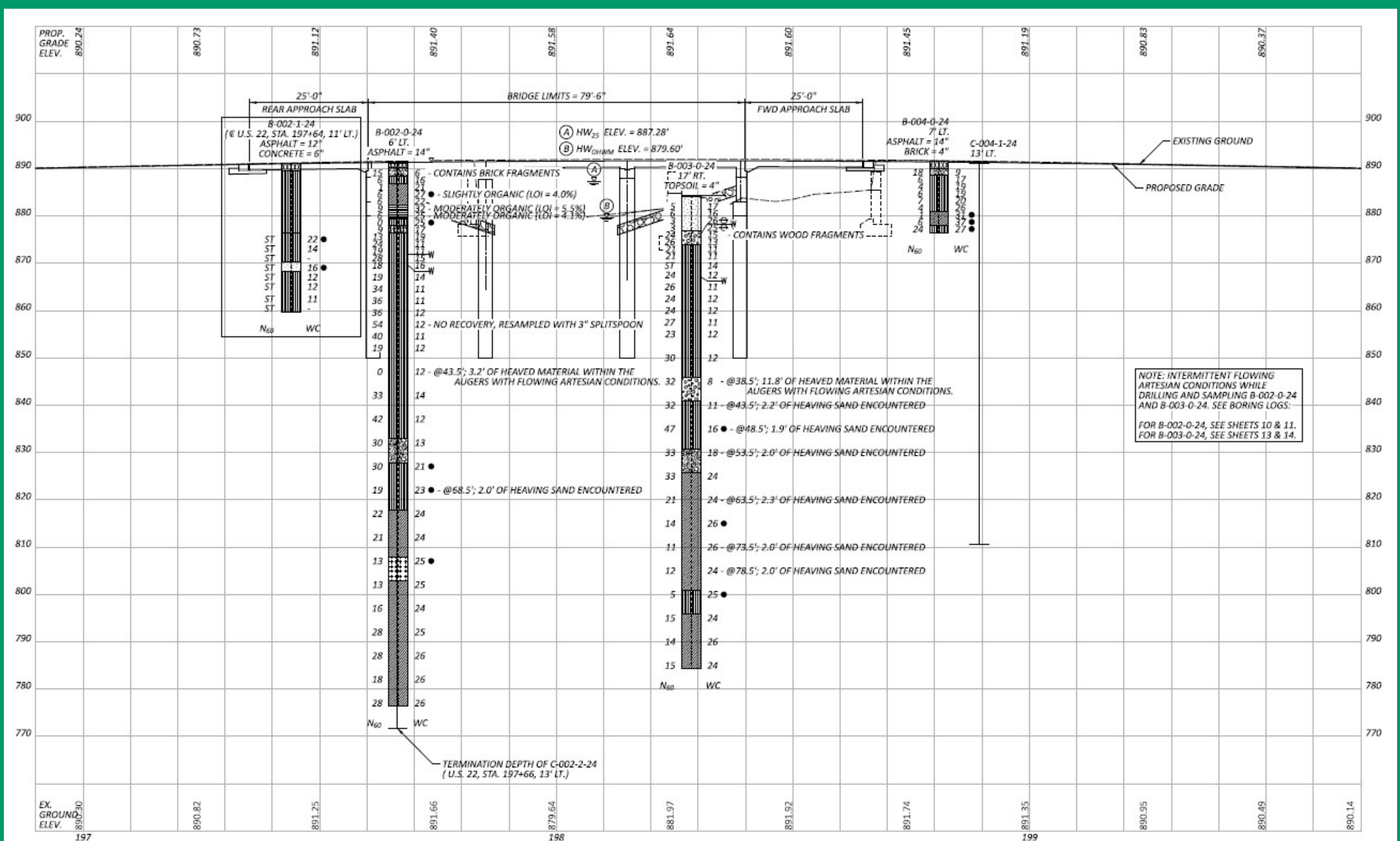
FINAL
STRUCTURE EXPLORATION REPORT

FAI US 22 03.68, PID 115691

Bridge No. FAI-22-0374 U.S. 22 over Clear Creek

Replacement of the existing structure (SFN 2300095 FAI-22-0375) with new structure (SFN 2300096 FAI-22-0374) on US 22 109 over Clear Creek in Fairfield County; in addition to necessary related work.



Submitted to *ODOT District 5*
August 2025

Prepared by
ODOT Office of Geotechnical Engineering

Ohio Department of Transportation

EXECUTIVE SUMMARY

Subgrade:

A design CBR value of 6 is recommended for the project.

12” Item 204 Excavation and replacement with Item 204 Granular Material Type B and Geogrid should be expected to be used at the rear approach of the bridge, project beginning station of 194+50.00 to the rear approach slab end station of 197+36.00, due to unstable soils encountered in the vicinity of boring B-001-1-24 (US 22 Sta. 194+50.00 TO Sta. 197+27.00). Include ODOT Location & Design Vol. 3 Plan Note G121 for the proposed excavation and replacement work. There is no need to proof roll the subgrade.

Structures:

Because of an estimated scour depth exceeding 11 ft and flowing artesian conditions encountered at approximate elevation 840 ft, driven open-ended friction pipe piles, of a diameter larger than typical friction piles, penetrating through the artesian aquitard are recommended to support bridge no. FAI-22-3.74 at all substructure units. Bedrock was not encountered in any of the project borings. In accordance with 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.

See the Analyses and Recommendations section for more information.

INTRODUCTION

This project will enhance safety on US 22 by replacing the existing structure over Clear Creek in Fairfield County. The project also includes performing necessary related work. This document includes geotechnical exploration and roadway and bridge foundation recommendations for the proposed US22 bridge replacement. 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 (SGE), July 2024.
- ODOT Bridge Design Manual (BDM), July 2025.
- ODOT Geotechnical Design Manual, July 2025.
- AASHTO LRFD Bridge Design Specifications (AASHTO BDS), 10TH Edition, 2024.

GEOLOGY AND OBSERVATIONS OF THE PROJECT

Historical Records

No historical geotechnical records were found for this project.

Geology

The project is located within the Dissected Glaciated Portion of the Lexington Peneplain region of the floodplain of and over a tributary of Clear Creek, in an area where deep to potentially extremely deep glacial derived material and alluvial deposits overlie bedrock of Mississippian age. The Ohio Department of Natural Resources (ODNR) interactive geologic map indicates that the area contains predominately cohesive soils with areas of non-cohesive soils of 0 to 1092 ft thickness. The overburden soils are underlain by limestone overlying interbedded Shale and Sandstone of Mississippian age. Top of rock was not encountered in any of the project exploration. According to the “Bedrock topography of the East Ringgold, Ohio, quadrangle” map published by the Department of Natural Resources, top of rock (TR) at the project site is expected at or below elevation 750 ft.

EXPLORATION

Reconnaissance

Field reconnaissance was completed by personnel from the Office of Geotechnical Engineering (OGE) on April 15, 2024. The existing structure is in poor condition with spalling concrete and exposed and broken reinforcing tendons present within the prestressed box beams. Overall, the pavement is in good condition with cracking which has been sealed. The roadway approaches are supported by well vegetated embankment fill, and do not exhibit signs of instability. The stream channel is present between the center pier and the rear abutment with minor erosion of the stream bank. Sediment has deposited and filled the channel between the center pier and the forward abutment. The adjacent land usage was noted as being agricultural.

Project Subsurface Exploration

Two (2) exploration phases were completed for this project. The initial phase consisting of drilling five (5) borings, B-001-0-24 through B-005-0-24, was completed as part of the subsurface exploration between April 22 and June 11, 2024, utilizing a truck mounted CME 75 and Acker REBEL XL drill rigs. Boring B-002-1-24 was advanced through overburden soils using 3.25-inch I.D. Hollow stem augers. Disturbed soil samples were collected in accordance with the standard penetration test (AASHTO T206) at continuous, 2.5, and 5.0-foot intervals. The CME 75 hammer system used was calibrated on May 23, 2024, with a drill rod energy ratio (ER) of 89%. The Acker REBEL XL hammer system used was calibrated on November 7, 2024, with a drill rod energy ratio (ER) of 91.5% capped at 90% per ODOT specifications for geotechnical exploration (SGE) Section 404.3. An undisturbed soil sample was collected in accordance with AASHTO T 207 in boring B-003-0-24 at 13.5 feet.

The second phase consisted of advancing two (2) CPT soundings, C-002-2-24 and C-004-1-24, completed on November 5, 2024, and collection of 8 Shelby Tube undisturbed samples (ST-1, ST-2, ST-3, ST-4, ST-5, ST-6, ST-7, ST-8) at offset boring B-002-1-24 completed on November 4 and 5, 2024 within the anticipated scour zone for scour testing by the Federal Highway Administration (FHWA). The CPT Soundings C-002-2-24 and C-004-1-24 were extended to depths of 119.4 feet and 80.6 feet, respectively. The soundings were advanced using a 15 square centimeter cone that has a sleeve area of 225 square centimeters and 1 ¾-inch diameter pushed with an A.P. Van den Berg unit mounted on a hyson 23-ton crawler in accordance with ASTM D5778, using probe serial number 090304, calibrated on August 9, 2023, and probe serial number 201039, calibrated on August 11, 2023. The tip resistance (q_c), sleeve friction (f_s), and induced pore pressure (u_2) were measured at 2-centimeter intervals. Pore pressure dissipation was measured in the soundings at selected depths within representative strata for water table depth estimation.

The Shelby Tube undisturbed soil samples were collected in accordance with AASHTO T206 at continuous intervals utilizing a truck mounted CME55 rotary drill rig. Boring B-002-1-24 was advanced through overburden soils using 3.25-inch I.D. Hollow stem auger. The boring surface elevation is 891.1 feet. The boring was advanced with no soil sampling until elevation 876.4 feet (depth 14.7 feet) after which samples were collected at continuous intervals and extended to elevation 859.8 feet (depth 31.3 feet). Samples ST-1, ST-2, ST-4, ST-5, ST-6, and ST-7 were shipped to the FHWA Hydraulics Laboratory in late November 2024 for scour shear stress testing. Samples ST-3 and ST-8 had low recovery and were excluded from further analysis.

CPT soundings follow ASTM D5778 and were made by ordinary and conventional methods and with care deemed adequate for the department's design purposes. The CPT data collected are presented as graphical plots in the report, generated by CPeT-IT software. The plots include interpreted soil behavior type (SBT) based on the method described by Robertson (2010) and equivalent SPT N_{60}, described by Jefferies and Davies (1993) and presented in Robertson (2022). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed.

EXPLORATION FINDINGS

All drilled borings, except B-003-0-24, were completed within the existing pavement, encountering 12 to 14-inches of asphalt underlain by 3 to 4-inches of brick. The asphalt in B-002-0-24 was underlain by medium dense Gravel and Stone Fragments with Sand (A-1-b) which contained brick fragments. B-003-0-24 encountered 4-inches of topsoil.

B-001-0-24 and B-005-0-24 were drilled to evaluate subgrade support for the approaching roadway, and encountered predominately cohesive soils consisting of Sandy Silt (A-4a), Silt and Clay (A-6a), Silty Clay (A-6b), and Clay (A-7-6), which ranged from soft to stiff in consistency and damp to moist in condition. B-001-0-24 was terminated within cohesive soils while B-005-0-24 was terminated in medium dense Gravel and Stone Fragments (A-1-b) in damp condition encountered at Elevation 883.2 feet.

B-002-0-24, completed adjacent to the rear abutment, and B-003-0-24, completed adjacent to the center pier, were extended to depths of 115 and 100 feet, respectively, for foundation design. These borings encountered predominately cohesive soils consisting of Sandy Silt (A-4a) and Silt and Clay (A-6a), with lesser amounts of Silt (A-4b) and Silty Clay (A-6b), which ranged from soft to hard in consistency and damp to wet in condition. Non-cohesive layers were encountered in B-002-0-24 consisting of loose Gravel with Sand and Silt (A-2-4) between elevation 877.9 and 876.3 ft and medium dense Gravel with sand (A-1-b) in wet condition between elevation 832.9 and 827.9 ft. Beneath the surface topsoil B-003-0-24 encountered Coarse and Fine Sand (A-3a) and Gravel with Sand (A-1-b) in loose to medium dense compactness extending to elevation 873.8 ft. Additional non-cohesive soils in B-003-0-24 consisting of Dense Gravel with Stone Fragments (A-1-a) and Gravel with Sand (A-1-b) were encountered between elevation 845.8 and 840.8 ft and 830.8 and 825.8 feet, respectively.

B-004-0-24 was completed in the vicinity of the forward abutment for evaluation of potential scour, initially encountering medium dense Stone Fragments with Sand (A-1-b) beneath the pavement materials underlain by predominately cohesive soils consisting of Sandy Silt (A-4a) and Silt and Clay (A-6a) in medium stiff to stiff consistency and damp to wet condition into which the boring was terminated.

Organic soils, ranging from slightly to moderately organic, were encountered between elevation 887.9 and 883.4 ft within B-001-0-24, and between elevation 885.4 and 879.4 ft within B-002-0-24. These results are presented in tabular form, see the organic content by loss on ignition test table in the Geotechnical Profile. B-003-0-24 encountered wood fragments between elevation 876.8 and 873.8. Unconfined compressive strength testing and consolidation testing were completed on the Shelby tube sample collected in B-003-0-24.

Free water was encountered at elevation 881.2 ft within B-001-0-24. B-002-0-24 and B-003-0-24 both encountered flowing artesian conditions. B-002-0-24 first encountered flowing artesian conditions around El. 847.9 ft, becoming intermittent with depth. Initial flow was approximately 1 ft above the pavement surface with water reported at the pavement surface at completion of the boring. B-003-0-24 first encountered flowing artesian conditions around El. 845.8 ft, becoming intermittent with depth. Initial flow was more than 5 ft above the ground surface with a minor flowing condition at completion of the boring.

CPT soundings C-004-1-24 and C-002-2-24 generally encountered tip resistance less than 100 tsf and sleeve friction less than 4 tsf except for the non-cohesive layers which had higher tip resistance recorded. C-004-1-24 also encountered a silty sand and sandy silt layer between 20 and 23 feet which had a higher tip resistance and sleeve friction recorded.

For the Shelby tube samples in B-002-1-24, ODOT visually described every sample, calculated percent recovery for each sample, and performed index strength tests by hand penetrometer for samples ST-1, ST-5, ST-6, and ST-7. FHWA determined water content (ASTM D2216), calculated the apparent specific gravity (AASHTO T 100), performed Particle Size Analysis: Sieve analyses (ASTM D6913) and hydrometer analyses (ASTM D7928), performed Atterberg limits testing (ASTM D4318), and pocket penetrometer (ASTM WK27337). FHWA mechanically classified samples based on the Unified Soil Classification System (USCS) (ASTM D2487) and the American Association of State Highway and Transportation Officials (AASHTO) classification system (AASHTO M 145). According to the AASHTO M 145 classification system, all samples classify as A-4, except sample ST-4 which classifies as A-2-4; according to USCS classification system, all samples classify as CL, except ST-4 which classifies as SP-SM and ST-5 which classifies as CL-ML.

ANALYSES AND RECOMMENDATIONS

Roadway Subgrade

A design CBR value of 6 is recommended for the project.

Based on the subgrade analyses we preformed, subgrade stabilization consisting of 12" Item 204 Excavation and replacement with Item 204 Granular Material Type B and Geogrid is recommended at the rear approach of the bridge, project beginning station of 194+50.00 to the rear approach slab end station of 197+36.00, due to unstable soils encountered in the vicinity of boring B-001-1-24 (US 22 Sta. 194+50.00 TO Sta. 197+27.00). Include ODOT Location & Design Vol. 3 Plan Note G121 for the proposed excavation and replacement work. There is no need to proof roll the subgrade. Label the unstable subgrade on the cross sections. Add the quantities of the unstable subgrade to the General Summary under the pay item Excavation of Subgrade.

Bridge Foundations, FAI-22-3.74, over Clear Creek:

The existing US 22 bridge over Clear Creek will be replaced with a three-span new bridge. Two span arrangements were evaluated: 78 feet long bridge using span lengths 24'-30'-24' and 104 feet long bridge using span lengths 32'-40'-32'. For both span arrangements, we evaluated H-piles, closed-ended cast-in-place (CIP) reinforced concrete pipe piles, open-ended pipe piles, CFA piles, and drilled shafts bearing above or penetrating through the artesian aquitard layer using 7, 6, and 5 deep foundation elements per substructure unit, all using conventional concrete for the shorter bridge and using either conventional or lightweight concrete for the longer bridge. For deep foundations bearing above the artesian aquitard, to account for potential elevation variation, a minimum bearing elevation (minimum of 10 ft depth above the aquitard layer) is required. The minimum bearing elevation is 857.8 ft (847.8 ft aquitard elevation + 10.0 ft) using B-002-0-24 and the minimum bearing elevation is 855.6 ft (845.6 ft aquitard elevation + 10.0 ft) using B-003-0-24.

Deep Foundation Elements Bearing Above the Artesian Aquitard:

For the short span bridge, drilled shafts or driven piles bearing above the artesian aquitard cannot be used because the minimum required penetration of 15 ft below the controlling scour elevation for deep foundation elements per BDM Sections 305.3.2.1 and 305.4.1.1 cannot be achieved (except for the forward abutment). This option was excluded from further evaluation. See the table below.

Structure: Three-Span Slab (24'-30'-24')

Substructure Unit (Boring ID)	*Analysis Starting Elevation*	*Scour Elevation*	*Minimum Bearing Elevation*	*Distance Between Scour and Minimum Bearing Elevation*
Rear Abut. (B-002)	880	872.53	857.8	***14.73***
Forward Abut. (B-003)	880	872.53	855.6	16.93
Pier 1 (B-002)	879.6	868.24	857.8	***10.44***
Pier 2 (B-003)	880.4	869.04	855.6	***13.44***

For the long span bridge, the minimum required penetration of 15 ft below the controlling scour elevation for deep foundation elements per BDM Sections 305.3.2.1 and 305.4.1.1 can be achieved. This option can be advanced for further evaluation. See the table below.

Structure: Three-Span Slab (32'-40'-32')

Substructure Unit (Boring ID)	*Analysis Starting Elevation*	*Scour Elevation*	*Minimum Bearing Elevation*	*Distance Between Scour and Minimum Bearing Elevation*
Rear Abut. (B-002)	880	875.27	857.8	17.47
Forward Abut. (B-003)	880	875.27	855.6	19.67
Pier 1 (B-002)	879.6	872.79	857.8	***14.99***
Pier 2 (B-003)	880.4	873.59	855.6	17.99

For this option using conventional concrete, driven closed-ended CIP reinforced concrete pipe piles could not attain the required resistance above the minimum bearing elevation at Pier 1 or Pier 2 using 5 or 6 piles; in these cases, drilled shaft foundations with a minimum diameter of either 4 or 4.5 ft are required. See the table below.

Structure: Three-Span Slab (32'-40'-32'), Using Conventional Concrete							
Substructure Unit (Boring ID), No. of Piles	*Factored Load (kips)*	*Foundation Type and Size*	*Foundation Length*	*Min Bearing El*	*Foundation Tip EL*	*Distance Between Foundation Tip and Min Bearing EL*	*Distance Between Foundation Tip and Scour EL*
Rear Abut. (B-002), 7 piles	149	22-in CIP Pipe Pile	25	857.8	860.27	2.47	15.00
Forward Abut. (B-003), 7 piles	149	22-in CIP Pipe Pile	30	855.6	857.96	2.36	17.31
Pier 1 (B-002), 5 piles	226	24-in CIP Pipe Pile	45	857.8	848.54	***-9.26***	24.25
Pier 1 (B-002), 6 piles	190	24-in CIP Pipe Pile	45	857.8	849.78	***-8.02***	23.01
Pier 2 (B-003), 5 piles	226	24-in CIP Pipe Pile	45	855.6	846.80	***-8.8***	26.79
Pier 2 (B-003), 6 piles	190	24-in CIP Pipe Pile	40	855.6	854.14	***-1.46***	19.45

For the long span bridge bearing above the artesian aquitard using lightweight concrete, driven closed-ended CIP reinforced concrete pipe piles could not achieve required resistance above the minimum bearing elevation at Pier 1 using 5 or 6 piles nor at Pier 2 using 5 piles, in these cases, drilled shaft foundations with a minimum diameter of either 4 or 4.5 ft are required. See the table below.

Structure: Three-Span Slab (32'-40'-32'), Using Lightweight Concrete							
Substructure Unit (Boring ID), No. of Piles	*Factored Load (kips)*	*Foundation Type and Size*	*Foundation Length*	*Min Bearing El*	*Foundation Tip EL*	*Distance Between Foundation Tip and Min Bearing EL*	*Distance Between Foundation Tip and Scour EL*
Rear Abut. (B-002), 7 piles	134	22-in CIP Pipe Pile	25	857.8	860.27	2.47	15.00
Forward Abut. (B-003), 7 piles	134	22-in CIP Pipe Pile	25	855.6	859.22	3.62	16.05
Pier 1 (B-002), 5 piles	213	24-in CIP Pipe Pile	45	857.8	849.71	-8.09	23.08
Pier 1 (B-002), 6 piles	179	24-in CIP Pipe Pile	40	857.8	850.58	-7.22	22.21
Pier 2 (B-003), 5 piles	213	24-in CIP Pipe Pile	40	855.6	853.46	-2.14	20.13
Pier 2 (B-003), 6 piles	179	24-in CIP Pipe Pile	35	855.6	855.80	0.2	17.79

Deep Foundation Elements Penetrating through the Artesian Aquitard:

For deep foundation elements penetrating through the artesian aquitard, we evaluated the following options and in this order of sequence:

1. HP 10x42 and HP 12x53 Driven piles, estimated lengths ranged from 80 to 90 ft for the short bridge and from 75 to 100 ft for the long span bridge.
2. Continuous flight auger (CFA) piles.
3. Drilled Shafts with 18 inches diameter with permanent steel casing.
4. Driven Open-Ended Pipe Piles with 18 inches diameter.

An artesian aquifer is defined as a confined groundwater layer under positive pressure, trapped between impermeable aquitards. An aquitard is a low-permeability confining layer (e.g., clay or shale layers) that impedes water flow. Installing deep foundation elements (like driven piles or drilled shafts) through the artesian aquitard breaches the confining layer, potentially creating pathways for pressurized water to escape. When breached by foundation elements, water pressure can cause upwards flow, risking soil erosion (washout), reducing soil friction and bearing resistance and potentially causing foundation instability.

The head pressure of the intermittent flowing artesian condition measured at boring B-002-0-24 was approximately 1.0 foot above the ground surface (891.3 + 1 = 892.3), and measured at boring B-003-0-24 was ***greater than*** 5.0 foot above the ground surface (884.1 + 5 = 889.1), so we expect the head pressure is up to about elevation 892.3. The bottom of aquitard (top of artesian zone) encountered while drilling and sampling in boring B-002-0-24 was at 43.5 ft (approximate elevation 847.8 ft) and in boring B-003-0-24 was at 38.5 ft (approximate elevation 845.6 ft).

While Driven H-piles foundations were the first to be evaluated by us, this option was quickly dismissed due to concerns with the potential of large disturbance to the aquitard that could provide a preferential path for the artesian water, and the likelihood that the aquitard would not self-seal after being punched through by pile driving.

CFA or Augered Cast-in-Place (ACIP) piles are constructed by rotating a hollow stem continuous flight auger into the soil to a designed depth. Concrete or grout is pumped through the hollow stem, maintaining static head pressure, to fill the cylindrical cavity created as the auger is slowly removed. Use of ACIP/CFA Piles can be suitable in some artesian conditions if used in conjunction with pressure grouting to seal the aquifer zone post-installation. However, some concerns include:

- Borehole stability during pile installation
- Loss of grout or concrete due to water inflow
- Hydraulic heave at the ground surface.

Some of the same risks exist with any of the evaluated deep foundation elements. In discussion with FHWA and the District, our preferred approach was to minimize risks by utilizing the least disturbing foundation option: permanently cased 18-inch drilled shafts or 18-inch open-ended driven pipe piles bearing a minimum of 15 ft below the artesian conditions, in the lower aquitard. The permanent casing will eliminate the risk of borehole instability and loss of grout or drilling fluid due to water inflow. An open-ended casing is expected to minimize disturbance and it is hoped that the aquitard will form a seal around the casing. 18-inch drilled shafts, using permanent casing shear resistance reduction factors in accordance with AASHTO LRFD Article 10.8.3.5.1 and GDM Section 1306.4.1, did not achieve the required bearing resistance within the available soil information. Thus, 18-inch open-ended driven pipe piles are recommended for the final design.

