
	5		32	
	5			
	14			
	9		43	
	8			
-20				

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	3			EXISTING FILL: Gray to brown silty loam *(continued)*
	4	1.0	49	
	5			
	2			
	1	0.0	23	
	1			
-25				
	0			
	0	0.0	26	
	0			
				(334.63)
	0			CLAY: Gray, some broken limestone
	0		33	
	3			
				(331.63 ▼)
-30				
	2			GRAVEL: Orange and light gray broken limestone, with clay
	1		26	
	4			
				(329.63)
				SILTY LOAM: Gray
-35				
	0			
	3		28	
	3			
-40				

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)

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing, Inc.

SOIL BORING LOG

Date 12/21/23

ROUTE FAS RTE 945 **DESCRIPTION** Grapevine Trail Rd. over Clear Creek **LOGGED BY** M. Kaufman

SECTION 32B-F **LOCATION** East Abutment, **SEC.** 12, **TWP.** 14 S, **RNG.** 3 W, 3rd **PM**,
Latitude 37.3141794, **Longitude** -89.3933694

COUNTY Alexander **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. 002-3116
Station 87+29

BORING NO. B-5
Station 89+91.34
Offset 18.6 ft LT
Ground Surface Elev. 361.63 ft

Surface Water Elev. ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 331.6 ft ▼
Upon Completion ft
After Hrs. ft

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	Description
	0			SILTY LOAM: Gray *(continued)*
	0		26	
	0			
318.13				
				CLAY: Gray
-45	0			
	0	0.0	41	
	0			
-50	0			
	0		33	
	0			
307.33	50			With broken limestone
-55				End of Boring
-60				

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 D

Soil Laboratory Data

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.
500 SOUTH 17th STREET | PADUCAH, KY 42003

Laboratory Testing Summary

Project Number:	23038
Project Name:	Grapevine Trail over Clear Creek
Date:	2/7/2024

Moisture Content

Depth	Min%	Max%
0.0 - 12.5	19.8	36.1
15.0 – 22.5	22.9	52.0
25.0 – 35.0	25.6	55.1
40.0 – 55.0	23.4	63.7
60.0 – 75.0	9.0	42.0

Atterberg Limits

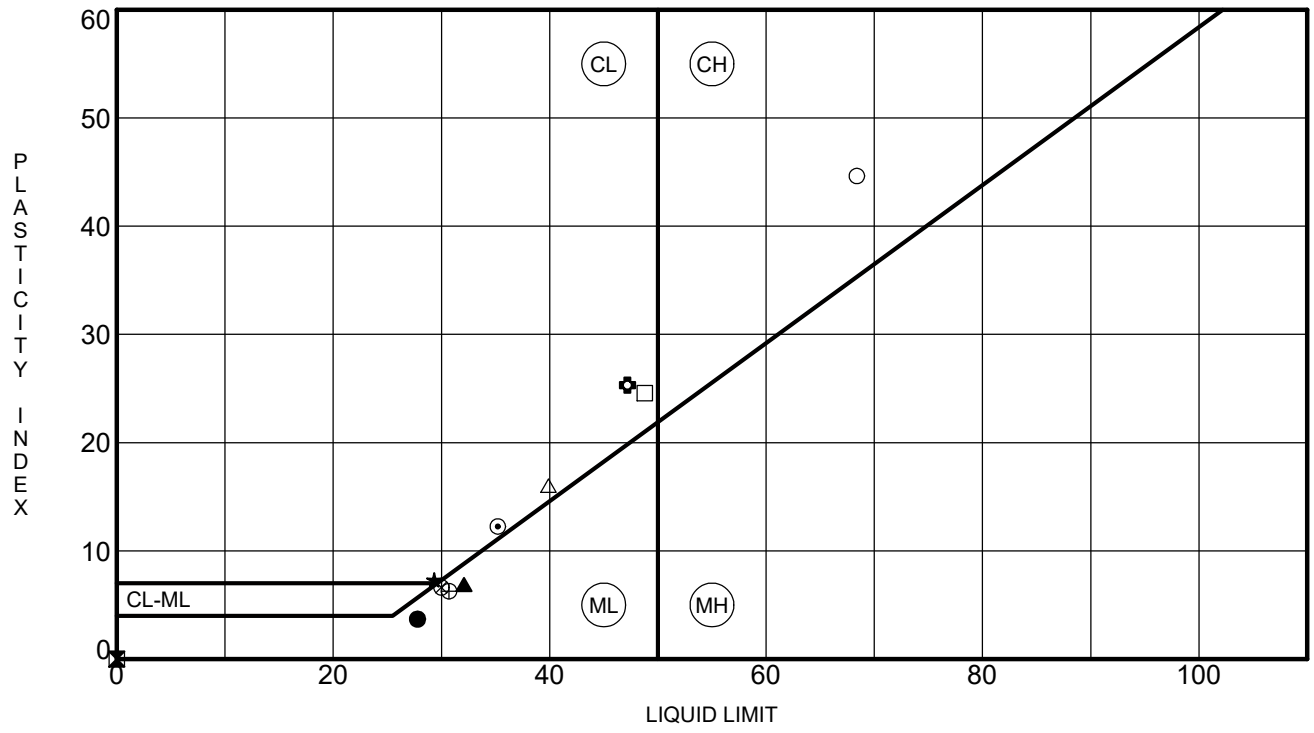
Sample	Depth(ft)	LL	PL	PI	Classification
B-1	20.0	27.8	24.1	3.7	ML
B-1	50.0	NP	NP	NP	NP
B-2	17.5	32.1	25.2	6.9	ML
B-2	35.0	29.3	22.0	7.3	CL
B-3	17.5	35.2	23.0	12.2	CL
B-3	40.0	47.2	21.9	25.3	CL
B-3	40.0	47.2	21.9	25.3	CL
B-4	20.0	68.4	23.7	44.7	CH
B-5	10.0	30.0	23.4	6.6	ML
B-5	35.0	30.7	24.4	6.3	ML
B-5	45.0	48.8	24.2	24.6	CL

Grain Size and Hydrometer Analysis

Sample	Depth(ft)	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
B-1	100.0	9.5	1.136	0.581	0.23	14.7	81.5	3.8	
B-2	65.0	4.75	0.117	0.078	-	0.0	72.9	27.1	
B-3	0.0	4.75	0.043	0.018	0.003	0.4	12.9	79.3	7.4
B-3	2.50	19	0.045	0.022	0.001	0.6	2.9	85.2	11.4
B-3	65.0	4.75	0.113	0.079	-	0.1	74.9	25.1	
B-4	0.0	19	0.055	0.027	0.005	3.0	7.4	78.6	6.0
B-4	2.50	19	0.049	0.026	0.006	6.5	4.1	82.4	7.0
B-4	60.0	2	0.205	0.087	-	0.0	73.6	26.4	

Unconfined Compressive Strength

Sample	Depth	Compressive Strength (psf)	Strain at Failure (%)
B-4	2.50	2442	6
B-5	5.0	3710	11



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-1**	**20.00**	**27.8**	**24.1**	**3.7**		
⊠	**B-1**	**50.00**	**NP**	**NP**	**NP**		
▲	**B-2**	**17.50**	**32.1**	**25.2**	**6.9**		
★	**B-2**	**35.00**	**29.3**	**22.0**	**7.3**		
⊙	**B-3**	**17.50**	**35.2**	**23.0**	**12.2**		
✿	**B-3**	**40.00**	**47.2**	**21.9**	**25.3**		
○	**B-4**	**20.00**	**68.4**	**23.7**	**44.7**		
△	**B-4**	**45.00**	**39.9**	**23.8**	**16.1**		
⊗	**B-5**	**10.00**	**30.0**	**23.4**	**6.6**		
⊕	**B-5**	**35.00**	**30.7**	**24.4**	**6.3**		
□	**B-5**	**45.00**	**48.8**	**24.2**	**24.6**		

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing Inc.

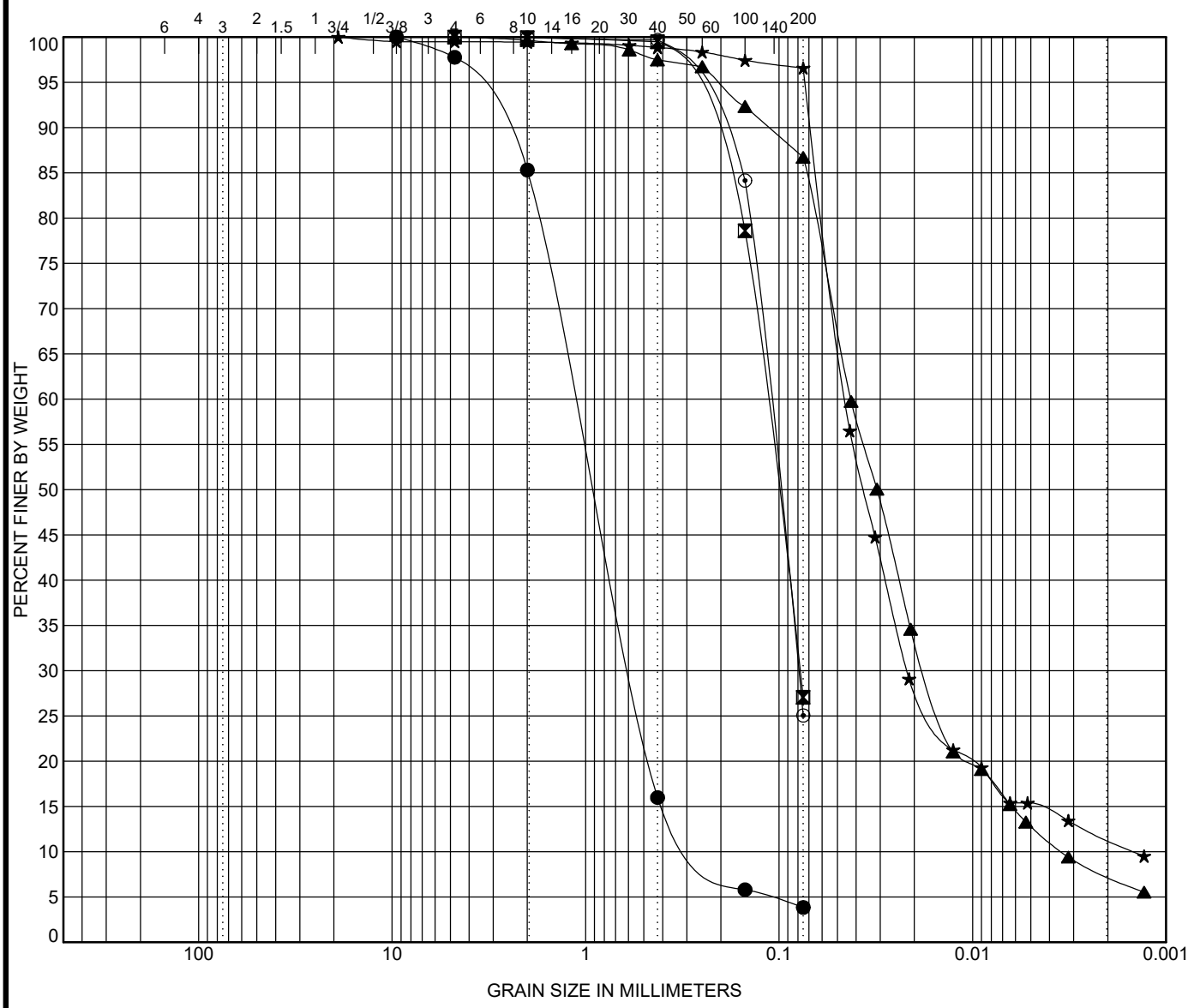
ATTERBERG LIMITS' RESULTS

Route: Grapevine Trail

Section: N/A

County:

ATTERBERG_LIMITS 23038 - GRAPEVINE TRAIL OVER CLEAR CREEK.GPJ IL_DOT.GDT 2/7/24



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-1	100.00	SAND				1.29	4.93
⊠	B-2	65.00						
▲	B-3	0.00	SILTY LOAM				2.11	12.33
★	B-3	2.50	SILT				7.23	31.13
⊙	B-3	65.00						

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	100.00	9.5	1.136	0.581	0.23	14.7	81.5	3.8	
⊠	B-2	65.00	4.75	0.117	0.078		0.0	72.9	27.1	
▲	B-3	0.00	4.75	0.043	0.018	0.003	0.4	12.9	79.3	7.4
★	B-3	2.50	19	0.045	0.022	0.001	0.6	2.9	85.2	11.4
⊙	B-3	65.00	4.75	0.113	0.079		0.1	74.9	25.1	

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing Inc.

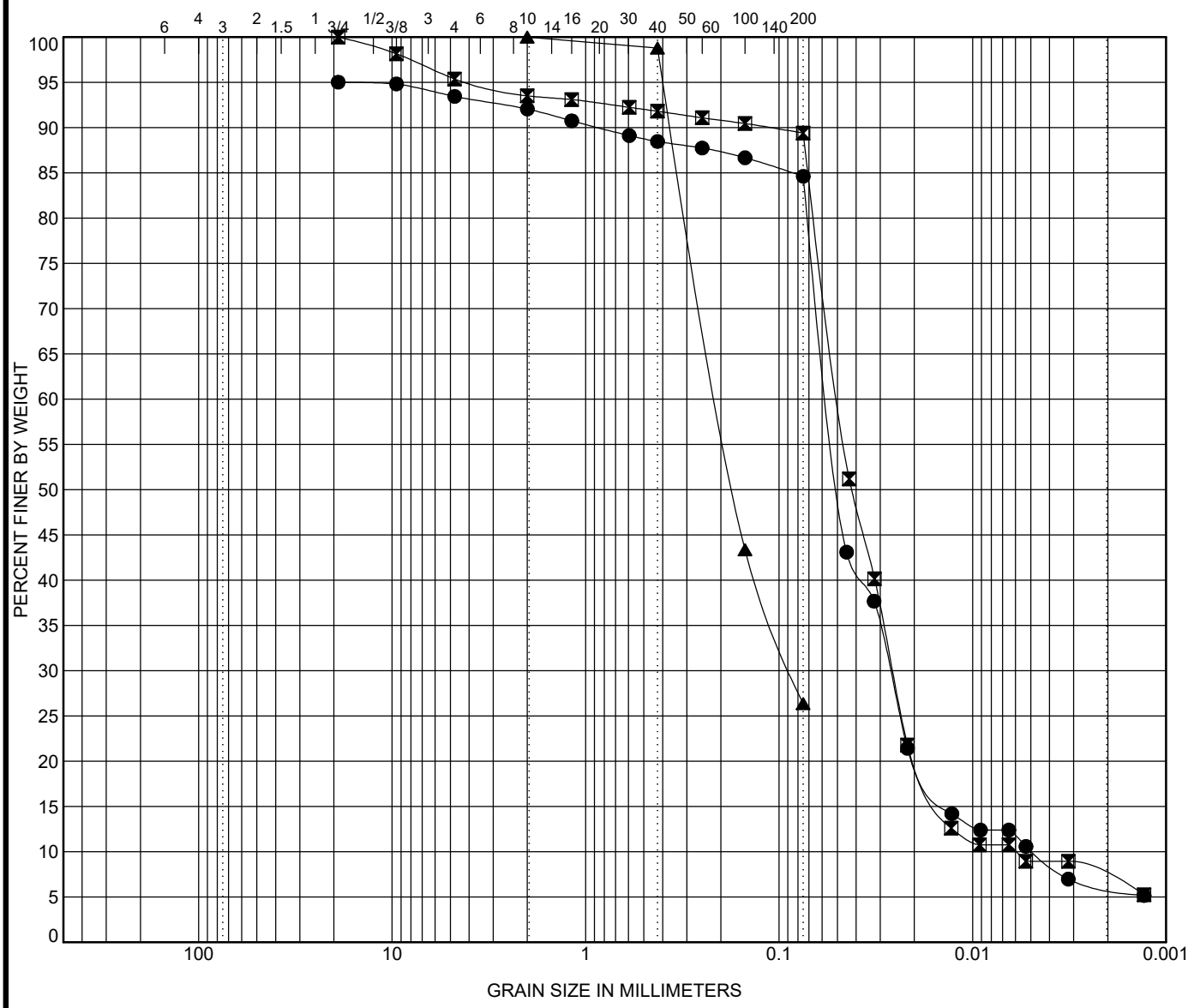
IDH GRAIN SIZE DISTRIBUTION

Route: Grapevine Trail

Section: N/A

County:

GRAIN_SIZE_IDH_3-18-11 23038 - GRAPEVINE TRAIL OVER CLEAR CREEK.GPJ IL_DOT.GDT 2/7/24



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-4	0.00	SILTY LOAM				2.65	11.31
⊠	B-4	2.50	SILT				2.27	8.25
▲	B-4	60.00						

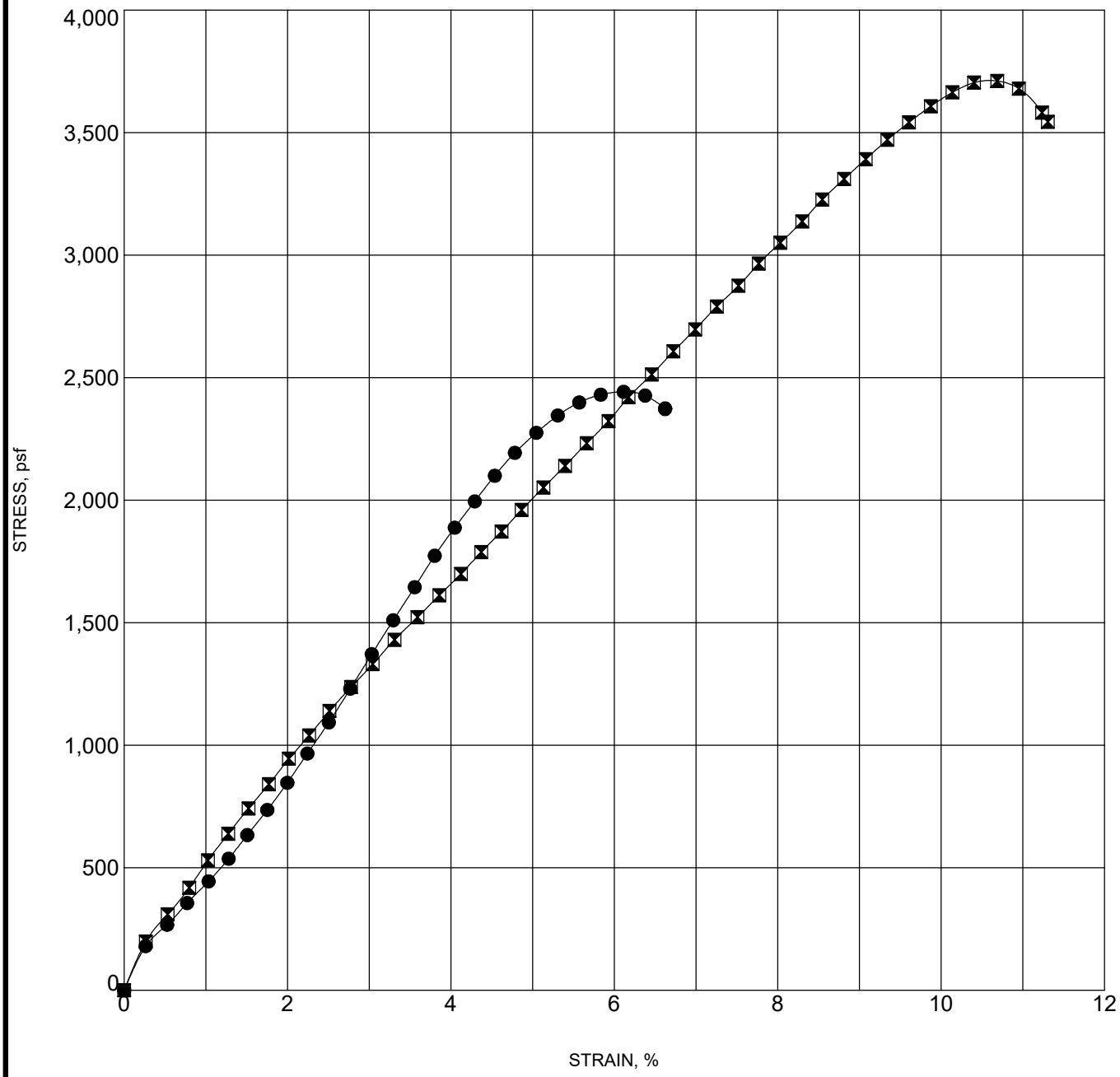
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-4	0.00	19	0.055	0.027	0.005	3.0	7.4	78.6	6.0
⊠	B-4	2.50	19	0.049	0.026	0.006	6.5	4.1	82.4	7.0
▲	B-4	60.00	2	0.205	0.087		0.0	73.6	26.4	

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing Inc.

IDH GRAIN SIZE DISTRIBUTION

Route: Grapevine Trail
Section: N/A
County:

GRAIN_SIZE_IDH_3-18-11 23038 - GRAPEVINE TRAIL OVER CLEAR CREEK.GPJ IL_DOT.GDT 2/7/24



Specimen Identification			Classification	γ_d	MC%
●	**B-4**	**2.50**	**SILT**	**99.4**	**24**
⊠	**B-5**	**5.00**		**104.4**	**22**

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing Inc.

