FINAL

STRUCTURE EXPLORATION REPORT

COS SR 93 19.10, PID 115365

Bridge No. COS-93-19.22 S.R. 93 over White Eyes Creek

Replacement of the existing structure (SFN 1602160 COS-93-19.22) with new structure (SFN 1602161 COS-93-19.22) on S.R. 93 over White Eyes Creek in Coshocton County; in addition to necessary related work.

Submitted to ODOT District 5
February 2026

Prepared by
ODOT Office of Geotechnical Engineering

OHIO DEPARTMENT OF
TRANSPORTATION

Executive Summary

The project involves replacing Bridge No. COS-93-19.22 (SFN 1602160) with a new structure (SFN 1602161) on S.R. 93 over White Eyes Creek in Coshocton County, Ohio. The work includes necessary related improvements to the approach roadway and substructure.

The site is located in the non-glaciated Muskingum-Pittsburgh Plateau, where cohesive overburden soils are underlain by Pennsylvanian-aged bedrock (shale, siltstone, sandstone, and conglomerate). Three borings were completed, revealing layers of asphalt, aggregate base, cohesive soils (sandy silt, silt, clay), and non-cohesive soils (stone fragments, sand). The subgrade soils are generally medium stiff to very stiff cohesive soils in moist to damp conditions. Sandstone bedrock was encountered at depths ranging from EL. 800.2 to 804.8 ft. Cobbly and bouldery zones were encountered in borings B-002 and B-003. The bedrock is slightly to moderately weathered sandstone, with unconfined compressive strengths ranging from 167 to 5,567 PSI. According to the ODNR Bedrock Topography of the Baltic, Ohio, Quadrangle Map, rock should be expected at or below elevation 890 at the project site.

Roadway Subgrade:

Due to the short length of the bridge replacement, subgrade construction is minimal. Standard ODOT subgrade compaction and proof rolling procedures (L&D Volume 3 Plan Note G121) are not required. Instead, the project uses the “Simplified Pavement Design for Short Projects” from Appendix C of the ODOT Pavement Design Manual (PDM) or matches the existing pavement buildup.

Temporary Shoring:

Cofferdams are needed for the placement of rock channel protection because the excavation will extend beyond an elevation of 842.86 ft (OHWM EL. 839.86 + 3.0), which is the maximum limit.

Structure:

Due to the varying geotechnical profile—ranging from mostly cohesive, medium stiff to very stiff soils with a thin medium dense cohesionless layer in B-001, to mostly cohesionless, loose to very dense soils with thin, stiff to hard cohesive layers in B-002 and B-003—and the proximity of the top of rock, either friction or point bearing piles can be used to support the structure. Pile tip elevations and ultimate bearing values (UBV) are provided for each option. Dynamic load testing is required for friction piles during driving.

Scour calculations were performed for both design and check flood events, with starting elevations and depths specified for abutments and piers. Buckling and axial compressive resistance analyses were conducted for HP12x53 and 16" CIP piles, confirming adequate factors of safety in accordance with AASHTO LRFD.

Introduction

This report documents the geotechnical exploration and recommendations for the replacement of Bridge No. COS-93-19.22 (SFN 1602160) with a new structure (SFN 1602161) on State Route 93 over White Eyes Creek in Coshocton County, Ohio. The project limits extend along S.R. 93, encompassing the bridge site and the adjacent approach roadways, as defined by ODOT Project Identification Number (PID) 115365.

The purpose of this geotechnical report is to present the findings of subsurface explorations, laboratory testing, and engineering analyses conducted to support the design and construction of the new bridge and its associated roadway improvements. The report includes detailed descriptions of the site geology, subsurface conditions, and laboratory test results, as well as recommendations for subgrade considerations, foundation design, and scour protection. The information provided herein is intended to guide the design team and construction personnel in selecting appropriate foundation systems and construction methods for the successful completion of the project.

The exploration and the design recommendations presented were performed and prepared in accordance with the following design manuals and specifications:

- ODOT Specifications for Geotechnical Explorations, January 2026.
- ODOT Bridge Design Manual, January 2026.
- ODOT Geotechnical Design Manual, January 2026.
- AASHTO LRFD Bridge Design Specifications, 10th Edition, 2024.
- ODOT Standard Construction Drawings
- ODNR Geological Survey resources

Geology and Observations of The Project

Historical Records

Historical records were obtained and reviewed from ODOT’s Transportation Information Mapping System (TIMS) for COS-93-8.89, sub-batch numbers 10727 and 2209, each completed in 1955, for the current S.R. 93 alignment and Bridge No. COS-93-0890, respectively. Historical subsurface explorations consisted of auger borings and drive rod penetration tests. This historical information was not utilized in the current design and is therefore not shown for clarity. Historical subsurface data was excluded because the old borings were either for previous alignments and or used drive rod methods, which cannot be reliably converted to useful engineering data for modern design. Recent, project-specific borings and laboratory tests provide more accurate and relevant information for this project.

Geology

The project is located within the non-glaciated Muskingum-Pittsburgh Plateau physiographic region, which is characterized as a moderate- to high-relief dissected plateau having broad major drainage valleys. These drainage valleys contain outwash and lacustrine terraces. The Ohio Department of Natural Resources (ODNR) interactive geologic map indicates that the overburden soils in the project area are predominately cohesive, underlain by Pennsylvanian-aged shale, siltstone, sandstone, conglomerate, and subordinate amounts of limestone, clay, flint, and coal of the Allegheny and Pottsville Groups, undivided. Rapid horizontal and vertical changes of rock types are common in this region.

EXPLORATION

Reconnaissance

Field reconnaissance was completed by personnel from the Office of Geotechnical Engineering (OGE) on June 3 and 12, 2025. The approach roadway was noted as being in poor condition with cracked pavement within the driving lanes and broken pavement along the shoulder, exposing rebar where the structure and paved surface meet. The structure is in poor condition due to age, with spalling and efflorescence of the concrete bridge deck, including rusted and dilapidated guard rail. There were no signs of current embankment instability. Beneath the structure, the stream meanders to the south side bank. Along the north side, the stream bed contains pooled, iron-stained water. The adjacent land usage was noted as being mostly wooded with rural residential lots to the west.

Project Subsurface Exploration

Three (3) borings, B-001-0-25 through B-003-0-25, were completed as part of the subsurface exploration between June 11 and 24, 2025. Drilling was completed with a truck-mounted CME 55 rotary drill rig utilizing 3.25-inch I.D. hollow stem (HSA) augers. Disturbed samples were collected in accordance with the Standard Penetration Test (AASHTO T206) at continuous 2.5- and 5-foot intervals within the overburden soils. Undisturbed soil samples were collected in B-001-0-25 and B-003-0-25 in accordance with AASHTO T207. The hammer system used was calibrated on November 7, 2023, with an average drill rod energy ratio (ER) of 88%. All borings were advanced into bedrock and sampled (AASHTO T225) using an N Series wireline core barrel, water method.

Strength testing was completed on select soil samples in accordance with AASHTO T208. Strength testing was completed on representative core samples in accordance with ASTM D7012, Method C.

EXPLORATION FINDINGS

B-001-0-25 and B-003-0-25 were completed within the existing roadway near the rear and forward abutments, encountering 2.5 and 6.0 inches of asphalt underlain by 15.5 and 6.0 inches of aggregate base, respectively, underlain by 15.5 and 6.0 inches of aggregate base, respectively. Beneath the surface materials, B-001-0-25 and B-003-0-25 encountered cohesive soils consisting of sandy silt (A-4a), silt (A-4b), and silt and clay (A-6a) in medium stiff to very stiff consistency and damp to wet moisture condition. The unconfined compressive strength test results were 1,077 PSF at 6.8% strain at EL. 825.3 ft within B-001-0-25 and 2,013 PSF at 4.5% strain at EL. 827.5 ft within B-003-0-25.

From EL. 838.0 to 834.8 ft, B-001-0-25 encountered wet stone fragments with sand (A-1-b) and coarse and fine sand (A-3a) in medium dense compactness underlain by stiff to hard silt (A-4b) and sandy silt (A-4a) that extended to top of bedrock. B-003-0-25 encountered non-cohesive soils from EL. 839.5 to EL. 806.0 ft consisting of medium dense to very dense stone fragments with sand and silt (A-2-4) and stone fragments with sand (A-1-b) in moist to wet condition underlain by very stiff sandy silt (A-4a), which extended to top of bedrock. A cobbly zone was encountered in B-003-0-25 between EL. 831.0 and 826.0 ft.

B-002-0-25 was completed through a pre-cored hole in the bridge deck, encountering predominately non-cohesive soils consisting of stone fragments with sand and silt (A-2-4), coarse and fine sand (A-3a), and stone fragments with sand (A-1-b) in variable compactness ranging from loose to very dense and variable moisture ranging from damp to wet to EL. 822.7 ft, where materials became moist. At EL. 805.2 ft, hard sandy silt (A-4a) in damp condition was encountered, extending to top of bedrock. Boulders and cobbles were encountered between EL. 843.7 and 840.7 ft.

Sandstone bedrock was encountered in B-001-0-25, B-002-0-25, and B-003-0-25 at EL. 804.8, 800.2, and 801.0 ft, respectively. The sandstone was described as slightly to moderately weathered and very weak to moderately strong. Unconfined compressive strength test results ranged from 167 to 5,567 PSI. These results are presented in tabular form in Table 1.

Table 1: Bedrock Test Summary

Exploration ID	Sample Elevation	Sample Depth	Q_u (psi)	Lithology
B-001-0-25	801.4' - 801.1'	51.9' - 52.2'	5,567	Sandstone
B-002-0-25	797.1' - 796.7'	46.6' - 47.0'	4,972	Sandstone
	793.4' - 793.0'	50.3' - 50.7'	4,450	Sandstone
	789.4' - 789.0'	54.3' - 54.7'	5,498	Sandstone
B-003-0-25	797.4' - 797.0'	57.1' - 57.5'	167	Sandstone

ANALYSES AND RECOMMENDATIONS

Roadway Subgrade

For this short-length bridge replacement project, the scope of subgrade construction is minimal. Therefore, standard procedures for subgrade compaction and proof rolling, as outlined in L&D Volume 3 Plan Note G121, are not applicable. Instead, Appendix C of the ODOT Pavement Design Manual (PDM), titled “Simplified Pavement Design for Short Projects,” is utilized. Alternatively, the pavement design may simply match the existing pavement buildup.

Scour Assessment:

For design year ADT (2046) of 1,700 and based on Other Highways (under 3,000 ADT), the Hydraulic Design Flood Frequency, per L&D V2 Section 1004.2, is 10 years (10% AEP). Thus, per L&D V2, Section 1008.10.5, the Scour Design Flood Frequency is 25 years (4% AEP), and the Scour Check Flood Frequency is 50 years (2% AEP). In accordance with HEC-18, Chapter 8, the scour calculation starting elevations at the abutments is at the elevation where flow is obstructed by the roadway embankment at the upstream end. At pier locations, the scour calculations start at the proposed ground elevation. In all cases, the scour calculation starting elevation should be at or below the applicable high-water flood event elevation but at or above the streambed elevation.

The plans show the high-water mark elevation for the 100-year frequency (1% AEP) as 846.85 ft and for the Hydraulic Design Flood Frequency (10 years at 10% AEP) as 844.68 ft. Elevations for the Scour Design Flood Frequency (4% AEP) and Scour Check Flood Frequency (2% AEP) are not provided but should fall between 846.85 and 844.68. The Scour Check Flood Frequency is applied for Extreme II Limit State checks and the Scour Design Flood Frequency is applied for the Strength and Service Limit State checks.

The following scour starting elevations were provided to the district for calculations:

Table 2: Scour Starting Elevation

Substructure Unit	Scour Starting Elevation
Rear Abutment	845.60'
Piers 1 & 2	842.22'
Forward Abutment	845.45'

Soil scour data was provided to the district on November 19, 2025, to assist in determining the potential scour depth, following Section 1302 of the GDM. The Soil scour data is summarized in Table 3: Scour Samples.

Table 3: Scour Samples

Boring ID	Sample ID	Sample Elevation	D50 Value (mm)	Erosion Category
B-001-0-25	SS-5	845.6' - 844.29'	0.2000	3.168

	SS-6	844.29' - 842.79'	0.2000	2.975
	SS-7	842.79' - 841.29'	0.2000	2.754
	SS-8	841.29' - 839.79'	0.2000	2.975
	SS-9a	839.79' - 838.29'	0.2000	2.754
	SS-9b	838.29' - 838.09'	0.4980	1.837
	SS-10	838.09' - 834.79'	0.2000	1.361
	SS-11	834.79' - 833.29'	0.2000	1.880
B-002-0-23	SS-1	842.22' - 840.72'	0.3680	1.679
	SS-2	840.72' - 839.22'	0.2000	1.361
	SS-3	839.22' - 837.72'	0.2620	1.502
	SS-4	837.72' - 836.22'	0.3290	1.621
	SS-5	836.22' - 834.72'	0.2000	1.361
	SS-6	834.72' - 832.72'	1.0960	2.248
	SS-7	832.72' - 830.22'	0.4160	1.743
B-003-0-25	SS-6	845.45' - 843.95'	0.2000	2.868
	SS-7	843.95' - 842.45'	0.2000	2.975
	SS-8	842.45' - 840.95'	0.2000	2.632
	SS-9	840.95' - 839.45'	0.2000	2.754

Perform rear abutment scour calculations using B-001-0-25, piers 1 and 2 using B-002-0-25, and forward abutment calculations using B-003-0-25. In accordance with L&D V2, Section 1008.10.4, use a D_{50} value of 0.2 mm for all soil samples where the measured D_{50} is less than or equal to 0.2 mm. For samples with a D_{50} greater than 0.2 mm, use the actual D_{50} value obtained from gradation testing. Where cohesive soils are present and the tested scour critical shear stress is not available, perform scour calculations with a D_{50} as for granular soil.

The district provided the table below as a summary of the scour calculation results.