Foundation Recommendations:

The District's preferred alternative is to construct a short span bridge (24'-30'-24') and install deep foundation elements penetrating through the artesian aquitard. The foundations will be 18-inch open-ended pipe (OEP) friction piles driven through the artesian aquitards and bearing at a tip elevation of 815 ft (a minimum of 15 ft below the artesian conditions) at all substructure units. We recommend dynamic load testing of all piles as a verification of successful installation, integrity verification, and evaluation of bearing resistance. The estimated and order pile lengths are as follows, with recommended Steel Grade and minimum pile wall thicknesses based on drivability analyses:

Driven Open-Ended Pipe Pile Foundation Recommendations

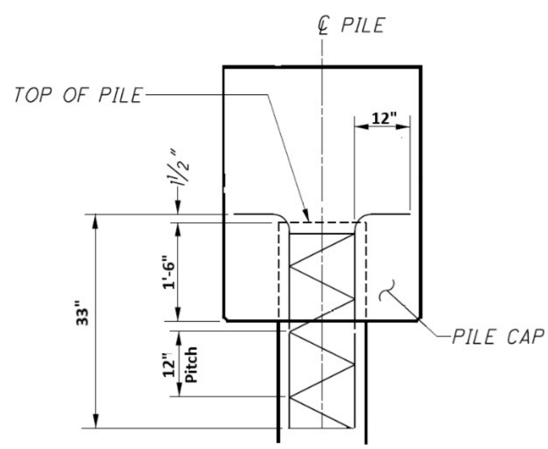
Substructure Unit and Soil Boring	Factored Load (kips)	UBV[3] (kips)	Frictional Resistance Lost Due to Scour (kips)	Pile Type and Size[2]	Pile Tip – Elevation (ft)	Estimated Length[1] (ft)	Order Length (ft)	Pile Thickness (in)
Rear Abutment C-002-2-24 B-002-0-24	136	247	66	18" OEP	815	70	75	0.625
Pier 1 C-002-2-24 B-002-0-24	182	353	110	18" OEP	815	75	80	0.625
Pier 2 C-004-1-24 B-003-0-24	182	333	90	18" OEP	815	75	80	0.625
Forward Abutment C-004-1-24 B-003-0-24	136	242	61	18" OEP	815	70	75	0.625

[1] At the Abutments: the Geotechnical Pile Length includes the Pile Cap Embedment depth of 2.0 ft.
[1] At the Piers: the Geotechnical Pile Length includes the Pile Cap Embedment depth of 1.5 ft and Pile unsupported length.
[2] Steel for OEP conforms to ASTM A252, Grade 3
[3] In accordance with BDM Table 305-1, a resistance factor (φ_{dyn}) = 0.75 is used for driven piles with 100% Dynamic Load Testing.

Since piles are to be driven to a maximum tip elevation and are calculated to have greater than the required Ultimate Bearing Value (UBV), assessment of soil setup potential is not required.

We have performed GRLWEAP drivability analyses and found that the driving stresses in the piles will exceed permissible driving stresses for ASTM A252 Grade 2 Steel at all substructure units using pile wall thickness of 0.625 in. The driving stresses need to be kept below 90% of the steel yield strength per AASHTO LRFD Bridge Design Specifications Article 10.7.8. ASTM A252 Grade 2 Steel yield strength is 35 ksi and Grade 3 Steel yield strength is 45 ksi. The compressive driving stresses need to be kept below 31.5 ksi for Grade 2 Steel piles and below 40.5 ksi for Grade 3 Steel piles. We recommend using Grade 3 Steel and pile wall thickness of 0.625 in.

We have discussed internal steel reinforcement with Office of Structural Engineering: At the piers, reinforcing steel shall be in accordance with standard construction drawing CPP-1-08, current version. At the abutments, reinforce the tops of the CIP piling in a capped pile abutment with 8 - #6 L-shaped bars inside a #4 spiral cage with 12" pitch. The vertical leg of the #6 L-shaped bar would be 33" long and the horizontal leg would be 12" long. The horizontal leg shall be placed a minimum of 1.5" above the top of the piling. See the detail below.



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 LPILE 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.

In accordance with BDM Section 305.3.5.5, we previously performed Strength Limit State analysis for free-standing 12- and 16-inch diameter driven pipe piles for buckling and lateral stability as unsupported columns above the point of fixity with scour depths included. We determined the depth to the point of fixity in accordance with LRFD 10.7.3.13.4. By observation, we consider buckling and lateral stability in the Extreme Event II Limit State with the maximum estimated scour depth at the check flood to not control, since the unsupported length is less than 3 feet greater, but the resistance factor is 1.00. 18-inch diameter driven pipe piles also have greater structural resistance than 12- and 16-inch piles for buckling and lateral stability, therefore we did not perform revised analyses for this check.

Scour holes are predicted as summarized below. The scour holes would result in a loss of frictional resistance due to scour as provided for in the pile design.

	Rear Abutment	Pier 1	Pier 2	Forward Abutment
Design Flood Scour Elevation (ft) (Annual Exceedance Probability Q2%) (Recurrence Interval 50-years)	873.35	869.76	870.56	873.35
Check Flood Scour Elevation (ft) (Annual Exceedance Probability Q1%) (Recurrence Interval 100-years)	872.53	868.24	868.24	872.53
Potential Scour Depth from Pile Bearing Elevation (ft)	11.27	11.36	11.36	11.27
Frictional Resistance Lost Due To Scour (kips)	66.4	110.3	90.0	60.8

No assessment of overall (global) stability has been performed, as there was no instability noted in the field and there is to be minimal to no change in the existing grade.

Temporary Shoring

The soils to be excavated behind the abutment walls classify as a Type B soil by the OSHA Regulations (cohesive soils with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf). Temporary excavations may be made at a 1H:1V slope angle of 45 degrees to a maximum depth less than 20 feet per OSHA requirements for Type B soils.

Temporary shoring at the roadway elevation will not be required for the construction of the bridge at either the rear or the forward abutments. However, in accordance with 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. Therefore, while Cofferdams are not required at the front face of the proposed rear and the forward abutments, they may be needed for the removal of the existing abutment walls to the top of footings and placement of the rock channel protection. Check to see if this is the case or add a note to limit the excavation to elevation 882.60 ft or above.

CLOSING REMARKS

Add the geotechnical plan notes provided in Appendix A of this design memo to the Structures General Notes. Add the following Pay Items to the estimated quantities or general summary in the project plans:

Item	Item Description	Units
204E13000	EXCAVATION OF SUBGRADE	CY
204E30010	GRANULAR MATERIAL, TYPE B	CY
505E11100	Pile Driving Equipment Mobilization	LS
507E98000	Piling, Misc: 18 Inch Open-Ended Steel Pipe Piles, Driven	FT
507E98000	Piling, Misc: 18 Inch Open-Ended Steel Pipe Piles, Furnished	FT
523E20001	Dynamic Load Testing, As Per Plan	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,
AM

APPENDICES

- Appendix A: Geotechnical Plan Notes.
- Appendix B: Snapshot of ODNR Bedrock Topography of the East Ringgold, Ohio, Quadrangle Map.
- Appendix C: Boring Location Plan
- Appendix D: Cone Penetration Test Soundings Report
- Appendix E: Project Boring Logs
- Appendix F: Grain Size Distribution Charts
- Appendix G: Undisturbed Test Data Results
- Appendix H: Calculations
- Appendix H-1: Plan Subgrade Analyses
- Appendix H-2: Pile Nominal Resistance versus Embedment Depth Graphs
    - Rear Abutment – C-002-2-24
    - Pier 1 – C-002-2-24
    - Pier 2 – C-004-1-24
    - Forward Abutment – C-004-1-24
  - Appendix H-3: GRLWEAP Drivability Analyses
    - Rear Abutment – C-002-2-24
    - Forward Abutment – C-004-1-24
  - Appendix H-4: Buckling Analyses using 12- and 16-inch piles

Appendix A: Geotechnical Plan Notes

The following plan notes need to be included with the Project Plans:

Item 204 - Subgrade Compaction:

CONSTRUCT THE SUBGRADE AS FOLLOWS AND IN THE FOLLOWING SEQUENCE:

1. SHAPE THE SUBGRADE TO WITHIN 0.2 FEET OF THE PLAN SUBGRADE ELEVATION.
2. COMPACT THE SUBGRADE ACCORDING TO C&MS 204.03.
3. APPROXIMATE LIMITS FOR EXCAVATION OF UNSTABLE SUBGRADE ARE SHOWN AND LABELED ON THE CROSS SECTIONS AS UNSTABLE SUBGRADE.
4. EXCAVATE UNSTABLE SUBGRADE AS DIRECTED BY THE ENGINEER AND STABILIZE BY REPLACING WITH THE SPECIFIED MATERIALS ACCORDING TO C&MS 204.07. EXCAVATIONS WILL EXTEND 18 INCHES BEYOND THE EDGE OF THE SURFACE OF THE PAVEMENT, PAVED SHOULDERS, OR PAVED MEDIANS.
5. FINE GRADE THE SUBGRADE TO THE SPECIFIED GRADE.

THE QUANTITY FOR EXCAVATING THE UNSTABLE SUBGRADE IS PAID UNDER ITEM 204, EXCAVATION OF SUBGRADE.

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

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

PILE DESIGN LOADS (ULTIMATE BEARING VALUE):

THE ULTIMATE BEARING VALUE (UBV) AND FRICTIONAL RESISTANCE LOST DUE TO POTENTIAL SCOUR FOR EACH SUBSTRUCTURE UNIT ARE AS SUMMARIZED IN THE FOLLOWING TABLE. DRIVE THE PILES TO THE UBV OR TO THE TIP ELEVATION IN THE TABLE, WHICHEVER IS DEEPER.:

	REAR ABUTMENT	PIER 1	PIER 2	FORWARD ABUTMENT
ULTIMATE BEARING VALUE (KIPS)	247	353	333	242
POTENTIAL SCOUR DEPTH (FT)	11.27	11.36	11.36	11.27
FRICTIONAL RESISTANCE LOST DUE TO POTENTIAL SCOUR (KIPS)	66	110	90	61
MAXIMUM TIP ELEVATION (FT)	815.00	815.00	815.00	815.00

FORWARD AND REAR ABUTMENT PILES:
18" OPEN-ENDED STEEL PIPE PILES, 75 FEET LONG, ORDER LENGTH
14 DYNAMIC LOAD TESTING ITEMS, AS PER PLAN

PIER 1 AND PIER 2 PILES:
18" OPEN-ENDED STEEL PIPE PILES, 80 FEET LONG, ORDER LENGTH
10 DYNAMIC LOAD TESTING ITEMS, AS PER PLAN

PROVIDE PLAIN CYLINDRICAL CASINGS WITH A MINIMUM PILE WALL THICKNESS OF 0.625 INCH FOR THE CAST-IN-PLACE REINFORCED CONCRETE PILES.

PILE DRIVING:

USE A PILE DRIVING HAMMER WITH A RATED ENERGY OF NOT LESS THAN 100,000 FOOT-POUNDS TO INSTALL THE PILES. ENSURE THAT STRESSES IN THE PILES DURING DRIVING DO NOT EXCEED 40.5 POUNDS PER SQUARE INCH.

ITEM 507 - PILING, MISC: 18 INCH OPEN-ENDED STEEL PIPE PILES, FURNISHED:
THE REQUIREMENTS OF CMS SECTION 507 GOVERN, AS MODIFIED BY THIS NOTE.

FURNISH STEEL PIPE PILES WITH AN OUTSIDE DIAMETER OF 18 INCHES AND A MINIMUM PILE WALL THICKNESS OF 0.625 INCH. DO NOT ATTACH COVER PLATES TO THE PILE TIPS. FURNISH STEEL PIPE PILES THAT CONFORM TO ASTM A252 GRADE 3 - YIELD STRENGTH 45 KSI, WITH THE FOLLOWING ADDITIONAL REQUIREMENTS:

1. WELDING AND PRE-QUALIFICATION OF BASE METAL SHALL BE IN CONFORMANCE WITH THE REQUIREMENTS IN AWS D1.1.

2. PROVIDE FABRICATOR DOCUMENTATION THAT THE OUTSIDE CIRCUMFERENCE OF EACH STEEL PIPE PILE SECTION DOES NOT VARY MORE THAN 3/8 INCH FROM THE NOMINAL PLAN DIMENSION.

ENSURE THAT THE BOTTOM END OF EACH STEEL PIPE SECTION IS BEVELED AND PRE-PREPARED FOR FIELD SPLICING WITH FULL-PENETRATION WELDING.

ITEM 507 - PILING, MISC: 18 INCH OPEN-ENDED STEEL PIPE PILES, DRIVEN:
THE REQUIREMENTS OF CMS SECTION 507 GOVERN, AS MODIFIED BY THIS NOTE.

DRIVE THE STEEL PIPE PILES OPEN ENDED, WITHOUT COVER PLATES AT THE PILE TIPS. THE PILES MAY BE INSTALLED UP TO A DEPTH OF 20.0 FT USING A VIBRATORY HAMMER FOR ENHANCED CONTROL OF VERTICAL AND HORIZONTAL ALIGNMENT AS SPECIFIED IN THE PLANS. USE AN IMPACT HAMMER TO COMPLETE PILE INSTALLATION. DRIVE ALL PILES TO THE REQUIRED ULTIMATE BEARING VALUE OR UNTIL THE PILE TIP REACHES THE MINIMUM PILE TIP ELEVATION AS SHOWN IN THE PLANS, WHICHEVER IS DEEPER. ENSURE THAT THE STEEL PIPE PILES ARE UNDAMAGED AFTER BEING DRIVEN.

AFTER THE DEPARTMENT HAS ACCEPTED ALL INSTALLED PILING, CLEAN ALL SOIL FROM WITHIN THE STEEL PIPE PILE INTERIOR TO A MINIMUM ELEVATION OF 876.50 FT AT THE ABUTMENTS AND MINIMUM ELEVATION OF 862.00 FT AT THE PIERS. KEEP THE TOP OF STEEL PIPE PILE COVERED AFTER CLEANING UNTIL THE REINFORCING STEEL AND CONCRETE ARE PLACED. PLACE THE REINFORCING STEEL IN THE STEEL PIPE PILE, THEN PLACE THE CONCRETE IN THE STEEL PIPE PILE ACCORDING TO CMS 524.10 EITHER WITH A TREMIE ACCORDING TO CMS 524.12 OR BY PUMPING ACCORDING TO CMS 524.13. USE CLASS QC2 CONCRETE THAT MEETS THE REQUIREMENTS OF CMS 524.10.

DURING THE CLEANING OF THE STEEL PIPE PILE INTERIOR, PREVENT DISTURBING THE FOUNDATION MATERIAL SURROUNDING THE PILE OR THE SOIL WITHIN THE PLUGGED PORTION OF THE PILE BELOW THE CLEAN OUT ELEVATION. EQUIPMENT OR METHODS USED FOR CLEANING OUT THE STEEL PIPE PILES MUST NOT CAUSE QUICK SOIL CONDITIONS OR CAUSE SCOURING OR CAVING AROUND OR BELOW THE PILES. THE CLEANED PORTION OF THE STEEL PIPE PILE MUST BE FREE OF ANY SOIL, ROCK, OR OTHER MATERIAL DELETERIOUS TO THE BOND BETWEEN CONCRETE AND STEEL. AFTER CLEANING OUT IS COMPLETED, PLACE THE REINFORCING STEEL AND CONCRETE WITHIN 24 HOURS TO PREVENT DETERIORATION FROM WATER OF THE SOIL WITHIN THE PLUGGED PORTION OF THE PILE. BECAUSE THE PILES ARE OPEN ENDED, THE DEPARTMENT WILL NOT CHECK FOR WATER TIGHTNESS.

AT LEAST 14 DAYS PRIOR TO DRIVING PILING, SUBMIT THE FOLLOWING INFORMATION, PER CMS 501.05.B, TO THE ENGINEER AND TO THE OFFICE OF GEOTECHNICAL ENGINEERING FOR REVIEW:

1. DETAILS OF METHODS FOR CLEANING OUT OF THE STEEL PIPE PILE INTERIOR.

2. DETAILS OF REINFORCING STEEL PLACEMENT INCLUDING SUPPORT AND CENTRALIZATION METHODS.

3. DETAILS OF CONCRETE PLACEMENT INCLUDING PROPOSED OPERATIONAL PROCEDURES FOR TREMIE OR PUMPING METHODS.

4. A LIST OF PROPOSED EQUIPMENT TO BE USED SUCH AS CRANES, HAMMERS, CLEANING EQUIPMENT, PUMPS, TREMIES, ETC.

5. THE PROPOSED METHOD TO BE USED FOR COMPLETING THE PILE DRIVING WHILE PREVENTING DAMAGE TO THE STEEL PIPE PILES SHOULD OBSTRUCTIONS TO DRIVING BE ENCOUNTERED.

Do not begin pile driving operations until the engineer gives authorization upon approval of the above information. The acceptance of the above information will not relieve the contractor of the responsibility of obtaining the required results, including selecting the appropriate hammer to install the pile to the required ultimate bearing value and tip elevation.

Payment for this item is full compensation for installing the completed and accepted piles, including driving, welding splices, cleaning out, disposing of material removed during cleaning, furnishing and placing reinforcing steel and concrete, and cutting to final elevation. No additional payment will be made for cutoff allowances of damaged steel pipe pile section ends or if obstructions to driving are encountered. Payment also includes the removal of any excess steel pipe pile above the top of pile plan elevation.

ITEM 523 - DYNAMIC LOAD TESTING, AS PER PLAN:

The requirements of CMS section 523 govern, as modified by this note.

Perform dynamic load testing on all piles during driving according to CMS 523. Determine the ultimate bearing value at the end of initial driving (EOID) and submit the results to the office of geotechnical engineering for review and acceptance. The office of geotechnical engineering will review the test results and recommend a course of action if the pile has not achieved the required ultimate bearing value.

Perform a CAPWAP analyses on all piles tested for every dynamic load test.

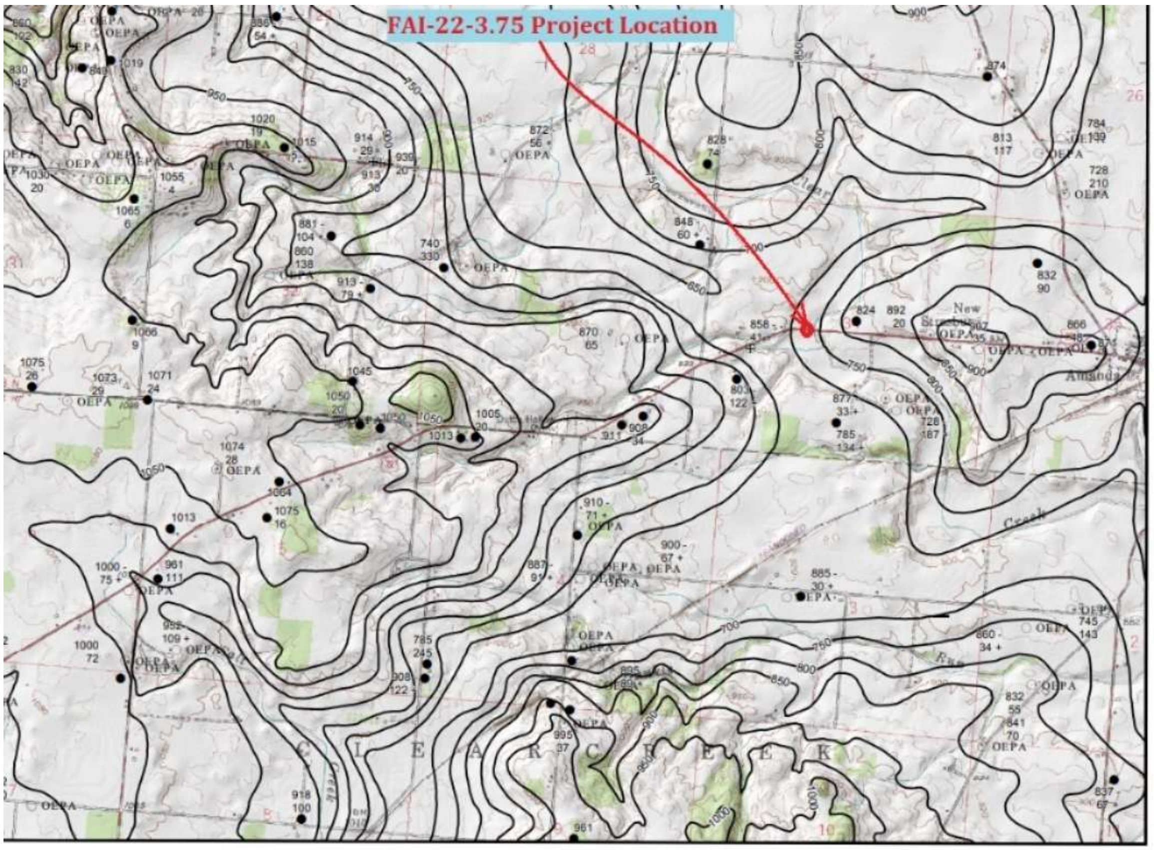
Submit all electronic data files including but not limited to recorded data during the initial pile driving operation, and CAPWAP analyses input and output data files.

SCOUR ELEVATIONS:

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

	Rear Abutment	Pier 1	Pier 2	Forward Abutment
Design Flood (Annual Exceedance Probability Q2%) (Recurrence Interval 50-years)	873.35	869.76	870.56	873.35
Check Flood (Annual Exceedance Probability Q1%) (Recurrence Interval 100-years)	872.53	868.24	868.24	872.53

Appendix B: Snapshot of ODNR Bedrock Topography of the East Ringgold, Ohio, Quadrangle Map at the Project Site.



Appendix C: Boring Location Plan

Cone Penetration Test Soundings Report

Office of Geotechnical Engineering
Division of Engineering

Project: FAI-22-3.68
PID: 119512
Date: December 5, 2024
Number of Soundings: 2
Equipment: A.P. van den Berg, 23 Ton Crawler, Hyson 200kN

Sounding ID	Completion Date	Probe SN	Calibration Date	Elevation	Latitude	Longitude	Surface Material	Depth (ft.)
C-002-2-24	11/05/24	090304	08/09/23	891.3	39.652536	-82.773152	Asphalt (23")	119.4
C-004-1-24	11/05/24	201039	08/11/23	891.4	39.652516	-82.772716	Asphalt (23")	80.6

Project Information

Two soundings were completed for this project. Both soundings were completed within the road through pre-cored holes. The static water levels reported on the attached logs were determined by pore pressure response. Sounding C-002-2-24 was terminated due to excessive inclination. Sounding C-004-1-24 was terminated upon reaching the necessary depth for characterizing upper soils. The soundings were completed to supplement previously drilled geotechnical soil borings in the vicinity (B-002-0-24, B-002-1-24, B-003-0-24, B-004-0-24). The latitude and longitude values are from a Juniper Geode GNS3 GPS Receiver. The elevation values are from the USGS 3DEP map service. The exploration locations are shown on the attached exploration plan.

The included CPT logs are for informational purposes only. The CPT logs have been filtered for negative values, corrected for inclination at depth, and filtered for data spikes. Additionally, for each sounding, the measured values of qc and fs were shifted relative to one another with a cross-correlation function. The raw CPT data is available upon request.

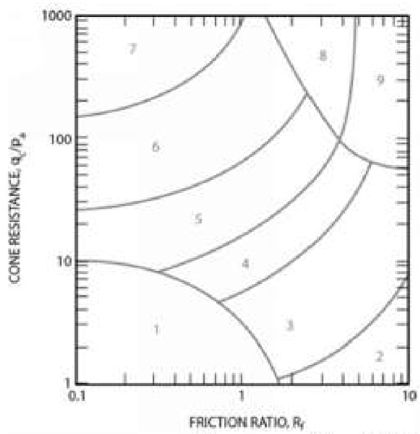
Cone Penetration Test Data and Interpretation

These Cone Penetration Test (CPT) Soundings follow ASTM D 5778 and were made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. The CPT data collected are presented as graphical plots in the report, generated by CPeT-IT software. The plots include interpreted Soil Behavior Type (SBT) based on the method described by Robertson (2010) & equivalent SPT N_{60}, described by Jefferies and Davies (1993) and presented in Robertson (2022). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed.

The department does not warrant the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for use of the results in any design or review.

Date: December 5, 2024
Subject: FAI-22-3.68, PID 119512

The user should be fully aware of the techniques and limitations of any method used in the software. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections, or interpolations made by the contractor, or other users of this report. While the Department believes that the information as to the condition and materials reported is accurate, it does not warrant that the information is necessarily complete. Water pressure measurements and subsequent interpreted water levels shown in this report should be used with discretion since they represent dynamic conditions. Dynamic pore water pressure measurements may deviate substantially from hydrostatic conditions, especially in cohesive soils.



