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October 7, 2024
December 9, 2024 (1st Revision)
December 17, 2024 (2nd Revision)

HNTB Ohio, Inc.
88 E. Broad St.
Ste. 1600
Columbus, OH 43215

Attention: Mr. Naiel Hussein, PE
Transportation Group Director – Ohio

Reference: Structure Foundation Exploration Report - Final
ATH/MEG-033-18.70/0.00, PID No. 119141
ATH/MEG-033-23.23/0.00, PID No. 119142
Agreement No. 39087
Alexander, Lodi and Bedford Townships, Athens & Meigs Counties, Ohio
CTL Project No. 23050059COL

Dear Mr. Hussein:

CTL Engineering, Inc. (CTL) has completed the geotechnical exploration report for the above referenced project. We are providing an electronic version (PDF file) of the Final Report via email.

Thank you for the opportunity to be of service to you on this project. If you have any questions, please contact me at our office.

Respectfully Submitted,

CTL Engineering, Inc.

Sastry Malladi, P. E.
Project Engineer

STRUCTURE FOUNDATION EXPLORATION- FINAL REPORT

ATH/MEG-033-18.70/0.00, PID No. 119141
ATH/MEG-033-23.23/0.00, PID No. 119142
AGREEMENT NO. 39087
ALEXANDER, LODI AND BEDFORD TOWNSHIPS
ATHENS & MEIGS COUNTIES, OHIO
CTL PROJECT NO. 23050059COL

PREPARED FOR:

HNTB OHIO, INC.
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December 17, 2024

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I. EXECUTIVE SUMMARY

The overall ATH/MEG-033-18.70/00.00 project will convert 10.7 miles of roadway located in Athens and Meigs Counties from the existing two-lane highway configuration to a four lane, divided highway. The work will take place from just south of Athens extending down to Darwin. The overall project is divided into two sub projects, PID 119141 and PID 119142.

This report addresses the seven (7) new bridge structures planned within the project limits. The information regarding the proposed bridges is provided in Table 1.

Structure design memos addressing the proposed structures were previously submitted by CTL. This Final report includes our recommendations and addresses comments received by the District on the previously submitted Structure design memos.

A total of thirty-one (31) structure test borings were performed for this project. Beneath the surface cover, the test borings encountered both fine-grained soils and coarse-grained soils or bedrock extending down to the boring termination depths. The fine-grained soils were described as A-4a, A-6a, A-6b, A-7-5 or A-7-6 soils. The coarse-grained soils were described as A-1-a, A-1-b, A-2-4, A-2-7, A-3 or A-3a. Below the soil overburden, bedrock was encountered in all test borings except B-035-1-23, B-039-1-23 and B-050-0-23. The bedrock was described as claystone, sandstone or shale.

Groundwater was encountered during drilling in test borings B-037-0-23, B-038-0-23 and B-039-0-23 at a depth of 8.0 feet below existing grade. Groundwater was also encountered during drilling in borings B-058-0-23 and B-059-0-23 at depth of 6.0 and 4.0 feet, respectively These groundwater depths correspond to elevations ranging from 656.7 to 671.9.

Please refer to the Analyses and Recommendations section of this report for foundation support recommendations for each structure.

II. INTRODUCTION

The overall ATH/MEG-033-18.70/00.00 project will convert 10.7 miles of roadway located in Athens and Meigs Counties from the existing two-lane highway configuration to a four lane, divided highway. The work will take place from just south of Athens extending down to Darwin. The overall project is divided into two sub projects, PID 119141 and PID 119142.

This report addresses the seven (7) new bridge structures planned within the project limits. The information regarding the proposed bridges is provided in Table 1.

Table 1: Bridge Information

PID	Location	Bridge No.	SFN
119141	Pleasant Hill Road over US 33	ATH-00021-02.072	0500315
	Pleasanton Road Over U.S. 33	ATH-C0016-05.908	0500317
119142	Eastbound US33 over Pratts Fork Creek	ATH-00033-23250R	0501191
	Eastbound US33 over Tributary to Pratts Fork Creek	ATH-00033-24250R	0501205
	Rainbow Lake Rd. (CR 89) over US 33	ATH-00033-24950	0500319
	Eastbound US 33 over West Branch of the Shade River and C.R.40 (Burlingham Road)	MEG-00033-01510R	5300403
	Ramp O over Tributary to Shade River	MEG-00033-03570	5300586

This is a Final Structure Foundation Exploration Report.

III. GEOLOGY AND OBSERVATIONS OF THE PROJECT

The proposed structures are located within the Marietta Plateau physiographic region. Soils in this area are described as Pleistocene (Teays) age Minford clay, red and brown silty clay loam colluvium underlain by Pennsylvanian age sedimentary bedrocks. The bedrock mainly consists of sandstone, siltstone, shale, claystone of the Conemaugh and Monongahela formations.

Table 2 summarizes soil units identified in the Web Soil Survey (United States Department of Agriculture, Natural Resources Conservation Service) which are located within the limits of the proposed structures. The table also provides various soil parameters for these soil types.

Table 2: USDA Soil Types and Properties

Bridge No.	Major USDA Soil Unit Name	Soil Unit Symbol	Risk of Corrosion to Concrete	Risk of Corrosion to Steel
ATH-00021-02.072	Guernsey-Upshur complex, 8 to 15 percent slopes	GuC	Moderate	High
ATH-C0016-05.908	Guernsey-Upshur complex, 15 to 25 percent slopes	GuD	Moderate	High
ATH-00033-23250R	Kinnick-Lindside silt loams, 0 to 3 percent slopes, frequently flooded & Dekalb-Westmoreland	KnL1AF, DtF	Low to High	Moderate

Bridge No.	Major USDA Soil Unit Name	Soil Unit Symbol	Risk of Corrosion to Concrete	Risk of Corrosion to Steel
	complex, 40 to 70 percent slopes			
ATH-00033-24250R	Dekalb-Westmoreland complex, 40 to 70 percent slopes	DtF	High	Moderate
ATH-00033-24950	Guernsey-Upshur complex, 15 to 25 percent slopes	GuD	Moderate	High
MEG-00033-01510R	Chagrin silt loam, 0 to 3 percent slopes, frequently flooded	Chg1AF	Low	High
MEG-00033-03570	Chagrin silt loam, 0 to 3 percent slopes, frequently flooded	Chg1AF	Low	High

According to the mapping of historic and active mines (ODNR Mines of Ohio), there are no documented mines in the immediate vicinity of the proposed structures. However, surface mining activities were performed on the hillsides south and west of US Route 33, outside the project limits.

According to the mapping of karst features (Known and Probable Karst in Ohio, *ODNR Geological Survey Map EG-1, 1999; Revised 2002, 2006*), there are no mapped karst features in the general vicinity of the proposed structures. Additionally, karst features were not observed at the ground surface during our field exploration.

Several site visits were completed by CTL personnel between October 30, 2023, and August 2, 2024. The US 33 roadway is a two lane, bi directional road that runs generally west to east within the project limits. The topography along the roadway alignment consists of rolling hills with upward and downward slopes immediately adjacent to the roadway. The construction of the proposed US 33 is planned on the south side of the existing US 33. The original roadway plans included the conceptual layout of a future four lane highway. The right of way is wide enough to accommodate the future four lane road, interchanges and proposed structures.

No major slope stability concerns were noted within the limits of the proposed structures. The land usage near the proposed structures consists of consists of grasslands and wooded areas.

Historic geotechnical records were obtained for the proposed US 33 mainline structures, from the original geotechnical soil profile sheets prepared for ATH-033-40.981, and completed in 2001.

IV. EXPLORATION

A total of thirty-one (31) structure test borings were performed for this project. The location, depth and elevations of the borings are summarized in Table 3. The boring locations are included in the Geotechnical Profile sheets included in Appendix A, and on the boring logs included in Appendix B.

Table 3: Boring Locations, Depths and Elevations

Boring No.	Station	Offset	Boring Elevation (ft)	Depth (ft)
B-042-0-23	1022+17	127.0	970.3	45
B-044-0-23	1021+77	12.9	969.3	30
B-045-0-23	1021+17	-121.1	973.6	25
B-047-0-23	1158+55	108.6	897.6	30
B-048-0-23	1158+83	7.9	899.0	40
B-049-0-23	1159+16	-96.1	896.6	45
B-007-0-23	1229+00	17.6	836.0	21
B-008-0-23	1230+63	27.5	781.8	44.3
B-009-0-23	1231+81	39.2	762.8	39.3
B-010-0-23	1233+15	24.5	755.3	30.7
B-011-0-23	1234+06	34.6	750.3	30
B-012-0-23	1236+37	62.2	852.0	60
B-018-0-23	1281+98	58.8	845.4	25
B-019-0-23	1283+53	56.9	763.9	30
B-020-0-23	1284+28	61.0	755.9	33.5
B-021-0-23	1285+32	89.9	762.0	24
B-022-0-23	1286+58	64.9	831.3	60
B-023-0-23	1287+85	39.5	863.7	72
B-035-0-23	1420+74	41.8	730.0	30
B-035-1-23	1420+17	-24.1	750.3	35
B-036-0-23	1421+78	51.8	697.2	35
B-037-0-23	1423+49	81.4	674.5	55
B-038-0-23	1424+23	66.8	679.9	55
B-039-0-23	1425+51	132.0	676.8	55
B-039-1-23	1425+96	-23.5	743.4	90
B-050-0-23*	1317+19	78.0	888.1	14
B-050-0A-23*	1317+19	65.2	888.1	30
B-051-0-23	1317+99	3.5	889.7	35
B-052-0-23	1318+39	-68.1	890.3	35
B-058-0-23	1529+78	461.8	662.7	20
B-059-0-23	1529+19	430.3	663.8	20

*Boring B-050-0-23 encountered soft zone at 6.0', augers dropped (without rotation) to a depth of 14.0 feet. Boring B-050-0A-23 was performed at an offset 13.0 feet east from B-050-0-23.

The borings were performed between November 7, 2023, and April 17, 2024. The borings were performed with track mounted drills rigs utilizing 3.25-inch inside diameter (I.D) hollow stem augers (HSA). Standard Penetration Tests (SPTs) were conducted using a 140-pound automatic hammer, falling 30 inches, to drive 2-inch outside diameter (O.D) split barrel samplers. Rock coring was performed in the borings using an NQ size core barrel with a diamond bit. The energy transfer ratio associated with the automatic SPT hammers ranged from 76.8 to 79.3 percent. These automatic hammers were calibrated between November 2022 and May 2023.

The recovered split spoon samples obtained during the drilling operations were preserved in glass jars, visually classified in the field, and laboratory, and tested for moisture content. Representative samples were subjected to additional laboratory testing including Atterberg Limits, grain size distribution and hand penetrometer. Representative Shelby tube samples collected from the borings were subjected to consolidation and triaxial testing.

The recovered rock from the coring operations was visually described, and the Rock Quality Designation (RQD) and core recovery values were determined. Representative samples of the recovered rock were subjected to compressive strength and slake durability testing.

The survey information at the test boring locations was provided by the survey team member Buckley Group.

IV. FINDINGS

Borings B-035-1-23 and B-039-1-23 encountered 2 inches of asphalt over 5 to 8 inches of concrete at the surface. Borings B-050-0-23, B-050-0A-23, B-051-0-23 and B-052-0-23 encountered 12 inches of gravel at the surface. Boring B-047-0-23 encountered 3 inches of topsoil over 6 inches of gravel near the surface. The remaining borings encountered 3 to 12 inches of topsoil at the surface.

Beneath the surface cover, the test borings encountered both fine-grained soils and coarse-grained soils to depths ranging from 1.0 to 90.0 feet below existing grade. The fine-grained soils were described as A-4a, A-6a, A-6b, A-7-5 or A-7-6 soils. The coarse-grained soils were described as A-1-a, A-1-b, A-2-4, A-2-7, A-3 or A-3a. standard penetration N_{60} values ranging from 4 blows per foot (bpf) to 50 blows for 1 inch of penetration, with natural moisture content values ranging from 5 to 39 percent.

It should be noted that boring B-039-1-23, rock fragments were encountered within the fill layers in the upper 58.5 feet. A layer of sandstone boulder fill layer was encountered at a depth of 58.5 feet. The augers were advanced through this layer to a depth of 70.0 feet. At this level, auger refusal was encountered. To further advance the boring, rock coring methods were utilized within the rock fill from 70.0 to 73.0 feet. Below 73.0 feet, boring encountered native soils to the termination depth of 90.0 feet.

Borings B-035-1-23, B-039-1-23 and B-050-0-23 were terminated within the soil overburden.

Below the soil overburden, bedrock was encountered in all test borings except B-035-1-23, B-039-1-23 0r B-050-0-23. The bedrock was described as claystone, sandstone or shale. The bedrock was encountered at depths ranging from 1.0 to 36.0 feet below existing grade. These depths correspond to elevations ranging from 638.5 to 970.1. The upper several inches to several feet of bedrock in majority of the structure borings was augered and sampled using soil sampling techniques. The augerable bedrock exhibited N_{60} values ranging from 28 bpf to 50 blows for 1 inch of penetration.

Rock coring was performed in all structure borings except B-035-1-23, B-039-1-23 and B-050-0-23. The recovered bedrock was described as claystone, sandstone or shale, and exhibited RQD values ranging from 0 to 100 percent, and core recovery values ranging from 40 to 100 percent.

Groundwater was encountered during drilling in test borings B-037-0-23, B-038-0-23 and B-039-0-23 at a depth of 8.0 feet below existing grade. Groundwater was also encountered during drilling in borings B-058-0-23 and B-059-0-23 at depth of 6.0 and 4.0 feet, respectively These groundwater depths correspond to elevations ranging from 656.7 to 671.9.

V. ANALYSES AND RECOMMENDATIONS

A. Bridge No. ATH-00021-02.072- Pleasant Hill Road over US 33

According to the Stage 2 plans, the proposed structure type will be two-span continuous steel plate girders with composite reinforced concrete deck on semi-integral abutments and cap and column pier. The proposed pier and forward abutment will be supported onto spread foundations and the proposed rear abutment will be supported onto HP 14x73 piles driven to refusal in the underlying bedrock. Foundation support recommendations for the considered foundation types are provided below.

Spread Foundations

Spread foundation bearing resistance calculations are appended to this report in Appendix D, and are summarized in Table 4.

Table 4. Unfactored Bearing Resistance

Location	Boring No.	Bottom of Footing Elevation, feet	Unfactored Bearing Resistance, q_n ksf
Pier	B-044-0-23	962.8	44.1
Forward Abutment	B-045-0-23	969.28	43.4

A resistance factor of 0.45 should be used for determining factored bearing resistance in the strength limit state. The resistance factor was obtained from AASHTO Table 10.5.5.2.2-1 for footing bearing on bedrock.

H- Pile Foundations

The bottom of pile cap elevation near the rear abutment was taken from Stage 2 plans. The estimated pile tip elevations, pile length and order length are provided in Table 5. The estimated pile length includes a 1-foot penetration into the pile cap and was rounded up to the nearest 5-foot length.

Table 5: Pile Information

Location/ Boring No.	Bottom of Pile Cap Elevation (Feet)	Pile Type	Estimated Pile Tip Elevation (feet)	Estimated Pile Length (feet)	Order Length (feet)
Rear Abutment/ B-042-0-23	969.76	HP 14x73	940.3	35	40

A spreadsheet containing lateral pile (L-pile) parameters which can be utilized while performing lateral analysis for the proposed piles is attached to this report in Appendix D.

Settlement and Negative Skin Friction (Downdrag Force)

According to the Stage 2 plans, it is understood that embankment fill will be placed in the vicinity of the proposed bridge approach embankments. The maximum fill height will be approximately 20± feet in the area of the proposed Rear and Forward Abutments.

Due to the presence of shallow bedrock, no significant settlements or downdrag forces are anticipated near the Forward Abutment due to the proposed fill placement.

Near the rear abutment, a settlement analysis was performed using soil data obtained from boring B-042-0-23. It is estimated that the underlying soils will settle about 2.6 inches at the Rear Abutment.

According to the ODOT BDM, the amount of relative settlement between the soil and pile that is necessary to mobilize negative shaft resistance is about 0.4 inch. Since the settlement of the soils below the proposed Rear Abutment is in excess of 0.4 inch, downdrag forces should be included in the design.

The estimated downdrag force for the piles for the proposed Rear Abutment is summarized in Table 6. Downdrag calculations are included under Appendix D.

Table 6. Downdrag Forces

Location	Pile Type	Unfactored Downdrag Force (Kips)	Factored Downdrag Force (Kips)
Rear Abutment	HP 14x73	44.9	47.2

The factored downdrag force was computed using a load factor of 1.05. This load factor was obtained from ODOT BDM 305.3.2.2 and ODOT GDM 1304.5.

The Factored Structural Resistance (P_r) for the piles in each substructure are provided in Table 7. The P_r provided is based on ODOT BDM Section 305.3.3.

Table 7: Pile Axial Structural Resistance

Location/ Boring No.	Pile Type	P_r (kips)*	Resistance Factor, ϕ_c
Rear Abutment/B-042-0-23	HP 14x73	530	0.5 **

* P_r value shown does not include a reduction for corrosion loss. The corrosion loss reduction will be determined by the structural engineer.

**According ODOT BDM Section 305.3.3, to account for potential damage from severe driving conditions. Since the neutral plane is very close to the top of bedrock, the 0.5 resistance factor is also considered appropriate for piles subjected to compression with the drag load.

Alternatively, to eliminate the need for including downdrag forces on the piles, the approach embankment could be constructed, and the underlying soils allowed to settle, prior to driving the piles for the abutment. In such an event, the settlement of the underlying soils should be monitored by means of settlement plates. The settlement data should be provided to the geotechnical engineer to determine when the settlement rate has attenuated and when the piles can be driven to refusal in the underlying bedrock.

At the rear abutment location, it is estimated that it will take about 16 months for 0.4 inch of settlement to remain.

According to the Stage 2 plans, the proposed piles have been designed to account for the downdrag loads. Therefore, no downdrag mitigation is required for this structure.

For point bearing piles on bedrock, select a hammer that is capable of reaching and penetrating bedrock for the specified pile type and size. Driving refusal is defined in ODOT BDM 305.3.1.2.

B. Bridge No. ATH-C0016-05.908- Pleasanton Road Over U.S. 33

According to the Stage 2 plans, the proposed structure type will be two-span prestressed concrete I-beams with reinforced concrete composite deck supported by integral abutments, cap and column piers on H-piles.

The proposed pier and abutments will be supported onto HP 14x73 piles driven to refusal in the underlying bedrock. Foundation support recommendations for the considered foundation types are provided below.

Pile Foundations

The bottom of pile cap elevations for the proposed substructures were taken from Stage 2 plans. The estimated pile tip elevations, pile length and order length are provided in Table 8. The estimated pile length includes a 2-foot penetration into the pile cap at the abutments, and a 1-foot penetration into the pile cap at the pier, and was rounded up to the nearest 5-foot length.