OHIO DEPARTMENT OF TRANSPORTATION	DATE: 21-Jan-26	INITIALS: TAG	
DISTRICT 5 BRIDGE	PID: 115365	CHECKED BY:	
	CRS: COS-93-19.20		
CALCULATION SHEET	DESCRIPTION: SCOUR - Revised		

SCOUR - Revised

3 - Scour Design Flood	4%	1670	ft3/s
4 - Scour Check Flood	2%	2050	ft3/s

Contraction Scour	25 Yr	1.19	ft
Contraction Scour	50 Yr	-0.94	ft
Pier Scour	25 Yr	3.97	ft
Pier Scour	50 Yr	3.98	ft
Abutment Scour	25 Yr	1.08	ft
Abutment Scour	50 Yr	1.16	ft

FINAL SCOUR

Contraction Scour	50 Yr	-1	ft
Pier Scour	50 Yr	4	ft
Abutment Scour	50 Yr	0	ft

From these results, the contraction scour depth was calculated as –0.94 ft (assume 0) for the scour check flood frequency of 50 years (2% AEP) and 1.19 ft for the scour design flood frequency of 25 years (4% AEP). This is notable because it is the opposite of what would normally be expected. Such a result is typically possible only in the case of pressure flow, also known as orifice flow, which occurs when the water surface elevation at the upstream face of the bridge is greater than or equal to the low chord of the bridge superstructure. This condition does not apply to this bridge.

In the Final Scour table, it appears that the designer simply added the contraction scour to the abutment scour to estimate the final scour depth. This approach is incorrect for two reasons: (1) when scour depth is predicted as a negative value, it should be changed to 0 ft, and (2) abutment scour already includes contraction scour, so these two values should not be added together. Additionally, the Final Scour is only provided for the scour check flood frequency, which should be used for Extreme II Limit State checks, but not for the scour design flood frequency, which should be used for Strength Limit State checks.

We summarized the scour depths results as follows to arrive at the final depths that should be used for the design in Table 4:

Table 4: Scour Depths Summary

		Scour Depth (ft)	Use for the Design (ft)
Design Scour	Contraction Scour	1.19	
25 Yr	Pier Scour	3.97	5.16 (3.97+1.19)
	Abutment Scour	1.08	1.08
Check Scour	Contraction Scour	-0.94	0
50 Yr	Pier Scour	3.98	3.98 (3.98 + 0)
	Abutment Scour	1.16	1.16

Temporary Shoring

Temporary shoring at the roadway elevation will not be required for the construction of the new bridge. However, in accordance with the BDM Section 307.10.3.1, a pay item for Cofferdams and Excavation Bracing is required when excavation extends below the ground water table or below an elevation defined as 3-ft above the OHWM. Thus, Cofferdams are needed for the placement of rock channel protection because the excavation will extend beyond an elevation of 842.86 ft (OHWM EL. 839.86 + 3.0), which is the maximum limit.

Structure:

Driven piles are recommended for all substructure units. Due to the varying geotechnical profiles—ranging from mostly cohesive, medium-stiff to very stiff soils with a thin, medium-dense cohesionless layer in B-001, to mostly cohesionless, loose to very dense soils with thin, stiff to hard cohesive layers in B-002 and B-003—and the proximity of the top of rock, either CIP friction piles or end-bearing H-piles driven to refusal on bedrock can be used to support the structure. While we have not performed a cost analysis, driven H-piles are typically more cost-effective than CIP friction piles. However, if the estimated length of H-piles is approximately 15 ft greater than that of CIP friction piles, CIP friction piles may be more economical. Additionally, while H-piles bearing on rock are generally easier to construct since they do not require backfilling with concrete, reinforcement bars, or dynamic load testing, as is required for friction CIP piles, they will require concrete encasement if used to support the capped-pile piers.

We have performed GRLWEAP drivability analyses to determine pile driving stresses, steel grade, and minimum pile wall thicknesses for the CIP pipe piles and to determine if the H-piles can be driven to refusal on bedrock without overstressing the pile for the point bearing piles option. The driving stresses in the piles will not exceed the permissible driving stresses for Steel CIP Piles ASTM A252, Grade 3 - Yield Strength 45 ksi, using pile wall thickness of 0.313 in and for H-Piles ASTM A572 - yield strength 50 ksi. The driving stresses must be kept below 90% of the steel yield strength per AASHTO LRFD Bridge Design Specifications Article 10.7.8. For Grade 3 Steel with yield strength of 45 ksi, the compressive driving stresses must be kept below 40.5 ksi. For Steel H-Piles ASTM A572 with yield strength 50 ksi, the compressive driving stresses must be kept below 45 ksi.

Buckling and axial compressive resistance analyses were conducted for HP12x53 and 16" CIP piles, confirming adequate resistance in accordance with AASHTO LRFD.

For the friction CIP piles, according to the BDM Equations C305.3.2.4-4 and C305.3.2.4-5 and based on the calculated EOID and UBV values, the estimated driving resistance indicates that driving losses would not result in an increase in pile length during driving by more than 10 feet at EOID as compared to the UBV, and thus, soil setup does not need to be accounted for in the design at the abutment piles.

As the bridge has short capped-pile stub abutments, we anticipate the lateral loadings on the piles to be insignificant (and their freedom of movement to be extremely limited), and therefore, we do not consider p-y analyses or other lateral load analyses on the bridge foundations to be necessary. The piles have a factored shear resistance more than 10 times the factored lateral load provided by the structural designer at the abutments.

Pile downdrag and drag loading are not anticipated to be significant, as there is a minimal change in the grade behind the proposed abutment. A global stability analysis was not performed for this project because field observations indicated no signs of existing embankment or slope instability, and the proposed work involves minimal to no change in the existing grade. Given these factors, the risk of global instability is considered low. Should site conditions change significantly during construction, or if instability is observed, a global stability assessment should be re-evaluated at that time.

Based on the cobbles and boulders encountered at the project site, provide conical pile points if friction CIP piles are used, or steel pile shoes if point-bearing H-piles are used. These will protect the tips of the steel piles at all substructure units, per BDM 305.3.5.6.

Based on the provided bridge loads; the foundation recommendations for “Friction 12” CIP at the Abutments and 16” CIP”, “Friction 16” CIP at Piers and Abutments”, and “Point H-Piles Bearing on Rock at all Substructure units” are presented in tables 5, 6, and 7 below.

Please note that at the rear abutment, the 12” CIP and 16” CIP piles’ tip elevation is estimated to be at the top of rock elevation and, therefore, they are predicted to be end-bearing. In an attempt to raise the piles’ tip elevation some distance above the top of rock elevation, we have investigated friction 16” CIP piles; however, the piles continue to tip at the top of rock elevation. If desired by the district, we can investigate larger diameter CIP piles to achieve a tip elevation above the top of rock.

The tables include both estimated and order lengths for piles to account for construction tolerances, potential variations in field conditions, and to ensure that piles can be installed to the required depths even if subsurface conditions differ slightly from those encountered during exploration. The estimated length is based on geotechnical analysis and design requirements, while the order length provides an additional allowance to accommodate unforeseen site-specific factors and to facilitate efficient construction without delays due to material shortages.

Table 5: Friction 12” CIP at the Abutments and 16” CIP

Substructure Unit	Factored Load (Kips)	Q_p/ϕ_{dyn} (Kips)	UBV (Kips)	Pile Tip EL.	Friction Resist. Lost due Scour	Geotechnical Pile Length	Estimated Length	Order Length
Forward Abut. 12” CIP	146	208.57	221.18	823.43	12.61	23.07 [1]	25	30
Piers 1 & 2 16” CIP	177	252.86	326.73	817.63	73.87	34.66 [2]	40	45
Rear Abut. 12” CIP	146	208.57	208.57	804.99	0	41.51 [1]	45	50

[1] the Geotechnical Pile Length includes the Pile Cap Embedment depth of 2.0 ft at the abutments.

[2] the Geotechnical Pile Length includes the Pile Cap Embedment depth of 1.5 ft and 13.79 ft of stickup length at the piers.

[3] Steel for the 12" CIP and 16" CIP conforms to ASTM A252, Grade 3, with pile wall thickness of 0.313".

Table 6: Friction 16” CIP at Piers and Abutments

	Factored Load (Kips)	Q_p/ϕ_{dyn} (Kips)	UBV (Kips)	Pile Tip EL.	Friction Resist. Lost due Scour	Geotechnical Pile Length	Estimated Length	Order Length
Forward Abut. 16” CIP [3]	146	208.57	215.29	831.36	6.72	17 [1, 4]	20	25
Piers 1 & 2 16” CIP [3]	177	252.86	326.73	817.63	73.87	34.66 [2]	40	45
Rear Abut. 16” CIP [3]	146	208.57	208.57	804.92	0	41.58 [1]	45	50

[1] the Geotechnical Pile Length includes the Pile Cap Embedment depth of 2.0 ft at the abutments.

[2] the Geotechnical Pile Length includes the Pile Cap Embedment depth of 1.5 ft and 13.79 ft of stickup length at the piers.

[3] Steel for 16" CIP conforms to ASTM A252, Grade 3, with pile wall thickness of 0.313".

[4] Piles extended to 15-ft below the maximum estimated scour depth to satisfy the minimum penetration requirement per BDM Section 305.3.2.1.

Table 7: Point H-Piles Bearing on Rock at all Substructure units

Substructure unit	Bottom Abut. EL.	Factored Load (Kips)	Pile Tip EL.	Geotechnical Length	Estimated Length	Order Length
Forward Abut. HP10x42 [3]	844.50	146	801.00	45.50 [1]	50	55
Piers 1 & 2 HP12x53 [3]	837.0 (Ground EL.)	177	800.20	52.09 [2]	55	60
Rear Abut. HP10x42 [3]	844.50	146	804.80	41.70 [1]	45	50

[1] the Geotechnical Pile Length includes the Pile Cap Embedment depth of 2.0 ft at the abutments.

[2] the Geotechnical Pile Length includes the Pile Cap Embedment depth of 1.5 ft and 13.79 ft of stickup length at the piers.

[3] Steel for HP10x42 and HP12x53 conforms to ASTM A572 - yield strength 50 ksi.

CLOSING REMARKS

Add the geotechnical plan notes provided in Appendix B of this report to the Structures General Notes. Include the following pay items in the estimated quantities. Based on the selected foundation type, choose either H-piles, 12” CIP at the abutments and 16” CIP at the piers, or only 16” CIP piles as pay items:

Item	Item Description	Units
503E11100	COFFERDAMS AND EXCAVATION BRACING	LS
507E00100	Steel Piles HP10x42, Furnished	FT
507E00150	Steel Piles HP10x42, Driven	FT
507E00200	Steel Piles HP12x53, Furnished	FT
507E00250	Steel Piles HP12x53, Driven	FT
507E00500	12" Cast-In-Place Reinforced Concrete Piles, Driven	FT
507E00550	12" Cast-In-Place Reinforced Concrete Piles, Furnished	FT
507E00700	16" Cast-In-Place Reinforced Concrete Piles, Driven	FT
507E00750	16" Cast-In-Place Reinforced Concrete Piles, Furnished	FT
505E11100	Pile Driving Equipment Mobilization	LS
523E20001	Dynamic Load Testing, As Per Plan	EACH
507E93300	Steel Points or Shoes	EACH

If you have any questions, please feel free to contact either myself at 614-387-2379, or Alex Dettloff, at 614-275-1308.

Thank you,

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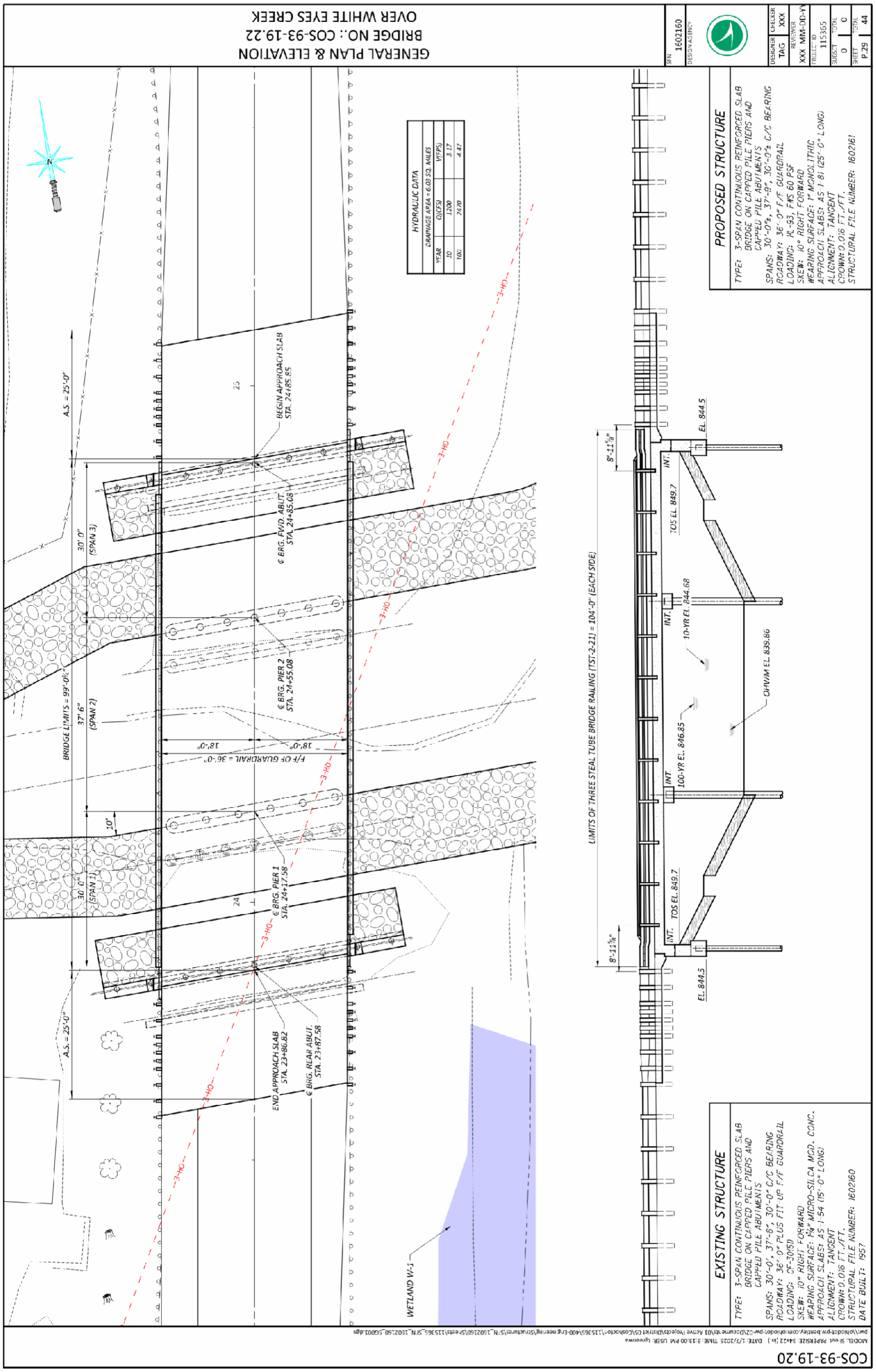
APPENDICES

