STRUCTURE GEOTECHNICAL REPORT

INTERSTATE 57 OVER ATCHISON CREEK
FAI ROUTE 57, SECTION (41-1)B-2
REPLACEMENT STRUCTURES
041-0111 AND 041-0112
JEFFERSON COUNTY, ILLINOIS
PTB 168-023

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JEFFERSON COUNTY, ILLINOIS

1.0 PROJECT DESCRIPTION AND PROPOSED STRUCTURE INFORMATION

1.1 INTRODUCTION

This report summarizes the results of a geotechnical investigation performed for the design of replacement structures for the existing bridges carrying Interstate 57 over Atchison Creek south of Mount Vernon, Jefferson County, Illinois. The purpose of this study was to provide a geotechnical assessment of the planned replacement structures, based on subsurface conditions encountered at four borings performed by the Illinois Department of Transportation (IDOT), at the existing structures. This report describes the exploration procedures used, presents the field and laboratory data, includes an assessment of the subsurface conditions in the area, and provides geotechnical recommendations for the construction.

1.2 PROJECT DESCRIPTION

The project consists of the removal and replacement of the existing Interstate 57 bridges over Atchison Creek in Jefferson County, Illinois. The general site area is shown on the attached Vicinity Map, Figure 1 in Appendix A. A plan that shows the approximate locations of the borings performed for this study is presented as the Site and Boring Location Plan, Figure 2 in Appendix A. Atchison Creek is oriented east and west beneath the existing I-57 overpass structures and flows westward into Rend Lake. These existing bridges are 143.5-foot long, three-span concrete deck structures supported on steel beams with wing walls on each structure. The end abutments and intermittent supports of each existing bridge are founded on steel piles. The intermittent supports are reinforced concrete piers. It is our understanding that the existing structures will be replaced with new two-span bridges using integral abutments. Based on the information provided, it appears that staged construction will be required to maintain traffic during construction.

1.3 PROPOSED STRUCTURE INFORMATION

The proposed structures will consist of two two-span bridges with concrete decks. The superstructures will be supported by integral abutments and concrete piers founded on solid wall pile bents. Roadway side slopes will be approximately 6 horizontal to 1 vertical (6H:1V) and the bridge slope will be 2H:1V. The anticipated fill is expected to be approximately 7 inches of asphalt grade raise. Therefore, the roadway profile across the bridges will remain essentially unchanged, with little or no grade change for the embankments.

2.0 Subsurface Exploration and Laboratory Testing

2.1 Subsurface Exploration

From May 1 through 15, 2015, IDOT conducted a subsurface exploration at the site, consisting of four soil test borings, designated as Borings 1-S and 2-S for both the southbound and northbound structures. The approximate locations of both sets of borings are indicated on the Site and Boring Location Plan, Figure 2.

The borings were advanced using hollow-stem auger drilling methods. Samples were obtained at 2.5-foot intervals until shale bedrock was encountered, and at 5-foot intervals thereafter to boring termination. Split-spoon samples were recovered using a 2-inch outside-diameter sampler, driven by a 140-pound hammer. This hammer has an energy efficiency rating of 75%. The split-spoon samples were placed in containers for later testing in the laboratory. The sampling sequence for each boring is summarized on the boring logs in Appendix B.

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

2.2 Laboratory Testing

A laboratory testing program consisting of natural moisture contents was conducted by IDOT to determine selected engineering properties of the obtained soil samples. The results of the individual tests are presented on the boring logs in Appendix B.

3.0 Subsurface Conditions

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

3.1 Geology

The site lies in the Illinois Basin. The surficial deposits consist of Illinoian till of the Glasford and Winnebago Formations. The underlying bedrock formation is the Spoon of the Kewanee Group of the Pennsylvanian Subsystem. This unit is a cyclic deposit, consisting of repeated layers of shale, limestone and sandstone, with thin layers of coal. Shale is the dominant constituent, with generally discontinuous layers of limestone and sandstone.

3.2 Generalized Subsurface Profile

The natural soils at the site are predominantly made up of silty clay, silty clay loam, silt loam, clay loam, and clay. The natural soils contain variable amounts of sand, sand seams, and gravel. Moisture contents vary from 15 to 28%. The standard penetration test (N) values range from 0, where the sampler advanced under the weight of the hammer, to 23 blows per foot (bpf). Rimac unconfined compression test values on samples range from 0.2 to 3.7 tons per square foot (tsf), with outlier values of 0.1 and 4.5 tsf.

Weathered clay shale was encountered above the shale bedrock in all four of the borings ranging in elevations from approximately 383 to 386. The N-values in the weathered shale range from 26 to 80 bpf. Moisture contents that were taken in the weathered shale produced values ranging from 12 to 18%.

Competent shale bedrock was encountered at levels ranging from Elevation 379.7 to 383.2, approximately 34.5 to 37.5 feet below the natural ground surface. The N-values in the shale range from 100 for 3 inches to 100 for 10 inches of penetration.

3.3 Groundwater

At the time of drilling, groundwater was observed at all of the borings, at depths ranging from 12.5 feet (Elevation 405.2) to 24.5 feet (Elevation 393.2). The presence or absence of groundwater at a particular location does not necessarily mean that groundwater will be present or absent at that location at other times. Groundwater levels may vary significantly over time due to the effect of seasonal variations in precipitation, the water level in the Atchison Creek, or other factors not evident at the time of exploration.

4.0 GEOTECHNICAL EVALUATIONS

4.1 EARTHWORK

Grade changes on the approach embankments will be minimal along the roadways. For lane shifts or constructability, it may require that the embankments be widened accordingly in the vicinity of the abutments. Any significant widening should be accomplished by placing fill in horizontal layers starting from the bottom, rather than attempting to place and compact material on the slope. Assuming that there are right-of-way restrictions limiting the work space at the toe of the slope, it may be necessary to cut into the existing slope to permit standard-width equipment to operate while placing additional fill up the slope. This will effectively key the new fill into the existing embankment.

4.2 SETTLEMENT

The upper portion of the soil could be moderately compressible. However, no significant increase in embankment loading should result from the replacement of the bridges, other than beneath the side slopes where minimal amounts of new fill will be placed to widen the embankments near the abutments. In our opinion, this should not result in a significant additional load. This minor increase should result in no more than 0.4 inches of additional settlement, thus downdrag should not be a concern at the abutments. In accordance with IDOT Geotechnical Manual, Section 6.9.2, downdrag is not a concern if the settlement is less than 0.4 inches.

4.3 SLOPE STABILITY

A slope stability analysis was performed for the new abutment slopes of the bridges utilizing the SLOPE/W 2007 program. In accordance with the IDOT Geotechnical Manual, Section 6.10.3, the minimum factor of safety (FOS) required is 1.5 for end-of-construction and long-term stability. Analyses of these conditions indicate the slopes as designed are within the required minimums, as shown in Table 1 below. The output sheets for these analyses are given in Appendix C.

TABLE 1.
CALCULATED CRITICAL FACTOR OF SAFETY

Location	Calculated Factor of Safety		
	End-of-Construction	Long-Term	Seismic
Northbound, North Abutment	3.28	1.98	1.01
Northbound, South Abutment	2.83	1.71	1.00

4.4 Mining Activity

A review of undermining was made using the Illinois State Geological Survey (ISGS) website for mapped coal mines in Jefferson County, Illinois. Based on this information, the project site is unlikely to be undermined. The nearest coal mine is approximately 2 miles west of the site, near Nason.

4.5 Seismicity

Although several significant areas of seismic activity are present in the central United States, the site area is most directly affected by the Wabash Seismic Zone, located in south and east-central Illinois. An assessment of seismic criteria in accord with AASHTO 2009 Guide Specifications for LRFD Seismic Bridge Design has been performed for the site. The IDOT Spreadsheet "Seismic Site Class Determination" was used to determine a Soil Site Class D for the abutments and intermediate piers, if measured from the existing ground surface. The IDOT Spreadsheet "Seismic Site Class Determination" was used to determine a Soil Site Class C for the abutments and intermediate piers, if measured from the approximate elevation of fixity of the piles. We understand that IDOT utilizes the approximate fixity elevation as the point of reference. The United States Geological Survey (USGS) Design Maps Summary Report website was used with the Site Class C classification to provide acceleration coefficient values Sd_s of 0.627 g and Sd_1 of 0.226 g. The results of the Site Class determination and the Design Maps Summary Report are presented in Appendix D. It is understood that the IDOT District 9 has completed the liquefaction analysis and that no liquefiable soils are present at the site.

For the purposes of this report, the bridge has been assumed to be classified as "Regular and Essential." In accordance with the IDOT Bridge Manual, 2012 Edition, the structure should be designed for a design earthquake with a 7% probability of exceedance over a 75-year exposure period (1,000-year return period). A Peak Ground Acceleration (PGA) value of 0.273g was determined from data provided by the United States Geologic Survey (USGS) National Seismic Hazard Mapping Project.

Based on the guidelines in the IDOT All Geotechnical Manual Users (AGMU), including Table 3.15.2-1 in that manual, the Seismic Performance Zone is 2.

4.6 SCOUR

Due to the locations of the borings in relation to the proposed center pier locations, the scour should be assumed to be taken as 100 percent (%) of the scour predicted in the Hydraulic Report (0% reduction in scour depth). Abutment slope protection should be included to protect against scour potential. Countermeasure options for scour at bridge locations include webwalls to eliminate debris collection between columns, riprap, partially grouted riprap, geotextile sand containers, and sheet piling. Skin friction and lateral load design values for piers and driven piles should be ignored in the scour zone. The design scour elevations should correspond to the elevations of 411.0 feet for the northern and southern abutments and 393.5 feet for the center pier, as determined from the information provided by Oates Associates, Inc. Based on information provided by Oates Associates, Inc., the design scour elevations for the 100-year and 500-year events for the bridges are shown in Table 2.

TABLE 2.
SUMMARY OF DESIGN SCOUR ELEVATIONS

Event/Limit State	Design Scour Elevations (ft.)			Item 113
	S. Abut.	Pier 1	N. Abut.	
Q100	411.0	393.5	411.0	5
Q500	411.0	392.5	411.0	
Design	411.0	393.5	411.0	
Check	411.0	392.5	411.0	

5.0 Foundation Evaluations and Design Recommendations

5.1 Driven Pile Foundations

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

Six substructures have been assessed for selected pile sections. Copies of a typical input spreadsheet giving the input parameters for each substructure, and the corresponding summary sheets for the various pile types that are analyzed by the spreadsheet, are included in Appendix E. These tables give the pile embedment length to develop various capacities, up to that approaching the factored design capacity of the pile. The tables were prepared for pile lengths corresponding to selected depths of the input stratigraphy. Data for key assumptions such as pile cutoff elevation and ground surface elevation against pile driving were provided to TSi by Oates Associates, Inc. Preliminary factored loading for the bridges was not available at the time of this report.

Integral abutments are being considered for the new bridge structures. Use has been made of the pile selection chart given in ABD 12.3, 2012 Integral Abutment Bridge Policies.

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

5.2 Drilled Shaft Foundations

Consideration is being given to support of the center pier bents on drilled shafts. The total loads to be supported by these piers are currently unknown. Given the water level in the creek, it is anticipated that significant difficulty could be encountered in drilling through the overburden soils to the shale bedrock. The shafts will need to be socketed into bedrock. However, at this time rock core information is not available to be able to provide tip and side resistance values for the bedrock. Rock cores will be needed at the proposed pier location, and the SGR author will need to be contacted to provide drilled shaft design parameters. In addition, when the shafts are socketed into bedrock, the soil overburden is neglected.

Because of the water level in the creek, the soft soils, and possible sand layers that may exist above the surface of the shale, temporary steel casing for constructing the piers is recommended to control the flow of possible groundwater and sand into the pier. Groundwater control will likely require the installation of cofferdams, with adequate pumping capacity to transfer creek flow across the area. TSi understands that a Type 2 cofferdam is proposed for the construction of the center bent. Construction of the cofferdam, along with details of any seal coat required, should follow the IDOT Bridge Manual section 3.13.3 "Cofferdams and Seal Coats." Seal coats should be anticipated during drilled pier construction.

5.3 Lateral Capacity Geotechnical Parameters

Lateral load resistance and induced lateral deflection are typically assessed using finite difference computer models based on the lateral modulus-of-subgrade reaction, such as LPILE 2012-06. Based on the conditions encountered in the borings, the parameters are estimated for use in the analysis of the lateral capacity of the drilled piers as shown in Tables 5.1 through 5.5, using L-PILE Version 2012-06.

