Structure Foundation Exploration - Final
Replacement Bridge No. STA-15THSW-1350
15th St. SW over Nimishillen Creek, Canton, Ohio
S&ME Project No. 1117-20-054

PREPARED FOR:

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December 1, 2022

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Attention: Ms. Angela Trautman, P.E.

Reference: **Structure Foundation Exploration – Final Report**
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Ms. Trautman:

In accordance with our proposal dated March 19, 2021, which was authorized by the Prime AE Group, Inc. (Prime) Work Authorization Number WA-01 on July 13, 2021, S&ME, Inc. (S&ME) has completed a Structure Foundation Exploration for the planned STA-15THSW-1350 bridge replacement project in the City of Canton, Stark County, Ohio. We understand that the existing two-span steel beam bridge carrying 15th St. SW over Nimishillen Creek is to be replaced with a new three-span bridge of approximately the same length and along approximately the same alignment. The location of this site is shown on the Vicinity Map submitted as Plate 1 in Appendix A of this report.

In accordance with Section 701 of the current ODOT Specifications for Geotechnical Explorations (SGE), S&ME previously submitted a draft report for review by ODOT. On November 22, 2022, Prime AE advised S&ME that no review comments had been received regarding the draft report, and Prime AE requested that the final Structure Foundation Exploration report and Geotechnical Profile – Bridge sheets be submitted for this project.

We appreciate being given the opportunity to be of service. Please do not hesitate to contact our office if you have any questions.

Respectively,

S&ME, Inc.

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1.0 Executive Summary

The existing two-span bridge carrying 15th St. SW over Nimishillen Creek is planned to be replaced with a new single-span bridge supported on driven pile-supported foundations. The new bridge will be approximately the same length as the existing bridge, with only minimal adjustments to the vertical profile anticipated at either end of the bridge.

Abutment Borings B-001-0-20 and B-002-0-20, hereafter referred to as B-001 and B-002, were drilled behind the existing abutments as near as existing utilities would permit to the proposed west (rear) and east (forward) abutment locations.

Beneath 13 to 17 inches of asphalt, brick, and concrete pavement, Borings B-001 and B-002 encountered 9.6 to 9.9 feet of existing fill and possible fill consisting of medium-dense to dense GRAVEL WITH SAND (A-1-b) and GRAVEL WITH SAND, SILT, AND CLAY (A-2-6) containing slag, cinders and coal, medium-dense SILT AND CLAY (A-6a), medium-stiff SANDY SILT (A-4a), and stiff to hard SILT AND CLAY (A-6a). Beneath the fill, Boring B-001 encountered 2.5 feet of very-soft SANDY SILT (A-4a), AND Boring B-002 encountered 5.5 feet of very-loose COARSE AND FINE SAND (A-3a). Both borings then encountered 68.5 to 71.5 feet of loose to medium-dense GRAVEL WITH SAND (A-1-b), GRAVEL (A-1-a), and COARSE AND FINE SAND (A-3a). A few isolated cobbles were noted throughout this granular deposit. Borings B-001 and B-002 encountered groundwater at 12.5 and 15.0 feet, respectively.

Based on the results of the borings and the type of replacement structure being considered, S&ME recommends that the replacement bridge be supported on extended foundations consisting of cast-in-place, concrete-filled pipe piles. Recommendations for driven pipe piling are presented in Section 6.2 of this report.

Based on the classifications of the granular soils encountered at this site, significant pile set-up is not anticipated at this site. Also, based on the configuration of the proposed bridge relative to the existing structure, downdrag loads are not anticipated on the piles at this site.

Recommended soil parameters for use during the lateral load analyses of the driven piles are provided in Section 6.2.7 of this report

The seismic site classification for the site is estimated to be Seismic Site Class E.

2.0 Introduction

It is planned to replace the existing two-span steel beam bridge carrying 15th Street SW over Nimishillen Creek with a new single-span galvanized beam bridge with a composite concrete deck. The new bridge will be supported on semi-integral abutments bearing on driven, cast-in-place, reinforced concrete (pipe) piles. The length and width of the new bridge will be approximately the same as the existing structure, with the vertical and horizontal alignment of the new structure being relatively unchanged.

3.0 Geology and Observations of the Project

3.1 Site Reconnaissance

S&ME personnel visited the site on July 20, 2021, to assess the existing site conditions and features, traffic volumes, and utilities. In addition to overhead electric wires, active entrance drives for businesses were present east and west of the existing bridge along the south side of the street. Additionally, evidence of numerous underground utilities was noted in the immediate vicinity of each proposed abutment. As such, the borings had to be relocated up to 60 feet away (behind) the proposed abutments to avoid existing underground utilities while providing safe temporary maintenance of traffic. In general, the condition of the roadway pavement was fair, except near the edges of the pavement, where some distress was evident. The watercourse channel was very defined, with steep banks, retaining walls to the south of the site (not part of this project), and existing wall-type bridge abutments. Some evidence of erosion was also noted.

3.2 Geology and Hydrogeology

As previously discussed in S&ME's January 2021 Geotechnical Paper Study for this site, extensive deposits of granular soil, generally of Wisconsinan-age, are present in the vicinity of this site. The upper granular materials consist of interbedded sand and gravel that may contain thin and discontinuous layers of silt and clay. These upper granular materials may also contain local deposits of organic soils. The deeper sands and gravels consist primarily of undifferentiated outwash deposits. A review of available ODNR well logs and bedrock topography mapping indicate that these granular soils may be present to depths of 270 feet below the ground surface near this site. As such, bedrock is not expected to be encountered during drilling for this project.

4.0 Exploration

4.1 Available Information

The logs of several borings drilled on the southern side of US 30/SR 62 near over Nimishillen Creek were also located on the ODOT TIMS website. These boring logs reported predominantly granular soils (A-1-a, A-1-b, A-3a) to depths ranging from 60 to 76 feet. Some, but not all, of these borings encountered 30 feet of 30 blows per foot soil within this range of depths.

4.2 Field Exploration

During the period of August 24, 2021, and September 9, 2021, structure Borings B-001 and B-002 were drilled at the site of this proposed replacement structure and were advanced through the pavement behind the existing bridge abutments. A Plan of Borings showing the approximate locations of the borings is included as Plate 2 in Appendix A at the rear of this report.

Abutment Borings B-001 and B-002 were performed by a truck-mounted drill rig using 3¼" I.D. hollow-stem augers to advance the borings through the soil overburden. At regular intervals, disturbed but representative soil samples were obtained by lowering a 2-inch O.D. split-barrel sampler through the auger stem to the bottom of the boring and then driving the sampler into the soil with blows from a 140-pound hammer freely falling 30 inches (AASHTO T-206 - Standard Penetration Test). In addition to performing 20 feet of 2½-foot interval SPT sampling below the anticipated foundation level in these borings, 6 feet of continuous sampling was performed below the approximate streambed level in the watercourse.

As Boring B-002 was being advanced, a column of drilling mud was maintained inside the hollow-stem auger to minimize the potential for "sand heave" into the auger stem. However, between the depths of 43.5 and 70 feet, Boring B-002 encountered 1 to 5 feet of sand heave into the hollow-stem auger during SPT attempts. In Boring B-001, a column of water was maintained inside the hollow stem auger between the depths of 13.5 and 50 feet. A changeover to rotary drilling with a tricone bit and using a bentonite slurry was then made for the remainder of Boring B-001. At completion, the surface of the existing pavement at each boring location was repaired with cold patch asphalt.

In the field, experienced personnel performed the following specific duties: preserved all recovered samples; prepared a log of the borings; made seepage and groundwater observations; obtained hand penetrometer measurements in soil samples exhibiting cohesion; and coordinated with S&ME personnel so that the program of explorations could be modified, if necessary, because of unanticipated conditions. All samples were transported to the laboratory of S&ME for further identification and testing.

4.3 Laboratory Testing

In the laboratory, all recovered soil samples were visually identified and, in accordance with ODOT specifications, natural moisture content tests were performed on all recovered soil samples. In addition, Atterberg limit tests and grain-size determinations were performed on selected soil samples. Grain-size testing was also performed on the soil samples recovered from the continuously sampled scour zone below the streambed level.

Based on the results of the laboratory testing program, soil descriptions contained on the field logs were modified, if necessary, and laboratory-corrected logs are included as Plates 5 through 11 in Appendix A. Shown on these logs are: the numeric results of all tests; descriptions of the soil stratigraphy encountered; depths from which samples were attempted; sampling efforts (blow counts) required to obtain the specimens; calculated N_{60} values; seepage and groundwater observations; and, the values of hand-penetrometer measurements made in soil samples exhibiting cohesion. For your reference, hand-penetrometer values are roughly equivalent to the unconfined compressive strength of the cohesive fraction of the soil sample.

Soils have been classified in general accordance with Section 603 of the ODOT SGE and described in general accordance with Section 602. Explanation of the symbols and terms used on the boring logs, definitions of the special adjectives used to denote the minor soil components are presented on Plate 3 of Appendix A.

5.0 Exploration Findings

5.1 Existing Pavement Thicknesses

The existing pavement encountered in Boring B-001 consisted of 4 inches of asphalt over 4 inches of brick and 9 inches of concrete. Boring B-002 encountered a pavement section consisting of 1 inch of asphalt over 5 inches of brick and 7 inches of concrete.

5.2 General Subsurface Conditions

Beneath the existing pavement materials, Borings B-001 and B-002 encountered 9.6 to 9.9 feet of existing fill and possible fill consisting of medium-dense brown and gray GRAVEL WITH SAND (A-1-b), medium-dense dark-brown GRAVEL WITH SAND, SILT, AND CLAY (A-2-6), medium-dense to dense brown and dark-gray SILT AND CLAY (A-6a), medium-stiff gray SANDY SILT (A-4a), and stiff to hard brown and dark-gray SILT AND CLAY (A-6a). Coal fragments, cinders, and slag were noted in most of the fill materials.

The uppermost natural soils beneath the fill consisted of 2.5 feet of very-soft gray SANDY SILT (A-4a) in Boring B-001, whereas Boring B-002 encountered 5.5 feet of very-loose brown COARSE AND FINE SAND (A-3a) with thin layers of organic clay, decayed leaves, and wood fragments. Beneath these materials, both structure borings encountered 68.5 to 71.5 feet of primarily medium-dense to dense brown and gray GRAVEL WITH SAND (A-1-b), GRAVEL (A-1-a), and COARSE AND FINE SAND (A-3a). A few isolated cobbles were noted throughout this granular deposit. Borings B-001 and B-002 encountered groundwater at 12.5 and 15.0 feet, respectively.

5.3 Seepage and Groundwater Observations

During drilling, groundwater was in initially noted at the depths of 12.5 and 15.0 feet in Borings B-001 and B-002, respectively. No additional measurements were made as water or drilling fluid was introduced into the boreholes below the depths of 13.5 and 16.5 feet.

All groundwater levels and seepage measurements should be considered as temporary, short-term observations and should not be assumed to be representative of the long-term static groundwater level.

5.4 Scour Zone Grain Size Test Results

Table 2 summarizes the D_{50} particle sizes determined from the results of the gradation testing performed on the soil samples recovered from the continuously sampled scour zone in the borings.

Table 5-1: Scour Zone Grain-Size Information

Boring Number	Location	Top of Boring Elevation	Sample Depth (ft.)	Sample Elevation	D_{50} (mm)
B-001-0-20	West (Rear) Abutment N 40.783346 W 81.386338	1015.6	12.0 - 13.5	1002.1 - 1003.6	0.1244
			13.5 - 14.0	1001.6 - 1053.6	2.7138
			16.5 - 18.0	997.6 - 999.1	3.9131
			18.0 - 19.5	996.1 - 997.6	1.8741
B-002-0-20	East (Fwd.) Abutment N 40.783342 W 81.385602	1015.5	12.0 - 13.5	1002.0 - 1003.5	0.1564
			13.5 - 14.8	1000.7 - 1002.0	0.3543
			15.0 - 16.3	999.2 - 1000.5	0.2877
			16.5 - 17.5	998.0 - 999.0	0.4358
			18.0 - 18.7	996.8 - 997.5	7.8648

These scour zone grain-size analyses results were provided to Prime on September 28, 2021.

6.0 Analyses and Recommendations

6.1 General Geotechnical Discussion

S&ME understands that the replacement bridge is to be a single-span bridge along essentially the same horizontal and vertical alignment as the existing two-span bridges, and approximately the same width as the existing structure. Preliminary site plan information provided by Prime indicates that 2 feet of Type C rock-channel protection will be provided at the base of the new abutments.

Based on the borings, S&ME believes that extended foundations consisting of driven, cast-in-place, closed-end (pipe) piles driven into the underlying granular soil deposit may be used to support the replacement bridge being proposed at this site. Preliminary plan information from Prime indicates that 12-inch-diameter pipe piles are planned to be used at the new abutments and intermediate piers, respectively.

6.2 Bridge Foundation Recommendations

Based on the preliminary site plan provided by Prime, the bottom elevation of the abutment pile caps are summarized in Table 6-1.

Table 6-1: Bottom of Abutment Pile Cap Elevations

Location	Elevation
Rear Abutment	1001.34
Forward Abutment	999.62

S&ME understands that the existing bridge is supported on spread foundations, and that the abutments for the new bridge will bear at approximately the same location as the existing abutments. As such, the existing bridge foundations should be completely removed prior to commencing pile installation for the replacement bridge. Additionally, any existing soils that are disturbed by demolition of the existing bridge abutment foundations should be overexcavated and recompacted prior to commencing pile installation.

6.2.1 *Scour Analysis Results*

S&ME provided Prime with the results of the scour zone grain-size analyses presented in Table 5-1 to Prime in a letter dated September 28, 2021, for use during scour analyses of the new bridge. The results of the scour analyses provided to S&ME are as follows:

Table 6-2: Scour Elevations from Prime

Substructure	Design Flood Event Scour Elevation	Check Flood Event Scour Elevation
Rear & Fwd. Abutments	966	961

6.2.2 *Anticipated Pile Loads*

S&ME understands that 12-inch nominal diameter, cast-in-place (CIP) pipe piles are planned to support the abutments, although 14-inch nominal diameter pipe piles may also be considered. Table 6-3 includes the maximum factored per pile loads for strength limit state analyses provided by Prime, along with the nominal axial pile resistance required for each pile, as computed using Eqn. C305.3.2.-4 of the ODOT Bridge Design Manual (BDM). Table 6-4 includes the maximum factored per pile loads for the Extreme Event II limit state analyses (scour) and the required nominal per pile axial resistance for this limit state.

Table 6-3: Summary of Axial Pile Loads (Strength Limit State)

Substructure Element	Pipe Pile Diameter	Max. Factored Axial Load/Pile (Q_p)	Resistance Factor ϕ_{dyn}	Required Nominal Pile Resistance (R_n)
Rear Abutment	12-inch	141 kips	0.7	202 kips
	14-inch			
Forward Abutment	12-inch	115 kips	0.7	165 kips
	14-inch			

Table 6-4: Summary of Axial Pile Loads (Extreme Event II Limit State)

Substructure Element	Pipe Pile Diameter	Max. Factored Axial Load/Pile (Q_p)	Resistance Factor (ϕ_{dyn}) *	Required Nominal Pile Resistance (R_n)
Rear Abutment	12-inch	85 kips	1.0	85 kips
	14-inch			
Forward Abutment	12-inch	115 kips	1.0	115 kips
	14-inch			

* ODOT BDM Section 1010.4, S10.5.5.3.2, "Scour"

6.2.3 *Downdrag Load*

Because the new bridge will be approximately the same length and width as the existing bridge, no downdrag loads are anticipated.

6.2.4 *Pile Set-Up*

Except for the uppermost one to two feet of soil immediately below the proposed bottom of abutment elevations, the borings encountered coarse-grained granular soils (A-1-a, A-1-b, and A-3a). In accordance with Table 305.2 of the BDM, these soils do not typically exhibit pile set-up following pile driving. Therefore, no pile "set-up" (Rs_{su}) (BDM Eqn. C305.3.2.4-2,) is anticipated, and therefore, a pile restrike program will not be required.

6.2.5 *Pile Resistance Calculations*

Because no soil "set-up" is anticipated, the following pile analyses were performed to determine the Ultimate Bearing Value (UBV) needed for piles subjected to the previously presented axial pile loads.

1) Model the soil profile beginning at the bottom of the pile cap and using the provided strength limit state loads, determine the depth where the required nominal (unfactored) pile bearing resistance (Rn) plus the resistance in the design event scour zone (Rs_{sc}) is attained. This analysis provides the final required UBV for the piles at the End of Initial Driving (EOID).

2) Model the soil profile beginning at the scour elevation of the check flood to determine the pile depth where sufficient resistance is developed to support the maximum Extreme Event II Limit State load per pile, using a resistance factor of 1.0 (see Table 6-4). This analysis considers the condition where the bridge is freely standing on the piles after all overburden soil above the check flood scour elevation has been washed away (i.e., no overburden pressure).

Compare the calculated tip elevations for these two analyses models. The minimum pile tip elevation required for the new bridge piles is the lowest tip elevation determined by either Model #1 or Model #2.

The computer program APILE (Ver. 2019.9.10) developed by Ensoft, Inc., was used to perform the analyses summarized above. These estimated minimum tip elevations and associated UBV values required for this project are presented in Table 6-5. The output for these analysis scenarios described above are included in Appendix B for the rear abutment, and in Appendix C for the forward abutment. The UBV and estimated tip elevations will need to be revised if the maximum factored axial loads per pile differ from those presented in Table 6-5.

Table 6-4: Summary of Ultimate Static CIP Pipe Pile Analyses for Axial Loads

Sub-structure	CIP Pipe Pile Diam.	Max. Factored Load/Pile (kips)	R_n Required (kips)	R_{SSC} Scour Resistance During Driving (kips)	Pile Set-up (R_{SSU}) kips	EOID Resistance (kips) Required	Est. Pile Tip Elev. @ EOID Static Analysis)	Required Pile Tip Elevation (Ext. Event II)	Est. UBV at Req'd. Tip Elev. at EOID (kips)
						MODEL #1 (EOID)		MODEL #2 (Scour)	
Rear Abut.	12"	141 [1]	202	54	--	256	El. 937		
		85 [2]	85	--	--			**El. 936**	272
	14"	141 [1]	202	85	--	287	El. 946.5		
		85 [2]	85	--	--			**El. 940**	340
Fwd. Abut.	12"	115 [1]	165	49	--	214	El. 945		
		71 [2]	71	--	--			**El. 940**	245
	14"	115 [1]	165	76	--	241	El. 952		
		115 [2]	165	--	--			**El. 945**	322

[1] Strength Limit State
[2] Extreme Event II Limit State

As shown in the table above, because the required pile tip elevation to support the Extreme Event II loading during the scour check event is lower than the tip elevation required for the required UBV value at EOID, then the piles must be driven to the minimum required tip elevation during the scour event, not to the EOID pile resistance. However, the estimated UBV at the required minimum scour tip elevation is also included in Table 6-5 for comparison with the conditions being encountered during the ODOT CMS Item 523 "Dynamic Load Test".

All piles should be installed at a center-to-center spacing no closer than 2.5 pile diameters in accordance with AASHTO specifications. S&ME estimates that settlement of individual piles will be less than ½-inch provided the piles are designed and installed in accordance with ODOT specifications and the recommendations presented in this report.

6.2.6 Group Effects

All piles should be installed at a center-to-center spacing not be less than 2.5 pile diameters in accordance with AASHTO *LRFD* Article 10.7.1.2. The distance from the side of any pile to the nearest edge of the pile cap shall not be less than 9 inches. The tops of piles shall project at least 12 inches into the pile cap after all damaged material has been removed.

In accordance with Article 10.7.3.9 of the AASHTO *LRFD*, if the pile cap is in firm contact with the ground, no reduction in group efficiency is required when piles are installed in cohesive soils with the proper 2.5 diameter center-to-center spacing. In cohesionless soils, no reduction in efficiency factor is anticipated if the piles are spaced no closer than 2.5 diameters apart (center-to-center). It is anticipated that a group efficiency of 1.0 would be applicable if the proper pile spacing is achieved as noted above.

6.2.7 Lateral Loading

Due to the scour event and estimated depth of scoured soil, Section 305.3.2.1 of the ODOT BDM directs that the structural capacity of the pile should be investigated. The analysis referenced in the BDM is a buckling analysis of the piles under a free-standing bridge load, with no soil support above the design scour elevations (see Table 6-2 In Section 6.2.1). S&ME understands that Prime is performing this analysis.

In addition, BDM Section 305.3.2.1 also states that a p-y (lateral load) analysis should be performed to assess lateral stability and excess deflection of the piles under a free-standing bridge loading with no soil support above the design scour elevation (El. 966 during the design event). This analysis was not included in S&ME's scope of work for this project. However, to assist with this analysis, we are providing soil parameters in Tables 6-6 and Table 6-7 for use during the lateral load analyses to be performed by others.

Table 6-5: LPile 2019 Input Parameters for Strata in Boring B-001 (Rear Abutment)

Stratum	Depth Interval (ft.)*	Elevation Range	p-y Soil Model	Effective Unit Weight	ϕ'
Medium-dense Gravel (A-1-a) or Gravel with Sand (A-1-b)	0 – 27.4	966.0 – 938.6	Reese Sand	73 pcf	34º
Dense to very-dense Coarse and Fine Sand (A-3a)	27.4 – 35.4	938.6 – 930.6	Reese Sand	67 pcf	35º

* Depth Below Design Scour El. 966

Table 6-6: LPile 2019 Input Parameters for Strata in Boring B-002 (Fwd. Abutment)

Stratum	Depth Interval (ft.)*	Elevation Range	p-y Soil Model	Effective Unit Weight	ϕ'
Medium-dense Gravel (A-1-a) or Gravel with Sand (A-1-b)	0 – 14.1	966.0 – 951.9	Reese Sand	73 pcf	34º
Medium-dense to dense Gravel (A-1-a) or Gravel with Sand (A-1-b)	14.1 – 37.1	951.9 – 619.8	Reese Sand	75 pcf	35º

* Depth Below Design Scour El. 966

If the results of the lateral load analyses indicate that the piles require a tip elevation lower than the scour event tip elevations in Table 6-5, then the minimum tip elevation included in the example Plan Notes presented in Section 6.2.9 should be the minimum tip elevations required by the lateral load analyses.