Table 8: Pile Information

Location/ Boring No.	Bottom of Pile Cap Elevation (Feet)	Pile Type	Estimated Pile Tip Elevation (feet)	Estimated Pile Length (feet)	Order Length (feet)
Rear Abutment/ B-047-0-23	910.75	HP14x73	882.6	35	40
Pier/ B-048-0-23	894.5	HP14x73	874.0	25	30
Forward Abutment/ B-049-0-23	910.0	HP14x73	866.6	50	55

A spreadsheet containing lateral pile (L-pile) parameters which can be utilized while performing lateral analysis for the proposed piles is attached to this report in Appendix E.

Settlement and Negative Skin Friction (Downdrag Force)

According to the Stage 2 plans, it is understood that embankment fill will be placed in the vicinity of the proposed bridge approach embankments. The maximum fill height will be approximately 26.0 feet in the area of the Rear Abutment, and 38.0 feet in the area of the Forward Abutment.

A settlement analysis was performed using soil and rock data from borings B-047-0-23 and B-049-0-23. It is estimated that the underlying soils will settle about 2.5 inches at the Rear Abutment, and 2.5 inches at the Forward Abutment as a result of the fill placement.

According to the ODOT BDM, the amount of relative settlement between the soil and pile that is necessary to mobilize negative shaft resistance is about 0.4 inch. Since the settlement of the soils below the proposed Rear and Forward Abutments is in excess of 0.4 inch, downdrag forces should be included in the design.

The estimated downdrag force for the piles for the proposed rear and forward abutments is summarized in Table 9. Downdrag calculations are included in Appendix E.

Table 9. Downdrag Forces

Location	Pile Type	Unfactored Downdrag Force (Kips)	Factored Downdrag Force (Kips)
Rear Abutment	HP 14x73	125.1	131.3
Forward Abutment	HP 14x73	195.3	205.1

The factored downdrag force was computed using a load factor of 1.05. This load factor was obtained from ODOT BDM 305.3.2.2 and ODOT GDM 1304.5.

The Factored Structural Resistance (P_r) for the piles in each substructure are provided in Table 10. The P_r provided is based on ODOT BDM Section 305.3.3.

Table 10: Pile Axial Structural Resistance

Location/ Boring No.	Pile Type	P_r (kips)*	Resistance Factor, ϕ_c
Rear Abutment/ B-047-0-23	HP 14x73	530	0.5 **
Forward Abutment/ B-049-0-23	HP 14x73	530	0.5 **

* P_r value shown does not include a reduction for corrosion loss. The corrosion loss reduction will be determined by the structural engineer.

** According ODOT BDM Section 305.3.3, to account for potential damage from severe driving conditions. Since the neutral plane is very close to the top of bedrock, the 0.5 resistance factor is also considered appropriate for piles subjected to compression with the drag load.

Alternatively, to eliminate the need for including downdrag forces on the piles, the approach embankments could be constructed, and the underlying soils allowed to settle, prior to driving the piles for the abutments. In such an event, the settlement of the underlying soils should be monitored by means of settlement plates. The settlement data should be provided to the geotechnical engineer to determine when the settlement rate has attenuated and when the piles can be driven to refusal in the underlying bedrock.

At the Rear Abutment location, it is estimated that it will take about 14 weeks for 0.4 inch of settlement to remain. At the Forward Abutment location, it is estimated that it will take about 58 weeks for 0.4 inch of settlement to remain.

If the computed downdrag loads are determined to be excessive, and the estimated 14-week waiting period at the Rear Abutment, and 58-week waiting period at the Forward Abutment are determined to be too long, then prior to pile driving, the existing soils below the abutments should be removed down to elevation 889.4 at the Rear Abutment, and down to elevation 877.1 at the Forward Abutment. The grade should be restored using compacted granular embankment.

According to the Stage 2 plans, it is understood that the existing soils below the rear and forward abutments will be removed and replaced with granular materials. Under this option, it is expected that the settlement of the underlying soils will occur quickly. Therefore, under this option no settlement waiting periods are anticipated and downdrag will not be of concern. In addition, it is CTL's opinion that the piles can be driven through the new embankments without pre-boring.

For point bearing piles on bedrock, select a hammer that is capable of reaching and penetrating bedrock for the specified pile type and size. Driving refusal is defined in ODOT BDM 305.3.1.2.

C. ATH-00033-23250R - Eastbound US33 over Pratts Fork Creek

Scour Data

For the purpose of scour analysis, the mean particle grain size (D_{50}), critical shear stress (τ_c) and erosion category (EC) of the creek bed materials were determined according to ODOT Geotechnical Design Manual (GDM) Section 1302. The scour data for the proposed structure are shown in Table 11.

Table 11: Scour Parameters

Boring No.	Sample No.	Elevation (feet)	D_{50} (mm)	τ_c (psf)	$D_{50, equiv}$ (mm)	Erosion Category (EC)
B-010-0-23	SS-1	754.3 - 752.8	0.0461	0.1071	5.1304	3.337
	SS-2	751.8 - 750.3	0.0209	0.2346	11.2323	3.075
	SS-3	750.3 - 748.8	0.0132	0.4468	21.3927	3.413
	SS-4	748.8 - 747.3	0.1404	0.0208	0.9967	2.501
	SS-5	747.3 - 745.8	0.0145	0.0939	4.4983	3.168
B-011-0-23	SS-1	753.5 - 752.0	0.0194	0.0620	2.9707	3.075
	SS-2	751.0 - 749.5	0.0382	0.1114	5.3318	2.754
	SS-3	749.5 - 748.0	0.0239	0.0381	1.8232	2.868
	SS-4	748.0 - 746.5	0.0680	0.1647	7.8840	2.868
	SS-5	746.5 - 745.0	0.0214	0.1397	6.6871	3.075

Foundations

According to the Stage 2 plans, the proposed structure type will be five-span prestressed concrete I-beams and composite deck with cap and column piers.

The proposed abutments will be supported onto spread foundations, and the proposed piers will be supported onto drilled shafts. Foundation support recommendations for the considered foundation types are provided below.

Spread Foundations

Spread foundation bearing resistance calculations are attached to this report in Appendix F, and are summarized in Table 12.

Table 12: Unfactored Bearing Resistance

Location	Boring No.	Bottom of Footing Elevation, feet	Unfactored Bearing Resistance, q_n ksf
Rear Abutment	B-007-0-23	823.6	254.8
Forward Abutment	B-012-0-23	816.5	371.7

A resistance factor of 0.45 should be used for determining factored bearing resistance in strength limit state. The resistance factor was obtained from AASHTO Table 10.5.5.2.2-1 for footing bearing on bedrock.

Drilled Shaft Foundations

The drilled shaft foundations may be proportioned using a nominal unit tip resistance value not exceeding those provided in Table 13. Bottom of pier cap elevations were taken from Stage 2 plans. The rock socket lengths were provided by the structural engineer.

Table 13: Nominal Unit Tip Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Top of Bedrock Elevation (Feet)	Rock Socket Length (Feet)	Nominal Unit Tip Resistance, q_p (ksf)
Pier 1	781.00	B-008-0-23	773.3	20.8	316.8
Pier 2	763.73	B-009-0-23	744.3	8.3	1047.6
Pier 3	753.41	B-010-0-23	745.8	11.2	3704.4
Pier 4	753.35	B-011-0-23	740.8	10.4	2388.6

According to AASHTO Table 10.5.5.2.4-1, a resistance factor of 0.5 should be used for Unit Tip Resistance for the Strength Limit State.

The socket tip should extend at least 1.5 times the socket diameter into the bedrock per ODOT BDM 305.4.2 (AASHTO LRFD 10.8.3.5.4c).

Per ODOT GDM 1306.4.2, the drilled shafts should be designed for tip resistance or side resistance, but not both. If both tip and side resistance are used, then each value should be modified according to deflection and mobilization of resistance in accordance with ODOT GDM 1306.3.2.

Additionally, capacity can be achieved along the shafts from side resistance. Side resistance within the soil overburden and upper portion of the rock socket should be neglected as outlined in ODOT BDM section 305.4.2. Unfactored unit side resistance values are included in Table 14.

Table 14: Unfactored Unit Side Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Elevation (feet)	Nominal Unit Side Resistance, q_p (ksf)
Pier 1	781.00	B-008-0-23	773.3 to 757.5	0.8
			757.5 to 752.5	5.5
Pier 2	763.73	B-009-0-23	744.3 to 743.5	1.7
			743.5 to 736.0	21.4
Pier 3	753.41	B-010-0-23	745.8 to 744.6	1.5
			744.6 to 734.6	21.4
Pier 4	753.35	B-011-0-23	740.8 to 740.3	1.3
			740.3 to 730.4	21.4

The resistance factors in Table 15should be used for Shaft Side Resistance. The resistance factors were obtained from AASHTO Table 10.5.5.2.4-1.

Table 15. Resistance Factors for Shaft Side Resistance

Material Type	Resistance Factors	
	Compressive	Uplift
Rock	0.55	0.40

A spreadsheet containing lateral pile (L-pile) parameters which can be utilized while performing lateral analysis for the proposed piers is attached to this report in Appendix F.

D. ATH-00033-24250R - Eastbound US33 over Tributary to Pratts Fork Creek

Scour Data

For the purpose of scour analysis, the mean particle grain size (D_{50}), critical shear stress (τ_c) and erosion category (EC) of the creek bed materials were determined according to ODOT Geotechnical Design Manual (GDM) Section 1302. The scour data for the proposed structure are shown in Table 16.

Table 16: Scour Parameters

Boring No.	Sample No.	Elevation (feet)	D_{50} (mm)	τ_c (psf)	$D_{50, equiv}$ (mm)	Erosion Category (EC)
B-020-0-23	SS-1	754.9 - 753.4	0.0099	0.1028	4.9200	3.484
	SS-3	749.9 - 748.4	0.0098	0.3765	18.0272	3.550
	SS-4	747.4 - 745.9	0.0197	0.3792	18.1570	3.255
	SS-5	745.9 - 744.4	0.0088	0.5099	24.4151	3.413
	SS-6	744.4 - 742.9	0.0035	1.6183	77.4863	3.823
	SS-7	742.9 - 741.4	0.0072	1.0813	51.7726	3.550
	SS-8	741.4 - 739.9	0.0075	2.2176	106.1772	3.612

Foundations

According to the Stage 2 plans, the proposed structure type will be five-span prestressed concrete I-beams and composite deck with cap and column piers.

The proposed abutments will be supported onto spread foundations and proposed piers will be supported onto drilled shafts. Foundation support recommendations for the considered foundation types are provided below.

Spread Foundations

Spread foundation bearing resistance calculations are attached to this report in Appendix G, and are summarized in Table 17.

Table 17: Unfactored Bearing Resistance

Location	Boring No.	Bottom of Footing Elevation, feet	Unfactored Bearing Resistance, q_n ksf
Rear Abutment	B-018-0-23	836.3	67.8
Forward Abutment	B-023-0-23	843.3	85.8

A resistance factor of 0.45 should be used for determining factored bearing resistance in strength limit state. The resistance factor was obtained from AASHTO Table 10.5.5.2.2-1 for footing bearing on bedrock.

Drilled Shaft Foundations

The drilled shaft foundations may be proportioned using a nominal unit tip resistance value not exceeding those provided in Table 18. Bottom of pier cap elevation and rock socket lengths were taken from Stage 2 plans.

Table 18: Nominal Unit Tip Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Top of Bedrock Elevation (Feet)	Rock Socket Length (Feet)	Nominal Unit Tip Resistance, q_p (ksf)
Pier 1	781.8	B-019-0-23	752.9	10.0	82.8
				20.0*	1360.8
Pier 2	753.1	B-020-0-23	738.9	10.0	1360.8
Pier 3	755.5	B-021-0-23	753.5	10.0	2059.2
Pier 4	818.3	B-022-0-23	827.8	12.0	1044.0

* Rock socket length from Stage 2 plans appear to be using a top of rock elevation different from what is shown in this table and on the test boring records. This is likely due to the variation in the ground surface elevation between the boring location and the proposed pier location.

According to AASHTO Table 10.5.5.2.4-1, a resistance factor of 0.5 should be used for Unit Tip Resistance for the Strength Limit State.

The socket tip should extend at least 1.5 times the socket diameter into the bedrock per ODOT BDM 305.4.2 (AASHTO LRFD 10.8.3.5.4c).

Per ODOT GDM 1306.4.2, the drilled shafts should be designed for tip resistance or side resistance, but not both. If both tip and side resistance are used, then each value should be modified according to deflection and mobilization of resistance in accordance with ODOT GDM 1306.3.2.

Additionally, capacity can be achieved along the shafts from side resistance. Side resistance within the soil overburden and upper portion of the rock socket should be neglected as outlined in ODOT BDM section 305.4.2. Unfactored unit side resistance values are included in Table 19.

Table 19: Unfactored Unit Side Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Elevation (feet)	Nominal Unit Side Resistance, q_p (ksf)
Pier 1	781.8	B-019-0-23	758.8 to 748.9	0.9
			748.9 to 738.8	3.9
Pier 2	753.1	B-020-0-23	738.6 to 737.4	1.1
			737.4 to 728.6	34.9
Pier 3	755.5	B-021-0-23	753.5 to 753.0	1.7
			753.0 to 750.0	34.9
			750.0 to 745.0	4.9
			745.0 to 743.5	34.9
Pier 4	818.3	B-022-0-23	818.3 to 806.3	30.7

The resistance factors in Table 20 should be used for Shaft Side Resistance. The resistance factors were obtained from AASHTO Table 10.5.5.2.4-1.

Table 20: Resistance Factors for Shaft Side Resistance

Material Type	Resistance Factors	
	Compressive	Uplift
Rock	0.55	0.40

A spreadsheet containing lateral pile (L-pile) parameters which can be utilized while performing lateral analysis for the proposed piers is attached to this report in Appendix G.

Global Stability

Global stability analyses were performed for the existing slope between the Rear Abutment and Pier 1.

The global stability analyses were performed using the SLIDE computer program. This program is based on two-dimensional limit equilibrium methods in which the calculation of the factor of safety against instability of a slope is performed by the method of slices. The method used was the Morgenstern-Price method for surfaces of a circular shape.

The soil parameters used in the analysis are based on the subsurface conditions encountered in borings B-018-0-23, B-019-0-23 and B-020-0-23, and estimated parameters for the proposed embankment soils.

Results of the stability analysis are appended to this report in graphical format, in Appendix G. The graphs present the geometry of the proposed spill-through slopes; the modeled soil strata and their corresponding parameters; and the most critical failure surface along with the minimum factor of safety. Factor of safety is defined as the ratio of forces resisting movement (generally the shear strength value along the assumed failure surface) to forces acting on the slope, generally gravity and applied vehicular loads. Results of the global stability analyses are summarized in Table 21.

Table 21: Global Stability-Slope Between Rear Abutment and Pier 1

Case	**Calculated Factor of Safety**	**Minimum Required Factor of Safety**	**Capacity to Demand Ratio**
Effective Stress	2.0	1.5	0.75
Total Stress	2.6	1.5	0.58

E. ATH-00033-24950- Rainbow Lake Rd. (CR 89) over US 33

According to the Stage 2 plans, the proposed structure type will be two-span pre-stressed I-beam and composite deck with full height, semi integral abutments.

The proposed abutments and pier will be supported onto drilled shafts. Foundation support recommendations for the drilled shafts are provided below.

Drilled Shaft Foundations

The drilled shaft foundations may be proportioned using a nominal unit tip resistance value not exceeding those provided in Table 22. Bottom of pier cap elevation and rock socket lengths were taken from Stage 2 plans.

Table 22: Nominal Unit Tip Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Top of Bedrock Elevation (Feet)	Rock Socket Length (Feet)	Nominal Unit Tip Resistance, q_p (ksf)
Rear Abutment	884.0	B-050-0A-23	879.6	15.0	2260.8
Pier	889.5	B-051-0-23	873.7	9.5	2224.8
Forward Abutment	885.0	B-052-0-23	879.8	14.5	1854.0

According to AASHTO Table 10.5.5.2.4-1, a resistance factor of 0.5 should be used for Unit Tip Resistance for the Strength Limit State.

The socket tip should extend at least 1.5 times the socket diameter into the bedrock per ODOT BDM 305.4.2 (AASHTO LRFD 10.8.3.5.4c).

Per ODOT GDM 1306.4.2, the drilled shafts should be designed for tip resistance or side resistance, but not both. If both tip and side resistance are used, then each value should be modified according to deflection and mobilization of resistance in accordance with ODOT GDM 1306.3.2.

Additionally, capacity can be achieved along the shafts using side resistance. Side resistance within soil overburden and upper portion of the rock socket should be neglected as outlined in ODOT BDM section 305.4.2. Unfactored unit side resistance values are included in Table 23.

Table 23: Unfactored Unit Side Resistance

Location	Bottom of Pier Cap Elevation (Approx.)	Boring No.	Elevation (feet)	Nominal Unit Side Resistance, q_p (ksf)
Rear Abutment	884.0	B-050-0A-23	879.6 to 873.1	0.9
			873.1 to 864.6	3.0
Pier	889.5	B-051-0-23	873.7 to 869.7	1.0
			869.7 to 864.2	7.8
Forward Abutment	885.0	B-052-0-23	879.8 to 870.3	1.1
			870.3 to 865.3	34.9

The resistance factors in Table 24 should be used for Shaft Side Resistance. The resistance factors were obtained from AASHTO Table 10.5.5.2.4-1.

Table 24: Resistance Factors for Shaft Side Resistance

Material Type	Resistance Factors	
	Compressive	Uplift
Rock	0.55	0.40

Spreadsheets containing lateral pile (L-pile) parameters which can be utilized while performing lateral analysis for the proposed drilled shafts are attached to this report in Appendix H.

Settlement and Negative Skin Friction (Downdrag Force)

According to the Stage 2 plans, it is understood that embankment fill will be placed in the vicinity of the proposed bridge approach embankments. The maximum fill height will be approximately ± 24 feet in the area of the proposed Rear and Forward Abutments.

Settlement analyses were performed using soil and rock data from borings B-050-0A-23 and B-052-0-23 assuming that the embankment fill is constructed up to the level of the subgrade elevation for a minimum distance of 25 feet behind each abutment (1H:1V temporary slope from the existing grade behind the proposed abutment up to the proposed subgrade). It is estimated that the underlying soils will settle about 0.65 inch at the Rear Abutment, and 0.25 inch at the Forward Abutment as a result of the fill placement.