Table 5.1.
Parameters for Use in LPILE Analysis at Southbound Lanes, North Abutment (Structure 041-0112)

Elevation (ft.)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K (pci)
Above 409	Soft Clay (Matlock)	120	500	0.010	N/A	30
409 - 406	Stiff Clay w/o Free Water	125	1,250	0.008	N/A	425
406 - 401	Soft Clay (Matlock)	63	350	0.025	N/A	20
401 - 386	Stiff Clay w/ Free Water	63	1,250	0.008	N/A	425
386 - 380	Stiff Clay w/ Free Water	68	4,000	0.004	N/A	1,200
Below 380	Stiff Clay w/ Free Water	73	4,500	0.004	N/A	1,300

pcf = pounds per cubic foot
psf = pounds per square foot
pci = pounds per cubic inch

TABLE 5.2.
PARAMETERS FOR USE IN LPILE ANALYSIS AT SOUTHBOUND LANES, SOUTH ABUTMENT (STRUCTURE 041-0112)

Elevation (ft.)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K (pci)
Above 409	Stiff Clay w/o Free Water	125	1,600	0.007	N/A	510
409 - 405	Soft Clay (Matlock)	120	300	0.025	N/A	20
405 - 399	Stiff Clay w/ Free Water	63	1,250	0.008	N/A	425
399 - 395	Soft Clay (Matlock)	63	300	0.025	N/A	20
395 - 387	Stiff Clay w/ Free Water	63	1,000	0.009	N/A	350
387 - 383	Stiff Clay w/ Free Water	68	3,100	0.005	N/A	1,020
Below 383	Stiff Clay w/ Free Water	73	4,500	0.004	N/A	1,300

pcf = pounds per cubic foot
psf = pounds per square foot
pci = pounds per cubic inch

TABLE 5.3.
PARAMETERS FOR USE IN LPILE ANALYSIS AT NORTHBOUND LANES, SOUTH ABUTMENT (STRUCTURE 041-0111)

Elevation (ft.)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K (pci)
Above 405	Soft Clay (Matlock)	120	500	0.020	N/A	35
405 - 403	Stiff Clay w/ Free Water	63	1,800	0.0065	N/A	575
403 – 392.5	Soft Clay (Matlock)	63	500	0.020	N/A	35
392.5 - 388	Stiff Clay w/ Free Water	63	1,000	0.009	N/A	350
388 – 385.5	Stiff Clay w/ Free Water	68	2,500	0.006	N/A	850
Below 385.5	Stiff Clay w/ Free Water	73	4,500	0.004	N/A	1,300

pcf = pounds per cubic foot
psf = pounds per square foot
pci = pounds per cubic inch

TABLE 5.4.
PARAMETERS FOR USE IN LPILE ANALYSIS AT NORTHBOUND LANES, NORTH ABUTMENT (STRUCTURE 041-0111)

Elevation (ft.)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K (pci)
Above 407	Soft Clay (Matlock)	120	400	0.022	N/A	25
407 – 400	Stiff Clay w/ Free Water	63	1,100	0.009	N/A	355
400 - 397	Soft Clay (Matlock)	63	300	0.025	N/A	20
397 – 395.5	Stiff Clay w/ Free Water	63	1,000	0.009	N/A	350
395.5 - 392	Soft Clay (Matlock)	63	300	0.025	N/A	20
392 – 390.5	Stiff Clay w/ Free Water	63	1,700	0.0065	N/A	575
390.5 – 387.5	Soft Clay (Matlock)	63	400	0.022	N/A	25
387.5 – 382.5	Stiff Clay w/ Free Water	63	1,500	0.007	N/A	500
382.5 – 379.5	Stiff Clay w/ Free Water	68	3,100	0.005	N/A	1,000
Below 379.5	Stiff Clay w/ Free Water	73	4,500	0.004	N/A	1,300

pcf = pounds per cubic foot
psf = pounds per square foot
pci = pounds per cubic inch

TABLE 5.5.
PARAMETERS FOR USE IN LPILE ANALYSIS AT CENTER BENT

Elevation (ft.)	LPILE Soil Type	Effective Unit Weight (pcf)	Undrained Cohesion (psf)	Strain at 50% Maximum Stress	Angle of Internal Friction (degrees)	p-y Soil Modulus K (pci)
Above 393.5	Scour Zone	-	-	-	-	-
393.5 - 392	Soft Clay (Matlock)	63	300	0.025	N/A	20
392 – 390.5	Stiff Clay w/ Free Water	63	1,700	0.0065	N/A	575
390.5 – 387.5	Soft Clay (Matlock)	63	400	0.022	N/A	25
387.5 – 382.5	Stiff Clay w/ Free Water	63	1,500	0.007	N/A	500
382.5 – 379.5	Stiff Clay w/ Free Water	68	3,100	0.005	N/A	1,000
Below 379.5	Stiff Clay w/ Free Water	73	4,500	0.004	N/A	1,300

pcf = pounds per cubic foot
psf = pounds per square foot
pci = pounds per cubic inch

6.0 Construction Considerations

6.1 Temporary Sheeting and Soil Retention

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

Traffic along I-57 will be maintained by utilizing staged construction. It appears as though either a temporary sheet pile, which includes cantilever temporary sheet piling, or a soil retention system, will be feasible at the abutments. Soft soils observed below the anticipated retained height of approximately 7.5 feet may require additional embedment. Cantilever sheet pile systems may be designed using IDOT Design Guide 3.13.1 – Temporary Sheet Piling Design.

6.2 Subgrade Water Protection

Groundwater seepage should be anticipated for excavations extending more than a few feet below the roadway level along I-57. The free water surface, stated on the boring logs, is approximately 8 feet below the ground surface at the boring locations. It is anticipated that excavations within the soil that is down to approximately Elevation 411 may be adequately dewatered using sump and pump methods. Excavations below that level may encounter a water-bearing soil strata that may need a cofferdam to construct a pile cap or shallow footing foundation. Cofferdam installation for the center piers is described in section 5.2 of this report.

6.3 Driven Pile Installation

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

6.4 Drilled Shaft Installation

Drilled shafts should be installed in accordance with Section 516 of the IDOT Standard Specifications. In particular, the subcontractor should submit a detailed plan of installation procedures, including equipment to be used, casing installation and/or removal, placement of reinforcement, and concrete placement.

6.5 Subgrade, Fill, and Backfill

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

7.0 Report Limitations

This geotechnical report has been prepared for the exclusive use of **Oates Associates, Inc.** and the **Illinois Department of Transportation** for the specific application to the subject project. The information and recommendations contained in this report have been made in accordance with generally accepted geotechnical and foundation engineering practices; no other warranties are implied or expressed.

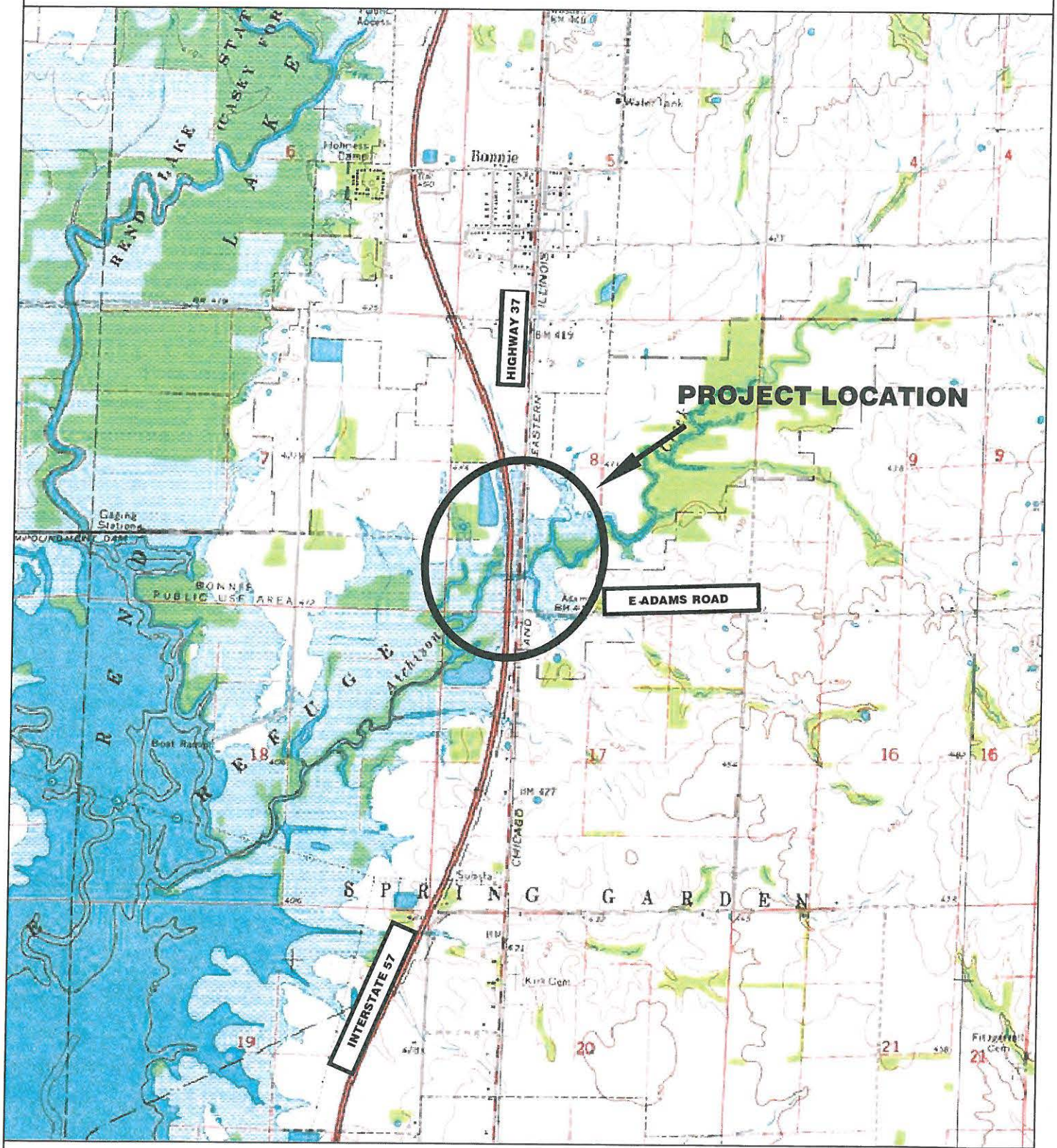
The assessments and recommendations submitted in this report are based in part upon the data obtained from the borings. The nature and extent of variations between the borings may not be evident at this time. If variations appear evident at a later date, it may be necessary to re-evaluate the recommendations of this report.

We emphasize that this report was prepared for design purposes only and may not be sufficient to prepare an accurate construction bid. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design purposes.

If conditions at the site have changed due to natural causes or other operations, this report should be reviewed by TSi to determine the applicability of the analyses and recommendations considering the changed conditions. The report should also be reviewed by TSi if changes occur in the structure locations, sizes, and types, in the planned loads, elevations, grading and site development plans or the project concepts.

TSi requests the opportunity to review the final plans and specifications for the project prior to construction to verify that the recommendations in this report are properly interpreted and incorporated in the design and construction documents. If TSi is not accorded the opportunity to make this recommended review, we can assume no responsibility for the misinterpretation of our recommendations.

APPENDIX A



NOT TO SCALE

NOTE:
DRAWING PREPARED FROM AN IMAGE OBTAINED FROM TOPOQUEST.COM ON 9/15/16

N

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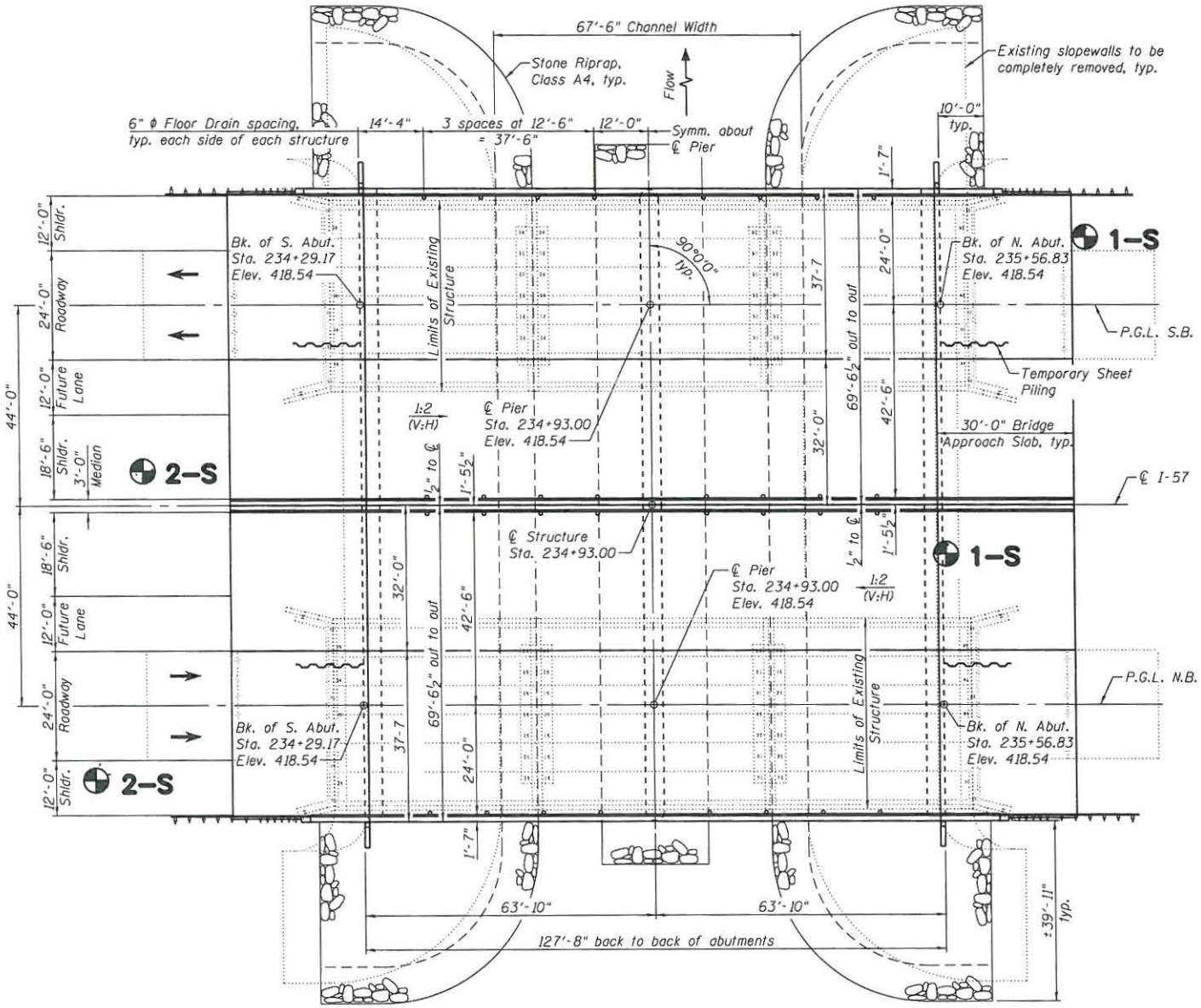
VICINITY MAP

INTERSTATE 57 OVER ATCHISON CREEK
JEFFERSON COUNTY, ILLINOIS

Drawn By: MDE	Checked By: JAS	
Project No. 20131219.02	Date: 10/07/16	Figure 1



LEGEND

1-S ⊕ APPROXIMATE BORING LOCATION AND NUMBER

NOTE: THIS PLAN WAS PREPARED FROM A DRAWING OBTAINED FROM OATES ASSOCIATES ON 08/22/16.