6.2.8 *Estimated Pay and Order Lengths for Driven Piles*

In accordance with Section 305.3.5.2 of the ODOT *BDM*, the “Estimated Length” for piling should be estimated by subtracting the estimated pile tip elevation from the estimated pile cut-off elevation (including embedment into the pile cap), and then be rounded up to the nearest 5-foot increment. Pile “Order Length” is the “Estimated Length” plus 5 feet. S&ME recommends that the lowest tip elevation provided for each substructure unit be used to compute these lengths.

6.2.9 *Plan Notes for Piles*

If 12-inch diameter pipe piles are used, S&ME recommends Plan Note 606.2-2 from the ODOT BDM should be included in the plans as follows:

> PILE DESIGN LOADS (ULTIMATE BEARING VALUE): The Ultimate Bearing Value (UBV) is 256 kips per pile for the rear abutment piles. The UBV is 214 kips per pile for the forward abutment piles. The UBV for the rear abutment piles includes an additional 54 kips per pile due to the possibility of losing 35.3 ft. of frictional resistance due to scour. The UBV for the forward abutment piles includes an additional 49 kips per pile due to the possibility of losing 33.6 ft. of frictional resistance due to scour. Drive the piles to the UBV, or to a tip Elevation of 936 (rear abutment) or 940 (forward abutment), whichever is deeper.
>
> Rear Abutment piles:
> 12” CIP piles 75 feet long, order length
> 1 Dynamic load testing item
>
> Forward Abutment piles:
> 12” CIP piles 70 feet long, order length
> 1 Dynamic load testing item

If, however, 14-inch diameter pipe piles are used, Plan Note 606.2-2 should read as follows:

> PILE DESIGN LOADS (ULTIMATE BEARING VALUE): The Ultimate Bearing Value (UBV) is 287 kips per pile for the rear abutment piles. The UBV is 241 kips per pile for the forward abutment piles. The UBV for the rear abutment piles includes an additional 85 kips per pile due to the possibility of losing 35.3 ft. of frictional resistance due to scour. The UBV for the forward abutment piles includes an additional 76 kips per pile due to the possibility of losing 33.6 ft. of frictional resistance due to scour. Drive the piles to the UBV, or to a tip Elevation of 940 (rear abutment) or 945 (forward abutment), whichever is deeper.
>
> Rear Abutment piles:
> 12” CIP piles 65 feet long, order length
> 1 Dynamic load testing item
>
> Forward Abutment piles:
> 12” CIP piles 65 feet long, order length
> 1 Dynamic load testing item

6.2.10 *Pile Driving Criteria and Construction Issues*

Prior to commencing pile driving operations, the contractor should be required to submit equipment specifications to the state so that the proposed pile hammer can be evaluated by a wave equation analysis. If excessive (FHWA limits driving stresses to 90 percent of f_y) compressive or tensile stresses are predicted with a wave equation analysis, alternative pile hammers and/or cushions should be investigated prior to pile installation to reduce the potential for pile damage during driving. Pile driving may also result in slight uplift of previously driven piles. All piles should be re-tapped prior to completing pile driving activities.

6.2.11 *Seismic Site Classification*

Based on the subsurface stratigraphy encountered within the borings, it is the opinion of S&ME that this site is best characterized by AASHTO *LRFD* Table 3.10.3.1-1 as Seismic Site Class E.

6.3 Groundwater Considerations for Excavations

S&ME believes that the long-term groundwater level at this site will be approximately the same as, and vary with, the level of water in Nimishillen Creek.

Some water seepage may emanate from any granular seams or zones encountered above the level of water in the creek; however, the quantity of water is expected to be limited and may likely be controlled by bailing or with portable pumps. Provisions for continuous pumping from sumps should be made for the larger groundwater flows that are anticipated to be encountered in excavations extending below the level of water in the creek.

S&ME recommends that the sides and bottoms of all excavations at this site be closely monitored during construction by the Geotechnical Engineer of Record or the Engineer's designated representative. If the soil at the bottom of an excavation becomes disturbed by construction activity, groundwater inflow, or channel flow, it is recommended that the disturbed material be removed and replaced with select granular fill such as ODOT Item 703.11 Type 3 Structural Backfill or Item 703.16.C Granular Material Type C or D, which may be properly compacted in the presence of water.

Additionally, all excavations should be either sloped back or braced in accordance with the most recent OSHA excavation guidelines.

6.4 Lateral Earth Pressures

The proposed bridge abutments must be designed to withstand lateral earth pressures, as well as hydrostatic pressures, that may develop behind the abutments. The magnitude of the lateral earth pressures varies on the soil type, permissible wall movement, and the configuration of the backfill.

To minimize lateral earth pressures, the zone behind abutment walls should be backfilled with granular soil, and the backfill should be effectively drained. For effective drainage, a zone of free-draining gravel (ODOT *CMS* Item 518.03) should be used directly behind the structures for a minimum thickness of 24 inches in accordance with ODOT CMS Item 518.05. This granular zone should drain to either weepholes or a pipe, so that hydrostatic pressures do not develop against the walls.

The type of backfill beyond the free-draining granular zone, however, will govern the magnitude of the pressure to be used for structural design. Pressures of a relatively low magnitude will be developed using granular backfill, whereas a cohesive (clay) backfill will result in the development of much higher pressures.

To minimize lateral pressures, it is recommended that granular backfill also be used behind the Item 518.03 drainage zone for the abutments. This backfill should be placed in a wedge formed by the back of the structure and a line rising from the base of the wall abutment foundations at an angle no greater than 60 degrees from horizontal. Granular backfill behind the abutments should be compacted in accordance with ODOT CMS Item 203, "Embankment Compaction". Over-compaction in areas directly behind the walls should be avoided, as this might cause damage to the structure.

If proper drainage (Item 518.03) is provided and compacted granular backfill is provided as described above, an equivalent fluid unit weight of 35 lb/ft^3 (pcf) may be used if movement equivalent to 0.25 percent of the height (H) of the abutment is allowed to occur. Such movement is considered sufficient to mobilize an active earth pressure condition, and the resultant lateral force should be taken as acting at 0.33H. If this movement is not anticipated or cannot occur, it is recommended that an “at-rest” equivalent fluid unit weight of 55 pcf be used.

Compacted cohesive materials tend alternatively to shrink, expand, and creep over periods of time and create significant lateral pressures on any adjacent structures. Cohesive materials also require a greater amount of movement to mobilize an active earth pressure condition. For these reasons, if proper drainage (ODOT CMS Item 518) is provided and a wall movement greater than 1.0 percent of the height of the abutment is allowed to occur, an equivalent fluid unit weight of 65 pcf may be used for design of the abutment walls to resist the lateral loads imparted by drained cohesive backfill placed and compacted behind the Item 518.03 drainage zone. If this amount of movement is not anticipated or cannot occur, it is recommended that an “at-rest” equivalent fluid unit weight of 95 pcf be used.

The structures must also be designed to withstand the surcharge effect of traffic in addition to the vertical load resulting from the weight of any fill and pavement to be placed over the structures. To estimate vertical loading, a total unit weight of 125 pcf and 135 pcf may be used for compacted cohesive and granular soil, respectively.

6.5 Temporary Excavation Considerations

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P". This document was issued to better ensure the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations be constructed in accordance with the OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR, Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. If an excavation, including a trench is extended to a depth of more than twenty (20) feet, it will be necessary to have the side slopes designed by a professional engineer registered in the state where the construction is occurring.

We are providing this information solely as a service to our client. S&ME does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

7.0 Final Considerations and Report Limitations

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other representation or warranty either express or implied, is made.

We relied on project information given to us to develop our conclusions and recommendations. If the project information in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional information if necessary.

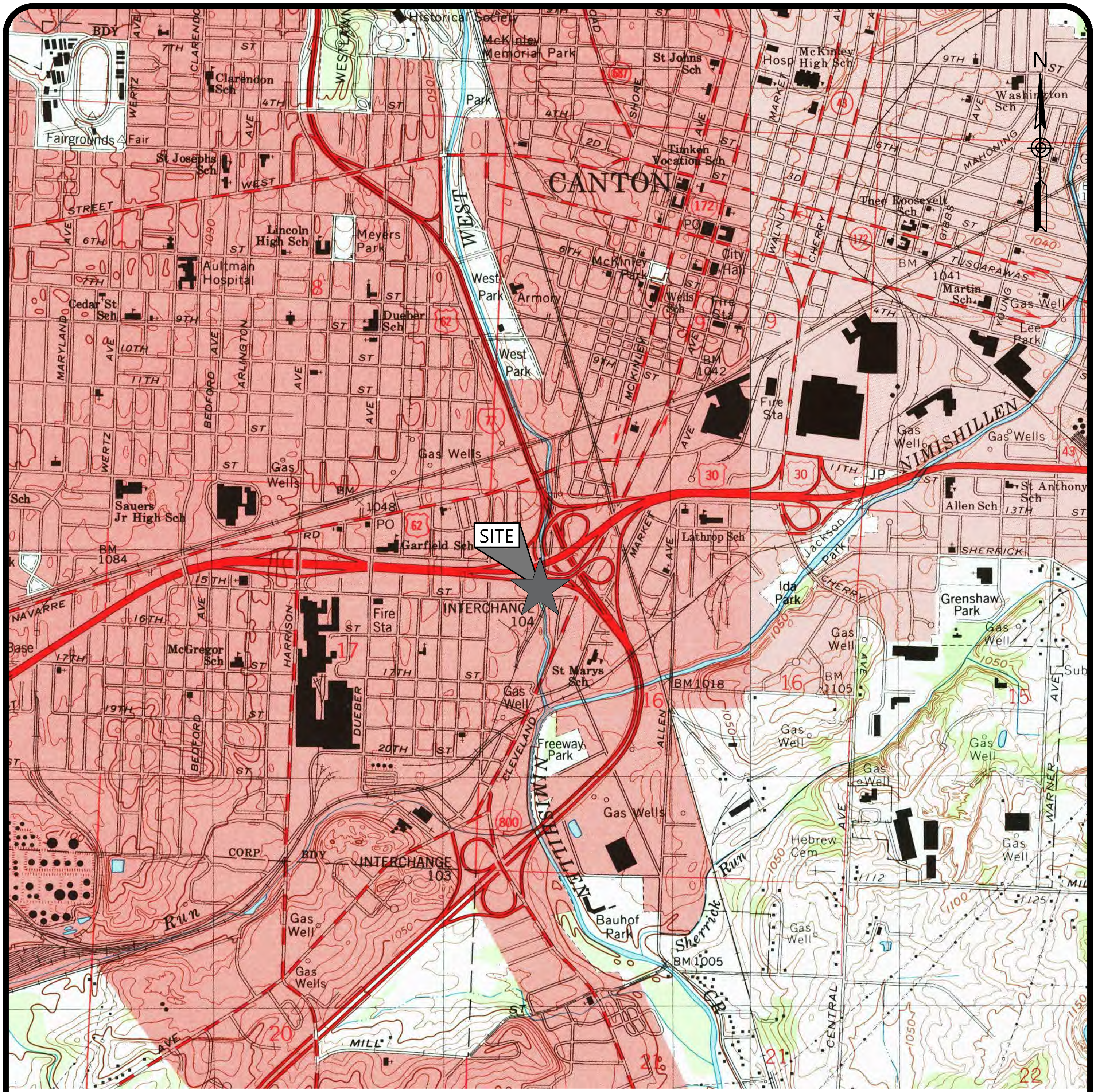
Our conclusions and recommendations are based on limited data from a field exploration program. Subsurface conditions can vary widely between explored areas. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, bacteria). If there is a concern about these items, other studies should be performed. S&ME can provide a proposal and perform these services if requested.

S&ME should be retained to review the final plans and specifications to confirm that earthwork, foundation, and other recommendations are properly interpreted and implemented. The recommendations in this report are contingent on S&ME's review of final plans and specifications followed by our observation and monitoring of earthwork and foundation construction activities.

Appendices

APPENDIX A – Vicinity Map, Boring Location Plan, Boring Logs



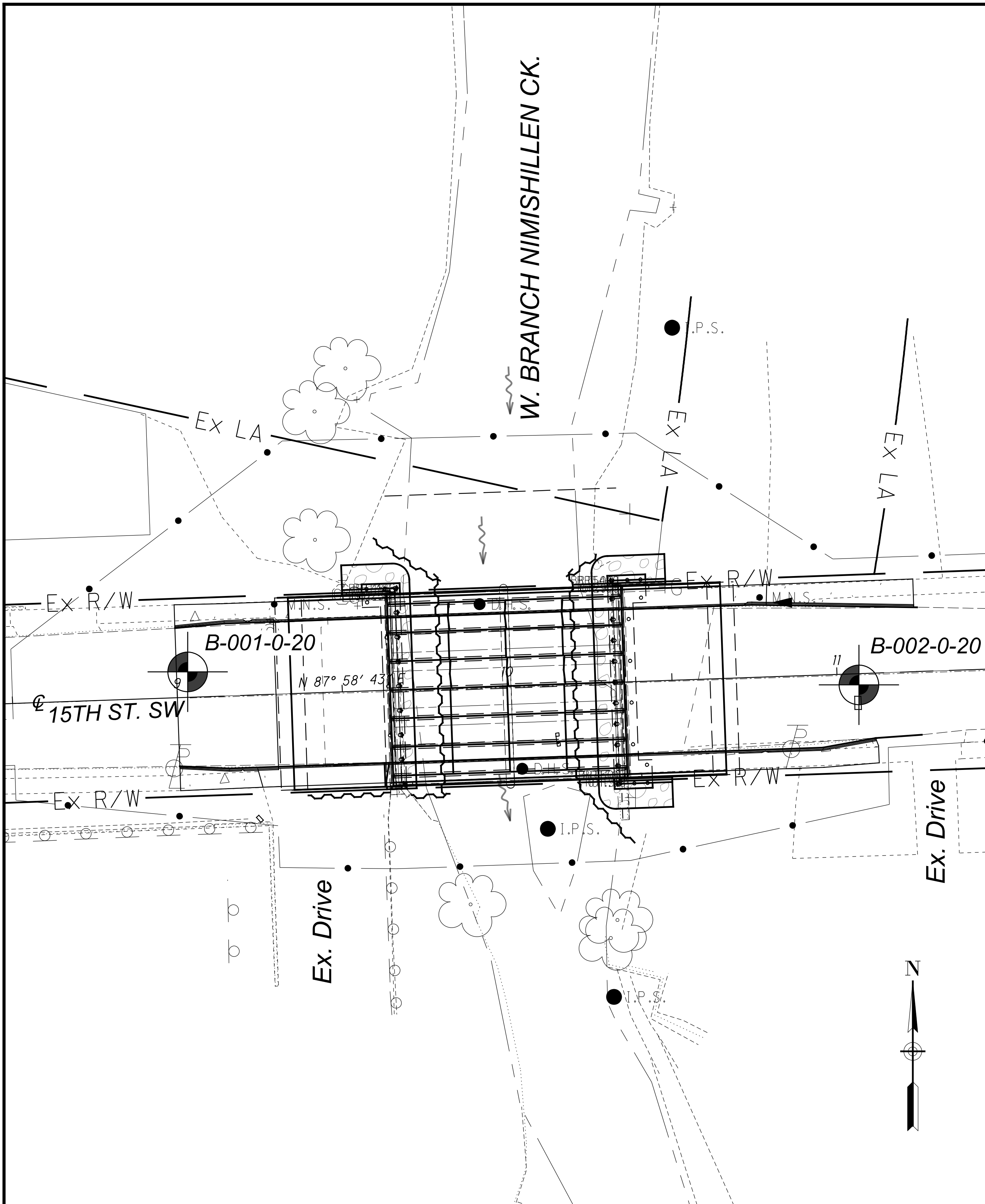
Project Location
Stark County, Ohio

USGS Mapping:
USGS Canton West, Ohio Quad

0 2000 4000
GRAPHIC SCALE (IN FEET)

Drawing Path: T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th St SW Bridge\Part 1 - Geotechnical Paper Study\CAD\Construction\Vicinity Map.dwg

Vicinity Map	SCALE: SEE GRAPHIC		PLATE NO.
Replacement Bridge No. STA-15SW-1350 15th Street SW over Nimishillen Creek, Canton, Ohio	DATE: 1-5-2021	PROJECT NUMBER 1117-20-054	1



BORING LOCATION PLAN

REPLACEMENT BRIDGE No. STA-15SW-1350
15TH STREET SW OVER NIMISHILLEN CREEK
CANTON, OHIO

SCALE:	1" = 40'
DATE:	8/28/2022
PROJECT NUMBER:	1117-20-054
PLATE NO.	2

EXPLANATION OF SYMBOLS AND TERMS USED ON BORING LOGS FOR SAMPLING AND DESCRIPTION OF SOIL

SAMPLING DATA

▮	-	Indicates sample was attempted within this depth interval.
2 3 5	-	The number of blows required for each 6-inch increment of penetration of a "Standard" 2-inch O.D. split-barrel sampler, driven a distance of 18 inches by a 140-pound hammer freely falling 30 inches (SPT). The raw "blowcount" or "N" is equal to the sum of the second and third 6-inch increments of penetration.
N_{60}	-	Corrected Blowcount = [(Drill Rod Energy Ratio) / (0.60 Standard)] X N
SS	-	Split-barrel sampler, any size.
ST	-	Shelby tube sampler, 3″ O.D., hydraulically pushed.
R	-	Refusal of sampler in very-hard or dense soil, or on a resistant surface.
50-0.3′	-	Number of blows (50) to drive a split-barrel sampler a certain distance (0.3 feet), other than the normal 6-inch increment.

DEPTH DATA

W	-	Depth of water or seepage encountered during drilling.
▼ AD	-	Depth to water in boring after drilling (AD) is terminated.
▼ 5 days	-	Depth to water in monitoring well or piezometer in boring a certain number of days (5) after termination of drilling.
TR	-	Depth to top of rock.

SOIL DESCRIPTIONS

Soils have been classified in general accordance with Section 603 of the most recent ODOT SGE, and described in general accordance with Section 602, including the use of special adjectives to designate approximate percentages of minor components as follows:

Adjective	Percent by Weight
trace	1 to 10
little	10 to 20
some	20 to 35
"and"	35 to 50

The following terms are used to describe density and consistency of soils:

Term (Granular Soils)	Blows per foot (N_{60})
Very-loose	Less than 5
Loose	5 to 10
Medium-dense	11 to 30
Dense	31 to 50
Very-dense	Over 50

Term (Cohesive Soils)	Qu (tsf)
Very-soft	Less than 0.25
Soft	0.25 to 0.5
Medium-stiff	0.5 to 1.0
Stiff	1.0 to 2.0
Very-stiff	2.0 to 4.0
Hard	Over 4.0

S&ME JOB: 1117-20-054

PROJECT: STA-15SW-13.50	DRILLING FIRM / OPERATOR: OTB / A. FAY	DRILL RIG: OTB MOBILE B-57	STATION / OFFSET: 9+04, 7' LT
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: S&ME / M. TORRES	HAMMER: CME AUTOMATIC	ALIGNMENT: 15TH ST. SW
PID: 113153 BR ID:	DRILLING METHOD: 3-1/4" HSA, 3-1/8" TRICONE	CALIBRATION DATE: 11/25/20	ELEVATION: 1015.6 (MSL) EOB: 85.0 ft.
START: 9/8/21 END: 9/9/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 40.783347 N, 81.386331 W

EXPLORATION ID **B-001-0-20**

MATERIAL DESCRIPTION AND NOTES	ELEV. 1015.6	DEPTHS
ASPHALT - 4 INCHES	1015.3	
BRICK - 4 INCHES	1015.0	
CONCRETE - 9 INCHES	1014.2	
Fill: Hard brown **SILT AND CLAY**, some fine to coarse sand, trace to little fine to coarse gravel, dry to damp.	1012.6	
Fill: Medium-dense dark-brown **GRAVEL WITH SAND, SILT AND CLAY**, contains coal fragments, cinders and slag, damp.	1008.6	
Possible Fill: Medium-stiff gray **SANDY SILT,** little clay, little fine gravel, moist.	1004.6	
Very-soft gray **SANDY SILT**, little clay, trace coarse sand, wet.	1002.1	W (approx. 12.5)
Medium-dense gray **GRAVEL**, some "and" fine to coarse sand, trace silt, trace clay, few cobbles. - Encountered cobble at 15.5'.	997.1	
Medium-dense brown and gray **GRAVEL WITH SAND**, trace silt, trace clay, few cobbles, few loose zones, wet.		