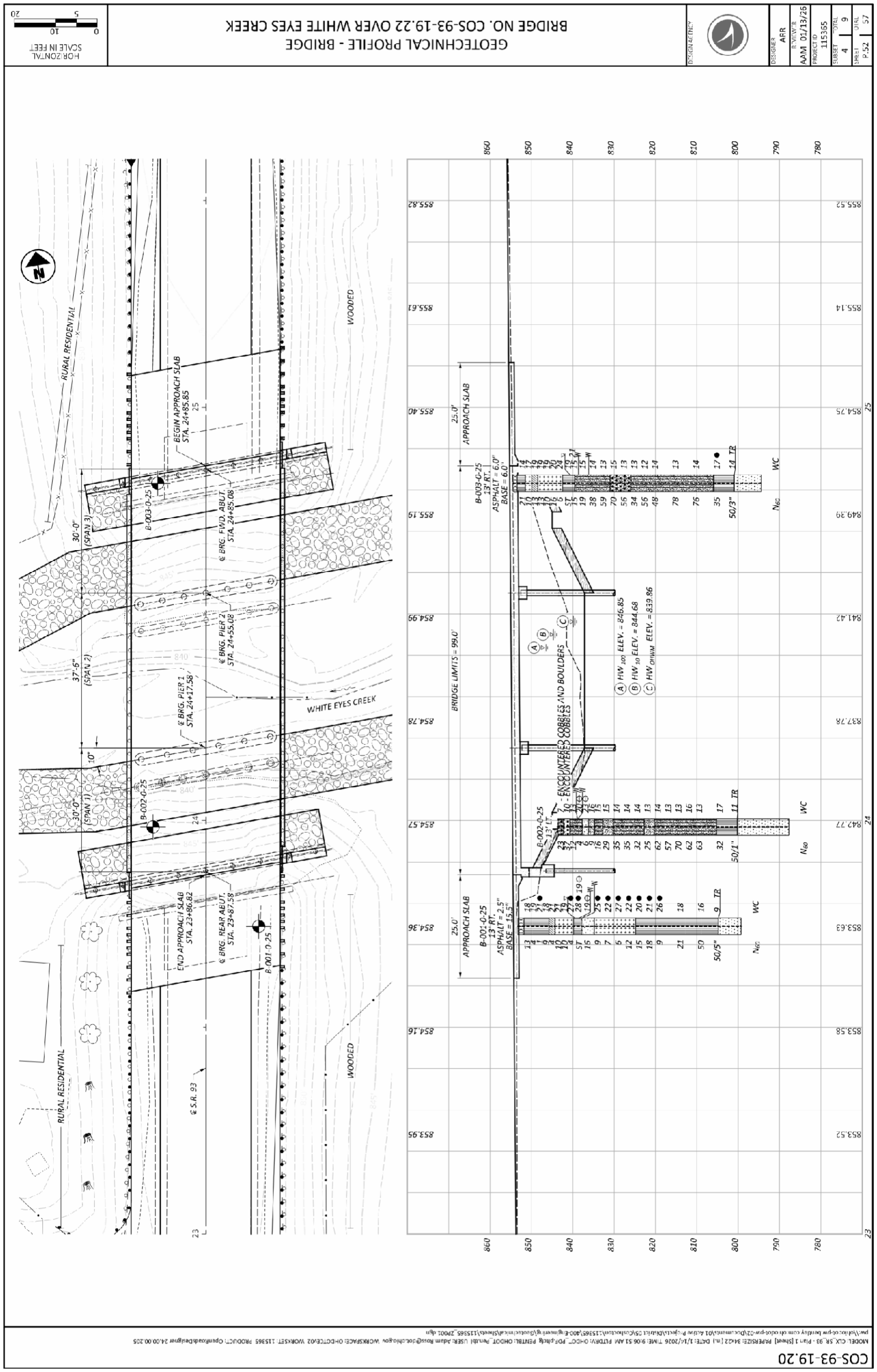
- Appendix A: Bridge Site Plan
- Appendix B: Geotechnical Profile Bridge Site Plan
- Appendix C: Geotechnical Plan Notes.
- Appendix D: Snapshot of ODNR Bedrock Topography of the Baltic, Ohio, Quadrangle Map.
- Appendix E: Boring Location Plan
- Appendix F: Project Boring Logs
- Appendix G: Rock Core Photos
- Appendix H: Unconfined Compressive Strength Test Reports
- Appendix I: Pile Nominal Resistance versus Embedment Depth Graphs
- Appendix J: Buckling Analyses for Piers 1 and 2

- *Drivability analyses are available upon request.*

Appendix A: Bridge Site Plan



Appendix B: Geotechnical Profile Bridge Site Plan



Appendix C: Geotechnical Plan Notes

Include the following plan note, no matter which foundation type is selected:

SCOUR ELEVATIONS:
The Design Flood and Check Flood scour elevations are provided below:

Flood Frequency (Return Period, AEP)	Rear Abutment	Pier 1	Pier 2	Forward Abutment
Scour Design (25 years, 4%)	843.42	831.84	831.84	843.42
Scour Check (50 years, 2%)	843.34	833.02	833.02	843.34

Use the following plan notes if friction 12” CIP piles at the abutments and 16” CIP piles at the piers are selected:

Add to BDM Sample Note [602.3-1] Design Data:
STEEL CIP PILES – ASTM A252 GRADE 3 - YIELD STRENGTH 45 KSI

PILE DESIGN LOADS (ULTIMATE BEARING VALUE):

THE ULTIMATE BEARING VALUE (UBV), THE POSSIBLE FRICTIONAL RESISTANCE LOST DUE TO SCOUR, THE PREDICTED SCOUR DEPTH, AND THE MINIMUM TIP ELEVATION ARE SUMMARIZED IN THE TABLE BELOW. DRIVE THE PILES TO EITHER THE UBV OR THE MINIMUM TIP ELEVATION, WHICHEVER IS DEEPER.

SUBSTRUCTURE UNIT	UBV (KIPS)	POSSIBLE FRICTIONAL RESISTANCE LOST DUE TO SCOUR (KIPS)	PREDICTED SCOUR DEPTH (FT)	MINIMUM PILE TIP EL. (FT)
FORWARD ABUT.	221.18	12.61	1.08	823.43
PIERS 1 & 2	326.73	73.87	5.16	817.63
REAR ABUT.	208.57	0	1.08	804.99

FORWARD ABUTMENT PILES:
12" CAST-IN-PLACE REINFORCED CONCRETE PILES, 30 FEET LONG, ORDER LENGTH
1 DYNAMIC LOAD TESTING ITEMS

REAR ABUTMENT PILES:
12" CAST-IN-PLACE REINFORCED CONCRETE PILES, 50 FEET LONG, ORDER LENGTH
1 DYNAMIC LOAD TESTING ITEMS

PIER 1 AND 2 PILES:
16" CAST-IN-PLACE REINFORCED CONCRETE PILES, 45 FEET LONG, ORDER LENGTH
1 DYNAMIC LOAD TESTING ITEMS

PROVIDE PLAIN CYLINDRICAL CASINGS WITH A MINIMUM PILE WALL THICKNESS OF 0.313 INCH FOR THE CAST-IN-PLACE REINFORCED CONCRETE PILES. USE CONICAL STEEL PILE POINTS TO PROTECT THE TIPS OF THE PROPOSED STEEL CIP REINFORCED CONCRETE PIPE PILES AT ALL SUBSTRUCTURE UNITS.

Use the following plan notes if friction 16” CIP piles at both the abutments and the piers are selected:

Add to BDM Sample Note [602.3-1] Design Data:

STEEL CIP PILES – ASTM A252 GRADE 3 - YIELD STRENGTH 45 KSI

PILE DESIGN LOADS (ULTIMATE BEARING VALUE):
THE ULTIMATE BEARING VALUE (UBV), THE POSSIBLE FRICTIONAL RESISTANCE LOST DUE TO SCOUR, THE PREDICTED SCOUR DEPTH, AND THE MINIMUM TIP ELEVATION ARE SUMMARIZED IN THE TABLE BELOW. DRIVE THE PILES TO EITHER THE UBV OR THE MINIMUM TIP ELEVATION, WHICHEVER IS DEEPER.

SUBSTRUCTURE UNIT	UBV (KIPS)	POSSIBLE FRICTIONAL RESISTANCE LOST DUE TO SCOUR (KIPS)	PREDICTED SCOUR DEPTH (FT)	MINIMUM PILE TIP EL. (FT)
FORWARD ABUT.	215.29	6.72	1.08	831.36
PIERS 1 & 2	326.73	73.87	5.16	817.63
REAR ABUT.	208.57	0	1.08	804.92

FORWARD ABUTMENT PILES:
16" CAST-IN-PLACE REINFORCED CONCRETE PILES, 25 FEET LONG, ORDER LENGTH
1 DYNAMIC LOAD TESTING ITEMS

REAR ABUTMENT PILES:
16" CAST-IN-PLACE REINFORCED CONCRETE PILES, 50 FEET LONG, ORDER LENGTH
1 DYNAMIC LOAD TESTING ITEMS

PIER 1 AND 2 PILES:
16" CAST-IN-PLACE REINFORCED CONCRETE PILES, 45 FEET LONG, ORDER LENGTH
1 DYNAMIC LOAD TESTING ITEMS

PROVIDE PLAIN CYLINDRICAL CASINGS WITH A MINIMUM PILE WALL THICKNESS OF 0.313 INCH FOR THE CAST-IN-PLACE REINFORCED CONCRETE PILES. USE CONICAL STEEL PILE POINTS TO PROTECT THE TIPS OF THE PROPOSED STEEL CIP REINFORCED CONCRETE PIPE PILES AT ALL SUBSTRUCTURE UNITS.

Use the following plan notes if point bearing H-Piles to rock at the abutments and the piers are selected:

Add to BDM Sample Note [602.3-1] Design Data:
STEEL H-PILES - ASTM A572 - YIELD STRENGTH 50 KSI

PILES TO BEDROCK:
DRIVE PILES TO REFUSAL ON BEDROCK. THE DEPARTMENT WILL CONSIDER REFUSAL TO BE OBTAINED WHEN THE PILE PENETRATION IS AN INCH OR LESS AFTER RECEIVING AT LEAST 20 BLOWS FROM THE PILE HAMMER. SELECT THE HAMMER SIZE TO ACHIEVE THE REQUIRED DEPTH TO BEDROCK AND REFUSAL. THE TOTAL FACTORED LOAD IS 146 KIPS PER PILE FOR THE ABUTMENT PILES. THE ABUTMENT PILES WERE DESIGNED TO ACCOMMODATE 1.08 FT. OF SCOUR. THE TOTAL FACTORED LOAD IS 177 KIPS PER PILE FOR THE PIER PILES. THE PIER PILES WERE DESIGNED TO ACCOMMODATE 5.16 FT. OF SCOUR.

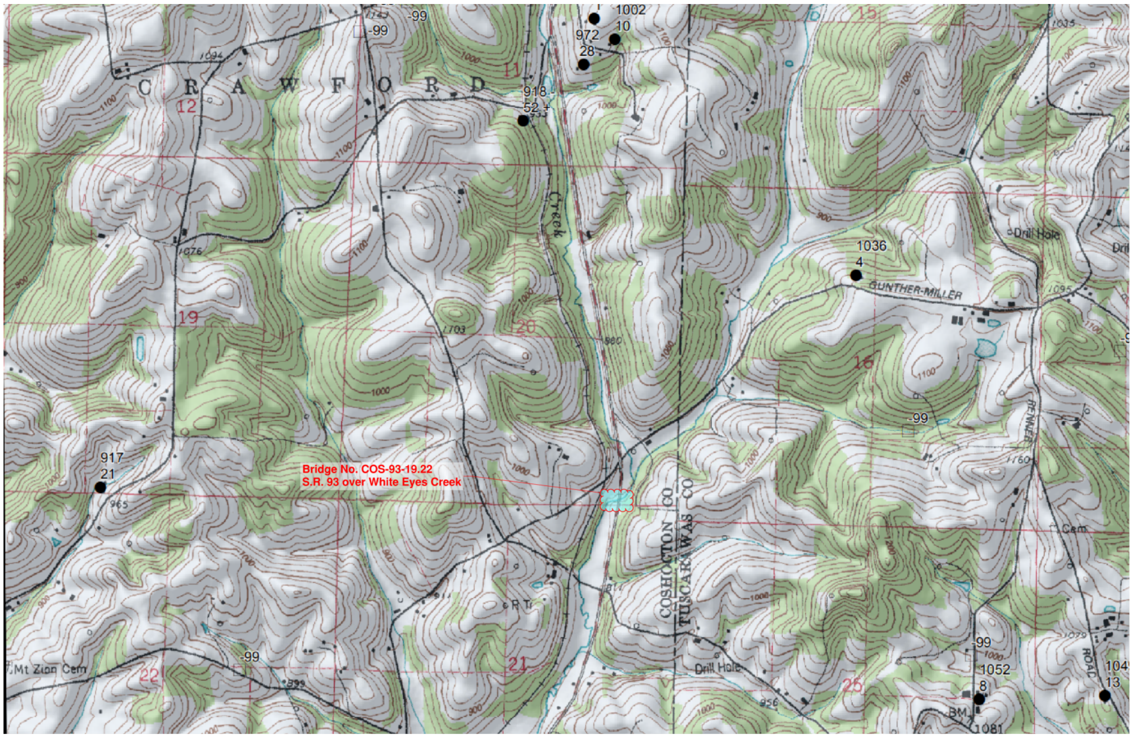
REAR ABUTMENT PILES:
HP10X42 PILES 50 FEET LONG, ORDER LENGTH

FORWARD ABUTMENT PILES:
HP10X42 PILES 55 FEET LONG, ORDER LENGTH

PIERS 1 AND 2 PILES:
HP12X53 PILES 60 FEET LONG, ORDER LENGTH

USE STEEL PILE POINTS TO PROTECT THE TIPS OF THE PROPOSED STEEL H-PILES AT ALL SUBSTRUCTURE UNITS.