According to the ODOT BDM, the amount of relative settlement between the soil and pile that is necessary to mobilize negative shaft resistance is about 0.4 inch. Since the settlement of the soils below the proposed Rear Abutment is in excess of 0.4 inch, downdrag forces should be included in the design of the drilled shafts at the Rear Abutment. Downdrag forces at the Forward Abutment should be neglected since the estimated total settlement is less than 0.4 inch.

The estimated downdrag force for the drilled shafts proposed near the Rear and Forward Abutments are summarized in Table 25. Downdrag calculations are appended to this report in Appendix H.

Table 25: Downdrag Forces

Location	Bottom of the Pier Cap	Unfactored Downdrag Force (Kips)	Factored Downdrag Force (Kips)
Rear Abutment	884.0	23.4	24.6

The factored downdrag force was computed using a load factor of 1.05. This load factor was obtained from ODOT BDM 305.4.1 and ODOT GDM 1306.2.2.

Alternatively, to eliminate the need for including downdrag forces on the drilled shafts, the approach embankments could be constructed, and the underlying soils allowed to settle, prior to installation of the drilled shafts and abutments. In such an event, the settlement of the underlying soils should be monitored by means of settlement plates. The settlement data should be provided to the geotechnical engineer to determine when the settlement rate has attenuated and when the drilled shafts and abutments may be constructed.

At the Rear Abutment location, it is estimated that it will take about 1 week for 0.4 inch of settlement to remain.

If the computed downdrag force is determined to be excessive, and the estimated 1-week waiting period at the Rear Abutment is determined to be too long, then prior to pile driving, the existing soils below the Rear Abutment should be removed down to elevation 882.3 (about 1.7 feet below the proposed bottom of footing). The grade should be restored using compacted granular embankment.

F. MEG-00033-01510R - Eastbound US 33 over West Branch of the Shade River and C.R.40 (Burlingham Road)

Scour Data

For the purpose of scour analysis, the mean particle grain size (D_{50}), critical shear stress (τ_c) and erosion category (EC) of the creek bed materials were determined according to ODOT Geotechnical Design Manual (GDM) Section 1302. The scour data for the proposed structure are shown in Table 26.

Table 26: Scour Parameters

Boring No.	Sample No.	Elevation (feet)	D_{50} (mm)	τ_c (psf)	$D_{50, equiv}$ (mm)	Erosion Category (EC)
B-037-0-23	SS-1	673.5 - 672.0	0.1216	0.0214	1.0238	2.211
	SS-3	668.5 - 667.0	0.1235	0.0100	0.4793	2.211
	SS-4	666.0 - 664.5	0.1101	0.0070	0.3368	2.211
	SS-5	664.5 - 663.0	0.1832	0.0002	0.0094	2.211
	SS-6	663.0 - 661.5	0.1605	0.0008	0.0374	2.211
	SS-7	661.5 - 660.0	0.1148	0.0001	0.0069	2.211
	SS-8	660.0 - 658.5	0.1244	0.0001	0.0069	2.211
	SS-10	656.0 - 654.5	0.0073	0.5004	23.9584	3.612

Foundations

According to the Stage 2 plans, the proposed structure type will be four-span prestressed concrete I-Beam and composite deck with semi-integral abutments, and cap and column piers.

The proposed abutments will be supported onto H-piles driven to refusal in the underlying bedrock, and the proposed piers will be supported onto drilled shafts socked into underlying bedrock. Therefore, foundation support recommendations for the considered foundation types are provided below.

H- Pile Foundations

It is understood that HP 10x42 piles will be utilized for the proposed Rear Abutment and HP 14x73 piles will be utilized for the proposed forward abutment. The estimated pile tip elevations, pile length and order length are provided in Table 27.

Table 27: Pile Information

Location/ Boring No.	Bottom of Pile Cap Elevation (Feet)	Pile Type	Estimated Pile Tip Elevation (feet)	Estimated Pile Length (feet)	Order Length (feet)
Rear Abutment/ B-035-0-23, B-035-1-23	735.3	HP10x42	715.0	25	30
Forward Abutment/ B-039-0-23, B-039-1-23	730.1	HP14x73	636.8*	100	105

*Rock fragments, rock pieces and rock layers should be expected within the existing embankment fills during pile driving for the proposed Forward Abutment. Drive points should be used for proposed H-piles for the Forward Abutment. Additionally, a quantity for pre-boring for the H-piles should be included at the Forward Abutment due to the presence of the rock fill layers within the embankment.

For point bearing piles on bedrock, select a hammer that is capable of reaching and penetrating bedrock for the specified pile type and size. Driving refusal is defined in ODOT BDM 305.3.1.2.

Settlement and Negative Skin Friction (Downdrag Force)

According to the Stage 2 plans, embankment fill will be placed in the vicinity of the proposed bridge approach embankments. The maximum fill height will be approximately 15.3 feet in the area of the Rear Abutment, and 40.4 feet in the area of the Forward Abutment.

Settlement analyses were performed using soil and rock data from borings B-035-0-23, B-035-1-23, B-039-0-23, and B-039-1-23.

The following 3 cases were considered while performing the settlement calculations for both the Rear Abutment and Forward Abutment.

- Settlement below the left corner of the abutment
- Settlement below the middle of the abutment
- Settlement below the right corner of the abutment

The influence value (I) for embankment loading utilized in the settlement calculation was computed based on "Influence Values for Vertical Stresses in Semi-Infinite Loading" charts (After Osterberg 1957). Since the embankment sides are not symmetrical, the influence values were computed separately based on the shape of the embankments on the left and right side for each case considered. The influence factors were then added and the combined "I" value was used to determine the final stress of the soil layer.

The downdrag calculations and time rate of settlement were computed for the worst-case scenarios from the settlement calculations. The settlement and downdrag calculations are appended to this report in Appendix I.

Based on the results of the settlement analyses, it is estimated that the underlying soils will settle up to about 2.1 inches at the Rear Abutment, and up to about 5.0 inches at the Forward Abutment as a result of the fill placement.

According to the ODOT BDM, the amount of relative settlement between the soil and pile that is necessary to mobilize negative shaft resistance is about 0.4 inch. Since the settlement of the soils below the proposed rear and forward abutments is in excess of 0.4 inch, downdrag forces should be included in the design.

The estimated downdrag force for the HP 10x42 piles for the proposed Rear Abutment and for the HP 14x73 piles for the proposed Forward Abutment are summarized in Table 28.

Table 28: Downdrag Forces

Location	Pile Type	Unfactored Downdrag Force (Kips)	Factored Downdrag Force (Kips)
Rear Abutment Pile Cap	HP 10x42	54.7	57.4
Forward Abutment Pile Cap	HP 14x73	305.6	320.9

The factored downdrag force was computed using a load factor of 1.05. This load factor was obtained from ODOT BDM 305.3.2.2 and ODOT GDM 1304.5.

According to BDM section 305.3.2.2, battered piles should not be used when downdrag is anticipated.

The Factored Structural Resistance (P_r) for the piles in each substructure are provided in Table 29. The P_r provided is based on ODOT BDM Section 305.3.3.

Table 29: Pile Axial Structural Resistance

Location/ Boring No.	Pile Type	P_r (kips)	Resistance Factor, ϕ_c
Rear Abutment/ B-035-0-23, B-035-1-23	HP10x42	310 or 372*	0.5 or 0.6*
Forward Abutment/ B-039-0-23, B-039-1-23	HP14x73	530 or 642*	0.5 or 0.6*

*According to ODOT BMD Section 305.3.2.2 and AASHTO LRFD 6.5.4.2, use the resistance factor for steel piles in compression under good driving conditions ($\phi_c = 0.6$) if including drag load. Otherwise, use the resistance factor for steel piles in compression and subject to damage due to severe driving conditions ($\phi_c = 0.5$).

Alternatively, to eliminate the need for including downdrag forces on the piles, the approach embankments could be constructed to allow the underlying soils to settle prior to driving the piles for the abutment. In such an event, the settlement of the underlying soils should be monitored by means of settlement plates. The settlement data should be provided to the geotechnical engineer to determine when the settlement rate has attenuated and when the piles can be driven to refusal in the underlying bedrock.

At the Rear Abutment location, it is estimated that it will take about 1.7 months for 0.4 inch of settlement to remain. At the Forward Abutment location, it is estimated that it will take about 3.3 months for 0.4 inch of settlement to remain.

According to the Stage 2 plans, the proposed HP10x42 piles (Rear Abutment) and HP14x73 piles (Forward Abutment) can accommodate the bridge loading and the downdrag forces. Therefore, no downdrag mitigation is required for this structure.

Drilled Shaft Foundations

Foundation support recommendations for the proposed pier foundations are provided below.

The drilled shaft foundations may be proportioned using a nominal unit tip resistance value not exceeding those provided in Table 30. Bottom of pier cap elevation and rock socket lengths were taken from Stage 2 plans.

Table 30: Nominal Unit Tip Resistance

Location	Bottom of Pier Cap Elevation (feet)	Boring No.	Top of Bedrock Elevation (Feet)	Rock Socket Length (Feet)	Nominal Unit Tip Resistance, q_p (ksf)
Pier 1	687.0	B-036-0-23	678.7	10	133.2
Pier 2	671.0	B-037-0-23	638.5	27	39.6
Pier 3	683.0	B-038-0-23	644.4	28	36.0

According to AASHTO Table 10.5.5.2.4-1, a resistance factor of 0.5 should be used for Unit Tip Resistance for the Strength Limit State.

The socket tip should extend at least 1.5 times the socket diameter into the bedrock per ODOT BDM 305.4.2 (AASHTO LRFD 10.8.3.5.4c).

Per ODOT GDM 1306.4.2, the drilled shafts should be designed for tip resistance or side resistance, but not both. If both tip and side resistance are used, then each value should be modified according to deflection and mobilization of resistance in accordance with ODOT GDM 1306.3.2.

Additional capacity can be achieved along the shafts using side resistance. Side resistance within soil overburden and upper portion of the rock socket should be neglected as outlined in ODOT BDM section 305.4.2. Unfactored unit side resistance values are included in Table 31.

Table 31: Unfactored Unit Side Resistance

Location	Bottom of Pier Cap Elevation (Approx.)	Boring No.	Elevation (feet)	Nominal Unit Side Resistance, q_p (ksf)
Pier 1	687.0	B-036-0-23	678.7 to 677.2	0.9
			677.2 to 668.7	10.6
Pier 2	671.0	B-037-0-23	638.5 to 634.5	1.3
			634.5 to 611.5	5.8
Pier 3	683.0	B-038-0-23	644.4 to 639.9	2.2
			639.9 to 616.4	5.2

The resistance factors in Table 32 should be used for Shaft Side Resistance. The resistance factors were obtained from AASHTO Table 10.5.5.2.4-1.

Table 32: Resistance Factors for Shaft Side Resistance

Material Type	Resistance Factors	
	Compressive	Uplift
Rock	0.55	0.40

A spreadsheet containing lateral pile (L-pile) parameters, which can be utilized while performing lateral analysis for the proposed shafts, is included in Appendix I.

Global Stability

Slope stability analyses were performed in the area of proposed forward abutment spill-through slope of the bridge with 2 horizontal to 1 vertical (2:1) maximum slope rate.

The global stability analyses were performed using the SLIDE computer program. This program is based on two-dimensional limit equilibrium methods in which the calculation of the factor of safety against instability of a slope is performed by the method of slices. The method used was the Morgenstern-Price method for surfaces of a circular shape.

The soil parameters used in the analysis are based on the subsurface conditions encountered in borings B-039-0-23 and B-039-1-23, and estimated parameters for the proposed embankment soils.

Results of the stability analysis are appended to this report in graphical format, under Appendix I. The graphs present the geometry of the proposed spill-through slopes; the modeled soil strata and their corresponding parameters; and the most critical failure surface along with the minimum factor of safety. Factor of safety is defined as the ratio of forces resisting movement (generally the shear strength value along the assumed failure surface) to forces acting on the slope, generally gravity and applied vehicular loads. Results of the global stability analyses are summarized in Table 33.

Table 33: Global Stability-Proposed Spill-Through Slopes

Case	Calculated Factor of Safety	Minimum Required Factor of Safety	Capacity to Demand Ratio
Effective Stress	1.5	1.5	1.0
Total Stress	1.7	1.5	0.9

The results from the global stability analysis indicated that the proposed abutment spill through slopes exhibit factor of safety values equal to or above the minimum required factor of safety values.

Based on the analyses, it is our opinion that the proposed abutment spill-through slopes are considered safe against overall (global) stability when constructed at a slope rate of 2 horizontal to 1 vertical.

G. MEG-00033-03570- Ramp O over Tributary to Shade River

According to the Stage 2 plans, the proposed culvert will be a 96-foot long 20'x8' Conduit, Type A. According to the Stage 2 plans, the foundations were designed using the following assumed soil parameters:

Backfill
Internal Angle of Friction = 30 degrees
Total Unit Weight of Soil = 120 pcf

Foundation
Internal Angle of Friction (Drained) = 28 degrees
Undrained Shear Strength (Cohesive) = 1,500 psf

According to the Stage 2 plans, the bottom of headwall foundations will be constructed at elevation 657.1 at the inlet, and elevation 656.3 at the outlet. It is understood that a cushion of granular bedding material will be placed immediately below the bottom of the proposed culvert.

In general, stiff cohesive soils or medium dense granular soils were encountered at elevations corresponding to the bottom of the proposed culvert or headwall/wingwall foundations.

The soils encountered in the test borings at elevations corresponding to the bottom of the proposed culvert or headwall/wingwall foundations exhibited an average standard penetration N_{60} value of 14 bpf in cohesive soils, and 13 bpf granular soils. The cohesive soils exhibit an undrained shear strength value of 1,750 psf (ODOT GDM 404.1). The granular soils exhibit a drained internal angle of friction value of 32 degrees (ODOT GDM 404.2). Since the foundation soils in the test borings exhibit strength values in excess of the assumed soil parameters used in the design, the existing soils are considered suitable to support the proposed culvert and headwall/wingwall foundations.

Backfill adjacent to the culvert should meet the assumed soil parameters provided above.

Groundwater was encountered during the field work at depths ranging from 4.0 to 6.0 feet below existing grade. These depths correspond to elevations ranging from 656.7 to 659.8 feet. Therefore, groundwater and/or surface water should be expected during culvert installation. Surface water flows should be diverted and the groundwater level will need to be temporarily lowered during construction.

H. Seismic Site Class

The seismic site class values provided in Table 34 may be used for the design of the bridges.

Table 34: Seismic Site Class

Structure	Site Class	Comments
ATH-00021-02.072	C	None
ATH-C0016-05.908	C/D	RA & Pier - Site Class "C" FA- Site Class "D"
ATH-00033-23250R	C/D	RA, Pier 1, 3 and FA- Site Class "C" Pier 2, Pier 4- Site Class "D"
ATH-00033-24250R	C	None
ATH-00033-24950	C	None
MEG-00033-01510R	C/D	RA, Pier 1 &2 -Site Class "C" Pier 3 & FA- Site Class "D"
MEG-00033-03570	C	None

VI. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL should be notified so that our recommendations can be modified, if required.

VII. TESTING AND OBSERVATION

During the design process, it is recommended that CTL work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report. It is recommended that CTL be retained to provide construction quality control services on

this project. If CTL is not retained for these services, CTL shall assume no responsibility for compliance with the design concepts or recommendations provided.

VIII. CLOSING

The report was prepared by CTL Engineering, Inc. (Consultant) solely for the use of Client in accordance with an executed contract. The Client's use of or reliance on this report is limited by the terms and conditions of the contract and by the qualifications and limitations stated in the report. It is also acknowledged that the Client's use of and reliance of this report is limited for reasons which include: actual site conditions that may change with time; hidden conditions, not discoverable within the scope of the assessment, may exist at the site; and the scope of the investigation may have been limited by time, budget and other constraints imposed by the Client.

Neither the report, nor its contents, conclusions or recommendations, are intended for the use of any party other than the Client. Consultant and the Client assume no liability for any reliance placed on this report by such party. The rights of the Client under contract may not be assigned to any person or entity, without the consent of the Consultant which consent shall not be unreasonably withheld. This geotechnical report does not address the environmental conditions of the site. The Consultant is not responsible for consequences or conditions arising from facts that were concealed, withheld, or not fully disclosed at the time the assessment was conducted.

To the fullest extent permitted by law, the Consultant and Client agree to indemnify and hold each other, and their officers and employees harmless from and against claims, damages, losses and expenses arising out of unknown or concealed conditions. Furthermore, neither the Consultant nor its employees shall be liable to the Owner in an amount in excess of the available professional liability insurance coverage of the Consultant. In addition, Client and Consultant agree neither shall be liable for any special, indirect or consequential damages of any kind or nature.

The Consultant's services have been provided consistent with its professional standard of care. No other warranties are made, either expressed or implied.

Respectfully Submitted,

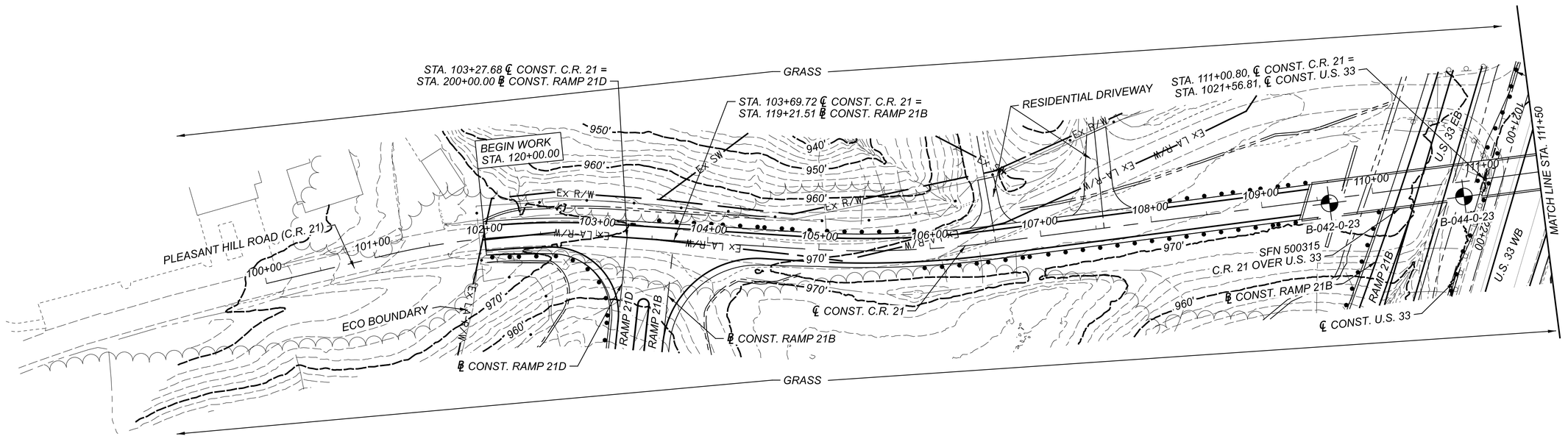
CTL ENGINEERING, INC.