UNCONFINED COMPRESSION TEST

Route: Grapevine Trail

Section: N/A

County:

UNCONFINED 23038 - GRAPEVINE TRAIL OVER CLEAR CREEK.GPJ IL_DOT.GDT 2/7/24

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	2.50							22.0			
B-1	7.50							23.3			
B-1	10.00							23.2			
B-1	12.50							24.7			
B-1	15.00							24.7			
B-1	17.50							25.3			
B-1	20.00	27.8	24.1	3.7				27.7			
B-1	22.50							27.6			
B-1	25.00							27.6			
B-1	27.50							28.5			
B-1	30.00							28.5			
B-1	40.00							36.3			
B-1	45.00							41.6			
B-1	50.00	NP	NP	NP				42.8			
B-1	55.00							30.7			
B-1	57.50							18.6			
B-1	60.00							25.1			
B-1	65.00							29.8			
B-1	70.00							21.0			
B-1	75.00							9.0			
B-1	80.00							25.8			
B-1	85.00							22.6			
B-1	90.00							18.6			
B-1	95.00							22.7			
B-1	100.00				9.5	4		17.2			
B-1	105.00							15.5			
B-1	110.00							20.7			
B-2	0.00							24.3			
B-2	2.50							27.3			
B-2	5.00							27.3			
B-2	7.50							32.5			
B-2	10.00							30.2			
B-2	12.50							32.8			
B-2	15.00							43.5			
B-2	17.50	32.1	25.2	6.9				46.9			
B-2	20.00							43.7			
B-2	22.50							37.5			
B-2	25.00							52.2			
B-2	27.50							44.0			
B-2	30.00							29.4			
B-2	35.00	29.3	22.0	7.3				40.4			
B-2	40.00							26.6			

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing Inc.

Summary of Laboratory Results

Route: Grapevine Trail

Section: N/A

County:

LAB_SUMMARY 23038 - GRAPEVINE TRAIL OVER CLEAR CREEK.GPJ IL_DOT.GDT 2/7/24

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-2	45.00							23.4			
B-2	50.00							27.4			
B-2	55.00							26.3			
B-2	60.00							27.9			
B-2	65.00				4.75	27		32.2			
B-2	70.00							30.9			
B-2	75.00							22.0			
B-2	80.00							28.6			
B-2	85.00							17.2			
B-2	90.00							7.2			
B-3	0.00				4.75	87		28.9			
B-3	2.50				19	97		24.2			
B-3	5.00							19.8			
B-3	7.50							30.2			
B-3	10.00							34.5			
B-3	12.50							31.1			
B-3	15.00							48.8			
B-3	17.50	35.2	23.0	12.2				47.8			
B-3	20.00							48.3			
B-3	22.50							49.4			
B-3	25.00							41.3			
B-3	27.50							34.4			
B-3	30.00							37.9			
B-3	35.00							46.3			
B-3	40.00	47.2	21.9	25.3				46.2			
B-3	45.00							22.9			
B-3	50.00							28.0			
B-3	55.00							24.4			
B-3	60.00							28.5			
B-3	65.00				4.75	25		30.3			
B-3	70.00							38.9			
B-3	75.00							42.0			
B-4	0.00				19	85		24.7			
B-4	2.50				19	89		28.6	99.4	113	0.679
B-4	5.00							28.1			
B-4	7.50							30.6			
B-4	10.00							33.9			
B-4	12.50							36.1			
B-4	15.00							34.5			
B-4	17.50							49.1			
B-4	20.00	68.4	23.7	44.7				52.0			
B-4	22.50							38.3			

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing Inc.

Summary of Laboratory Results

Route: Grapevine Trail

Section: N/A

County:

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-4	25.00							55.1			
B-4	27.50							43.7			
B-4	30.00							36.0			
B-4	35.00							39.6			
B-4	40.00							59.9			
B-4	45.00	39.9	23.8	16.1				63.7			
B-4	50.00							28.9			
B-4	55.00							33.1			
B-4	60.00				2	26		30.3			
B-5	0.00							26.0			
B-5	2.50							20.5			
B-5	5.00							25.0	104.4	112	0.600
B-5	7.50							22.8			
B-5	10.00	30.0	23.4	6.6				31.1			
B-5	12.50							36.1			
B-5	15.00							32.0			
B-5	17.50							42.9			
B-5	20.00							48.5			
B-5	22.50							22.9			
B-5	25.00							25.6			
B-5	27.50							33.4			
B-5	30.00							26.0			
B-5	35.00	30.7	24.4	6.3				28.4			
B-5	40.00							25.8			
B-5	45.00	48.8	24.2	24.6				41.2			
B-5	50.00							33.4			

Illinois Department of Transportation
Division of Highways
Bacon Farmer Workman Engineering & Testing Inc.

Summary of Laboratory Results

Route: Grapevine Trail

Section: N/A

County:

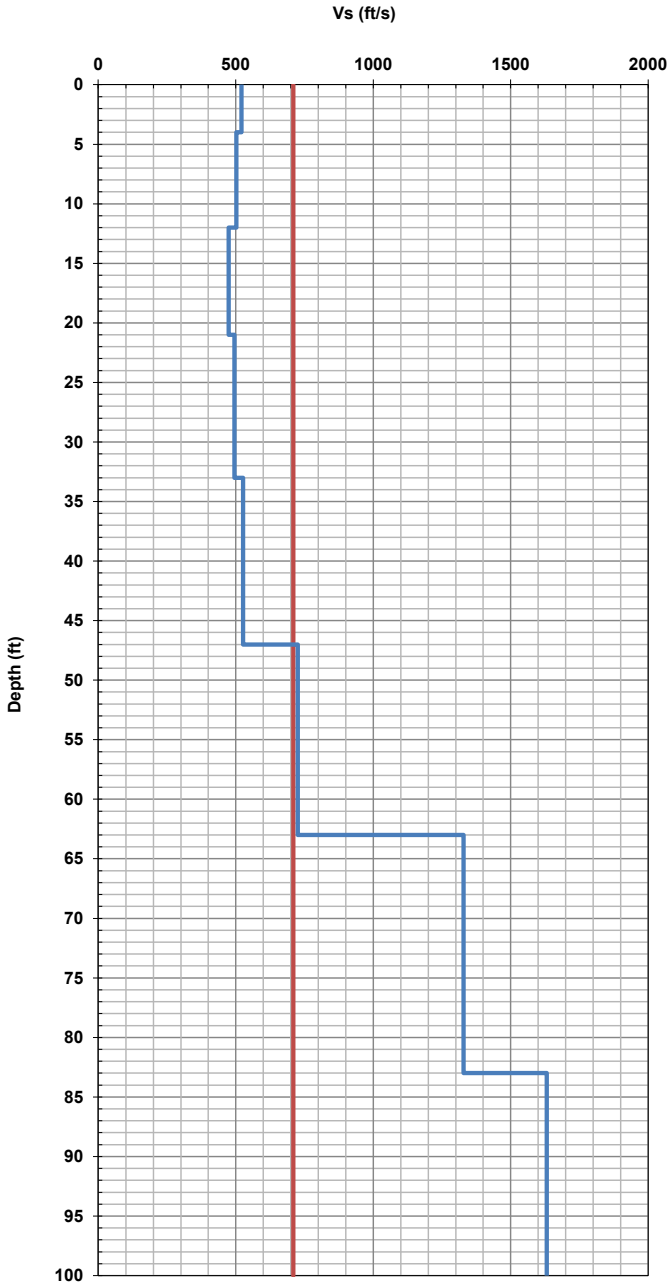
Appendix E

LRFD Seismic Site Classification

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

Shear Wave Velocity Profile

Project Name:	Grapevine Trail Road Over Clear Creak	**Date:**	5/9/2024
BFW Project #:	23038	**Test Method**	ReMi
Location:	Alexander County, Illinois	**ASTM:**	D 7400
Traverse:	1 West Abutment	**Geophone Spacing (ft):**	12
Operator:	AM	**# of Geophones:**	24
Engineer:	BF	**Elevation:**	n/a



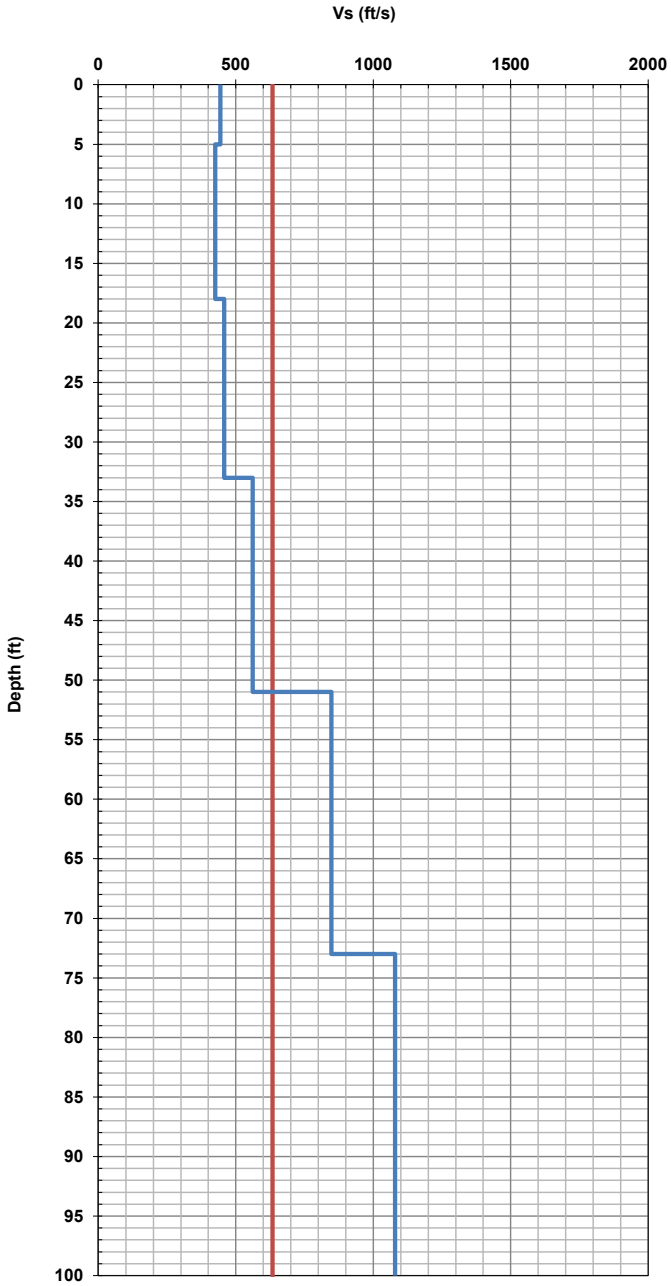
Depth	Vs
feet	ft/s
4	520
12	502
21	475
33	495
47	526
63	726
83	1328
100	1631

$V_{S,100}$ =	709	ft/s
Site Class*:	D	

BACON | FARMER | WORKMAN
ENGINEERING & TESTING, INC.