Zone	Soil Behavior Type
1	Sensitive, fine grained
2	Organic soils - clay
3	Clay – silty clay to clay
4	Silt mixtures – clayey silt to silty clay
5	Sand mixtures – silty sand to sandy silt
6	Sands – clean sand to silty sand
7	Gravelly sand to dense sand
8	Very stiff sand to clayey sand*
9	Very stiff fine grained*

* Heavily overconsolidated or cemented
P_a = atmospheric pressure = 100 kPa = 1 tsf

Non-normalized CPT Soil Behavior Type (SBT) chart
(Robertson et al., 1986, updated by Robertson, 2022)

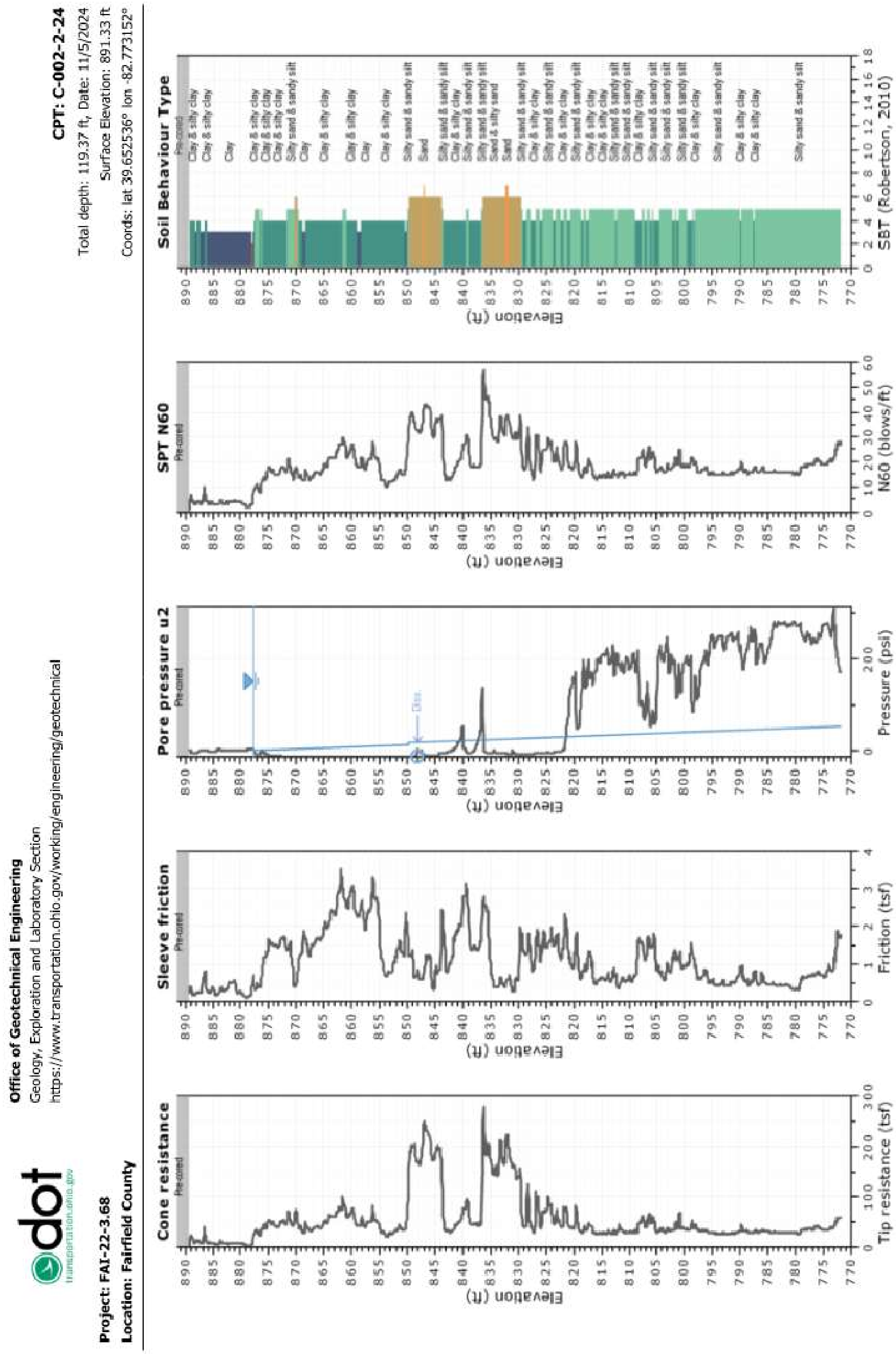
$$\frac{(q_t/p_a)}{N_{60}} = 8.5\left(1 - \frac{I_c}{4.6}\right)$$

q_t = Cone resistance I_c= SBTn Index
CPT Equivalent SPT N_{60} Correlation
(Robertson, 2022)

References

Robertson, P.K. and Cabal, K.L, 2022. *Guide to Cone Penetration Testing for Geotechnical Engineering, 7th Edition.* Signal Hill, California: 29, 38.
https://www.greggdrilling.com/wp-content/uploads/2022/11/CPT-Guide-7th-Final-sm.pdf
Accessed June 20, 2024

Jefferies, M.G. and Davies, M.P, "Use of CPTu to Estimate Equivalent SPT N_{60}," *Geotechnical Testing Journal*. GTJODJ. Vol. 16, No. 4. December 1993. pp. 458-468.
https://insitusoil.com/wp-content/uploads/2021/06/CPTU-for-Ic-SPT-N60-and-fines-content.pdf
Accessed July 1, 2024


Project: FAI-22-3.68
Location: Fairfield County
Office of Geotechnical Engineering
Geology, Exploration and Laboratory Section
https://www.transportation.ohio.gov/working/engineering/geotechnical
CPT: C-002-2-24
Total depth: 119.37 ft, Date: 11/5/2024
Surface Elevation: 891.33 ft
Coords: lat 39.652536° lon -82.773152°
Cone resistance
Tip resistance (tsf)
Sleeve friction
Friction (tsf)
Pore pressure u2
Pressure (psi)
SPT N60
N60 (blows/ft)
Soil Behaviour Type
SBT (Robertson, 2010)
Elevation (ft)
Pre-cored
Clay & silty clay
Clay
Silty sand & sandy silt
Sand
Sand & silty sand

Dissipation Tests Results

Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for t_{50}, which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction c_h was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position
r: piezocone radius
I_r: stiffness index, equal to shear modulus G divided by the undrained strength of clay (S_u).
t_{50}: time corresponding to 50% consolidation

Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

$$k_h = c_h \times \gamma_w / M$$

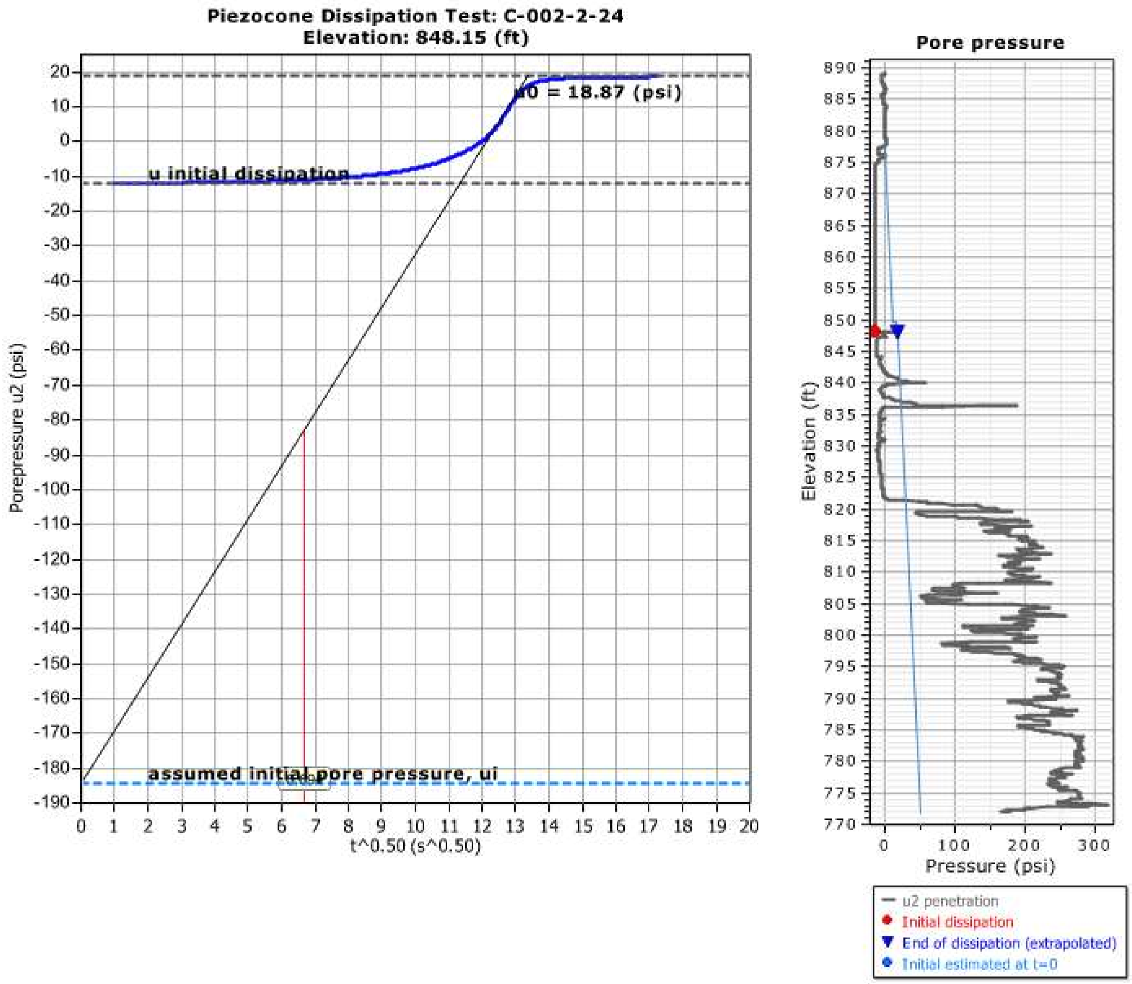
where: M is the 1-D constrained modulus and γ_w is the unit weight of water, in compatible units.

Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/S_u	c_h (ft^2/s)	c_h (ft^2/year)	M (tsf)	k_h (ft/s)
C-002-2-24	43.18	6.7	45	1.42E-006	100.00	2.81E-004	8866	92.92	9.45E-008

This software is licensed to: ODOT Office of Geotechnical Engineering

CPT name: C-002-2-2



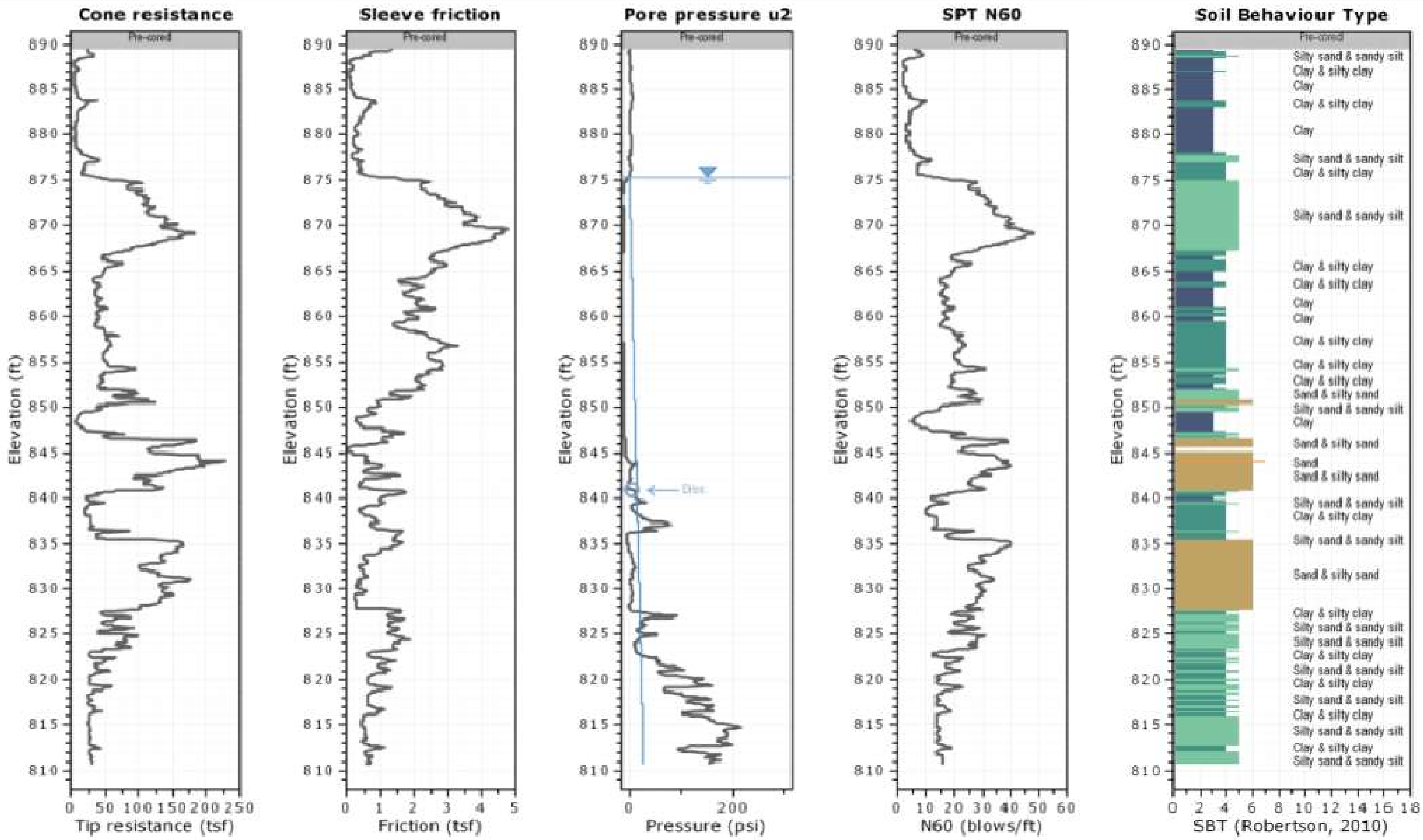
CPeT-IT v.3.9.5.9 - CPTU data presentation & interpretation software - Report created on: 7/31/2025, 12:38:47 PM 1

Project file: \\itcfs007\idrive\ProjectData\FAI\115691\400-Engineering\Geotechnical\EngData\CPT\FAI-22-3.68_imperial.cpt

Office of Geotechnical Engineering
Geology, Exploration and Laboratory Section
https://www.transportation.ohio.gov/working/engineering/geotechnical

Project: FAI-22-3.68
Location: Fairfield County

CPT: C-004-1-24
Total depth: 80.61 ft, Date: 11/5/2024
Surface Elevation: 891.33 ft
Coords: lat 39.652516° lon -82.772716°



CPeT-IT v.3.9.5.9 - CPTU data presentation & interpretation software - Report created on: 5/7/2025, 11:33:15 AM
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2

Office of Geotechnical Engineering
Geology, Exploration and Laboratory Section
https://www.transportation.ohio.gov/working/engineering/geotechnical

CPT: C-004-1-24
Total depth: 80.61 ft, Date: 11/5/2024
Surface Elevation: 891.33 ft, Est. GWL: 16.00 ft
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project: **FAI-22-3.68**
Location: **Fairfield County**

Dissipation Tests Results

Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for t_{50}, which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction c_h was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position
r: piezocone radius
I_r: stiffness index, equal to shear modulus G divided by the undrained strength of clay (S_u).
t_{50}: time corresponding to 50% consolidation

Permeability estimates based on dissipation test

The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

$$k_h = c_h \times \gamma_w / M$$

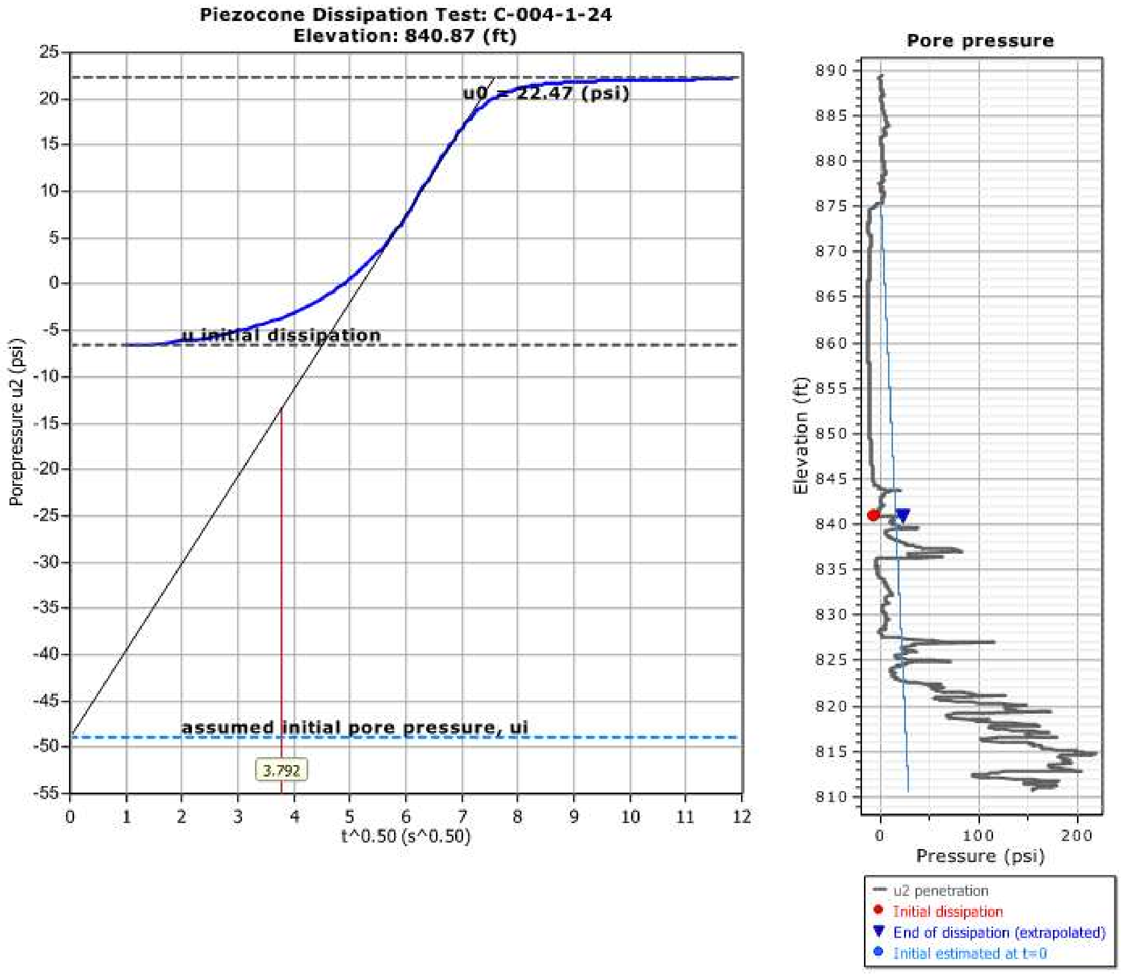
where: M is the 1-D constrained modulus and γ_w is the unit weight of water, in compatible units.

Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/S_u	c_h (ft²/s)	c_h (ft²/year)	M (tsf)	k_h (ft/s)
C-004-1-24	50.46	3.8	14	4.56E-007	100.00	8.76E-004	27622	76.48	3.58E-007

This software is licensed to: ODOT Office of Geotechnical Engineering

CPT name: C-004-1-24



Appendix E: Project Boring Logs

PROJECT: FAI-22-3.68	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: CME 75 TRUCK	STATION / OFFSET:	EXPLORATION ID B-001-0-24
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: ODOT / BENNING	HAMMER: CME AUTOMATIC	ALIGNMENT: CL SR 22	
PID: 115691 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/23/24	ELEVATION: 889.3 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/23/24 END: 5/23/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 89	LAT / LONG: 39.652508, -82.774354	

MATERIAL DESCRIPTION AND NOTES	ELEV. 889.3	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 (12") & BRICK (3")	888.0	1																
MEDIUM STIFF, GRAY AND REDDISH BROWN, **SILT AND CLAY**, SOME SAND, LITTLE STONE FRAGMENTS, SLIGHTLY ORGANIC (LOI = 2.7%), MOIST	886.3	2	6 2 3	7	6	SS-1	0.75	15	11	15	31	28	28	15	13	17	A-6a (6)	
MEDIUM STIFF, BLACK AND DARK GRAY, **CLAY**, "AND" SILT, LITTLE SAND, TRACE STONE FRAGMENTS, MODERATELY ORGANIC (LOI = 7.1%), MOIST	884.8	3–4	2 2 2	6	50	SS-2	0.75	4	3	7	39	47	45	25	20	32	A-7-6 (13)	
STIFF, GRAY, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, SLIGHTLY ORGANIC (LOI = 2.9%), MOIST	883.3	5–6	1 2 2	6	50	SS-3	1.25	3	3	38	31	25	25	15	10	21	A-4a (4)	
MEDIUM STIFF, MOTTLED GRAY AND BROWN, **SILTY CLAY**, SOME SAND, TRACE STONE FRAGMENTS, MOIST		7	1 2 2	6	50	SS-4	0.75	-	-	-	-	-	-	-	-	28	A-6b (V)	
	W 881.1	8																
@8.5'; SOFT	879.3	9 – EOB – 10	1 1 1	3	100	SS-5	0.50	2	1	27	36	34	31	15	16	25	A-6b (9)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/29/24 09:21 - X:\GINT\PROJECTS\601125.GPJ

NOTES: LAT/LONG/ELEV FROM OGE SURVEY GRADE INSTRUMENTS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 100 BENTONITE CHIPS

PROJECT: FAI-22-3.68	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: CME 75 TRUCK	STATION / OFFSET:	EXPLORATION ID B-002-0-24
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: ODOT / BENNING	HAMMER: CME AUTOMATIC	ALIGNMENT: CL SR 22	
PID: 115691 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/23/24	ELEVATION: 891.3 (ft) EOB: 115.0 ft.	PAGE 1 OF 2
START: 6/3/24 END: 6/10/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 89	LAT / LONG: 39.652523, -82.773138	

MATERIAL DESCRIPTION AND NOTES	ELEV. 891.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT (14")	890.1	891.3																
MEDIUM DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, CONTAINS BRICK FRAGMENTS, DAMP	888.3		12 7 3	15	33	SS-1	-	39	27	13	15	6	NP	NP	NP	6	A-1-b (0)	
MEDIUM STIFF, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, POOR RECOVERY, ADDITIONAL AUGER CUTTINGS TAKEN, MOIST	886.8		3 2 2	6	6	SS-2	-	6	6	29	37	22	22	15	7	16	A-4a (5)	
MEDIUM STIFF, BROWN AND GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST			0 0 1	1	6	SS-3	1.00	7	5	25	36	27	29	16	13	21	A-6a (7)	
@6.0'; SLIGHTLY ORGANIC (LOI = 4.0%)			2 2 2	6	72	SS-4	0.75	5	6	24	38	27	30	18	12	27	A-6a (7)	
@7.5'; BROWN	882.3		2 2 2	6	72	SS-5	0.75	13	10	22	30	25	30	17	13	22	A-6a (5)	
STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MODERATELY ORGANIC (LOI = 5.5%), POSSIBLE NATIVE GROUND, MOIST			2 3 3	9	100	SS-6	1.25	2	2	12	46	38	40	23	17	32	A-6b (11)	
@10.5'; MODERATELY ORGANIC (LOI = 4.1%)	879.3		2 2 2	6	94	SS-7	1.50	2	2	22	39	35	33	17	16	25	A-6b (10)	
SOFT, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, WET	877.8		0 0 0	0	89	SS-8	0.50	1	4	35	35	25	25	15	10	25	A-4a (5)	
LOOSE, DARK GRAY, **GRAVEL WITH SAND AND SILT**, TRACE CLAY, MOIST	876.3		1 3 3	9	56	SS-9	-	33	14	19	24	10	24	18	6	17	A-2-4 (0)	
MEDIUM STIFF, BROWN AND GRAY, **SANDY SILT**, SOME GRAVEL, LITTLE CLAY, MOIST			0 4 5	13	100	SS-10	0.50	32	10	17	26	15	24	16	8	19	A-4a (1)	
@16.5'; GRAY, LITTLE GRAVEL, DAMP			3 7 9	24	61	SS-11	3.50	19	8	21	33	19	20	14	6	11	A-4a (3)	
		W 871.7	4 6 7	19	56	SS-12	2.50	17	11	18	35	19	19	14	5	11	A-4a (4)	
@19.5'; SOME CLAY, MOIST			5 9 10	28	39	SS-13	0.75	16	12	17	34	21	21	13	8	15	A-4a (4)	
		W 869.5	2 4 8	18	83	SS-14	1.00	19	11	15	34	21	22	13	9	16	A-4a (4)	
@23.5'; HARD, DAMP			5 7 6	19	6	SS-15	4.5+	15	9	14	38	24	21	14	7	14	A-4a (5)	
			9 9 14	34	100	SS-16	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
@28.5'; VERY STIFF			7 10 14	36	83	SS-17	3.75	-	-	-	-	-	-	-	-	11	A-4a (V)	
@31.0'; HARD			9 12 12	36	94	SS-18	4.5+	14	10	15	36	25	21	13	8	12	A-4a (5)	
@33.5'; VERY STIFF, NO RECOVERY, RESAMPLED WITH 3" SPLITSPOON			19 16 20	54	0	SS-19	2.75	-	-	-	-	-	-	-	-	12	A-4a (V)	
@36.0'; HARD			6 3 24	40	100	SS-20	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	
@38.5'; VERY STIFF			4 5 8	19	100	SS-21	2.00	12	10	16	38	24	21	13	8	12	A-4a (5)	
@43.5'; 3.2' OF HEAVED MATERIAL WITHIN THE AUGERS WITH FLOWING ARTESIAN CONDITIONS.			0 0 0	0	17	SS-22	-	-	-	-	-	-	-	-	-	12	A-4a (V)	
@48.5'; VERY STIFF, SOME GRAVEL			4 12 10	33	72	SS-23	2.25	29	10	14	27	20	22	14	8	14	A-4a (2)	
@53.5'; HARD	832.8		6 11 17	42	100	SS-24	4.5+	-	-	-	-	-	-	-	-	12	A-4a (V)	
MEDIUM DENSE, GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, WET			12 8 12	30	100	SS-25	-	23	38	26	10	3	NP	NP	NP	13	A-1-b (0)	

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 7/26/24 12:50 - X:\GINT\PROJECTS\601125.GPJ

PID: 115691 | SFN: | PROJECT: FAI-22-3.68 | STATION / OFFSET: | START: 6/3/24 | END: 6/10/24 | PG 2 OF 2 | B-002-0-24

MATERIAL DESCRIPTION AND NOTES	ELEV. 831.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE, GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, WET *(continued)*	827.8	61–63																
STIFF, GRAY, **SANDY SILT**, "AND" CLAY, WET		64	6 7 13	30	89	SS-26	1.75	0	1	9	48	42	23	15	8	21	A-4a (8)	
@68.5'; 2.0' OF HEAVING SAND ENCOUNTERED	817.8	69	9 3 10	19	78	SS-27	2.00	-	-	-	-	-	-	-	-	23	A-4a (V)	
VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, MOIST		74	6 6 9	22	72	SS-28	2.25	0	0	1	44	55	30	17	13	24	A-6a (9)	
	807.8	79	3 6 8	21	78	SS-29	2.75	-	-	-	-	-	-	-	-	24	A-6a (V)	
VERY STIFF, GRAY, **SILT**, "AND" CLAY, TRACE SAND, WET	802.8	84	2 5 4	13	100	SS-30	2.75	0	0	1	57	42	23	17	6	25	A-4b (8)	
VERY STIFF, GRAY, **SILT AND CLAY**, VARVED, MOIST		89	2 5 4	13	100	SS-31	2.75	0	0	0	44	56	29	18	11	25	A-6a (8)	
@93.5'; STIFF		94	2 4 7	16	100	SS-32	1.75	0	0	0	44	56	31	19	12	24	A-6a (9)	
		99	5 7 12	28	100	SS-33	1.75	-	-	-	-	-	-	-	-	25	A-6a (V)	
		104	5 9 10	28	100	SS-34	1.75	-	-	-	-	-	-	-	-	26	A-6a (V)	
		109	0 5 7	18	100	SS-35	1.50	0	0	0	39	61	35	21	14	26	A-6a (10)	
	776.3	114 – EOB – 115	3 7 12	28	100	SS-36	1.25	-	-	-	-	-	-	-	-	26	A-6a (V)	

NOTE: INTERMITTENT FLOWING ARTESIAN CONDITIONS WHILE DRILLING AND SAMPLING BELOW 43.5 FT. WITH APPROXIMATELY 1-FOOT OF HEAD PRESSURE ABOVE THE GROUND SURFACE AT COMPLETION OF THE BORING.