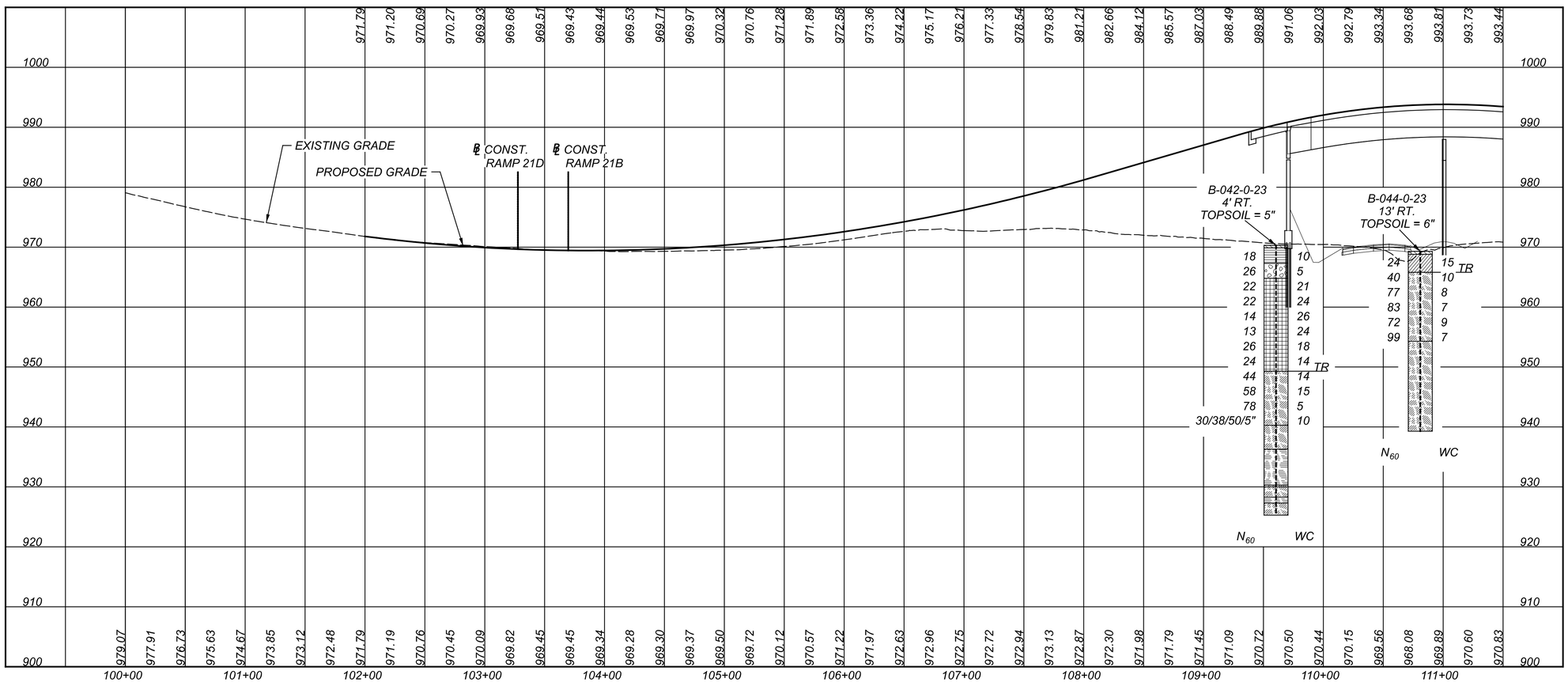
Sastry Malladi, P.E
Project Engineer

Joe Grani, P.E.
Project Engineer

APPENDIX A

GEOTECHNICAL PROFILE - STRUCTURE





HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 100+00.00 TO STA. 111+50.00 C.R. 21 (PLEASANT HILL ROAD)

DESIGN AGENCY

GTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119141
SUBSET	18
TOTAL	81
SHEET	P.
TOTAL	-

ATH-33-18.70

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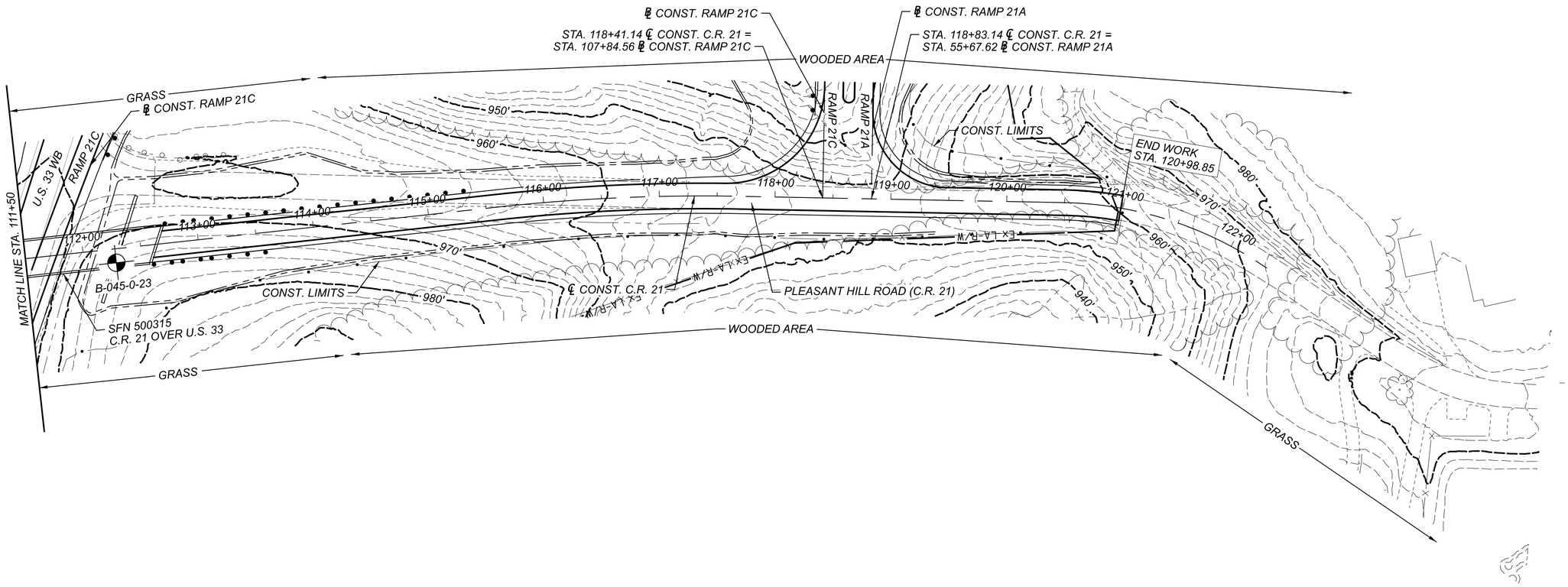

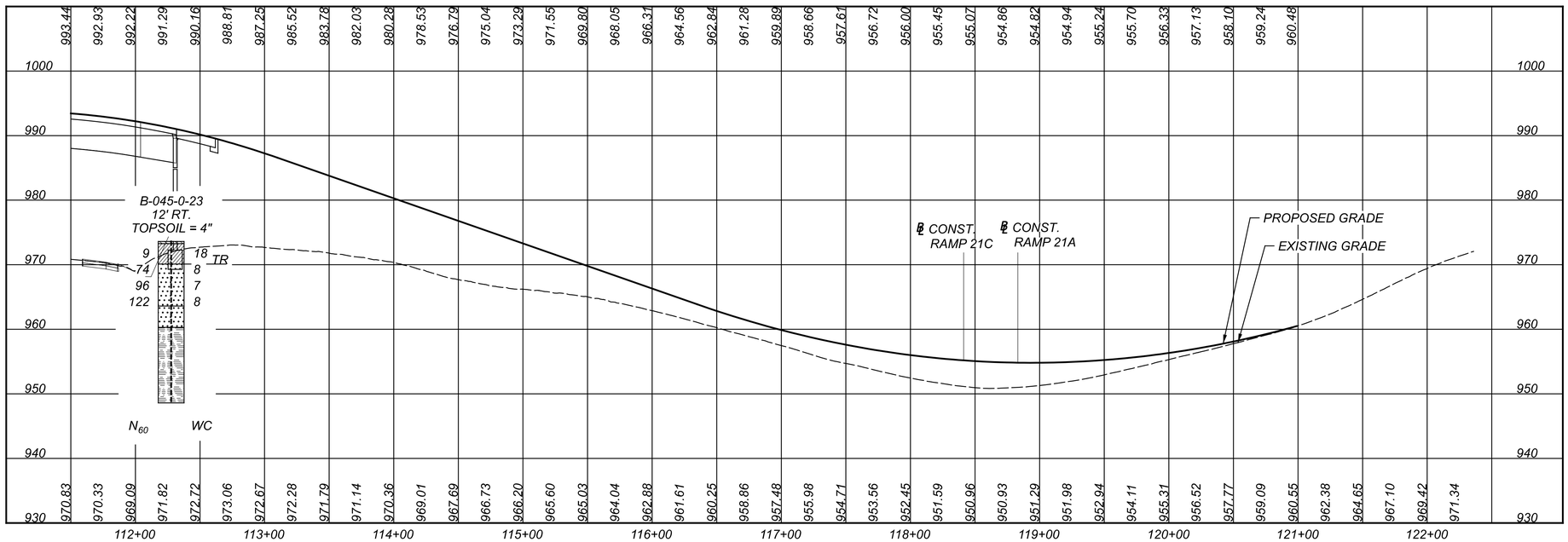

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 111+50.00 TO STA. 120+98.85 C.R. 21 (PLEASANT HILL ROAD)

PATH-US 33-18.70

MODEL: CLP_C021 - Plan 5 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 20:49:27 USER: hp
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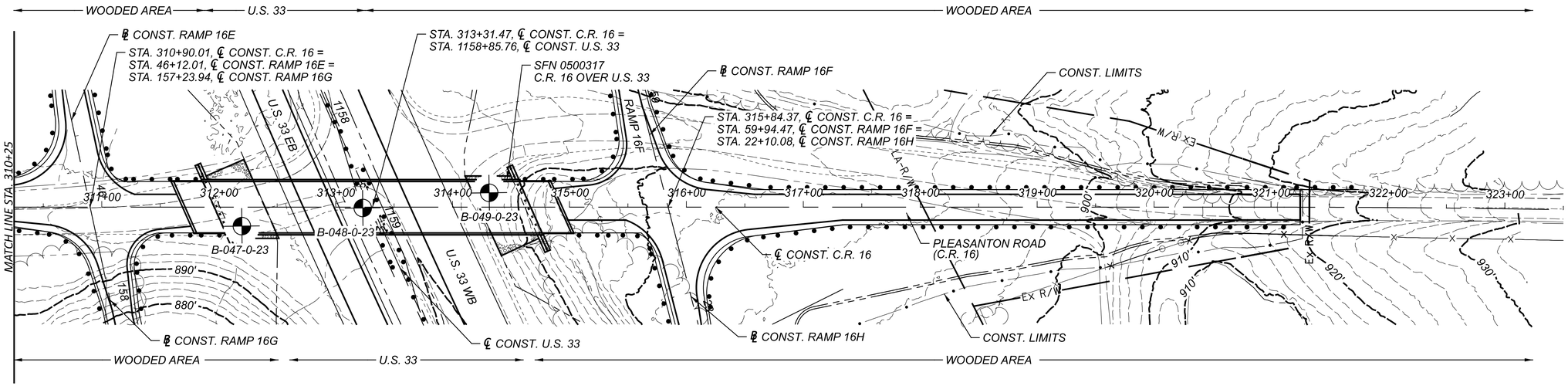
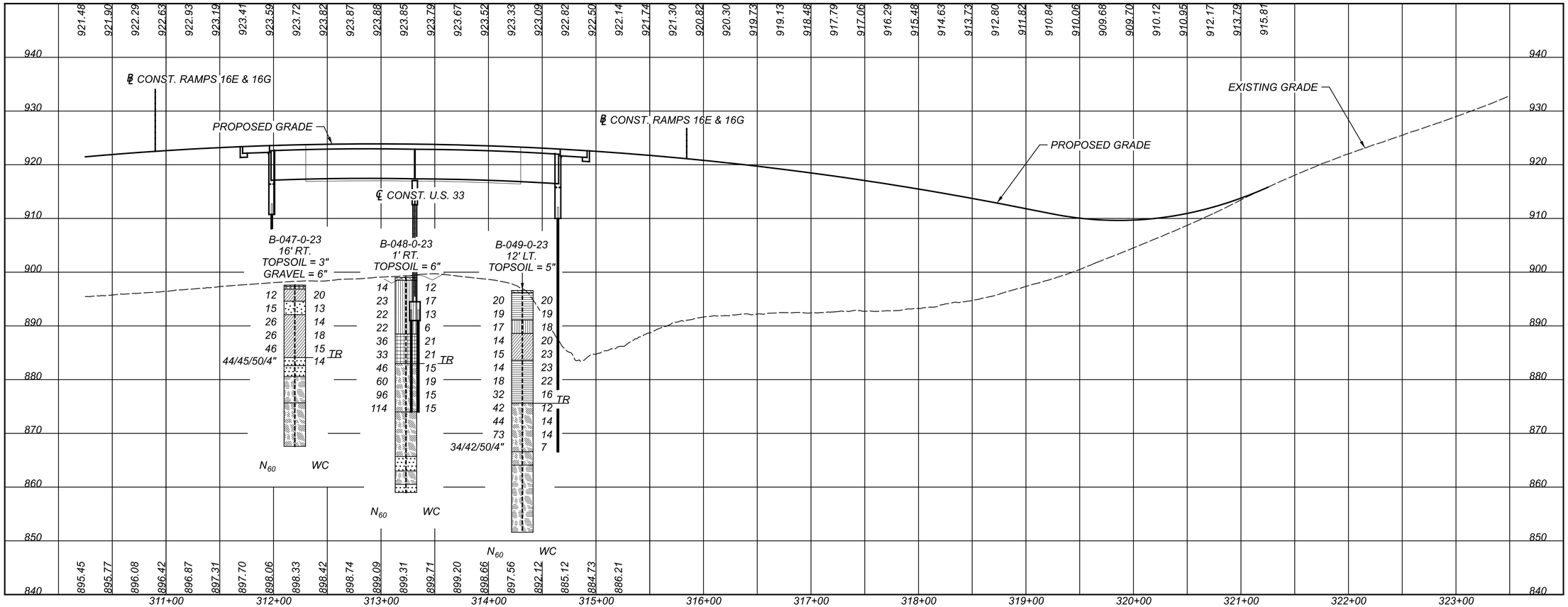
DESIGN AGENCY

ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119141
SUBSET	19
TOTAL	81
SHEET	P.
TOTAL	-





HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 310+25.00 TO STA. 323+50.00 C.R. 16 (PLEASANTON ROAD)

DESIGN AGENCY
GTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119141
SUBSET / TOTAL	23 / 81
SHEET / TOTAL	P. / -

PATH-US 33-18.70

MODEL: CLP_C016 - Plan 5 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 20:56:51 USER: hp
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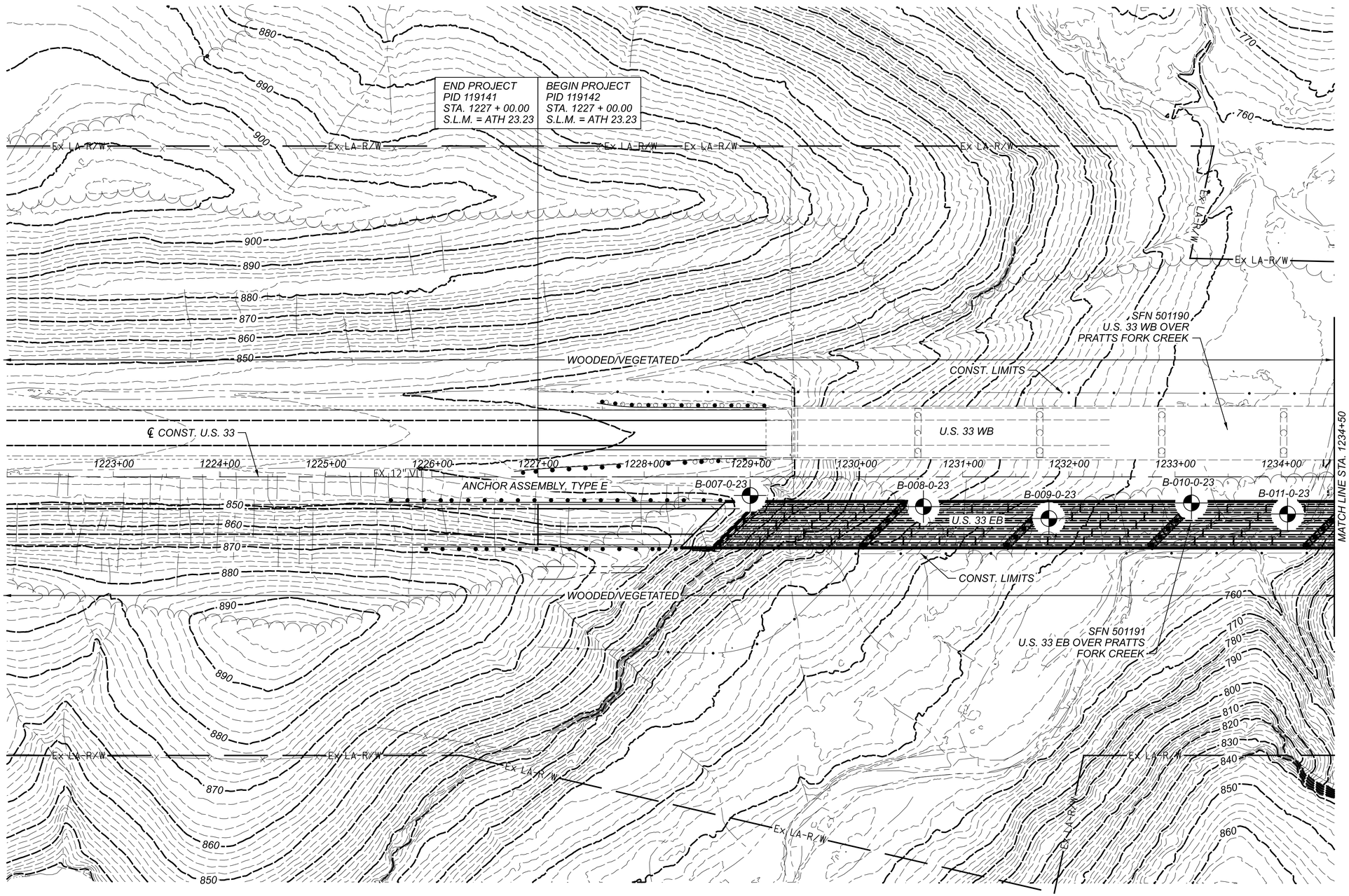

NOTE:

SEE SHEET 11 OF 172 FOR BORINGS B-007-0-23, B-008-0-23, B-009-0-23, B-010-0-23 AND B-011-0-23 SOIL PROFILES.