Shear Wave Velocity Profile

Project Name:	Grapevine Trail Road Over Clear Creak	**Date:**	5/9/2024
BFW Project #:	23038	**Test Method**	ReMi
Location:	Alexander County, Illinois	**ASTM:**	D 7400
Traverse:	2 East Abutment	**Geophone Spacing (ft):**	12
Operator:	AM	**# of Geophones:**	24
Engineer:	BF	**Elevation:**	n/a



Depth	Vs
feet	ft/s
5	444
18	425
33	458
51	561
73	848
100	1080

$V_{S,100}$ =	*634*	*ft/s*
Site Class:*	*D*	

Appendix F

Liquefaction Analysis

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-1 (west abut.)
ELEVATION OF BORING GROUND SURFACE ========== 349.17 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 45.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 45.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.251
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

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

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **283** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 52
Ground Motion Prediction Equations = NMSZ
PGA = **0.279**

	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
	0	5	0.5		15	30	22	0.114	0.000	8.532	8.532	0.100								
341.67	7.5	6	0.7		15	28	23	0.117	0.878	8.263	8.263	0.098	0.117	0.878	0.878	1.215	**0.119**	0.810	**0.132**	**N.L. (1)**
339.17	10	4	0.5		15	28	23	0.114	1.163	5.490	5.490	0.076	0.114	1.163	1.163	1.130	**0.086**	0.748	**0.122**	**N.L. (1)**
336.67	12.5	5	0.5		15	28	25	0.114	1.448	6.724	6.724	0.085	0.114	1.448	1.448	1.084	**0.093**	0.691	**0.113**	**N.L. (1)**
334.17	15	4	0.5		3.7	27.8	25	0.114	1.733	5.214	5.214	0.074	0.114	1.733	1.733	1.042	**0.077**	0.638	**0.104**	**N.L. (1)**
331.67	17.5	4	0.5		3.7	27.8	25	0.114	2.018	5.021	5.021	0.072	0.114	2.018	2.018	1.010	**0.073**	0.592	**0.096**	**N.L. (1)**
329.17	20	1	0.01		3.7	27.8	28	0.078	2.213	1.226	1.226	0.050	0.078	2.213	2.213	0.991	**0.049**	0.552	**0.090**	**N.L. (1)**
326.67	22.5	4	0.5		15	30	28	0.114	2.498	4.690	4.690	0.070	0.114	2.498	2.498	0.968	**0.068**	0.519	**0.085**	**N.L. (1)**
324.17	25	1	0.01		15	30	28	0.078	2.693	1.140	1.140	0.050	0.078	2.693	2.693	0.953	**0.047**	0.491	**0.080**	**N.L. (1)**
321.67	27.5	2	0.25		15	30	29	0.107	2.960	2.183	2.183	0.054	0.107	2.960	2.960	0.935	**0.050**	0.468	**0.076**	**N.L. (1)**
319.17	30	1	0.01		15	30	29	0.078	3.155	1.060	1.060	0.049	0.078	3.155	3.155	0.924	**0.046**	0.450	**0.073**	**N.L. (1)**
309.17	40	3	0.3		15	30	36	0.108	4.235	2.710	2.710	0.057	0.108	4.235	4.235	0.871	**0.049**	0.407	**0.066**	**N.L. (1)**
304.17	45	4	0.5		15	30	42	0.114	4.805	3.352	3.352	0.061	0.114	4.805	4.805	0.849	**0.051**	0.397	**0.065**	**N.L. (1)**
299.17	50	4						0.053	5.070	3.251	3.251	0.060	0.053	5.070	5.382	0.840	**0.050**	0.391	**0.068**	**0.735 (C)**
294.17	55	2	0.25		15	25	31	0.044	5.290	1.585	1.585	0.051	0.044	5.290	5.914	0.833	**0.043**	0.388	**0.071**	**N.L. (2)**
289.17	60	20	3		15	25	25	0.072	5.650	15.377	15.377	0.164	0.072	5.650	6.586	0.771	**0.126**	0.385	**0.073**	**N.L. (2)**
284.17	65	9	1		15	25	30	0.059	5.945	6.600	6.600	0.084	0.059	5.945	7.193	0.805	**0.068**	0.382	**0.075**	**N.L. (2)**
279.17	70	34						0.072	6.305	25.646	25.646	0.305	0.072	6.305	7.865	0.698	**0.213**	0.375	**0.076**	**N.L. (3)**
274.17	75	22						0.068	6.645	15.074	15.074	0.161	0.068	6.645	8.517	0.740	**0.119**	0.368	**0.077**	**1.545 (D)**
269.17	80	42						0.074	7.015	30.037	30.037	0.470	0.074	7.015	9.199	0.653	**0.307**	0.361	**0.077**	**N.L. (3)**
264.17	85	55						0.077	7.400	39.482	39.482	0.105	0.077	7.400	9.896	0.607	**0.064**	0.354	**0.077**	**N.L. (3)**
259.17	90	43						0.074	7.770	28.258	28.258	0.379	0.074	7.770	10.578	0.638	**0.242**	0.347	**0.077**	**N.L. (3)**
254.17	95	26						0.069	8.115	15.416	15.416	0.164	0.069	8.115	11.235	0.700	**0.115**	0.340	**0.077**	**1.494 (D)**
249.17	100	20						0.067	8.450	11.130	11.130	0.123	0.067	8.450	11.882	0.719	**0.089**	0.333	**0.076**	**1.171 (C)**
244.17	105	21						0.068	8.790	10.744	10.744	0.120	0.068	8.790	12.534	0.715	**0.086**	0.326	**0.076**	**1.132 (C)**
239.17	110	24						0.069	9.135	10.556	10.556	0.118	0.069	9.135	13.191	0.709	**0.084**	0.319	**0.075**	**1.120 (C)**

* 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 ========== B-2 (Pier 1)
ELEVATION OF BORING GROUND SURFACE ========== 334.58 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 4.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 4.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.251
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

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

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **201** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 52
Ground Motion Prediction Equations = NMSZ
PGA = **0.279**

	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
334.57	0.01	6	0.8					0.119	0.001	10.257	10.257	0.115	0.119	0.001	0.001	1.500	**0.173**	1.000	**0.163**	**N.L. (1)**
332.08	2.5	4	1.5		30	12	27	0.126	0.315	6.550	6.550	0.084	0.126	0.315	0.315	1.492	**0.125**	0.910	**0.148**	**N.L. (1)**
329.58	5	6	0.8		30	12	27	0.057	0.457	9.359	9.359	0.108	0.057	0.457	0.520	1.417	**0.152**	0.825	**0.153**	**N.L. (2)**
327.08	7.5	1	0.01		6.9	32.1	33	0.016	0.497	1.549	1.549	0.051	0.016	0.497	0.716	1.336	**0.068**	0.746	**0.175**	**0.389 (C)**
324.58	10	1	0.5		6.9	32.1	30	0.051	0.625	1.605	1.605	0.051	0.051	0.625	0.999	1.277	**0.065**	0.677	**0.176**	**0.369 (C)**
322.08	12.5	1	0.01		6.9	32.1	33	0.016	0.665	1.673	1.673	0.051	0.016	0.665	1.195	1.261	**0.065**	0.616	**0.180**	**0.361 (C)**
319.58	15	1	0.01		6.9	32.1	43	0.016	0.705	1.716	1.716	0.052	0.016	0.705	1.391	1.246	**0.064**	0.564	**0.181**	**0.354 (C)**
317.08	17.5	1	0.01		6.9	32.1	47	0.016	0.745	1.741	1.741	0.052	0.016	0.745	1.587	1.233	**0.064**	0.521	**0.181**	**0.354 (C)**
314.58	20	1	0.01		6.9	32.1	44	0.016	0.785	1.752	1.752	0.052	0.016	0.785	1.783	1.220	**0.063**	0.485	**0.180**	**0.350 (C)**
312.08	22.5	1	0.01		6.9	32.1	38	0.016	0.825	1.755	1.755	0.052	0.016	0.825	1.979	1.208	**0.063**	0.457	**0.178**	**0.354 (C)**
309.58	25	1	0.01		6.9	32.1	52	0.016	0.865	1.750	1.750	0.052	0.016	0.865	2.175	1.196	**0.062**	0.433	**0.178**	**0.348 (C)**
307.08	27.5	1	0.01		6.9	32.1	44	0.016	0.905	1.742	1.742	0.052	0.016	0.905	2.371	1.186	**0.061**	0.415	**0.177**	**0.345 (C)**
304.58	30	1						0.043	1.012	1.698	1.698	0.052	0.043	1.012	2.635	1.159	**0.060**	0.401	**0.170**	**0.353 (C)**
299.58	35	1	0.01		7.3	29.3	40	0.016	1.092	1.674	1.674	0.051	0.016	1.092	3.027	1.142	**0.059**	0.380	**0.172**	**0.343 (C)**
294.58	40	12						0.063	1.407	19.303	19.303	0.207	0.063	1.407	3.654	1.126	**0.233**	0.368	**0.156**	**1.494 (D)**
289.58	45	13						0.063	1.722	19.485	19.485	0.209	0.063	1.722	4.281	1.062	**0.222**	0.360	**0.146**	**1.521 (D)**
284.58	50	30						0.071	2.077	47.475	47.475	0.273	0.071	2.077	4.948	1.008	**0.275**	0.356	**0.138**	**N.L. (3)**
279.58	55	25						0.069	2.422	35.088	35.088	-0.664	0.069	2.422	5.605	0.950	**-0.631**	0.353	**0.133**	**N.L. (3)**
274.58	60	22						0.068	2.762	27.983	27.983	0.369	0.068	2.762	6.257	0.913	**0.337**	0.352	**0.130**	**N.L. (3)**
269.58	65	19						0.067	3.097	22.056	22.056	0.243	0.067	3.097	6.904	0.890	**0.216**	0.349	**0.127**	**1.701 (D)**
264.58	70	6						0.057	3.382	6.304	6.304	0.082	0.057	3.382	7.501	0.907	**0.074**	0.342	**0.124**	**0.597 (C)**
259.58	75	52						0.076	3.762	60.709	60.709	0.407	0.076	3.762	8.193	0.795	**0.324**	0.335	**0.119**	**N.L. (3)**
254.58	80	33						0.072	4.122	34.569	34.569	-1.505	0.072	4.122	8.865	0.774	**-1.165**	0.328	**0.115**	**N.L. (3)**
249.58	85	43						0.074	4.492	44.561	44.561	0.231	0.074	4.492	9.547	0.741	**0.171**	0.321	**0.111**	**N.L. (3)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-3 (Pier 2)
ELEVATION OF BORING GROUND SURFACE ========== 332.01 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 7.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 7.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.251
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

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

AVG. SHEAR WAVE VELOCITY (top 40')
$\bar{V}_{s,40'}$ = **229** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 52
Ground Motion Prediction Equations = NMSZ
PGA = **0.279**