Appendix D: Snapshot of ODNR Bedrock Topography of the Baltic, Ohio, Quadrangle Map at the Project Site.



Appendix E: Boring Location Plan.

Appendix F: Project Boring Logs

PROJECT:	COS-93-19.20	DRILLING FIRM/OPERATOR:	ODOT/M. Blodgett	DRILL RIG:	CME 55 Truck NWJ	STATION/OFFSET:	23+74, 13' Rt.
TYPE:	Bridge	SAMPLING FIRM/LOGGER:	ODOT/J. Sprouse	HAMMER:	Automatic	ALIGNMENT:	CL SR 93
PID:	115365 SFN: 1602161 (P)	DRILLING METHOD:	3.25" HSA/NQ2	CALIBRATION DATE:	11/07/2023	ELEVATION:	853.3 (ft.) EOB: 54.0 ft.
START:	06/11/2025 END: 06/16/2025	SAMPLING METHOD:	SPT/ST/NQ2	ENERGY RATIO (%):	88	LAT/LONG:	40.386065, -81.715194

EXPLORATION ID: B-001-0-25
PAGE: 1OF1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS
ASPHALT 2.5 IN	853.1	
BASE 15.5 IN	851.8	
SANDY SILT, very stiff, brown and gray, some clay, trace stone fragments, moist. @3.0'; stiff @6.0'; very stiff	845.8	
SILT AND CLAY, stiff, brown and gray, little sand, moist. Bottom of Rear Abutment Elevation of 844.50	844.3	
SILT, very stiff, brown and gray, some clay, little sand, trace stone fragments, moist. @10.5'; no stone fragments @12.0'; stiff, wet	839.8	▽ 839.5
SANDY SILT, medium stiff, gray, little clay, wet. @14.0'; QU = 1,078 PSF @ 6.81% STRAIN; γd = 99.56 PCF	838.0	W 838.5
STONE FRAGMENTS WITH SAND, medium dense, gray, trace silt, trace clay, wet.	837.8	W 837.8
COARSE AND FINE SAND, medium dense, gray and white, little silt, trace stone fragments, trace clay, wet.	834.8	
SILT, stiff, gray, little sand, little clay, wet. @23.0'; some sand, trace stone fragments	824.8	
SANDY SILT, stiff, gray, little clay, trace stone fragments, wet. @31.0 - 33.5'; very stiff	814.8	
SANDY SILT, very stiff, gray, some clay, trace stone fragments, moist. @43.5'; Hard, gray and brown	804.8	TR
SANDSTONE, Gray, moderately weathered, moderately strong, very fine grained to medium grained, very thin to thin bedded, micaceous, joint, fractured to moderately fractured, narrow, slightly rough; blocky, good; Unit RQD 70%, Unit Rec 95%. @51.9'; δ = 150 pcf; Qu = 5,567 psi	799.3	EOB

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)
					GR	CS	FS	SI	CL	LL	PL	PI		
6 5 4	13	67	SS-1	3.25	5	3	20	49	23	27	17	10	18	A-4a(7)
1 1 2	4	67	SS-2	1.50	1	2	35	42	20	23	15	8	19	A-4a(5)
0 0 1	1	61	SS-3	1.50	1	2	28	49	20	24	16	8	21	A-4a(7)
3 3 3	9	67	SS-4	2.25	2	3	29	46	20	23	16	7	18	A-4a(6)
0 1 2	4	61	SS-5	1.75	0	1	11	62	26	29	17	12	21	A-6a(9)
1 3 4	10	72	SS-6	3.50	1	1	12	59	27	28	18	10	21	A-4b(8)
2 3 4	10	78	SS-7	3.75	0	1	19	58	22	25	17	8	19	A-4b(8)
1 1 2	4	100	SS-8	1.00	0	0	19	55	26	28	18	10	27	A-4b(8)
	0	100	ST-9a	1.00	0	2	44	34	20	23	15	8	28	A-4a(4)
			ST-9b		44	7	33	9	7	NP	NP	NP	19	A-1-b(0)
4 7 4	16	61	SS-10		7	11	67	11	4	NP	NP	NP	19	A-3a(0)
1 2 4	9	78	SS-11	1.75	0	1	18	67	14	24	22	2	25	A-4b(8)
1 2 3	7	72	SS-12	2.00	-	-	-	-	-	-	-	-	22	A-4b (V)
0 1 3	6	78	SS-13	1.25	2	1	19	63	15	26	20	6	27	A-4b(8)
3 3 5	12	78	SS-14	1.50	1	0	25	59	15	24	21	3	22	A-4b(8)
2 4 6	15	67	SS-15	1.00	6	2	30	47	15	22	18	4	20	A-4a(5)
9 6 6	18	89	SS-16	2.75	-	-	-	-	-	-	-	-	21	A-4a (V)
0 2 4	9	72	SS-17	2.00	-	-	-	-	-	-	-	-	26	A-4a (V)
4 6 8	21	94	SS-18	4.00	1	0	33	43	23	22	16	6	18	A-4a(6)
8 13 21	50	75	SS-19	4.50	-	-	-	-	-	-	-	-	16	A-4a (V)
50/5"	-	60	SS-20		-	-	-	-	-	-	-	-	9	Rock (V)
46		88	RC-1											Rock (V)
86		100	RC-2											Rock (V)

NOTES: Latitude/Longitude/Elevation from survey grade instruments.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: Tremied 30 gal. bentonite grout; Auger cuttings mixed with 50 lbs. bentonite chips; Placed asphalt patch.

PROJECT: COS-93-19.20	DRILLING FIRM/OPERATOR: ODOT/J. Sprouse	DRILL RIG: CME 55 Truck NWJ	STATION/OFFSET: 23+98, 13' Lt.
TYPE: Bridge	SAMPLING FIRM/LOGGER: ODOT/J. Kolberg	HAMMER: Automatic	ALIGNMENT: CL SR 93
PID: 115365 SFN: 1602161 (P)	DRILLING METHOD: 3.25" HSA/NQ2	CALIBRATION DATE: 11/07/2023	ELEVATION: 843.7 (ft.) EOB: 56.0 ft.
START: 06/23/2025 END: 06/24/2025	SAMPLING METHOD: SPT/NQ2	ENERGY RATIO (%): 88	LAT/LONG: 40.386142, -81.715270

EXPLORATION ID: B-002-0-25
PAGE 1OF1

MATERIAL DESCRIPTION AND NOTES	ELEV.
STONE FRAGMENTS WITH SAND AND SILT, medium dense, light brown and dark brown, trace clay, contains concrete cobbles and boulders, damp.	842.2
COARSE AND FINE SAND, dense, light brown and dark brown, little stone fragments, little silt, trace clay, contains cobbles, moist.	840.7
STONE FRAGMENTS WITH SAND AND SILT, medium dense, light brown and dark brown, trace clay, wet. @4.5'; very loose	837.7
COARSE AND FINE SAND, loose, light brown, little silt, little stone fragments, trace clay, wet.	836.2
STONE FRAGMENTS WITH SAND, loose, brown and reddish brown, little silt, trace clay, wet.	834.7
STONE FRAGMENTS WITH SAND AND SILT, medium dense, olive brown and gray, trace clay, wet.	832.7
STONE FRAGMENTS WITH SAND, medium dense, grayish brown, little silt, trace clay, wet.	830.2
STONE FRAGMENTS WITH SAND AND SILT, dense, grayish brown and, trace clay, wet. @16.0'; brown	822.7
STONE FRAGMENTS WITH SAND, medium dense, brown, little silt, trace clay, moist.	820.2
STONE FRAGMENTS WITH SAND AND SILT, very dense, brown, trace clay, moist.	805.2
SANDY SILT, hard, brown, some clay, trace stone fragments, damp.	800.2
SANDSTONE, Gray, moderately weathered, slightly strong, very fine grained.	797.7
SANDSTONE, Gray, slightly weathered, moderately strong, fine grained to medium grained, very thin to thin bedded, joint, moderately fractured, narrow, slightly rough; blocky, fair; Unit RQD 78%, Unit Rec 100%. @46.6'; δ = 146 pcf; Qu = 4,972 psi @48.3 - 48.5'; high angle fracture	795.0
SANDSTONE, Black, moderately weathered, moderately strong, very fine grained, very thin bedded, carbonaceous, argillaceous, joint, fractured to moderately fractured, narrow, slightly rough; blocky, poor; Unit RQD 37%, Unit Rec 97%. @49.6 - 50.2'; severely weathered @50.3'; δ = 200 pcf; Qu = 4,450 psi @53.0 - 53.4'; impure coal	790.0
SANDSTONE, White and light gray, moderately weathered, moderately strong, fine grained, thin bedded, siliceous, joint, moderately to slightly fractured, narrow, slightly rough; blocky, fair; Unit RQD 93%, Unit Rec 100%. @54.3'; δ = 154 pcf; Qu = 5,498 psi	787.7

DEPTHS: W 838.8; W 838.7; TR; EOB

Top of Existing Grade Elevation of 837.0

SPT/RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
3 6 10	23	47	SS-1		41	5	44	7	3	NP	NP	NP	7	A-2-4(0)	
3 12 13	37	72	SS-2		16	1	62	15	6	NP	NP	NP	10	A-3a(0)	
3 4 4	12	56	SS-3		32	6	42	14	6	NP	NP	NP	13	A-2-4(0)	
3 2 1	4	56	SS-4		31	13	39	12	5	NP	NP	NP	20	A-2-4(0)	
0 2 2	6	11	SS-5		11	13	56	14	6	NP	NP	NP	23	A-3a(0)	
1 3 3	9	44	SS-6		45	14	25	11	5	NP	NP	NP	16	A-1-b(0)	
3 3 8	16	61	SS-7		37	13	32	13	5	NP	NP	NP	15	A-2-4(0)	
6 8 12	29	72	SS-8		41	11	30	13	5	NP	NP	NP	15	A-1-b(0)	
10 12 12	35	50	SS-9		35	13	34	13	5	NP	NP	NP	14	A-2-4(0)	
9 12 12	35	83	SS-10		31	17	29	16	7	NP	NP	NP	14	A-2-4(0)	
10 9 13	32	67	SS-11		28	15	33	17	7	NP	NP	NP	14	A-2-4(0)	
13 10 7	25	78	SS-12		41	13	25	15	6	NP	NP	NP	13	A-1-b(0)	
8 21 21	62	78	SS-13		32	17	31	14	6	NP	NP	NP	14	A-2-4(0)	
20 19 20	57	78	SS-14		23	11	43	16	7	NP	NP	NP	13	A-2-4(0)	
11 25 23	70	83	SS-15	1.75	36	11	28	17	8	NP	NP	NP	13	A-2-4(0)	
17 22 20	62	100	SS-16	1.50	27	16	33	17	7	NP	NP	NP	16	A-2-4(0)	
18 20 23	63	83	SS-17		24	19	30	19	8	NP	NP	NP	13	A-2-4(0)	
8 10 12	32	58	SS-18	4.25	5	2	33	39	21	22	18	4	17	A-4a(5)	
50/1"		104	SS-19		-	-	-	-	-	-	-	-	11	Rock (V)	
79		100	RC-1											Rock (V)	
39		94	RC-2											Rock (V)	
67		100	RC-3											Rock (V)	

NOTES: Bridge deck boring, 10.1' below road surface. Latitude/Longitude/Elevation from survey grade instruments.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: N/A.