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
7 50-5"	-	100	SS-1	4.5+	-	-	-	-	-	-	-	-	11	A-6a (V)
3 4 4	12	100	SS-2	-	-	-	-	-	-	-	-	-	13	A-2-6 (V)
2 3 3	9	67	SS-3	0.5-0.75	-	-	-	-	-	-	-	-	25	A-4a (V)
1 1 1	3	100	SS-4	0.0	0	1	56	30	13	-	-	-	34	A-4a (V)
1 4 5	14	33	SS-5	-	55	17	19	7	2	-	-	-	12	A-1-a (V)
6 26 28	81	0	--		-	-	-	-	-	-	-	-	-	
4 14 5	29	100	SS-6	-	62	16	15	5	2	-	-	-	9	A-1-a (V)
4 3 4	11	67	SS-7	-	49	35	12	3	1	-	-	-	14	A-1-b (V)
4 4 5	14	100	SS-8	-	-	-	-	-	-	-	-	-	22	A-1-b (V)
4 4 7	17	39	SS-9	-	-	-	-	-	-	-	-	-	15	A-1-b (V)
4 5 5	15	67	SS-10	-	-	-	-	-	-	-	-	-	12	A-1-b (V)
2 2 4	9	39	SS-11	-	-	-	-	-	-	-	-	-	12	A-1-b (V)

PID: 113153	BR ID:	PROJECT: STA-15SW-13.50	STATION / OFFSET: 9+04, 7' LT	START: 9/8/21	END: 9/9/21	PG 2 OF 3	B-001-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 985.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Medium-dense brown and gray **GRAVEL WITH SAND**, trace silt, trace clay, few cobbles, few loose zones, wet. *(continued)*		31–32	4 6 7	20	67	SS-12	-	32	46	18	2	2	-	-	-	13	A-1-b (V)	
		34–35	7 7 5	18	44	SS-13	-	-	-	-	-	-	-	-	-	17	A-1-b (V)	
		39–40	3 5 6	17	100	SS-14	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
- Encountered cobble at 44.9'.		44–45	5 6 8	21	67	SS-15	-	44	32	19	4	1	-	-	-	12	A-1-b (V)	
		49–50	4 4 3	11	33	SS-16	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	
		54–55	10 7 5	18	67	SS-17	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
	956.9																	
Medium-dense gray and brown **GRAVEL**, "and" fine to coarse sand, trace silt, trace clay, few cobbles, wet.		59–60	7 6 7	20	0	--		-	-	-	-	-	-	-	-	-		
- Encountered cobble at 58.7'.		60–61	2 3 6	14	100	SS-18	-	54	25	16	4	1	-	-	-	11	A-1-a (V)	

Depth scale: 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61

PID: 113153	BR ID:	PROJECT: STA-15SW-13.50	STATION / OFFSET: 9+04, 7' LT	START: 9/8/21	END: 9/9/21	PG 3 OF 3	B-001-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 953.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Medium-dense gray and brown **GRAVEL WITH SAND**, trace silt, trace clay, wet.	953.1	63																
		64–65	3 5 5	15	33	SS-19	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
		69–70	4 7 11	27	100	SS-20	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	
		74–75	6 7 7	21	100	SS-21	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
Dense to very-dense brown **COARSE AND FINE SAND**, trace fine gravel, trace silt, trace clay, wet.	938.6	76.5																
		79–80	8 16 23	59	100	SS-22	-	2	18	70	7	3	-	-	-	19	A-3a (V)	
		84–85	8 10 15	38	100	SS-23	-	-	-	-	-	-	-	-	-	18	A-3a (V)	
	930.6	EOB 85																

NOTES:
- Encountered water at 12.5'.
- Maintained column of water inside HSA from 13.5' to 50.0'.
- Switched to rotary drilling with bentonitic drilling mud and tricone bit beginning at 50.0'.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS

S&ME JOB: 1117-20-054

PROJECT: STA-15SW-13.50	DRILLING FIRM / OPERATOR: OTB / A. FAY	DRILL RIG: OTB MOBILE B-57	STATION / OFFSET: 11+06, 4' RT	EXPLORATION ID B-002-0-20
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: S&ME / A. MAINS	HAMMER: CME AUTOMATIC	ALIGNMENT: 15TH ST. SW	
PID: 113153 BR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/25/20	ELEVATION: 1013.9 (MSL) EOB: 85.0 ft.	PAGE 1 OF 3
START: 8/24/21 END: 9/7/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 40.783328 N, 81.385598 W	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1013.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 1 INCH	1013.8																	
BRICK - 5 INCHES	1013.4	1																
CONCRETE - 7 INCHES	1012.8	2																
Fill: Medium-dense (est.) brown and gray **GRAVEL WITH SAND**, trace silt, trace clay, dry.	1011.9	3	31 19 9	42	100	SS-1	-	-	-	-	-	-	-	-	-	5	A-6a (V)	
Fill: Medium-dense to dense brown and dark-gray **SILT AND CLAY**, "and" fine to coarse sand, little fine gravel, contains coal fragments and cinders, dry.	1009.4	4–5																
Fill: Stiff brown and dark-gray **SILT AND CLAY**, some fine to coarse sand, trace to little fine to coarse gravel, few coal fragments, moist.		6–8																
		9	1 1 1	3	67	SS-2	1.25	-	-	-	-	-	-	-	-	25	A-6a (V)	
	1002.9	10																
Very-loose brown **COARSE AND FINE SAND**, trace to some fine gravel, little silt, trace clay, contains numerous thin (1/2" to 1") layers of dark-gray organic clay, decayed leaves and wood fragments, moist becoming wet.		11–12																
		13	0 0 1	2	100	SS-3	-	2	6	61	20	11	NP	NP	NP	86	A-3a (0)	
		14	1 1 2	5	89	SS-4	-	28	15	36	14	7	-	-	-	71	A-3a (V)	
		W 15																
	997.4	16	1 1 1	3	89	SS-5	-	6	28	36	23	7	-	-	-	42	A-3a (V)	
Medium-dense gray **COARSE AND FINE SAND**, little fine to coarse gravel, trace silt, trace clay, slightly organic, wet.	995.4	17–18	2 3 5	12	67	SS-6	-	19	32	42	3	4	-	-	-	23	A-3a (V)	
Medium-dense brown and gray **GRAVEL**, little fine to coarse sand, trace silt, trace clay, wet.	992.9	19–20	3 6 5	17	11	SS-7	-	78	12	5	4	1	-	-	-	9	A-1-a (V)	
Loose to medium-dense gray **GRAVEL WITH SAND**, trace silt, trace clay, few cobbles, wet.		21–22	2 2 5	11	67	SS-8	-	-	-	-	-	-	-	-	-	16	A-1-b (V)	
		23–24	2 3 5	12	33	SS-9	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	
		25–27	3 4 4	12	67	SS-10	-	48	27	19	4	2	-	-	-	15	A-1-b (V)	
		28–29	3 3 3	9	67	SS-11	-	-	-	-	-	-	-	-	-	19	A-1-b (V)	

S&ME ODOT LOG (8.5X11) - SGE 07/2018 - OH DOT.GDT - 10/14/21 09:43 - T:\CS\RESOURCES\COLUMBUS\GINT\WPROJECTS\111720054.GPJ

PLATE 7

PID: 113153	BR ID:	PROJECT: STA-15SW-13.50	STATION / OFFSET: 11+06, 4' RT	START: 8/24/21	END: 9/7/21	PG 2 OF 3	B-002-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 983.9	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Loose to medium-dense gray **GRAVEL WITH SAND**, trace silt, trace clay, few cobbles, wet. *(continued)*		31 – 32	1 2 5	11	33	SS-12	-	-	-	-	-	-	-	-	-	24	A-1-b (V)	
- Encountered cobble at 31.0'.		34 – 35	4 5 4	14	22	SS-13	-	-	-	-	-	-	-	-	-	25	A-1-b (V)	
		39 – 40	3 4 5	14	78	SS-14	-	31	32	31	4	2	-	-	-	15	A-1-b (V)	
		44 – 45	3 6 5	17	67	SS-15	-	-	-	-	-	-	-	-	-	26	A-1-b (V)	
	961.9	49 – 50	3 6 5	17	100	SS-16	-	-	-	-	-	-	-	-	-	22	A-1-b (V)	
Medium-dense gray **GRAVEL**, some fine to coarse sand, trace silt, trace clay, wet.	956.9	54 – 55	6 6 5	17	100	SS-17	-	71	22	3	2	2	-	-	-	18	A-1-a (V)	
Medium-dense to dense gray **GRAVEL WITH SAND**, trace silt, trace clay, wet.		59 – 60	3 5 6	17	11	SS-18	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	

PID: 113153	BR ID:	PROJECT: STA-15SW-13.50	STATION / OFFSET: 11+06, 4' RT	START: 8/24/21	END: 9/7/21	PG 3 OF 3	B-002-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 951.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Medium-dense to dense gray **GRAVEL WITH SAND**, trace silt, trace clay, wet. *(continued)*		63																
		64–65	6 7 8	23	100	SS-19	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	
		66–68																
		69–70	4 4 9	20	100	SS-20	-	8	46	43	2	1	-	-	-	18	A-1-b (V)	
		71–73																
		74–75	2 3 5	12	44	SS-21	-	-	-	-	-	-	-	-	-	16	A-1-b (V)	
		76–78																
		79–80	4 10 15	38	44	SS-22	-	-	-	-	-	-	-	-	-	18	A-1-b (V)	
		81–83																
	928.9	84–85 EOB	6 11 11	33	61	SS-23	-	20	37	32	7	4	-	-	-	15	A-1-b (V)	

<u>NOTES</u>:
- Encountered groundwater 15.0'.
- Below 16.5', maintained column of bentonitic drilling mud inside HSA.
- Between 43.5' and 70.0', encountered 1 to 5 feet of heaving sand into the HSA during SPT attempts.
- Boring terminated at 70.0' on 8/25/21 after rig breakdown. Boring backfilled and patched.
- Boring completed on 9/7/21 in an offset boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; BENTONITE POWDER; CEMENT; SOIL CUTTINGS; WATER

SEISMIC SITE CLASSIFICATION DETERMINATION

Project #: 1117-20-054

Project: STA-15th St SW over Nimishillen

Calculated By: RSW Date: 7/8/2022

Checked By: Date:

Boring: B-001-0-20

Layer Top Elevation	Layer Bottom Elevation	Layer Thickness	Average Blow Counts, Raw N	Layer/Bpf
1014.2	1012.6	1.6	50	0.032
1012.6	1008.6	4	8	0.500
1008.6	1004.6	4	6	0.667
1004.6	1002.1	2.5	2	1.250
1002.1	997.1	5	21	0.238
997.1	956.9	40.2	10.0	4.020
956.9	953.1	3.8	11	0.345
953.1	938.6	14.5	14	1.036
938.6	930.6	8	32	0.250
930.6		930.6		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
		Total, Denominator		8.338
		$= 100/\sum_{i=0}^{n} Layer/N$		12.0

Site Class A

Site Class B

Site Class C $\overline{N} > 50$

Site Class D $15 \leq \overline{N} \leq 50$

Site Class E $\overline{N} < 15$

Boring: B-002-0-20

Layer Top Elevation	Layer Bottom Elevation	Layer Thickness	Average Blow Counts, Raw N	Layer/Bpf
1011.9	1009.4	2.5	28	0.089
1009.4	1002.9	6.5	2	3.250
1002.9	997.4	5.5	2	2.750
997.4	995.4	2	8	0.250
995.4	992.9	2.5	11	0.227
992.9	961.9	31	8	3.875
961.9	956.9	5	11	0.455
956.9	951.9	5	11	0.455
951.9	928.9	23	17	1.353
928.9		928.9		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
0		0		0.000
		Total, Denominator		12.704
				7.9

Site Class A

Site Class B

Site Class C $\overline{N} > 50$

Site Class D $15 \leq \overline{N} \leq 50$

Site Class E $\overline{N} < 15$

Important Information About Your
Geotechnical Engineering Report

Variations in subsurface conditions can be a principal cause of construction delays, cost overruns and claims. The following information is provided to assist you in understanding and managing the risk of these variations.

Geotechnical Findings Are Professional Opinions

Geotechnical engineers cannot specify material properties as other design engineers do. Geotechnical material properties have a far broader range on a given site than any manufactured construction material, and some geotechnical material properties may change over time because of exposure to air and water, or human activity.

Site exploration identifies subsurface conditions at the time of exploration and only at the points where subsurface tests are performed or samples obtained. Geotechnical engineers review field and laboratory data and then apply their judgment to render professional opinions about site subsurface conditions. Their recommendations rely upon these professional opinions. Variations in the vertical and lateral extent of subsurface materials may be encountered during construction that significantly impact construction schedules, methods and material volumes. While higher levels of subsurface exploration can mitigate the risk of encountering unanticipated subsurface conditions, no level of subsurface exploration can eliminate this risk.

Scope of Geotechnical Services

Professional geotechnical engineering judgment is required to develop a geotechnical exploration scope to obtain information necessary to support design and construction. A number of unique project factors are considered in developing the scope of geotechnical services, such as the exploration objective; the location, type, size and weight of the proposed structure; proposed site grades and improvements; the construction schedule and sequence; and the site geology.

Geotechnical engineers apply their experience with construction methods, subsurface conditions and exploration methods to develop the exploration scope. The scope of each exploration is unique based on available project and site information. Incomplete project information or constraints on the scope of exploration increases the risk of variations in subsurface conditions not being identified and addressed in the geotechnical report.

Services Are Performed for Specific Projects

Because the scope of each geotechnical exploration is unique, each geotechnical report is unique. Subsurface conditions are explored and recommendations are made for a specific project. Subsurface information and recommendations may not be adequate for other uses. Changes in a proposed structure location, foundation loads, grades, schedule, etc. may require additional geotechnical exploration, analyses, and consultation. The geotechnical engineer should be consulted to determine if additional services are required in response to changes in proposed construction, location, loads, grades, schedule, etc.

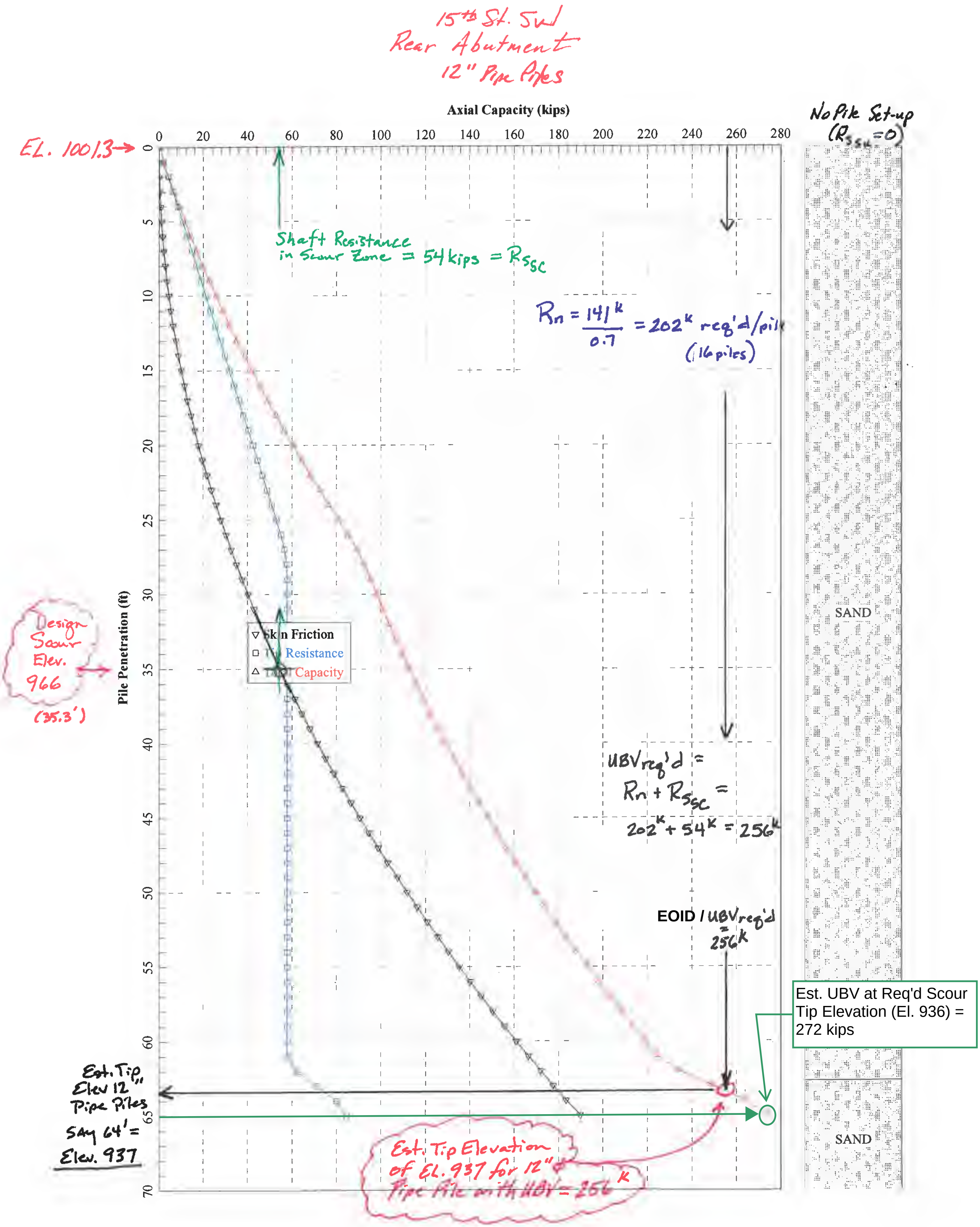
Geo-Environmental Issues

The equipment, techniques, and personnel used to perform a geo-environmental study differ significantly from those used for a geotechnical exploration. Indications of environmental contamination may be encountered incidental to performance of a geotechnical exploration but go unrecognized. Determination of the presence, type or extent of environmental contamination is beyond the scope of a geotechnical exploration.

Geotechnical Recommendations Are Not Final

Recommendations are developed based on the geotechnical engineer's understanding of the proposed construction and professional opinion of site subsurface conditions. Observations and tests must be performed during construction to confirm subsurface conditions exposed by construction excavations are consistent with those assumed in development of recommendations. It is advisable to retain the geotechnical engineer that performed the exploration and developed the geotechnical recommendations to conduct tests and observations during construction. This may reduce the risk that variations in subsurface conditions will not be addressed as recommended in the geotechnical report.

APPENDIX B – Rear Abutment Pile Calculations



15th St. SW
Rear Abutment
12" Pipe Piles
Axial Capacity (kips)
No Pile Set-up (R_{SSU} = 0)
EL. 1001.3
Pile Penetration (ft)
Shaft Resistance in Scour Zone = 54 kips = R_{SSC}
$R_n = \frac{141^k}{0.7} = 202^k$ req'd/pile (16 piles)
Skin Friction
Tip Resistance
Total Capacity
Design Scour Elev. 966 (35.3')
$UBV_{req'd} = R_n + R_{SSC} = 202^k + 54^k = 256^k$
SAND
EOID / $UBV_{req'd} = 256^k$
Est. UBV at Req'd Scour Tip Elevation (El. 936) = 272 kips
Est. Tip Elev 12" Pipe Piles Say 64' = Elev. 937
Est. Tip Elevation of EL. 937 for 12"Ø Pipe Pile with UBV = 256^k
SAND

```
===========================================================================

                 APILE for Windows, Version 2019.9.10

                  Serial Number :  136084183

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
                 (c) Copyright ENSOFT, Inc., 1987-2019
                      All Rights Reserved

===========================================================================


This program is licensed to :

S&ME, Inc.
Dublin, OH

Path to file locations      : T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th
St SW Bridge\Part 2 - Geotechnical Exploration\Calcs\APile Output\
Name of input data file     : Rear Abutment ultimate 12.ap9d
Name of output file         : Rear Abutment ultimate 12.ap9o
Name of plot output file    : Rear Abutment ultimate 12.ap9p

---------------------------------------------------------------------------
                     Time and Date of Analysis
---------------------------------------------------------------------------

          Date:  March 04, 2022     Time:  11:41:00


1
     *********************
     * INPUT INFORMATION *
     *********************



     15th St SW - Rear Abutment

     DESIGNER   : NDA

     JOB NUMBER : 1117-20-054


     METHOD FOR UNIT LOAD TRANSFERS :
```

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

```
- MODULUS OF ELASTICITY     = 0.290E+08 PSI
- CROSS SECTION AREA        =      9.23 IN2
```

CIRCULAR PILE PROPERTIES :

```
- OUTSIDE DIAMETER, OD      =     12.00 IN.
- INTERNAL DIAMETER, ID     =     11.50 IN.
- TOTAL PILE LENGTH, TL     =     65.00 FT.
- BATTER ANGLE              =      0.00 DEG
- PILE STICKUP LENGTH, PSL  =      0.00 FT.
- ZERO FRICTION LENGTH, ZFL =      0.00 FT.
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION       =      1.00 FT.
- LENGTH OF ENHANCED
  END SECTION               =     65.00 FT.
- INTERNAL DIAMETER OF
  ENHANCED END SECTION      =     11.50 IN.
```

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	SAND	0.80*	73.00	34.00	36.00**	55.60**
62.70	SAND	0.80*	73.00	34.00	36.00**	55.60**
62.70	SAND	0.80*	68.00	35.00	40.00**	64.00**
70.70	SAND	0.80*	68.00	35.00	40.00**	64.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
62.70	1.000	1.000
62.70	1.000	1.000
70.70	1.000	1.000

1

****
* COMPUTATION RESULT *
****

****

* FED. HWY. METHOD *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.8	0.8
1.00	0.0	1.8	1.9
2.00	0.2	4.2	4.4
3.00	0.4	6.3	6.7
4.00	0.7	8.5	9.2
5.00	1.1	10.6	11.7
6.00	1.6	12.7	14.3
7.00	2.2	14.8	17.0
8.00	2.9	16.9	19.8
9.00	3.6	19.0	22.6
10.00	4.5	21.1	25.6
11.00	5.4	23.2	28.7
12.00	6.4	25.4	31.8
13.00	7.6	27.5	35.0
14.00	8.8	29.6	38.4
15.00	10.1	31.7	41.8
16.00	11.5	33.8	45.3
17.00	12.9	35.9	48.9
18.00	14.5	38.0	52.5
19.00	16.2	40.1	56.3
20.00	17.9	42.3	60.2
21.00	19.7	44.4	64.1
22.00	21.7	46.5	68.1
23.00	23.7	48.6	72.3
24.00	25.8	50.7	76.5
25.00	28.0	52.8	80.8
26.00	30.3	54.9	85.1
27.00	32.6	56.5	89.1
28.00	35.1	57.4	92.5
29.00	37.6	57.7	95.4
30.00	40.3	57.7	98.0
31.00	43.0	57.7	100.7
32.00	45.8	57.7	103.6
33.00	48.7	57.7	106.5
34.00	51.7	57.7	109.5
35.00	54.8	57.7	112.6
36.00	58.0	57.7	115.7
37.00	61.3	57.7	119.0
38.00	64.6	57.7	122.4
39.00	68.1	57.7	125.8
40.00	71.6	57.7	129.3
41.00	75.2	57.7	133.0
42.00	78.9	57.7	136.7
43.00	82.7	57.7	140.5

44.00	86.6	57.7	144.4
45.00	90.6	57.7	148.4
46.00	94.7	57.7	152.4
47.00	98.9	57.7	156.6
48.00	103.1	57.7	160.9
49.00	107.5	57.7	165.2
50.00	111.9	57.7	169.6
51.00	116.4	57.7	174.1
52.00	121.0	57.7	178.8
53.00	125.7	57.7	183.5
54.00	130.5	57.7	188.2
55.00	135.4	57.7	193.1
56.00	140.3	57.7	198.1
57.00	145.4	57.7	203.1
58.00	150.5	57.7	208.3
59.00	155.8	57.7	213.5
60.00	161.1	57.7	218.9
61.00	166.5	57.7	224.3
62.00	172.0	62.2	234.2
63.00	177.6	71.1	248.7
64.00	183.5	80.0	263.6
65.00	189.8	84.5	274.3