	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
	0	1	0.3					0.108	0.000	1.706	1.706	0.052								
329.51	2.5	12	1.5		4	28	24	0.126	0.315	21.360	21.360	0.233	0.126	0.315	0.315	1.500	**0.350**	0.920	**0.150**	**N.L. (1)**
327.01	5	10	1.25		10	30	20	0.124	0.625	15.406	15.406	0.164	0.124	0.625	0.625	1.383	**0.227**	0.841	**0.137**	**N.L. (1)**
324.51	7.5	1	0.01		12.2	35.2	30	0.016	0.665	1.468	1.468	0.051	0.016	0.665	0.696	1.261	**0.064**	0.768	**0.131**	**N.L. (2)**
322.01	10	1	0.01		12.2	35.2	35	0.016	0.705	1.566	1.566	0.051	0.016	0.705	0.892	1.246	**0.064**	0.700	**0.145**	**N.L. (2)**
319.51	12.5	1	0.01		12.2	35.2	31	0.016	0.745	1.632	1.632	0.051	0.016	0.745	1.088	1.233	**0.063**	0.640	**0.152**	**N.L. (2)**
317.01	15	3	0.01		12.2	35.2	49	0.016	0.785	5.024	5.024	0.072	0.016	0.785	1.284	1.220	**0.088**	0.587	**0.157**	**N.L. (2)**
314.51	17.5	1	0.3		12.2	35.2	48	0.046	0.900	1.662	1.662	0.051	0.046	0.900	1.555	1.187	**0.061**	0.543	**0.153**	**N.L. (2)**
312.01	20	1	0.01		12.2	35.2	48	0.016	0.940	1.674	1.674	0.051	0.016	0.940	1.751	1.177	**0.061**	0.506	**0.154**	**N.L. (2)**
309.51	22.5	1	0.01		12.2	35.2	49	0.016	0.980	1.677	1.677	0.051	0.016	0.980	1.947	1.167	**0.060**	0.476	**0.154**	**N.L. (2)**
307.01	25	1	0.01		12.2	35.2	41	0.016	1.020	1.674	1.674	0.051	0.016	1.020	2.143	1.158	**0.060**	0.451	**0.155**	**N.L. (2)**
304.51	27.5	2	0.25		12.2	35.2	34	0.044	1.130	3.271	3.271	0.060	0.044	1.130	2.409	1.134	**0.068**	0.432	**0.150**	**N.L. (2)**
302.01	30	3	0.3		12.2	35.2	38	0.046	1.245	4.782	4.782	0.070	0.046	1.245	2.680	1.112	**0.078**	0.416	**0.146**	**N.L. (2)**
297.01	35	4	0.01		12.2	35.2	46	0.016	1.325	6.292	6.292	0.082	0.016	1.325	3.072	1.103	**0.090**	0.394	**0.149**	**N.L. (2)**
292.01	40	2	0.01		25.3	47.2	46	0.016	1.405	3.102	3.102	0.059	0.016	1.405	3.464	1.086	**0.064**	0.381	**0.153**	**N.L. (2)**
287.01	45	22						0.068	1.745	35.590	35.590	-0.370	0.068	1.745	4.116	1.079	**-0.399**	0.373	**0.143**	**N.L. (3)**
282.01	50	31						0.071	2.100	48.819	48.819	0.289	0.071	2.100	4.783	1.004	**0.290**	0.368	**0.137**	**N.L. (3)**
277.01	55	35						0.072	2.460	51.329	51.329	0.318	0.072	2.460	5.455	0.942	**0.299**	0.365	**0.132**	**N.L. (3)**
272.01	60	28						0.070	2.810	36.794	36.794	-0.090	0.070	2.810	6.117	0.894	**-0.081**	0.363	**0.129**	**N.L. (3)**
267.01	65	15						0.065	3.135	16.790	16.790	0.179	0.065	3.135	6.754	0.898	**0.160**	0.360	**0.127**	**1.260 (D)**
262.01	70	10	1		12	30	39	0.059	3.430	10.422	10.422	0.117	0.059	3.430	7.361	0.893	**0.104**	0.353	**0.124**	**N.L. (2)**
257.01	75	13	0.75		12	30	42	0.056	3.710	12.950	12.950	0.140	0.056	3.710	7.953	0.869	**0.122**	0.346	**0.121**	**N.L. (2)**
252.01	80	7	0.8		12	30	42	0.057	3.995	6.681	6.681	0.085	0.057	3.995	8.550	0.875	**0.074**	0.339	**0.118**	**N.L. (2)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-4 (Pier 3)
ELEVATION OF BORING GROUND SURFACE ========== 332.33 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 4.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 4.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.251
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

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

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **196** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 52
Ground Motion Prediction Equations = NMSZ
PGA = **0.279**

	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
	0	15	2					0.130	0.000	29.202	29.202	0.420									
327.33	5	3	0.3		4	28	28	0.046	0.230	5.063	5.063	0.073	0.046	0.230	0.292	1.500	**0.109**	0.821	**0.170**	**0.641**	**(C)**
324.83	7.5	1	0.01		4	28	31	0.016	0.270	1.674	1.674	0.051	0.016	0.270	0.488	1.500	**0.077**	0.742	**0.219**	**0.352**	**(C)**
322.33	10	1	0.01		4	28	34	0.016	0.310	1.782	1.782	0.052	0.016	0.310	0.684	1.469	**0.076**	0.672	**0.242**	**0.314**	**(C)**
319.83	12.5	1	0.01		4	28	36	0.016	0.350	1.855	1.855	0.052	0.016	0.350	0.880	1.434	**0.075**	0.611	**0.251**	**0.299**	**(C)**
317.33	15	1	0.01		4	28	35	0.016	0.390	1.900	1.900	0.052	0.016	0.390	1.076	1.403	**0.074**	0.559	**0.252**	**0.294**	**(C)**
314.83	17.5	1	0.01		4	28	49	0.016	0.430	1.925	1.925	0.053	0.016	0.430	1.272	1.376	**0.072**	0.516	**0.249**	**0.289**	**(C)**
312.33	20	1	0.01		44.7	68.4	52	0.016	0.470	1.936	1.936	0.053	0.016	0.470	1.468	1.352	**0.071**	0.481	**0.245**	**N.L. (2)**	
309.83	22.5	1	0.01		7	30	38	0.016	0.510	1.936	1.936	0.053	0.016	0.510	1.664	1.330	**0.070**	0.453	**0.241**	**0.290**	**(C)**
307.33	25	1	0.01		7	30	55	0.016	0.550	1.929	1.929	0.053	0.016	0.550	1.860	1.310	**0.069**	0.430	**0.237**	**0.291**	**(C)**
304.83	27.5	1	0.01		7	30	44	0.016	0.590	1.917	1.917	0.053	0.016	0.590	2.056	1.292	**0.068**	0.412	**0.234**	**0.291**	**(C)**
302.33	30	1	0.01		7	30	36	0.016	0.630	1.903	1.903	0.052	0.016	0.630	2.252	1.275	**0.067**	0.397	**0.232**	**0.289**	**(C)**
297.33	35	8	0.01		7	30	40	0.016	0.710	15.162	15.162	0.162	0.016	0.710	2.644	1.334	**0.216**	0.377	**0.229**	**0.943**	**(D)**
292.33	40	1	0.01		7	30	60	0.016	0.790	1.837	1.837	0.052	0.016	0.790	3.036	1.218	**0.064**	0.365	**0.229**	**0.279**	**(C)**
287.33	45	1	0.01		12	33	64	0.016	0.870	1.804	1.804	0.052	0.016	0.870	3.428	1.195	**0.062**	0.358	**0.230**	**N.L. (2)**	
282.33	50	1	0.01		12	33	29	0.016	0.950	1.771	1.771	0.052	0.016	0.950	3.820	1.174	**0.061**	0.353	**0.232**	**N.L. (2)**	
277.33	55	10	0.5		12	33	33	0.051	1.205	16.931	16.931	0.180	0.051	1.205	4.387	1.168	**0.210**	0.351	**0.208**	**N.L. (2)**	
272.33	60	4	0.5		12	33	30	0.051	1.460	6.215	6.215	0.081	0.051	1.460	4.954	1.081	**0.088**	0.349	**0.193**	**N.L. (2)**	
267.33	65	43						0.074	1.830	72.331	72.331	0.505	0.074	1.830	5.636	1.061	**0.535**	0.347	**0.174**	**N.L. (3)**	

* FACTOR OF SAFETY DESCRIPTIONS

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

Illinois Department of Transportation

LIQUEFACTION ANALYSIS

REFERENCE BORING NUMBER ========== B-5 (east abut.)
ELEVATION OF BORING GROUND SURFACE ========== 361.63 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 30.00 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 30.00 FT. (Below Finished Grade Cut or Fill Surface)
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ========== 0.251
EARTHQUAKE MOMENT MAGNITUDE ========== 7.5
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 %
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

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

AVG. SHEAR WAVE VELOCITY (top 40')
$V_{s,40'}$ = **340** FT./SEC.

PGA CALCULATOR
Earthquake Moment Magnitude = 7.5
Source-To-Site Distance, R (km) = 52
Ground Motion Prediction Equations = NMSZ
PGA = **0.279**

	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
	0	16	2					0.130	0.000	31.571	31.571	0.641								
359.13	2.5	10	4.5					0.140	0.350	17.076	17.076	0.182	0.140	0.350	0.350	1.500	**0.272**	0.955	**0.156**	**N.L. (1)**
354.13	7.5	9	1					0.122	0.960	12.320	12.320	0.134	0.122	0.960	0.960	1.215	**0.163**	0.855	**0.140**	**N.L. (1)**
351.63	10	8	1					0.122	1.265	10.684	10.684	0.119	0.122	1.265	1.265	1.129	**0.135**	0.803	**0.131**	**N.L. (1)**
349.13	12.5	10	4.5					0.140	1.615	13.049	13.049	0.141	0.140	1.615	1.615	1.071	**0.151**	0.750	**0.122**	**N.L. (1)**
346.63	15	10	1.25					0.124	1.925	12.524	12.524	0.136	0.124	1.925	1.925	1.024	**0.139**	0.700	**0.114**	**N.L. (1)**
344.13	17.5	17	2.2					0.131	2.253	21.497	21.497	0.235	0.131	2.253	2.253	0.982	**0.231**	0.653	**0.107**	**N.L. (1)**
341.63	20	9	1					0.122	2.558	10.292	10.292	0.116	0.122	2.558	2.558	0.957	**0.111**	0.611	**0.100**	**N.L. (1)**
339.13	22.5	2	0.01					0.078	2.753	2.232	2.232	0.054	0.078	2.753	2.753	0.949	**0.051**	0.575	**0.094**	**N.L. (1)**
336.63	25	1	0.01					0.078	2.948	1.087	1.087	0.049	0.078	2.948	2.948	0.936	**0.046**	0.543	**0.089**	**N.L. (1)**
334.13	27.5	3	0.3					0.108	3.218	3.128	3.128	0.059	0.108	3.218	3.218	0.920	**0.054**	0.516	**0.084**	**N.L. (1)**
331.63	30	5						0.111	3.495	5.000	5.000	0.072	0.111	3.495	3.495	0.905	**0.065**	0.494	**0.081**	**N.L. (1)**
326.63	35	6	0.6		6.3	30.7	28	0.053	3.760	5.793	5.793	0.078	0.053	3.760	4.072	0.889	**0.069**	0.462	**0.082**	**0.841 (C)**
321.63	40	1	0.01		6.3	30.7	26	0.016	3.840	0.959	0.959	0.049	0.016	3.840	4.464	0.888	**0.044**	0.442	**0.084**	**N.L. (2)**
316.63	45	1	0.01		24.6	48.8	41	0.016	3.920	0.953	0.953	0.049	0.016	3.920	4.856	0.884	**0.043**	0.429	**0.087**	**N.L. (2)**
311.63	50	1	0.01		24.6	48.8	33	0.016	4.000	0.946	0.946	0.049	0.016	4.000	5.248	0.881	**0.043**	0.421	**0.090**	**N.L. (2)**