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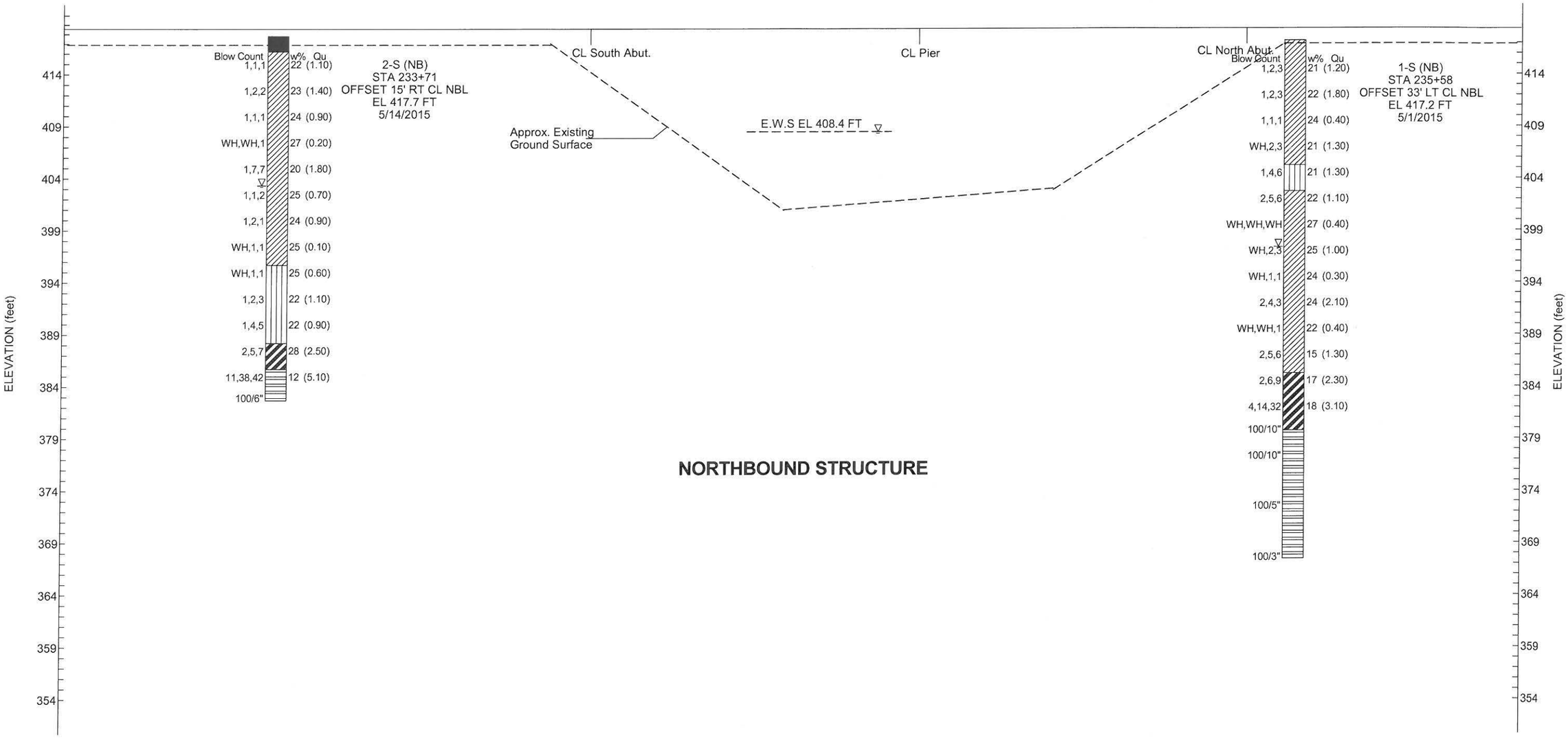
SITE AND BORING LOCATION PLAN

INTERSTATE 57 OVER ATCHISON CREEK
JEFFERSON COUNTY, ILLINOIS

Drawn By: MDE	Checked By: JAS	
Project No. 20131219.02	Date: 10/07/16	Figure 2



NORTHBOUND STRUCTURE

NOTES:
1. Horizontal scale is approximate.
2. The existing ground surface shown is a line extended between surveyed ground surface elevations at boring locations, and does not necessarily reflect the actual ground surface between borings.
3. The generalized stratigraphy shown is an interpretation of subsurface conditions based on field and laboratory test results on samples recovered at the indicated boring locations. The conditions between the borings could vary significantly from those shown.

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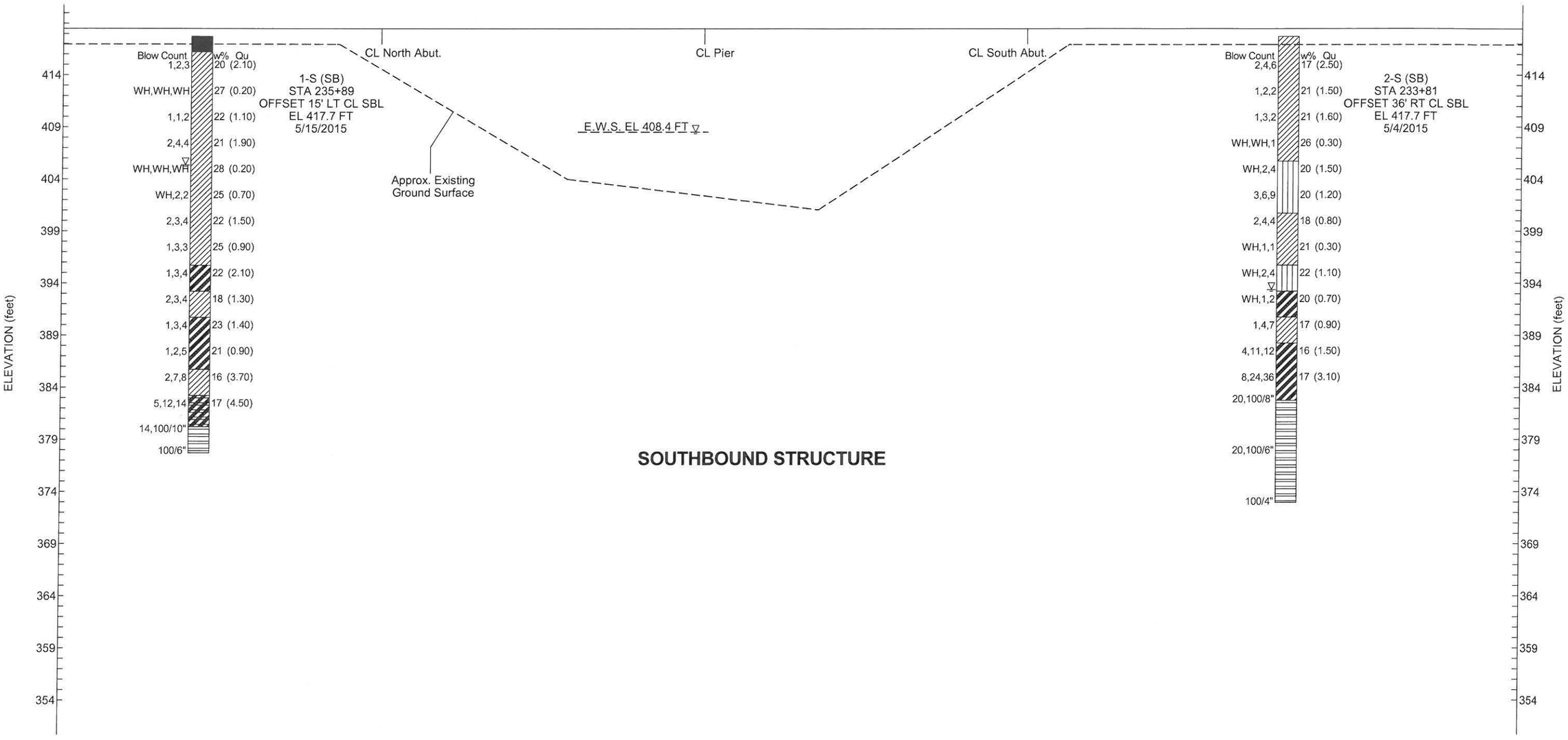
SUBSURFACE PROFILE

Interstate 57 over Atchison Creek
Jefferson County, Illinois

Prepared By: DDI	Checked By: JAS	
Project No. 20131219.02	Date:10/6/2016	Figure 3.1



SOUTHBOUND STRUCTURE

NOTES:
1. Horizontal scale is approximate.
2. The existing ground surface shown is a line extended between surveyed ground surface elevations at boring locations, and does not necessarily reflect the actual ground surface between borings.
3. The generalized stratigraphy shown is an interpretation of subsurface conditions based on field and laboratory test results on samples recovered at the indicated boring locations. The conditions between the borings could vary significantly from those shown.

TSi geotechnical, inc.
1340 NORTH PRICE ROAD
ST. LOUIS, MISSOURI 63132

SUBSURFACE PROFILE

Interstate 57 over Atchison Creek
Jefferson County, Illinois

Prepared By: DDI	Checked By: JAS	
Project No. 20131219.02	Date:10/6/2016	Figure 3.2

APPENDIX B

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

FAI 57 NB Over Atchison Creek — Sheet 1 of 2

Rou FAI 57 NB — Structure Number: 041-0001 — Date: 5/1/2015

Section 41-1B-1 — Bored By: R Moberly

County: Jefferson — Location: 2 miles north of Ina Interchange — Checked By: R Graeff

Boring No 1-S
Station 235+58
Offset 33' LT CL NBL
Ground Surface 417.2 Ft

Surf Wat Elev: 408.9
Ground Water Elevation
when Drilling 397.2
At Completion
At: Hrs:

	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, grey and brown, Silty Clay A-6				
		1		
		2	1.2B	21
		3		
	5.0	1		
		2	1.8B	22
		3		
	10.0	WH		
Soft, very moist, grey, Silty Clay A-6		1		
		1	0.4B	24
		1		
	15.0	2		
Stiff, moist, grey, Silty Clay Loam A-6		2	1.3B	21
		3		
	20.0	WH		
Stiff, moist, grey, Silt Loam to Silty Clay Loam A-4		1		
		4	1.3S	21
		6		
	25.0	2		
Stiff, moist, brown, Silty Clay to Silty Clay Loam A-6		5	1.1B	22
		6		
	30.0	2		
Soft, very moist, brown mottled grey, Silty Clay A-6		WH		
		WH	0.4B	27
		WH		
	35.0	WH		
Medium to stiff, moist to very moist, grey mottled brown, Silty Clay A-6		2	1.0B	25
		3		
	40.0	WH		
Soft, very moist, grey mottled brown, Silty Clay A-6		1	0.3B	24
		1		
	45.0	2		
Very stiff, moist, red brown, Silty Clay Loam A-6		4	2.1S	24
		3		
390.2				
Soft, very moist, grey, Silty Clay A-6		WH		
		WH	0.4B	22
		1		
387.7				
Stiff, moist, grey, Clay Loam A-6	30.0	2		
		5	1.3S	15
		6		
385.2				
Very stiff, moist, grey, Clay A7-6 with sand seams		2		
		6	2.3S	17
		9		
382.7				
Very stiff, moist, grey, Clay A7-6 to weathered Clay Shale	35.0	4		
		14	3.1S	18
		32		
379.7		9		
Hard, dry, grey, Clay Shale		100/10"		
	40.0	9		
		100/10"		
++++++++++++++++++++++++++				
Bottom of hole = 49.8 feet				
Free water observed at 20.0 feet				
Elevation referenced to BM at NE wingwall = 419.3 feet				
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)	45.0	100/5"		
To convert "N" values to "N60" multiply by 1.25				
++++++++++++++++++++++++++				
Hard, dry, grey, Clay Shale 367.2	50.0	100/3"		

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

Rou FAI 57 NB

Date: 5/1/2015

Section: 41-1B-1

County: Jefferson

Boring No: 1-S

Station: 235+58

Offset: 33' LT CL NBL

Ground Surface: 417.2 Ft

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
55.0				80.0			
60.0				85.0			
65.0				90.0			
70.0				95.0			
75.0				100.0			

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAI 57 NB Over Atchison Creek
Rou . FAI 57 NB Structure Number: 041-0001 Date: 5/14/2015
Section 41-1B-1 Bored By: R Moberly
County: Jefferson Location: 2 miles north of Ina Interchange Checked By: R Graeff