NOTES: LAT/LONG/ELEV FROM OGE SURVEY GRADE INSTRUMENTS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 1400 LB. CEMENT; TREMIED 160 GAL. WATER

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 7/26/24 12:50 - X:\GINT\PROJECTS\601125.GPJ

PROJECT: FAI-22-3.68	DRILLING FIRM / OPERATOR: ODOT / SPROUSE	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 197+64, 11' LT.	EXPLORATION ID B-002-1-24
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: ODOT / KOLBERG	HAMMER: CME AUTOMATIC	ALIGNMENT: CL US 22	
PID: 115691 SFN: 2300096 (P)	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/7/23	ELEVATION: 891.1 (ft) EOB: 31.3 ft.	PAGE 1 OF 1
START: 11/4/24 END: 11/5/24	SAMPLING METHOD: ST	ENERGY RATIO (%): 88	LAT / LONG: 39.652532, -82.773161	

MATERIAL DESCRIPTION AND NOTES	ELEV. 891.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT (12") & CONCRETE (6")	889.6																	
BROWN, **SILT AND CLAY**, DAMP NOTE: VISUAL DESCRIPTION FROM AUGER CUTTINGS; SEE B-002-0-24 FOR DETAILED DESCRIPTION	876.4																	
MEDIUM STIFF, DARK BROWN, **SANDY SILT**, TRACE CLAY, TRACE GRAVEL, MOIST					75	ST-1	0.78	2	3	39	47	9	25	17	8	22	A-4a (4)	
					71	ST-2	1.05	1	3	35	42	19	23	14	9	14	A-4a (5)	
	870.4				50	ST-3	-	-	-	-	-	-	-	-	-	-		
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, WET	868.4				100	ST-4	1.22	0	2	87	8	3	16	12	4	16	A-3a (0)	
HARD, DARK BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP					79	ST-5	4.25	2	3	29	52	14	20	13	7	12	A-4b (6)	
					85	ST-6	4.50	2	2	29	54	13	22	14	8	12	A-4b (6)	
					71	ST-7	4.50	3	4	31	51	11	25	15	10	11	A-4b (5)	
	859.8	EOB 31			56	ST-8	-	-	-	-	-	-	-	-	-	-		

NOTES: LAT/LONG FROM JUNIPER GEODE GNS3 GPS RECEIVER. ELEV FROM CONSULTANT SURVEY TIN.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 30 GAL. BENTONITE CEMENT GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/30/25 11:12 - X:\GINT\PROJECTS\2024 COMPLETE\601167.GPJ

PROJECT: FAI-22-3.68	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: ACKER REBEL XL	STATION / OFFSET:	EXPLORATION ID B-003-0-24
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: ODOT / DALEY	HAMMER: ACKER AUTOMATIC	ALIGNMENT: CL SR 22	
PID: 115691 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/7/23	ELEVATION: 884.1 (ft) EOB: 100.0 ft.	PAGE 1 OF 2
START: 4/22/24 END: 4/29/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 39.652431, -82.772925	

MATERIAL DESCRIPTION AND NOTES	ELEV. 884.1	DEPTHS ∇
TOPSOIL (4")	883.8	884.1
LOOSE, BROWN, **COARSE AND FINE SAND**, SOME SILT, LITTLE CLAY, WET @3.0'; LITTLE SILT, TRACE CLAY @4.5'; DARK BROWN AND GRAY, TRACE GRAVEL	876.6	
MEDIUM DENSE, GRAYISH BROWN, **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, CONTAINS WOOD FRAGMENTS, WET @7.5' - 9.0'; NOT ENOUGH MATERIAL TO TEST @9.0'; MOIST	873.6	W 875.9
STIFF, GRAY, **SANDY SILT**, LITTLE GRAVEL AND STONE FRAGMENTS, LITTLE CLAY, DAMP @12.0'; VERY STIFF, SOME CLAY @13.5'; STIFF, MOIST @14.3'; QU = 3,362 PSF @ 15.0% STRAIN; γ_d = 127.99 PCF @14.9' - 15.1'; C_c = 0.065, C_r = 0.041 @16.0'; DAMP @28.5'; LITTLE CLAY @33.5'; SOME GRAVEL AND STONE FRAGMENTS	845.6	W 866.9
DENSE, GRAY AND BROWN, **GRAVEL AND STONE FRAGMENTS**, LITTLE SAND, TRACE SILT, TRACE CLAY, WET @83.5'; 11.8' OF HEAVED MATERIAL WITHIN THE AUGERS WITH FLOWING ARTESIAN CONDITIONS.	840.6	
HARD, GRAY, **SANDY SILT**, SOME GRAVEL, LITTLE CLAY, 2.2' OF HEAVING SAND ENCOUNTERED, DAMP @48.5'; VERY STIFF, LITTLE GRAVEL, 1.9' OF HEAVING SAND ENCOUNTERED, WET	830.6	
DENSE, GRAY, **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, 2.0' OF HEAVING SAND ENCOUNTERED, WET	825.6	
VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, MOIST		

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
1 2 1	5	44	SS-1	-	0	4	61	24	11	NP	NP	NP	17	A-3a (0)	
1 2 2	6	44	SS-2	-	0	3	76	14	7	NP	NP	NP	16	A-3a (0)	
1 1 1	3	44	SS-3	-	7	10	59	16	8	NP	NP	NP	26	A-3a (0)	
1 1 1	3	44	SS-4	-	3	18	55	16	8	NP	NP	NP	25	A-3a (0)	
7 9 7	24	28	SS-5	-	-	-	-	-	-	-	-	-	15	A-1-b (V)	
8 9 8	26	33	SS-6	-	59	13	11	12	5	NP	NP	NP	13	A-1-b (0)	
5 7 7	21	44	SS-7	1.50	20	15	17	30	18	18	13	5	11	A-4a (3)	
5 7 7	21	44	SS-8	3.00	17	11	15	37	20	19	13	6	11	A-4a (4)	
		88	ST-9	3.00	14	9	15	37	25	20	13	7	14	A-4a (5)	
7 7 9	24	56	SS-10	3.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
6 8 9	26	44	SS-11	3.00	-	-	-	-	-	-	-	-	11	A-4a (V)	
4 6 10	24	56	SS-12	2.50	12	10	15	40	23	21	14	7	12	A-4a (6)	
5 7 9	24	56	SS-13	3.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
5 8 10	27	56	SS-14	3.00	-	-	-	-	-	-	-	-	11	A-4a (V)	
5 7 8	23	56	SS-15	3.00	19	15	20	34	12	16	13	3	12	A-4a (2)	
5 10 10	30	44	SS-16	3.00	29	8	14	31	18	20	13	7	12	A-4a (3)	
7 10 11	32	28	SS-17	-	83	9	4	3	1	NP	NP	NP	8	A-1-a (0)	
9 9 12	32	33	SS-18	4.50	21	11	18	31	19	19	13	6	11	A-4a (3)	
8 12 19	47	56	SS-19	2.00	19	4	14	48	15	17	14	3	16	A-4a (6)	
8 10 12	33	33	SS-20	-	11	38	32	14	5	NP	NP	NP	18	A-1-b (0)	
6 10 12	33	44	SS-21	2.00	0	1	2	44	53	29	17	12	24	A-6a (9)	

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 7/26/24 12:50 - X:\GINT\PROJECTS\601125.GPJ

PID: 115691	SFN:	PROJECT: FAI-22-3.68	STATION / OFFSET:	START: 4/22/24	END: 4/29/24	PG 2 OF 2	B-003-0-24

MATERIAL DESCRIPTION AND NOTES	ELEV. 824.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF, GRAY, **SILT AND CLAY**, TRACE SAND, MOIST *(continued)*		61 – 63																
@63.5'; 2.3' OF HEAVING SAND ENCOUNTERED		64 – 65	4-6-8	21	67	SS-22	2.00	-	-	-	-	-	-	-	-	24	A-6a (V)	
		66 – 68																
@68.5'; STIFF		69 – 70	3-4-5	14	67	SS-23	1.50	-	-	-	-	-	-	-	-	26	A-6a (V)	
		71 – 73																
@73.5'; 2.0' OF HEAVING SAND ENCOUNTERED		74 – 75	3-3-4	11	67	SS-24	1.50	0	0	1	43	56	31	18	13	26	A-6a (9)	
		76 – 78																
@78.5'; 2.0' OF HEAVING SAND ENCOUNTERED		79 – 80	3-3-5	12	56	SS-25	1.50	-	-	-	-	-	-	-	-	24	A-6a (V)	
	800.6	81 – 83																
MEDIUM STIFF, GRAY, **SILT**, "AND" CLAY, TRACE SAND, WET		84 – 85	1-1-2	5	89	SS-26	1.00	0	0	1	54	45	25	16	9	25	A-4b (8)	
	795.6	86 – 88																
STIFF, GRAY, **SILT AND CLAY**, VARVED, MOIST		89 – 90	3-4-6	15	67	SS-27	1.50	-	-	-	-	-	-	-	-	24	A-6a (V)	
		91 – 93																
		94 – 95	4-4-5	14	67	SS-28	2.00	0	0	0	39	61	32	18	14	26	A-6a (10)	
		96 – 98																
	784.1	99 – 100 (EOB)	4-4-6	15	56	SS-29	2.00	-	-	-	-	-	-	-	-	24	A-6a (V)	

NOTE: INTERMITTENT FLOWING ARTESIAN CONDITIONS WHILE DRILLING AND SAMPLING BELOW 38.5 FT. WITH OVER 5-FEET OF INITIAL HEAD PRESSURE ABOVE THE GROUND SURFACE.

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 7/26/24 12:50 - X:\GINT\PROJECTS\601125.GPJ

NOTES: LAT/LONG/ELEV FROM OGE SURVEY GRADE INSTRUMENTS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 1128 LB. CEMENT; TREMIED 90 GAL. WATER

PROJECT: FAI-22-3.68	DRILLING FIRM / OPERATOR: ODOT / KINNEY	DRILL RIG: CME 75 TRUCK	STATION / OFFSET:	EXPLORATION ID B-004-0-24
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: ODOT / BENNING	HAMMER: CME AUTOMATIC	ALIGNMENT: CL SR 22	
PID: 115691 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/23/24	ELEVATION: 891.6 (ft) EOB: 15.0 ft.	PAGE 1 OF 1
START: 6/11/24 END: 6/11/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 89	LAT / LONG: 39.652504, -82.772724	

MATERIAL DESCRIPTION AND NOTES	ELEV. 891.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI			
ASPHALT (14") & BRICK (4")	890.1	1																
MEDIUM DENSE, BROWN, **STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP	888.6	2	13 7 5	18	28	SS-1	-	44	24	10	13	9	27	21	6	9	A-1-b (0)	
MEDIUM STIFF, GRAYISH BROWN, **SANDY SILT**, SOME STONE FRAGMENTS, LITTLE CLAY, DAMP		3, 4	3 2 2	6	22	SS-2	0.75	-	-	-	-	-	-	-	-	17	A-4a (V)	
		5	1 1 2	4	39	SS-3	0.50	21	13	20	30	16	25	19	6	19	A-4a (2)	
@6.0'; STIFF, BROWN AND GRAY, LITTLE GRAVEL AND STONE FRAGMENTS		6, 7	2 2 2	6	83	SS-4	1.50	10	10	28	32	20	25	19	6	19	A-4a (3)	
		8	1 2 3	7	78	SS-5	1.50	18	12	21	30	19	27	20	7	20	A-4a (3)	
@9.0'; MEDIUM STIFF, DARK GRAY AND GRAY, SOME CLAY, TRACE GRAVEL, MOIST	881.1	9, 10	1 1 2	4	83	SS-6	1.00	9	6	20	37	28	30	20	10	26	A-4a (6)	
MEDIUM STIFF, DARK GRAY AND GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		11	0 0 1	1	100	SS-7	0.75	2	3	21	41	33	34	23	11	31	A-6a (8)	
@12.0'; DARK GRAY, SOME SAND, TRACE GRAVEL, WET	878.1	12, 13	0 0 4	6	78	SS-8	1.00	6	2	13	41	38	39	25	14	37	A-6a (10)	
MEDIUM STIFF, GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, WET	876.6	14, EOB 15	2 6 10	24	11	SS-9	0.50	6	11	19	37	27	29	19	10	27	A-4a (6)	

NOTES: HOLE DRY UPON COMPLETION. LAT/LONG/ELEV FROM OGE SURVEY GRADE INSTRUMENTS.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 50 LB. BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/29/24 09:21 - X:\GINT\PROJECTS\601125.GPJ

PROJECT: FAI-22-3.68	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: CME 75 TRUCK	STATION / OFFSET:	EXPLORATION ID B-005-0-24
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: ODOT / BENNING	HAMMER: CME AUTOMATIC	ALIGNMENT: CL SR 22	
PID: 115691 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/23/24	ELEVATION: 892.5 (ft) EOB: 10.0 ft.	PAGE 1 OF 1
START: 5/23/24 END: 5/23/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 89	LAT / LONG: 39.652406, -82.771512	

MATERIAL DESCRIPTION AND NOTES	ELEV. 892.5	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
ASPHALT (12") & BRICK (3")	891.2	1																
VERY STIFF, BROWN AND YELLOWISH BROWN, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL AND STONE FRAGMENTS, DAMP	889.5	2	3 5 8	19	56	SS-1	3.75	1	1	3	37	58	38	20	18	20	A-6b (11)	
HARD, BROWN AND YELLOWISH BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL AND STONE FRAGMENTS, DAMP	888.0	3, 4	4 6 9	22	100	SS-2	4.50	6	7	11	37	39	31	17	14	16	A-6a (10)	
HARD, BROWN, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL AND STONE FRAGMENTS, DAMP		5	4 7 9	24	100	SS-3	4.25	14	11	15	35	25	25	15	10	13	A-4a (5)	
		6, 7	7 10 10	30	83	SS-4	4.5+	-	-	-	-	-	-	-	-	12	A-4a (V)	
		8																
@8.5'; VERY STIFF	883.2	9	5 11 11	33	72	SS-5A	4.00	-	-	-	-	-	-	-	-	11	A-4a (V)	
MEDIUM DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP	882.5	EOB 10				SS-5B	-	53	15	12	14	6	20	17	3	7	A-1-b (0)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT GDT - 7/29/24 09:21 - X:\GINT\PROJECTS\601125.GPJ

NOTES: HOLE DRY UPON COMPLETION. LAT/LONG/ELEV FROM OGE SURVEY GRADE INSTRUMENTS.

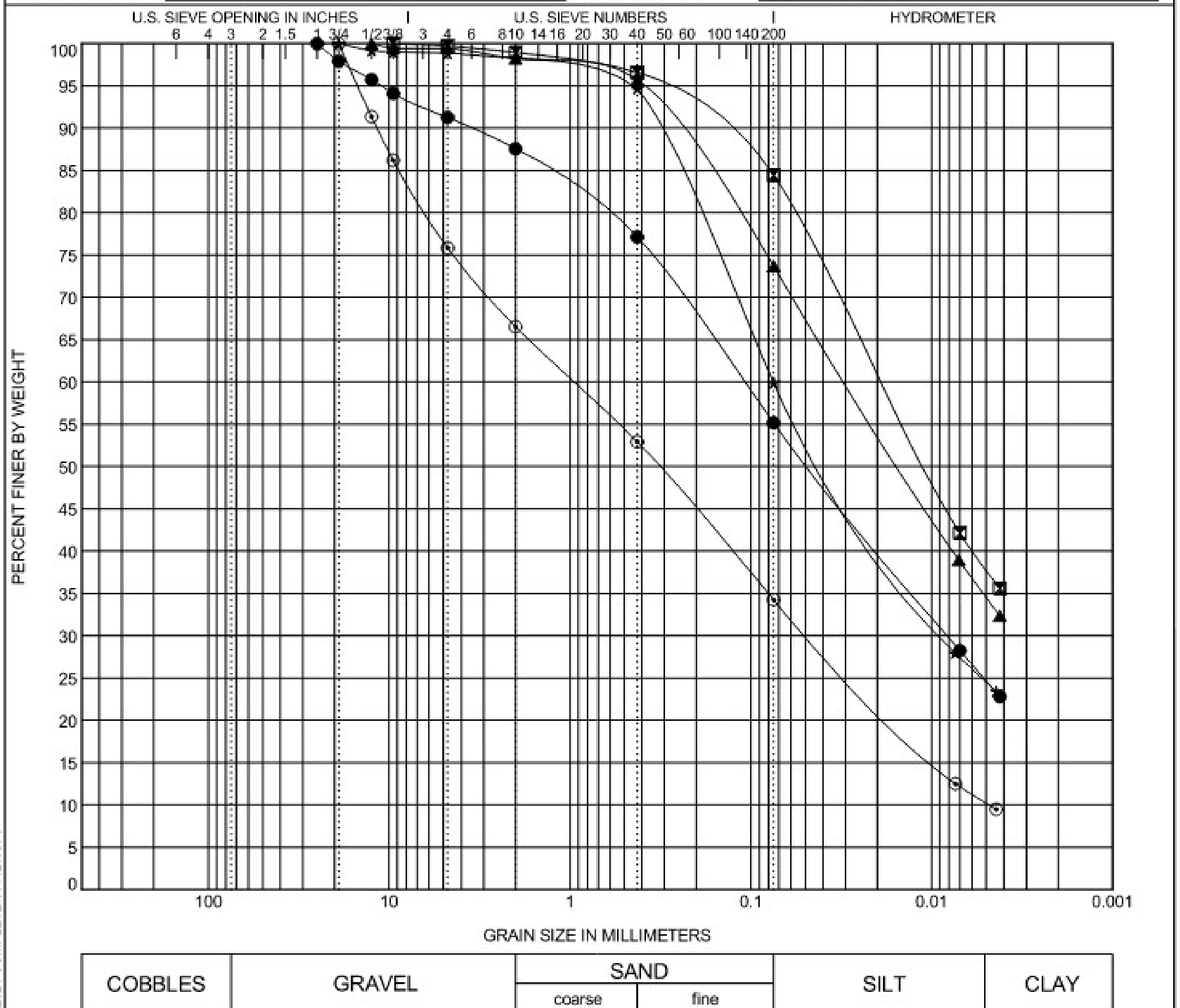
ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 50 LB. BENTONITE CHIPS

Appendix F: Grain Size Distribution Charts

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

GRAIN SIZE DISTRIBUTION

PROJECT FAI-22-3.68 **PID** 115691
OGE NUMBER 601125 **PROJECT TYPE** STRUCTURE



	Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	B-002-0-24	7.5	A-6a ~ SANDY LEAN CLAY(CL)	30	17	13
⊠	B-002-0-24	9.0	A-6b ~ LEAN CLAY with SAND(CL)	40	23	17
▲	B-002-0-24	10.5	A-6b ~ LEAN CLAY with SAND(CL)	33	17	16
★	B-002-0-24	12.0	A-4a ~ SANDY LEAN CLAY(CL)	25	15	10
⊙	B-002-0-24	13.5	A-2-4 ~ SILTY, CLAYEY SAND with GRAVEL(SC-SM)	24	18	6

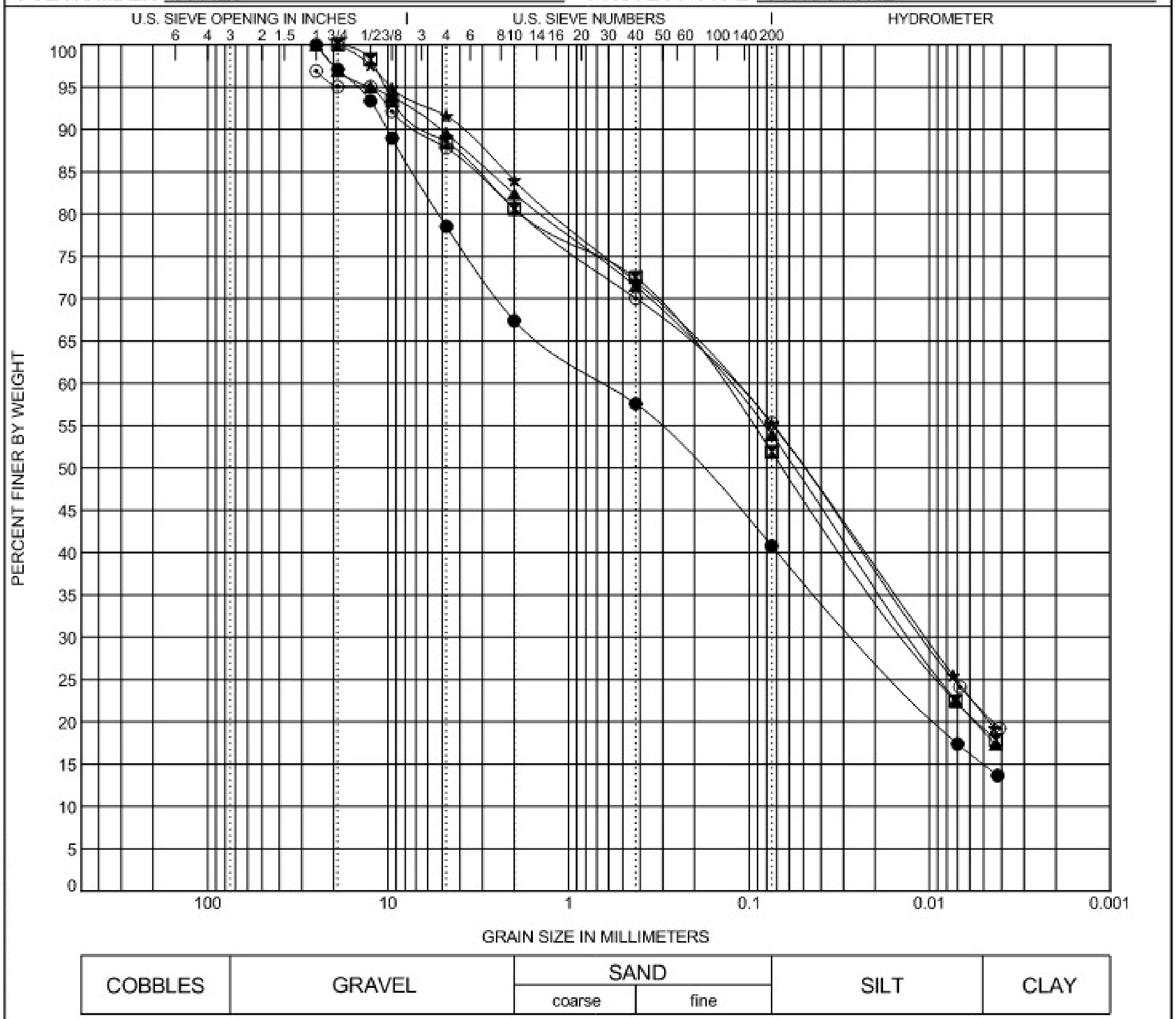
	Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	B-002-0-24	7.5	3.516	0.048	0.008		13	10	22	30	25		
⊠	B-002-0-24	9.0	0.166	0.011			2	2	12	46	38		
▲	B-002-0-24	10.5	0.271	0.015			2	2	22	39	35		
★	B-002-0-24	12.0	0.336	0.037	0.009		1	4	35	35	25		
⊙	B-002-0-24	13.5	11.628	0.324	0.048	0.005	33	14	19	24	10	0.50	198.43