****
* API RP-2A (2010) *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.8	0.8
1.00	0.1	1.8	1.9
2.00	0.2	4.1	4.3
3.00	0.5	6.2	6.6
4.00	0.8	8.3	9.1
5.00	1.3	10.3	11.6
6.00	1.8	12.4	14.2
7.00	2.5	14.4	16.9
8.00	3.3	16.5	19.8
9.00	4.1	18.6	22.7
10.00	5.1	20.6	25.7
11.00	6.2	22.7	28.9
12.00	7.3	24.8	32.1
13.00	8.6	26.8	35.4
14.00	10.0	28.9	38.9
15.00	11.4	31.0	42.4
16.00	13.0	33.0	46.0
17.00	14.7	35.1	49.8

18.00	16.5	37.2	53.6
19.00	18.4	39.2	57.6
20.00	20.3	41.3	61.6
21.00	22.4	43.3	65.8
22.00	24.6	45.4	70.0
23.00	26.9	47.5	74.4
24.00	29.3	49.5	78.8
25.00	31.8	51.6	83.4
26.00	34.4	53.7	88.0
27.00	37.1	55.7	92.8
28.00	39.9	57.8	97.7
29.00	42.8	59.9	102.6
30.00	45.8	61.9	107.7
31.00	48.9	64.0	112.9
32.00	52.1	66.0	118.1
33.00	55.4	68.1	123.5
34.00	58.8	70.2	129.0
35.00	62.3	72.2	134.5
36.00	65.9	74.3	140.2
37.00	69.6	76.4	146.0
38.00	73.4	78.4	151.9
39.00	77.3	80.5	157.8
40.00	81.4	82.6	163.9
41.00	85.5	84.6	170.1
42.00	89.7	86.7	176.4
43.00	94.0	88.8	182.8
44.00	98.4	90.8	189.3
45.00	103.0	92.9	195.9
46.00	107.6	94.9	202.5
47.00	112.3	97.0	209.3
48.00	117.2	99.1	216.2
49.00	122.1	101.1	223.2
50.00	127.1	103.2	230.3
51.00	132.3	105.3	237.5
52.00	137.5	107.3	244.8
53.00	142.8	109.4	252.2
54.00	148.3	111.5	259.7
55.00	153.8	113.5	267.3
56.00	159.5	115.6	275.0
57.00	165.2	117.6	282.9
58.00	171.1	119.7	290.8
59.00	177.0	121.8	298.8
60.00	183.1	123.8	306.9
61.00	189.1	125.9	315.1
62.00	195.2	130.4	325.6
63.00	201.3	137.3	338.6
64.00	207.5	144.2	351.7
65.00	213.8	148.8	362.6

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

```
*************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
*************************************************
```

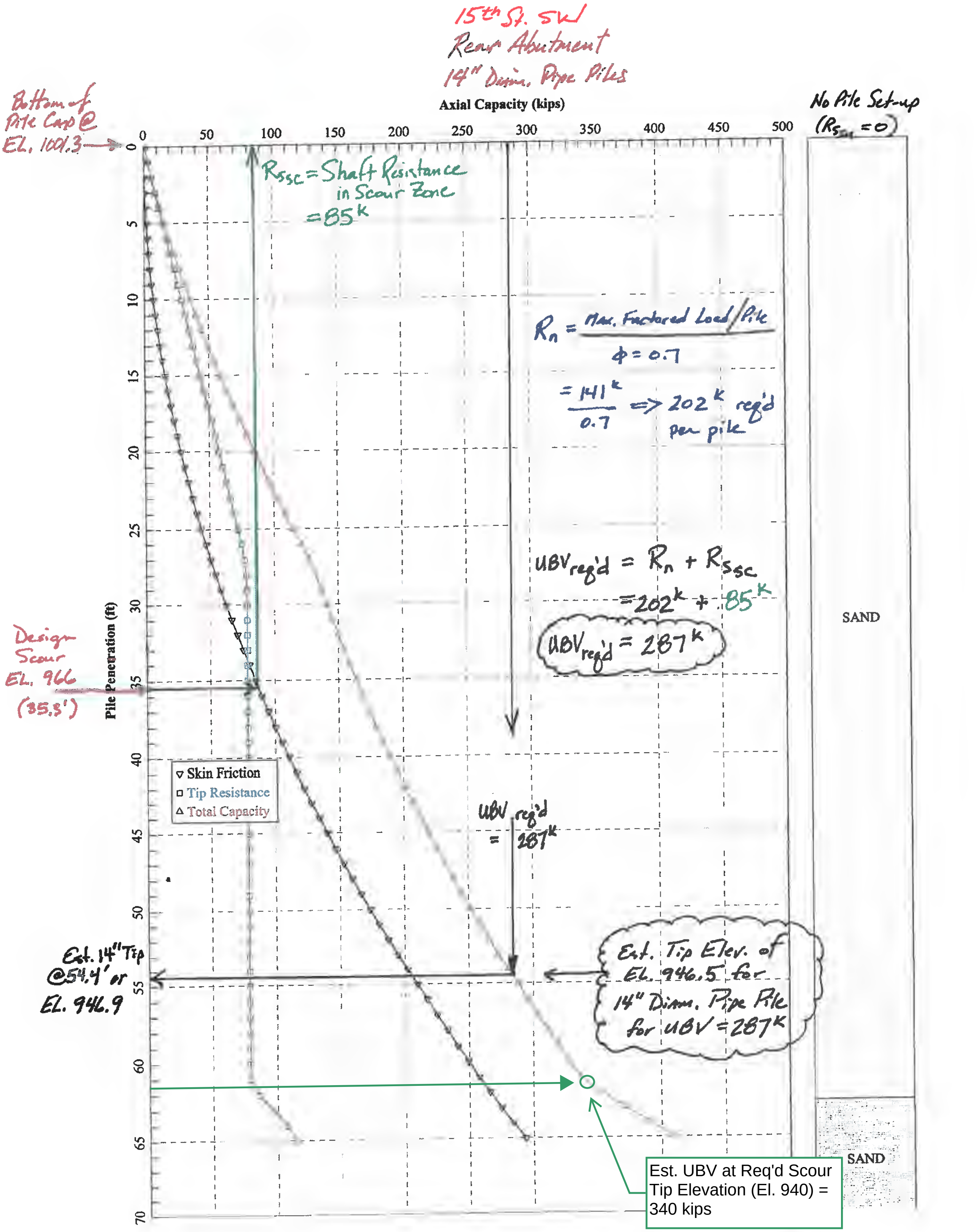
T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.2473E-02	0.1920E-01
			0.4122E-02	0.3720E-01
			0.6183E-02	0.6840E-01
			0.7419E-02	0.9600E-01
			0.8244E-02	0.1200E+00
			0.8244E-02	0.2400E+00
			0.8244E-02	0.3600E+00
			0.8244E-02	0.6000E+00
			0.8244E-02	0.2400E+01
2	10	0.3135E+02		
			0.0000E+00	0.0000E+00
			0.1861E+01	0.1920E-01
			0.3101E+01	0.3720E-01
			0.4652E+01	0.6840E-01
			0.5582E+01	0.9600E-01
			0.6203E+01	0.1200E+00
			0.6203E+01	0.2400E+00
			0.6203E+01	0.3600E+00
			0.6203E+01	0.6000E+00
			0.6203E+01	0.2400E+01
3	10	0.6266E+02		
			0.0000E+00	0.0000E+00
			0.3719E+01	0.1920E-01
			0.6198E+01	0.3720E-01
			0.9298E+01	0.6840E-01
			0.1116E+02	0.9600E-01
			0.1240E+02	0.1200E+00
			0.1240E+02	0.2400E+00
			0.1240E+02	0.3600E+00
			0.1240E+02	0.6000E+00
			0.1240E+02	0.2400E+01
4	10	0.6274E+02		

			0.0000E+00	0.0000E+00
			0.3724E+01	0.1920E-01
			0.6207E+01	0.3720E-01
			0.9310E+01	0.6840E-01
			0.1117E+02	0.9600E-01
			0.1241E+02	0.1200E+00
			0.1241E+02	0.2400E+00
			0.1241E+02	0.3600E+00
			0.1241E+02	0.6000E+00
			0.1241E+02	0.2400E+01
5	10	0.6670E+02		
			0.0000E+00	0.0000E+00
			0.4166E+01	0.1920E-01
			0.6943E+01	0.3720E-01
			0.1041E+02	0.6840E-01
			0.1250E+02	0.9600E-01
			0.1389E+02	0.1200E+00
			0.1389E+02	0.2400E+00
			0.1389E+02	0.3600E+00
			0.1389E+02	0.6000E+00
			0.1389E+02	0.2400E+01
6	10	0.7066E+02		
			0.0000E+00	0.0000E+00
			0.4166E+01	0.1920E-01
			0.6943E+01	0.3720E-01
			0.1041E+02	0.6840E-01
			0.1250E+02	0.9600E-01
			0.1389E+02	0.1200E+00
			0.1389E+02	0.2400E+00
			0.1389E+02	0.3600E+00
			0.1389E+02	0.6000E+00
			0.1389E+02	0.2400E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.5282E+01	0.6000E-02
0.1056E+02	0.1200E-01
0.2113E+02	0.2400E-01
0.4225E+02	0.1560E+00
0.6338E+02	0.5040E+00
0.7606E+02	0.8760E+00
0.8451E+02	0.1200E+01
0.8451E+02	0.1800E+01
0.8451E+02	0.2400E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1263E+01	0.1972E-02	0.8803E-01	0.1000E-03
0.1283E+02	0.1992E-01	0.8803E+00	0.1000E-02
0.5688E+02	0.9514E-01	0.4401E+01	0.5000E-02
0.9495E+02	0.1707E+00	0.8803E+01	0.1000E-01
0.1415E+03	0.2814E+00	0.1761E+02	0.2000E-01
0.1894E+03	0.4268E+00	0.2529E+02	0.5000E-01
0.2119E+03	0.5154E+00	0.3009E+02	0.8000E-01
0.2209E+03	0.5602E+00	0.3329E+02	0.1000E+00
0.2347E+03	0.7002E+00	0.4493E+02	0.2000E+00
0.2529E+03	0.1053E+01	0.6314E+02	0.5000E+00
0.2632E+03	0.1383E+01	0.7347E+02	0.8000E+00
0.2690E+03	0.1600E+01	0.7929E+02	0.1000E+01
0.2742E+03	0.2616E+01	0.8451E+02	0.2000E+01


15th St. SW
Rear Abutment
14" Diam. Pipe Piles
Axial Capacity (kips)
0
50
100
150
200
250
300
350
400
450
500
No Pile Set-up
(Rssc = 0)
Bottom of Pile Cap @ EL. 1001.3
Pile Penetration (ft)
Rssc = Shaft Resistance in Scour Zone = 85k
Rn = Max. Factored Load/Pile / φ = 0.7
= 141k / 0.7 => 202k req'd per pile
UBVreq'd = Rn + Rssc
= 202k + 85k
UBVreq'd = 287k
Design Scour EL. 966 (35.3')
Skin Friction
Tip Resistance
Total Capacity
UBV req'd = 287k
Est. 14" Tip @54.4' or EL. 946.9
Est. Tip Elev. of EL. 946.5 for 14" Diam. Pipe Pile for UBV = 287k
Est. UBV at Req'd Scour Tip Elevation (El. 940) = 340 kips
SAND
SAND

```
==========================================================================

                 APILE for Windows, Version 2019.9.11

                  Serial Number :  136084183

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
                (c) Copyright ENSOFT, Inc., 1987-2019
                      All Rights Reserved

==========================================================================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Dublin, OH

Path to file locations      : T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th
St SW Bridge\Part 2 - Geotechnical Exploration\Calcs\APile Output\
Name of input data file     : Rear Abutment ultimate 14.ap9d
Name of output file         : Rear Abutment ultimate 14.ap9o
Name of plot output file    : Rear Abutment ultimate 14.ap9p

--------------------------------------------------------------------------
                     Time and Date of Analysis
--------------------------------------------------------------------------

          Date:  July 26, 2022     Time:  16:56:41



1
     *********************
     * INPUT INFORMATION *
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     15th St SW - Rear Abutment 14 " Ultimate

     DESIGNER   : NDA

     JOB NUMBER : 1117-20-054


     METHOD FOR UNIT LOAD TRANSFERS :
```

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

```
- MODULUS OF ELASTICITY     = 0.290E+08 PSI
- CROSS SECTION AREA        =     10.80 IN2
```

CIRCULAR PILE PROPERTIES :

```
- OUTSIDE DIAMETER, OD      =     14.00 IN.
- INTERNAL DIAMETER, ID     =     13.50 IN.
- TOTAL PILE LENGTH, TL     =     65.00 FT.
- BATTER ANGLE              =      0.00 DEG
- PILE STICKUP LENGTH, PSL  =      0.00 FT.
- ZERO FRICTION LENGTH, ZFL =      0.00 FT.
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION       =      1.00 FT.
- LENGTH OF ENHANCED
  END SECTION               =     65.00 FT.
- INTERNAL DIAMETER OF
  ENHANCED END SECTION      =     13.50 IN.
```

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	SAND	0.80*	73.00	34.00	36.00**	55.60**
62.70	SAND	0.80*	73.00	34.00	36.00**	55.60**
62.70	SAND	0.80*	68.00	35.00	40.00**	64.00**
70.70	SAND	0.80*	68.00	35.00	40.00**	64.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
62.70	1.000	1.000
62.70	1.000	1.000
70.70	1.000	1.000

1

****
* COMPUTATION RESULT *
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* FED. HWY. METHOD *
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PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.3	1.3
1.00	0.1	2.7	2.8
2.00	0.3	5.8	6.0
3.00	0.6	8.6	9.3
4.00	1.1	11.5	12.6
5.00	1.7	14.4	16.1
6.00	2.5	17.3	19.7
7.00	3.4	20.1	23.5
8.00	4.4	23.0	27.4
9.00	5.6	25.9	31.5
10.00	6.9	28.8	35.7
11.00	8.4	31.6	40.0
12.00	10.0	34.5	44.5
13.00	11.7	37.4	49.1
14.00	13.6	40.3	53.8
15.00	15.6	43.1	58.7
16.00	17.7	46.0	63.7
17.00	20.0	48.9	68.9
18.00	22.4	51.8	74.2
19.00	25.0	54.6	79.6
20.00	27.7	57.5	85.2
21.00	30.5	60.4	90.9
22.00	33.5	63.3	96.8
23.00	36.6	66.1	102.8
24.00	39.9	69.0	108.9
25.00	43.3	71.9	115.2
26.00	46.8	74.6	121.4
27.00	50.5	76.7	127.2
28.00	54.3	78.0	132.3
29.00	58.2	78.5	136.7
30.00	62.3	78.6	140.9
31.00	66.5	78.6	145.1
32.00	70.9	78.6	149.5
33.00	75.4	78.6	154.0
34.00	80.0	78.6	158.6
35.00	84.8	78.6	163.4
36.00	89.7	78.6	168.3
37.00	94.8	78.6	173.4
38.00	100.0	78.6	178.6
39.00	105.3	78.6	183.9
40.00	110.8	78.6	189.3
41.00	116.4	78.6	195.0
42.00	122.1	78.6	200.7
43.00	128.0	78.6	206.6

44.00	134.0	78.6	212.6
45.00	140.2	78.6	218.8
46.00	146.5	78.6	225.1
47.00	152.9	78.6	231.5
48.00	159.5	78.6	238.1
49.00	166.2	78.6	244.8
50.00	173.1	78.6	251.6
51.00	180.0	78.6	258.6
52.00	187.2	78.6	265.8
53.00	194.4	78.6	273.0
54.00	201.9	78.6	280.4
55.00	209.4	78.6	288.0
56.00	217.1	78.6	295.7
57.00	224.9	78.6	303.5
58.00	232.9	78.6	311.5
59.00	241.0	78.6	319.6
60.00	249.2	78.6	327.8
61.00	257.6	78.6	336.2
62.00	266.1	86.4	352.5
63.00	274.7	96.8	371.6
64.00	283.9	107.2	391.1
65.00	293.6	115.0	408.7

****
* API RP-2A (2010) *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.2	1.2
1.00	0.1	2.6	2.7
2.00	0.2	5.6	5.9
3.00	0.5	8.4	9.0
4.00	0.9	11.2	12.2
5.00	1.5	14.0	15.5
6.00	2.1	16.9	19.0
7.00	2.9	19.7	22.6
8.00	3.8	22.5	26.3
9.00	4.8	25.3	30.1
10.00	5.9	28.1	34.0
11.00	7.2	30.9	38.1
12.00	8.5	33.7	42.3
13.00	10.0	36.5	46.5
14.00	11.6	39.3	51.0
15.00	13.3	42.1	55.5
16.00	15.2	44.9	60.1
17.00	17.1	47.8	64.9

18.00	19.2	50.6	69.8
19.00	21.4	53.4	74.8
20.00	23.7	56.2	79.9
21.00	26.2	59.0	85.2
22.00	28.7	61.8	90.5
23.00	31.4	64.6	96.0
24.00	34.2	67.4	101.6
25.00	37.1	70.2	107.3
26.00	40.1	73.0	113.1
27.00	43.2	75.9	119.1
28.00	46.5	78.7	125.2
29.00	49.9	81.5	131.4
30.00	53.4	84.3	137.7
31.00	57.0	87.1	144.1
32.00	60.7	89.9	150.6
33.00	64.6	92.7	157.3
34.00	68.6	95.5	164.1
35.00	72.7	98.3	171.0
36.00	76.9	101.1	178.0
37.00	81.2	103.9	185.2
38.00	85.7	106.8	192.4
39.00	90.2	109.6	199.8
40.00	94.9	112.4	207.3
41.00	99.7	115.2	214.9
42.00	104.6	118.0	222.6
43.00	109.7	120.8	230.5
44.00	114.9	123.6	238.5
45.00	120.1	126.4	246.6
46.00	125.5	129.2	254.8
47.00	131.0	132.0	263.1
48.00	136.7	134.8	271.5
49.00	142.4	137.7	280.1
50.00	148.3	140.5	288.8
51.00	154.3	143.3	297.6
52.00	160.4	146.1	306.5
53.00	166.6	148.9	315.5
54.00	173.0	151.7	324.7
55.00	179.5	154.5	334.0
56.00	186.0	157.3	343.4
57.00	192.7	160.1	352.9
58.00	199.6	162.9	362.5
59.00	206.5	165.8	372.3
60.00	213.6	168.6	382.1
61.00	220.7	171.4	392.0
62.00	227.8	178.4	406.2
63.00	234.9	186.9	421.8
64.00	242.1	195.4	437.5
65.00	249.4	202.5	451.9

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

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************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.3279E-02	0.2240E-01
			0.5465E-02	0.4340E-01
			0.8197E-02	0.7980E-01
			0.9837E-02	0.1120E+00
			0.1093E-01	0.1400E+00
			0.1093E-01	0.2800E+00
			0.1093E-01	0.4200E+00
			0.1093E-01	0.7000E+00
			0.1093E-01	0.2800E+01
2	10	0.3135E+02		
			0.0000E+00	0.0000E+00
			0.2467E+01	0.2240E-01
			0.4112E+01	0.4340E-01
			0.6168E+01	0.7980E-01
			0.7401E+01	0.1120E+00
			0.8223E+01	0.1400E+00
			0.8223E+01	0.2800E+00
			0.8223E+01	0.4200E+00
			0.8223E+01	0.7000E+00
			0.8223E+01	0.2800E+01
3	10	0.6266E+02		
			0.0000E+00	0.0000E+00
			0.4931E+01	0.2240E-01
			0.8218E+01	0.4340E-01
			0.1233E+02	0.7980E-01
			0.1479E+02	0.1120E+00
			0.1644E+02	0.1400E+00
			0.1644E+02	0.2800E+00
			0.1644E+02	0.4200E+00
			0.1644E+02	0.7000E+00
			0.1644E+02	0.2800E+01
4	10	0.6274E+02		

			0.0000E+00	0.0000E+00
			0.4937E+01	0.2240E-01
			0.8229E+01	0.4340E-01
			0.1234E+02	0.7980E-01
			0.1481E+02	0.1120E+00
			0.1646E+02	0.1400E+00
			0.1646E+02	0.2800E+00
			0.1646E+02	0.4200E+00
			0.1646E+02	0.7000E+00
			0.1646E+02	0.2800E+01
5	10	0.6670E+02		
			0.0000E+00	0.0000E+00
			0.5564E+01	0.2240E-01
			0.9274E+01	0.4340E-01
			0.1391E+02	0.7980E-01
			0.1669E+02	0.1120E+00
			0.1855E+02	0.1400E+00
			0.1855E+02	0.2800E+00
			0.1855E+02	0.4200E+00
			0.1855E+02	0.7000E+00
			0.1855E+02	0.2800E+01
6	10	0.7066E+02		
			0.0000E+00	0.0000E+00
			0.5564E+01	0.2240E-01
			0.9274E+01	0.4340E-01
			0.1391E+02	0.7980E-01
			0.1669E+02	0.1120E+00
			0.1855E+02	0.1400E+00
			0.1855E+02	0.2800E+00
			0.1855E+02	0.4200E+00
			0.1855E+02	0.7000E+00
			0.1855E+02	0.2800E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.7189E+01	0.7000E-02
0.1438E+02	0.1400E-01
0.2876E+02	0.2800E-01
0.5751E+02	0.1820E+00
0.8627E+02	0.5880E+00
0.1035E+03	0.1022E+01
0.1150E+03	0.1400E+01
0.1150E+03	0.2100E+01
0.1150E+03	0.2800E+01

LOAD VERSUS SETTLEMENT CURVE

****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1809E+01	0.2316E-02	0.1027E+00	0.1000E-03
0.1847E+02	0.2348E-01	0.1027E+01	0.1000E-02
0.8171E+02	0.1121E+00	0.5135E+01	0.5000E-02
0.1363E+03	0.2010E+00	0.1027E+02	0.1000E-01
0.2036E+03	0.3322E+00	0.2054E+02	0.2000E-01
0.2785E+03	0.5148E+00	0.3286E+02	0.5000E-01
0.3126E+03	0.6197E+00	0.3847E+02	0.8000E-01
0.3269E+03	0.6727E+00	0.4220E+02	0.1000E+00
0.3524E+03	0.8347E+00	0.5879E+02	0.2000E+00
0.3736E+03	0.1188E+01	0.8004E+02	0.5000E+00
0.3883E+03	0.1524E+01	0.9470E+02	0.8000E+00
0.3962E+03	0.1744E+01	0.1026E+03	0.1000E+01
0.4086E+03	0.2775E+01	0.1150E+03	0.2000E+01