* FACTOR OF SAFETY DESCRIPTIONS

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

Appendix G

Integral Abutment Feasibility Analysis

Illinois Department of Transportation

INTEGRAL ABUTMENT FEASIBILITY ANALYSIS

Modified 10/30/17

GENERAL DATA

STRUCTURE NUMBER	002-3116		TOTAL STRUCTURE LENGTH	443.00	FT
STRUCTURE TYPE	MULTI-SPAN		NUMBER OF SPANS	4	
STRUCTURE SKEW	10	DEGREES	END SPAN LENGTH	112.00	FT
SUPER. DATA IN REFERENCE TO SUB. DATA	ABUT 1		ADJACENT INTERIOR SPAN LENGTH	130.00	FT

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN)

BEAM TYPE	PLATE GIRDER	
TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN)

TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

ABUTMENT #1 DATA

ABUTMENT NAME	East	
ABUTMENT REFERENCE BORING	B-5	
BOTTOM OF ABUTMENT ELEVATION	353.48	FT
ESTIMATED NUMBER OF PILES AT ABUT.	4	
PILE SPACING PERP. TO CL	8	FT

ABUTMENT #2 DATA

ABUTMENT NAME	West	
ABUTMENT REFERENCE BORING	B-1	
BOTTOM OF ABUTMENT ELEVATION	349.29	FT
ESTIMATED NUMBER OF PILES AT ABUT.	4	
PILE SPACING PERP. TO CL	8	FT

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
351.13	2.35	1.0		
348.63	2.50	1.0		
346.13	2.50	4.5		
343.63	2.50		10	2.4
343.48	0.15		17	2.8

10.00 FT = TOTAL DEPTH ENTERED

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
347.76	1.53		6	2.0
345.26	2.50		4	1.7
342.76	2.50		5	1.9
340.26	2.50		4	1.7
339.29	0.97		4	1.7

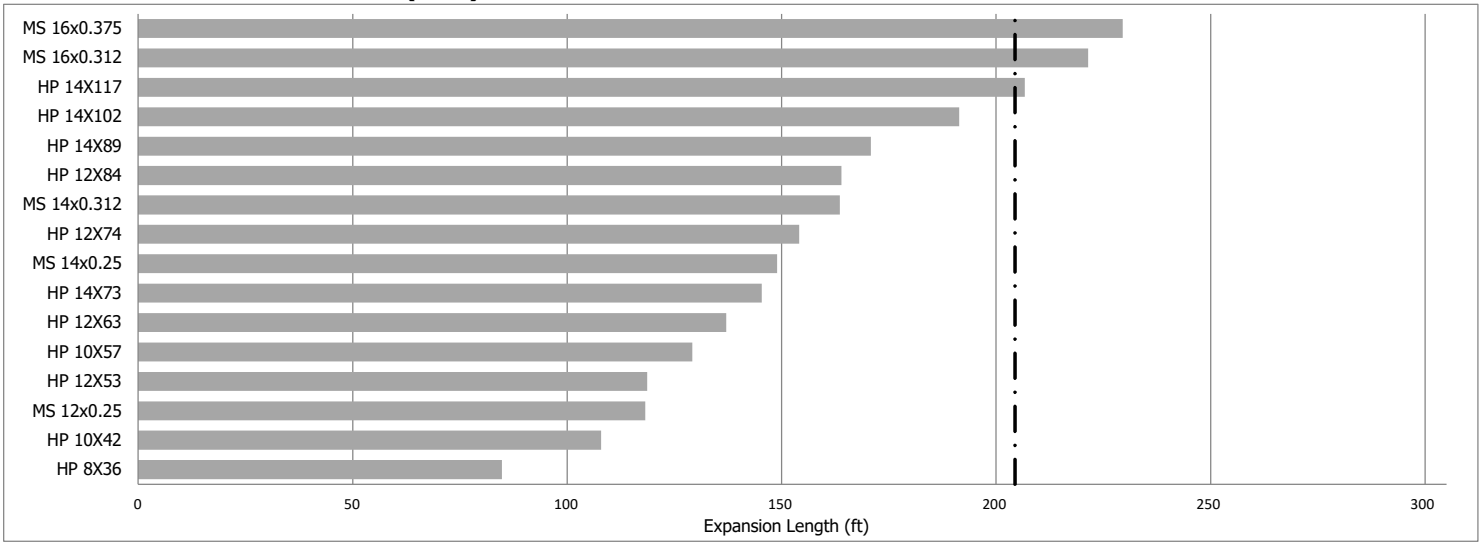
10.00 FT = TOTAL DEPTH ENTERED

WEIGHTED AVERAGE Qu FOR ABUTMENT #1	2.26	TSF	WEIGHTED AVERAGE Qu FOR ABUTMENT #2	1.83	TSF
PILE STIFFNESS MODIFIER FOR ABUTMENT #1 = 1/(1.45-[0.3*2.26])	1.29		PILE STIFFNESS MODIFIER FOR ABUTMENT #2 = 1/(1.45-[0.3*1.83])	1.11	

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 = [1.29*4*0+1.11*4*443]/[1.29*4+1.11*4] = 204.39 FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 = [1.11*4*0+1.29*4*443]/[1.11*4+1.29*4] = 238.61 FT

ABUT 1 (East) - EXPANSION LENGTH LIMIT CHART - 10.0 DEG. SKEW



= Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration. (Note: The same size pile should be used at both abutments.)

Illinois Department of Transportation

INTEGRAL ABUTMENT FEASIBILITY ANALYSIS

Modified 10/30/17

GENERAL DATA

STRUCTURE NUMBER	002-3116		TOTAL STRUCTURE LENGTH	443.00	FT
STRUCTURE TYPE	MULTI-SPAN		NUMBER OF SPANS	4	
STRUCTURE SKEW	10	DEGREES	END SPAN LENGTH	112.00	FT
SUPER. DATA IN REFERENCE TO SUB. DATA	ABUT 1		ADJACENT INTERIOR SPAN LENGTH	130.00	FT

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN)

BEAM TYPE	PLATE GIRDER	
TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN)

TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

ABUTMENT #1 DATA

ABUTMENT NAME	East	
ABUTMENT REFERENCE BORING	B-5	
BOTTOM OF ABUTMENT ELEVATION	353.48	FT
ESTIMATED NUMBER OF PILES AT ABUT.	7	
PILE SPACING PERP. TO CL	4	FT

ABUTMENT #2 DATA

ABUTMENT NAME	West	
ABUTMENT REFERENCE BORING	B-1	
BOTTOM OF ABUTMENT ELEVATION	349.29	FT
ESTIMATED NUMBER OF PILES AT ABUT.	7	
PILE SPACING PERP. TO CL	4	FT

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
351.13	2.35	1.0		
348.63	2.50	1.0		
346.13	2.50	4.5		
343.63	2.50		10	2.4
343.48	0.15		17	2.8

10.00 FT = TOTAL DEPTH ENTERED

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
347.76	1.53		6	2.0
345.26	2.50		4	1.7
342.76	2.50		5	1.9
340.26	2.50		4	1.7
339.29	0.97		4	1.7

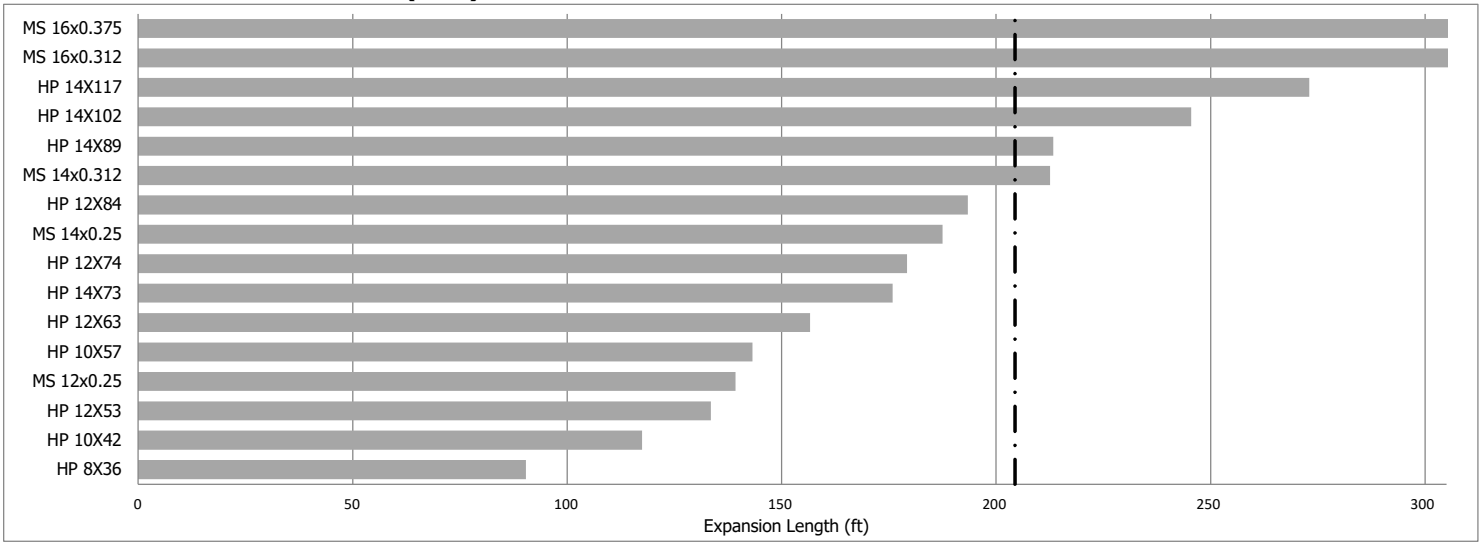
10.00 FT = TOTAL DEPTH ENTERED

WEIGHTED AVERAGE Qu FOR ABUTMENT #1	2.26	TSF	WEIGHTED AVERAGE Qu FOR ABUTMENT #2	1.83	TSF
PILE STIFFNESS MODIFIER FOR ABUTMENT #1 = 1/(1.45-[0.3*2.26])	1.29		PILE STIFFNESS MODIFIER FOR ABUTMENT #2 = 1/(1.45-[0.3*1.83])	1.11	

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 = [1.29*7*0+1.11*7*443]/[1.29*7+1.11*7] = 204.39 FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 = [1.11*7*0+1.29*7*443]/[1.11*7+1.29*7] = 238.61 FT

ABUT 1 (East) - EXPANSION LENGTH LIMIT CHART - 10.0 DEG. SKEW



= *Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration.*
(Note: The same size pile should be used at both abutments.)