Boring No 2-S
Station 233+71
Offset 15' RT CL NBL
Ground Surface 417.7 Ft

Surf Wat Elev: 408.9
Ground Water Elevation
when Drilling 403.2
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	Description
				Asphalt and Concrete
416.2				
				Stiff, moist, grey, Silty Clay A-6
	1			
	1	1.1B	22	
	1			
5.0	1			
	2	1.4B	23	
	2			
410.7				
	1			Medium, very moist, grey mottled
	1	0.9B	24	brown, Silty Clay A-6
	1			
408.2				
10.0	WH			Very soft, very moist, grey, Silty
	WH	0.2B	27	Clay A-6
	1			
405.7				
	1			Stiff, moist, grey, Silty Clay to
	7	1.8S	20	Silty Clay Loam A-6
	7			
403.2				
15.0	1			Medium, very moist, grey mottled
	1	0.7B	25	brown, Silty Clay A-6
	2			
	1			
	2	0.9B	24	
	1			
398.2				
20.0	WH			Very soft, wet, brown mottled
	1	0.1B	25	grey, Silty Clay Loam A-6
	1			
395.7				
	WH			Medium, very moist, grey mottled
	1	0.6B	25	brown, Silty Clay Loam A-4
	1			
393.2				
25.0	1			

DEPTH	BLOWS	Qu tsf	W%	Description
	2	1.1B	22	Stiff, moist, brown, Silty Clay Loam
	3			A-4
390.7				
	1			Medium, very moist, brown, Silty
	4	0.9B	22	Clay Loam to Silt Loam A-4
	5			
388.2				
30.0	2			Very stiff, moist, grey mottled
	5	2.5B	28	brown, Clay A7-6
	7			
385.7				
	11			Hard, damp, grey, weathered
	38	5.1S	12	Clay Shale
	42			
383.2				
382.7 35.0	100/6"			Hard, dry, grey, Clay Shale

Bottom of hole = 35.0 feet

Free water observed at 14.5 feet

Elevation referenced to BM at NE wingwall = 419.3 feet

40.0

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

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

45.0

50.0

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log
Sheet 1 of 1

FAI 57 SB Over Atchison Creek
Ro : FAI 57 SB Structure Number: 041-0002 Date: 5/15/2015
Section 41-1B-1 Bored By: R Moberly
County: Jefferson Location: 2 miles north of Ina Interchange Checked By: R Graeff

Boring No 1-S
Station 235+89
Offset 15' LT CL SBL
Ground Surface 417.7 Ft

Surf Wat Elev: 408.7
Ground Water Elevation
when Drilling 405.2
At Completion
At: Hrs:

	DEPTH	BLOWS	Qu tsf	W%
Asphalt and concrete				
416.2				
Very stiff, moist, grey mottled brown, Silty Clay A-6		1		
		2	2.1B	20
		3		
413.2				
Very soft, very moist, grey, Silty Clay A-6	5.0	WH		
		WH	0.2B	27
		WH		
410.7				
Stiff, moist, grey, Silty Clay A-6		1		
		1	1.1B	22
		2		
	10.0	2		
		4	1.9B	21
		4		
405.7				
Very soft, very moist to wet, grey, Silty Clay A-6		WH		
		WH	0.2B	28
		WH		
403.2				
Medium, very moist, grey, Silty Clay to Silty Clay Loam A-6	15.0	WH		
		2	0.7B	25
		2		
400.7				
Stiff, moist, brown mottled grey, Silty Clay to Silty Clay Loam A-6		2		
		3	1.5B	22
		4		
398.2				
Medium, very moist, brown mottled grey, Silty Clay to Silty Clay Loam A-6	20.0	1		
		3	0.9B	25
		3		
395.7				
Very stiff, moist, brown mottled grey, Clay A7-6		1		
		3	2.1B	22
		4		
393.2				
	25.0	2		

	DEPTH	BLOWS	Qu tsf	W%
Stiff, moist, brown mottled grey, Silty Clay A-6		3	1.3B	18
		4		
390.7				
Stiff, moist, brown mottled grey, Clay A7-6		1		
		3	1.4B	23
		4		
388.2				
Medium, moist to very moist, grey, Clay to Silty Clay A7-6	30.0	1		
		2	0.9B	21
		5		
385.7				
Very stiff, moist, brown and grey, Clay to Clay Loam A-6		2		
		7	3.7B	16
		8		
383.2				
Hard, damp, grey, Clay to Weathered Clay Shale	35.0	5		
		12	4.5B	17
		14		
380.2		14		
Hard, dry, grey, Clay Shale		100/10"		
377.7	40.0	100/6"		

Bottom of hole = 40.0 feet

Free water observed at 12.5 feet

Elevation referenced to BM at NE wingwall = 419.3 feet

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

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

45.0

50.0

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

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

FAI 57 SB Over Atchison Creek

Sheet 1 of 1

Ro . FAI 57 SB Structure Number: 041-0002 Date: 5/4/2015

Section 41-1B-1 Bored By: R Moberly

County: Jefferson Location: 2 miles north of Ina Interchange Checked By: R Graeff

Boring No 2-S
Station 233+81
Offset 36' RT CL SBL
Ground Surface 417.7 Ft

Surf Wat Elev: 408.7
Ground Water Elevation
when Drilling 393.2
At Completion
At: Hrs:

	DEPTH	BLOWS	Qu tsf	W%
Very stiff, moist, brown and grey, Silty Clay A-6				
		2		
		4	2.5B	17
		6		
	413.2			
Stiff, moist, brown and grey, Silty Clay Loam A-6	5.0	1		
		2	1.5S	21
		2		
		1		
		3	1.6B	21
		2		
	408.2			
Soft, very moist, grey, Silty Clay A-6	10.0	WH		
		WH	0.3B	26
		1		
	405.7			
Stiff, moist, grey mottled brown, Silty Clay Loam to Silt Loam A-4		WH		
		2	1.5S	20
		4		
	15.0	3		
		6	1.2S	20
		9		
	400.7			
Medium, very moist, brown, Silty Clay Loam A-6		2		
		4	0.8S	18
		4		
	398.2			
Soft, very moist, brown, Silty Clay Loam A-6	20.0	WH		
		1	0.3B	21
		1		
	395.7			
Stiff, moist to very moist, reddish brown, Silty Clay Loam to Clay Loam A-4		WH		
		2	1.1S	22
		4		
	393.2			
	25.0	WH		

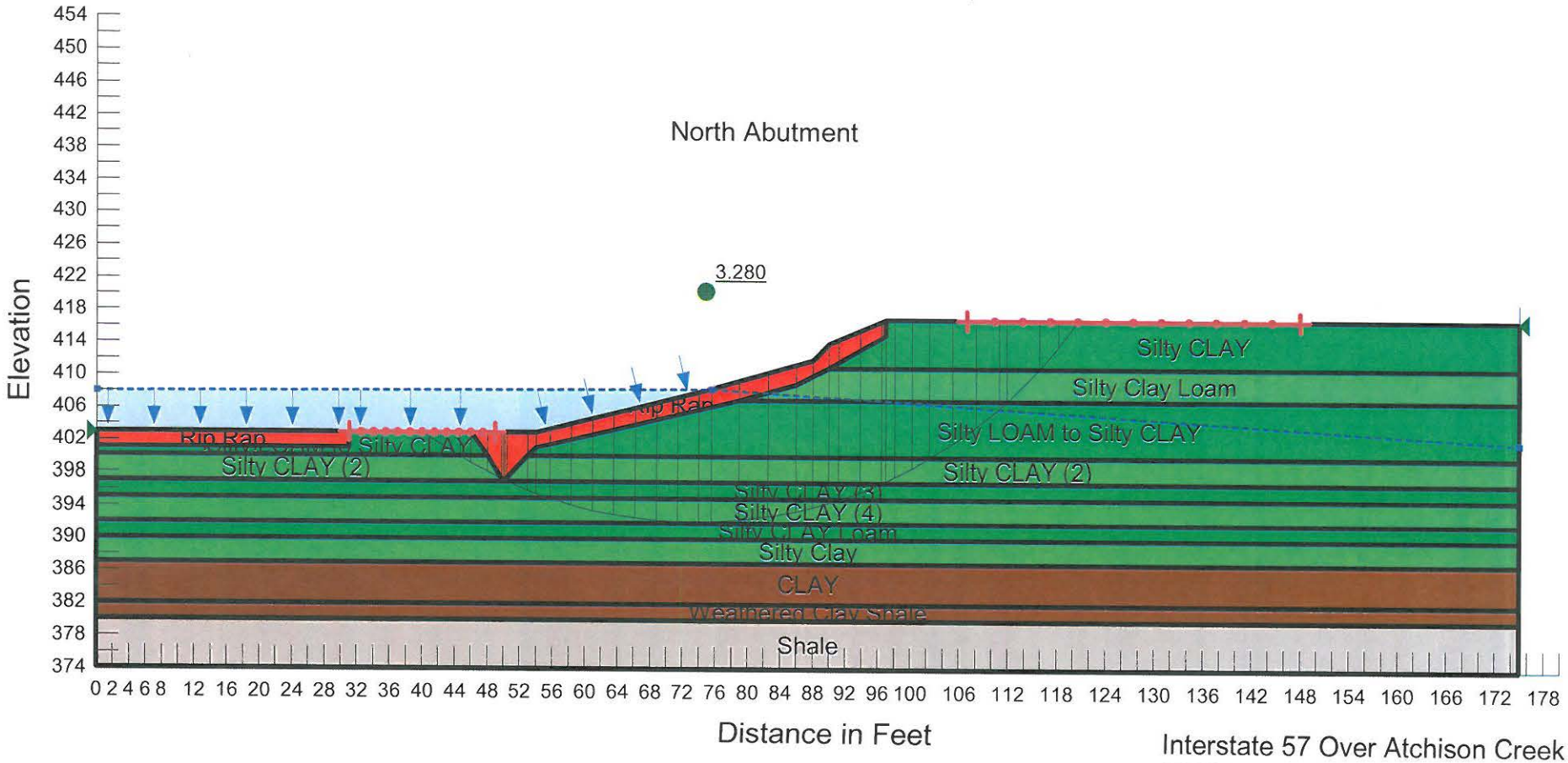
	DEPTH	BLOWS	Qu tsf	W%
Medium, very moist, red brown, Silty Clay to Clay A7-6		1	0.7B	20
		2		
	390.7			
Medium, very moist, brown and grey, Clay Loam A-6		1		
		4	0.9B	17
		7		
	388.2			
Stiff, moist, brown, Clay Loam to Clay with gravel	30.0	4		
		11	1.5E	16
		12		
	385.7			
Very stiff, damp to moist, grey, Clay A7-6 to weathered Clay Shale		8		
		24	3.1S	17
		36		
	382.7	35.0	20	
Hard, dry, grey, Clay Shale		100/8"		
++++++++++++++++++++++++++				
Borehole advanced with hollow stem auger (8" O.D, 3.25" I.D.)				
To convert "N" values to "N60" multiply by 1.25				
++++++++++++++++++++++++++	40.0	20		
		100/6"		
Hard, dry, grey, Clay Shale	372.7	45.0	100/4"	
Bottom of hole = 44.8 feet				
Free water observed at 24.5 feet				
Elevation referenced to BM at NE wingwall: Elevation = 419.3 feet				
		50.0		

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

APPENDIX C

SOIL PROPERTIES

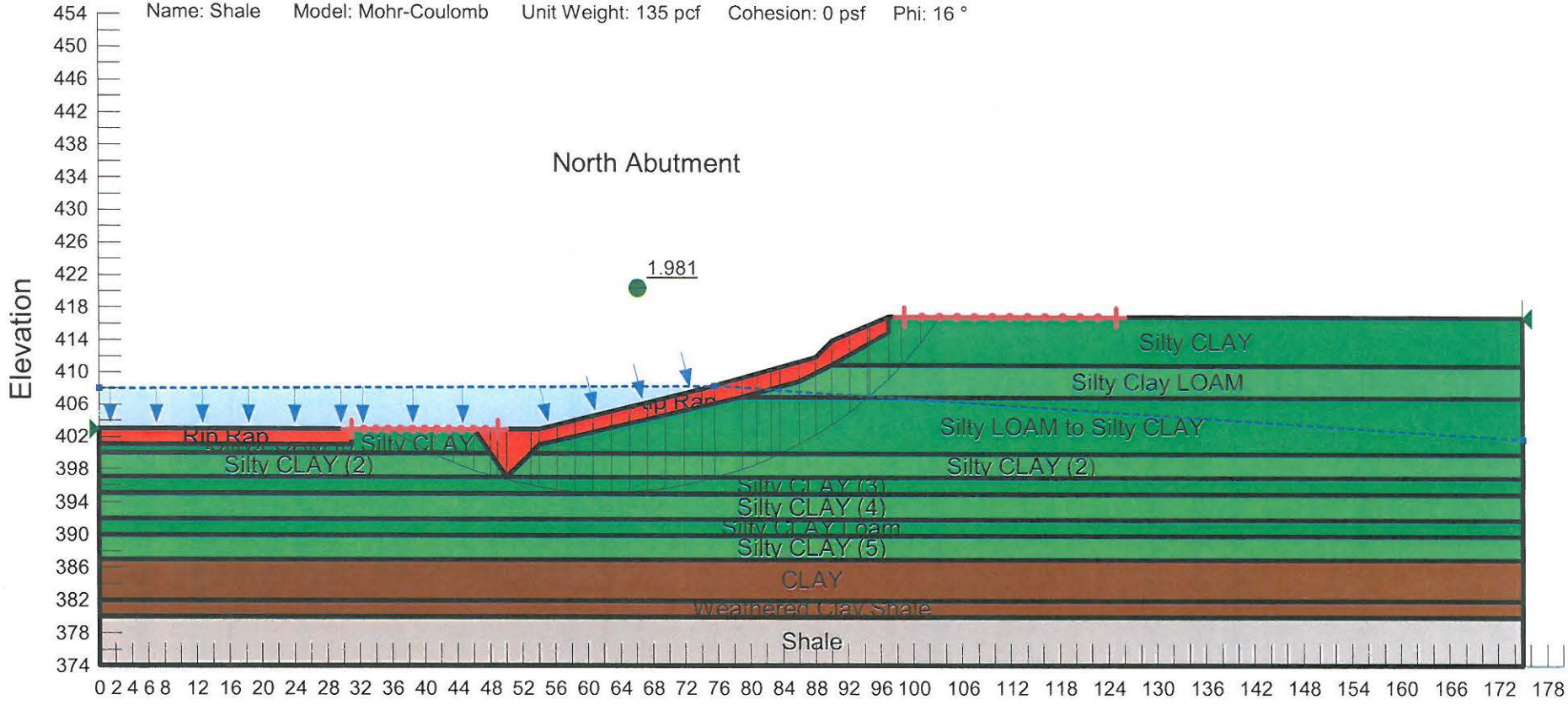
Name: Rip Rap Model: Mohr-Coulomb Unit Weight: 150 pcf Cohesion: 5000 psf Phi: 0 °
Name: Silty CLAY Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 1500 psf Phi: 0 °
Name: Silty Clay Loam Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 400 psf Phi: 0 °
Name: Silty LOAM to Silty CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 1100 psf Phi: 0 °
Name: Silty CLAY (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 350 psf Phi: 0 °
Name: Silty CLAY (3) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 1000 psf Phi: 0 °
Name: Silty CLAY (4) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 300 psf Phi: 0 °
Name: Silty CLAY Loam Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 1700 psf Phi: 0 °
Name: Silty Clay Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 400 psf Phi: 0 °
Name: CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 1500 psf Phi: 0 °
Name: Weathered Clay Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 3100 psf Phi: 0 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 4500 psf Phi: 0 °