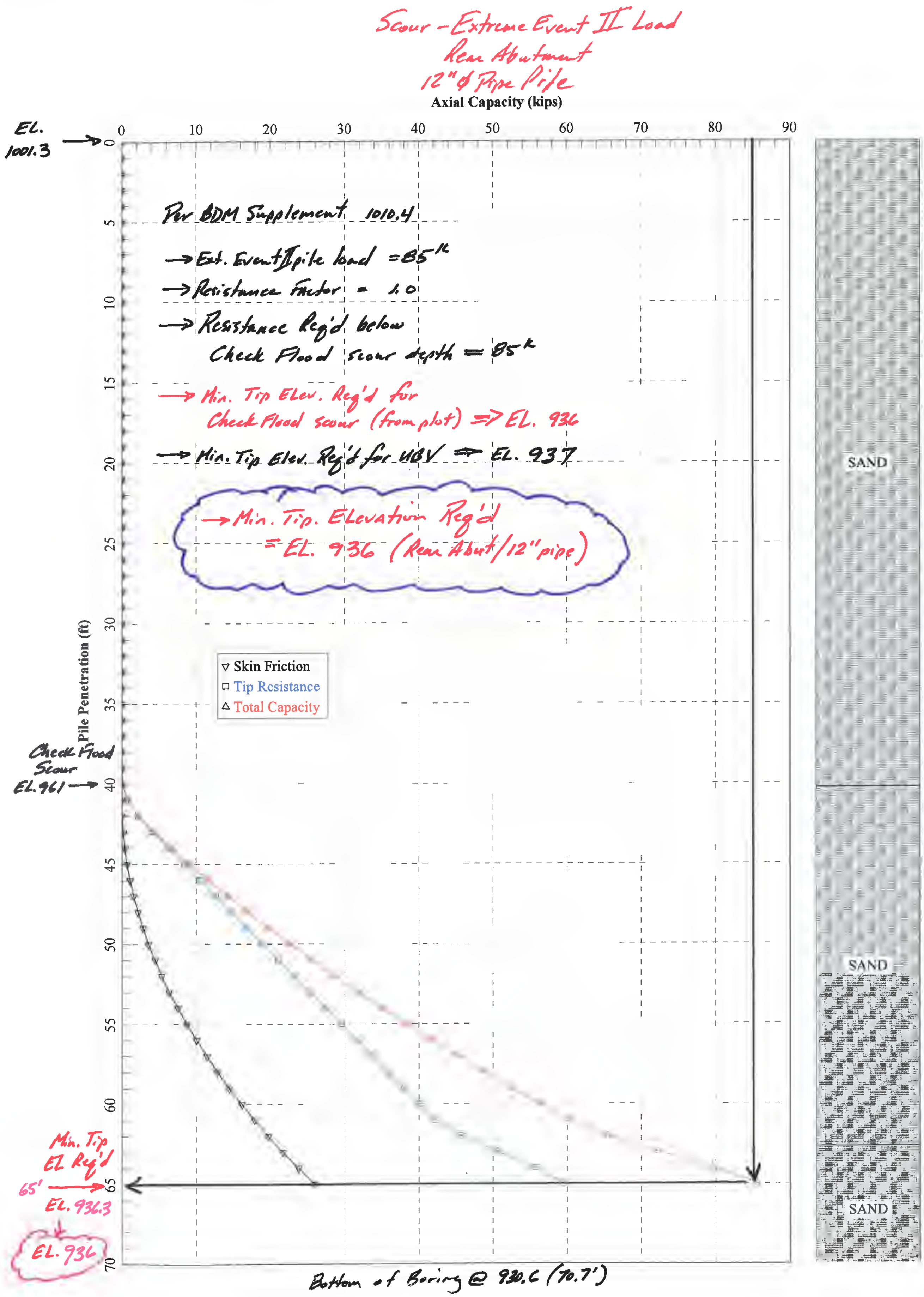
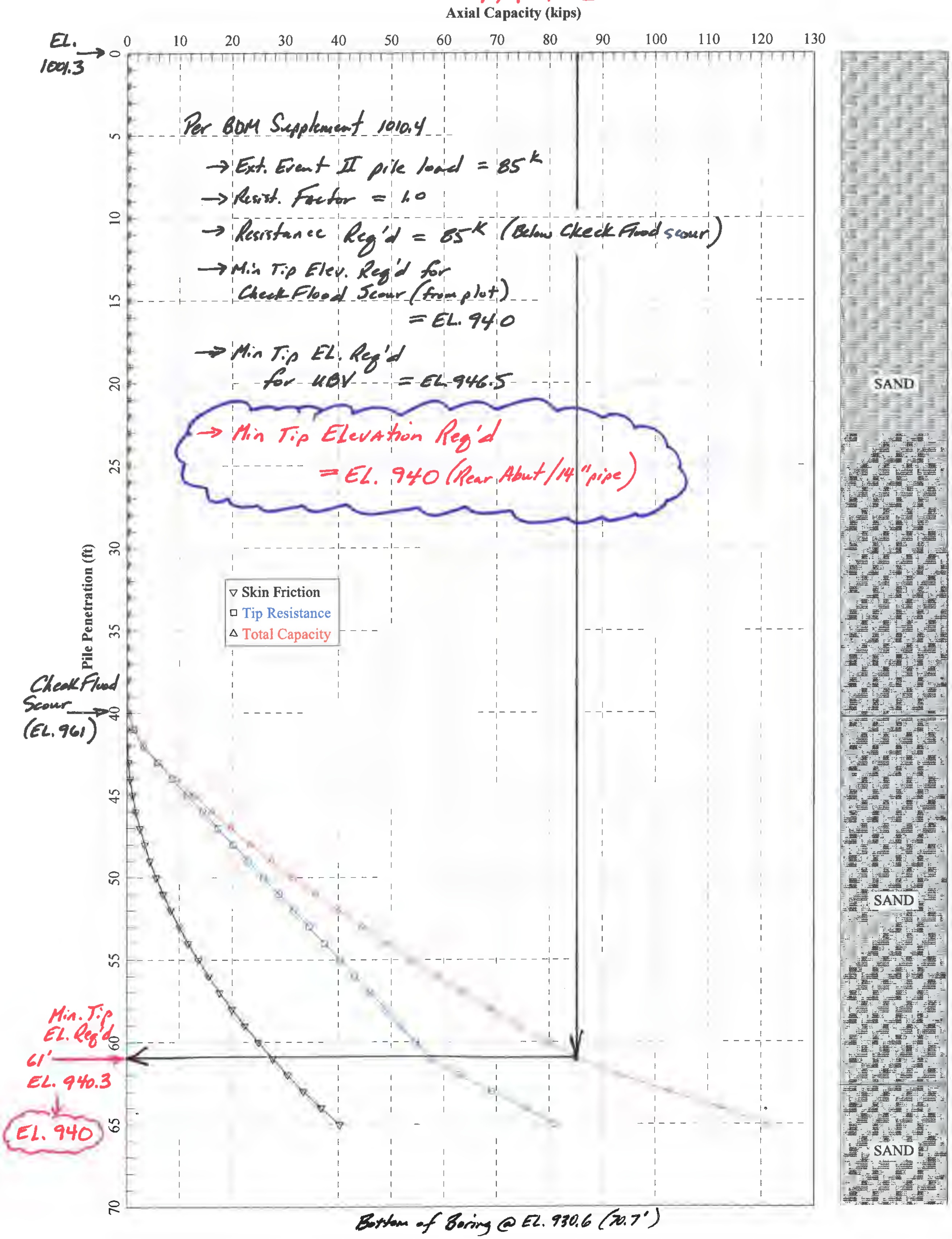
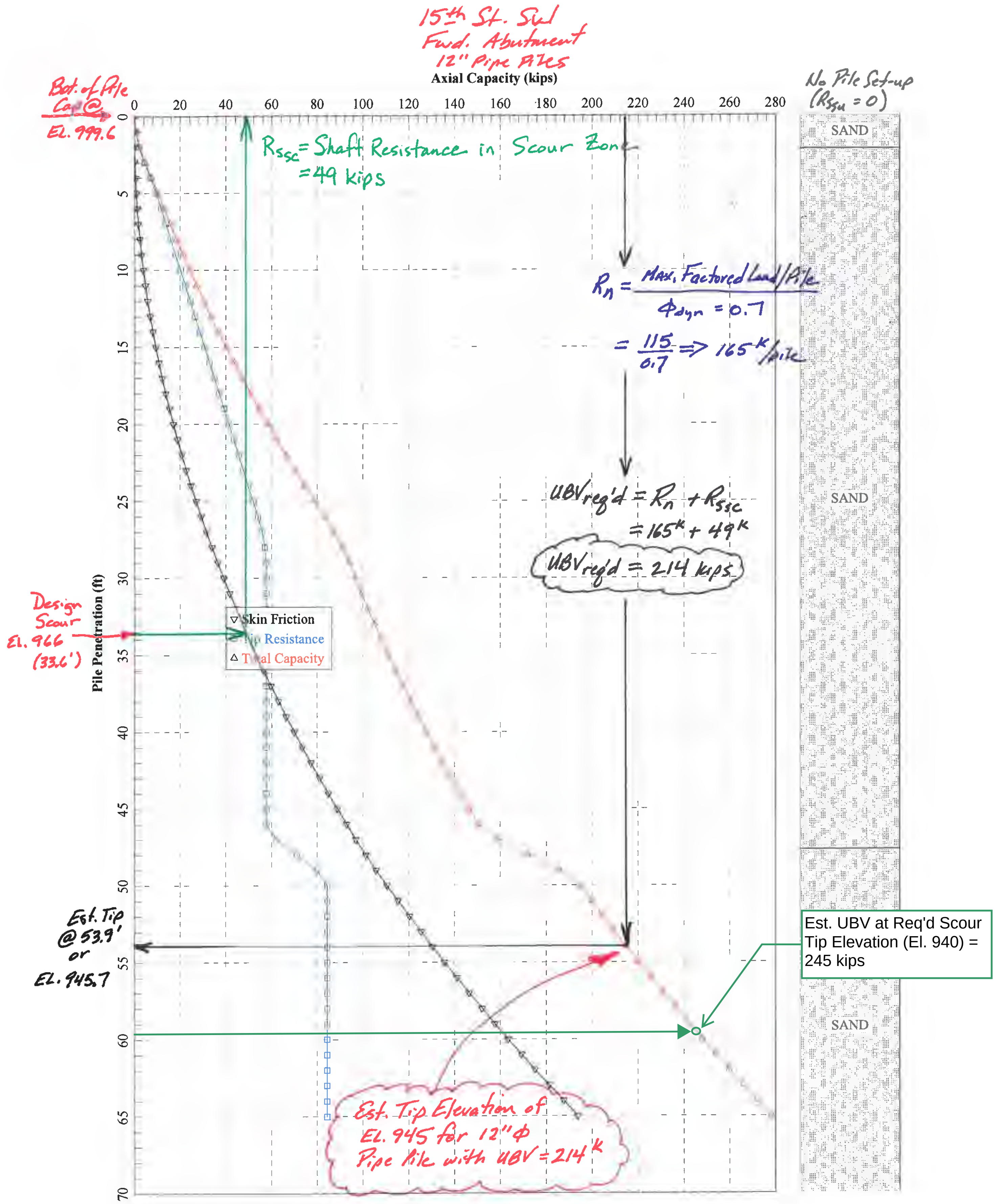

Scour - Extreme Event II Load
Rear Abutment
12"ϕ Pipe Pile
Axial Capacity (kips)
EL. 1001.3
0 10 20 30 40 50 60 70 80 90
Pile Penetration (ft)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Per BDM Supplement 1010.4
→ Ext. Event II pile load = 85k
→ Resistance Factor = 1.0
→ Resistance Req'd below Check Flood scour depth = 85k
→ Min. Tip Elev. Req'd for Check Flood scour (from plot) ⇒ EL. 936
→ Min. Tip Elev. Req'd for UBV ⇒ EL. 937
→ Min. Tip. Elevation Req'd = EL. 936 (Rear Abut/12" pipe)
Skin Friction
Tip Resistance
Total Capacity
Check Flood Scour EL. 961
Min. Tip EL Req'd
65'
EL. 936.3
EL. 936
SAND
SAND
SAND
Bottom of Boring @ 930.6 (70.7')

PLATE 21

Scour - Extreme Event II Load
Rear Abutment
14" ϕ Pipe Pile



APPENDIX C – Forward Abutment Pile Calculations



15th St. Swl
Fwd. Abutment
12" Pipe Piles
Axial Capacity (kips)
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
Pile Penetration (ft)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Bot. of Pile Cap @ EL. 999.6
Rssc = Shaft Resistance in Scour Zone = 49 kips
No Pile Set-up (Rssu = 0)
SAND
SAND
SAND
Rn = Max. Factored Load/Pile / Φdyn = 0.7 = 115/0.7 => 165 k/pile
UBVreq'd = Rn + Rssc = 165k + 49k
UBVreq'd = 214 kips
Skin Friction
Tip Resistance
Total Capacity
Design Scour El. 966 (33.6')
Est. Tip @ 53.9' or EL. 945.7
Est. UBV at Req'd Scour Tip Elevation (El. 940) = 245 kips
Est. Tip Elevation of EL. 945 for 12"Φ Pipe Pile with UBV = 214k

PLATE 1

```
=========================================================================

                 APILE for Windows, Version 2019.9.10

                  Serial Number :  136084183

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
                (c) Copyright ENSOFT, Inc., 1987-2019
                      All Rights Reserved

=========================================================================


     This program is licensed to :

     S&ME, Inc.
     Dublin, OH

     Path to file locations      : T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th
St SW Bridge\Part 2 - Geotechnical Exploration\Calcs\APile Output\
     Name of input data file     : Forward Abutment ultimate 12.ap9d
     Name of output file         : Forward Abutment ultimate 12.ap9o
     Name of plot output file    : Forward Abutment ultimate 12.ap9p

     -------------------------------------------------------------------------
                         Time and Date of Analysis
     -------------------------------------------------------------------------

               Date:  March 04, 2022     Time:  12:03:53


1
          *********************
          * INPUT INFORMATION *
          *********************



          15th St SW - Rear Abutment

          DESIGNER   : NDA

          JOB NUMBER : 1117-20-054


          METHOD FOR UNIT LOAD TRANSFERS :
```

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

```
- MODULUS OF ELASTICITY     = 0.290E+08 PSI
- CROSS SECTION AREA        =      9.23 IN2
```

CIRCULAR PILE PROPERTIES :

```
- OUTSIDE DIAMETER, OD      =     12.00 IN.
- INTERNAL DIAMETER, ID     =     11.50 IN.
- TOTAL PILE LENGTH, TL     =     65.00 FT.
- BATTER ANGLE              =      0.00 DEG
- PILE STICKUP LENGTH, PSL  =      0.00 FT.
- ZERO FRICTION LENGTH, ZFL =      0.00 FT.
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION       =      1.00 FT.
- LENGTH OF ENHANCED
  END SECTION               =     65.00 FT.
- INTERNAL DIAMETER OF
  ENHANCED END SECTION      =     11.50 IN.
```

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	SAND	0.80*	63.00	30.00	20.00**	30.00**
2.20	SAND	0.80*	63.00	30.00	20.00**	30.00**
2.20	SAND	0.80*	73.00	34.00	36.00**	55.60**
47.70	SAND	0.80*	73.00	34.00	36.00**	55.60**
47.70	SAND	0.80*	75.00	35.00	40.00**	64.00**
70.70	SAND	0.80*	75.00	35.00	40.00**	64.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
2.20	1.000	1.000
2.20	1.000	1.000
47.70	1.000	1.000
47.70	1.000	1.000
70.70	1.000	1.000

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* COMPUTATION RESULT *
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****
* FED. HWY. METHOD *
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PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.3	0.3
1.00	0.0	0.8	0.8
2.00	0.1	2.3	2.4
3.00	0.2	4.5	4.7
4.00	0.5	7.2	7.6
5.00	0.8	9.7	10.5
6.00	1.3	11.8	13.1
7.00	1.8	13.9	15.8
8.00	2.5	16.0	18.5
9.00	3.2	18.1	21.3
10.00	4.0	20.3	24.3
11.00	4.9	22.4	27.3
12.00	5.9	24.5	30.4
13.00	7.0	26.6	33.6
14.00	8.2	28.7	36.9
15.00	9.4	30.8	40.2
16.00	10.8	32.9	43.7
17.00	12.2	35.1	47.3
18.00	13.7	37.2	50.9
19.00	15.4	39.3	54.6
20.00	17.1	41.4	58.5
21.00	18.9	43.5	62.4
22.00	20.8	45.6	66.4
23.00	22.7	47.7	70.5
24.00	24.8	49.8	74.6
25.00	27.0	52.0	78.9
26.00	29.2	54.0	83.2
27.00	31.5	55.9	87.4
28.00	34.0	57.1	91.1
29.00	36.5	57.7	94.2
30.00	39.1	57.7	96.8
31.00	41.8	57.7	99.5
32.00	44.6	57.7	102.3
33.00	47.4	57.7	105.2
34.00	50.4	57.7	108.1
35.00	53.4	57.7	111.2
36.00	56.6	57.7	114.3
37.00	59.8	57.7	117.6

38.00	63.1	57.7	120.9
39.00	66.5	57.7	124.3
40.00	70.0	57.7	127.8
41.00	73.6	57.7	131.4
42.00	77.3	57.7	135.0
43.00	81.1	57.7	138.8
44.00	84.9	57.7	142.7
45.00	88.9	57.7	146.6
46.00	92.9	57.7	150.7
47.00	97.0	62.2	159.2
48.00	101.3	71.1	172.4
49.00	105.7	80.0	185.8
50.00	110.5	84.5	195.0
51.00	115.3	84.5	199.9
52.00	120.3	84.5	204.8
53.00	125.4	84.5	209.9
54.00	130.5	84.5	215.0
55.00	135.8	84.5	220.3
56.00	141.1	84.5	225.6
57.00	146.6	84.5	231.1
58.00	152.1	84.5	236.6
59.00	157.8	84.5	242.3
60.00	163.5	84.5	248.1
61.00	169.4	84.5	253.9
62.00	175.3	84.5	259.9
63.00	181.4	84.5	265.9
64.00	187.6	84.5	272.1
65.00	193.8	84.5	278.3

****
* API RP-2A (2010) *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.4	0.4
1.00	0.0	0.9	0.9
2.00	0.1	2.4	2.6
3.00	0.3	4.6	4.9
4.00	0.6	7.1	7.7
5.00	1.0	9.5	10.5
6.00	1.6	11.5	13.1
7.00	2.2	13.6	15.8
8.00	2.9	15.7	18.6
9.00	3.7	17.7	21.4
10.00	4.6	19.8	24.4
11.00	5.7	21.9	27.5

12.00	6.8	23.9	30.7
13.00	8.0	26.0	34.0
14.00	9.4	28.0	37.4
15.00	10.8	30.1	40.9
16.00	12.3	32.2	44.5
17.00	14.0	34.2	48.2
18.00	15.7	36.3	52.0
19.00	17.5	38.4	55.9
20.00	19.5	40.4	59.9
21.00	21.5	42.5	64.0
22.00	23.7	44.6	68.2
23.00	25.9	46.6	72.5
24.00	28.3	48.7	77.0
25.00	30.7	50.8	81.5
26.00	33.3	52.8	86.1
27.00	35.9	54.9	90.8
28.00	38.7	56.9	95.6
29.00	41.5	59.0	100.5
30.00	44.5	61.1	105.6
31.00	47.5	63.1	110.7
32.00	50.7	65.2	115.9
33.00	54.0	67.3	121.2
34.00	57.3	69.3	126.7
35.00	60.8	71.4	132.2
36.00	64.4	73.5	137.8
37.00	68.0	75.5	143.6
38.00	71.8	77.6	149.4
39.00	75.7	79.6	155.3
40.00	79.7	81.7	161.4
41.00	83.7	83.8	167.5
42.00	87.9	85.8	173.8
43.00	92.2	87.9	180.1
44.00	96.6	90.0	186.6
45.00	101.1	92.0	193.1
46.00	105.7	94.1	199.8
47.00	110.3	98.0	208.3
48.00	115.1	103.8	218.9
49.00	120.1	109.7	229.8
50.00	125.3	113.9	239.2
51.00	130.6	116.2	246.8
52.00	136.1	118.6	254.6
53.00	141.6	120.9	262.5
54.00	147.2	123.3	270.5
55.00	153.0	125.6	278.6
56.00	158.8	128.0	286.8
57.00	164.8	130.3	295.1
58.00	170.9	132.7	303.6
59.00	177.1	135.1	312.1
60.00	183.3	137.4	320.7
61.00	189.6	139.8	329.4

62.00	195.9	142.1	338.0
63.00	202.2	144.5	346.7
64.00	208.5	146.8	355.3
65.00	214.7	149.2	363.9

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

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*************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
*************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.1449E-02	0.1920E-01
			0.2416E-02	0.3720E-01
			0.3624E-02	0.6840E-01
			0.4348E-02	0.9600E-01
			0.4831E-02	0.1200E+00
			0.4831E-02	0.2400E+00
			0.4831E-02	0.3600E+00
			0.4831E-02	0.6000E+00
			0.4831E-02	0.2400E+01
2	10	0.1100E+01		
			0.0000E+00	0.0000E+00
			0.3826E-01	0.1920E-01
			0.6377E-01	0.3720E-01
			0.9566E-01	0.6840E-01
			0.1148E+00	0.9600E-01
			0.1275E+00	0.1200E+00
			0.1275E+00	0.2400E+00
			0.1275E+00	0.3600E+00
			0.1275E+00	0.6000E+00
			0.1275E+00	0.2400E+01
3	10	0.2158E+01		
			0.0000E+00	0.0000E+00
			0.7508E-01	0.1920E-01
			0.1251E+00	0.3720E-01
			0.1877E+00	0.6840E-01
			0.2252E+00	0.9600E-01