Illinois Department of Transportation

INTEGRAL ABUTMENT FEASIBILITY ANALYSIS

Modified 10/30/17

GENERAL DATA

STRUCTURE NUMBER	002-3116		TOTAL STRUCTURE LENGTH	443.00	FT
STRUCTURE TYPE	MULTI-SPAN		NUMBER OF SPANS	4	
STRUCTURE SKEW	10	DEGREES	END SPAN LENGTH	96.00	FT
SUPER. DATA IN REFERENCE TO SUB. DATA	ABUT 1		ADJACENT INTERIOR SPAN LENGTH	105.00	FT

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN)

BEAM TYPE	PLATE GIRDER	
TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN)

TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

ABUTMENT #1 DATA

ABUTMENT NAME	West	
ABUTMENT REFERENCE BORING	B-1	
BOTTOM OF ABUTMENT ELEVATION	349.29	FT
ESTIMATED NUMBER OF PILES AT ABUT.	4	
PILE SPACING PERP. TO CL	8	FT

ABUTMENT #2 DATA

ABUTMENT NAME	East	
ABUTMENT REFERENCE BORING	B-5	
BOTTOM OF ABUTMENT ELEVATION	353.48	FT
ESTIMATED NUMBER OF PILES AT ABUT.	4	
PILE SPACING PERP. TO CL	8	FT

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
347.76	1.53		6	2.0
345.26	2.50		4	1.7
342.76	2.50		5	1.9
340.26	2.50		4	1.7
339.29	0.97		4	1.7

10.00 FT = TOTAL DEPTH ENTERED

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
351.13	2.35	1.0		
348.63	2.50	1.0		
346.13	2.50	4.5		
343.63	2.50		10	2.4
343.48	0.15		17	2.8

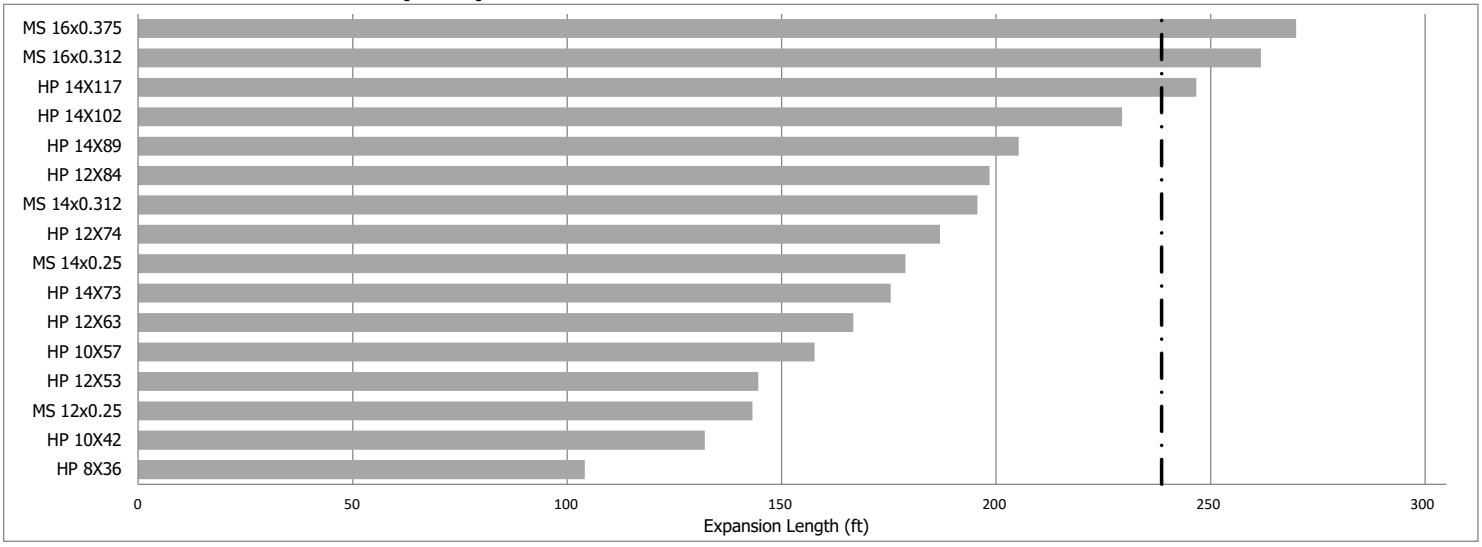
10.00 FT = TOTAL DEPTH ENTERED

WEIGHTED AVERAGE Qu FOR ABUTMENT #1	1.83	TSF	WEIGHTED AVERAGE Qu FOR ABUTMENT #2	2.26	TSF
PILE STIFFNESS MODIFIER FOR ABUTMENT #1 = 1/(1.45-[0.3*1.83])	1.11		PILE STIFFNESS MODIFIER FOR ABUTMENT #2 = 1/(1.45-[0.3*2.26])	1.29	

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 = [1.11*4*0+1.29*4*443]/[1.11*4+1.29*4] = 238.61 FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 = [1.29*4*0+1.11*4*443]/[1.29*4+1.11*4] = 204.39 FT

ABUT 1 (West) - EXPANSION LENGTH LIMIT CHART - 10.0 DEG. SKEW



= Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration.
(Note: The same size pile should be used at both abutments.)

Illinois Department of Transportation

INTEGRAL ABUTMENT FEASIBILITY ANALYSIS

Modified 10/30/17

GENERAL DATA

STRUCTURE NUMBER	002-3116		TOTAL STRUCTURE LENGTH	443.00	FT
STRUCTURE TYPE	MULTI-SPAN		NUMBER OF SPANS	4	
STRUCTURE SKEW	10	DEGREES	END SPAN LENGTH	96.00	FT
SUPER. DATA IN REFERENCE TO SUB. DATA	ABUT 1		ADJACENT INTERIOR SPAN LENGTH	105.00	FT

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN)

BEAM TYPE	PLATE GIRDER	
TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN)

TOP FLANGE WIDTH	16.00	IN
TOP FLANGE THICKNESS	1.00	IN
WEB DEPTH	50.00	IN
WEB THICKNESS	0.63	IN
BOTTOM FLANGE WIDTH	16.00	IN
BOTTOM FLANGE THICKNESS	1.00	IN
BEAM SPACING PERP. TO CL	8.00	FT
SLAB THICKNESS	8.00	IN
SLAB F'C	4.00	KSI

ABUTMENT #1 DATA

ABUTMENT NAME	West	
ABUTMENT REFERENCE BORING	B-1	
BOTTOM OF ABUTMENT ELEVATION	349.29	FT
ESTIMATED NUMBER OF PILES AT ABUT.	7	
PILE SPACING PERP. TO CL	4	FT

ABUTMENT #2 DATA

ABUTMENT NAME	East	
ABUTMENT REFERENCE BORING	B-5	
BOTTOM OF ABUTMENT ELEVATION	353.48	FT
ESTIMATED NUMBER OF PILES AT ABUT.	7	
PILE SPACING PERP. TO CL	4	FT

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
347.76	1.53		6	2.0
345.26	2.50		4	1.7
342.76	2.50		5	1.9
340.26	2.50		4	1.7
339.29	0.97		4	1.7

10.00 FT = TOTAL DEPTH ENTERED

SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2

BOT. OF LAYER ELEV. (FT)	*LAYER THICKNESS (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (TSF)*	*N S.P.T. VALUE (BLOWS/12 IN.)*	*Qu EQUIV. FOR N VALUE (TSF)*
351.13	2.35	1.0		
348.63	2.50	1.0		
346.13	2.50	4.5		
343.63	2.50		10	2.4
343.48	0.15		17	2.8

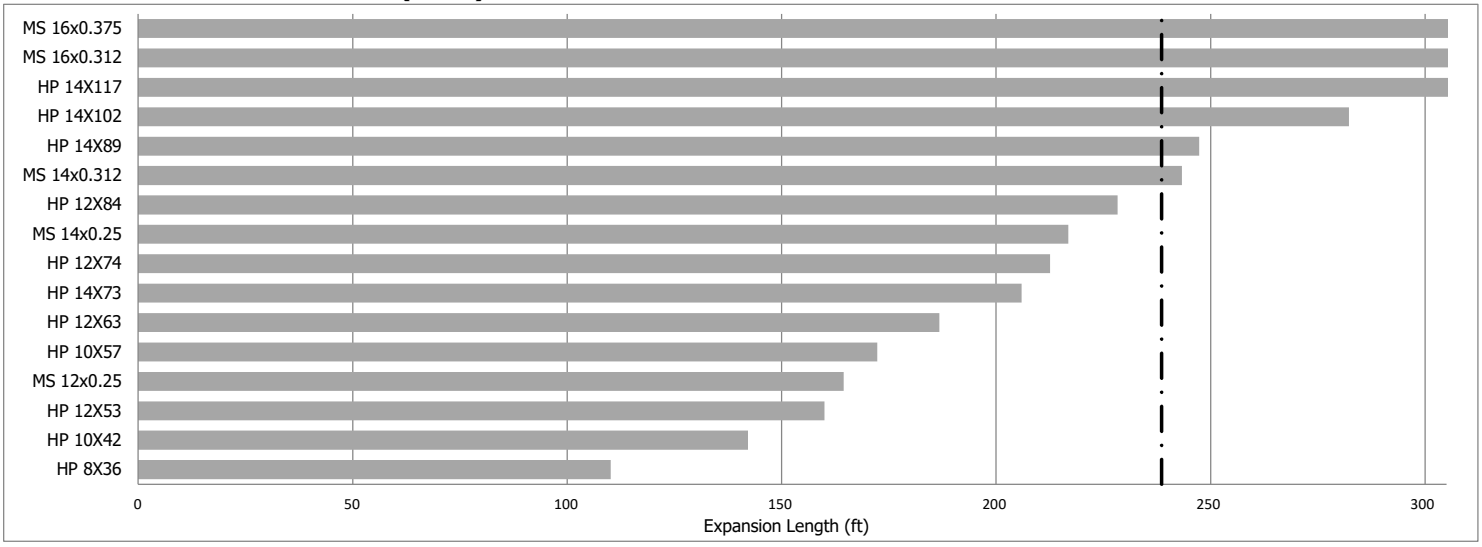
10.00 FT = TOTAL DEPTH ENTERED

WEIGHTED AVERAGE Qu FOR ABUTMENT #1	1.83	TSF	WEIGHTED AVERAGE Qu FOR ABUTMENT #2	2.26	TSF
PILE STIFFNESS MODIFIER FOR ABUTMENT #1 = 1/(1.45-[0.3*1.83])	1.11		PILE STIFFNESS MODIFIER FOR ABUTMENT #2 = 1/(1.45-[0.3*2.26])	1.29	

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 = [1.11*7*0+1.29*7*443]/[1.11*7+1.29*7] = 238.61 FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 = [1.29*7*0+1.11*7*443]/[1.29*7+1.11*7] = 204.39 FT

ABUT 1 (West) - EXPANSION LENGTH LIMIT CHART - 10.0 DEG. SKEW



= Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration. (Note: The same size pile should be used at both abutments.)