Interstate 57 Over Atchison Creek
20131219.02
Station 235+58, Boring 1-S NBL
Undrained

SOIL PROPERTIES

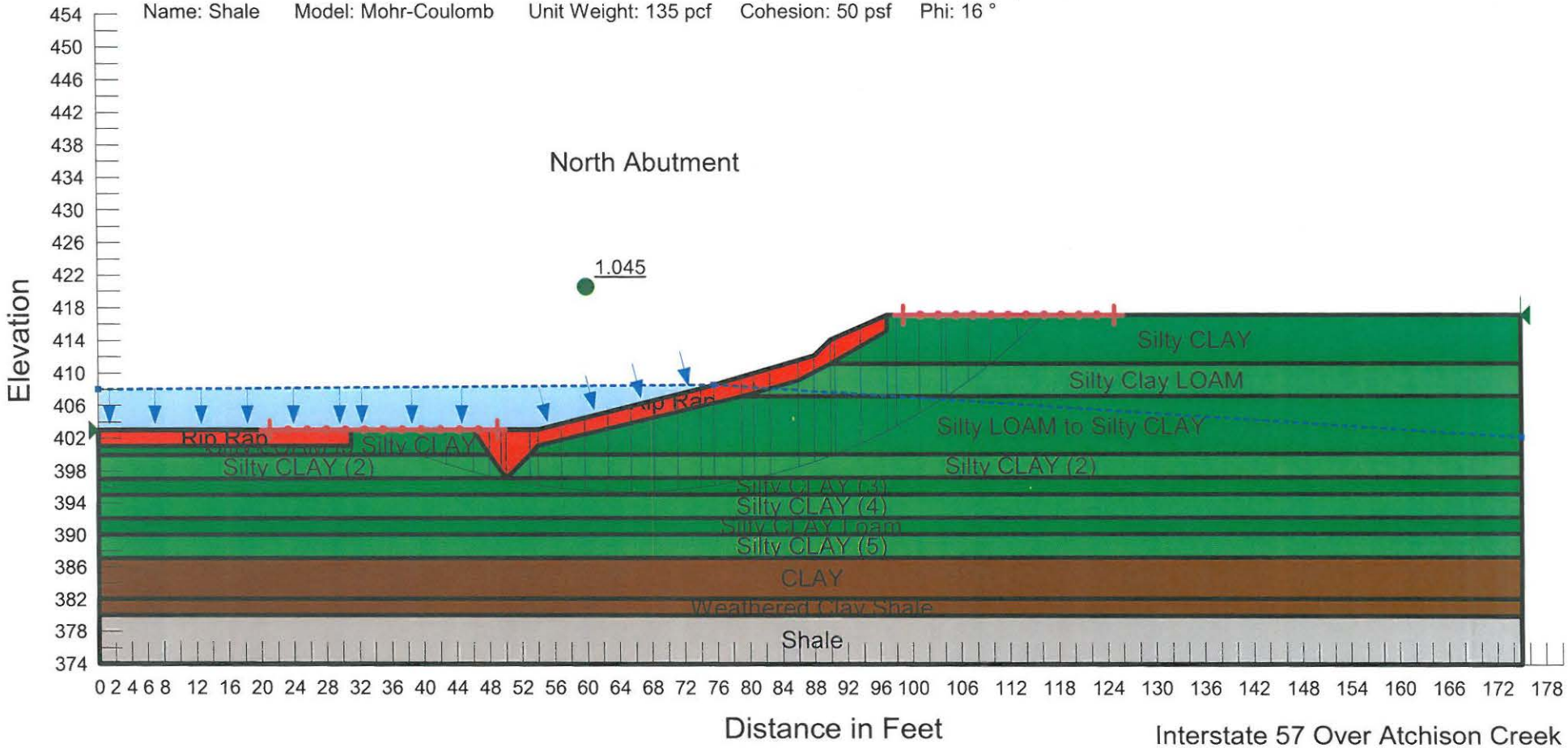
Name: Rip Rap Model: Mohr-Coulomb Unit Weight: 150 pcf Cohesion: 5000 psf Phi: 0 °
Name: Silty CLAY Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 27 °
Name: Silty Clay LOAM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 25 °
Name: Silty LOAM to Silty CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 29 °
Name: Silty CLAY (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 26 °
Name: Silty CLAY (3) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 26 °
Name: Silty CLAY (4) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 26 °
Name: Silty CLAY Loam Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 27 °
Name: Silty CLAY (5) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 26 °
Name: CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 25 °
Name: Weathered Clay Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 0 psf Phi: 22 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 0 psf Phi: 16 °



Interstate 57 Over Atchison Creek
20131219.02
Station 235+58, Boring 1-S NBL
Drained

SOIL PROPERTIES

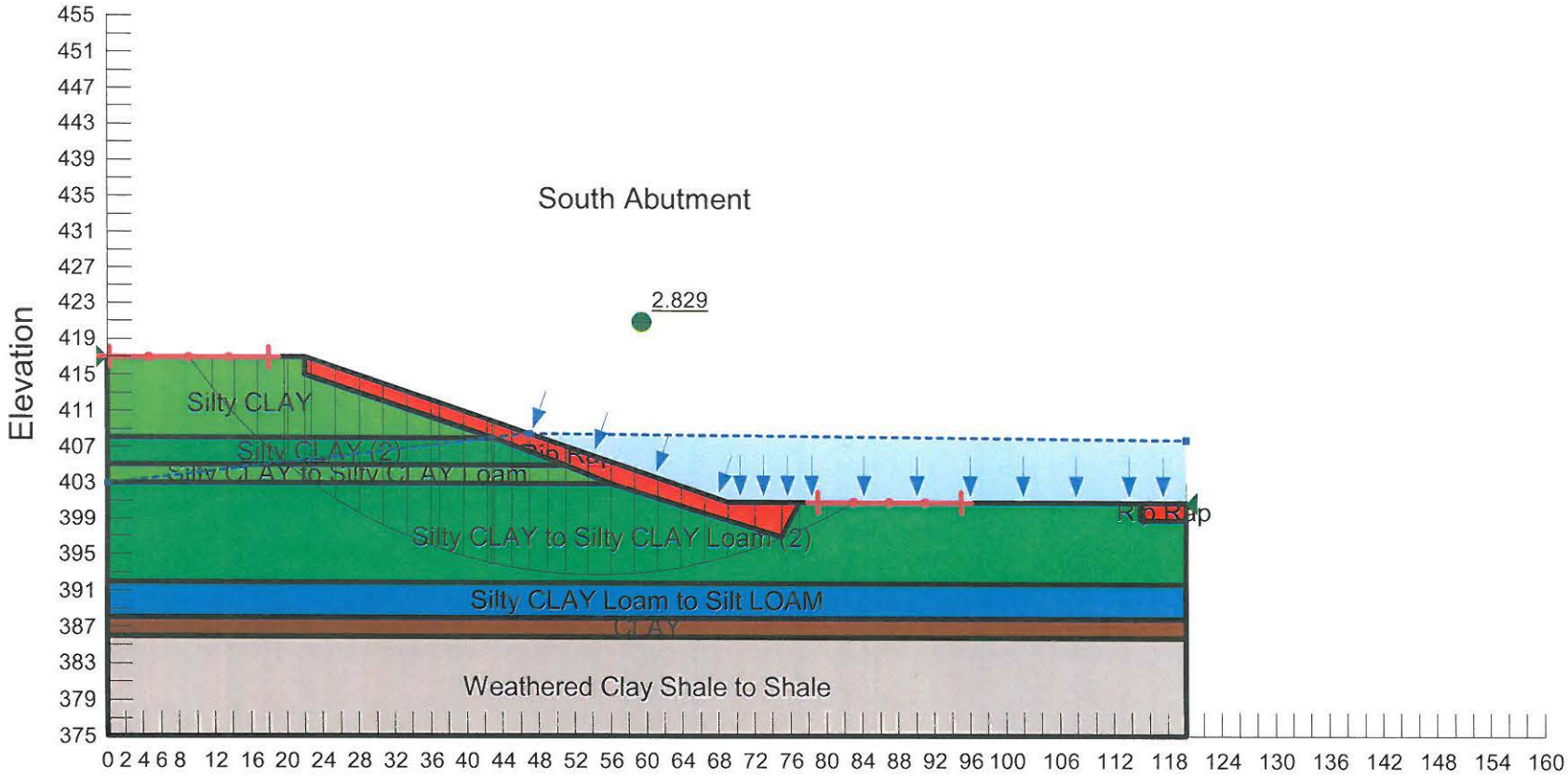
Name: Rip Rap Model: Mohr-Coulomb Unit Weight: 150 pcf Cohesion: 5000 psf Phi: 0 °
Name: Silty CLAY Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 100 psf Phi: 27 °
Name: Silty Clay LOAM Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 100 psf Phi: 25 °
Name: Silty LOAM to Silty CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 100 psf Phi: 29 °
Name: Silty CLAY (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 100 psf Phi: 26 °
Name: Silty CLAY (3) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 100 psf Phi: 26 °
Name: Silty CLAY (4) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 100 psf Phi: 26 °
Name: Silty CLAY Loam Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 100 psf Phi: 27 °
Name: Silty CLAY (5) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 100 psf Phi: 26 °
Name: CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 100 psf Phi: 25 °
Name: Weathered Clay Shale Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 50 psf Phi: 22 °
Name: Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 50 psf Phi: 16 °



Interstate 57 Over Atchison Creek
20131219.02
Station 235+58, Boring 1-S NBL
Seismic

SOIL PROPERTIES

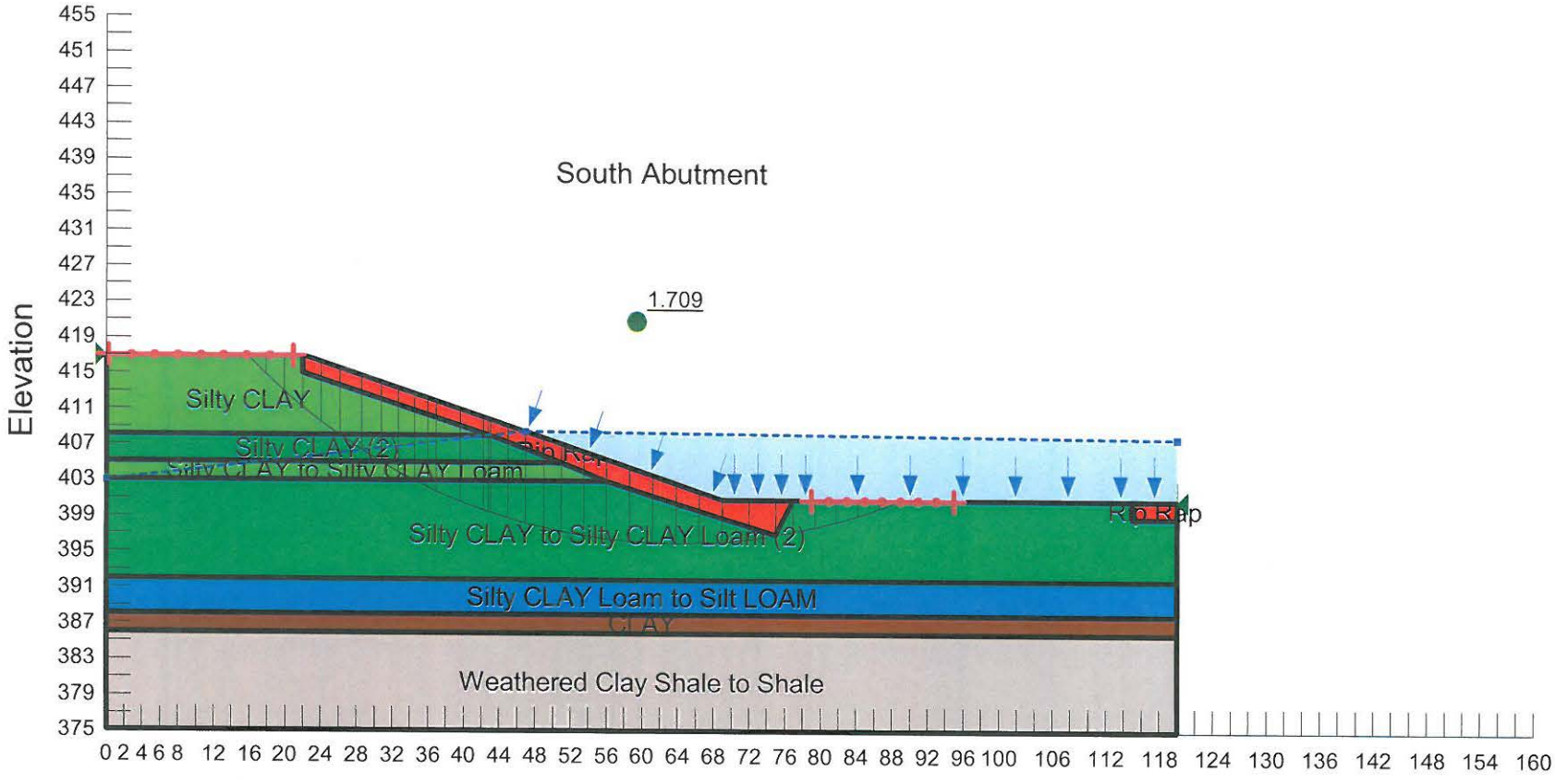
Name: Rip Rap Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 4000 psf Phi: 0 °
Name: Silty CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 800 psf Phi: 0 °
Name: Silty CLAY (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 500 psf Phi: 0 °
Name: Silty CLAY to Silty CLAY Loam Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 1800 psf Phi: 0 °
Name: Silty CLAY to Silty CLAY Loam (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 500 psf Phi: 0 °
Name: Silty CLAY Loam to Silt LOAM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 1000 psf Phi: 0 °
Name: CLAY Model: Mohr-Coulomb Unit Weight: 128 pcf Cohesion: 2500 psf Phi: 0 °
Name: Weathered Clay Shale to Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 4500 psf Phi: 0 °