GRAIN SIZE - OH DOT.GDT - 2/19/25 06:30 - X:\GINT\PROJECTS\2024 COMPLETE\601125.GPJ

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT FAI-22-3.68 **PID** 115691
OGE NUMBER 601125 **PROJECT TYPE** STRUCTURE



	Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	B-002-0-24	15.0	A-4a ~ CLAYEY SAND with GRAVEL(SC)	24	16	8
⊠	B-002-0-24	16.5	A-4a ~ SANDY SILTY CLAY(CL-ML)	20	14	6
▲	B-002-0-24	18.0	A-4a ~ SANDY SILTY CLAY(CL-ML)	19	14	5
★	B-002-0-24	19.5	A-4a ~ SANDY LEAN CLAY(CL)	21	13	8
⊙	B-002-0-24	21.0	A-4a ~ SANDY LEAN CLAY(CL)	22	13	9

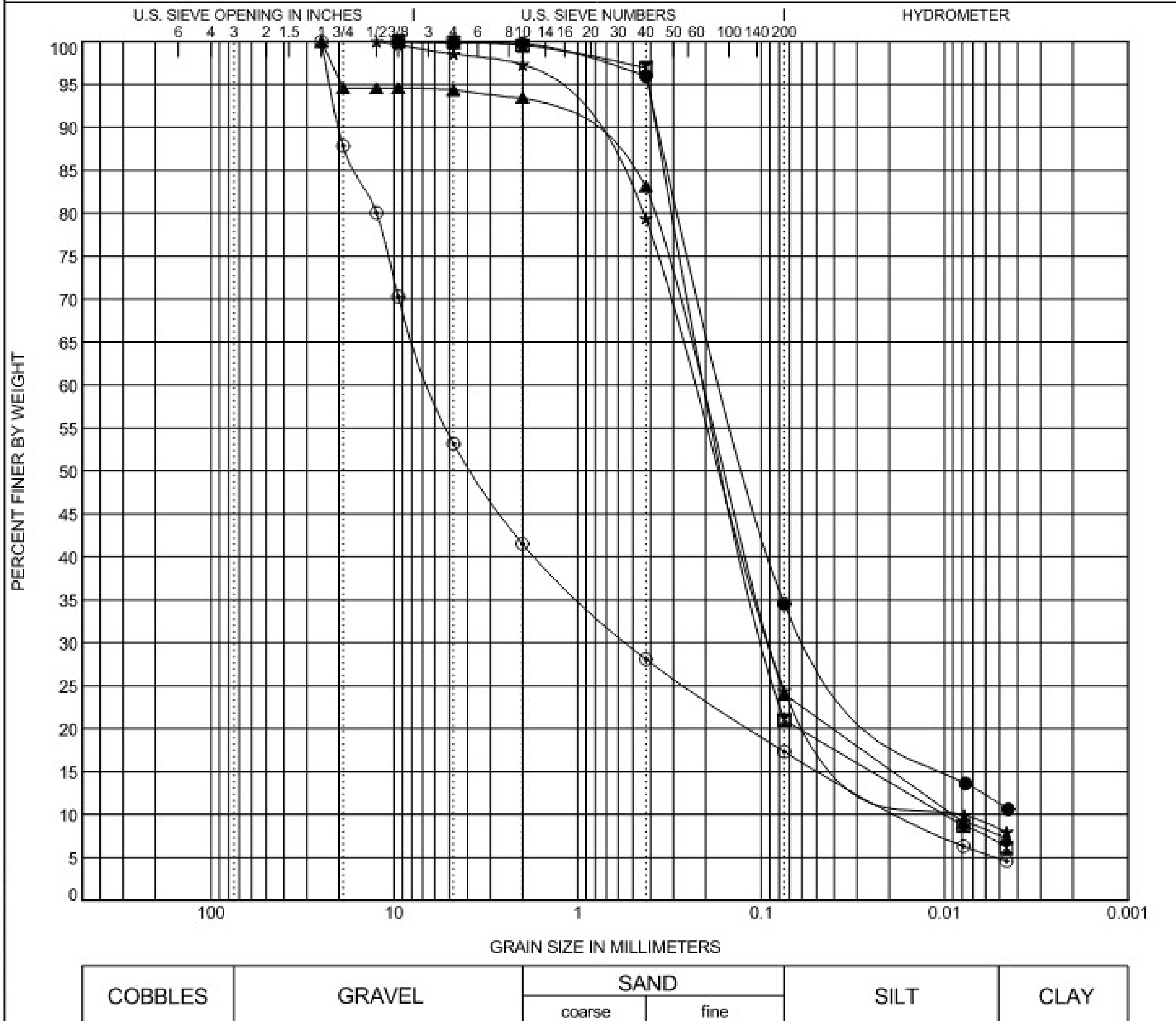
	Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	B-002-0-24	15.0	10.127	0.194	0.025		32	10	17	26	15		
⊠	B-002-0-24	16.5	5.851	0.064	0.013		19	8	21	33	19		
▲	B-002-0-24	18.0	5.141	0.056	0.013		17	11	18	35	19		
★	B-002-0-24	19.5	3.96	0.05	0.011		16	12	17	34	21		
⊙	B-002-0-24	21.0	6.734	0.05	0.011		19	11	15	34	21		

GRAIN SIZE - OH DOT.GDT - 2/19/25 08:30 - X:\GINT\PROJECTS\2024 COMPLETE\601125.GPJ

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

GRAIN SIZE DISTRIBUTION

PROJECT FAI-22-3.68 PID 115691
OGE NUMBER 601125 PROJECT TYPE STRUCTURE



	Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	B-003-0-24	1.5	A-3a ~ SILTY SAND(SM)	NP	NP	NP
⊠	B-003-0-24	3.0	A-3a ~ SILTY SAND(SM)	NP	NP	NP
▲	B-003-0-24	4.5	A-3a ~ SILTY SAND(SM)	NP	NP	NP
★	B-003-0-24	6.0	A-3a ~ SILTY SAND(SM)	NP	NP	NP
⊙	B-003-0-24	9.0	A-1-b ~ SILTY GRAVEL with SAND(GM)	NP	NP	NP

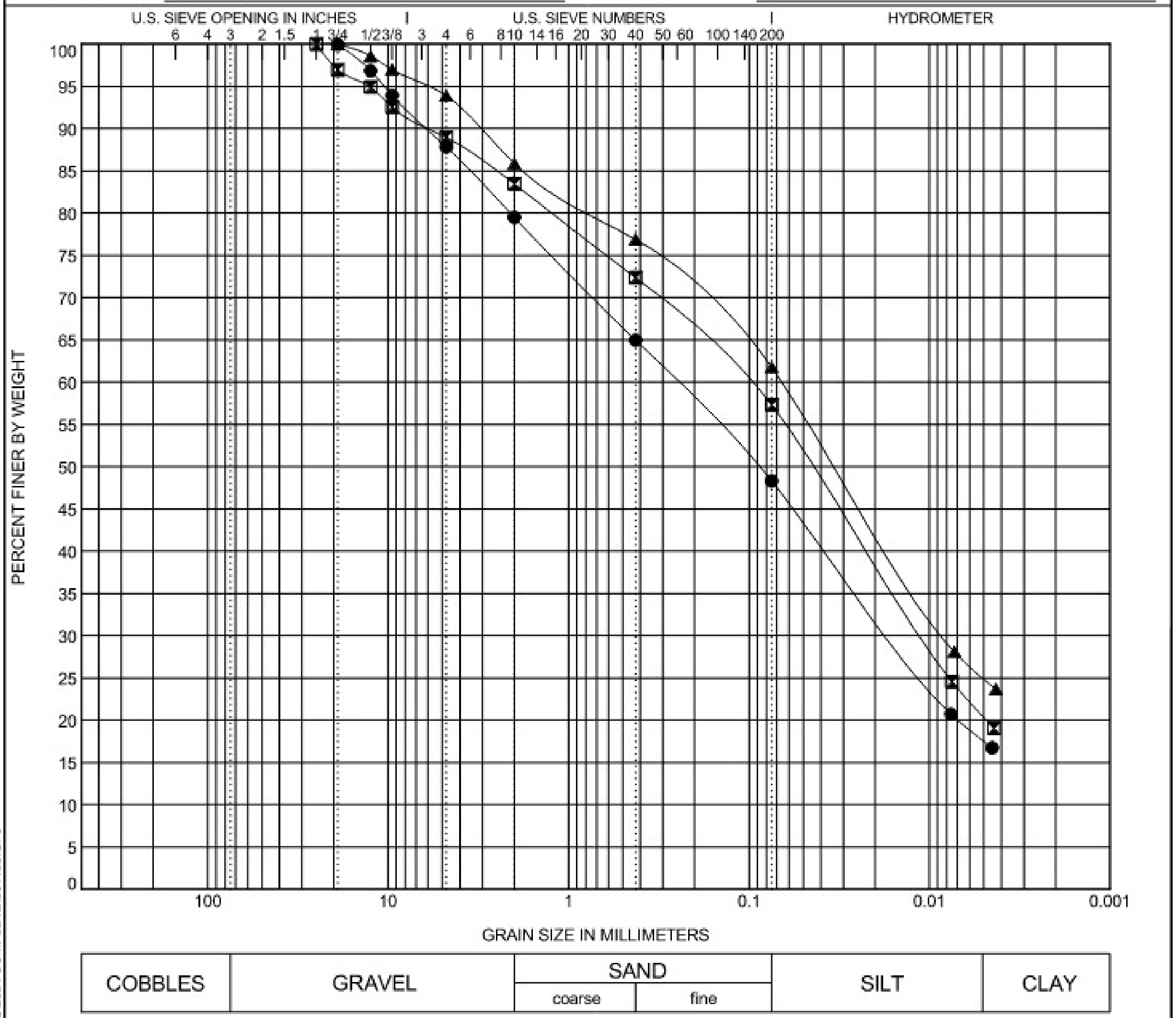
	Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	B-003-0-24	1.5	0.359	0.116	0.046		0	4	61	24	11		
⊠	B-003-0-24	3.0	0.363	0.146	0.092	0.01	0	3	76	14	7	4.63	18.21
▲	B-003-0-24	4.5	1.188	0.161	0.089	0.009	7	10	59	16	8	4.10	23.86
★	B-003-0-24	6.0	1.063	0.168	0.089	0.008	3	18	55	16	8	4.39	29.14
⊙	B-003-0-24	9.0	19.942	3.745	0.529	0.017	59	13	11	12	5	2.67	373.48

GRAIN SIZE - OH DOT.GDT - 2/19/25 06:31 - X:\GINT\PROJECTS\2024 COMPLETE\601125.GPJ

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT FAI-22-3.68 **PID** 115691
OGE NUMBER 601125 **PROJECT TYPE** STRUCTURE



Specimen Identification			ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	**B-003-0-24**	**10.5**	**A-4a ~ SILTY, CLAYEY SAND(SC-SM)**	**18**	**13**	**5**
⊠	**B-003-0-24**	**12.0**	**A-4a ~ SANDY SILTY CLAY(CL-ML)**	**19**	**13**	**6**
▲	**B-003-0-24**	**13.5**	**A-4a ~ SANDY SILTY CLAY(CL-ML)**	**20**	**13**	**7**

Specimen Identification			D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	**B-003-0-24**	**10.5**	**6.06**	**0.089**	**0.016**		**20**	**15**	**17**	**30**	**18**		
⊠	**B-003-0-24**	**12.0**	**5.784**	**0.045**	**0.011**		**17**	**11**	**15**	**37**	**20**		
▲	**B-003-0-24**	**13.5**	**3.114**	**0.033**	**0.008**		**14**	**9**	**15**	**37**	**25**		

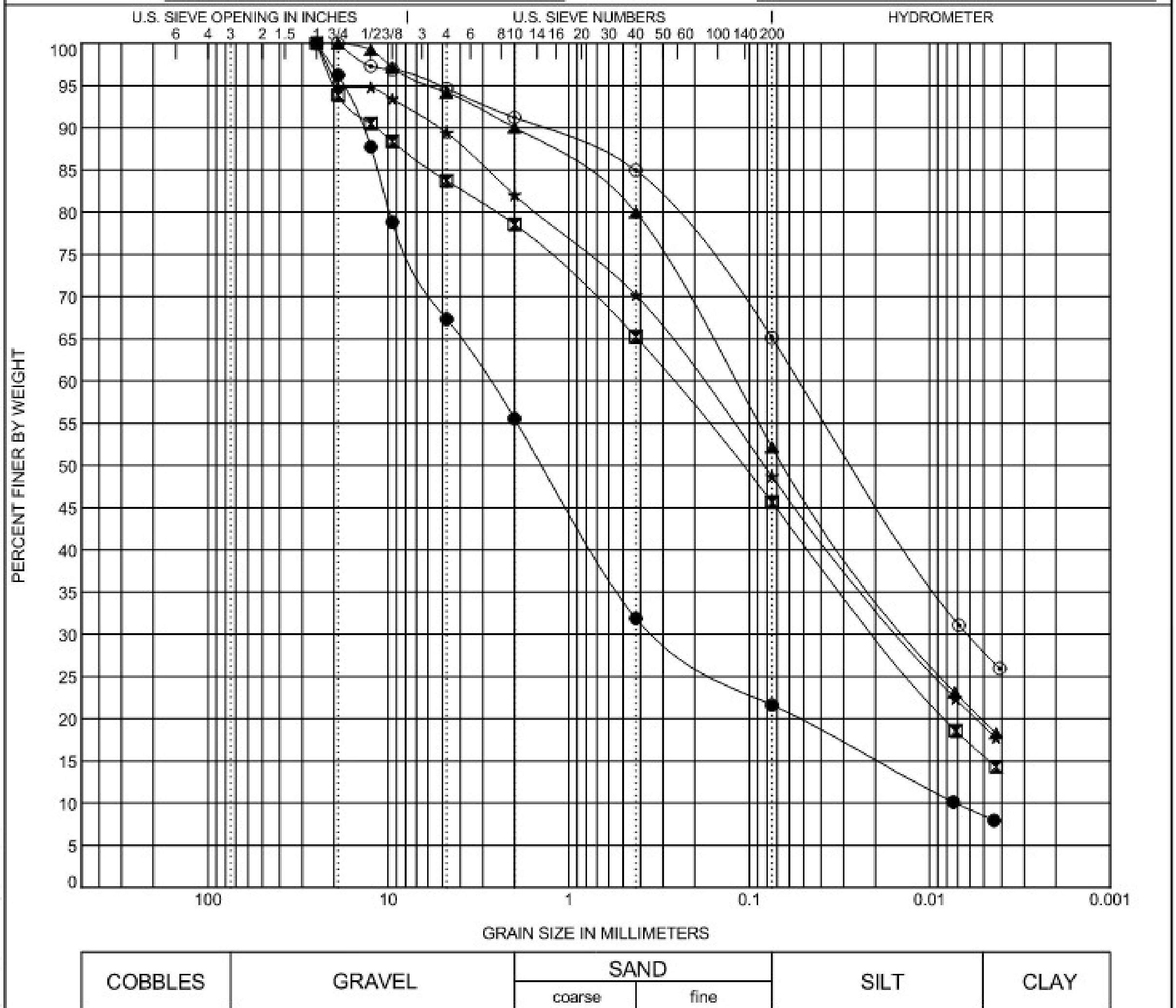
GRAIN SIZE - OH DOT.GDT - 2/19/25 06:31 - X:\GINT\PROJECTS\2024 COMPLETE\601125.GPJ

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT FAI-22-3.68 **PID** 115691

OGE NUMBER 601125 **PROJECT TYPE** STRUCTURE



Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
● B-004-0-24	1.5	**A-1-b ~ SILTY, CLAYEY SAND with GRAVEL(SC-SM)**	**27**	**21**	**6**
⊠ B-004-0-24	4.5	**A-4a ~ SILTY, CLAYEY SAND with GRAVEL(SC-SM)**	**25**	**19**	**6**
▲ B-004-0-24	6.0	**A-4a ~ SANDY SILTY CLAY(CL-ML)**	**25**	**19**	**6**
★ B-004-0-24	7.5	**A-4a ~ SILTY, CLAYEY SAND(SC-SM)**	**27**	**20**	**7**
⊙ B-004-0-24	9.0	**A-4a ~ SANDY LEAN CLAY(CL)**	**30**	**20**	**10**

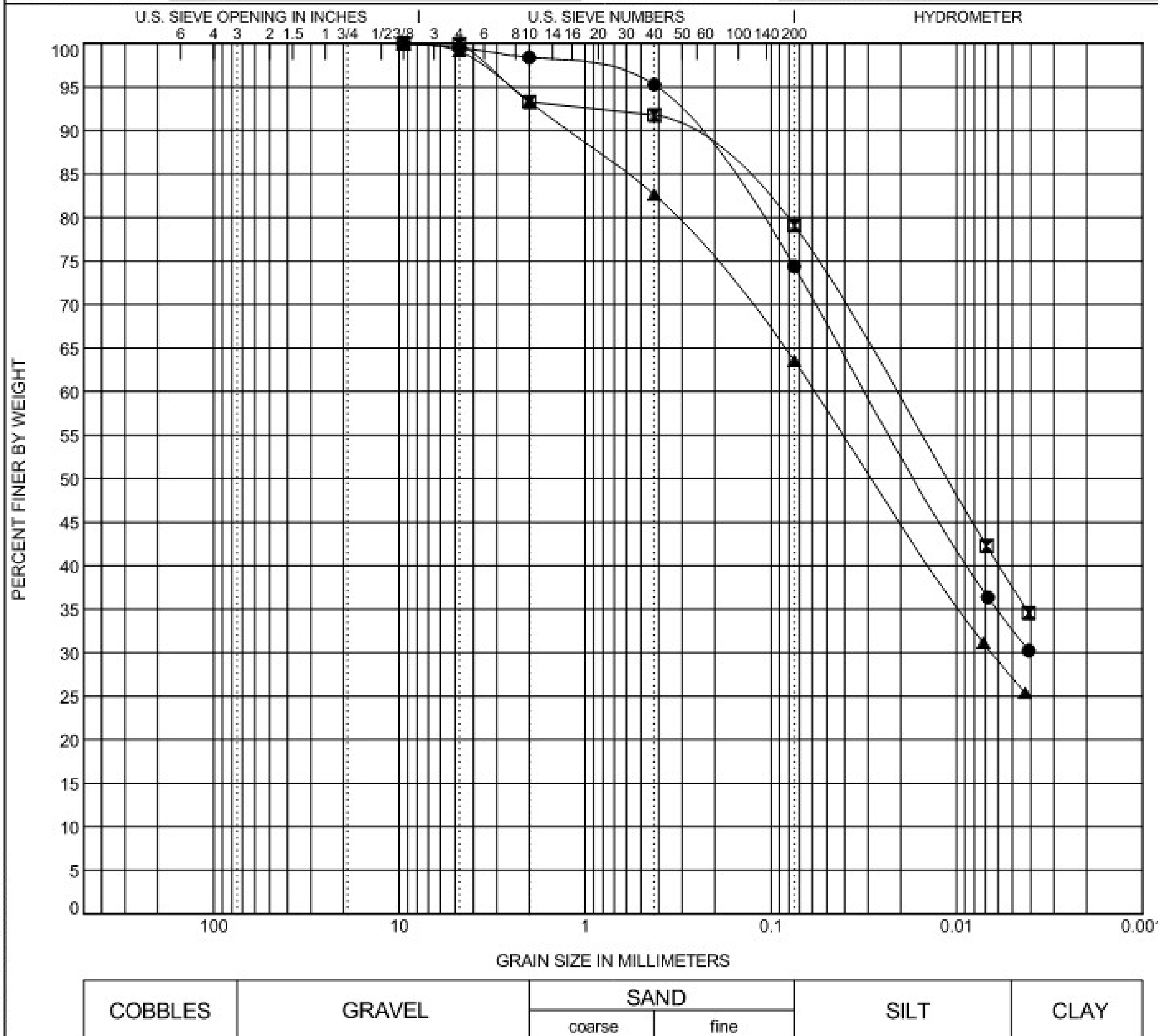
Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
● B-004-0-24	1.5	13.963	1.389	0.307	0.007	44	24	10	13	9	4.79	388.72
⊠ B-004-0-24	4.5	11.728	0.11	0.019		21	13	20	30	16		
▲ B-004-0-24	6.0	1.991	0.063	0.013		10	10	28	32	20		
★ B-004-0-24	7.5	5.25	0.083	0.014		18	12	21	30	19		
⊙ B-004-0-24	9.0	1.475	0.026	0.006		9	6	20	37	28		

GRAIN SIZE - OH DOT.GDT - 2/19/25 12:20 - X:\GINT\PROJECTS\2024 COMPLETE\601125.GPJ

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT FAI-22-3.68 **PID** 115691
OGE NUMBER 601125 **PROJECT TYPE** STRUCTURE



Specimen Identification			ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	**B-004-0-24**	**10.5**	**A-6a ~ LEAN CLAY with SAND(CL)**	**34**	**23**	**11**
⊠	**B-004-0-24**	**12.0**	**A-6a ~ LEAN CLAY with SAND(CL)**	**39**	**25**	**14**
▲	**B-004-0-24**	**13.5**	**A-4a ~ SANDY LEAN CLAY(CL)**	**29**	**19**	**10**

Specimen Identification			D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	**B-004-0-24**	**10.5**	**0.274**	**0.016**			**2**	**3**	**21**	**41**	**33**		
⊠	**B-004-0-24**	**12.0**	**0.332**	**0.011**			**6**	**2**	**13**	**41**	**38**		
▲	**B-004-0-24**	**13.5**	**1.234**	**0.028**	**0.006**		**6**	**11**	**19**	**37**	**27**		

GRAIN SIZE - OH DOT.GDT - 2/19/25 12:20 - X:\GINT\PROJECTS\2024 COMPLETE\601125.GPJ

Appendix G: Undisturbed Test Data Results

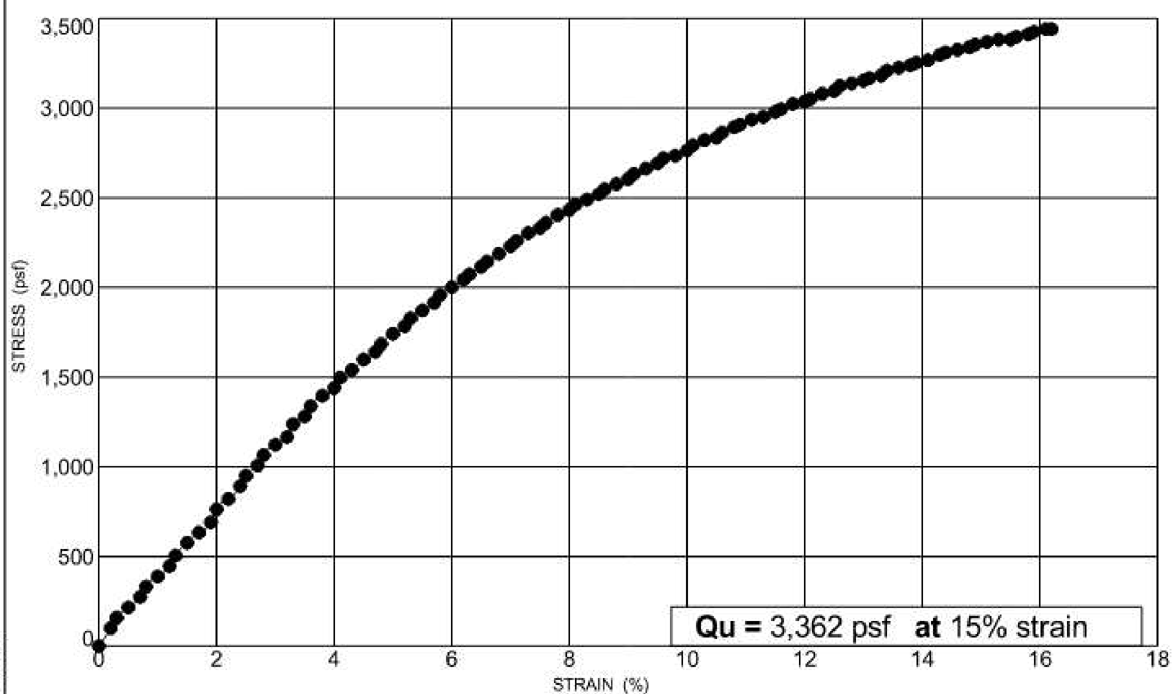
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