PROJECT:	COS-93-19.20	DRILLING FIRM/OPERATOR:	ODOT/Rian Lopez	DRILL RIG:	CME 55 Truck NWJ	STATION/OFFSET:	24+82, 12' Lt.
TYPE:	Bridge	SAMPLING FIRM/LOGGER:	ODOT/J. Kolberg	HAMMER:	Automatic	ALIGNMENT:	CL SR 93
PID: 115365	SFN: 1602161 (P)	DRILLING METHOD:	3.25" HSA/NQ2	CALIBRATION DATE:	11/07/2023	ELEVATION: 854.5 (ft.)	EOB: 60.0 ft.
START: 06/17/2025	END: 06/18/2025	SAMPLING METHOD:	SPT/ST/NQ2	ENERGY RATIO (%):	88	LAT/LONG:	40.386367, -81.715217

EXPLORATION ID: B-003-0-25

PAGE: 1OF1

MATERIAL DESCRIPTION AND NOTES	ELEV.	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
ASPHALT 6.0 IN	854.0																	
BASE 6.0 IN	853.5																	
SANDY SILT, very stiff, brown, some clay, trace stone fragments, damp.	851.5		6 7 7	21	53	SS-1	3.50	12	1	16	47	24	26	17	9	14	A-4a(7)	
SILT, very stiff, brown, some clay, some sand, little stone fragments, moist.	850.0		3 3 4	10	56	SS-2	3.00	11	1	18	50	20	26	17	9	17	A-4b(7)	
SILT AND CLAY, very stiff, mottled brown gray, little sand, trace stone fragments, moist.	848.5		3 4 5	13	81	SS-3	3.50	4	1	13	55	27	29	18	11	19	A-6a(8)	
SILT, very stiff, gray, some clay, some sand, trace stone fragments, moist.			3 3 6	13	33	SS-4	2.50	3	2	19	53	23	27	18	9	19	A-4b(8)	
@7.5'; little sand			3 3 4	10	67	SS-5	3.50	4	0	19	53	24	26	18	8	19	A-4b(8)	
Bottom of Abutment Elevation of 844.50			3 4 7	16	83	SS-6	3.00	7	2	16	51	24	28	19	9	20	A-4b(8)	
@10.5'; stiff, no stone fragments	842.5		2 2 2	6	81	SS-7	1.20	0	1	12	58	29	30	20	10	24	A-4b(8)	
SANDY SILT, stiff, mottled brown and gray, some clay, trace stone fragments, moist.				0	100	ST-8	1.75	1	2	30	46	21	25	18	7	19	A-4a(6)	
@13.5'; QU = 2,013 PSF @ 4.45% STRAIN; γd = 107.38 PCF	839.5	▽ 840.1	4 5 5	15	44	SS-9a	1.75	1	2	28	45	24	28	20	8	21	A-4a(7)	
STONE FRAGMENTS WITH SAND AND SILT, medium dense, reddish brown and gray, trace clay, moist.		W 838.7				SS-9b		28	7	33	22	10	NP	NP	NP	15	A-2-4(0)	
			3 6 7	19	50	SS-10		-	-	-	-	-	-	-	-	15	A-2-4 (V)	
@18.5'; dense		W 836.2	11 14 12	38	83	SS-11		-	-	-	-	-	-	-	-	14	A-2-4 (V)	
@21.0'; very dense	831.0		13 19 21	59	72	SS-12		-	-	-	-	-	-	-	-	13	A-2-4 (V)	
STONE FRAGMENTS WITH SAND, very dense, brown, little silt, trace clay, contains cobbles, wet.			19 24 24	70	89	SS-13		42	10	23	17	8	20	17	3	15	A-1-b(0)	
	826.0		28 17 21	56	50	SS-14		-	-	-	-	-	-	-	-	13	A-1-b (V)	
STONE FRAGMENTS WITH SAND AND SILT, dense, brown, trace clay, wet.			8 12 11	34	83	SS-15		33	13	28	18	8	20	16	4	13	A-2-4(0)	
@31.0 - 33.5'; very dense			16 20 18	56	61	SS-16		-	-	-	-	-	-	-	-	12	A-2-4 (V)	
			12 17 16	48	92	SS-17		-	-	-	-	-	-	-	-	14	A-2-4 (V)	
@38.5'; very dense			18 19 34	78	61	SS-18		-	-	-	-	-	-	-	-	13	A-2-4 (V)	
	806.0		18 21 31	76	56	SS-19		24	12	36	19	9	18	15	3	14	A-2-4(0)	
SANDY SILT, very stiff, gray and brown, little clay, trace stone fragments, wet.	801.0	TR	12 12 12	35	89	SS-20	2.50	3	2	29	47	19	18	15	3	17	A-4a(6)	
SANDSTONE, Grayish black, moderately weathered, very weak, fine grained, thin bedded, argillaceous, joint, fractured to moderately fractured, narrow, slightly rough; blocky, good; Unit RQD 58%, Unit Rec 100%.			50/3"	-	100	SS-21	4.00	-	-	-	-	-	-	-	-	14	Rock (V)	
			17		96	RC-1											Rock (V)	
@57.1'; δ = 155 pcf; Qu = 167 psi	794.5	EOB	86		100	RC-2											Rock (V)	

NOTES: Latitude/Longitude/Elevation from survey grade instruments.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: Tremied 50 lbs. bentonite grout; Auger cuttings mixed with 50 lbs. bentonite chips; Placed 5 lbs. asphalt patch.

Appendix G: Rock Core Photos

OHIO DEPARTMENT OF
TRANSPORTATION
DIVISION OF ENGINEERING

Office of Geotechnical Engineering

B-001-0-25

Run #:	Depth		Recovery		RQD	
RC-1	49.0’	51.0’	21/24	88%	11/24	46%
RC-2	51.0’	54.0’	36/36	100%	31/36	86%

COS-93-19.20 PID 115365

OHIO DEPARTMENT OF
TRANSPORTATION
DIVISION OF ENGINEERING

Office of Geotechnical Engineering

B-002-0-25

Run #:	Depth		Recovery		RQD	
RC-1	46.0’	48.0’	24/24	100%	19/24	79%
RC-2	48.0’	51.0’	34/36	94%	14/36	39%
RC-3	51.0’	56.0’	60/60	100%	40/60	67%

COS-93-19.20 PID 115365

Ohio Department of Transportation
Division of Engineering

Office of Geotechnical Engineering

B-003-0-25

Run #:	Depth		Recovery		RQD	
RC-1	55.0’	57.0’	23/24	96%	4/24	17%
RC-2	57.0’	60.0’	36/36	100%	31/36	86%

COS-93-19.20 PID 115365

Appendix H: Unconfined Compressive Strength Test Reports

Unconfined Compressive Strength Test
AASHTO T 208
ODOT - Office of Geotechnical Engineering

Lab No.	OGE Geotechnical Lab
Report Date:	6/23/25
Tech:	awillis

Site Name	COS-93-19.20	Soil Description	A-4a	Sample No.	9a
Job Ref	cos-93-19.2~pid115365	Top Depth (ft)	13.50	Sample Type	ST
Borehole/Pit No.	B-001-0-25	Bottom Depth (ft)	15.25	KeyLAB ID	OGEL2025062319
Specimen Reference	2025-009-037	Ground Elevation (ft)	839.3	Latitude	40.386065
Specimen Depth (ft)	14.0	Date started	6/23/25	Longitude	-81.715194

Specimen Description	sandy silt, medium stiff, gray, little clay, wet

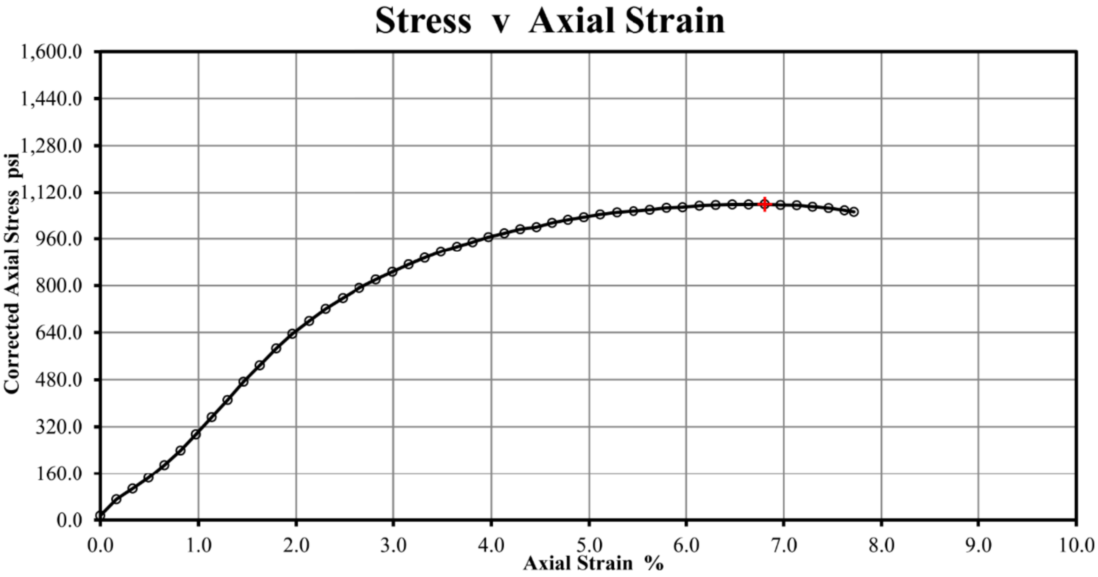
Initial Conditions

Height	in	5.76
Diameter	in	2.84
Bulk Density	pcf	123.84
Water Content	%	28
Dry Density	pcf	99.56
Void Ratio		0.673
Degree of Saturation	%	97

Rate of Strain applied			0.1
At failure	Axial Strain	%	6.8
	Maximum Stress	psf	1077.5

Front

Side



Remarks

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Fig. No.
1

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1

Lab Sheet Reference :

Unconfined Compressive Strength Test
AASHTO T 208
ODOT - Office of Geotechnical Engineering

Lab No.	OGE Geotechnical Lab
Report Date:	6/23/25
Tech:	awillis

Site Name	COS-93-19.20	Soil Description	A-4a	Sample No.	8
Job Ref	cos-93-19.2~pid115365	Top Depth (ft)	12.00	Sample Type	ST
Borehole/Pit No.	B-003-0-25	Bottom Depth (ft)	14.00	KeyLAB ID	OGEL2025062341
Specimen Reference	2025-009-057	Ground Elevation (ft)	841.0	Latitude	40.386367
Specimen Depth (ft)	13.5	Date started	6/23/25	Longitude	-81.715217

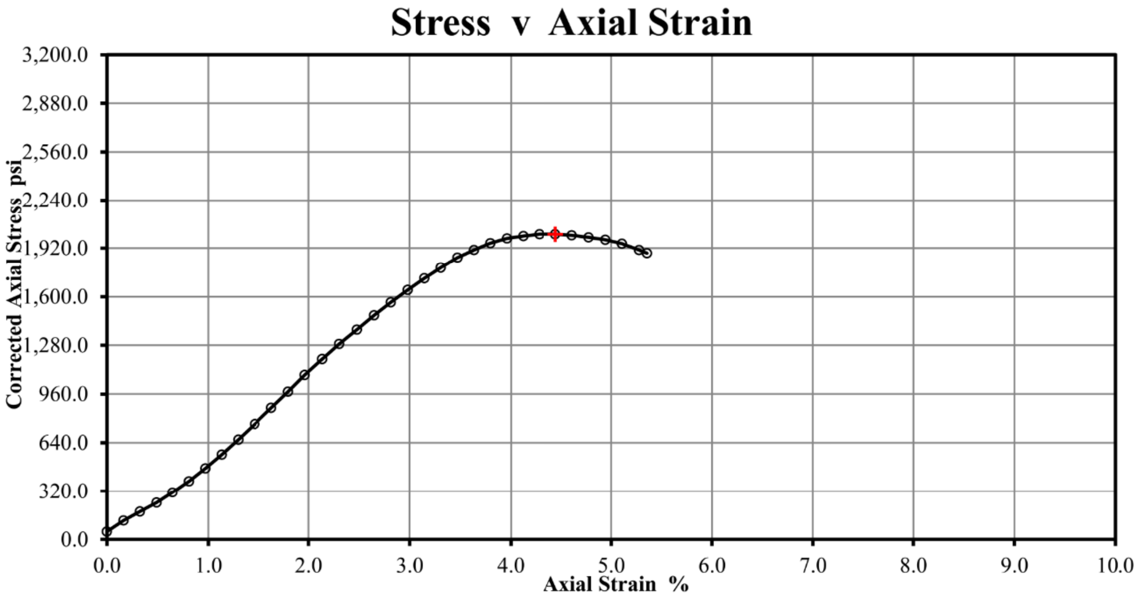
Specimen Description	sandy silt, stiff, mottled brown and gray, some clay, trace stone fragments, moist

Initial Conditions

Height		in	5.77
Diameter		in	2.88
Bulk Density		pcf	128.42
Water Content		%	19
Dry Density		pcf	107.38
Void Ratio			0.552
Degree of Saturation		%	95
Rate of Strain applied			0.1
At failure	Axial Strain	%	4.4
	Maximum Stress	psf	2012.7

Front

Side



Remarks

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Fig. No.

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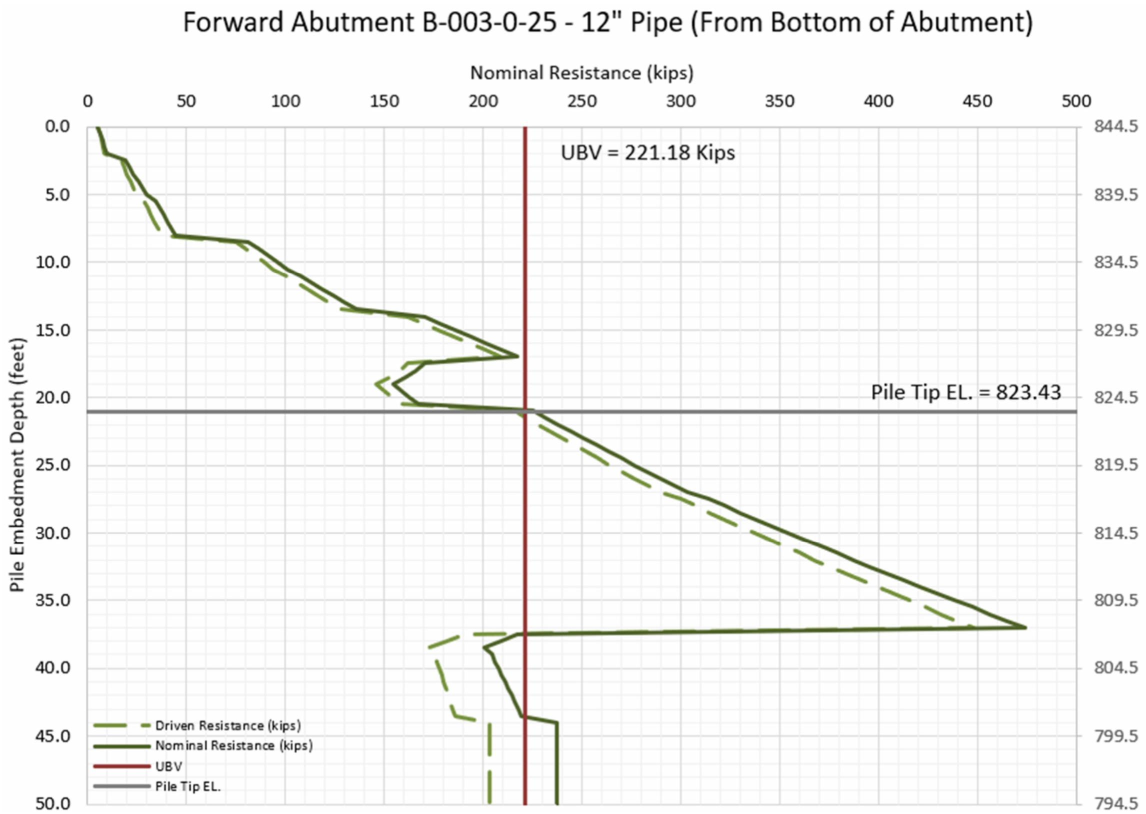
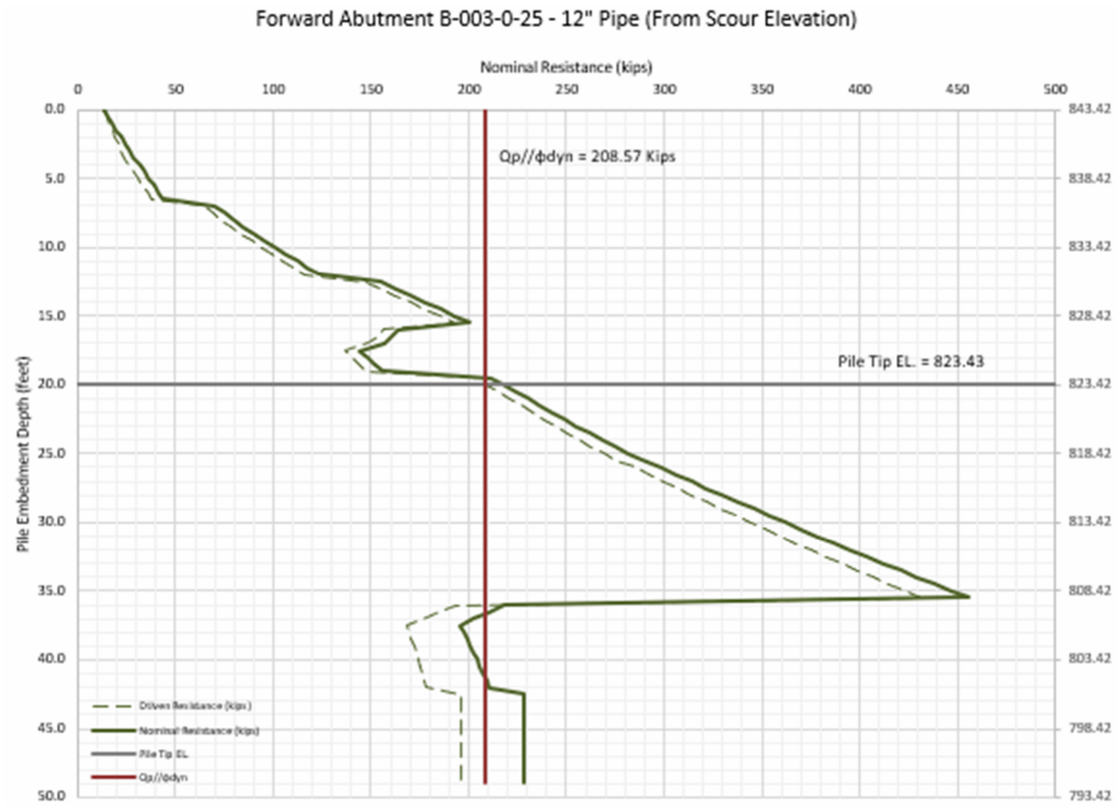
2