Interstate 57 Over Atchison Creek
20131219.02
Station 233+71, Boring 2-S NBL
Undrained

SOIL PROPERTIES

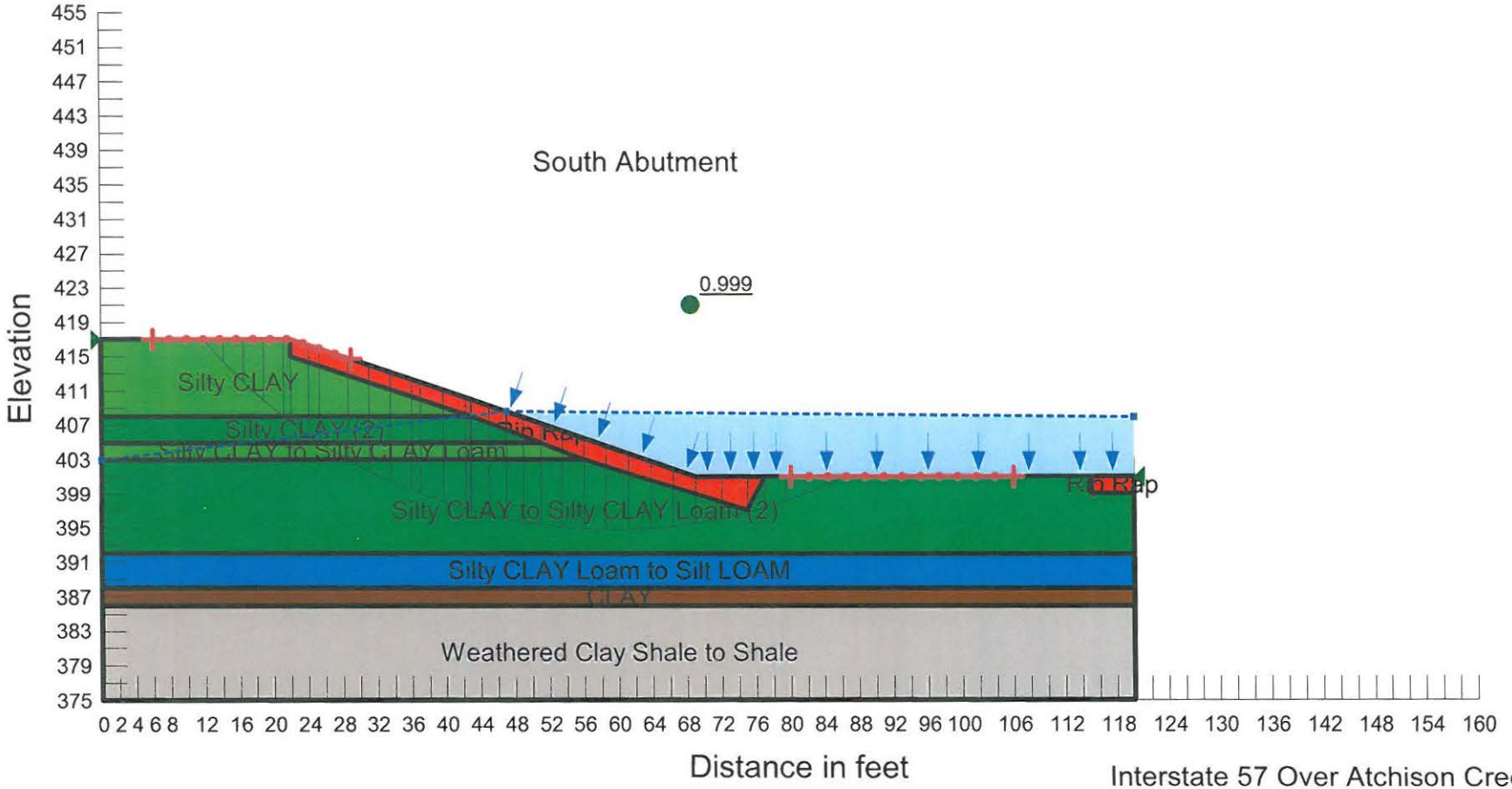
Name: Rip Rap Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 4000 psf Phi: 0 °
Name: Silty CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 27 °
Name: Silty CLAY (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 25 °
Name: Silty CLAY to Silty CLAY Loam Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 26 °
Name: Silty CLAY to Silty CLAY Loam (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 27 °
Name: Silty CLAY Loam to Silt LOAM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 0 psf Phi: 30 °
Name: CLAY Model: Mohr-Coulomb Unit Weight: 128 pcf Cohesion: 200 psf Phi: 23 °
Name: Weathered Clay Shale to Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 4500 psf Phi: 16 °



Interstate 57 Over Atchison Creek
20131219.02
Station 233+71, Boring 2-S NBL
Drained

SOIL PROPERTIES

Name: Rip Rap Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion: 5000 psf Phi: 0 °
Name: Silty CLAY Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 100 psf Phi: 27 °
Name: Silty CLAY (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 100 psf Phi: 25 °
Name: Silty CLAY to Silty CLAY Loam Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 100 psf Phi: 26 °
Name: Silty CLAY to Silty CLAY Loam (2) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 100 psf Phi: 27 °
Name: Silty CLAY Loam to Silt LOAM Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 100 psf Phi: 30 °
Name: CLAY Model: Mohr-Coulomb Unit Weight: 128 pcf Cohesion: 200 psf Phi: 23 °
Name: Weathered Clay Shale to Shale Model: Mohr-Coulomb Unit Weight: 135 pcf Cohesion: 4500 psf Phi: 16 °



Interstate 57 Over Atchison Creek
20131219.02
Station 233+71, Boring 2-S NBL
Seismic

APPENDIX D

SEISMIC SITE CLASS DETERMINATION

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

Modified on 12/10/10

PROJECT TITLE=====FAI 57 over Atchison Creek

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	412.2	ft.
Pile or Shaft Dia.	12	inches
Boring Number	1-S	
Top of Boring Elev.	417.2	ft.
Approximate Fixity Elev.	406.2	ft.

Individual Site Class Definition:

N (bar): 16 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.1 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	414.2	3.00	5	1.20	B
	411.2	3.00	5	1.80	B
	408.5	2.70	2	0.40	B
0.4	405.8	2.70	5	1.30	B
2.9	403.3	2.50	10	1.30	B
5.1	401.1	2.20	11	1.10	B
7.6	398.6	2.50	0	0.40	B
10.1	396.1	2.50	5	1.00	B
12.6	393.6	2.50	2	0.30	B
15.1	391.1	2.50	7	2.10	B
17.6	388.6	2.50	1	0.40	B
20.1	386.1	2.50	11	1.30	B
22.6	383.6	2.50	15	2.30	B
26.5	379.7	3.90	46	3.10	B
100.0	306.2	73.50	100	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	412.7	ft.
Pile or Shaft Dia.	12	inches
Boring Number	2-S	
Top of Boring Elev.	417.7	ft.
Approximate Fixity Elev.	406.7	ft.

Individual Site Class Definition:

N (bar): 16 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 1.7 (ksf) Soil Site Class D <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	414.7	3.00	2	1.10	B
	412.2	2.50	4	1.40	B
	409.7	2.50	2	0.90	B
	407.2	2.50	1	0.20	B
2.0	404.7	2.50	14	1.80	B
4.5	402.2	2.50	3	0.70	B
7.0	399.7	2.50	3	0.90	B
9.5	397.2	2.50	2	0.10	B
12.0	394.7	2.50	2	0.60	B
14.5	392.2	2.50	5	1.10	B
17.0	389.7	2.50	9	0.90	B
19.5	387.2	2.50	12	2.50	B
22.0	384.7	2.50	80	5.10	B
100.0	306.7	78.00	100	5.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)	412.7	ft.
Pile or Shaft Dia.	12	inches
Boring Number	1-S	
Top of Boring Elev.	417.7	ft.
Approximate Fixity Elev.	406.7	ft.

Individual Site Class Definition:

N (bar): 26 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.38 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	414.7	3.00	5	2.10	B
	412.2	2.50	0	0.20	B
	409.7	2.50	3	1.10	B
	407.2	2.50	8	1.90	B
2.0	404.7	2.50	0	0.20	B
4.5	402.2	2.50	4	0.70	B
7.0	399.7	2.50	7	1.50	B
9.5	397.2	2.50	6	0.90	B
12.0	394.7	2.50	7	2.10	B
14.5	392.2	2.50	7	1.30	B
17.0	389.7	2.50	7	1.40	B
19.5	387.2	2.50	7	0.90	B
22.0	384.7	2.50	15	3.70	B
24.5	382.2	2.50	26	4.50	B
100.0	306.7	75.50	100	5.00	R

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)	412.7	ft.
Pile or Shaft Dia.	12	inches
Boring Number	2-S	
Top of Boring Elev.	417.7	ft.
Approximate Fixity Elev.	406.7	ft.

Individual Site Class Definition:

N (bar): 22 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.39 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	414.2	3.50	10	2.50	B
	411.7	2.50	4	1.50	B
	409.2	2.50	5	1.60	B
	406.7	2.50	1	0.30	B
2.5	404.2	2.50	6	1.50	B
5.0	401.7	2.50	15	1.20	B
7.5	399.2	2.50	8	0.80	B
10.0	396.7	2.50	2	0.30	B
12.5	394.2	2.50	6	1.10	B
15.0	391.7	2.50	3	0.70	B
17.5	389.2	2.50	11	0.90	B
20.0	386.7	2.50	23	1.50	B
22.5	384.2	2.50	60	3.10	B
100.0	306.7	77.50	100	5.00	R

Global Site Class Definition: Substructures 1 through 4

N (bar): 20 (Blows/ft.) Soil Site Class D
N_{ch} (bar): (Blows/ft.) NA
s_u (bar): 2.14 (ksf) Soil Site Class C <----Controls

APPENDIX E

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE========== North Abutment NB
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 413.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 411.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 411.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 66.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE =========
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== KIPS

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	335 KIPS	184 KIPS	34 FT.