			0.2503E+00	0.1200E+00
			0.2503E+00	0.2400E+00
			0.2503E+00	0.3600E+00
			0.2503E+00	0.6000E+00
			0.2503E+00	0.2400E+01
4	10	0.2242E+01		
			0.0000E+00	0.0000E+00
			0.7798E-01	0.1920E-01
			0.1300E+00	0.3720E-01
			0.1949E+00	0.6840E-01
			0.2339E+00	0.9600E-01
			0.2599E+00	0.1200E+00
			0.2599E+00	0.2400E+00
			0.2599E+00	0.3600E+00
			0.2599E+00	0.6000E+00
			0.2599E+00	0.2400E+01
5	10	0.2495E+02		
			0.0000E+00	0.0000E+00
			0.1457E+01	0.1920E-01
			0.2428E+01	0.3720E-01
			0.3641E+01	0.6840E-01
			0.4370E+01	0.9600E-01
			0.4855E+01	0.1200E+00
			0.4855E+01	0.2400E+00
			0.4855E+01	0.3600E+00
			0.4855E+01	0.6000E+00
			0.4855E+01	0.2400E+01
6	10	0.4766E+02		
			0.0000E+00	0.0000E+00
			0.2804E+01	0.1920E-01
			0.4674E+01	0.3720E-01
			0.7011E+01	0.6840E-01
			0.8413E+01	0.9600E-01
			0.9348E+01	0.1200E+00
			0.9348E+01	0.2400E+00
			0.9348E+01	0.3600E+00
			0.9348E+01	0.6000E+00
			0.9348E+01	0.2400E+01
7	10	0.4774E+02		
			0.0000E+00	0.0000E+00
			0.2809E+01	0.1920E-01
			0.4682E+01	0.3720E-01
			0.7023E+01	0.6840E-01
			0.8428E+01	0.9600E-01
			0.9364E+01	0.1200E+00
			0.9364E+01	0.2400E+00
			0.9364E+01	0.3600E+00
			0.9364E+01	0.6000E+00
			0.9364E+01	0.2400E+01
8	10	0.5920E+02		

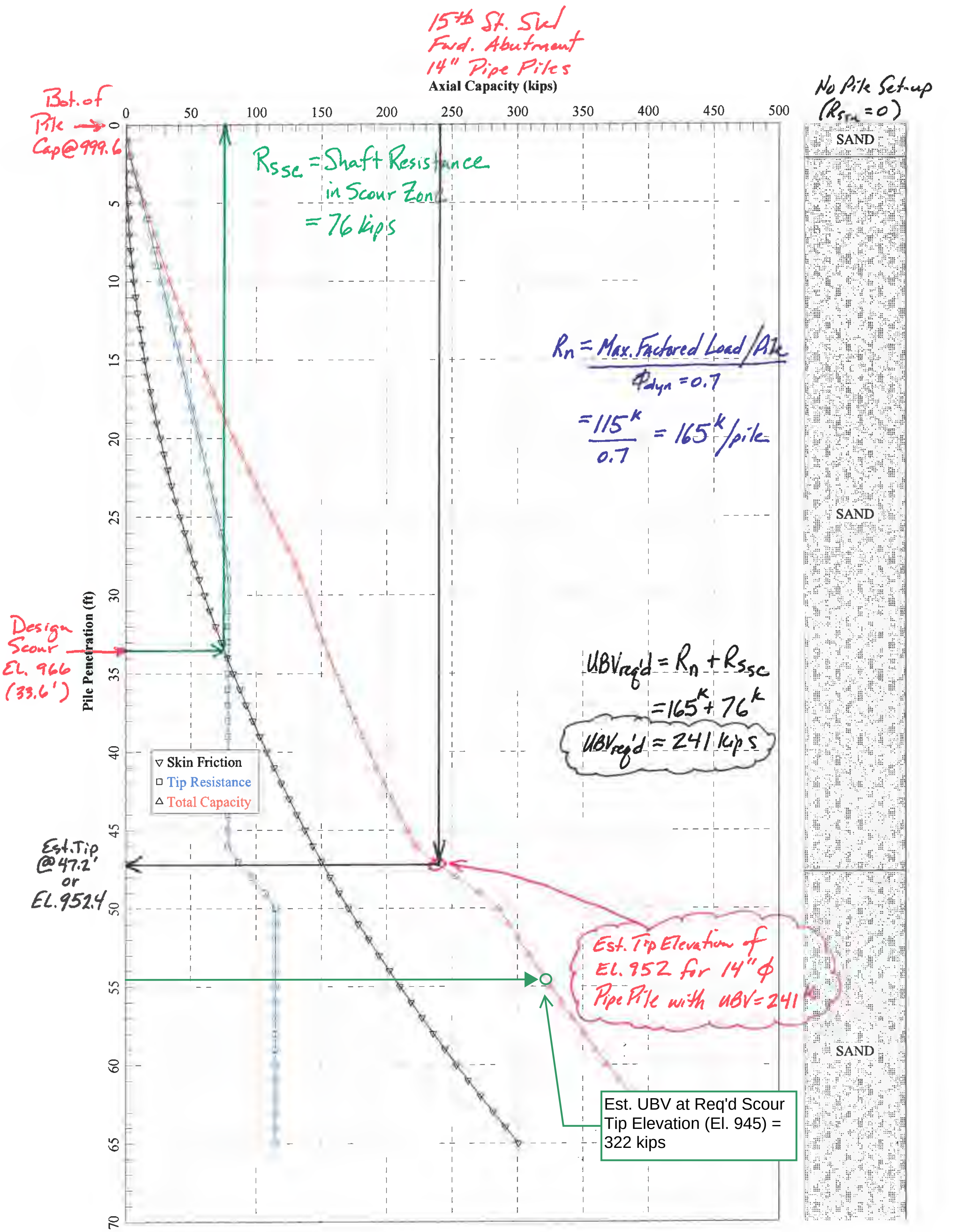
			0.0000E+00	0.0000E+00
			0.3795E+01	0.1920E-01
			0.6325E+01	0.3720E-01
			0.9488E+01	0.6840E-01
			0.1139E+02	0.9600E-01
			0.1265E+02	0.1200E+00
			0.1265E+02	0.2400E+00
			0.1265E+02	0.3600E+00
			0.1265E+02	0.6000E+00
			0.1265E+02	0.2400E+01
9	10	0.7066E+02		
			0.0000E+00	0.0000E+00
			0.4178E+01	0.1920E-01
			0.6963E+01	0.3720E-01
			0.1044E+02	0.6840E-01
			0.1253E+02	0.9600E-01
			0.1393E+02	0.1200E+00
			0.1393E+02	0.2400E+00
			0.1393E+02	0.3600E+00
			0.1393E+02	0.6000E+00
			0.1393E+02	0.2400E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.5282E+01	0.6000E-02
0.1056E+02	0.1200E-01
0.2113E+02	0.2400E-01
0.4225E+02	0.1560E+00
0.6338E+02	0.5040E+00
0.7606E+02	0.8760E+00
0.8451E+02	0.1200E+01
0.8451E+02	0.1800E+01
0.8451E+02	0.2400E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1280E+01	0.2025E-02	0.8803E-01	0.1000E-03
0.1302E+02	0.2047E-01	0.8803E+00	0.1000E-02
0.5762E+02	0.9759E-01	0.4401E+01	0.5000E-02

0.9618E+02	0.1749E+00	0.8803E+01	0.1000E-01
0.1433E+03	0.2879E+00	0.1761E+02	0.2000E-01
0.1923E+03	0.4366E+00	0.2529E+02	0.5000E-01
0.2155E+03	0.5273E+00	0.3009E+02	0.8000E-01
0.2248E+03	0.5729E+00	0.3329E+02	0.1000E+00
0.2387E+03	0.7132E+00	0.4493E+02	0.2000E+00
0.2569E+03	0.1066E+01	0.6314E+02	0.5000E+00
0.2672E+03	0.1396E+01	0.7347E+02	0.8000E+00
0.2730E+03	0.1613E+01	0.7929E+02	0.1000E+01
0.2783E+03	0.2629E+01	0.8451E+02	0.2000E+01



15th St. SW
Fwd. Abutment
14" Pipe Piles
Axial Capacity (kips)
0 50 100 150 200 250 300 350 400 450 500
Pile Penetration (ft)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70
Bot. of Pile Cap @ 999.6
No Pile Set-up (R_{Srn} = 0)
SAND
SAND
SAND
R_{SSC} = Shaft Resistance in Scour Zone = 76 kips
R_n = Max. Factored Load / Pile / ϕ_{dyn} = 0.7
= 115k / 0.7 = 165k/pile
UBVreq'd = R_n + R_{SSC}
= 165k + 76k
UBVreq'd = 241 kips
Design Scour EL. 966 (33.6')
Est. Tip @ 47.2' or EL. 952.4
Skin Friction
Tip Resistance
Total Capacity
Est. Tip Elevation of EL. 952 for 14" φ Pipe Pile with UBV = 241
Est. UBV at Req'd Scour Tip Elevation (El. 945) = 322 kips

PLATE 12

```
=========================================================================

                 APILE for Windows, Version 2019.9.11

                  Serial Number :  136084183

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
                (c) Copyright ENSOFT, Inc., 1987-2019
                      All Rights Reserved

=========================================================================


     This program is licensed to :

     S&ME, Inc.
     Dublin, OH

     Path to file locations      : T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th
St SW Bridge\Part 2 - Geotechnical Exploration\Calcs\APile Output\
     Name of input data file     : Forward Abutment ultimate 14.ap9d
     Name of output file         : Forward Abutment ultimate 14.ap9o
     Name of plot output file    : Forward Abutment ultimate 14.ap9p

     -------------------------------------------------------------------------
                          Time and Date of Analysis
     -------------------------------------------------------------------------

               Date:  July 26, 2022     Time:  17:07:16



1
          *********************
          * INPUT INFORMATION *
          *********************



          15th St SW - Forward Abutment Ultiate 14"

          DESIGNER   : NDA

          JOB NUMBER : 1117-20-054


          METHOD FOR UNIT LOAD TRANSFERS :
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- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.



COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)


TYPE OF LOADING :
- COMPRESSION


PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile


DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY     = 0.290E+08 PSI
- CROSS SECTION AREA        =     10.80 IN2


CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD      =     14.00 IN.
- INTERNAL DIAMETER, ID     =     13.50 IN.
- TOTAL PILE LENGTH, TL     =     65.00 FT.
- BATTER ANGLE              =      0.00 DEG
- PILE STICKUP LENGTH, PSL  =      0.00 FT.
- ZERO FRICTION LENGTH, ZFL =      0.00 FT.
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION       =      1.00 FT.
- LENGTH OF ENHANCED
  END SECTION               =     65.00 FT.
- INTERNAL DIAMETER OF
  ENHANCED END SECTION      =     13.50 IN.


PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program



SOIL INFORMATIONS :
```

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	SAND	0.80*	63.00	30.00	20.00**	30.00**
2.20	SAND	0.80*	63.00	30.00	20.00**	30.00**
2.20	SAND	0.80*	73.00	34.00	36.00**	55.60**
47.70	SAND	0.80*	73.00	34.00	36.00**	55.60**
47.70	SAND	0.80*	75.00	35.00	40.00**	64.00**
70.70	SAND	0.80*	75.00	35.00	40.00**	64.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
2.20	1.000	1.000
2.20	1.000	1.000
47.70	1.000	1.000
47.70	1.000	1.000
70.70	1.000	1.000

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* COMPUTATION RESULT *
****

****
* FED. HWY. METHOD *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.5	0.5
1.00	0.0	1.1	1.1
2.00	0.2	3.3	3.5
3.00	0.4	6.2	6.6
4.00	0.7	9.6	10.3
5.00	1.3	13.2	14.5
6.00	2.0	16.1	18.1
7.00	2.8	18.9	21.8
8.00	3.8	21.8	25.6
9.00	4.9	24.7	29.6
10.00	6.2	27.6	33.8
11.00	7.6	30.5	38.0
12.00	9.1	33.3	42.5
13.00	10.8	36.2	47.0
14.00	12.6	39.1	51.7
15.00	14.6	42.0	56.5
16.00	16.6	44.8	61.5
17.00	18.9	47.7	66.6
18.00	21.2	50.6	71.8
19.00	23.7	53.5	77.2
20.00	26.4	56.3	82.7
21.00	29.2	59.2	88.4
22.00	32.1	62.1	94.2
23.00	35.1	65.0	100.1
24.00	38.3	67.8	106.2
25.00	41.7	70.7	112.4
26.00	45.2	73.5	118.7
27.00	48.8	76.0	124.7
28.00	52.5	77.6	130.1
29.00	56.4	78.4	134.8
30.00	60.4	78.6	139.0
31.00	64.6	78.6	143.2
32.00	68.9	78.6	147.5
33.00	73.3	78.6	151.9
34.00	77.9	78.6	156.5
35.00	82.6	78.6	161.2
36.00	87.5	78.6	166.1
37.00	92.5	78.6	171.1

38.00	97.6	78.6	176.2
39.00	102.9	78.6	181.5
40.00	108.3	78.6	186.9
41.00	113.9	78.6	192.5
42.00	119.6	78.6	198.2
43.00	125.4	78.6	204.0
44.00	131.3	78.6	209.9
45.00	137.5	78.6	216.0
46.00	143.7	78.6	222.3
47.00	150.1	86.4	236.5
48.00	156.6	96.8	253.4
49.00	163.6	107.2	270.8
50.00	171.0	115.0	286.0
51.00	178.5	115.0	293.6
52.00	186.3	115.0	301.3
53.00	194.1	115.0	309.2
54.00	202.2	115.0	317.2
55.00	210.4	115.0	325.4
56.00	218.7	115.0	333.7
57.00	227.2	115.0	342.2
58.00	235.9	115.0	350.9
59.00	244.7	115.0	359.7
60.00	253.7	115.0	368.7
61.00	262.8	115.0	377.8
62.00	272.0	115.0	387.1
63.00	281.5	115.0	396.5
64.00	291.1	115.0	406.1
65.00	300.8	115.0	415.8

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*  API RP-2A (2010)  *
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PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.6	0.6
1.00	0.0	1.3	1.3
2.00	0.2	3.5	3.7
3.00	0.4	6.3	6.7
4.00	0.7	9.5	10.2
5.00	1.2	12.9	14.1
6.00	1.8	15.7	17.5
7.00	2.5	18.5	21.1
8.00	3.4	21.3	24.7
9.00	4.3	24.1	28.5
10.00	5.4	26.9	32.4
11.00	6.6	29.7	36.4

12.00	7.9	32.6	40.5
13.00	9.4	35.4	44.7
14.00	10.9	38.2	49.1
15.00	12.6	41.0	53.6
16.00	14.4	43.8	58.2
17.00	16.3	46.6	62.9
18.00	18.3	49.4	67.7
19.00	20.5	52.2	72.7
20.00	22.7	55.0	77.8
21.00	25.1	57.8	83.0
22.00	27.6	60.7	88.3
23.00	30.2	63.5	93.7
24.00	33.0	66.3	99.2
25.00	35.8	69.1	104.9
26.00	38.8	71.9	110.7
27.00	41.9	74.7	116.6
28.00	45.1	77.5	122.6
29.00	48.5	80.3	128.8
30.00	51.9	83.1	135.0
31.00	55.5	85.9	141.4
32.00	59.2	88.7	147.9
33.00	63.0	91.6	154.5
34.00	66.9	94.4	161.3
35.00	70.9	97.2	168.1
36.00	75.1	100.0	175.1
37.00	79.4	102.8	182.2
38.00	83.8	105.6	189.4
39.00	88.3	108.4	196.7
40.00	92.9	111.2	204.2
41.00	97.7	114.0	211.7
42.00	102.6	116.8	219.4
43.00	107.6	119.6	227.2
44.00	112.7	122.5	235.1
45.00	117.9	125.3	243.2
46.00	123.3	128.1	251.3
47.00	128.7	134.1	262.8
48.00	134.3	141.3	275.6
49.00	140.1	148.6	288.8
50.00	146.2	155.0	301.2
51.00	152.4	158.2	310.6
52.00	158.7	161.4	320.1
53.00	165.2	164.6	329.8
54.00	171.8	167.8	339.6
55.00	178.5	171.0	349.5
56.00	185.3	174.2	359.5
57.00	192.3	177.4	369.7
58.00	199.4	180.6	380.0
59.00	206.6	183.8	390.4
60.00	213.9	187.0	400.9
61.00	221.2	190.2	411.4

PLATE 18

62.00	228.5	193.4	422.0
63.00	235.9	196.7	432.5
64.00	243.2	199.9	443.1
65.00	250.5	203.1	453.6