Lab Sheet Reference :

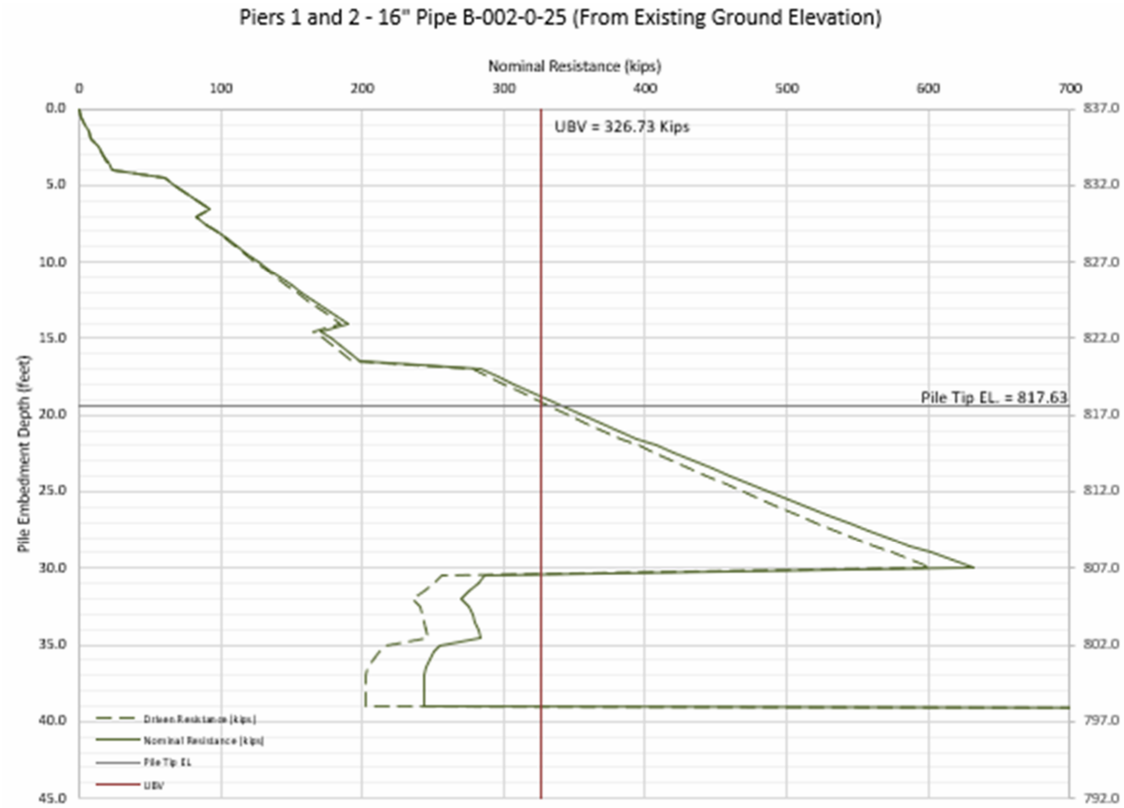
Appendix I: Pile Nominal Resistance versus Embedment Depth Graphs



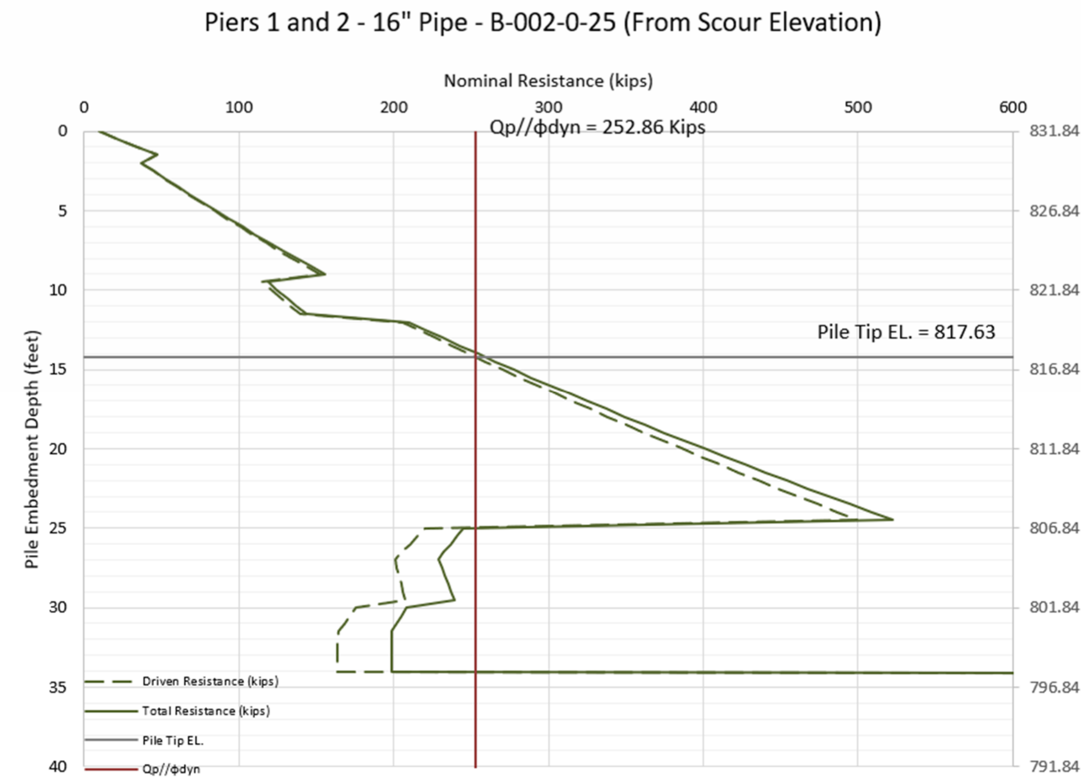
Forward Abutment B-003-0-25 - 12" Pipe (From Bottom of Abutment)



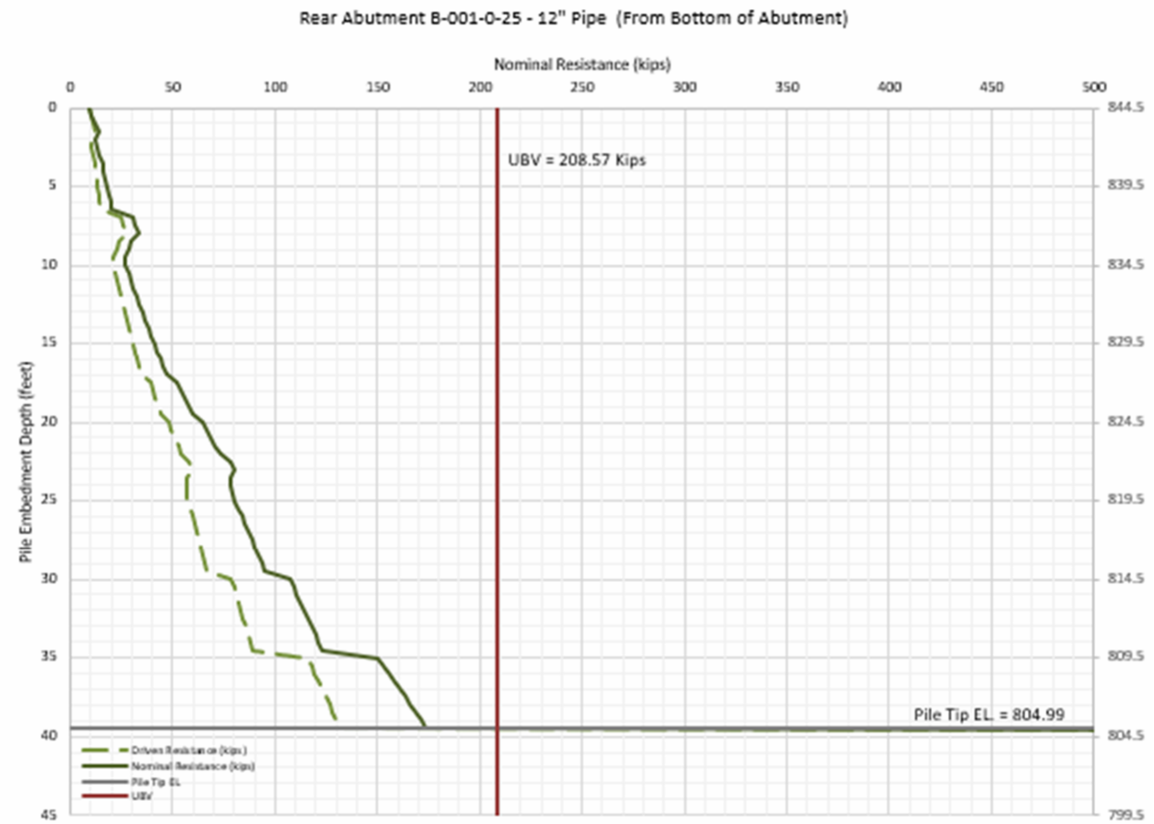
Forward Abutment B-003-0-25 - 12" Pipe (From Scour Elevation)



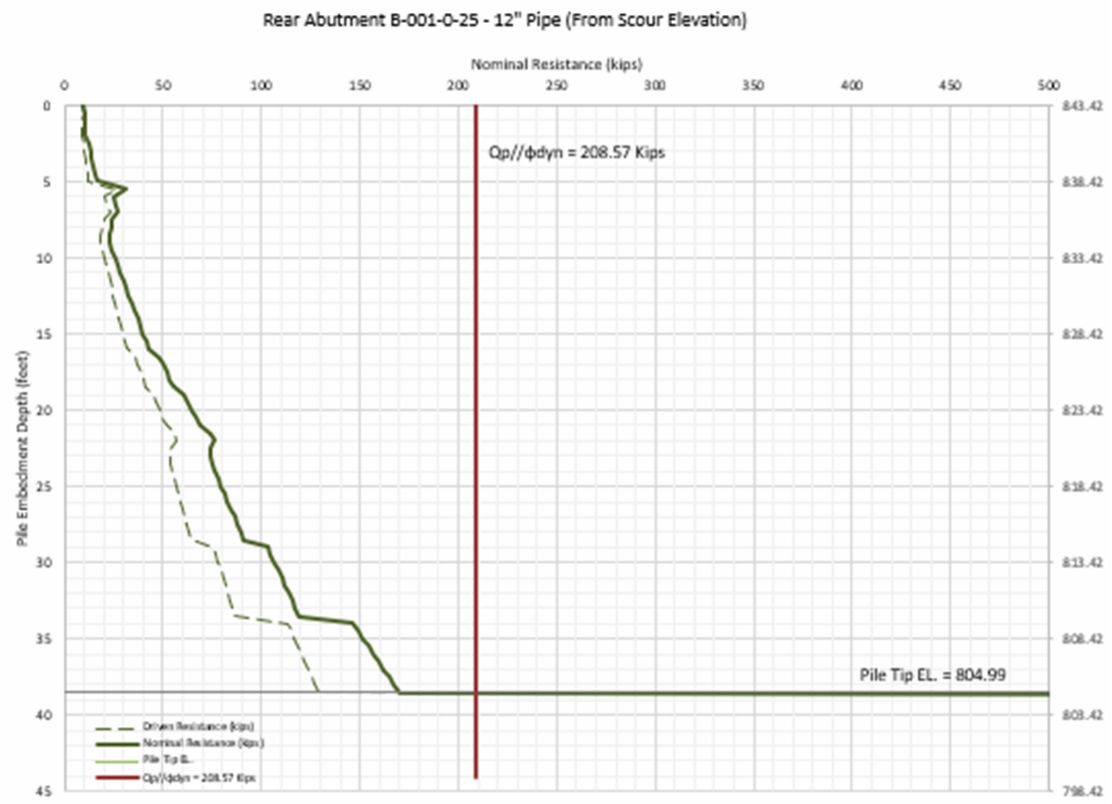
Piers 1 and 2 - 16" Pipe B-002-0-25 (From Existing Ground Elevation)