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1227+00.00 TO STA. 1234+50.00 (US 33)

DESIGN AGENCY

GTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET / TOTAL	10 / 172
SHEET / TOTAL	P. / -

ATH/MEG-33-23.23/0.00

MODEL: CLP_U033 - Plan 1 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 19:48:17 USER: hp
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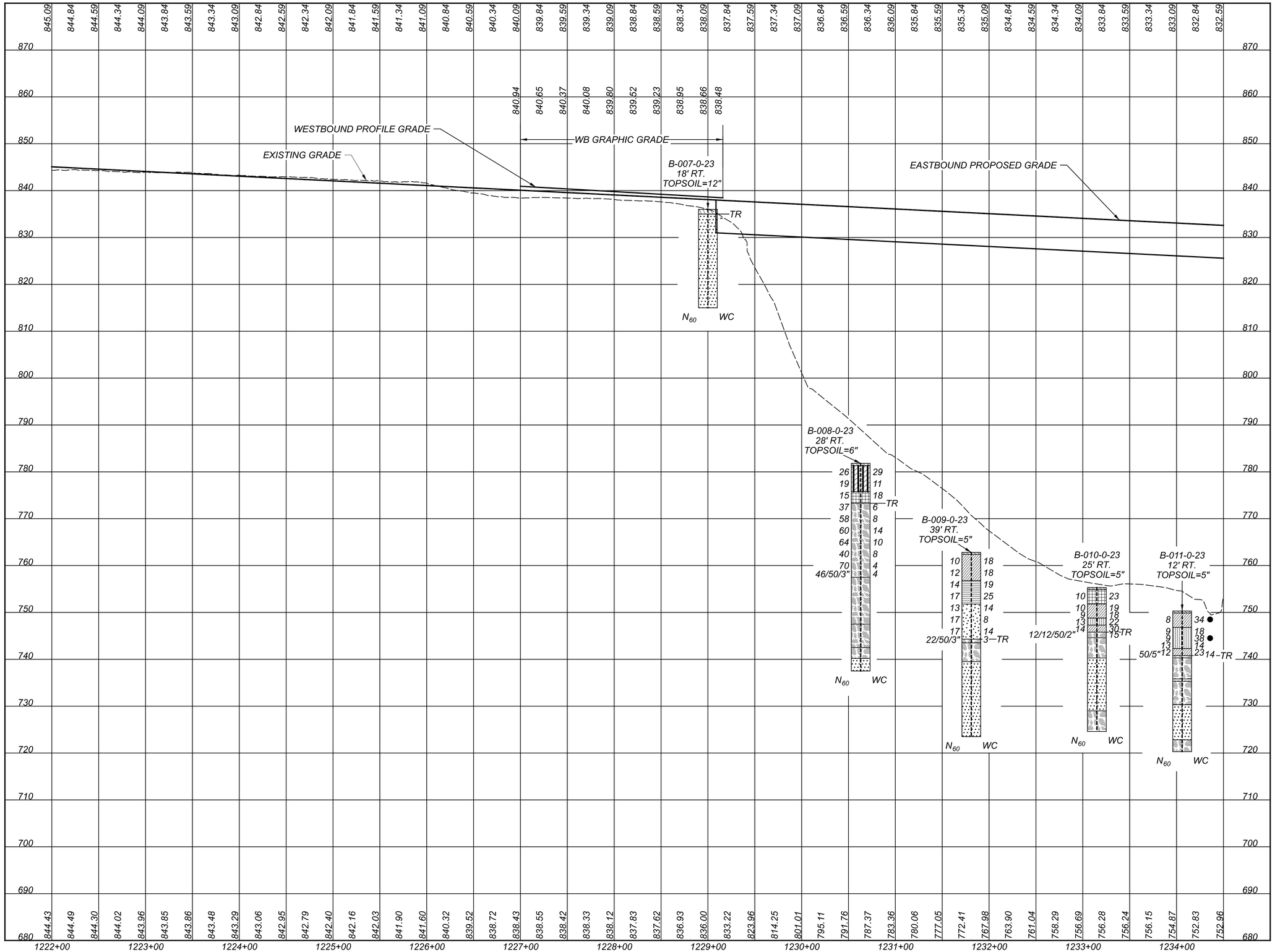

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1227+00.00 TO STA. 1234+50.00 (US 33)

'ATH/MEG-33-23.23/0.00

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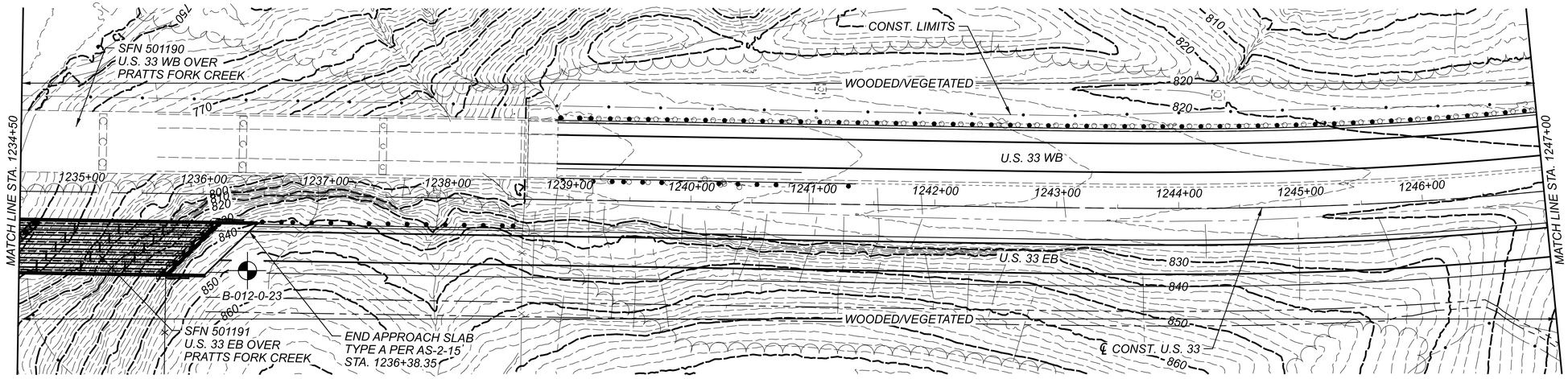
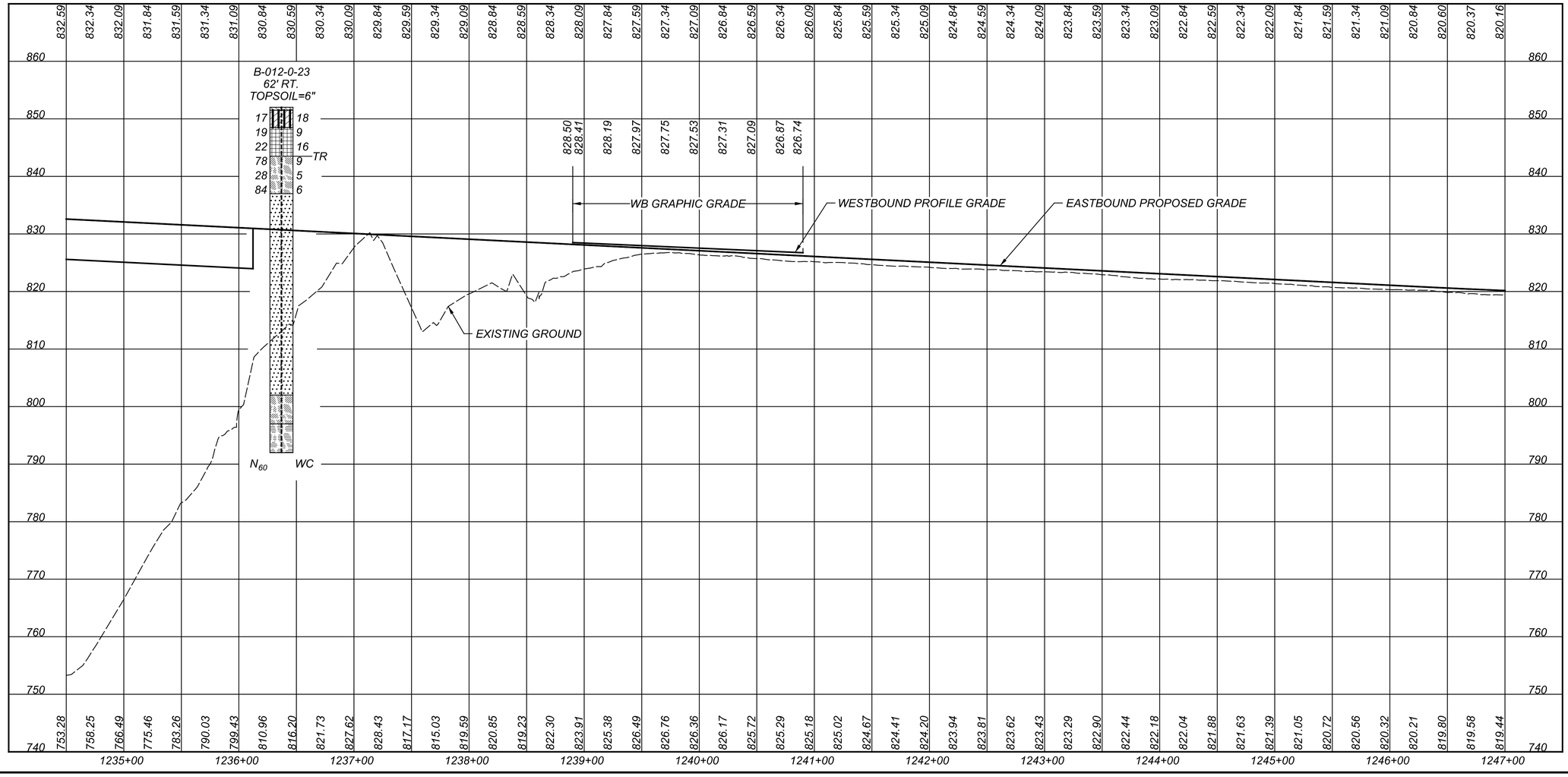
DESIGN AGENCY

GTL ENGINEERING INC
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET	11
TOTAL	172
SHEET	P.
TOTAL	-





HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1234+50.00 TO STA. 1247+00.00 (US 33)

DESIGN AGENCY

GTL ENGINEERING LLC
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-8377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET	12
TOTAL	172
SHEET	P.
TOTAL	-

ATH/MEG-33-23.23/0.00

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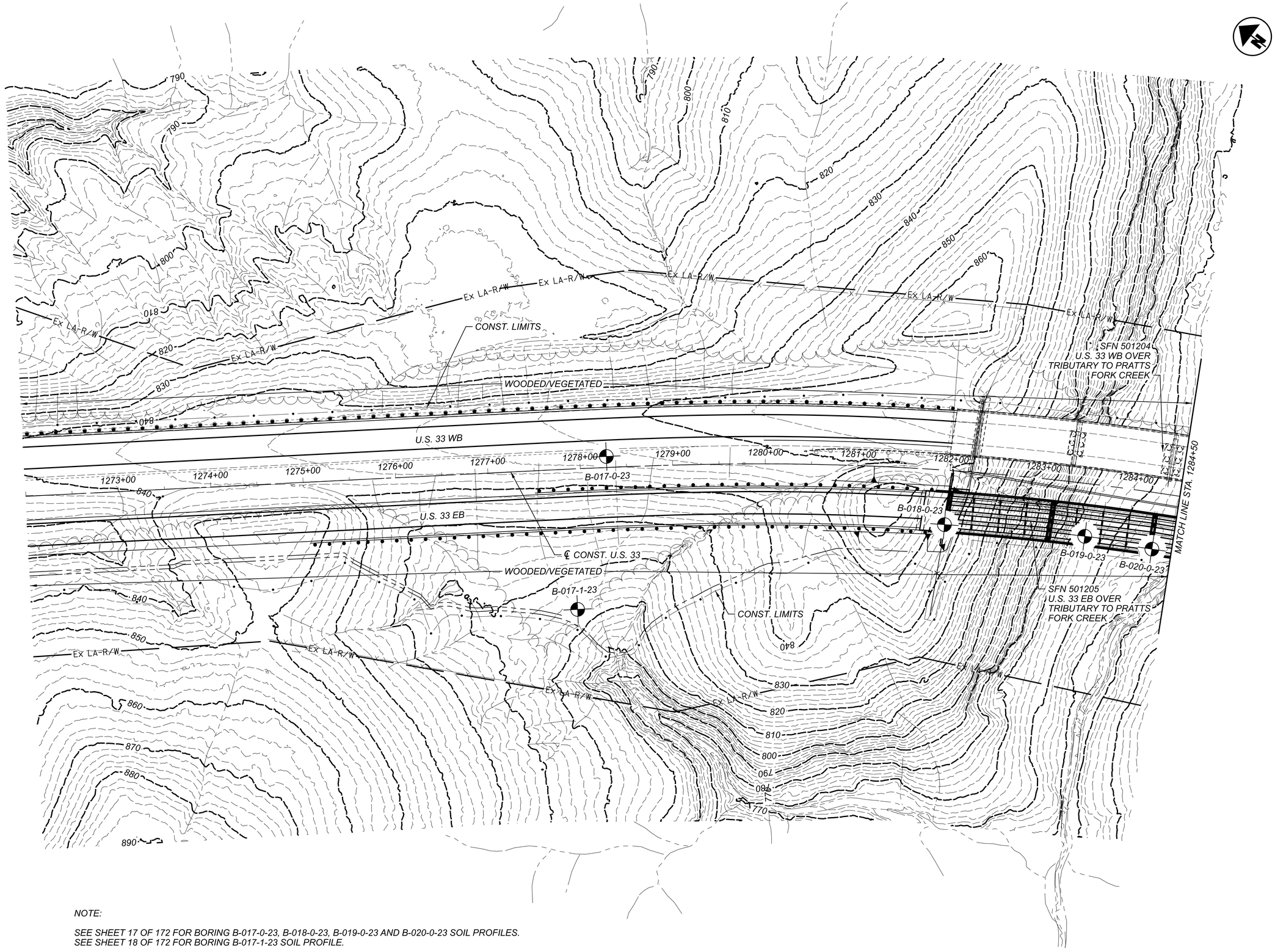

NOTE:

SEE SHEET 17 OF 172 FOR BORING B-017-0-23, B-018-0-23, B-019-0-23 AND B-020-0-23 SOIL PROFILES.
SEE SHEET 18 OF 172 FOR BORING B-017-1-23 SOIL PROFILE.

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1272+00.00 TO STA. 1284+50.00 (US 33)

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER N.K.S
REVIEWER SM 10-04-24
PROJECT ID 119142
SUBSET 16 TOTAL 172
SHEET P. TOTAL -

PATH/MEG-33-23.23/0.00
MODEL: CLP_U033 - Plan 5 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 20:25:57 USER: hp
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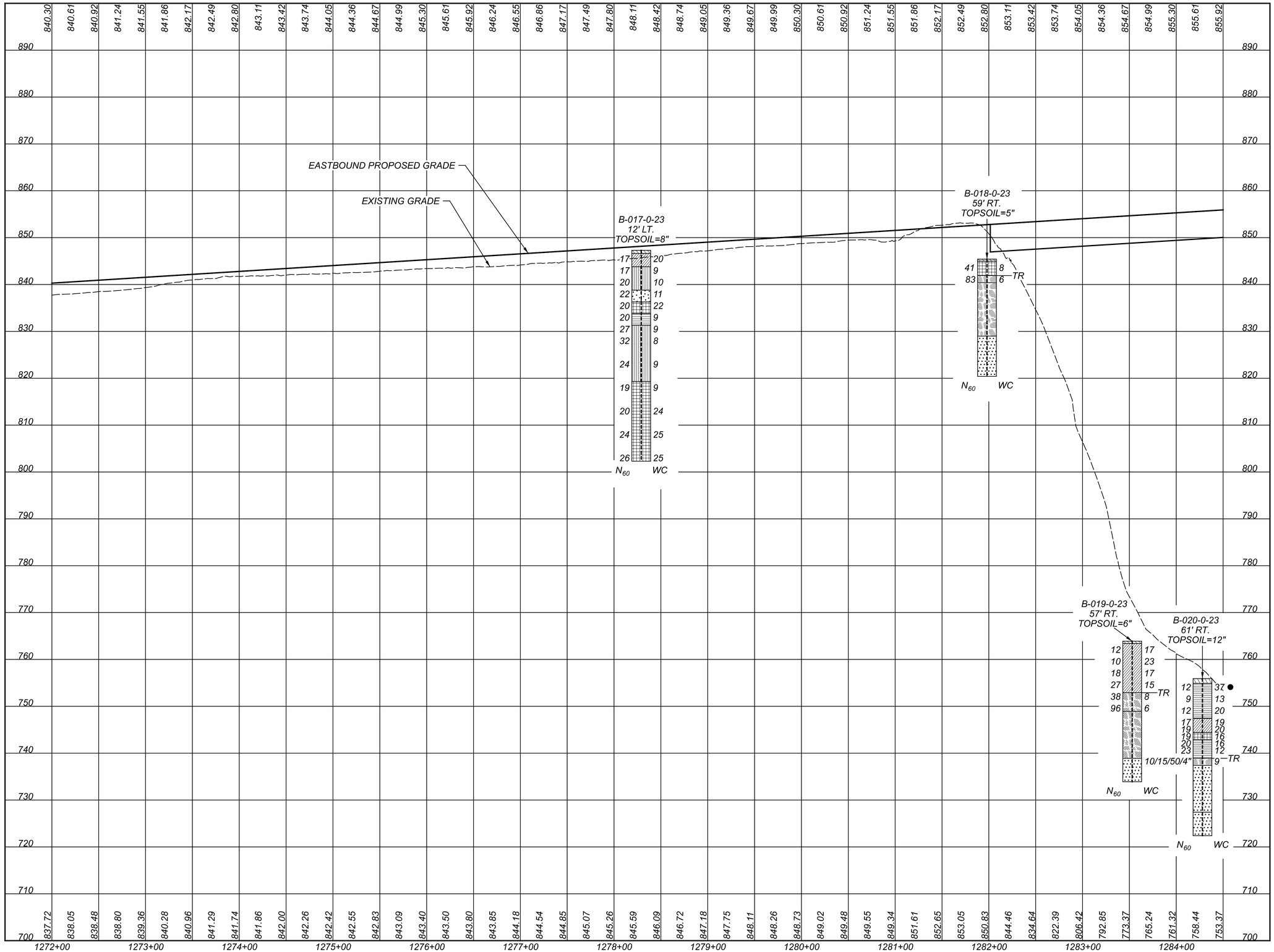