Appendix H

Pile Tables

Pile Design Table for West Abutment utilizing Boring #B-1

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
120	66	58
286	157	68
Metal Shell 14"Φ w/.25" walls		
142	78	58
355	195	68
Metal Shell 14"Φ w/.312" walls		
142	78	58
355	195	68
524	288	73
Metal Shell 16"Φ w/.312" walls		
164	90	58
430	236	68
646	355	73
Metal Shell 16"Φ w/.375" walls		
164	90	58
430	236	68
646	355	73
Steel HP 8 X 36		
167	92	103
229	126	108
286	157	109

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
212	117	103
284	156	108
335	184	109
Steel HP 10 X 57		
206	113	98
217	120	103
293	161	108
454	250	110
Steel HP 12 X 53		
188	103	73
216	119	78
241	132	93
250	138	98
265	146	103
340	187	108
418	230	109
Steel HP 12 X 63		
192	106	73
222	122	78
243	134	93
253	139	98
268	147	103
350	193	108
497	273	110
Steel HP 12 X 74		
195	108	73
226	124	78
247	136	93
257	141	98
272	150	103
357	196	108
589	324	110

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
199	109	73
229	126	78
250	138	93
260	143	98
276	152	103
364	200	108
664	365	111
Steel HP 14 X 73		
207	114	68
228	125	73
262	144	78
296	163	93
308	169	98
327	180	103
414	228	108
578	318	109
Steel HP 14 X 89		
211	116	68
233	128	73
269	148	78
300	165	93
312	171	98
331	182	103
426	234	108
705	388	110
Steel HP 14 X 102		
197	109	63
213	117	68
236	130	73
273	150	78
303	167	93
316	174	98
336	185	103
434	238	108
810	445	111
Steel HP 14 X 117		
202	111	63
216	119	68
241	133	73
280	154	78
307	169	93
320	176	98
340	187	103
444	244	108
929	511	111
Precast 14"x 14"		
181	99	58

Pile Design Table for Pier 1 utilizing Boring #B-2

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
111	61	38
213	117	43
215	118	63
Metal Shell 14"Φ w/.25" walls		
142	78	38
256	141	63
Metal Shell 14"Φ w/.312" walls		
142	78	38
256	141	63
Metal Shell 16"Φ w/.312" walls		
177	97	38
297	163	63
Metal Shell 16"Φ w/.375" walls		
177	97	38
297	163	63
713	392	73
Steel HP 8 X 36		
280	154	82

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
287	158	81
Steel HP 10 X 57		
416	229	82
Steel HP 12 X 53		
417	229	82
Steel HP 12 X 63		
496	273	82
Steel HP 12 X 74		
180	99	78
214	118	80
589	324	82

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
183	101	78
220	121	80
664	365	82
Steel HP 14 X 73		
210	115	78
245	135	80
578	318	82
Steel HP 14 X 89		
187	103	73
215	118	78
255	140	80
705	388	82
Steel HP 14 X 102		
190	105	73
218	120	78
263	144	80
810	445	82
Steel HP 14 X 117		
194	107	73
223	123	78
272	150	80
929	511	82
Precast 14"x 14"		
181	100	38

Pile Design Table for Pier 1 utilizing Boring #B-2

Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
111	50	38
213	152	43
215	154	63
Metal Shell 14"Φ w/.25" walls		
142	71	38
256	184	63
Metal Shell 14"Φ w/.312" walls		
142	71	38
256	184	63
Metal Shell 16"Φ w/.312" walls		
177	96	38
297	216	63
Metal Shell 16"Φ w/.375" walls		
177	96	38
297	216	63
713	632	73
Steel HP 8 X 36		
280	246	82

Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
144	103	78
166	125	80
335	294	82
Steel HP 10 X 57		
148	106	78
175	133	80
454	454	82
Steel HP 12 X 53		
151	102	73
173	123	78
200	151	80
418	369	82
Steel HP 12 X 63		
155	105	73
177	128	78
207	158	80
497	447	82
Steel HP 12 X 74		
157	107	73
180	130	78
214	164	80
589	589	82

Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
160	109	73
183	133	78
220	169	80
664	664	82
Steel HP 14 X 73		
139	81	68
183	125	73
210	151	78
245	187	80
578	519	82
Steel HP 14 X 89		
144	85	68
187	128	73
215	156	78
255	196	80
705	705	82
Steel HP 14 X 102		
148	88	68
190	130	73
218	159	78
263	203	80
810	810	82
Steel HP 14 X 117		
153	93	68
194	134	73
223	163	78
272	212	80
929	929	82
Precast 14"x 14"		
181	91	38

Pile Design Table for Pier 2 utilizing Boring #B-3

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
210	115	50
225	124	55
239	132	60
Metal Shell 14"Φ w/.25" walls		
155	85	25
232	128	30
247	136	50
264	145	55
281	154	60
Metal Shell 14"Φ w/.312" walls		
155	85	25
232	128	30
247	136	50
264	145	55
281	154	60
Metal Shell 16"Φ w/.312" walls		
195	107	25
284	156	50
303	167	55
322	177	60
Metal Shell 16"Φ w/.375" walls		
195	107	25
284	156	50
303	167	55
322	177	60
Steel HP 8 X 36		
285	157	65

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
331	182	65
Steel HP 10 X 57		
418	230	66
Steel HP 12 X 53		
410	226	65
Steel HP 12 X 63		
496	273	66
Steel HP 12 X 74		
508	279	66

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
515	284	66
Steel HP 14 X 73		
130	71	60
220	121	64
578	318	66
Steel HP 14 X 89		
131	72	60
230	126	64
705	388	66
Steel HP 14 X 102		
133	73	60
237	131	64
810	445	66
Steel HP 14 X 117		
134	74	60
247	136	64
929	511	66
Precast 14"x 14"		
197	109	25

Pile Design Table for Pier 3 utilizing Boring #B-4

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls	39	21	41
Metal Shell 14"Φ w/.25" walls	46	25	41
Metal Shell 14"Φ w/.312" walls	46	25	41
Metal Shell 16"Φ w/.312" walls	54	30	41
Metal Shell 16"Φ w/.375" walls	54	30	41
Steel HP 8 X 36	247	136	48

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42	307	169	48
Steel HP 10 X 57	417	230	48
Steel HP 12 X 53	368	202	48
Steel HP 12 X 63	497	273	48
Steel HP 12 X 74	507	279	48

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84	515	283	48
Steel HP 14 X 73	578	318	48
Steel HP 14 X 89	604	332	48
Steel HP 14 X 102	613	337	48
Steel HP 14 X 117	625	344	48
Precast 14"x 14"	59	32	41

Pile Design Table for Pier 3 utilizing Boring #B-4

	Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls	39	-4	41
Metal Shell 14"Φ w/.25" walls	46	-4	41
Metal Shell 14"Φ w/.312" walls	46	-4	41
Metal Shell 16"Φ w/.312" walls	54	-4	41
Metal Shell 16"Φ w/.375" walls	54	-4	41
Steel HP 8 X 36	247	224	48

	Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42	307	278	48
Steel HP 10 X 57	418	388	48
Steel HP 12 X 53	368	333	48
Steel HP 12 X 63	496	461	48
Steel HP 12 X 74	508	473	48

	Nominal Required Bearing (Kips)	Seismic Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84	516	480	48
Steel HP 14 X 73	578	536	48
Steel HP 14 X 89	605	563	48
Steel HP 14 X 102	614	572	48
Steel HP 14 X 117	626	583	48
Precast 14"x 14"	59	-5	41

Pile Design Table for East Abutment utilizing Boring #B-5

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls		
150	83	42
Metal Shell 14"Φ w/.25" walls		
175	96	42
Metal Shell 14"Φ w/.312" walls		
175	96	42
Metal Shell 16"Φ w/.312" walls		
200	110	42
Metal Shell 16"Φ w/.375" walls		
200	110	42
Steel HP 8 X 36		
278	153	48

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
285	157	47
Steel HP 10 X 57		
418	230	48
Steel HP 12 X 53		
413	227	48
Steel HP 12 X 63		
496	273	48
Steel HP 12 X 74		
508	279	48

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 12 X 84		
120	66	42
216	119	46
664	365	48
Steel HP 14 X 73		
138	76	42
241	133	46
578	318	48
Steel HP 14 X 89		
139	76	42
251	138	46
705	388	48
Steel HP 14 X 102		
140	77	42
258	142	46
810	445	48
Steel HP 14 X 117		
142	78	42
268	147	46
929	511	48
Precast 14"x 14"		
192	106	19
215	118	27
223	122	32
223	123	37
223	123	42

Appendix I

LPile Tables

LPILE Parameters

West Abutment (Boring B-1)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	307.26	120	500	0.01	-	-
Sand	297.26	52	-	-	30	3
Soft Clay	287.26	57	250	0.02	-	-
Sand	241.06	52	-	-	35	75

Pier 1 (Boring B-2)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	327.58	120	750	0.01	-	-
Soft Clay	296.08	57	500	0.01	-	-
Sand	291.08	52	-	-	30	30
Sand	247.58	52	-	-	35	75

Pier 2 (Boring B-3)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	325.01	120	1,000	0.001	-	-
Soft Clay	288.51	57	500	0.02	-	-
Sand	263.51	52	-	-	30	30
Soft Clay	248.71	57	1,000	.001	-	-

Pier 3 (Boring B-4)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	287.83	57	500	0.02	-	-
Soft Clay	278.83	57	500	0.02	-	-
Sand	266.83	52	-	-	35	75

East Abutment (Boring B-5)

Material Type	Bottom Elevation of Layer	Unit Weight (pcf)	Cohesion (psf)	E_{50}	Friction Angle (°)	*k* Value (pci)
Soft Clay	340.13	120	1,000	0.001	-	-
Soft Clay	331.63	120	500	0.02	-	-
Soft Clay	322.63	57	750	0.01	-	-
Soft Clay	307.33	57	500	0.02	-	-