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

```
*************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
*************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.1857E-02	0.2240E-01
			0.3095E-02	0.4340E-01
			0.4642E-02	0.7980E-01
			0.5571E-02	0.1120E+00
			0.6190E-02	0.1400E+00
			0.6190E-02	0.2800E+00
			0.6190E-02	0.4200E+00
			0.6190E-02	0.7000E+00
			0.6190E-02	0.2800E+01
2	10	0.1100E+01		
			0.0000E+00	0.0000E+00
			0.4902E-01	0.2240E-01
			0.8171E-01	0.4340E-01
			0.1226E+00	0.7980E-01
			0.1471E+00	0.1120E+00
			0.1634E+00	0.1400E+00
			0.1634E+00	0.2800E+00
			0.1634E+00	0.4200E+00
			0.1634E+00	0.7000E+00
			0.1634E+00	0.2800E+01
3	10	0.2158E+01		
			0.0000E+00	0.0000E+00
			0.9619E-01	0.2240E-01
			0.1603E+00	0.4340E-01
			0.2405E+00	0.7980E-01
			0.2886E+00	0.1120E+00

			0.3206E+00	0.1400E+00
			0.3206E+00	0.2800E+00
			0.3206E+00	0.4200E+00
			0.3206E+00	0.7000E+00
			0.3206E+00	0.2800E+01
4	10	0.2242E+01		
			0.0000E+00	0.0000E+00
			0.9990E-01	0.2240E-01
			0.1665E+00	0.4340E-01
			0.2498E+00	0.7980E-01
			0.2997E+00	0.1120E+00
			0.3330E+00	0.1400E+00
			0.3330E+00	0.2800E+00
			0.3330E+00	0.4200E+00
			0.3330E+00	0.7000E+00
			0.3330E+00	0.2800E+01
5	10	0.2495E+02		
			0.0000E+00	0.0000E+00
			0.1931E+01	0.2240E-01
			0.3218E+01	0.4340E-01
			0.4828E+01	0.7980E-01
			0.5793E+01	0.1120E+00
			0.6437E+01	0.1400E+00
			0.6437E+01	0.2800E+00
			0.6437E+01	0.4200E+00
			0.6437E+01	0.7000E+00
			0.6437E+01	0.2800E+01
6	10	0.4766E+02		
			0.0000E+00	0.0000E+00
			0.3718E+01	0.2240E-01
			0.6197E+01	0.4340E-01
			0.9295E+01	0.7980E-01
			0.1115E+02	0.1120E+00
			0.1239E+02	0.1400E+00
			0.1239E+02	0.2800E+00
			0.1239E+02	0.4200E+00
			0.1239E+02	0.7000E+00
			0.1239E+02	0.2800E+01
7	10	0.4774E+02		
			0.0000E+00	0.0000E+00
			0.3725E+01	0.2240E-01
			0.6208E+01	0.4340E-01
			0.9311E+01	0.7980E-01
			0.1117E+02	0.1120E+00
			0.1242E+02	0.1400E+00
			0.1242E+02	0.2800E+00
			0.1242E+02	0.4200E+00
			0.1242E+02	0.7000E+00
			0.1242E+02	0.2800E+01
8	10	0.5920E+02		

			0.0000E+00	0.0000E+00
			0.5070E+01	0.2240E-01
			0.8449E+01	0.4340E-01
			0.1267E+02	0.7980E-01
			0.1521E+02	0.1120E+00
			0.1690E+02	0.1400E+00
			0.1690E+02	0.2800E+00
			0.1690E+02	0.4200E+00
			0.1690E+02	0.7000E+00
			0.1690E+02	0.2800E+01
9	10	0.7066E+02		
			0.0000E+00	0.0000E+00
			0.5581E+01	0.2240E-01
			0.9301E+01	0.4340E-01
			0.1395E+02	0.7980E-01
			0.1674E+02	0.1120E+00
			0.1860E+02	0.1400E+00
			0.1860E+02	0.2800E+00
			0.1860E+02	0.4200E+00
			0.1860E+02	0.7000E+00
			0.1860E+02	0.2800E+01

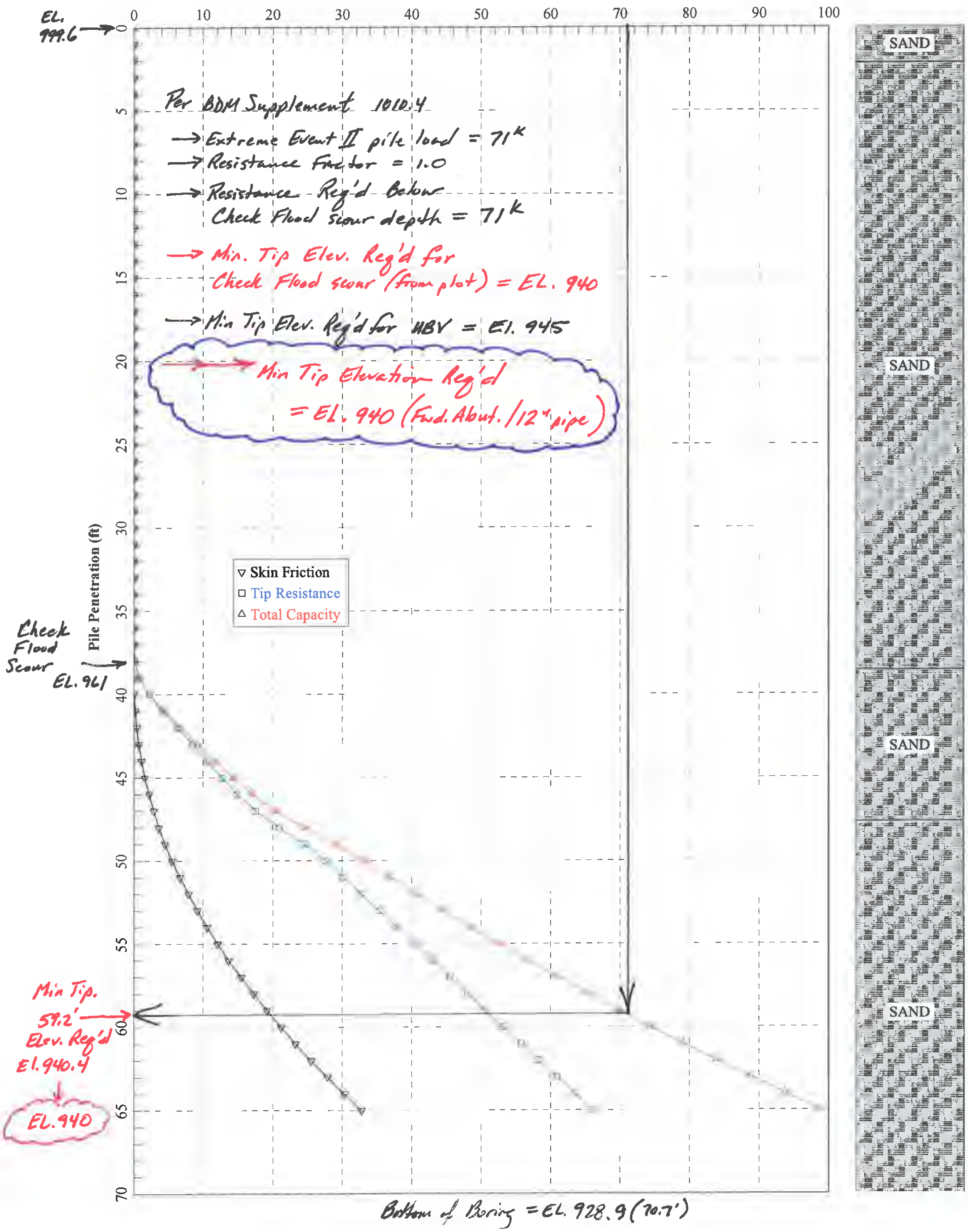
TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.7189E+01	0.7000E-02
0.1438E+02	0.1400E-01
0.2876E+02	0.2800E-01
0.5751E+02	0.1820E+00
0.8627E+02	0.5880E+00
0.1035E+03	0.1022E+01
0.1150E+03	0.1400E+01
0.1150E+03	0.2100E+01
0.1150E+03	0.2800E+01

LOAD VERSUS SETTLEMENT CURVE
****

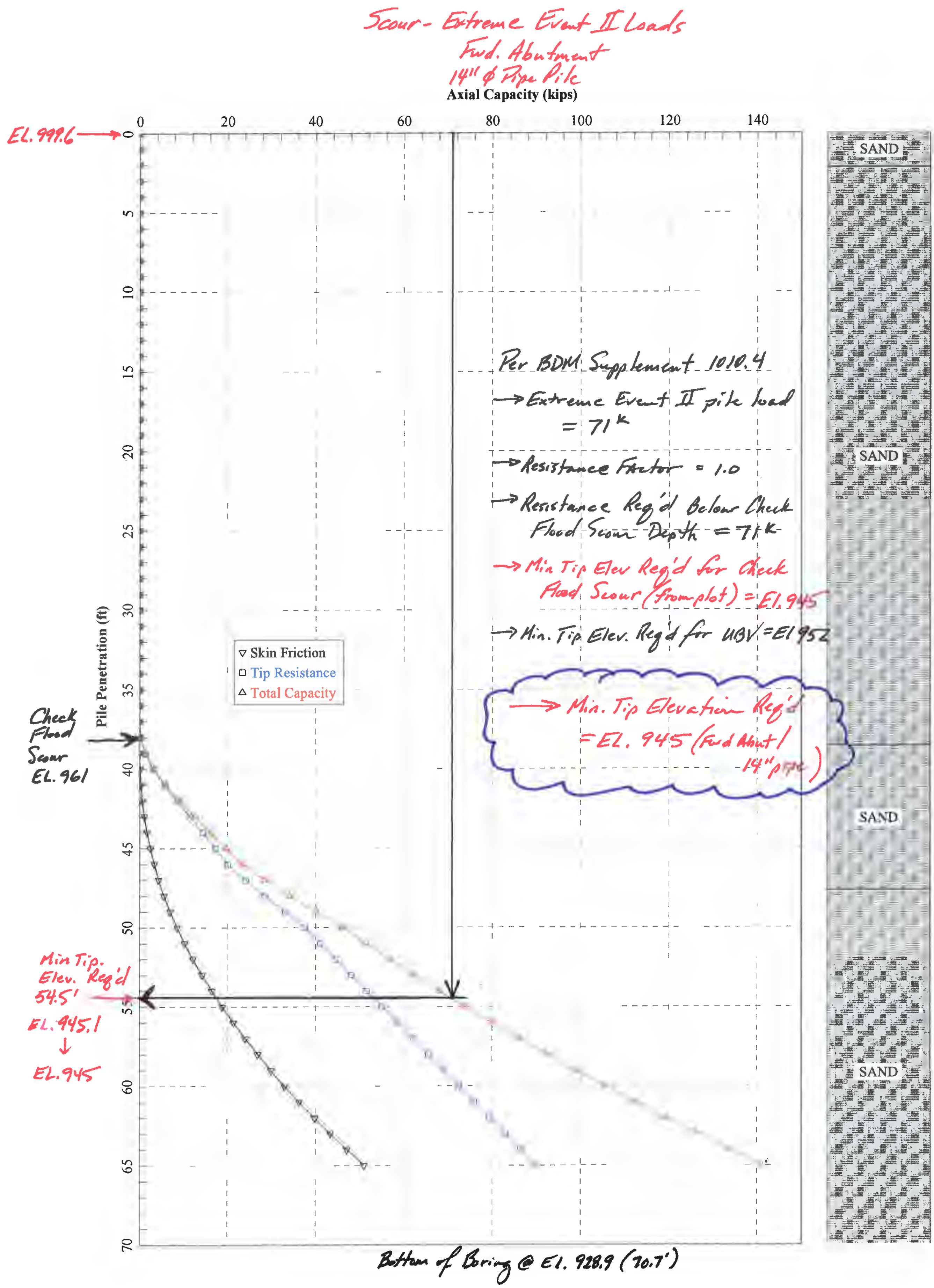
TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1843E+01	0.2392E-02	0.1027E+00	0.1000E-03
0.1882E+02	0.2426E-01	0.1027E+01	0.1000E-02
0.8308E+02	0.1155E+00	0.5135E+01	0.5000E-02

0.1385E+03	0.2070E+00	0.1027E+02	0.1000E-01
0.2067E+03	0.3414E+00	0.2054E+02	0.2000E-01
0.2834E+03	0.5287E+00	0.3286E+02	0.5000E-01
0.3187E+03	0.6365E+00	0.3847E+02	0.8000E-01
0.3336E+03	0.6909E+00	0.4220E+02	0.1000E+00
0.3595E+03	0.8539E+00	0.5879E+02	0.2000E+00
0.3808E+03	0.1207E+01	0.8004E+02	0.5000E+00
0.3954E+03	0.1543E+01	0.9470E+02	0.8000E+00
0.4034E+03	0.1763E+01	0.1026E+03	0.1000E+01
0.4157E+03	0.2794E+01	0.1150E+03	0.2000E+01

Scour – Extreme Event II Loads
Fwd. Abutment
12"ϕ Pipe Pile



Bottom of Boring = EL. 928.9 (70.7')



Scour- Extreme Event II Loads
Fwd. Abutment
14" φ Pipe Pile
Axial Capacity (kips)
0
20
40
60
80
100
120
140
Pile Penetration (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
EL. 999.6
SAND
SAND
SAND
SAND
Skin Friction
Tip Resistance
Total Capacity
Per BDM Supplement 1010.4
→ Extreme Event II pile load = 71k
→ Resistance Factor = 1.0
→ Resistance Req'd Below Check Flood Scour Depth = 71k
→ Min Tip Elev Req'd for Check Flood Scour (from plot) = El. 945
→ Min. Tip Elev. Req'd for UBV = El 952
→ Min. Tip Elevation Req'd = EL. 945 (Fwd Abut / 14" pipe)
Check Flood Scour EL. 961
Min Tip. Elev. Req'd 54.5'
EL. 945.1
EL. 945
Bottom of Boring @ El. 928.9 (70.7')

APPENDIX D – Geotechnical Profile – Bridge Sheets

STA-15THSW-1350

PROJECT DESCRIPTION

THE EXISTING TWO-SPAN STEEL BEAM BRIDGE CARRYING 15TH STREET SW OVER NIMISHILLEN CREEK IS TO BE REPLACED WITH A NEW SINGLE-SPAN BRIDGE SUPPORTED ON SEMI-INTEGRAL ABUTMENTS BEARING ON DRIVEN, CAST-IN-PLACE, REINFORCED CONCRETE (PIPE) PILES. THE LENGTH AND WIDTH OF THE NEW BRIDGE WILL BE APPROXIMATELY THE SAME AS THE EXISTING STRUCTURE, WITH THE VERTICAL AND HORIZONTAL ALIGNMENT OF THE NEW STRUCTURE BEING RELATIVELY UNCHANGED.

HISTORIC RECORDS

THE LOGS OF SEVERAL BORINGS DRILLED ON THE SOUTHERN SIDE OF US 30/SR 62 NEAR OVER NIMISHILLEN CREEK WERE LOCATED ON THE ODOT TIMS WEBSITE. THESE LOGS REPORTED PREDOMINANTLY GRANULAR SOILS TO DEPTHS RANGING FROM 60 TO 76 FEET. SOME BUT NOT ALL OF THESE BORINGS ENCOUNTERED 30 FEET OF 30 BLOWS PER FOOT SOIL WITHIN THIS RANGE OF DEPTHS.

GEOLOGY

EXTENSIVE DEPOSITS OF GRANULAR SOIL, GENERALLY OF WISCONSINAN-AGE, ARE PRESENT IN THE VICINITY OF THIS SITE. THE UPPER GRANULAR MATERIALS CONSIST OF INTERBEDDED SAND AND GRAVEL THAT MAY CONTAIN THIN AND DISCONTINUOUS LAYERS OF SILT AND CLAY. THESE UPPER GRANULAR MATERIALS MAY ALSO CONTAIN LOCAL DEPOSITS OF ORGANIC SOILS. THE DEEPER SANDS AND GRAVELS CONSIST PRIMARILY OF UNDIFFERENTIATED OUTWASH DEPOSITS. A REVIEW OF AVAILABLE ODNR WELL LOGS AND BEDROCK TOPOGRAPHY MAPPING INDICATE THAT THESE GRANULAR SOILS MAY BE PRESENT TO DEPTHS OF 270 FEET BELOW THE GROUND SURFACE NEAR THIS SITE.

RECONNAISSANCE

S&ME PERSONNEL VISITED THE SITE ON JULY 20, 2021, TO ASSESS THE EXISTING SITE CONDITIONS AND FEATURES, TRAFFIC VOLUMES, AND UTILITIES. OVERHEAD ELECTRIC WIRES AND ACTIVE ENTRANCE DRIVES FOR BUSINESSES WERE PRESENT EAST AND WEST OF THE EXISTING BRIDGE ALONG THE SOUTH SIDE OF THE STREET, AND EVIDENCE OF NUMEROUS UNDERGROUND UTILITIES WAS NOTED IN THE IMMEDIATE VICINITY OF EACH PROPOSED ABUTMENT. AS SUCH, THE BORING HAD TO BE RELOCATED UP TO 60 FEET BEHIND THE PROPOSED ABUTMENTS TO AVOID EXISTING UNDERGROUND UTILITIES WHILE PROVIDING SAFE TEMPORARY MAINTENANCE OF TRAFFIC. IN GENERAL, THE CONDITION OF THE ROADWAY PAVEMENT WAS FAIR, EXCEPT NEAR THE EDGES OF THE PAVEMENT, WHERE SOME DISTRESS WAS EVIDENT. THE WATERCOURSE CHANNEL WAS VERY DEFINED, WITH STEEP BANKS, RETAINING WALLS TO THE SOUTH OF THE SITE (NOT PART OF THIS PROJECT), AND EXISTING WALL-TYPE BRIDGE ABUTMENTS. SOME EVIDENCE OF EROSION WAS ALSO NOTED.

SUBSURFACE EXPLORATION

DURING THE PERIOD OF AUGUST 24, 2021, THROUGH SEPTEMBER 9, 2021, STRUCTURE BORINGS B-001-0-20 AND B-002-0-20 WERE DRILLED AT THE SITE BY A TRUCK-MOUNTED DRILL RIG USING A 3-1/4-INCH I.D. HOLLOW-STEM AUGER TO ADVANCE THE BORINGS THROUGH THE SOIL OVERBURDEN. AT REGULAR INTERVALS, DISTURBED BUT REPRESENTATIVE SOIL SAMPLES WERE OBTAINED BY LOWERING A 2-INCH O.D. SPLIT-BARREL SAMPLER THROUGH THE AUGER STEM TO THE BOTTOM OF THE BORING AND THEN DRIVING THE SAMPLER INTO THE SOIL WITH BLOWS FROM A 140-POUND HAMMER FREELY FALLING 30 INCHES (AASHTO T-206 - STANDARD PENETRATION TEST). IN ADDITION TO PERFORMING 20 FEET OF 2-1/2-FOOT INTERVAL SPT SAMPLING BELOW THE ANTICIPATED FOUNDATION LEVEL IN THESE BORINGS, 6 FEET OF CONTINUOUS SAMPLING WAS PERFORMED BELOW THE APPROXIMATE STREAMBED LEVEL.

AS BORING B-002 WAS BEING ADVANCED, A COLUMN OF DRILLING MUD WAS MAINTAINED INSIDE THE HOLLOW-STEM AUGER TO MINIMIZE THE POTENTIAL FOR "SAND HEAVE" INTO THE AUGER STEM. HOWEVER, BETWEEN THE DEPTHS OF 43.5 AND 70 FEET, BORING B-002 ENCOUNTERED 1 TO 5 FEET OF SAND HEAVE INTO THE HOLLOW-STEM AUGER DURING SPT ATTEMPTS. IN BORING B-001, A COLUMN OF WATER WAS MAINTAINED INSIDE THE HOLLOW STEM AUGER BETWEEN THE DEPTHS OF 13.5 AND 50 FEET. A CHANGEOVER TO ROTARY DRILLING WITH A TRICONE BIT AND USING A BENTONITE SLURRY WAS THEN MADE FOR THE REMAINDER OF BORING B-001. AFTER COMPLETION, THE SURFACE OF THE EXISTING PAVEMENT AT EACH BORING LOCATION WAS REPAIRED WITH COLD PATCH ASPHALT.

EXPLORATION FINDINGS

BENEATH THE EXISTING PAVEMENT MATERIALS, THE BORINGS ENCOUNTERED 9.6 TO 9.9 FEET OF EXISTING FILL AND POSSIBLE FILL CONSISTING OF MEDIUM-DENSE BROWN AND GRAY GRAVEL WITH SAND (A-1-b), MEDIUM-DENSE DARK-BROWN GRAVEL WITH SAND, SILT, AND CLAY (A-2-6), MEDIUM-DENSE TO DENSE BROWN AND DARK-GRAY SILT AND CLAY (A-6a), MEDIUM-STIFF GRAY SANDY SILT (A-4a), AND STIFF TO HARD BROWN AND DARK-GRAY SILT AND CLAY (A-6a). COAL FRAGMENTS, CINDERS, AND SLAG WERE NOTED IN MOST OF THE FILL MATERIALS.

THE UPPERMOST NATURAL SOILS BENEATH THE FILL CONSISTED OF 2.5 FEET OF VERY-SOFT GRAY SANDY SILT (A-4a) IN BORING B-001, WHEREAS BORING B-002 ENCOUNTERED 5.5 FEET OF VERY-LOOSE BROWN COARSE AND FINE SAND (A-3a) WITH THIN LAYERS OF ORGANIC CLAY, DECAYED LEAVES, AND WOOD FRAGMENTS. BENEATH THESE MATERIALS, BOTH STRUCTURE BORINGS ENCOUNTERED 68.5 TO 71.5 FEET OF LOOSE TO MEDIUM-DENSE BROWN AND GRAY GRAVEL WITH SAND (A-1-b), GRAVEL (A-1-a), AND COARSE AND FINE SAND (A-3a). A FEW ISOLATED COBBLES WERE NOTED THROUGHOUT THIS GRANULAR DEPOSIT.

LEGEND

DESCRIPTION	ODOT CLASS	CLASSIFIED MECH.	CLASSIFIED VISUAL
GRAVEL AND/OR STONE FRAGMENTS	*A-1-a*	*5*	*-*
GRAVEL AND/OR STONE FRAGMENTS WITH SAND	*A-1-b*	*7*	*22*
GRAVEL AND/OR STONE FRAGMENTS WITH SAND, SILT AND CLAY	*A-2-6*	*-*	*1*
COARSE AND FINE SAND	*A-3a*	*5*	*1*
SANDY SILT	*A-4a*	*1*	*1*
SILT AND CLAY	*A-6a*	*-*	*3*
	TOTAL	*18*	*28*

PAVEMENT OR BASE = X = APPROXIMATE THICKNESS — *VISUAL*

BORING LOCATION - PLAN VIEW.

DRIVE SAMPLE AND/OR ROCK CORE BORING PLOTTED TO VERTICAL SCALE ONLY. HORIZONTAL BAR INDICATES A CHANGE IN STRATIGRAPHY.

WC INDICATES WATER CONTENT IN PERCENT.

N_{60} INDICATES STANDARD PENETRATION RESISTANCE NORMALIZED TO 60% DRILL ROD ENERGY RATIO.

X/Y/D" NUMBER OF BLOWS FOR STANDARD PENETRATION TEST (SPT):
X= NUMBER OF BLOWS FOR FIRST 6 INCHES.
Y/D"= NUMBER OF BLOWS (UNCORRECTED) FOR D" OF PENETRATION AT REFUSAL.

W INDICATES FREE WATER ELEVATION.

INDICATES A NON-PLASTIC MATERIAL WITH A MOISTURE CONTENT GREATER THAN 25 % OR GREATER THAN 19 % WITH A WET APPEARANCE.

SS INDICATES A SPLIT SPOON SAMPLE.

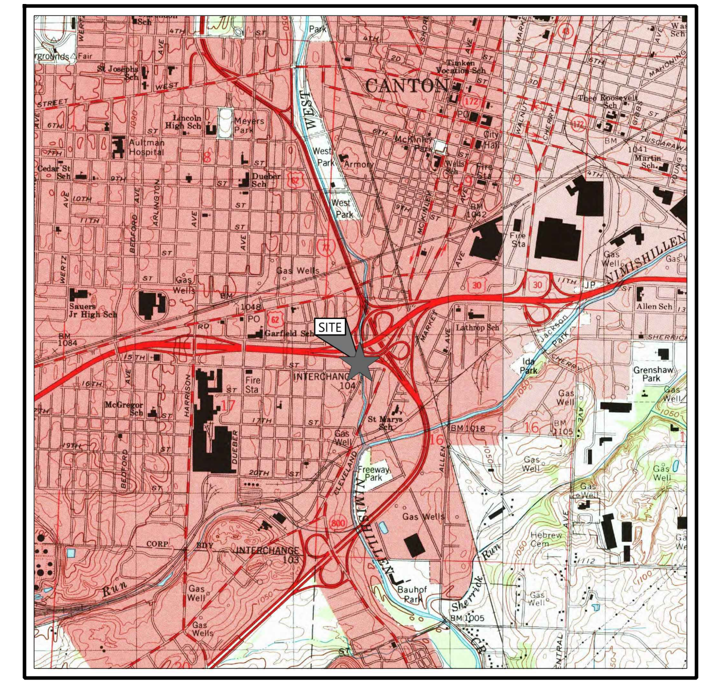
NP INDICATES A NON-PLASTIC SAMPLE.

SPECIFICATIONS

THIS GEOTECHNICAL EXPLORATION WAS PERFORMED IN ACCORDANCE WITH THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION, OFFICE OF GEOTECHNICAL ENGINEERING, SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS, JANUARY 2021.

AVAILABLE INFORMATION

ALL AVAILABLE SOIL AND BEDROCK INFORMATION THAT CAN BE CONVENIENTLY SHOWN ON THE GEOTECHNICAL EXPLORATION SHEETS HAS BEEN SO REPORTED. ADDITIONAL EXPLORATIONS MAY HAVE BEEN MADE TO STUDY SOME SPECIAL ASPECT OF THE PROJECT. COPIES OF THIS DATA, IF ANY, MAY BE INSPECTED IN THE DISTRICT DEPUTY DIRECTOR'S OFFICE OR THE OFFICE OF GEOTECHNICAL ENGINEERING AT 1980 WEST BROAD STREET.



LOCATION MAP

SCALE IN MILES

0 1 2 3 4

N

PARTICLE SIZE DEFINITIONS

	12"	3"	2.0 mm	0.42 mm	0.074 mm	0.005 mm
BOULDERS	COBBLES	GRAVEL	COARSE SAND	FINE SAND	SILT	CLAY
			No. 10 SIEVE	No. 40 SIEVE	No. 200 SIEVE	

D_{50} Values

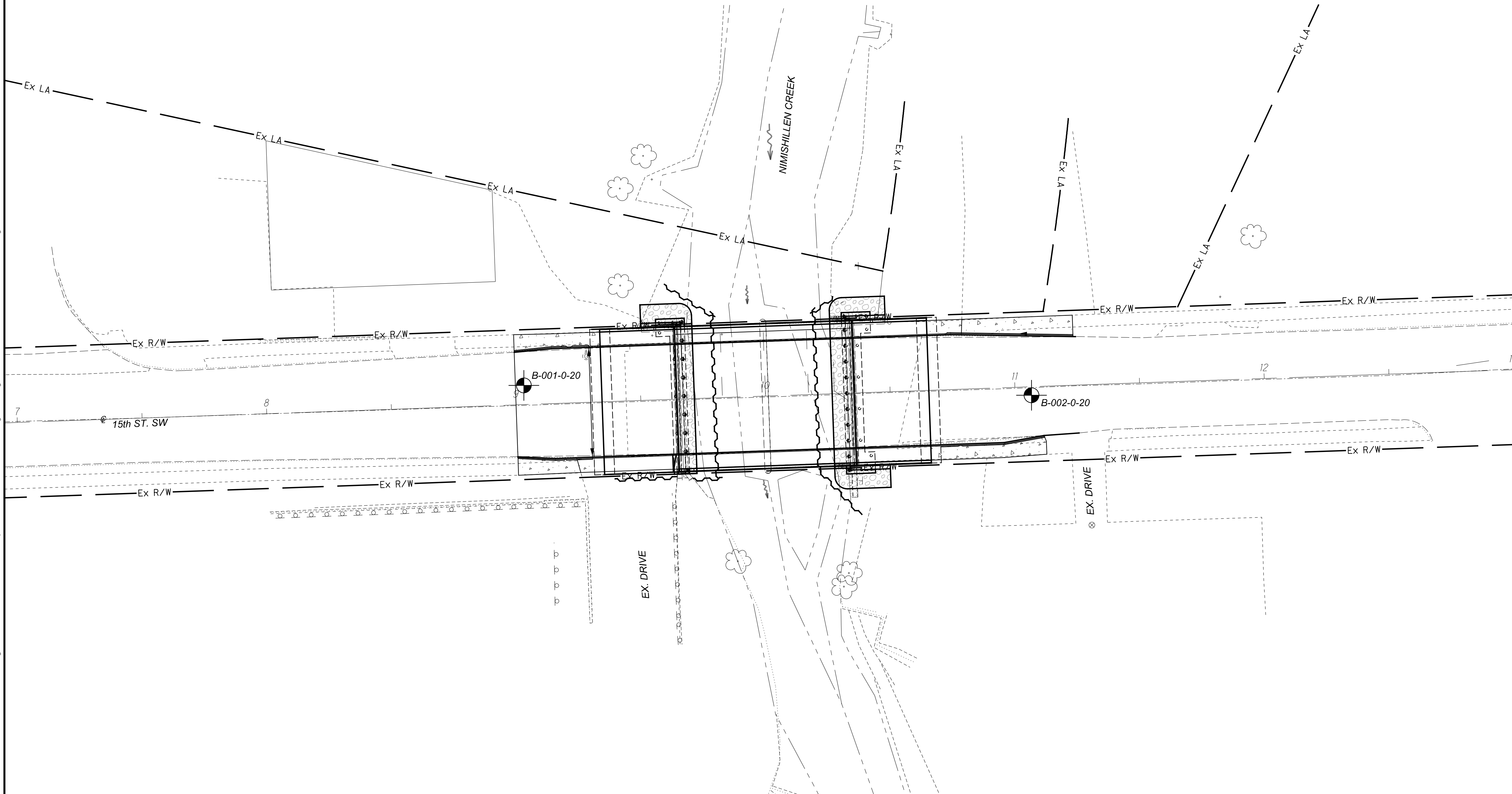
Boring Number	Location	Top of Boring Elevation	Sample Depth (ft.)	Sample Elevation	D_{50} (mm)
B-001-0-20	West (Rear) Abutment N 40.783346 W 81.386338	1015.6	12.0 - 13.5	1002.1 - 1003.6	0.1244