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1272+00.00 TO STA. 1284+50.00 (US 33)

DESIGN AGENCY

GTL ENGINEERING LLC
2960 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-8377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET	17
TOTAL	172
SHEET	P.
TOTAL	-

ATH/MEG-33-23.23/0.00

MODEL: CLP_U033_Final - Profile 5 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 22:06:19 USER: hp
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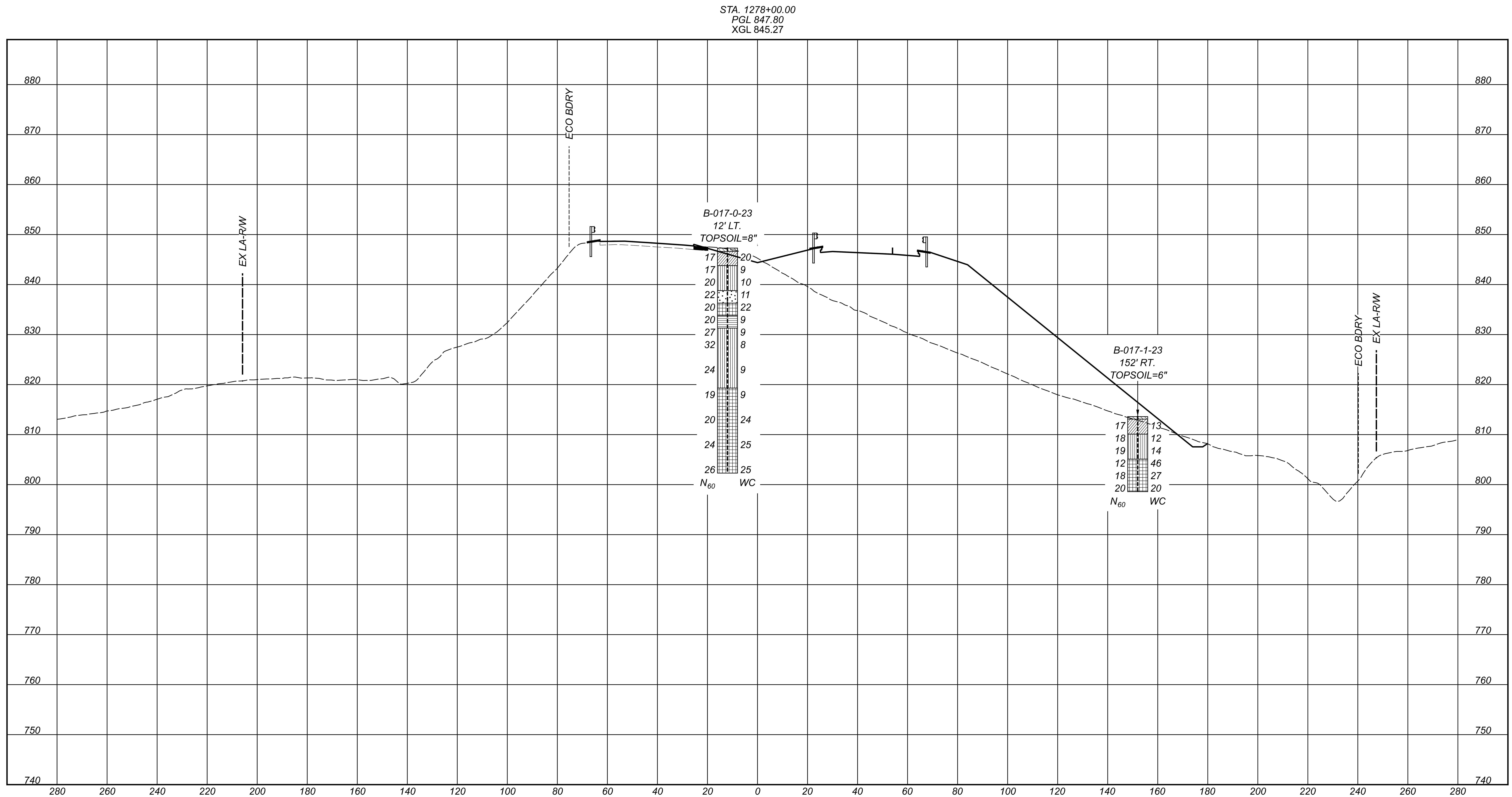

HORIZONTAL SCALE IN FEET
0 10 20 40

GEOTECHNICAL PROFILE - ROADWAY CROSS SECTION STA. 1278+00.00

DESIGN AGENCY

CTL ENGINEERING INC.
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER
N.K.S

REVIEWER
SM 10-04-24

PROJECT ID
119142

SUBSET 18 TOTAL 172

SHEET P. TOTAL -

ATH/MEG-33-23.23/0.00

MODEL: CLP_U033 - 1278+00.00 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 22:08:17 USER: hp
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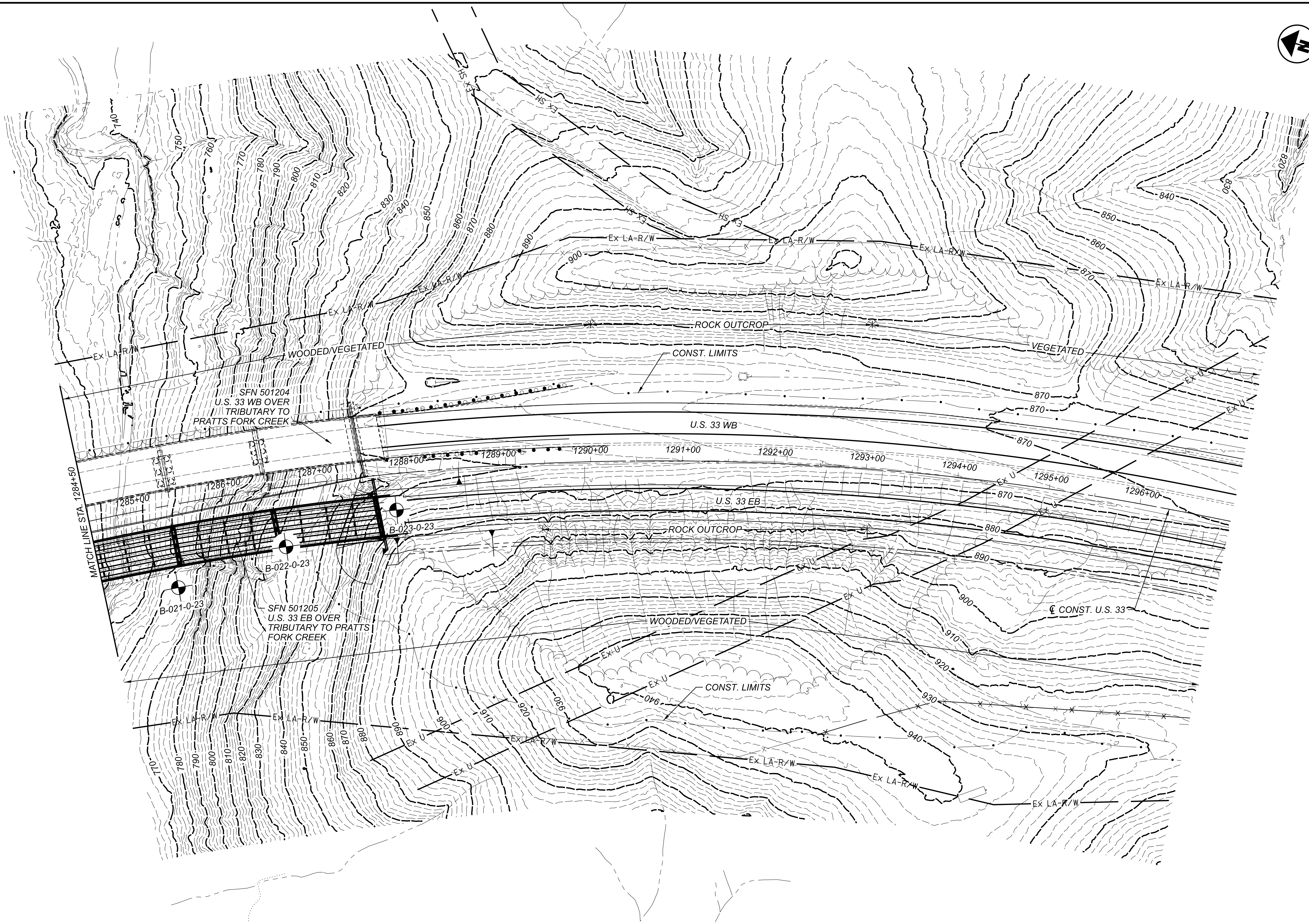

NOTE:

SEE SHEET 20 OF 172 FOR BORING B-021-0-23, B-022-0-23 AND B-023-0-23 SOIL PROFILES.

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1284+50.00 TO STA. 1297+00.00 (US 33)

DESIGN AGENCY

CTL ENGINEERING INC

2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER N.K.S

REVIEWER SM 10-04-24

PROJECT ID 119142

SUBSET	TOTAL
19	172

SHEET	TOTAL
P.	-

ATH/MEG-33-23.23/0.00

MODEL: CLP_U033 - Plan 6 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 22:00:48 USER: hp
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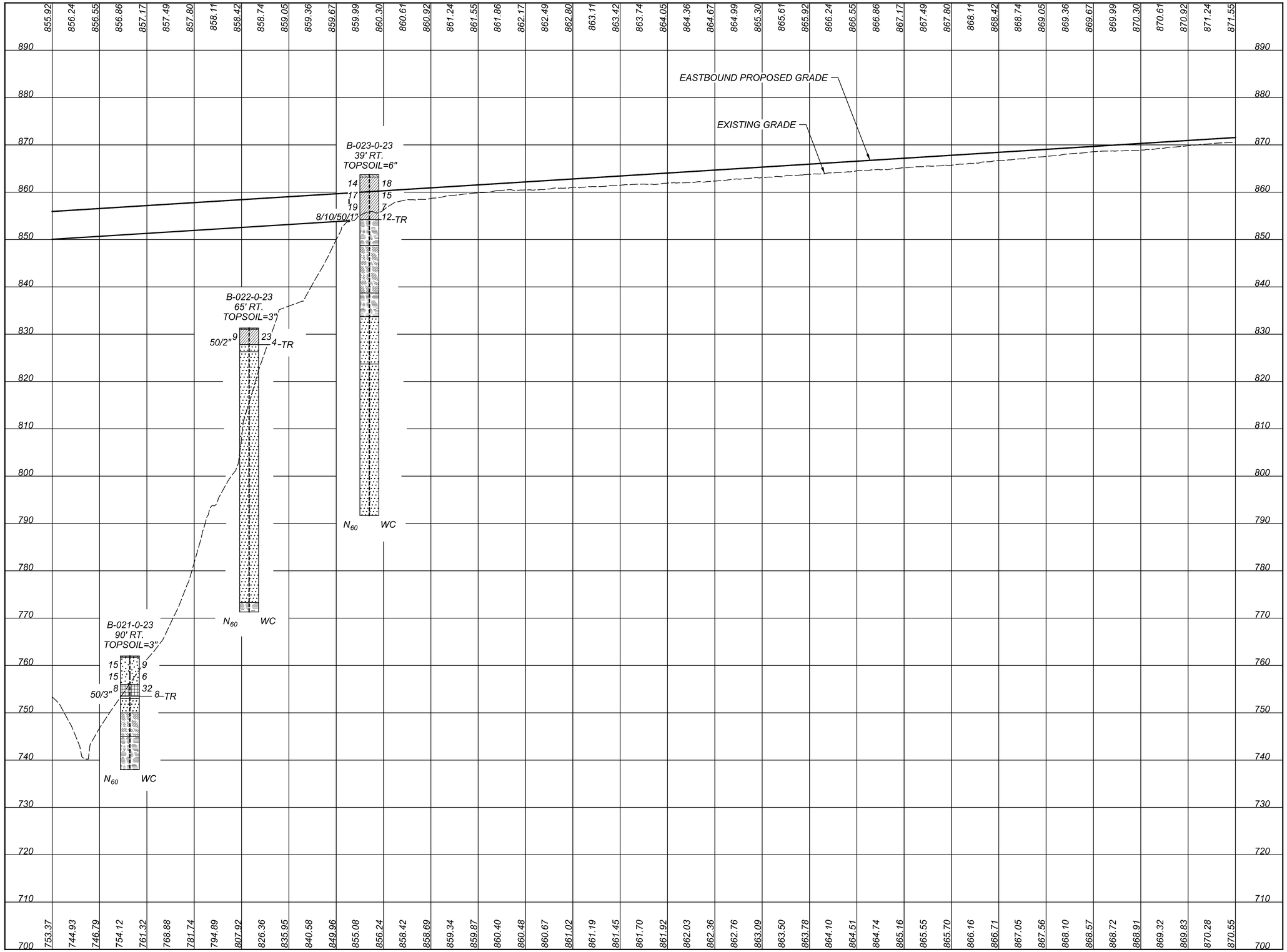

HORIZONTAL
SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1284+50.00 TO STA. 1297+00.00 (US 33)

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET	20
TOTAL	172
SHEET	P.
TOTAL	-

ATH/MEG-33-23.23/0.00

MODEL: CLP_U033_Final - Profile 6 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 22:13:15 USER: hp
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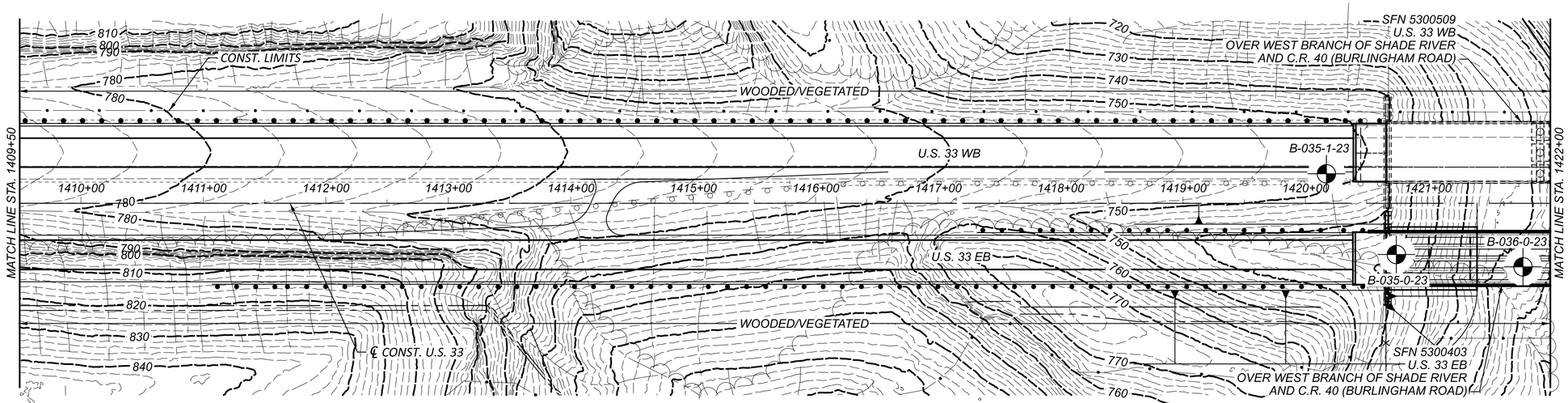

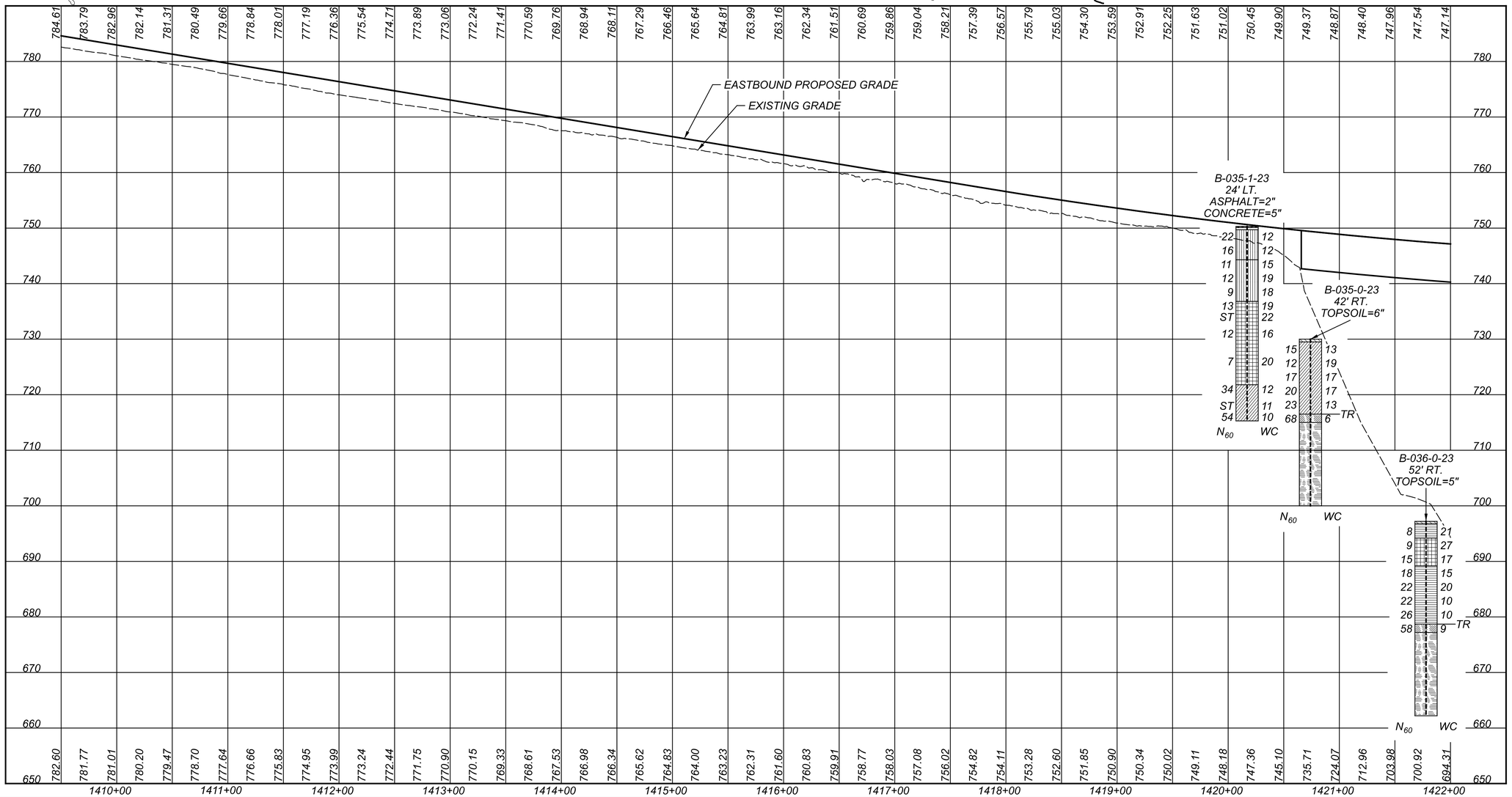

HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1409+50.00 TO STA. 1422+00.00 (US 33)