UNCONFINED COMPRESSION TEST
AASHTO T - 208

PROJECT FAI-22-3.68 | **PID** 115691
OGE NUMBER 601125 | **PROJECT TYPE** STRUCTURE

SAMPLE IDENTIFICATION

BORING ID: B-003-0-24 | SAMPLE ID: ST-9
STATION: NOT RECORDED | DEPTH: 14.3 - 14.8 feet



SPECIMEN FAILURE SKETCHES OR PHOTOGRAPHS

FRONT VIEW

SIDE VIEW

SPECIMEN DETAILS

HEIGHT: 5.76 inches
DIAMETER: 2.88 inches
WET UNIT WT: 143.37 pcf
DRY UNIT WT: 127.99 pcf

TESTED BY: AW 5/21/2024

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
14	9	15	37	25

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
20	13	7	14

ODOT CLASS: A-4a | HP (tsf): 3.00

DESCRIPTION: Stiff, Gray, **SANDY SILT**, Some Clay, Little Gravel and Stone Fragments, Moist

OHDOT UNCONFINED COMPRESSION - OH DOT.GDT - 7/17/24 15:29 - X:\GINT\PROJECTS\601125.GPJ

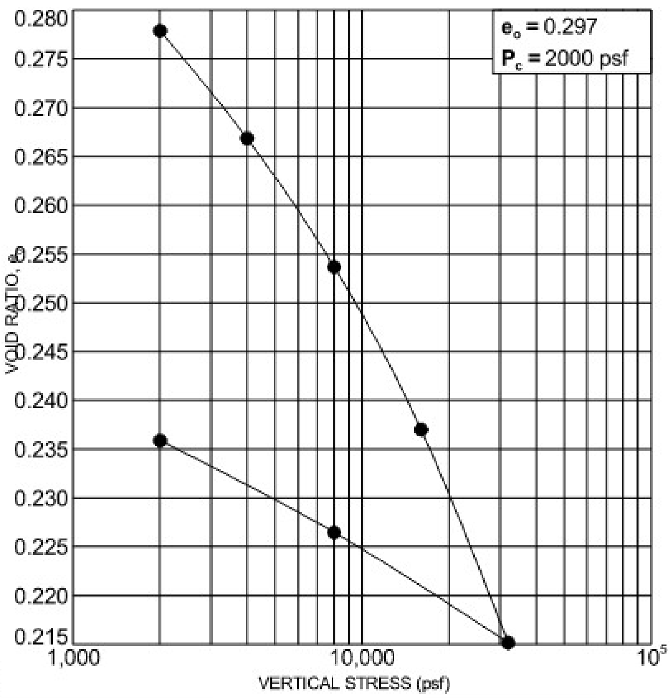
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

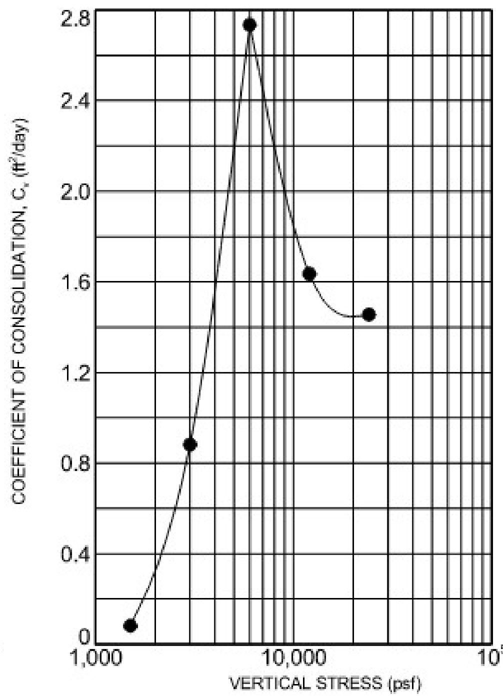
ONE-DIMENSIONAL CONSOLIDATION
AASHTO T - 216
(Page 1 of 2)

PROJECT FAI-22-3.68 **PID** 115691
OGE NUMBER 601125 **PROJECT TYPE** STRUCTURE

SAMPLE IDENTIFICATION

BORING ID: B-003-0-24 SAMPLE ID: ST-9
STATION: NOT RECORDED DEPTH: 14.9 - 15.1 feet





SPECIMEN DETAILS

Initial Height, H_o =	1.001 in
Ring Diameter, D =	2.500 in
Initial Volume, V_o =	4.911 in^3
Initial (Total) Weight, W_{tot} =	0.410 lb
Dry Weight, W_{dry} =	0.365 lb
Initial Water Content, WC_o =	12.2 %
Wet (Total) Unit Weight, γ_{tot} =	144.16 pcf
Dry Unit Weight, γ_{dry} =	128.48 pcf
Volume of Solids, V_s =	3.786 in^3
Initial Saturation, S_o =	109.6 %
Final Water Content, WC_f =	10.0 %
Final Wet Weight, $W_{wet,f}$ =	0.402 lb
Final Dry Unit Weight, $\gamma_{dry,f}$ =	132.20 pcf
Final Saturation, S_f =	113.4 %
Final Void Ratio, e_f =	0.236

C_c = 0.065 C_r = 0.041
P_o = 1714 psf OCR = 1.167

TEST DETAILS

METHOD OF TESTING: "Method B"
CONDITION OF TEST: "Natural Moisture Content"
SPECIFIC GRAVITY: 2.67 (Assumed)
NOTES:

TESTED BY: AW 5/9/2024

CLASSIFICATION RESULTS

GRADATION (%)

GR	CS	FS	SI	CL
14	9	15	37	25

ATTERBERG LIMITS / MOISTURE

LL	PL	PI	WC
20	13	7	14

ODOT CLASS: A-4a HP (tsf): 3.00

DESCRIPTION: Stiff, Gray, **SANDY SILT**, Some Clay, Little Gravel and Stone Fragments, Moist

OHDOT CONSOLIDATION - PAGE 1 - OH DOT.GDT - 7/18/24 12:54 - X:\GINT\PROJECTS\601125.GPJ

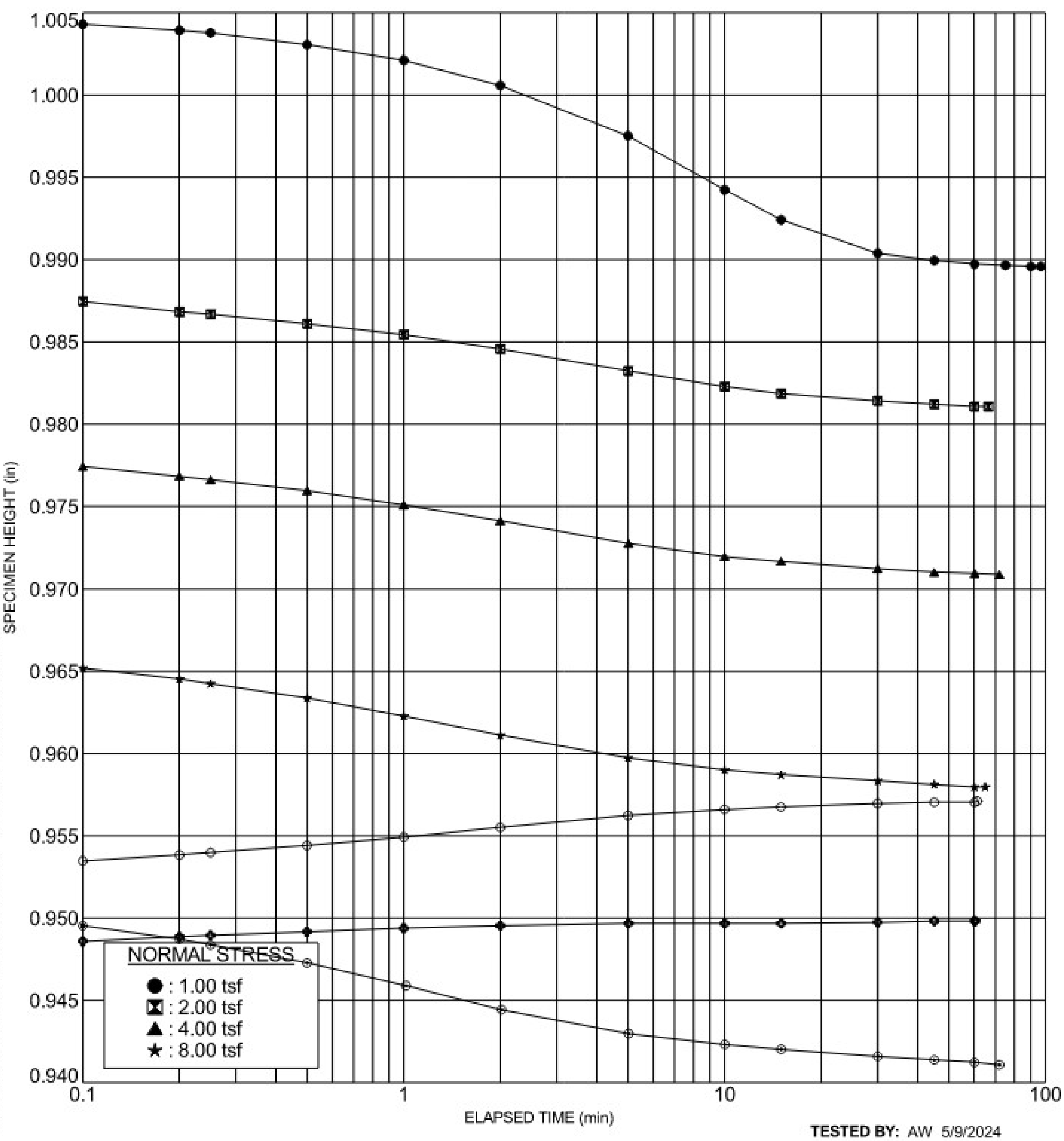
OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

ONE-DIMENSIONAL CONSOLIDATION AASHTO T - 216 (Page 2 of 2)

PROJECT FAI-22-3.68
PID 115691
OGE NUMBER 601125
PROJECT TYPE STRUCTURE

SAMPLE IDENTIFICATION

BORING ID: B-003-0-24
SAMPLE ID: ST-9
STATION: NOT RECORDED
DEPTH: 14.9 - 15.1 feet



OHDOT CONSOLIDATION - PAGE 2 - OH DOT.GDT - 7/18/24 12:56 - X:\GINT\PROJECTS\601125.GPJ

TESTED BY: AW 5/9/2024

Appendix H: Calculations

Appendix H-1: Plan Subgrade Analyses

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis
V. 14.7 11/6/2024

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

<FAI US 22 03.68>
<115691>
<Replacement of the existing structure with new structure on US 22 109 over Clear Creek in Fairfield County; in addition to necessary related work. >

<ODOT OGE>

Prepared By: <Amal Mohi>
Date prepared: <04/02/2025>

ODOT OGE
1980 W Broad Street
Columbus, OH 43223

614-387-2379
AMAL.MOHI@DOT.OHIO.GOV

NO. OF BORINGS: 2

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 11/6/2024

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-25	U.S. 22	194+50	0	CL	CME 75 TRUCK	89	889.3	888.0	1.3 C
2	B-005-0-25	U.S. 22	201+50	0	CL	CME 75 TRUCK	89	892.5	891.2	1.3 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 11/6/2024

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B 001-0 25	SS-1	1.5	3.0	0.2	1.7	7		0.75	28	15	13	31	28	59	17	14	A-6a	6			HP & Mc		18"	
		SS-2	3.0	4.5	1.7	3.2	6		0.75	45	25	20	39	47	86	32	22	A-7-6	13			HP & Mc			
		SS-3	4.5	6.0	3.2	4.7	6		1.25	25	15	10	31	25	56	21	10	A-4a	4						
		SS-4	6.0	7.5	4.7	6.2	6	6	0.75							28	16	A-6b	16						
2	B 005-0 25	SS-1	1.5	3.0	0.2	1.7	19		3.75	38	20	18	37	58	95	20	16	A-6b	11			Mc			
		SS-2	3.0	4.5	1.7	3.2	22		4.5	31	17	14	37	39	76	16	14	A-6a	10						
		SS-3	4.5	6.0	3.2	4.7	24		4.25	25	15	10	35	25	60	13	10	A-4a	5						
		SS-4	6.0	7.5	4.7	6.2	30	19	4.5							12	10	A-4a	8						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 11/6/2024

PID: <115691>

County-Route-Section: <FAI US 22 03.68>
No. of Borings: 2

Geotechnical Consultant: <ODOT OGE>
Prepared By: <Amal Mohi>
Date prepared: <04/02/2025>

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	12"

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L): Average(HP):	 12" 0"
Global Geogrid Average(N60L): Average(HP):	 0" 0"

Design CBR	6

% Samples within 3 feet of subgrade			
$N_{60} \leq 5$	0%	$HP \leq 0.5$	0%
$N_{60} < 12$	25%	$0.5 < HP \leq 1$	25%
$12 \leq N_{60} < 15$	0%	$1 < HP \leq 2$	0%
$N_{60} \geq 20$	13%	$HP > 2$	25%
M+	38%		
Rock	0%		
Unsuitable Soil	0%		

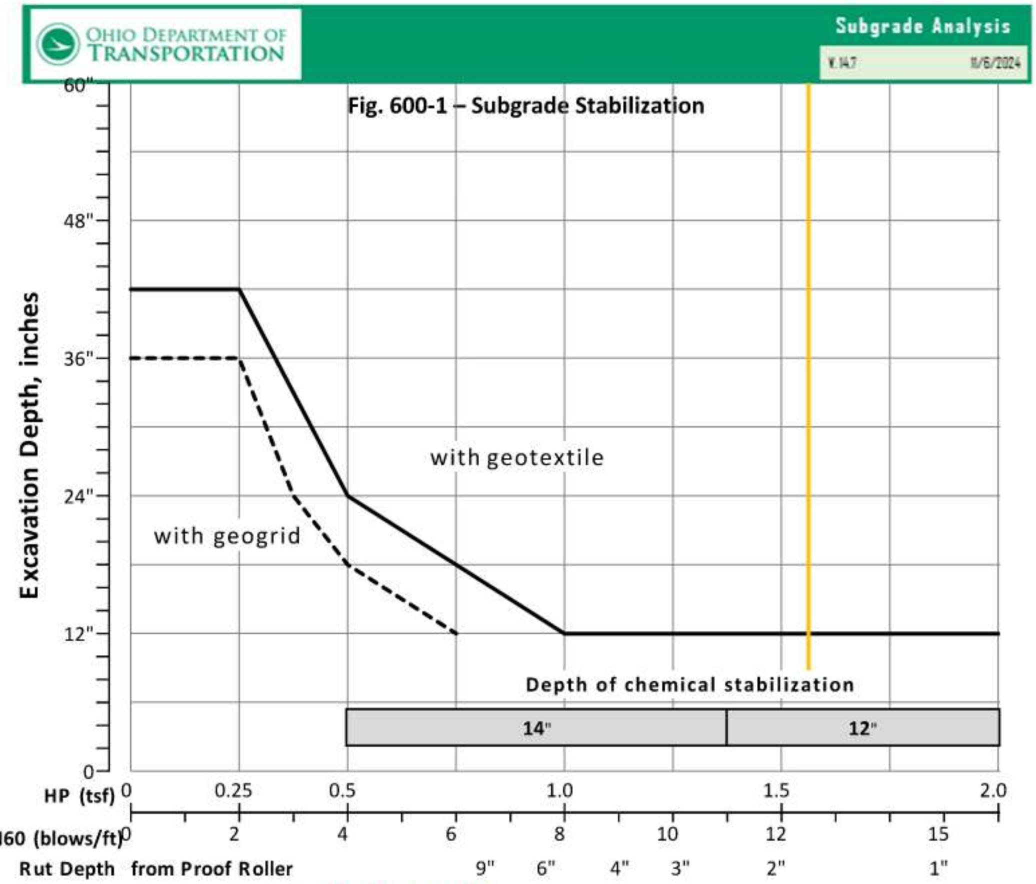
Excavate and Replace at Surface	
Average	0"
Maximum	0"
Minimum	0"

% Proposed Subgrade Surface	
Unstable & Unsuitable	75%
Unstable	75%
Unsuitable (Soil & Rock)	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	15	13	2.56	32	18	14	35	37	72	20	14	9
Maximum	30	19	4.50	45	25	20	39	58	95	32	22	16
Minimum	6	6	0.75	25	15	10	31	25	56	12	10	4

Classification Counts by Sample

ODOT Class	UCF	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	3	0	0	2	2	0	1	0	0	8
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	38%	0%	0%	25%	25%	0%	13%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%	38%									63%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	0	0	4
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	50%	25%	0%	25%	0%	0%	100%



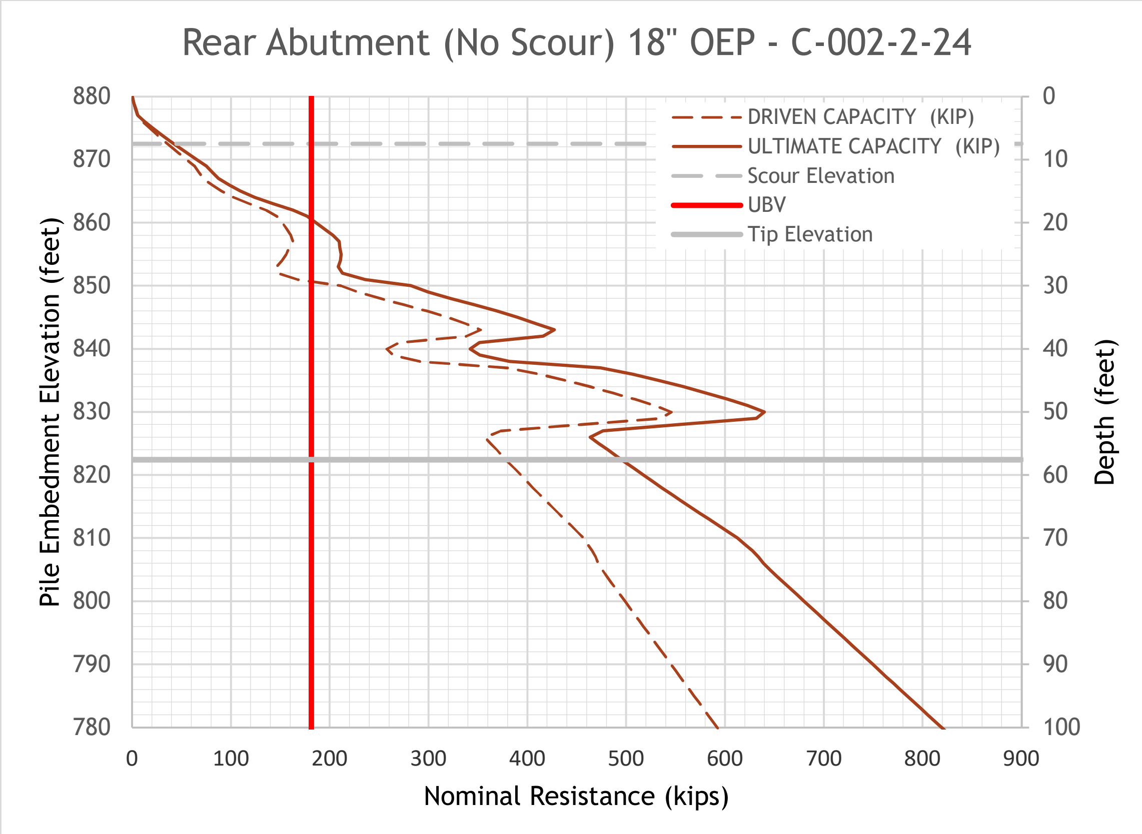
OVERRIDE TABLE

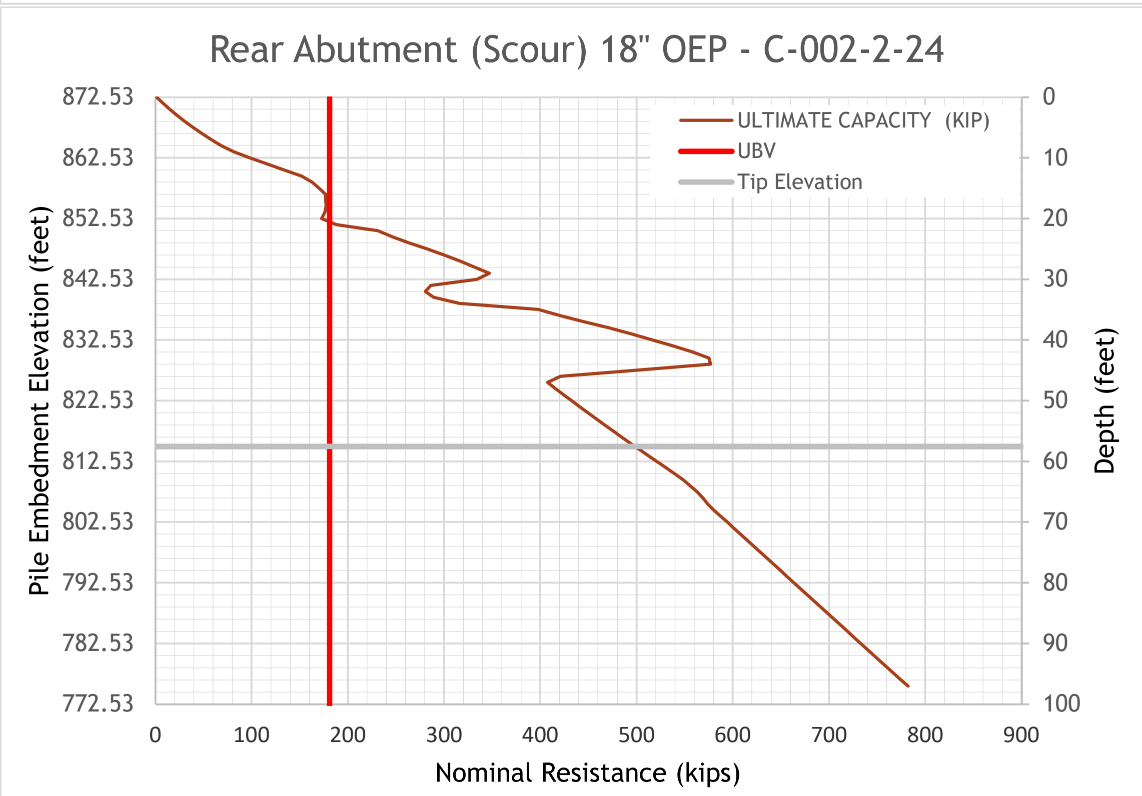
Calculated Average	New Values	Check to Override
2.56		☐ HP
12.50		☐ N60L