			13.5 - 14.0	1001.6 - 1053.6	2.7138
			16.5 - 18.0	997.6 - 999.1	3.9131
			18.0 - 19.5	996.1 - 997.6	1.8741
B-002-0-20	East (Fwd.) Abutment N 40.783342 W 81.385602	1015.5	12.0 - 13.5	1002.0 - 1003.5	0.1564
			13.5 - 14.8	1000.7 - 1002.0	0.3543
			15.0 - 16.3	999.2 - 1000.5	0.2877
			16.5 - 17.5	998.0 - 999.0	0.4358
			18.0 - 18.7	996.8 - 997.5	7.8648

RECON. - *AM 07/20/21*
DRILLING - *OTB 08/24-25/21*
OTB 09/07-09/21
DRAWN - *DWM 08/29/22 - 09/02/22, 12/01/22*
REVIEWED - *RSW 08/31/22, 12/01/22*
NDA 09/01/22

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. STA-15THSW-1350 OVER NIMISHILLEN CREEK

DESIGN AGENCY
S&ME

DESIGNER
DWM
REVIEWER
RSW 12-01-22
PROJECT ID
113153
SUBSET 1 TOTAL 7
SHEET - TOTAL -



GEOTECHNICAL PROFILE - BRIDGE

BRIDGE NO. STA-15THSW-1350 OVER NIMISHILLEN CREEK

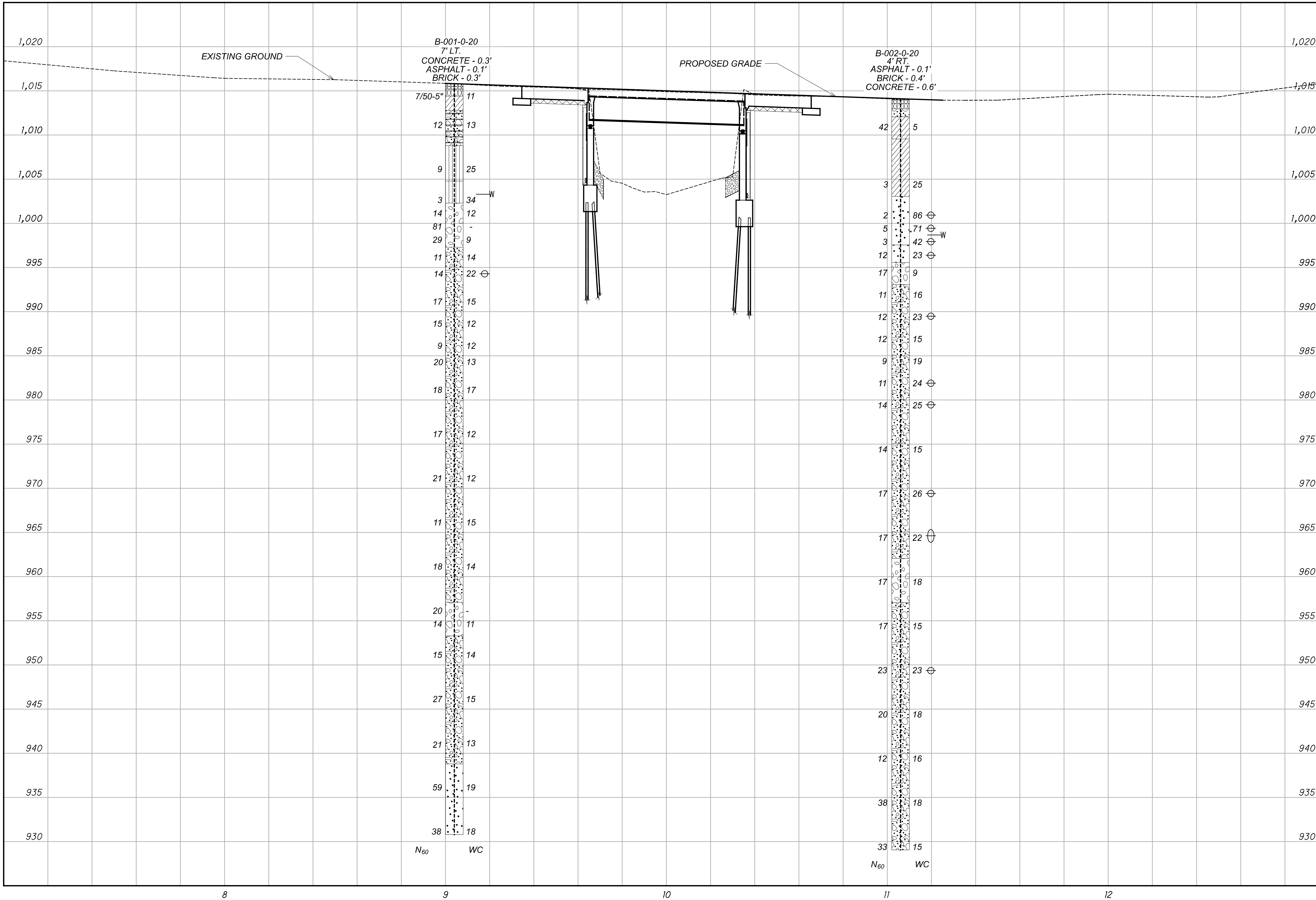
HORIZONTAL SCALE IN FEET
0 20 40 80

DESIGN AGENCY

DESIGNER	DWM
REVIEWER	RSW 9-2-22
PROJECT ID	113153
SUBSET 2	TOTAL 7
SHEET P.0	TOTAL 0

STA-15SW-13560

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 9/2/2022 TIME: 7:41:35 AM USER: dmorales
T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th St SW Bridge\Part 2 - Geotechnical\Exploration\CAD\113153\400-Engineering\Geotechnical\Sheets\113153_ZP001.dgn



HORIZONTAL SCALE IN FEET

0 0 0

GEOTECHNICAL PROFILE - BRIDGE
BRIDGE NO. STA-15THSW-1350 NIMISHILLEN CREEK

DESIGN AGENCY

DESIGNER
DWM

REVIEWER
RSW 9-2-22

PROJECT ID
113153

SUBSET	TOTAL
3	7

SHEET	TOTAL
P.0	0

STA-15SW-1350

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 9/2/2022 TIME: 7:12:38 AM USER: dmorales
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STA-15THSW-1350

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 9/2/2022 TIME: 7:08:51 AM USER: dmorales
T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th St SW Bridge\Part 2 - GeotechnicalExploration\CAD\113153\400-Engineering\Geotechnical\Sheets\113153_ZD001.dgn

PROJECT: STA-15SW-13.50	DRILLING FIRM / OPERATOR: OTB / A. FAY	DRILL RIG: OTB MOBILE B-57	STATION / OFFSET: 9+04, 7' LT	EXPLORATION ID **B-001-0-20**
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: S&ME / M. TORRES	HAMMER: CME AUTOMATIC	ALIGNMENT: 15TH ST. SW	
PID: 113153 BR ID:	DRILLING METHOD: 3-1/4" HSA, 3-1/8" TRICONE	CALIBRATION DATE: 11/25/20	ELEVATION: 1015.6 (MSL) EOB: 85.0 ft.	PAGE 1 OF 2
START: 9/8/21 END: 9/9/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 40.783347 N, 81.386331 W	

MATERIAL DESCRIPTION AND NOTES (ELEV. 1015.6)

Material Description and Notes	Bottom Elev.
ASPHALT - 4 INCHES	1015.3
BRICK - 4 INCHES	1015.0
CONCRETE - 9 INCHES	1014.2
Fill: Hard brown **SILT AND CLAY**, some fine to coarse sand, trace to little fine to coarse gravel, dry to damp.	1012.6
Fill: Medium-dense dark-brown **GRAVEL WITH SAND, SILT AND CLAY**, contains coal fragments, cinders and slag, damp.	1008.6
Possible Fill: Medium-stiff gray **SANDY SILT,** little clay, little fine gravel, moist.	1004.6
Very-soft gray **SANDY SILT**, little clay, trace coarse sand, wet.	1002.1
Medium-dense gray **GRAVEL**, some "and" fine to coarse sand, trace silt, trace clay, few cobbles. - Encountered cobble at 15.5'.	997.1
Medium-dense brown and gray **GRAVEL WITH SAND**, trace silt, trace clay, few cobbles, few loose zones, wet. - Encountered cobble at 44.9'.	956.9
Medium-dense gray and brown **GRAVEL**, "and" fine to coarse sand, trace silt, trace clay, few cobbles, wet.	

W 1003.1 (water level)

Depth (ft)	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
2	7 50-5"	-	100	SS-1	4.5+	-	-	-	-	-	-	-	-	11	A-6a (V)
4	3 4 4	12	100	SS-2	-	-	-	-	-	-	-	-	-	13	A-2-6 (V)
9	2 3 3	9	67	SS-3	0.5-0.75	-	-	-	-	-	-	-	-	25	A-4a (V)
13	1 1 1	3	100	SS-4	0.0	0	1	56	30	13	-	-	-	34	A-4a (V)
14	1 4 5	14	33	SS-5	-	55	17	19	7	2	-	-	-	12	A-1-a (V)
16	6 26 28	81	0	--	-	-	-	-	-	-	-	-	-	-	
17	4 14 5	29	100	SS-6	-	62	16	15	5	2	-	-	-	9	A-1-a (V)
19	4 3 4	11	67	SS-7	-	49	35	12	3	1	-	-	-	14	A-1-b (V)
22	4 4 5	14	100	SS-8	-	-	-	-	-	-	-	-	-	22	A-1-b (V)
24	4 4 7	17	39	SS-9	-	-	-	-	-	-	-	-	-	15	A-1-b (V)
27	4 5 5	15	67	SS-10	-	-	-	-	-	-	-	-	-	12	A-1-b (V)
29	2 2 4	9	39	SS-11	-	-	-	-	-	-	-	-	-	12	A-1-b (V)
32	4 6 7	20	67	SS-12	-	32	46	18	2	2	-	-	-	13	A-1-b (V)
34	7 7 5	18	44	SS-13	-	-	-	-	-	-	-	-	-	17	A-1-b (V)
39	3 5 6	17	100	SS-14	-	-	-	-	-	-	-	-	-	12	A-1-b (V)
44	5 6 8	21	67	SS-15	-	44	32	19	4	1	-	-	-	12	A-1-b (V)
49	4 4 3	11	33	SS-16	-	-	-	-	-	-	-	-	-	15	A-1-b (V)
54	10 7 5	18	67	SS-17	-	-	-	-	-	-	-	-	-	14	A-1-b (V)
59	7 6 7	20	0	--	-	-	-	-	-	-	-	-	-	-	

CONTINUED ON NEXT SHEET

DESIGN AGENCY

DESIGNER DWM
REVIEWER RSW 9-2-22
PROJECT ID 113153
SUBSET 4 TOTAL 7
SHEET P.0 TOTAL 0

GEOTECHNICAL EXPLORATION - BRIDGE
BRIDGE NO. STA-15THSW-1350 OVER NIMISHILLEN CREEK
BORING LOG B-001-0-20

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 9/2/2022 TIME: 7:53:26 AM USER: dmorales
T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th St SW Bridge\Part 2 - Geotechnical Exploration\CAD\113153\400-Engineering\Geotechnical\Sheets\113153_ZD002.dgn

PID: 113153 | BR ID: | PROJECT: STA-15SW-13.50 | STATION / OFFSET: 9+04, 7' LT | START: 9/8/21 | END: 9/9/21 | PG 2 OF 2 | **B-001-0-20**

MATERIAL DESCRIPTION AND NOTES	ELEV. 955.6	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Medium-dense gray and brown **GRAVEL**, "and" fine to coarse sand, trace silt, trace clay, few cobbles, wet. *(continued)* - Encountered cobble at 58.7'.	953.1	61	2 3 6	14	100	SS-18	-	54	25	16	4	1	-	-	-	11	A-1-a (V)	
Medium-dense gray and brown **GRAVEL WITH SAND**, trace silt, trace clay, wet.		64	3 5 5	15	33	SS-19	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
		69	4 7 11	27	100	SS-20	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	
	938.6	74	6 7 7	21	100	SS-21	-	-	-	-	-	-	-	-	-	13	A-1-b (V)	
Dense to very-dense brown **COARSE AND FINE SAND**, trace fine gravel, trace silt, trace clay, wet.		79	8 16 23	59	100	SS-22	-	2	18	70	7	3	-	-	-	19	A-3a (V)	
	930.6	84 / EOB 85	8 10 15	38	100	SS-23	-	-	-	-	-	-	-	-	-	18	A-3a (V)	

NOTES:
- Encountered water at 12.5'.
- Maintained column of water inside HSA from 13.5' to 50.0'.
- Switched to rotary drilling with bentonitic drilling mud and tricone bit beginning at 50.0'.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS

DESIGN AGENCY

DESIGNER DWM

REVIEWER RSW 9-2-22

PROJECT ID 113153

SUBSET 5 TOTAL 7

SHEET P.0 TOTAL 0

GEOTECHNICAL EXPLORATION - BRIDGE
BRIDGE NO. STA-15THSW-1350 OVER NIMISHILLEN CREEK
BORING LOG B-001-0-20 (CONTINUED)

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 9/2/2022 TIME: 7:55:23 AM USER: dmorales
T:\GEO\Projects\2020\1117-20-054_Prime AE - 15th St SW Bridge\Part 2 - GeotechnicalExploration\CAD\113153\400-Engineering\Geotechnical\Sheets\113153_ZD003.dgn

PROJECT: STA-15SW-13.50	DRILLING FIRM / OPERATOR: OTB / A. FAY	DRILL RIG: OTB MOBILE B-57	STATION / OFFSET: 11+06, 4' RT
TYPE: BRIDGE REPLACEMENT	SAMPLING FIRM / LOGGER: S&ME / A. MAINS	HAMMER: CME AUTOMATIC	ALIGNMENT: 15TH ST. SW
PID: 113153 BR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/25/20	ELEVATION: 1013.9 (MSL) EOB: 85.0 ft.
START: 8/24/21 END: 9/7/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 40.783328 N, 81.385598 W

EXPLORATION ID **B-002-0-20** PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 1013.9
ASPHALT - 1 INCH	1013.8
BRICK - 5 INCHES	1013.4
CONCRETE - 7 INCHES	1012.8
Fill: Medium-dense (est.) brown and gray **GRAVEL WITH SAND**, trace silt, trace clay, dry.	1011.9
Fill: Medium-dense to dense brown and dark-gray **SILT AND CLAY**, "and" fine to coarse sand, little fine gravel, contains coal fragments and cinders, dry.	1009.4
Fill: Stiff brown and dark-gray **SILT AND CLAY**, some fine to coarse sand, trace to little fine to coarse gravel, few coal fragments, moist.	1002.9
Very-loose brown **COARSE AND FINE SAND**, trace to some fine gravel, little silt, trace clay, contains numerous thin (1/2" to 1") layers of dark-gray organic clay, decayed leaves and wood fragments, moist becoming wet.	997.4
Medium-dense gray **COARSE AND FINE SAND**, little fine to coarse gravel, trace silt, trace clay, slightly organic, wet.	995.4
Medium-dense brown and gray **GRAVEL**, little fine to coarse sand, trace silt, trace clay, wet.	992.9
Loose to medium-dense gray **GRAVEL WITH SAND**, trace silt, trace clay, few cobbles, wet. - Encountered cobble at 31.0'.	961.9
Medium-dense gray **GRAVEL**, some fine to coarse sand, trace silt, trace clay, wet.	956.9
Medium-dense to dense gray **GRAVEL WITH SAND**, trace silt, trace clay, wet.	

Water level: W 998.9 (depth ~15 ft)

DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
2-3.5	31 19 9	42	100	SS-1	-	-	-	-	-	-	-	-	-	5	A-6a (V)
8.5-10	1 1 1	3	67	SS-2	1.25	-	-	-	-	-	-	-	-	25	A-6a (V)
12-13.5	0 0 1	2	100	SS-3	-	2	6	61	20	11	NP	NP	NP	86	A-3a (0)
13.5-15	1 1 2	5	89	SS-4	-	28	15	36	14	7	-	-	-	71	A-3a (V)
15-16.5	1 1 1	3	89	SS-5	-	6	28	36	23	7	-	-	-	42	A-3a (V)
16.5-18	2 3 5	12	67	SS-6	-	19	32	42	3	4	-	-	-	23	A-3a (V)
18.5-20	3 6 5	17	11	SS-7	-	78	12	5	4	1	-	-	-	9	A-1-a (V)
21-22.5	2 2 5	11	67	SS-8	-	-	-	-	-	-	-	-	-	16	A-1-b (V)
23.5-25	2 3 5	12	33	SS-9	-	-	-	-	-	-	-	-	-	23	A-1-b (V)
26-27.5	3 4 4	12	67	SS-10	-	48	27	19	4	2	-	-	-	15	A-1-b (V)
28.5-30	3 3 3	9	67	SS-11	-	-	-	-	-	-	-	-	-	19	A-1-b (V)
31-32.5	1 2 5	11	33	SS-12	-	-	-	-	-	-	-	-	-	24	A-1-b (V)
33.5-35	4 5 4	14	22	SS-13	-	-	-	-	-	-	-	-	-	25	A-1-b (V)
38.5-40	3 4 5	14	78	SS-14	-	31	32	31	4	2	-	-	-	15	A-1-b (V)
43.5-45	3 6 5	17	67	SS-15	-	-	-	-	-	-	-	-	-	26	A-1-b (V)
48.5-50	3 6 5	17	100	SS-16	-	-	-	-	-	-	-	-	-	22	A-1-b (V)
53.5-55	6 6 5	17	100	SS-17	-	71	22	3	2	2	-	-	-	18	A-1-a (V)
58.5-60	3 5 6	17	11	SS-18	-	-	-	-	-	-	-	-	-	15	A-1-b (V)

CONTINUED ON NEXT SHEET

DESIGN AGENCY | DESIGNER DWM | REVIEWER RSW 9-2-22 | PROJECT ID 113153 | SUBSET 6 TOTAL 7 | SHEET P.0 TOTAL 0

GEOTECHNICAL EXPLORATION - BRIDGE
BRIDGE NO. STA-15THSW-1350 OVER NIMISHILLEN CREEK
BORING LOG B-002-0-20

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 9/2/2022 TIME: 7:57:11 AM USER: dmorales
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PID: 113153 | BR ID: | PROJECT: STA-15SW-13.50 | STATION / OFFSET: 11+06, 4' RT | START: 8/24/21 | END: 9/7/21 | PG 2 OF 2 | **B-002-0-20**

MATERIAL DESCRIPTION AND NOTES	ELEV. 953.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
Medium-dense to dense gray **GRAVEL WITH SAND**, trace silt, trace clay, wet. *(continued)*		61–63																
		64	6 7 8	23	100	SS-19	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	
		65–68																
		69	4 4 9	20	100	SS-20	-	8	46	43	2	1	-	-	-	18	A-1-b (V)	
		70–73																
		74	2 3 5	12	44	SS-21	-	-	-	-	-	-	-	-	-	16	A-1-b (V)	
		75–78																
		79	4 10 15	38	44	SS-22	-	-	-	-	-	-	-	-	-	18	A-1-b (V)	
		80–83																
		84	6 11 11	33	61	SS-23	-	20	37	32	7	4	-	-	-	15	A-1-b (V)	
	928.9	EOB 85																

NOTES:
- Encountered groundwater 15.0'.
- Below 16.5', maintained column of bentonitic drilling mud inside HSA.
- Between 43.5' and 70.0', encountered 1 to 5 feet of heaving sand into the HSA during SPT attempts.
- Boring terminated at 70.0' on 8/25/21 after rig breakdown. Boring backfilled and patched.
- Boring completed on 9/7/21 in an offset boring.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH; BENTONITE POWDER; CEMENT; SOIL CUTTINGS; WATER

DESIGN AGENCY

DESIGNER DWM

REVIEWER RSW 9-2-22

PROJECT ID 113153

SUBSET 7 TOTAL 7

SHEET P.0 TOTAL 0

GEOTECHNICAL EXPLORATION - BRIDGE
BRIDGE NO. STA-15THSW-1350 OVER NIMISHILLEN CREEK
BORING LOG B-002-0-20 (CONTINUED)