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area===== 0.086 SQFT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
408.70	2.30	0.40	2		2.4		14.8	3.5		***5.1***	5	0	0	3	4
406.20	2.50	1.30	5		7.2	12.4	22.0	10.6	1.6	***15.7***	16	0	0	9	7
403.70	2.50	1.30	10		7.2	12.4	27.2	10.6	1.6	***26.0***	26	0	0	14	9
401.20	2.50	1.10	11		6.3	10.5	***26.9***	9.3	1.3	34.5	27	0	0	15	12
398.70	2.50	0.40	0		2.6	3.8	***35.2***	3.9	0.5	39.0	35	0	0	19	14
396.20	2.50	1.00	5		5.9	9.5	***34.4***	8.6	1.2	46.8	34	0	0	19	17
393.70	2.50	0.30	2		2.0	2.9	53.6	2.9	0.4	***51.9***	52	0	0	29	19
391.20	2.50	2.10	7		9.9	20.0	***47.3***	14.6	2.5	64.5	47	0	0	26	22
388.70	2.50	0.40	1		2.6	3.8	***58.5***	3.9	0.5	69.4	58	0	0	32	24
386.20	2.50	1.30	11		7.2	12.4	***75.2***	10.6	1.6	81.2	75	0	0	41	27
383.70	2.50	2.30	15		10.5	21.9	148.5	15.5	2.8	***104.6***	105	0	0	58	29
382.70	1.00			Shale	41.1	84.8	189.6	60.5	10.7	***165.1***	165	0	0	91	30.3
381.70	1.00			Shale	41.1	84.8	230.7	60.5	10.7	***225.6***	226	0	0	124	31.3
380.70	1.00			Shale	41.1	84.8	***271.8***	60.5	10.7	286.2	272	0	0	150	32.3
379.70	1.00			Shale	41.1	84.8	***313.0***	60.5	10.7	346.7	313	0	0	172	33.3
378.70	1.00			Shale	41.1	84.8	***354.1***	60.5	10.7	407.2	~~354~~	~~0~~	~~0~~	~~195~~	~~34.3~~
377.70	1.00			Shale	41.1	84.8	***395.2***	60.5	10.7	467.7	~~395~~	~~0~~	~~0~~	~~217~~	~~35.3~~
376.70	1.00			Shale	41.1	84.8	***436.3***	60.5	10.7	528.2	~~436~~	~~0~~	~~0~~	~~240~~	~~36.3~~
375.70	1.00			Shale	41.1	84.8	***477.4***	60.5	10.7	588.8	~~477~~	~~0~~	~~0~~	~~263~~	~~37.3~~
374.70	1.00			Shale	41.1	84.8	***518.5***	60.5	10.7	649.3	~~518~~	~~0~~	~~0~~	~~285~~	~~38.3~~
373.70	1.00			Shale	41.1	84.8	***559.6***	60.5	10.7	709.8	~~560~~	~~0~~	~~0~~	~~308~~	~~39.3~~
372.70	1.00			Shale	41.1	84.8	***600.7***	60.5	10.7	770.3	~~601~~	~~0~~	~~0~~	~~330~~	~~40.3~~
371.70	1.00			Shale	41.1	84.8	***641.8***	60.5	10.7	830.9	~~642~~	~~0~~	~~0~~	~~353~~	~~41.3~~
370.70	1.00			Shale	41.1	84.8	***682.9***	60.5	10.7	891.4	~~683~~	~~0~~	~~0~~	~~376~~	~~42.3~~
369.70	1.00			Shale		84.8			10.7						

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

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 42		
5	3	4
16	9	7
26	14	9
27	15	12
34	19	17
47	26	22
58	32	24
75	41	27
105	58	29
335	184	34
Steel HP 10 X 57		
6	3	4
16	9	7
27	15	9
28	15	12
35	19	17
48	27	22
60	33	24
77	42	27
109	60	29
454	250	37
Steel HP 12 X 53		
6	3	4
19	10	7
31	17	9
33	18	12
42	23	17
58	32	22
73	40	24
96	53	27
125	69	29
418	230	34
Steel HP 12 X 63		
7	4	4
19	11	7
32	18	9
34	18	12
42	23	17
58	32	22
74	41	24
97	53	27
130	71	29
497	273	35
Steel HP 12 X 74		
7	4	4
20	11	7
32	18	9
34	19	12
43	24	17
59	32	22
75	41	24
98	54	27
133	73	29
589	324	37
Steel HP 12 X 84		
7	4	4
20	11	7
33	18	9
35	19	12
44	24	17
60	33	22
76	42	24
100	55	27
136	75	29
664	365	38
Steel HP 14 X 73		
8	4	4
23	13	7
38	21	9
41	22	12
51	28	17
70	38	22
91	50	24
117	65	27
153	84	29
578	318	35
Steel HP 14 X 89		
8	5	4
24	13	7
39	21	9
41	23	12
51	28	17
70	39	22
92	51	24
119	66	27
158	87	29
705	388	37
Steel HP 14 X 102		
9	5	4
24	13	7
39	21	9
42	23	12
52	29	17
71	39	22
93	51	24
121	66	27
162	89	29
810	445	38
Steel HP 14 X 117		
10	5	4
25	14	7
40	22	9
42	23	12
53	29	17
72	40	22
94	52	24
123	67	27
167	92	29
929	511	40
Precast 14"x 14"		
25	14	4
41	22	7
54	29	9
57	31	12
72	39	14
74	41	17
102	56	22
121	67	24
152	84	27
Timber Pile		
7	4	4
18	10	7
28	16	9
36	20	12
41	23	14
48	26	17
56	31	19
66	36	22
72	40	24
86	47	27

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE========== North Abutment SB
REFERENCE BORING ========== 1-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 413.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 411.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 411.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 66.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE =========
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== KIPS

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area===== 0.086 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	335 KIPS	184 KIPS	35 FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
409.50	1.50	1.10	3		3.8		21.9	5.6		***7.9***	8	0	0	4	4
407.00	2.50	1.90	8		9.3	18.1	***15.0***	13.7	2.3	19.5	15	0	0	8	6
404.50	2.50	0.20	0		1.4	1.9	***21.1***	2.0	0.2	22.1	21	0	0	12	9
402.00	2.50	0.70	4		4.3	6.7	33.1	6.4	0.8	***29.5***	29	0	0	16	11
399.50	2.50	1.50	7		7.9	14.3	***35.3***	11.7	1.8	40.4	35	0	0	19	14
397.00	2.50	0.90	6		5.4	8.6	52.1	7.9	1.1	***49.8***	50	0	0	27	16
394.50	2.50	2.10	7		9.9	20.0	***54.4***	14.6	2.5	63.4	54	0	0	30	19
392.00	2.50	1.30	7		7.2	12.4	***62.5***	10.6	1.6	74.1	63	0	0	34	21
389.50	2.50	1.40	7		7.6	13.3	***65.3***	11.1	1.7	84.6	65	0	0	36	24
387.00	2.50	0.90	7		5.4	8.6	97.4	7.9	1.1	***95.9***	96	0	0	53	26
384.50	2.50	3.70	15		14.7	35.3	119.8	21.7	4.5	***118.6***	119	0	0	65	29
382.00	2.50	4.50	26		17.1	42.9	178.8	25.2	5.4	***149.1***	149	0	0	82	31
381.00	1.00			Shale	41.1	84.8	219.9	60.5	10.7	***209.6***	210	0	0	115	32
380.00	1.00			Shale	41.1	84.8	***261.0***	60.5	10.7	270.2	261	0	0	144	33
379.00	1.00			Shale	41.1	84.8	***302.1***	60.5	10.7	330.7	302	0	0	166	34
378.00	1.00			Shale	41.1	84.8	***343.2***	60.5	10.7	391.2	~~343~~	~~0~~	~~0~~	~~189~~	~~35~~
377.00	1.00			Shale	41.1	84.8	***384.3***	60.5	10.7	451.7	~~384~~	~~0~~	~~0~~	~~211~~	~~36~~
376.00	1.00			Shale	41.1	84.8	***425.4***	60.5	10.7	512.3	~~425~~	~~0~~	~~0~~	~~234~~	~~37~~
375.00	1.00			Shale	41.1	84.8	***466.5***	60.5	10.7	572.8	~~467~~	~~0~~	~~0~~	~~257~~	~~38~~
374.00	1.00			Shale	41.1	84.8	***507.6***	60.5	10.7	633.3	~~508~~	~~0~~	~~0~~	~~279~~	~~39~~
373.00	1.00			Shale	41.1	84.8	***548.7***	60.5	10.7	693.8	~~549~~	~~0~~	~~0~~	~~302~~	~~40~~
372.00	1.00			Shale	41.1	84.8	***589.8***	60.5	10.7	754.3	~~590~~	~~0~~	~~0~~	~~324~~	~~41~~
371.00	1.00			Shale	41.1	84.8	***631.0***	60.5	10.7	814.9	~~631~~	~~0~~	~~0~~	~~347~~	~~42~~
370.00	1.00			Shale	41.1	84.8	***672.1***	60.5	10.7	875.4	~~672~~	~~0~~	~~0~~	~~370~~	~~43~~
369.00	1.00			Shale		84.8			10.7						

Pile Design Table for North Abutment SB utilizing Boring #1-S

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36		
6	4	4
12	7	6
16	9	9
24	13	11
28	15	14
40	22	16
43	23	19
49	27	21
52	29	24
74	41	26
91	50	29
120	66	31
286	157	36
Steel HP 10 X 42		
8	4	4
15	8	6
21	12	9
29	16	11
35	19	14
50	27	16
54	30	19
63	34	21
65	36	24
96	53	26
119	65	29
149	82	31
335	184	35

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57		
9	5	4
15	8	6
22	12	9
30	17	11
36	20	14
51	28	16
56	31	19
64	35	21
67	37	24
98	54	26
121	67	29
154	85	31
454	250	38
Steel HP 12 X 53		
10	5	4
18	10	6
26	15	9
35	19	11
45	24	14
60	33	16
68	38	19
78	43	21
81	44	24
115	63	26
142	78	29
179	98	31
418	230	35
Steel HP 12 X 63		
10	6	4
19	10	6
27	15	9
36	20	11
45	25	14
61	34	16
69	38	19
79	44	21
81	45	24
117	65	26
145	80	29
184	101	31
497	273	37
Steel HP 12 X 74		
11	6	4
19	10	6
27	15	9
37	20	11
46	25	14
62	34	16
70	39	19
80	44	21
83	45	24
119	65	26
147	81	29
187	103	31
589	324	38
Steel HP 12 X 84		
11	6	4
19	11	6
28	15	9
37	21	11
46	26	14
63	35	16
71	39	19
82	45	21
84	46	24
121	66	26
149	82	29
191	105	31
664	365	40

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73		
12	7	4
23	12	6
32	18	9
43	24	11
55	30	14
72	40	16
85	47	19
97	53	21
98	54	24
139	76	26
172	95	29
217	119	31
578	318	36
Steel HP 14 X 89		
13	7	4
23	13	6
33	18	9
44	24	11
56	31	14
74	41	16
86	47	19
98	54	21
99	55	24
142	78	26
175	96	29
223	123	31
705	388	38
Steel HP 14 X 102		
14	8	4
23	13	6
33	18	9
45	25	11
57	31	14
75	41	16
87	48	19
100	55	21
101	55	24
144	79	26
178	98	29
227	125	31
810	445	40
Steel HP 14 X 117		
15	8	4
23	13	6
33	18	9
46	25	11
58	32	14
76	42	16
89	49	19
101	56	21
102	56	24
146	80	26
181	99	29
232	128	31
929	511	42
Precast 14"x 14"		
32	18	6
42	23	9
64	35	11
73	40	14
102	56	16
112	62	19
130	71	21
139	76	24
193	106	26
237	131	29
Timber Pile		
11	6	4
20	11	6
24	13	9
32	18	11
42	23	14
54	30	16
66	37	19
77	43	21
87	48	24
103	57	26
128	70	29

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE========== South Abutment NB
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 413.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 411.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 411.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 66.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE =========
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== KIPS

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area===== 0.086 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	**335** KIPS	**184** KIPS	**31** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
409.20	1.80	0.90	2		3.9		***5.8***	5.7		5.9	6	0	0	3	4
406.70	2.50	0.20	1		1.4	1.9	22.4	2.0	0.2	***9.9***	10	0	0	5	6
404.20	2.50	1.80	14		9.0	17.2	***20.9***	13.2	2.2	21.7	21	0	0	11	9
401.70	2.50	0.70	3		4.3	6.7	***27.1***	6.4	0.8	28.4	27	0	0	15	11
399.20	2.50	0.90	3		5.4	8.6	***24.9***	7.9	1.1	35.3	25	0	0	14	14
396.70	2.50	0.10	2		0.7	1.0	***30.3***	1.0	0.1	37.0	30	0	0	17	16
394.20	2.50	0.60	2		3.8	5.7	***38.9***	5.6	0.7	43.1	39	0	0	21	19
391.70	2.50	1.10	5		6.3	10.5	***43.3***	9.3	1.3	52.2	43	0	0	24	21
389.20	2.50	0.90	9		5.4	8.6	63.9	7.9	1.1	***62.1***	62	0	0	34	24
386.70	2.50	2.50	12		11.1	23.8	136.0	16.4	3.0	***86.1***	86	0	0	47	26
385.70	1.00			Shale	41.1	84.8	177.1	60.5	10.7	***146.6***	147	0	0	81	27.3
384.70	1.00			Shale	41.1	84.8	218.2	60.5	10.7	***207.2***	207	0	0	114	28.3
383.70	1.00			Shale	41.1	84.8	***259.3***	60.5	10.7	267.7	259	0	0	143	29.3
382.70	1.00			Shale	41.1	84.8	***300.4***	60.5	10.7	328.2	300	0	0	165	30.3
381.70	1.00			Shale	41.1	84.8	***341.5***	60.5	10.7	388.7	~~342~~	*0*	*0*	~~*188*~~	~~*31.3*~~
380.70	1.00			Shale	41.1	84.8	***382.6***	60.5	10.7	449.2	~~383~~	*0*	*0*	~~*210*~~	~~*32.3*~~
379.70	1.00			Shale	41.1	84.8	***423.7***	60.5	10.7	509.8	~~424~~	*0*	*0*	~~*233*~~	~~*33.3*~~
378.70	1.00			Shale	41.1	84.8	***464.8***	60.5	10.7	570.3	~~465~~	*0*	*0*	~~*256*~~	~~*34.3*~~
377.70	1.00			Shale	41.1	84.8	***505.9***	60.5	10.7	630.8	~~506~~	*0*	*0*	~~*278*~~	~~*35.3*~~
376.70	1.00			Shale	41.1	84.8	***547.1***	60.5	10.7	691.3	~~547~~	*0*	*0*	~~*301*~~	~~*36.3*~~
375.70	1.00			Shale	41.1	84.8	***588.2***	60.5	10.7	751.9	~~588~~	*0*	*0*	~~*323*~~	~~*37.3*~~
374.70	1.00			Shale	41.1	84.8	***629.3***	60.5	10.7	812.4	~~629~~	*0*	*0*	~~*346*~~	~~*38.3*~~
373.70	1.00			Shale	41.1	84.8	***670.4***	60.5	10.7	872.9	~~670~~	*0*	*0*	~~*369*~~	~~*39.3*~~
372.70	1.00			Shale		84.8			10.7						