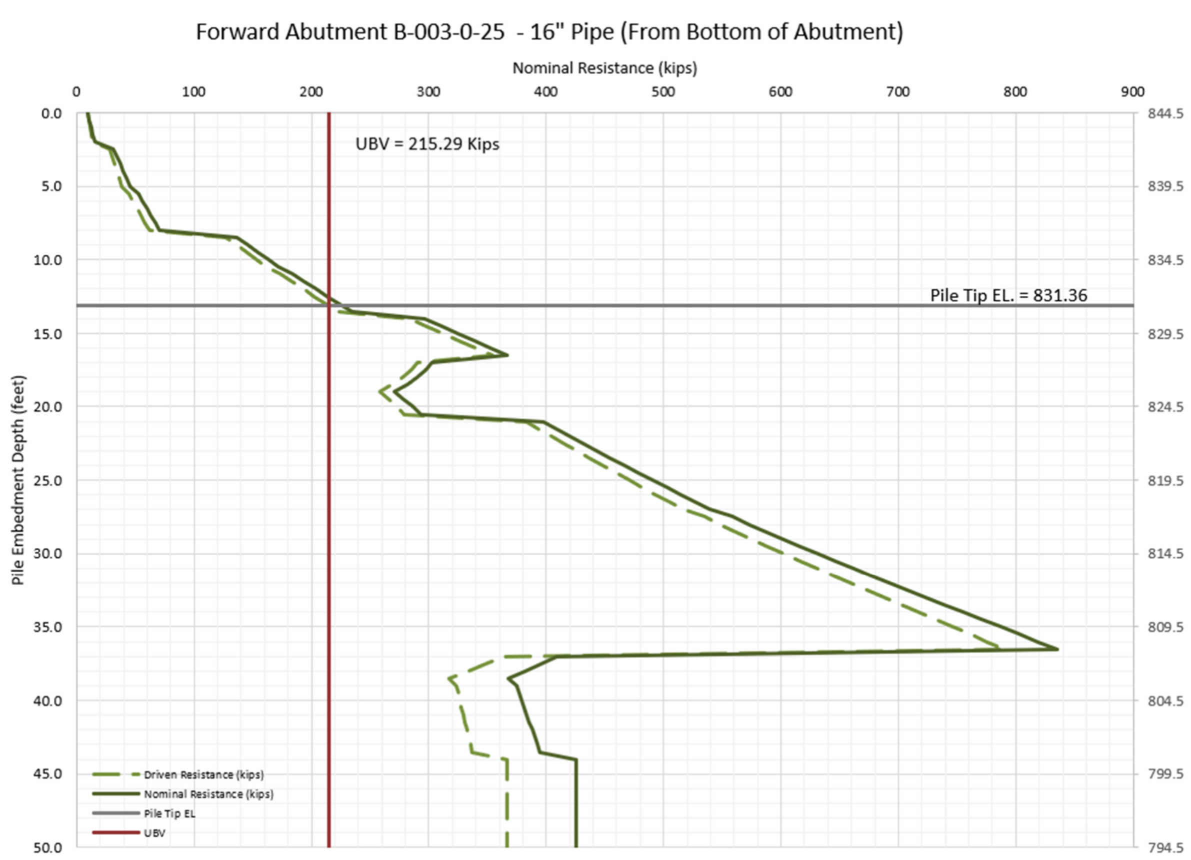
Piers 1 and 2 - 16" Pipe - B-002-0-25 (From Scour Elevation)

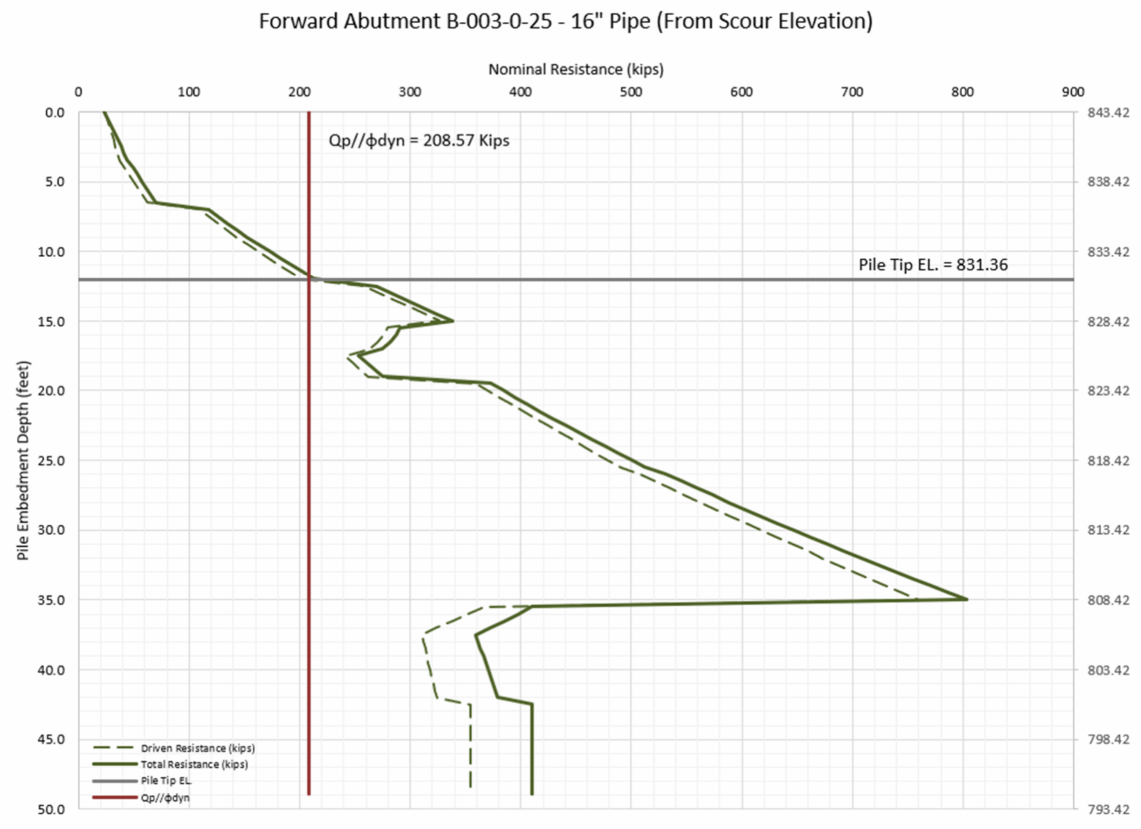


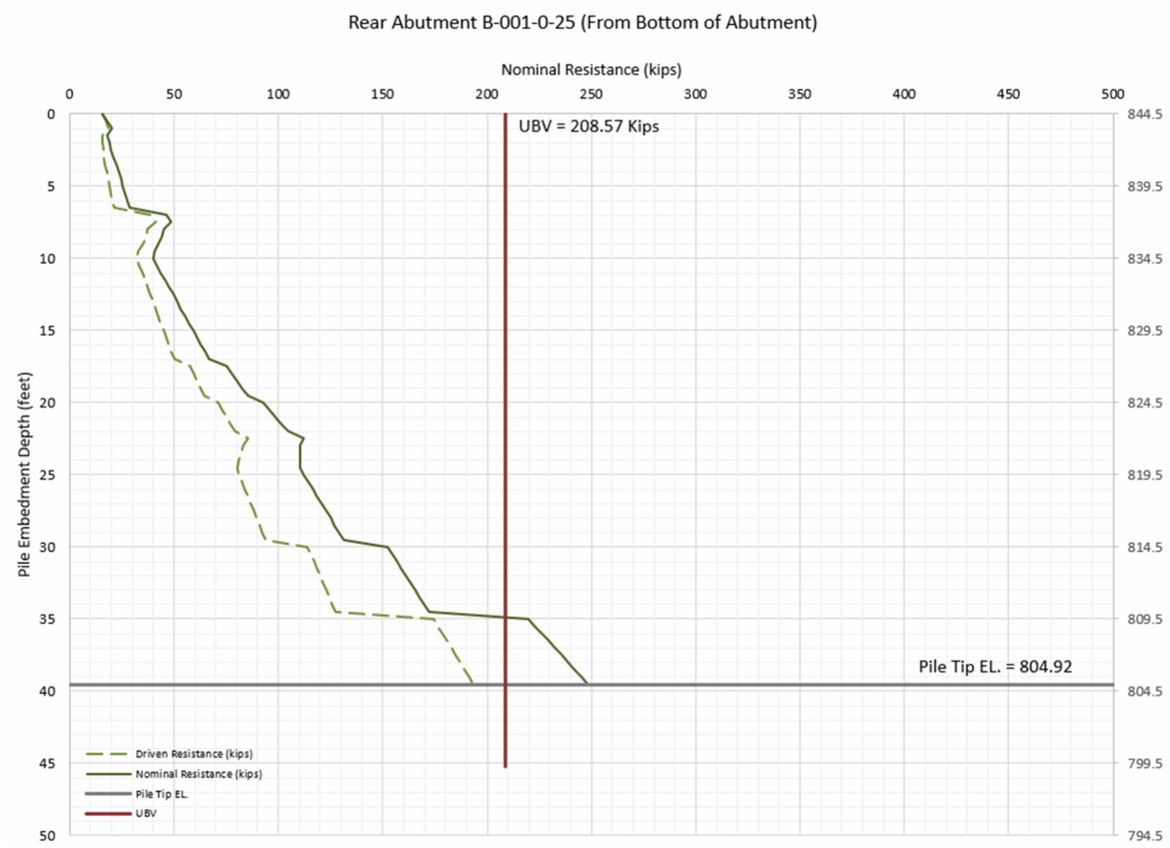
Rear Abutment B-001-0-25 - 12" Pipe (From Bottom of Abutment)



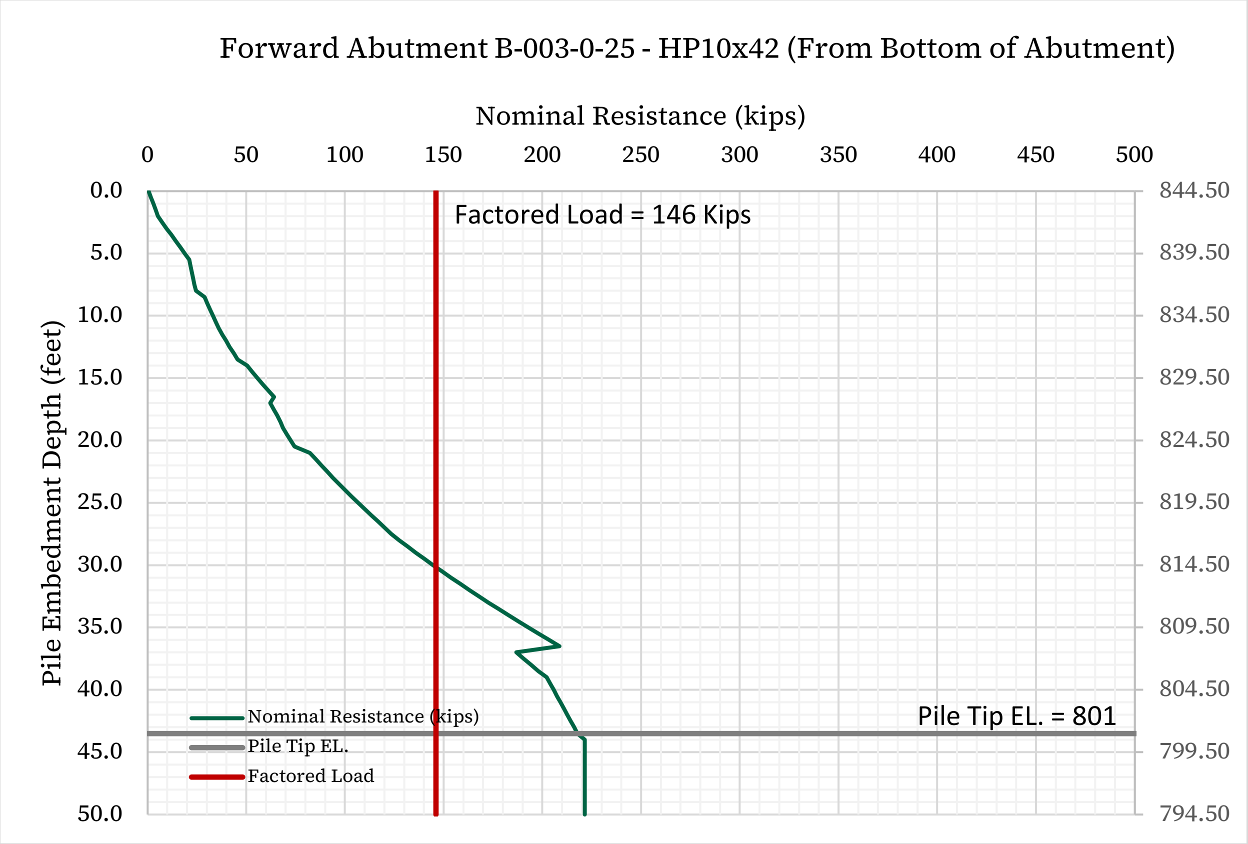
Rear Abutment B-001-0-25 - 12" Pipe (From Scour Elevation)