DESIGN AGENCY
GTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET / TOTAL	31 / 172
SHEET / TOTAL	P. / -

PATH/MEG-33-23.23/0.00

MODEL: CLP_U033 - Plan 16 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 23:24:42 USER: hp
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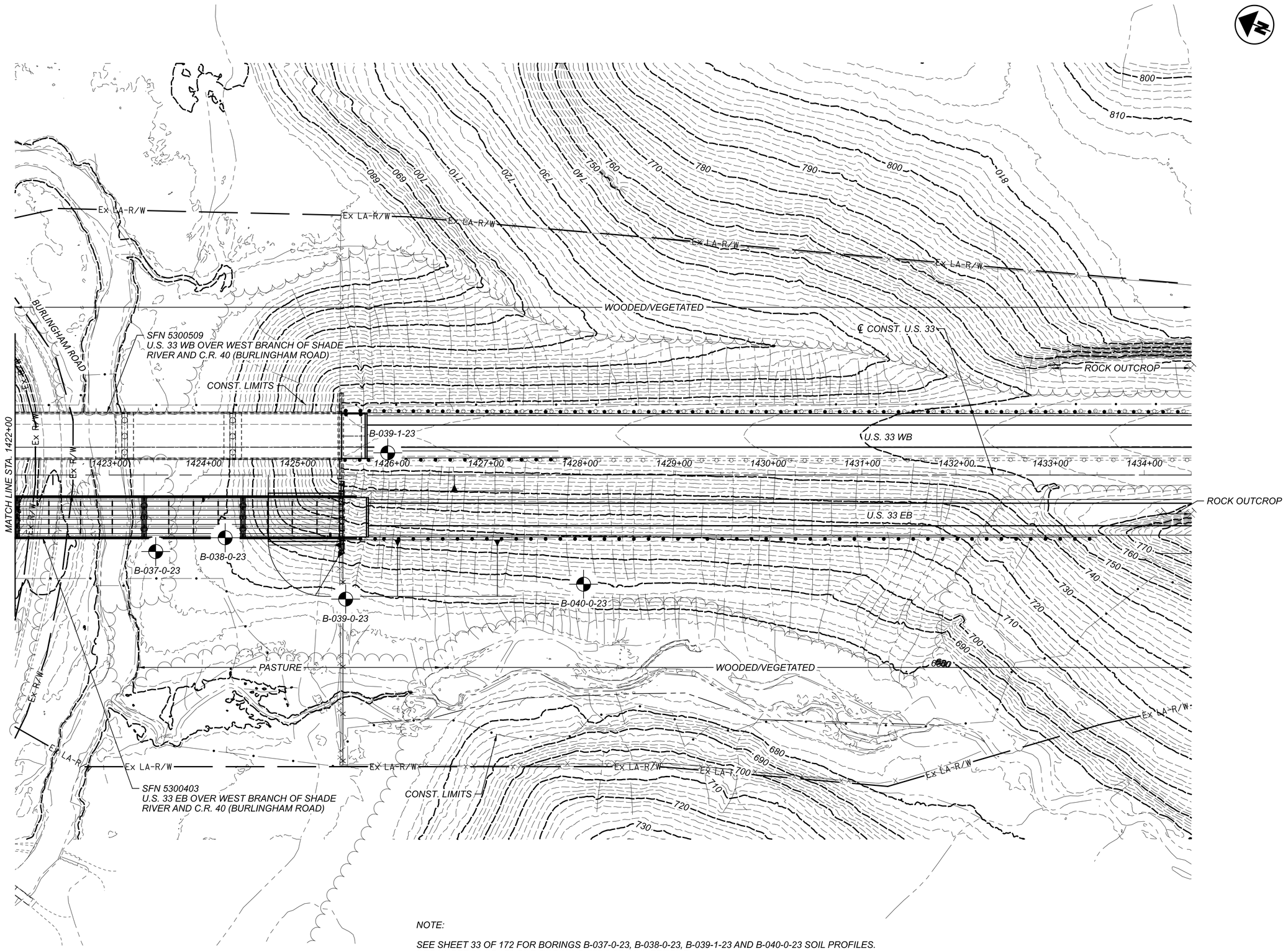
GEOTECHNICAL PROFILE - ROADWAY
STA. 1422+00.00 TO STA. 1434+50.00 (US 33)

HORIZONTAL SCALE IN FEET
0 25 50 100



NOTE:

SEE SHEET 33 OF 172 FOR BORINGS B-037-0-23, B-038-0-23, B-039-1-23 AND B-040-0-23 SOIL PROFILES.
SEE SHEET 34 OF 172 FOR BORING B-039-0-23 SOIL PROFILE.

DESIGN AGENCY

CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-8377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET	32
TOTAL	172
SHEET	P.
TOTAL	-

ATH/MEG-33-23.23/0.00

MODEL: CLP_U033 - Plan 17 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 23:41:02 USER: hp
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PATH/MEG-33-23.23/0.00

MODEL: CLP_U033_Final - Profile 17 PAPERSIZE: 34x22 (in.) DATE: 04-10-2024 TIME: 23:44:41 USER: hp
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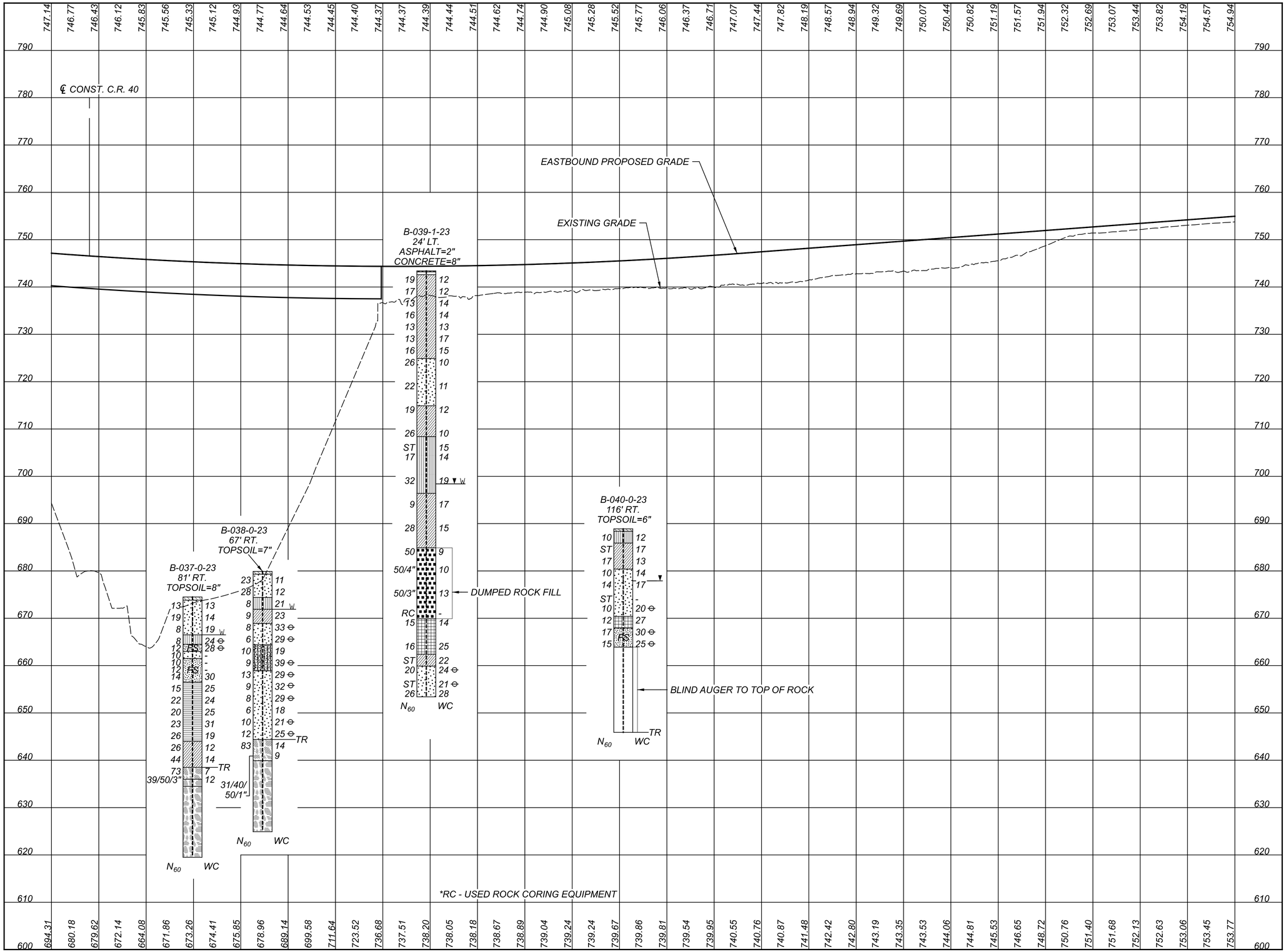
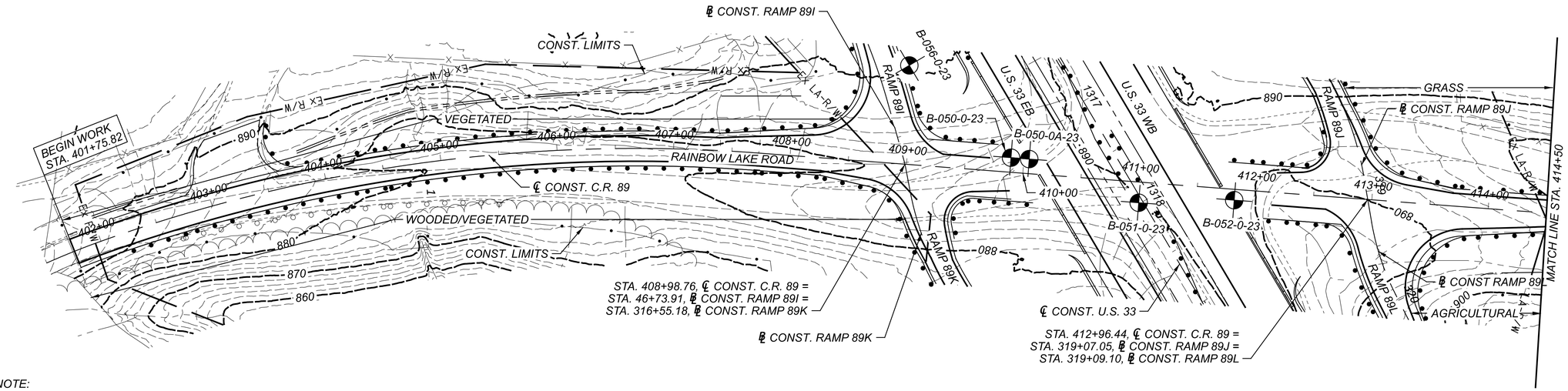


HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 1422+00.00 TO STA. 1434+50.00 (US 33)

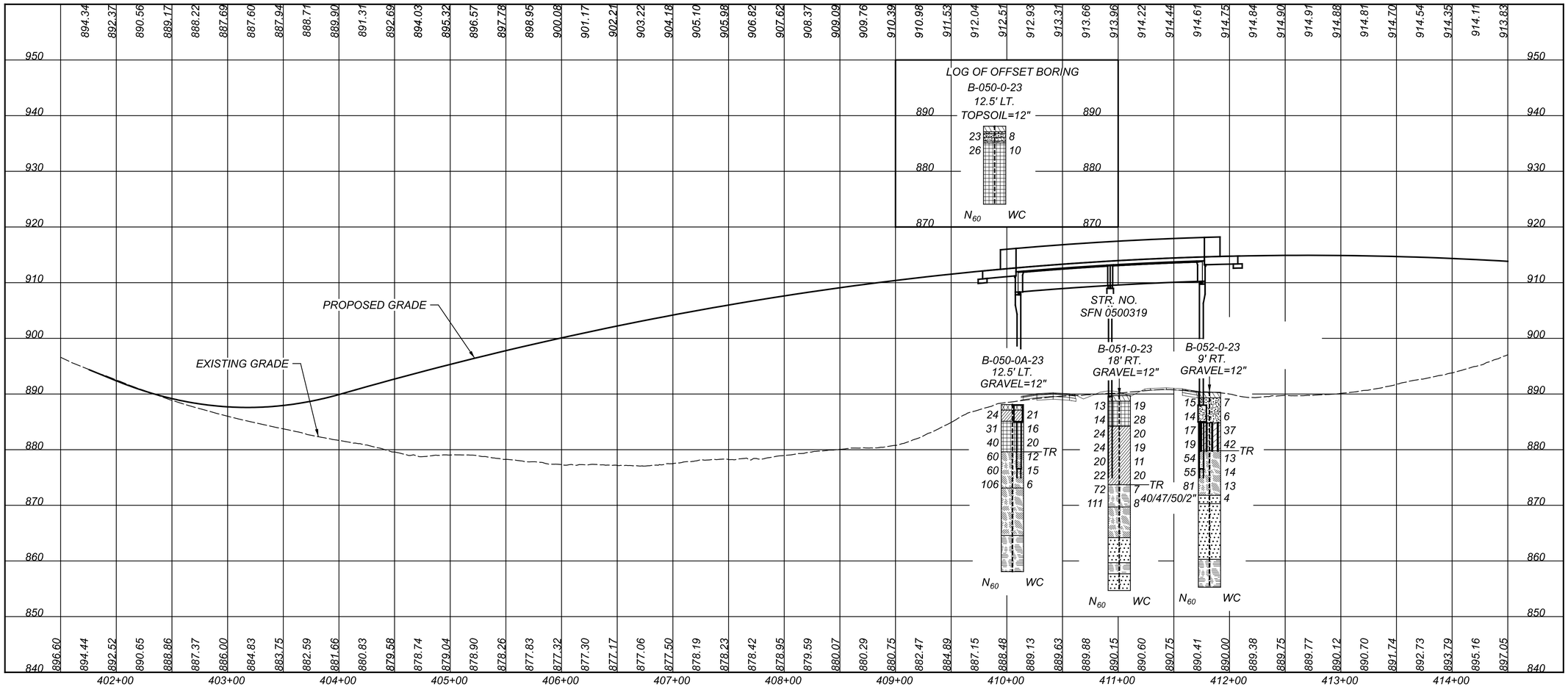
DESIGN AGENCY
GTL ENGINEERING
2960 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 10-04-24
PROJECT ID	119142
SUBSET	33
TOTAL	172
SHEET	P.
TOTAL	-



NOTE:

SEE SHEET 40 OF 172 FOR BORING B-056-0-23 SOIL PROFILE.



HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - ROADWAY
STA. 401+75.82 TO STA. 414+50.00 C.R.89 (RAINBOW LAKE ROAD)

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX:(614)276-6377

DESIGNER N.K.S
REVIEWER SM 10-04-24
PROJECT ID 119142
SUBSET 37 TOTAL 172
SHEET P. TOTAL -

PATH/MEG-33-23.23/0.00

MODEL: CLP_C089 - Plan 2 PAPERSIZE: 34x22 (in.) DATE: 05-10-2024 TIME: 00:07:12 USER: hp
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MODEL: BLP_R6810 - Plan 2 PAPERSIZE: 34x22 (in.) DATE: 05-10-2024 TIME: 00:45:54 USER: hp
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GEOTECHNICAL PROFILE - ROADWAY
STA. 126+01.32 TO STA. 139+87.30 RAMP 681 O

HORIZONTAL SCALE IN FEET
0 50
25 100

DESIGN AGENCY
CTL ENGINEERING, INC.
COLUMBUS, OHIO 43204
PHONE (614) 276-8123
FAX (614) 276-6073

DESIGNER N.K.S
REVIEWER SM 10-04-24
PROJECT ID 119142
SUBSET 46 TOTAL 172
SHEET P. - TOTAL

ATH/MEG-33-23.23/0.00

MODEL: PGL_BLP_R6810 - Profile 1 PAPERSIZE: 34x22 (in.) DATE: 05-10-2024 TIME: 00:49:01 USER: hp
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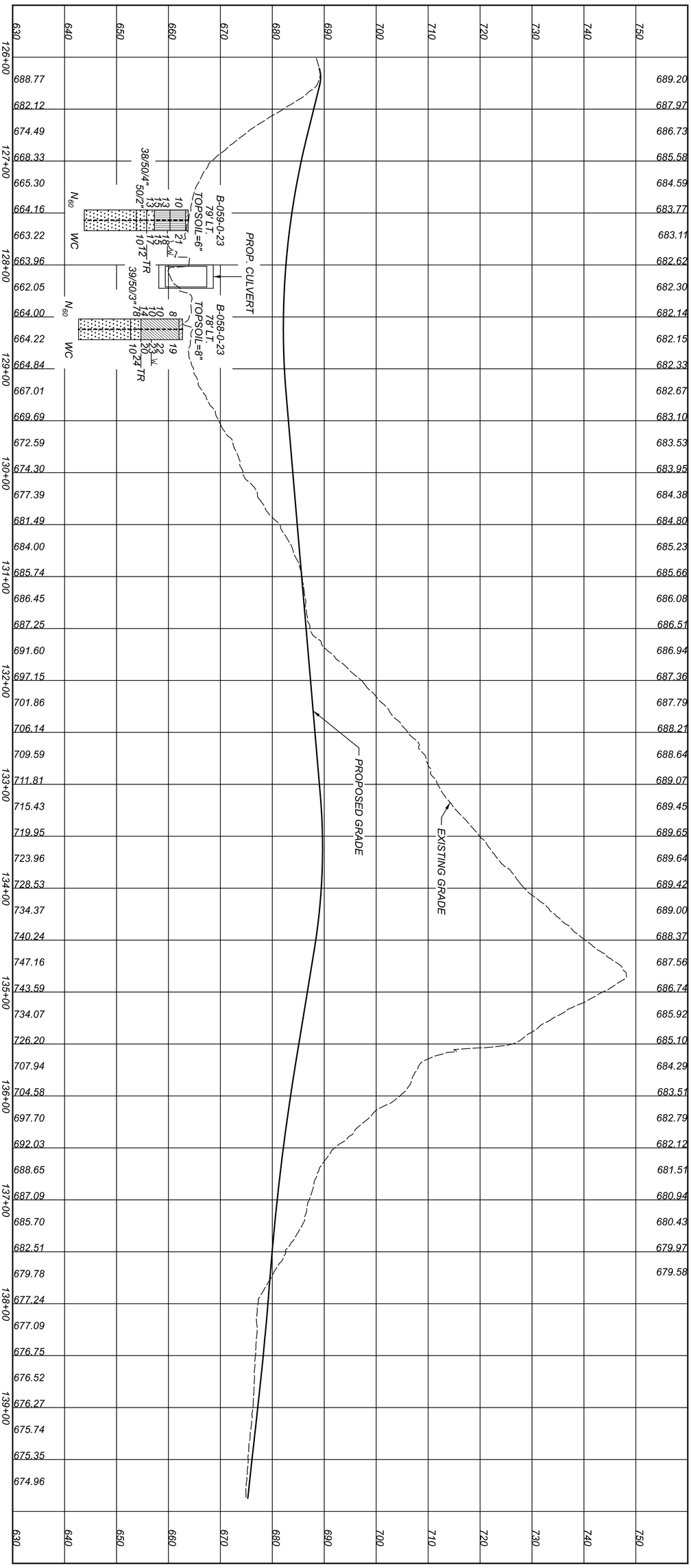