Pile Design Table for South Abutment NB utilizing Boring #2-S

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36		
4	2	4
8	4	6
16	9	9
20	11	14
24	13	16
30	17	19
34	19	21
49	27	24
70	38	26
286	157	32
Steel HP 10 X 42		
6	3	4
10	5	6
21	11	9
25	14	14
30	17	16
39	21	19
43	24	21
62	34	24
86	47	26
335	184	31

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57		
6	3	4
11	6	6
21	12	9
25	14	14
31	17	16
40	22	19
44	24	21
63	35	24
90	50	26
454	250	34
Steel HP 12 X 53		
7	4	4
12	7	6
26	14	9
30	17	14
38	21	16
49	27	19
54	30	21
74	41	24
103	57	26
418	230	31
Steel HP 12 X 63		
7	4	4
13	7	6
27	15	9
30	17	14
38	21	16
50	27	19
55	30	21
76	42	24
107	59	26
497	273	33
Steel HP 12 X 74		
7	4	4
13	7	6
27	15	9
31	17	14
39	21	16
51	28	19
56	31	21
77	42	24
111	61	26
589	324	34
Steel HP 12 X 84		
7	4	4
14	8	6
27	15	9
31	17	14
39	22	16
51	28	19
56	31	21
78	43	24
113	62	26
664	365	36

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73		
9	5	4
15	8	6
31	17	9
36	20	14
47	26	16
62	34	19
67	37	21
90	49	24
127	70	26
578	318	32
Steel HP 14 X 89		
9	5	4
16	9	6
32	18	9
36	20	14
47	26	16
63	34	19
68	37	21
92	51	24
132	72	26
705	388	34
Steel HP 14 X 102		
9	5	4
16	9	6
32	18	9
37	20	14
48	26	16
63	35	19
69	38	21
93	51	24
135	75	26
810	445	36
Steel HP 14 X 117		
9	5	4
17	10	6
33	18	9
37	20	14
49	27	16
64	35	19
70	38	21
95	52	24
140	77	26
929	511	38
Precast 14"x 14"		
12	6	4
38	21	6
42	23	9
54	30	14
63	35	16
79	44	19
90	50	21
126	69	24
Timber Pile		
6	3	4
13	7	6
23	13	9
30	17	11
36	20	14
38	21	16
46	25	19
54	30	21
67	37	24

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE========== South Abutment SB
REFERENCE BORING ========== 2-S
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 413.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 411.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 411.00 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 66.50 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE =========
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== KIPS

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area===== 0.086 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	**335** KIPS	**184** KIPS	**31** FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
409.20	1.80	1.60	5		6.0		***8.8***	8.8		9.2	9	0	0	5	4
406.70	2.50	0.30	1		2.0	2.9	22.3	2.9	0.4	***13.5***	14	0	0	7	6
404.20	2.50	1.50	6		7.9	14.3	27.3	11.7	1.8	***24.9***	25	0	0	14	9
401.70	2.50	1.20	15		6.8	11.4	***30.3***	10.0	1.4	34.3	30	0	0	17	11
399.20	2.50	0.80	8		4.9	7.6	***30.4***	7.2	1.0	40.9	30	0	0	17	14
396.70	2.50	0.30	2		2.0	2.9	***40.0***	2.9	0.4	44.8	40	0	0	22	16
394.20	2.50	1.10	6		6.3	10.5	***42.5***	9.3	1.3	53.6	43	0	0	23	19
391.70	2.50	0.70	3		4.3	6.7	***48.8***	6.4	0.8	60.3	49	0	0	27	21
389.20	2.50	0.90	11		5.4	8.6	***59.9***	7.9	1.1	68.9	60	0	0	33	24
386.70	2.50	1.50	23		7.9	14.3	138.3	11.7	1.8	***89.5***	90	0	0	49	26
385.70	1.00			Shale	41.1	84.8	179.4	60.5	10.7	***150.0***	150	0	0	83	27.3
384.70	1.00			Shale	41.1	84.8	220.5	60.5	10.7	***210.6***	211	0	0	116	28.3
383.70	1.00			Shale	41.1	84.8	***261.6***	60.5	10.7	271.1	262	0	0	144	29.3
382.70	1.00			Shale	41.1	84.8	***302.7***	60.5	10.7	331.6	303	0	0	166	30.3
381.70	1.00			Shale	41.1	84.8	***343.8***	60.5	10.7	392.1	~~344~~	*0*	*0*	~~189~~	~~31.3~~
380.70	1.00			Shale	41.1	84.8	***384.9***	60.5	10.7	452.6	~~385~~	*0*	*0*	~~212~~	~~32.3~~
379.70	1.00			Shale	41.1	84.8	***426.0***	60.5	10.7	513.2	~~426~~	*0*	*0*	~~234~~	~~33.3~~
378.70	1.00			Shale	41.1	84.8	***467.1***	60.5	10.7	573.7	~~467~~	*0*	*0*	~~257~~	~~34.3~~
377.70	1.00			Shale	41.1	84.8	***508.2***	60.5	10.7	634.2	~~508~~	*0*	*0*	~~280~~	~~35.3~~
376.70	1.00			Shale	41.1	84.8	***549.4***	60.5	10.7	694.7	~~549~~	*0*	*0*	~~302~~	~~36.3~~
375.70	1.00			Shale	41.1	84.8	***590.5***	60.5	10.7	755.2	~~590~~	*0*	*0*	~~325~~	~~37.3~~
374.70	1.00			Shale	41.1	84.8	***631.6***	60.5	10.7	815.8	~~632~~	*0*	*0*	~~347~~	~~38.3~~
373.70	1.00			Shale	41.1	84.8	***672.7***	60.5	10.7	876.3	~~673~~	*0*	*0*	~~370~~	~~39.3~~
372.70	1.00			Shale		84.8			10.7						

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

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36		
7	4	4
11	6	6
20	11	9
24	13	11
24	13	14
31	17	16
34	19	19
39	21	21
47	26	24
72	40	26
286	157	32
Steel HP 10 X 42		
9	5	4
14	7	6
25	14	9
30	17	11
30	17	14
40	22	16
43	23	19
49	27	21
60	33	24
90	49	26
335	184	31

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57		
9	5	4
14	8	6
25	14	9
31	17	11
31	17	14
41	23	16
44	24	19
50	27	21
61	34	24
94	52	26
454	250	34
Steel HP 12 X 53		
11	6	4
16	9	6
30	16	9
37	20	14
51	28	16
53	29	19
61	33	21
75	42	24
107	59	26
418	230	31
Steel HP 12 X 63		
11	6	4
17	9	6
31	17	9
38	21	14
51	28	16
53	29	19
61	34	21
76	42	24
111	61	26
497	273	33
Steel HP 12 X 74		
11	6	4
17	10	6
31	17	9
38	21	14
52	29	16
54	30	19
62	34	21
77	43	24
115	63	26
589	324	34
Steel HP 12 X 84		
11	6	4
18	10	6
32	17	9
39	21	14
53	29	16
55	30	19
63	35	21
79	43	24
118	65	26
664	365	36

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73		
13	7	4
20	11	6
36	20	9
45	25	14
63	35	16
65	36	19
75	41	21
94	52	24
132	72	26
578	318	32
Steel HP 14 X 89		
13	7	4
21	11	6
37	20	9
46	25	14
64	35	16
65	36	19
76	42	21
95	52	24
137	75	26
705	388	34
Steel HP 14 X 102		
14	8	4
21	12	6
38	21	9
46	25	14
65	36	16
66	36	19
77	42	21
97	53	24
140	77	26
810	445	36
Steel HP 14 X 117		
14	8	4
22	12	6
38	21	9
47	26	14
66	36	16
67	37	19
78	43	21
98	54	24
145	80	26
929	511	38
Precast 14"x 14"		
18	10	4
40	22	6
53	29	9
62	34	11
65	36	14
82	45	16
90	49	19
102	56	21
123	68	24
Timber Pile		
10	5	4
16	9	6
27	15	9
36	20	11
42	23	14
47	26	16
55	31	19
63	34	21
72	40	24

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

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

Modified 10/18/2011

SUBSTRUCTURE========== Center Pile Bent Pier
REFERENCE BORING ========== 1-S NB
LRFD or ASD or SEISMIC ========== LRFD
PILE CUTOFF ELEV. ========== 413.00 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRI 395.00 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) Scour
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ========= 393.50 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) ========== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ========== kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)==== 66.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE =========
Approx. Factored Loading Applied per pile at 8 ft. Cts ===== KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ===== KIPS

PILE TYPE AND SIZE ========== Steel HP 10 X 42
Plugged Pile Perimeter========== 3.300 FT. Unplugged Pile Perimeter========== 4.858 FT.
Plugged Pile End Bearing Area========== 0.680 SQFT. Unplugged Pile End Bearing Area===== 0.086 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
335 KIPS	335 KIPS	184 KIPS	36 FT.

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL PLUGGED SIDE RESIST. (KIPS)	NOMINAL PLUGGED END BRG. RESIST. (KIPS)	NOMINAL PLUGGED TOTAL RESIST. (KIPS)	NOMINAL UNPLUG'D SIDE RESIST. (KIPS)	NOMINAL UNPLUG'D END BRG. RESIST. (KIPS)	NOMINAL UNPLUG'D TOTAL RESIST. (KIPS)	NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
393.20	1.80	0.30	2		1.4		21.5	2.1		***4.7***	5	0	0	3	20
390.70	2.50	2.10	7		9.9	20.0	***15.2***	14.6	2.5	17.2	15	0	0	8	22
388.20	2.50	0.40	1		2.6	3.8	26.4	3.9	0.5	***22.1***	22	0	0	12	25
385.70	2.50	1.30	11		7.2	12.4	43.1	10.6	1.6	***33.9***	34	0	0	19	27
383.20	2.50	2.30	15		10.5	21.9	116.4	15.5	2.8	***57.3***	57	0	0	32	30
382.20	1.00			Shale	41.1	84.8	157.5	60.5	10.7	***117.8***	118	0	0	65	30.8
381.20	1.00			Shale	41.1	84.8	198.6	60.5	10.7	***178.4***	178	0	0	98	31.8
380.20	1.00			Shale	41.1	84.8	239.7	60.5	10.7	***238.9***	239	0	0	131	32.8
379.20	1.00			Shale	41.1	84.8	***280.8***	60.5	10.7	299.4	281	0	0	154	33.8
378.20	1.00			Shale	41.1	84.8	***321.9***	60.5	10.7	359.9	322	0	0	177	34.8
377.20	1.00			Shale	41.1	84.8	***363.0***	60.5	10.7	420.4	~~363~~	~~0~~	~~0~~	~~200~~	~~35.8~~
376.20	1.00			Shale	41.1	84.8	***404.2***	60.5	10.7	481.0	~~404~~	~~0~~	~~0~~	~~222~~	~~36.8~~
375.20	1.00			Shale	41.1	84.8	***445.3***	60.5	10.7	541.5	~~445~~	~~0~~	~~0~~	~~245~~	~~37.8~~
374.20	1.00			Shale	41.1	84.8	***486.4***	60.5	10.7	602.0	~~486~~	~~0~~	~~0~~	~~268~~	~~38.8~~
373.20	1.00			Shale	41.1	84.8	***527.5***	60.5	10.7	662.5	~~527~~	~~0~~	~~0~~	~~290~~	~~39.8~~
372.20	1.00			Shale	41.1	84.8	***568.6***	60.5	10.7	723.0	~~569~~	~~0~~	~~0~~	~~313~~	~~40.8~~
371.20	1.00			Shale	41.1	84.8	***609.7***	60.5	10.7	783.6	~~610~~	~~0~~	~~0~~	~~335~~	~~41.8~~
370.20	1.00			Shale	41.1	84.8	***650.8***	60.5	10.7	844.1	~~651~~	~~0~~	~~0~~	~~358~~	~~42.8~~
369.20	1.00			Shale		84.8			10.7						

Pile Design Table for Center Pile Bent Pier utilizing Boring #1-S NB

Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 8 X 36		
4	2	20
12	6	22
18	10	25
27	15	27
46	26	30
286	157	37
Steel HP 10 X 42		
5	3	20
15	8	22
22	12	25
34	19	27
57	32	30
335	184	36
Steel HP 10 X 57		
6	3	20
16	9	22
23	13	25
35	19	27
61	34	30
454	250	38
Steel HP 12 X 53		
6	3	20
19	11	22
26	15	25
41	22	27
69	38	30
418	230	36
Steel HP 12 X 63		
6	3	20
19	11	22
27	15	25
42	23	27
72	40	30
497	273	37
Steel HP 12 X 74		
7	4	20
20	11	22
28	15	25
43	23	27
76	42	30
589	324	39
Steel HP 12 X 84		
8	4	20
20	11	22
28	16	25
44	24	27
78	43	30
664	365	40
Steel HP 14 X 73		
7	4	20
24	13	22
32	18	25
49	27	27
85	47	30
578	318	37
Steel HP 14 X 89		
8	5	20
24	13	22
33	18	25
51	28	27
90	50	30
705	388	39
Steel HP 14 X 102		
9	5	20
25	14	22
34	19	25
52	29	27
94	51	30
810	445	40
Steel HP 14 X 117		
10	6	20
25	14	22
34	19	25
53	29	27
98	54	30
929	511	40
Precast 14"x 14"		
31	17	22
50	28	25
81	45	27
Timber Pile		
8	5	20
18	10	22
25	14	25