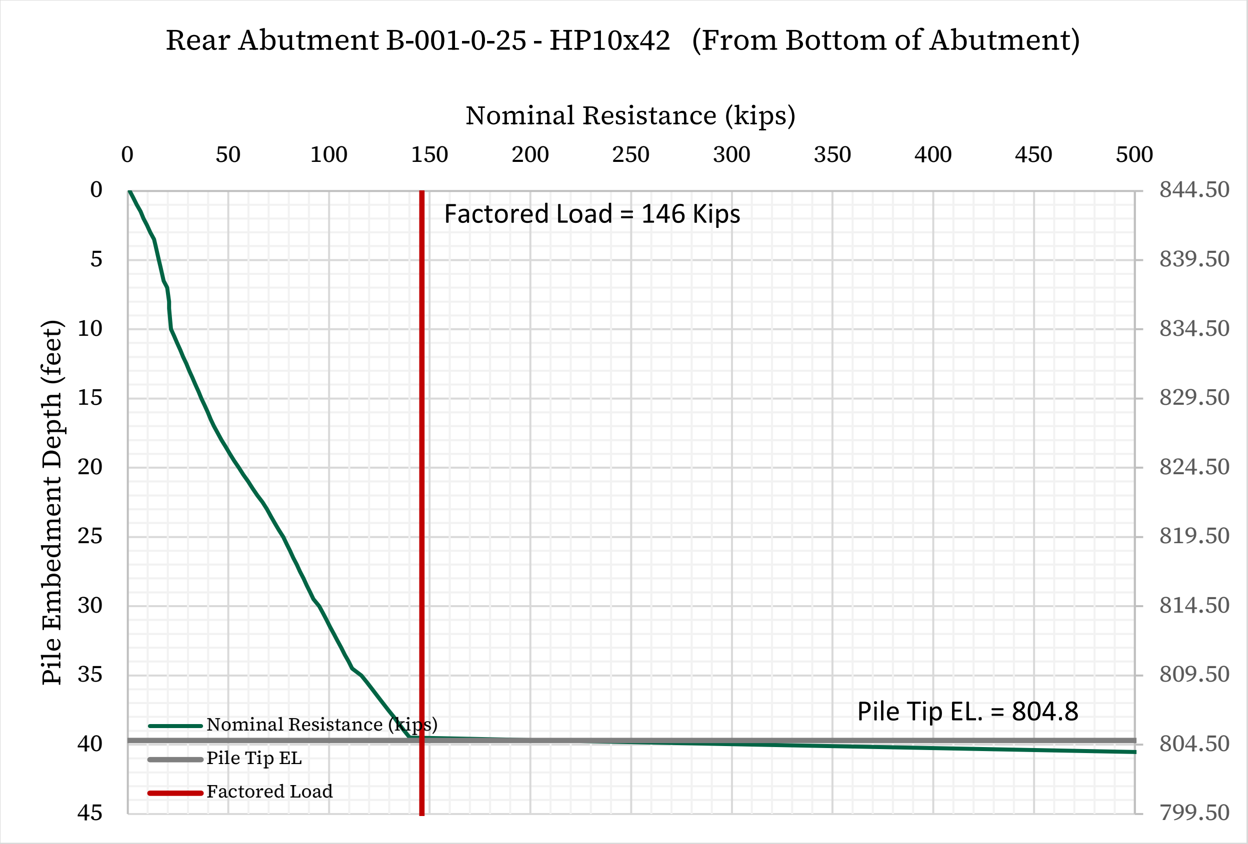

Forward Abutment B-003-0-25 - 16" Pipe (From Bottom of Abutment)

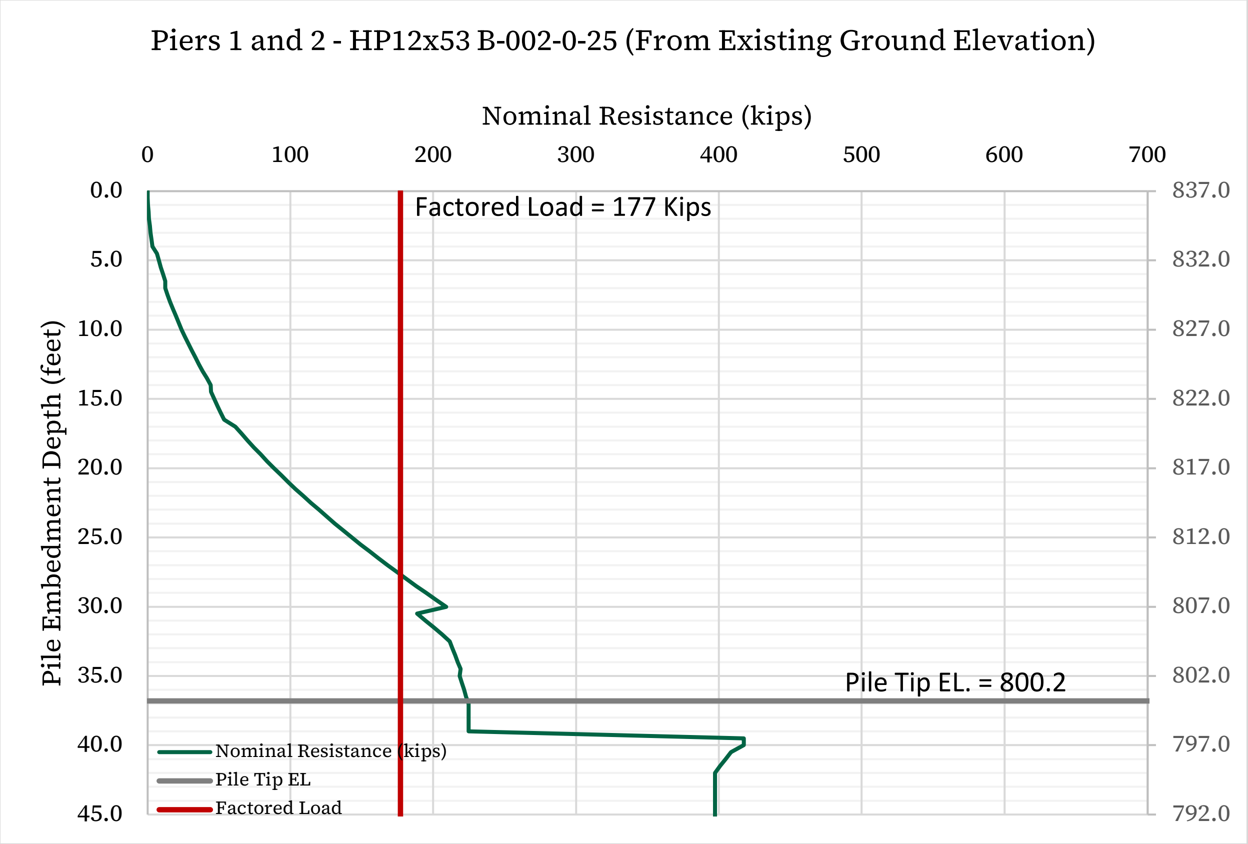

Forward Abutment B-003-0-25 - 16" Pipe (From Scour Elevation)


Rear Abutment B-001-0-25 (From Bottom of Abutment)
Nominal Resistance (kips)
0
50
100
150
200
250
300
350
400
450
500
Pile Embedment Depth (feet)
0
5
10
15
20
25
30
35
40
45
50
844.5
839.5
834.5
829.5
824.5
819.5
814.5
809.5
804.5
799.5
794.5
UBV = 208.57 Kips
Pile Tip EL. = 804.92
Driven Resistance (kips)
Nominal Resistance (kips)
Pile Tip EL.
UBV


Rear Abutment B-001-0-25 (From Scour Elevation)
Nominal Resistance (kips)
0
50
100
150
200
250
300
350
400
450
500
Pile Embedment Depth (feet)
0
5
10
15
20
25
30
35
40
45
50
843.42
838.42
833.42
828.42
823.42
818.42
813.42
808.42
803.42
798.42
793.42
Qp//ϕdyn = 208.57 Kips
Pile Tip EL. = 804.92
Driven Resistance (kips)
Nominal Resistance (kips)
Pile Tip EL.
Qp//ϕdyn


Forward Abutment B-003-0-25 - HP10x42 (From Bottom of Abutment)
Nominal Resistance (kips)
0
50
100
150
200
250
300
350
400
450
500
Pile Embedment Depth (feet)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
844.50
839.50
834.50
829.50
824.50
819.50
814.50
809.50
804.50
799.50
794.50
Factored Load = 146 Kips
Pile Tip EL. = 801
Nominal Resistance (kips)
Pile Tip EL.
Factored Load


Rear Abutment B-001-0-25 - HP10x42 (From Bottom of Abutment)
Nominal Resistance (kips)
0
50
100
150
200
250
300
350
400
450
500
Pile Embedment Depth (feet)
0
5
10
15
20
25
30
35
40
45
844.50
839.50
834.50
829.50
824.50
819.50
814.50
809.50
804.50
799.50
Factored Load = 146 Kips
Pile Tip EL. = 804.8
Nominal Resistance (kips)
Pile Tip EL
Factored Load


Piers 1 and 2 - HP12x53 B-002-0-25 (From Existing Ground Elevation)
Nominal Resistance (kips)
0
100
200
300
400
500
600
700
Pile Embedment Depth (feet)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
837.0
832.0
827.0
822.0
817.0
812.0
807.0
802.0
797.0
792.0
Factored Load = 177 Kips
Pile Tip EL. = 800.2
Nominal Resistance (kips)
Pile Tip EL
Factored Load

Appendix J: Buckling Analyses for Piers 1 and 2

AASHTO LRFD BDS Article 10.9.3.10.6—Buckling and Lateral Stability:

Pile Size	Factored Structural Resistance(kip/pile)	Factored Axial Load (kip/pile)	CDR
HP12X53	177.00	387.5	2.19
16” CIP	177.00	593.44	3.35

Structural Resistance of the HP12X53 Driven Pile Axial Compressive Resistance per AASHTO LRFD 6.9.2.1

$P_r = \phi_c \times P_n$, P_r= 387.5 kips .... (6.9.2.1-1)

P_r = factored axial resistance of components in compression

P_n = nominal compressive resistance as specified in Articles 6.9.5 (kip)

ϕ_c = Compression Resistance Factor, 0.50 for pipe piles (6.5.4.2)

If $\frac{P_o}{P_e} \leq 2.25, then$

$P_n = \left[0.658^{\left(\frac{P_o}{P_e}\right)}\right] \times P_o$, P_n = 775 kips .... (6.9.4.1.1-1)

P_n = nominal compressive resistance (kip)

P_o = compressive resistance of the column without consideration of buckling (kip)

$P_o = F_y \times A_g$, 775 kips

$P_e = \frac{\pi^2 \times E}{\left(\frac{K \times l}{r_s}\right)^2} \times A_g$, *7.79476E+57* .... *(6.9.4.1.2-1)*

F_y = specified minimum yield strength of the steel section, 50 ksi

A_g = gross cross-sectional area of the member, 15.50 in^2.

P_e = elastic critical buckling resistance

K = effective length factor in the plane of buckling determined as specified in Article 4.6.2.5 (unitless), 1.2.

l = unbraced length in the plane of buckling, 245.40 in (15.29 ft + 5.16 ft).

r_s = radius of gyration about the axis normal to the plane of buckling, 5.03 in.

E = modulus of elasticity of steel, 29000 ksi

Structural Resistance of the 16-in CIP Driven Pile Axial Compressive Resistance per AASHTO LRFD 6.9.2.1

$P_r = \phi_c \times P_n$, P_r= 593.44 kips.. (6.9.2.1-1)

P_r = factored axial resistance of components in compression

P_n = nominal compressive resistance as specified in Articles 6.9.5 (kip)

ϕ_c = Compression Resistance Factor, 0.60 for pipe piles (6.5.4.2)

$P_n = 0.66^{\lambda} \times F_e \times A_s$, for $\lambda \leq 2.25$, P_n = 989.06 kips .... (6.9.5.1-1)

λ = normalized column slenderness factor

F_e = modified yield stress (ksi)

A_s = cross-sectional area of the steel section, $A_s = \pi \times (r^2 - (r-t)^2)$, assumed pile wall thickness (t) = 0.313”, 15.43 in^2.

$\lambda = (\frac{Kl}{r_s \pi})^2 \times (\frac{F_e}{E_e})$, 0.7044 .... (6.9.5.1-3)

K = effective length factor in the plane of buckling determined as specified in Article 4.6.2.5 (unitless), 1.2.

l = unbraced length in the plane of buckling, 245.40 in (15.29 ft + 5.16 ft).

r_s = radius of gyration about the axis normal to the plane of buckling, $r_s = 0.3 \times D$, 4.80 in.

F_e = modified yield stress (ksi)

E_e = modified modulus of elasticity (ksi)

$F_e = F_y + C_1 \times F_{yr} \times \left(\frac{A_r}{A_s}\right) + C_2 \times f_c' \times \left(\frac{A_c}{A_s}\right)$, 85.917 ksi............................ (6.9.5.1-4)

$E_e = E \times \left[1 + \left(\frac{C_3}{n}\right) \times \left(\frac{A_c}{A_s}\right)\right]$, 46517.37 ksi .... (6.9.5.1-5)

F_y = specified minimum yield strength of the steel section, 45 ksi

F_{yr} = specified minimum yield strength of the longitudinal reinforcement, 60 ksi

A_r = total cross-sectional area of the longitudinal reinforcement, 0

A_c = cross-sectional area of Concrete, $A_c = \pi r^2 - A_s$, 185.64 in^2.

A_g = gross cross-sectional area of the member, $A_g = \pi r^2$, 201.06 in^2.

f_c' = Concrete Compressive Strength, 4.0 ksi

n = Concrete Modular Ratio..(Eq. 6.10.1.1.1b-1)

C_1 = Composite Column Constant 1, 1.00 for filled tubes ....(Table 6.9.5.1-1)

C_2 = Composite Column Constant 2, 0.85 for filled tubes ....(Table 6.9.5.1-1)

C_3 = Composite Column Constant 3, 0.40 for filled tubes ....(Table 6.9.5.1-1)

$n = \frac{E}{E_c}$, 7.967 ....(6.10.1.1.1b-1)

E = modulus of elasticity of steel, 29000 ksi

E_c = modulus of elasticity of the concrete, 3640 ksi.............................(A. 5.4.2.4)

$E_c = 1{,}820 \times \sqrt{f_c'}$, 3640 ksi ....(C5.4.2.4-3)