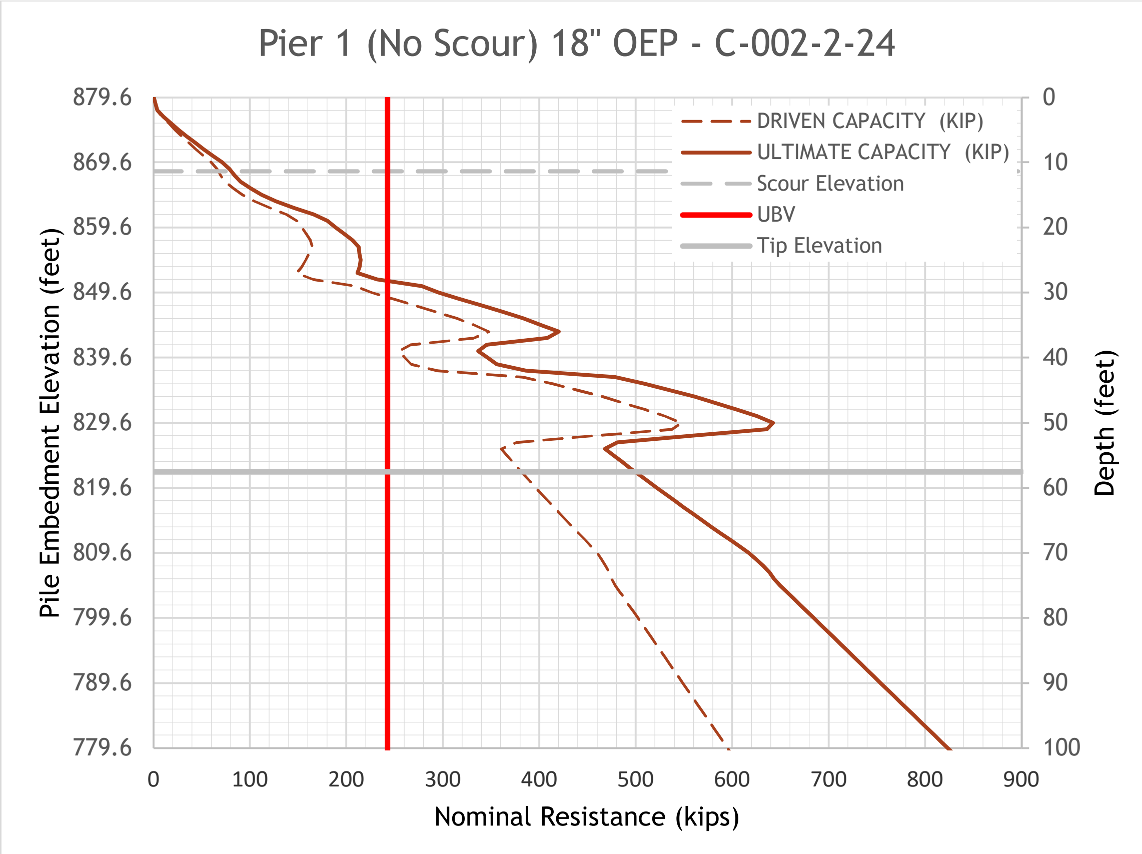
Average HP

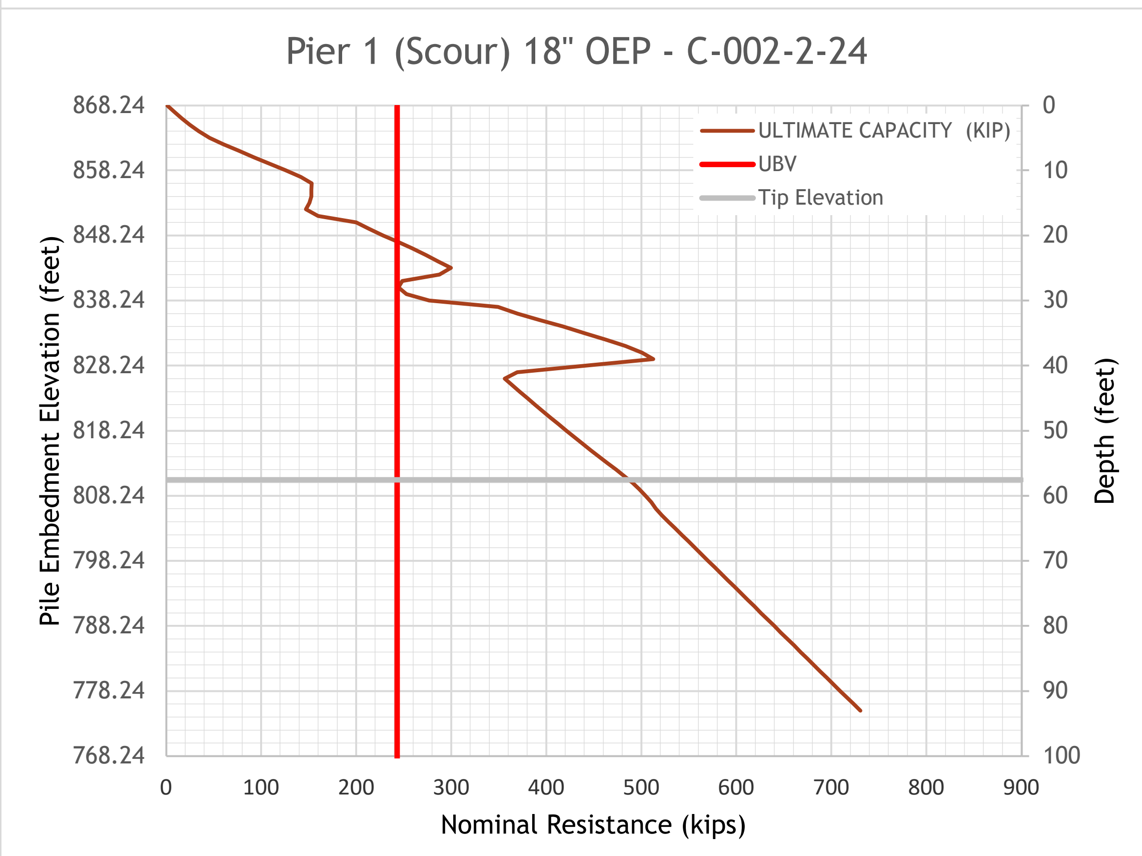
Average N_{60L}

Appendix H-2: Pile Nominal Resistance versus Embedment Depth Graphs

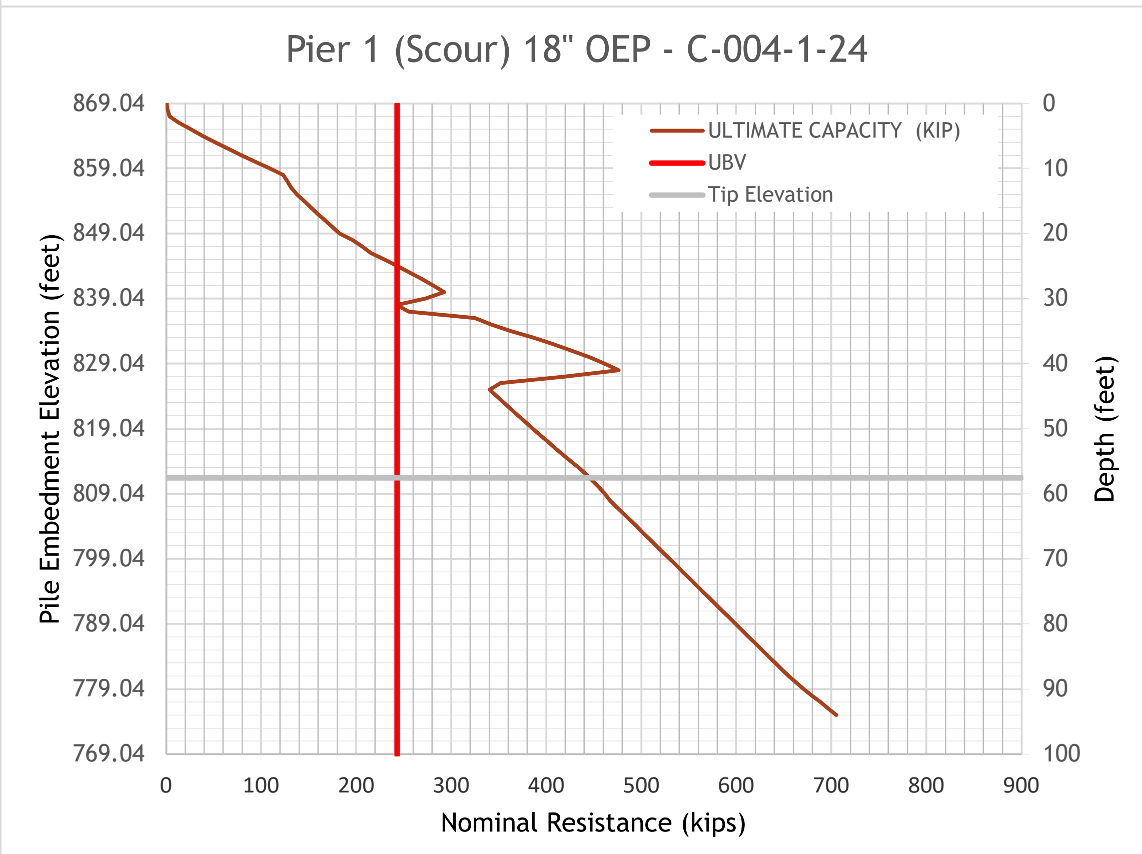


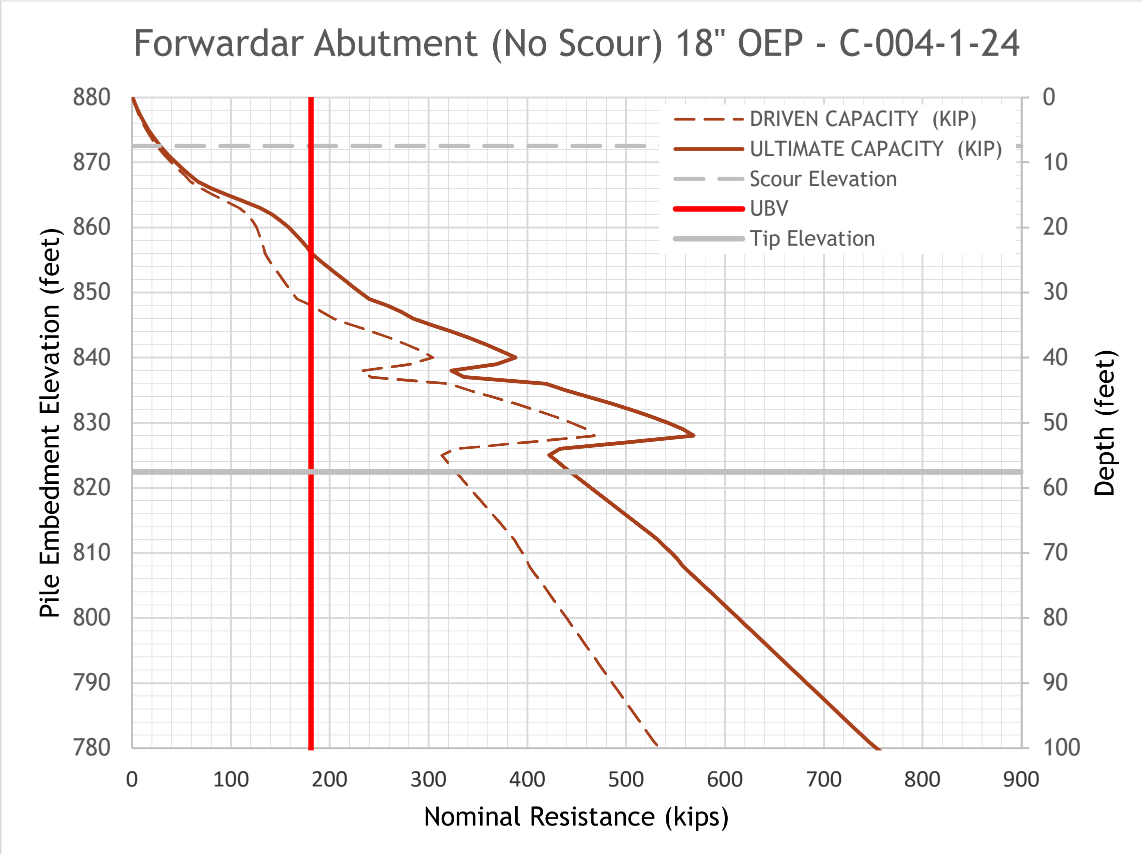


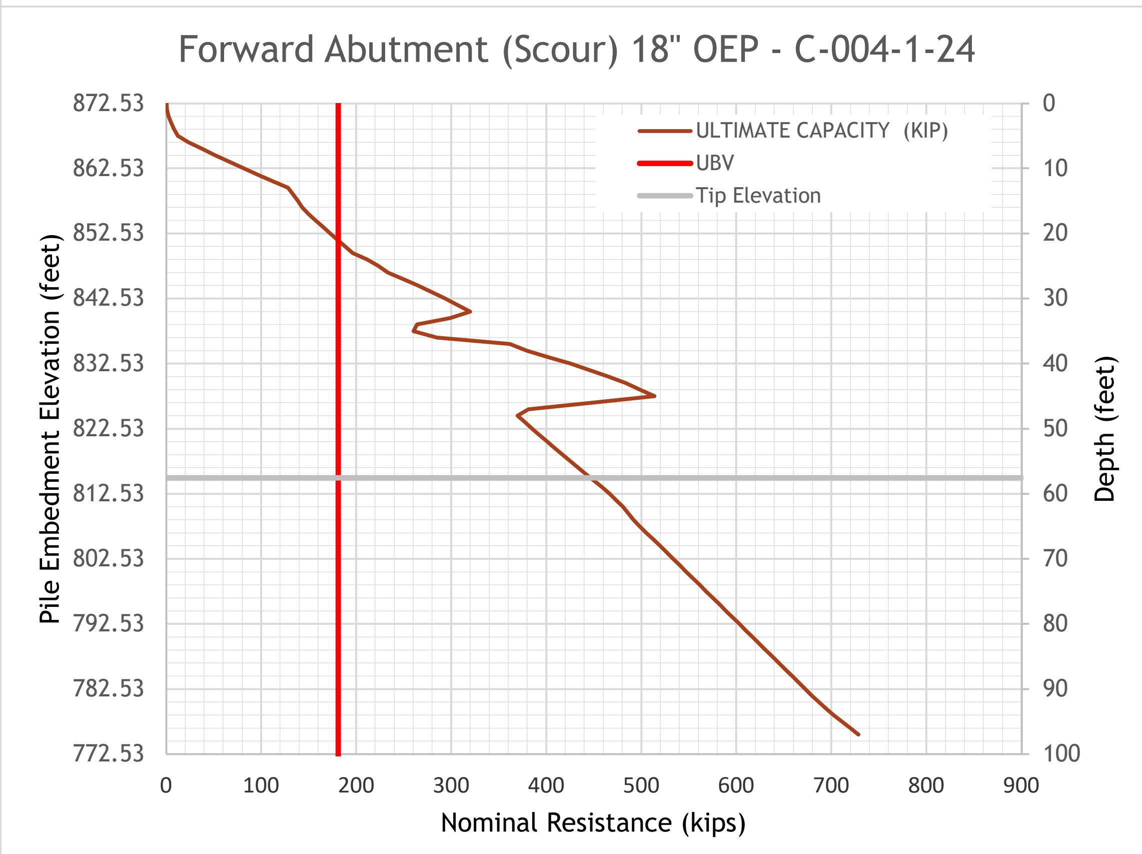

Pier 1 (No Scour) 18" OEP - C-002-2-24
Pile Embedment Elevation (feet)
Depth (feet)
Nominal Resistance (kips)
DRIVEN CAPACITY (KIP)
ULTIMATE CAPACITY (KIP)
Scour Elevation
UBV
Tip Elevation
879.6
869.6
859.6
849.6
839.6
829.6
819.6
809.6
799.6
789.6
779.6
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900


Pier 1 (Scour) 18" OEP - C-002-2-24
Pile Embedment Elevation (feet)
Depth (feet)
Nominal Resistance (kips)
ULTIMATE CAPACITY (KIP)
UBV
Tip Elevation
868.24
858.24
848.24
838.24
828.24
818.24
808.24
798.24
788.24
778.24
768.24
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900


Pier 2 (No Scour) 18" OEP - C-004-1-24
DRIVEN CAPACITY (KIP)
ULTIMATE CAPACITY (KIP)
Scour Elevation
UBV
Tip Elevation
Pile Embedment Elevation (feet)
880.4
870.4
860.4
850.4
840.4
830.4
820.4
810.4
800.4
790.4
780.4
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
Nominal Resistance (kips)

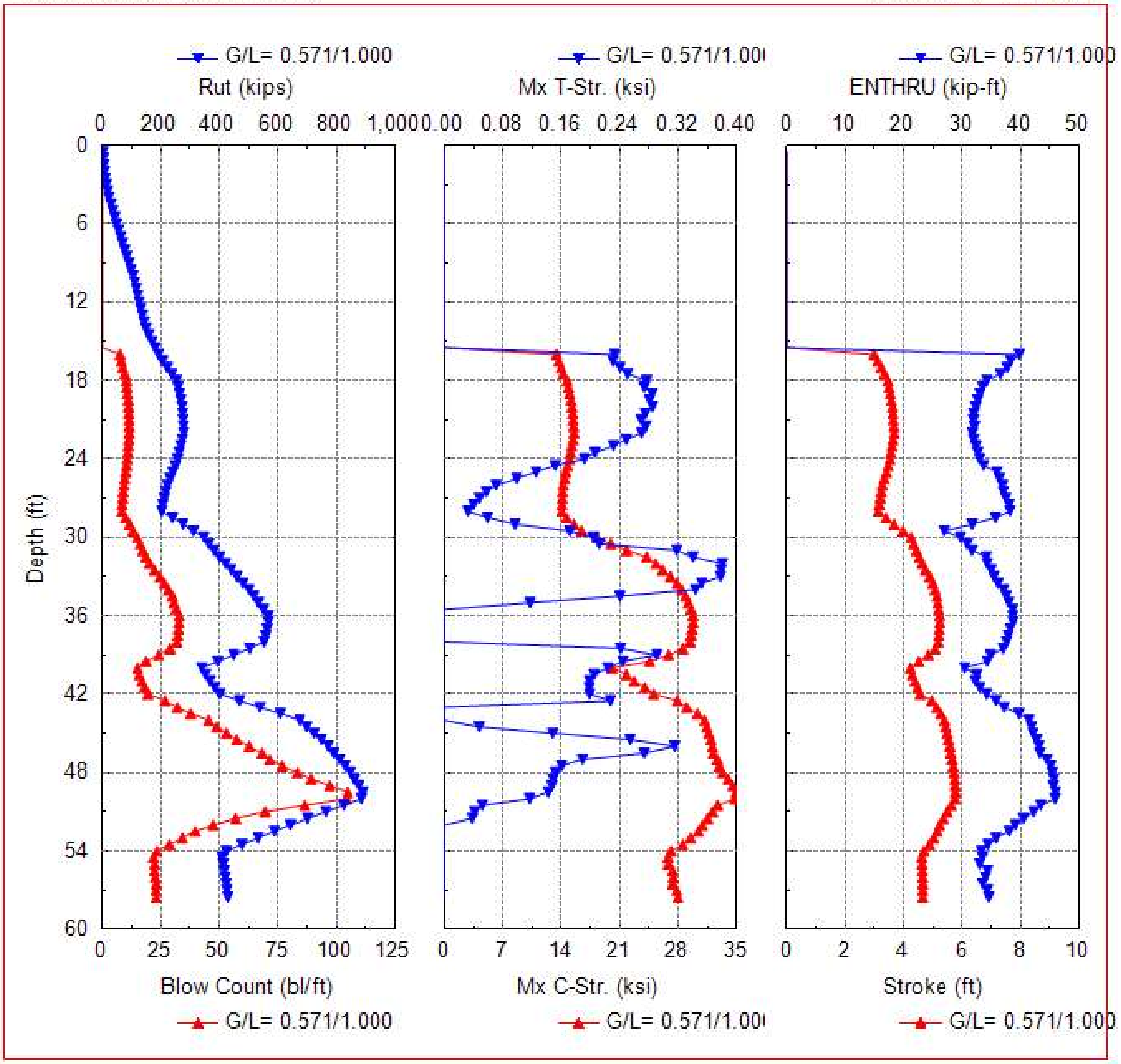

Pier 1 (Scour) 18" OEP - C-004-1-24
ULTIMATE CAPACITY (KIP)
UBV
Tip Elevation
Pile Embedment Elevation (feet)
869.04
859.04
849.04
839.04
829.04
819.04
809.04
799.04
789.04
779.04
769.04
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
Nominal Resistance (kips)


Forwardar Abutment (No Scour) 18" OEP - C-004-1-24
DRIVEN CAPACITY (KIP)
ULTIMATE CAPACITY (KIP)
Scour Elevation
UBV
Tip Elevation
Pile Embedment Elevation (feet)
880
870
860
850
840
830
820
810
800
790
780
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
Nominal Resistance (kips)


Forward Abutment (Scour) 18" OEP - C-004-1-24
ULTIMATE CAPACITY (KIP)
UBV
Tip Elevation
Pile Embedment Elevation (feet)
872.53
862.53
852.53
842.53
832.53
822.53
812.53
802.53
792.53
782.53
772.53
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600
700
800
900
Nominal Resistance (kips)

Appendix H-3: GRLWEAP Drivability Analyses

OHIO DEPARTMENT OF TRANSPORTATION 8/11/2025
Rear Abutment (C-002-2-24) GRLWEAP 14.1.20.1



OHIO DEPARTMENT OF TRANSPORTATION — 8/11/2025
Rear Abutment (C-002-2-24) — GRLWEAP 14.1.20.1

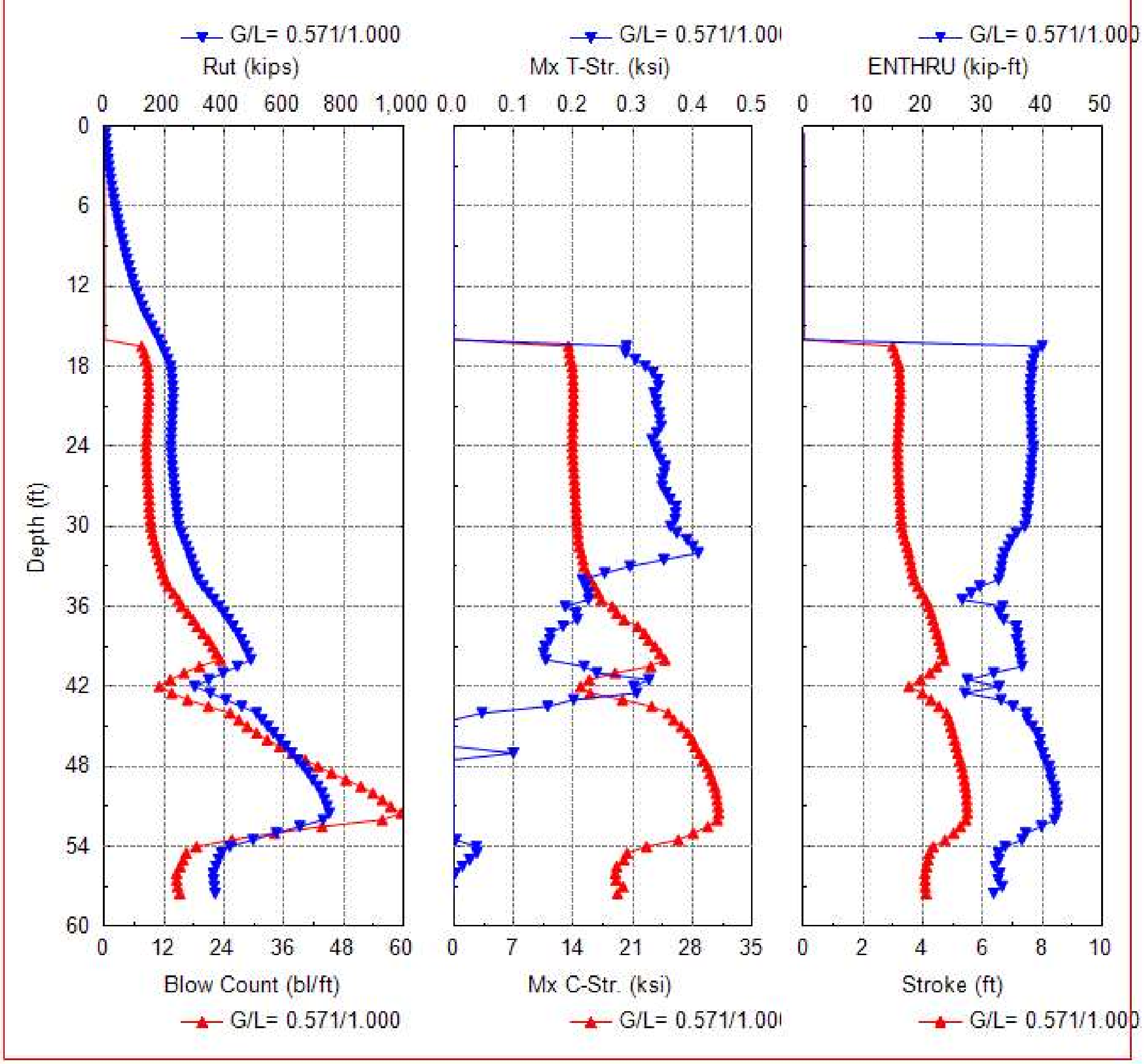
Gain/Loss 1 at Shaft and Toe 0.571/1.000

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow Ct bl/ft	Mx C-Str. ksi	Mx T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
0.5	2.0	0.2	1.8	0.0	0.00	0.00	0.00	0.0	200-S
1.0	3.6	0.4	3.2	0.0	0.00	0.00	0.00	0.0	200-S
1.5	5.2	0.6	4.5	0.0	0.00	0.00	0.00	0.0	200-S
2.0	6.8	0.9	5.9	0.0	0.00	0.00	0.00	0.0	200-S
2.5	10.4	1.2	9.2	0.0	0.00	0.00	0.00	0.0	200-S
3.0	14.3	1.8	12.5	0.0	0.00	0.00	0.00	0.0	200-S
3.5	18.4	2.7	15.8	0.0	0.00	0.00	0.00	0.0	200-S
4.0	22.8	3.8	19.1	0.0	0.00	0.00	0.00	0.0	200-S
4.5	29.3	5.0	24.3	0.0	0.00	0.00	0.00	0.0	200-S
5.0	35.8	6.4	29.5	0.0	0.00	0.00	0.00	0.0	200-S
5.5	42.4	7.8	34.6	0.0	0.00	0.00	0.00	0.0	200-S
6.0	49.0	9.2	39.8	0.0	0.00	0.00	0.00	0.0	200-S
6.5	55.8	10.6	45.2	0.0	0.00	0.00	0.00	0.0	200-S
7.0	62.6	12.1	50.6	0.0	0.00	0.00	0.00	0.0	200-S
7.5	69.5	13.5	55.9	0.0	0.00	0.00	0.00	0.0	200-S
8.0	76.4	15.1	61.3	0.0	0.00	0.00	0.00	0.0	200-S
8.5	83.7	16.6	67.1	0.0	0.00	0.00	0.00	0.0	200-S
9.0	91.1	18.2	72.9	0.0	0.00	0.00	0.00	0.0	200-S
9.5	98.5	19.8	78.7	0.0	0.00	0.00	0.00	0.0	200-S
10.0	105.9	21.4	84.5	0.0	0.00	0.00	0.00	0.0	200-S
10.5	110.9	23.0	87.9	0.0	0.00	0.00	0.00	0.0	200-S
11.0	115.9	24.7	91.2	0.0	0.00	0.00	0.00	0.0	200-S
11.5	121.0	26.4	94.6	0.0	0.00	0.00	0.00	0.0	200-S
12.0	126.0	28.1	97.9	0.0	0.00	0.00	0.00	0.0	200-S
12.5	131.8	29.8	102.0	0.0	0.00	0.00	0.00	0.0	200-S
13.0	137.6	31.6	106.1	0.0	0.00	0.00	0.00	0.0	200-S
13.5	143.4	33.3	110.1	0.0	0.00	0.00	0.00	0.0	200-S
14.0	149.3	35.1	114.2	0.0	0.00	0.00	0.00	0.0	200-S
14.5	159.6	36.9	122.7	0.0	0.00	0.00	0.00	0.0	200-S
15.0	170.2	39.0	131.2	0.0	0.00	0.00	0.00	0.0	200-S
15.5	181.1	41.3	139.7	0.0	0.00	0.00	0.00	0.0	200-S
16.0	192.1	43.8	148.3	7.6	13.42	0.23	2.99	39.8	200-S
16.5	207.0	46.4	160.6	8.2	13.68	0.23	3.11	38.3	200-S
17.0	222.2	49.3	172.9	8.8	13.96	0.24	3.23	37.7	200-S
17.5	237.6	52.4	185.3	9.6	14.18	0.25	3.35	36.6	200-S
18.0	253.2	55.6	197.6	10.3	14.67	0.28	3.46	34.2	200-S
18.5	258.4	59.0	199.4	10.5	14.84	0.27	3.50	33.5	200-S
19.0	263.3	62.4	200.9	10.7	14.98	0.28	3.54	33.0	200-S
19.5	268.2	65.8	202.3	11.0	15.14	0.28	3.58	32.7	200-S
20.0	273.1	69.3	203.8	11.2	15.27	0.28	3.63	32.4	200-S
20.5	274.8	72.6	202.2	11.3	15.34	0.27	3.64	32.0	200-S
21.0	276.3	75.9	200.4	11.4	15.39	0.27	3.65	32.0	200-S
21.5	277.7	79.0	198.7	11.4	15.44	0.28	3.68	32.1	200-S
22.0	278.9	81.9	197.0	11.5	15.49	0.27	3.69	31.8	200-S
22.5	273.7	84.7	189.0	11.3	15.37	0.25	3.64	32.0	200-S
23.0	268.4	87.6	180.8	11.1	15.23	0.23	3.61	32.4	200-S
23.5	263.1	90.4	172.7	10.9	15.11	0.21	3.56	32.7	200-S
24.0	257.9	93.3	164.5	10.6	14.97	0.19	3.53	33.0	200-S
24.5	249.6	96.1	153.4	10.4	14.76	0.15	3.46	33.7	200-S
25.0	240.9	98.6	142.3	10.0	14.51	0.13	3.41	36.0	200-S
25.5	231.9	100.9	131.1	9.6	14.39	0.10	3.34	36.4	200-S
26.0	222.8	102.8	120.0	9.3	14.20	0.07	3.27	36.9	200-S
26.5	217.8	104.7	113.1	9.0	14.14	0.06	3.23	37.0	200-S
27.0	212.7	106.5	106.2	8.8	14.09	0.05	3.20	37.5	200-S
27.5	207.7	108.4	99.3	8.5	14.06	0.04	3.17	38.1	200-S
28.0	203.8	110.3	93.5	8.4	14.01	0.03	3.13	38.2	200-S
28.5	239.9	112.3	127.6	10.0	14.60	0.06	3.40	35.7	200-S
29.0	275.9	114.2	161.7	11.6	15.49	0.10	3.68	31.7	200-S
29.5	312.0	116.1	195.9	13.1	16.39	0.17	3.98	27.0	200-S
30.0	347.6	118.1	229.5	15.0	18.24	0.20	4.25	29.7	200-S
30.5	364.7	120.4	244.3	16.2	19.92	0.21	4.35	30.9	200-S
31.0	382.5	123.4	259.2	17.4	21.82	0.32	4.44	31.7	200-S
31.5	401.1	127.1	274.0	18.7	24.20	0.34	4.54	34.1	200-S
32.0	420.4	131.6	288.8	20.3	25.29	0.38	4.64	34.3	200-S
32.5	440.5	136.7	303.8	22.2	26.10	0.38	4.75	35.0	200-S
33.0	460.6	141.9	318.8	24.6	27.03	0.38	4.89	35.4	200-S
33.5	480.9	147.2	333.7	26.6	27.80	0.35	5.00	36.2	200-S
34.0	501.3	152.7	348.7	28.3	28.42	0.34	5.07	37.1	200-S
34.5	518.6	158.1	360.5	29.9	28.85	0.24	5.13	37.5	200-S
35.0	534.8	163.5	371.3	30.6	29.20	0.12	5.17	38.0	200-S
35.5	551.1	169.0	382.1	31.6	29.51	0.00	5.20	38.7	200-S
36.0	567.5	174.6	392.9	32.8	29.73	0.00	5.23	38.7	200-S
36.5	567.6	180.0	387.5	32.7	29.75	0.00	5.24	38.7	200-S
37.0	563.5	184.9	378.6	32.5	29.62	0.00	5.22	38.2	200-S
37.5	558.6	189.0	369.7	32.2	29.51	0.00	5.20	37.9	200-S
38.0	553.1	192.3	360.8	31.8	29.39	0.00	5.19	37.6	200-S
38.5	504.1	195.3	308.7	28.9	28.53	0.24	5.07	37.0	200-S
39.0	449.5	198.5	251.0	24.1	26.80	0.29	4.84	34.9	200-S
39.5	395.0	201.7	193.3	18.7	24.54	0.24	4.52	34.3	200-S
40.0	340.6	205.0	135.6	15.1	20.04	0.22	4.23	30.5	200-S
40.5	353.1	208.3	144.8	15.7	21.76	0.20	4.29	32.5	200-S
41.0	369.1	211.5	157.6	17.0	22.72	0.20	4.39	32.3	200-S
41.5	385.0	214.6	170.4	18.2	23.97	0.20	4.47	33.0	200-S
42.0	401.6	217.8	183.7	19.5	25.02	0.20	4.57	34.2	200-S
42.5	470.2	221.3	248.8	26.9	27.86	0.23	4.96	35.8	200-S
43.0	539.3	225.4	314.0	32.0	28.98	0.00	5.12	37.2	200-S
43.5	609.0	229.9	379.1	37.8	30.27	0.00	5.28	39.7	200-S
44.0	675.5	234.7	440.8	45.5	31.12	0.00	5.40	41.5	200-S
44.5	699.5	239.6	459.9	49.0	31.39	0.05	5.44	41.9	200-S
45.0	723.7	244.7	479.0	53.0	31.64	0.15	5.49	42.1	200-S
45.5	748.1	250.0	498.1	57.5	31.90	0.25	5.54	42.8	200-S
46.0	772.0	255.5	516.5	62.8	32.07	0.31	5.58	43.1	200-S
46.5	791.4	261.1	530.3	68.3	32.17	0.27	5.62	43.3	200-S
47.0	810.8	266.6	544.1	71.6	32.66	0.19	5.66	44.5	200-S
47.5	830.0	272.0	558.0	76.9	32.89	0.16	5.70	45.2	200-S
48.0	848.1	277.3	570.8	83.4	33.27	0.15	5.73	45.4	200-S
48.5	862.4	282.8	579.6	89.3	33.95	0.15	5.75	45.7	200-S
49.0	876.6	288.2	588.4	97.2	34.51	0.15	5.76	45.6	200-S
49.5	891.0	293.9	597.2	104.9	34.91	0.14	5.77	46.0	200-S
50.0	886.0	299.4	586.6	104.4	34.75	0.12	5.75	45.9	200-S
50.5	825.7	304.2	521.5	86.6	32.68	0.05	5.63	43.4	200-S
51.0	764.6	308.3	456.4	69.6	32.08	0.04	5.49	42.2	200-S
51.5	703.0	311.7	391.2	57.1	31.51	0.04	5.36	40.5	200-S
52.0	643.2	314.7	328.5	47.4	30.87	0.00	5.23	39.1	200-S
52.5	588.3	317.7	270.7	39.8	30.36	0.00	5.14	38.0	200-S
53.0	533.5	320.7	212.8	34.2	29.45	0.00	5.03	35.8	200-S
53.5	478.6	323.7	155.0	28.7	28.53	0.00	4.88	34.4	200-S
54.0	423.6	326.5	97.1	23.3	27.10	0.00	4.70	33.3	200-S
54.5	410.9	329.3	81.6	21.9	26.74	0.00	4.62	33.5	200-S
55.0	413.8	332.1	81.6	22.4	26.78	0.00	4.64	33.0	200-S
55.5	416.8	335.1	81.6	22.3	27.32	0.00	4.65	34.4	200-S
56.0	419.9	338.3	81.6	22.6	27.39	0.00	4.65	34.0	200-S
56.5	423.0	341.3	81.6	23.2	27.32	0.00	4.66	33.5	200-S
57.0	426.0	344.3	81.6	22.9	27.76	0.00	4.66	34.3	200-S
57.5	429.0	347.3	81.6	23.1	27.93	0.00	4.66	34.6	200-S

Total driving time: 24 minutes; Total Number of Blows: 1240 (starting at penetration 1.6 ft)

OHIO DEPARTMENT OF TRANSPORTATION 8/11/2025

Forward Abutment (C-004-1-24) GRLWEAP 14.1.20.1



OHIO DEPARTMENT OF TRANSPORTATION 8/11/2025
Forward Abutment (C-004-1-24) GRLWEAP 14.1.20.1

Gain/Loss 1 at Shaft and Toe 0.571/1.000

Depth ft	Rut kips	Rshaft kips	Rtoe kips	Blow Ct bl/ft	Mx C-Str. ksi	Mx T-Str. ksi	Stroke ft	ENTHRU kip-ft	Hammer -
0.5	3.2	0.4	2.8	0.0	0.00	0.00	0.00	0.0	200-S
1.0	5.4	0.9	4.5	0.0	0.00	0.00	0.00	0.0	200-S
1.5	7.6	1.3	6.3	0.0	0.00	0.00	0.00	0.0	200-S
2.0	9.8	1.8	8.1	0.0	0.00	0.00	0.00	0.0	200-S
2.5	12.4	2.3	10.1	0.0	0.00	0.00	0.00	0.0	200-S
3.0	15.0	2.8	12.2	0.0	0.00	0.00	0.00	0.0	200-S
3.5	17.6	3.3	14.3	0.0	0.00	0.00	0.00	0.0	200-S
4.0	20.3	3.9	16.4	0.0	0.00	0.00	0.00	0.0	200-S
4.5	24.0	4.5	19.5	0.0	0.00	0.00	0.00	0.0	200-S
5.0	27.8	5.1	22.6	0.0	0.00	0.00	0.00	0.0	200-S
5.5	31.6	5.8	25.7	0.0	0.00	0.00	0.00	0.0	200-S
6.0	35.5	6.6	28.9	0.0	0.00	0.00	0.00	0.0	200-S
6.5	40.0	7.4	32.5	0.0	0.00	0.00	0.00	0.0	200-S
7.0	44.5	8.3	36.2	0.0	0.00	0.00	0.00	0.0	200-S
7.5	49.1	9.2	39.8	0.0	0.00	0.00	0.00	0.0	200-S
8.0	53.7	10.2	43.5	0.0	0.00	0.00	0.00	0.0	200-S
8.5	59.0	11.3	47.7	0.0	0.00	0.00	0.00	0.0	200-S
9.0	64.3	12.4	51.9	0.0	0.00	0.00	0.00	0.0	200-S
9.5	69.8	13.7	56.1	0.0	0.00	0.00	0.00	0.0	200-S
10.0	75.3	15.0	60.3	0.0	0.00	0.00	0.00	0.0	200-S
10.5	81.3	16.4	64.9	0.0	0.00	0.00	0.00	0.0	200-S
11.0	87.4	17.9	69.5	0.0	0.00	0.00	0.00	0.0	200-S
11.5	93.5	19.5	74.0	0.0	0.00	0.00	0.00	0.0	200-S
12.0	99.8	21.2	78.6	0.0	0.00	0.00	0.00	0.0	200-S
12.5	108.4	23.0	85.4	0.0	0.00	0.00	0.00	0.0	200-S
13.0	117.3	25.1	92.2	0.0	0.00	0.00	0.00	0.0	200-S
13.5	126.4	27.4	99.0	0.0	0.00	0.00	0.00	0.0	200-S
14.0	135.6	29.8	105.8	0.0	0.00	0.00	0.00	0.0	200-S
14.5	147.3	32.2	115.1	0.0	0.00	0.00	0.00	0.0	200-S
15.0	159.1	34.6	124.5	0.0	0.00	0.00	0.00	0.0	200-S
15.5	170.8	36.9	133.9	0.0	0.00	0.00	0.00	0.0	200-S
16.0	182.5	39.2	143.3	0.0	0.00	0.00	0.00	0.0	200-S
16.5	192.3	41.7	150.6	7.5	13.43	0.29	2.99	40.0	200-S
17.0	202.1	44.2	157.9	8.0	13.53	0.29	3.06	38.8	200-S
17.5	212.0	46.7	165.2	8.3	13.67	0.30	3.14	38.5	200-S
18.0	221.8	49.2	172.5	8.7	13.83	0.32	3.21	38.2	200-S
18.5	223.9	51.7	172.2	8.7	13.91	0.33	3.22	38.3	200-S
19.0	225.9	54.2	171.7	8.8	13.95	0.34	3.23	38.0	200-S
19.5	227.9	56.7	171.2	8.9	13.99	0.34	3.23	38.0	200-S
20.0	230.0	59.3	170.7	8.9	13.99	0.34	3.24	37.9	200-S
20.5	229.2	62.0	167.2	8.9	14.00	0.34	3.23	38.0	200-S
21.0	228.2	64.6	163.6	8.8	13.96	0.34	3.22	37.9	200-S
21.5	227.2	67.2	160.0	8.7	13.97	0.34	3.21	38.1	200-S
22.0	226.2	69.7	156.5	8.7	13.92	0.34	3.20	38.1	200-S
22.5	225.1	72.3	152.9	8.6	13.91	0.35	3.18	38.2	200-S
23.0	224.1	74.8	149.3	8.5	13.90	0.34	3.17	38.2	200-S
23.5	223.0	77.3	145.7	8.5	13.87	0.33	3.16	38.2	200-S
24.0	221.8	79.7	142.1	8.4	13.87	0.34	3.15	38.5	200-S
24.5	223.5	82.0	141.5	8.5	13.90	0.34	3.16	38.4	200-S
25.0	225.3	84.3	141.0	8.5	13.94	0.35	3.16	38.2	200-S
25.5	227.1	86.5	140.5	8.6	13.99	0.35	3.17	38.1	200-S
26.0	228.9	88.9	140.0	8.6	14.04	0.35	3.18	38.1	200-S
26.5	231.3	91.3	140.0	8.7	14.10	0.35	3.19	38.1	200-S
27.0	233.8	93.7	140.0	8.8	14.16	0.35	3.20	37.8	200-S
27.5	236.1	96.1	140.0	8.9	14.20	0.36	3.21	37.7	200-S
28.0	238.5	98.5	140.0	9.0	14.24	0.36	3.23	37.6	200-S
28.5	240.8	100.8	140.0	9.0	14.31	0.37	3.25	37.6	200-S
29.0	243.2	103.2	140.0	9.1	14.34	0.37	3.26	37.3	200-S
29.5	245.7	105.7	140.0	9.2	14.41	0.37	3.27	37.4	200-S
30.0	248.4	108.2	140.2	9.3	14.44	0.36	3.28	37.1	200-S
30.5	257.0	110.7	146.4	9.6	14.51	0.37	3.34	35.6	200-S
31.0	265.7	113.1	152.6	9.9	14.57	0.39	3.40	34.8	200-S
31.5	274.3	115.6	158.7	10.3	14.68	0.40	3.47	34.3	200-S
32.0	282.9	118.0	164.9	10.6	14.93	0.41	3.52	33.6	200-S
32.5	290.0	120.8	169.2	11.0	15.11	0.35	3.57	33.4	200-S
33.0	297.6	124.1	173.5	11.3	15.20	0.29	3.61	33.2	200-S
33.5	305.7	127.9	177.7	11.7	15.59	0.25	3.66	33.0	200-S
34.0	314.1	132.1	182.0	12.2	15.99	0.21	3.71	32.7	200-S
34.5	329.9	136.6	193.3	12.9	16.44	0.22	3.83	29.5	200-S
35.0	347.8	141.0	206.7	13.9	16.87	0.22	3.96	28.1	200-S
35.5	365.7	145.5	220.2	14.9	17.24	0.23	4.10	26.6	200-S
36.0	383.7	150.0	233.6	15.4	18.57	0.19	4.19	33.4	200-S
36.5	399.6	154.5	245.1	16.7	19.10	0.20	4.28	32.8	200-S
37.0	415.1	158.9	256.2	17.8	19.92	0.21	4.34	33.5	200-S
37.5	430.6	163.4	267.2	18.6	21.51	0.18	4.40	35.6	200-S
38.0	446.0	167.7	278.3	19.8	22.30	0.16	4.47	35.8	200-S
38.5	457.9	171.9	286.0	20.9	22.82	0.16	4.54	35.6	200-S
39.0	469.0	175.7	293.3	21.7	23.54	0.15	4.59	36.1	200-S
39.5	479.7	179.1	300.6	22.5	24.15	0.15	4.66	36.2	200-S
40.0	489.8	181.9	307.9	23.3	24.73	0.15	4.71	36.4	200-S
40.5	445.0	184.4	260.6	19.1	23.06	0.22	4.46	36.6	200-S
41.0	397.1	186.7	210.4	16.0	18.90	0.24	4.23	31.9	200-S
41.5	349.0	188.9	160.1	13.2	15.86	0.33	3.92	27.4	200-S
42.0	302.0	191.1	110.8	11.0	14.84	0.30	3.53	32.7	200-S
42.5	354.5	193.3	161.1	13.5	15.95	0.31	3.98	27.0	200-S
43.0	407.0	195.6	211.4	16.7	19.73	0.20	4.27	33.1	200-S
43.5	459.4	197.7	261.7	20.9	23.19	0.16	4.54	35.1	200-S
44.0	509.3	199.9	309.4	25.2	25.08	0.05	4.79	37.3	200-S
44.5	527.5	202.3	325.1	27.0	25.74	0.00	4.88	37.5	200-S
45.0	546.3	205.5	340.8	28.7	26.65	0.00	4.94	38.3	200-S
45.5	565.9	209.3	356.5	30.6	27.39	0.00	5.01	39.1	200-S
46.0	586.1	214.0	372.2	32.7	27.94	0.00	5.07	39.6	200-S
46.5	606.1	218.9	387.3	35.2	28.23	0.00	5.11	39.6	200-S
47.0	626.1	223.7	402.3	37.7	28.78	0.10	5.17	40.1	200-S
47.5	646.1	228.6	417.4	40.3	29.19	0.00	5.24	40.4	200-S
48.0	665.3	233.5	431.7	42.9	29.69	0.00	5.30	41.1	200-S
48.5	681.3	238.4	442.9	45.6	29.97	0.00	5.34	41.3	200-S
49.0	697.4	243.3	454.1	48.5	30.25	0.00	5.39	41.4	200-S
49.5	713.5	248.3	465.3	51.5	30.55	0.00	5.41	42.0	200-S
50.0	727.7	253.1	474.6	53.9	30.73	0.00	5.45	42.0	200-S
50.5	736.3	257.7	478.6	55.8	30.84	0.00	5.46	42.3	200-S
51.0	744.5	261.9	482.6	57.5	30.95	0.00	5.47	42.5	200-S
51.5	752.3	265.6	486.7	59.6	30.99	0.00	5.48	42.4	200-S
52.0	731.9	269.0	462.9	55.8	30.85	0.00	5.44	42.0	200-S
52.5	654.0	272.2	381.8	43.7	29.75	0.00	5.25	39.9	200-S
53.0	575.9	275.2	300.7	34.2	28.02	0.00	5.03	37.2	200-S
53.5	497.7	278.1	219.6	25.6	26.29	0.00	4.74	36.6	200-S
54.0	419.4	280.9	138.5	18.5	22.56	0.04	4.34	33.8	200-S
54.5	391.7	283.6	108.1	16.4	20.28	0.04	4.21	32.6	200-S
55.0	382.6	286.3	96.3	15.8	19.90	0.03	4.17	32.7	200-S
55.5	373.6	289.1	84.5	15.2	19.08	0.01	4.11	32.1	200-S
56.0	364.5	291.8	72.7	14.5	18.92	0.00	4.07	32.9	200-S
56.5	364.8	294.6	70.3	14.5	19.01	0.00	4.07	32.6	200-S
57.0	367.6	297.3	70.3	14.7	19.80	0.00	4.08	33.3	200-S
57.5	370.5	300.3	70.3	15.1	19.17	0.00	4.10	31.8	200-S

Total driving time: 15 minutes; Total Number of Blows: 804 (starting at penetration 1.6 ft)

Appendix H-4: Buckling Analyses using 12- and 16-inch piles

Substructure Unit	Factored Axial Load (kip/pile)	Factored Structural Resistance (kip/pile)	CDR
Rear Abutment	162.43	356.25	2.19
Pier 1	188.00	475.77	2.53
Pier 2	187.50	475.77	2.54
Forward Abutment	254.24	356.25	1.40

Structural Resistance of the 12-in and 16-in CIP Driven Pile Axial Compressive Resistance per AASHTO LRFD 6.9.2.1

$P_r = \varphi_c P_n$, P_r = 356.25 kips *at the rear and forward abutments and* 475.77 kips *at Piers 1 and 2* (6.9.2.1-1)

For $\lambda \leq 2.25$*:*

$P_n = 0.66^{\lambda} F_e A_s$ (kip), P_n = 593.75 kips *at the rear and forward abutments* and 792.95 *at Piers 1 and 2* (6.9.5.1-1)

$\lambda = (K\ell/r_s\pi)^2\ (Fe/Ee)$, 1.14 *at the rear and forward abutments and* 0.994 *at Piers 1 and 2* (6.9.5.1-3)

$F_e = F_y + C_1 F_{yr}(A_r/A_s) + C_2 f'_c(A_c/A_s)$*, 69.68 ksi at the rear and forward abutments and 96.86 ksi at Piers 1 and 2 (6.9.5.1-4)*

$E_e = E\,[1 + (C_3/n)(A_c/A_s)]$*, 39567.74 ksi at the rear and forward abutments and 51209.78 ksi at Piers 1 and 2 (6.9.5.1-5)*

where:

Assumed pile wall thickness = 0.375" at the rear and forward abutments and 0.250" at Piers 1 and 2.

λ *= normalized column slenderness factor*

F_e = modified yield stress (ksi)

E_e = modified modulus of elasticity (ksi)

P_r = factored axial resistance of components in compression

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

E = modulus of elasticity of steel (ksi), 29000 ksi

A_g = gross cross-sectional area of the member (in^2), 113.10 in^2 at rear and forward abutments and 201.06 in^2 at Piers 1 and 2.

A_c = cross-sectional area of Concrete (in^2), 99.40 in^2 at rear and forward abutments and 188.69 in^2 at Piers 1 and 2.

A_s = cross-sectional area of Steel Pipe (in^2), 13.70 in^2 at rear and forward abutments and 12.37 in^2 at Piers 1 and 2.

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 (in), 240 in (20 ft) at rear and forward abutments and 288 in (24 ft) at Piers 1 and 2.

r_s = radius of gyration about the axis normal to the plane of buckling (in), 3.60 in at rear and forward abutments and 4.80 in at Piers 1 and 2.

f'_c = Concrete Compressive Strength, 4.0 ksi

E_c = Concrete Elastic Modulus, 3640 ksi

n = E/E_c = Concrete Modular Ratio, 7.967

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)

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