SHEET	SUBSET	PROJECT ID	DESIGNER	REVIEWER	DESIGN AGENCY
P. - TOTAL -	47 TOTAL 172	119142	N.K.S	SM 10-04-24	GTL ENGINEERING LLC COLUMBUS, OHIO 43204 PHONE:614.276.8123 FAX:614.276.6373

GEOTECHNICAL PROFILE - ROADWAY
STA. 126+01.32 TO STA. 139+87.30 RAMP 681 O

HORIZONTAL SCALE IN FEET
0 50
25 100

APPENDIX B

TEST BORING RECORDS

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1229+00, 18' RT.	EXPLORATION ID B-007-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 836.0 (MSL) EOB: 21.0 ft.	PAGE 1 OF 1
START: 11/8/23 END: 11/8/23	SAMPLING METHOD: NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.220771, -82.065568	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (12")	836.0						-	-	-	-	-	-	-	-	-	-		
	835.0	TR																
@1.0'; AUGER REFUSAL ENCOUNTERED		1																
SANDSTONE, BROWN AND GRAY, SLIGHTLY WEATHERED, WEAK TO SLIGHTLY STRONG; RQD 84%, REC 100%.		2																
@1.0'-6.0'; SLAKE DURABILITY INDEX = 83%		3	77		100	NQ2-1											CORE	
		4																
		5																
		6																
		7																
		8	83		100	NQ2-2											CORE	
		9																
		10																
		11																
		12																
@12.4'-12.9'; UCS = 1,360 PSI		13	88		100	NQ2-3											CORE	
		14																
		15																
		16																
@16.0'-16.5'; UCS = 2,040 PSI		17																
		18	88		100	NQ2-4											CORE	
		19																
		20																
	815.0	EOB 21																

NOTES: CAVED AT 20'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1230+63, 28' RT.	EXPLORATION ID B-008-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 781.8 (MSL) EOB: 44.3 ft.	PAGE 1 OF 2
START: 11/8/23 END: 11/8/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.220324, -82.065508	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	781.8																	
HARD, BROWN, **ELASTIC CLAY**, SOME SILT, LITTLE SAND, CONTAINS ROCK FRAGMENTS, DAMP	781.3	1	8 9 11	26	100	SS-1	4.50	0	3	15	24	58	55	30	25	29	A-7-5 (17)	
		2																
		3																
		4	7 7 8	19	100	SS-2	4.50	-	-	-	-	-	-	-	-	11	A-7-5 (V)	
		5																
	775.8	6																
VERY STIFF, BROWN, **CLAY**, "AND" SILT, TRACE SAND, CONTAINS ROCK FRAGMENTS, DAMP		7	4 6 6	15	100	SS-3	3.50	0	2	2	51	45	44	28	16	18	A-7-6 (11)	
	773.3	8																
CLAYSTONE, RED AND BROWN, HIGHLY WEATHERED.		TR 9	12 12 17	37	100	SS-4	-	-	-	-	-	-	-	-	-	6	Rock (V)	
		10																
		11																
		12	18 21 24	58	100	SS-5	-	-	-	-	-	-	-	-	-	8	Rock (V)	
		13																
		14	20 22 25	60	100	SS-6	-	-	-	-	-	-	-	-	-	14	Rock (V)	
		15																
		16																
		17	23 23 27	64	100	SS-7	-	-	-	-	-	-	-	-	-	10	Rock (V)	
		18																
		19	12 15 16	40	100	SS-8	-	-	-	-	-	-	-	-	-	8	Rock (V)	
		20																
		21																
		22	22 25 30	70	100	SS-9	-	-	-	-	-	-	-	-	-	4	Rock (V)	
		23																
	757.5	24	46 50/3"	-	100	SS-10	-	-	-	-	-	-	-	-	-	4	Rock (V)	
@24.3'; AUGER REFUSAL ENCOUNTERED		25																
CLAYSTONE, GRAY, MODERATELY WEATHERED, VERY WEAK TO WEAK; RQD 76%, REC 100%. @24.3'-29.3'; SLAKE DURABILITY INDEX = 3.6% @25.7'-26.2'; UCS = 100 PSI		26	80		100	NQ2-1											CORE	
		27																
		28																
		29																

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1230+63, 28' RT.	START: 11/8/23	END: 11/8/23	PG 2 OF 2	B-008-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
CLAYSTONE, GRAY, MODERATELY WEATHERED, VERY WEAK TO WEAK; RQD 76%, REC 100%. *(continued)* @31.5'-32.0'; UCS = 880 PSI	751.8	31 32 33 34	72		100	NQ2-2											CORE	
CLAYSTONE, GRAY, MODERATELY WEATHERED, SLIGHTLY STRONG, CONTAINS INTERBEDDED SHALE LAYERS; RQD 50%, REC 100%.	747.5	35 36 37 38 39	50		100	NQ2-3											CORE	
SHALE, GRAY, MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 69%, REC 100%.	742.5	40 41																
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 99%, REC 100%.	740.2	42 43	85		100	NQ2-4											CORE	
	737.5 EOB	44																

NOTES: CAVED AT 8'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1231+81, 39' RT.	EXPLORATION ID B-009-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 762.8 (MSL) EOB: 39.3 ft.	PAGE 1 OF 2
START: 11/7/23 END: 11/7/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.219999, -82.065481	

MATERIAL DESCRIPTION AND NOTES	ELEV. 762.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (5")	762.4																	
VERY STIFF, BROWN, **SILT AND CLAY**, "AND" SAND, DAMP		1	3 4 4	10	100	SS-1	3.50	0	8	28	30	34	32	21	11	18	A-6a (6)	
@3.5'; CONTAINS ROCK FRAGMENTS		2 3 4	4 4 5	12	100	SS-2	3.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
	756.8	5 6	5 5 6	14	100	SS-3	3.50	0	3	20	40	37	37	21	16	19	A-6b (10)	
VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, CONTAINS ROCK FRAGMENTS, DAMP		7 8																
@8.5'; MOIST		9 10	6 6 7	17	100	SS-4	2.75	-	-	-	-	-	-	-	-	25	A-6b (V)	
	751.8	11	5 5 5	13	100	SS-5	-	0	9	64	15	12	NP	NP	NP	14	A-3a (0)	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, LITTLE CLAY, DAMP		12 13																
@13.5'; GRAY		14 15	4 6 7	17	100	SS-6	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
@16.0'; TRACE GRAVEL		16 17	7 7 6	17	100	SS-7	-	1	15	54	16	14	NP	NP	NP	14	A-3a (0)	
	744.3	18																
SHALE, GRAY, HIGHLY WEATHERED.	743.5	TR 19	22 50/3"	-	67	SS-8	-	-	-	-	-	-	-	-	-	3	Rock (V)	
SHALE, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 83%, REC 100%. @19.3'-24.3'; SLAKE DURABILITY INDEX = 61.5%		20 21 22	87		100	NQ2-1											CORE	
	739.5	23 24																
SANDSTONE, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 92%, REC 100%. @23.3'-23.9'; UCS = 3,560 PSI		25 26																
@26.8'-27.3'; UCS = 2,910 PSI		27 28 29	100		100	NQ2-2											CORE	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1231+81, 39' RT.	START: 11/7/23	END: 11/7/23	PG 2 OF 2	B-009-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SANDSTONE, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 92%, REC 100%. *(continued)*	732.8	31	92		100	NQ2-3											CORE	
		32																
		33																
		34																
		35	83		100	NQ2-4											CORE	
		36																
		37																
		38																
	723.5	39 EOB																

NOTES: CAVED AT 18'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1233+15, 25' RT.	EXPLORATION ID B-010-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 755.3 (MSL) EOB: 30.7 ft.	PAGE 1 OF 2
START: 11/7/23 END: 11/7/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.219642, -82.065353	

MATERIAL DESCRIPTION AND NOTES	ELEV. 755.3	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
TOPSOIL (5")	754.9																	
STIFF, BROWN, **CLAY**, "AND" SAND, SOME SILT, DAMP	751.8	1	3 4 4	10	100	SS-1	1.50	0	9	36	32	23	41	27	14	23	A-7-6 (6)	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	748.8	4	4 4 4	10	100	SS-2	2.50	1	8	20	44	27	34	23	11	19	A-6a (8)	
		5	4 4 3	9	100	SS-3	3.25	1	8	19	40	32	37	22	15	18	A-6a (9)	
STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, CONTAINS ROCK FRAGMENTS, MOIST	747.3	7	4 5 5	13	100	SS-4	1.75	3	28	30	23	16	28	22	6	22	A-4a (1)	
STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST	745.8	9	5 5 6	14	100	SS-5	1.75	1	6	21	40	32	35	23	12	30	A-6a (8)	
SHALE, BROWN, HIGHLY WEATHERED.	744.6	TR 10	12 12 50/2"	-	86	SS-6	-	-	-	-	-	-	-	-	-	15	Rock (V)	
@10.7'; AUGER REFUSAL ENCOUNTERED																		
SHALE, GRAY, MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 33%, REC 100%. @10.7'-15.7'; SLAKE DURABILITY INDEX = 18.5%	740.3	11	35		100	NQ2-1											CORE	
SANDSTONE, GRAY, SLIGHTLY WEATHERED, STRONG; RQD 82%, REC 100%. @15.2'-15.7'; UCS = 12,850 PSI @16.7'-17.2'; UCS = 10,290 PSI	729.0	16	78		100	NQ2-2											CORE	
		21	88		100	NQ2-3											CORE	
SHALE, GRAY, MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 47%, REC 100%.		26	53		100	NQ2-4											CORE	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1233+15, 25' RT.	START: 11/7/23	END: 11/7/23	PG 2 OF 2	B-010-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	HOLE SEALED
								GR	CS	FS	SI	CL	LL	PL	PI			
	725.3																	
	724.6	EOB																

NOTES: CAVED AT 16'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1234+06, 35' RT.	EXPLORATION ID B-011-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 750.3 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 11/8/23 END: 11/8/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.219391, -82.065336	

MATERIAL DESCRIPTION AND NOTES	ELEV. 750.3	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
TOPSOIL (5")	749.8																	
VERY STIFF, BROWN, **SILT AND CLAY**, "AND" SAND, WET		1	4 4 2	8	100	SS-1	3.00	0	8	29	33	30	34	23	11	34	A-6a (6)	
	746.8	2																
VERY STIFF, BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, CONTAINS ORGANICS, DAMP		3																
@5.0'; STIFF, NO GRAVEL, WET		4	4 4 3	9	100	SS-2	2.50	1	7	35	29	28	27	19	8	18	A-4a (4)	
		5	3 3 4	9	100	SS-3	1.75	0	1	29	41	29	30	21	9	38	A-4a (7)	
@6.5'; VERY STIFF, TRACE GRAVEL, NO ORGANICS, DAMP		6																
	742.3	7	4 5 5	13	100	SS-4	2.25	2	12	35	28	23	30	21	9	14	A-4a (3)	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST		8																
	740.8	9	4 5 4	12	100	SS-5	3.50	3	8	27	31	31	31	20	11	23	A-6a (6)	
SHALE, GRAY, HIGHLY WEATHERED.	740.3	TR	50/5"	-	100	SS-6	-	-	-	-	-	-	-	-	-	14	Rock (V)	
@10.0'; AUGER REFUSAL ENCOUNTERED		10																
SHALE, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 76%, REC 100%.		11																
@10.0'-15.0'; SLAKE DURABILITY INDEX = 66.7%		12																
		13	78		100	NQ2-1											CORE	
	735.8	14																
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 100%, REC 100%.	735.3	15																
INTERBEDDED SHALE (50%) AND SANDSTONE (50%), RQD 40%, REC. 100%;		16																
SHALE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, STRONG;		17																
SANDSTONE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG.		18																
@17.7'-18.3'; UCS = 11,020 PSI ON SANDSTONE		19	40		100	NQ2-2											CORE	
	730.3	20																
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 93%, REC 100%.		21																
		22																
@22.0'-22.5'; UCS = 6,790 PSI		23	95		100	NQ2-3											CORE	
		24																
	722.8	25																
SHALE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 70%, REC 100%.		26																
		27	80		100	NQ2-4											CORE	
	720.3	28																
		EOB 29																

NOTES: CAVED AT 21'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1236+37, 62' RT.	EXPLORATION ID B-012-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 852.0 (MSL) EOB: 60.0 ft.	PAGE 1 OF 2
START: 11/9/23 END: 11/9/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.218754, -82.065299	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	852.0																	
HARD, BROWN, **ELASTIC CLAY**, SOME SILT, TRACE SAND,, DAMP	851.5		5 5 8	17	100	SS-1	4.50	0	2	8	33	57	51	31	20	18	A-7-5 (14)	
HARD, LIGHT BROWN, **CLAY**, SOME SAND, SOME SILT, DAMP	848.5		7 7 8	19	100	SS-2	4.50	-	-	-	-	-	-	-	-	9	A-7-5 (V)	
			8 8 9	22	100	SS-3	4.50	0	3	27	25	45	43	23	20	16	A-7-6 (12)	
CLAYSTONE, BROWN, HIGHLY WEATHERED.	843.5	TR	7 21 40	78	100	SS-4	-	-	-	-	-	-	-	-	-	9	Rock (V)	
			9 12 10	28	100	SS-5	-	-	-	-	-	-	-	-	-	5	Rock (V)	
@15.0'; AUGER REFUSAL ENCOUTNERED	837.0		22 25 41	84	100	SS-6	-	-	-	-	-	-	-	-	-	6	Rock (V)	
SANDSTONE, BROWN, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG; RQD 88%, REC 97%. @15.0'-20.0'; SLAKE DURABILITY INDEX = 19.9%			82		100	NQ2-1											CORE	
@20.0'; SLIGHTLY WEATHERED, MODERATELY STRONG. @23.0'-23.4'; SLIGHTLY STRONG; UCS = 2,040 PSI			82		100	NQ2-2											CORE	
@26.4'-27.0'; UCS = 2,710 PSI			92		100	NQ2-3											CORE	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1236+37, 62' RT.	START: 11/9/23	END: 11/9/23	PG 2 OF 2	B-012-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SANDSTONE, BROWN, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG; RQD 88%, REC 97%. *(continued)*	822.0	31	92		100	NQ2-4											CORE	
@33.6'-34.1'; MODERATELY STRONG; UCS = 4,110 PSI		32																
@35.0'; SLIGHTLY TO MODERATELY STRONG.		33																
		34																
		35	97		100	NQ2-5											CORE	
		36																
		37																
		38																
		39																
		40	100		100	NQ2-6											CORE	
		41																
		42																
		43																
		44																
		45	70		80	NQ2-7											CORE	
		46																
		47																
		48																
		49																
	802.0	50																
INTERBEDDED CLAYSTONE (50%) AND SHALE (50%), RQD 33%, REC. 100%; **CLAYSTONE**, GRAY, MODERATELY TO SLIGHTLY WEATHERED, WEAK TO SLIGHTLY STRONG; **SHALE**, GRAY, MODERATELY TO SLIGHTLY WEATHERED, WEAK TO SLIGHTLY STRONG.		51	33		100	NQ2-8											CORE	
		52																
		53																
		54																
	797.0	55																
INTERBEDDED SANDSTONE (50%) AND SHALE (50%), RQD 50%, REC. 100%; **SANDSTONE**, GRAY, SLIGHTLY WEATHERED, SLIGHTLY TO MODERATELY STRONG; **SHALE**, GRAY, SLIGHTLY WEATHERED, SLIGHTLY TO MODERATELY STRONG.		56	50		100	NQ2-9											CORE	
		57																
		58																
		59																
	792.0	EOB 60																

NOTES: CAVED AT 30'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1281+98, 59' RT.	EXPLORATION ID B-018-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501204	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 845.4 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1
START: 11/14/23 END: 11/14/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.208071, -82.057455	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (5")	845.4																	
HARD, BROWN, **CLAY**, SOME SILT, SOME SAND, CONTAINS ORGANICS, TRACE GRAVEL, DAMP	845.0	1	7															
		2	12	41	100	SS-1	4.50	1	15	8	37	39	41	25	16	8	A-7-6 (11)	
			20															
	841.9	3																
		TR 4	21															
SHALE, BROWN, HIGHLY WEATHERED.			27	83	100	SS-2	-	-	-	-	-	-	-	-	-	6	Rock (V)	
	840.4	5	38															
SHALE, BROWN, MODERATELY TO SEVERLY WEATHERED, WEAK TO SLIGHTLY STRONG; RQD 15%, REC 100%. @5.8'-6.4'; UCS = 2,410 PSI		6																
		7	18		100	NQ2-1											CORE	
		8																
		9																
		10																
		11																
		12	17		100	NQ2-2											CORE	
		13																
		14																
		15																
@15.0'-16.4'; GRAY, SLAKE DURABILITY INDEX = 40.9%	829.0	16																
SANDSTONE, BROWN, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 82%, REC 100%. @16.4'-16.9'; UCS = 5,370 PSI		17	57		100	NQ2-3											CORE	
		18																
		19																
		20																
		21																
@21.0'-21.5'; UCS = 5,030 PSI		22	85		100	NQ2-4											CORE	
	820.4	23																
		EOB 24																
		25																

NOTES: CAVED AT 14'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 9/10/24 10:48 - O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB OHIO INC\REPORTS\LAB REPORTS\MAST

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1283+53, 57' RT.	EXPLORATION ID B-019-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501204	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 763.9 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 11/15/23 END: 11/15/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.207719, -82.057165	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	763.9																	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, DAMP	763.4	1	4 4 5	12	100	SS-1	4.50	0	7	22	35	36	33	20	13	17	A-6a (8)	
@3.5'; VERY STIFF, MOIST		2																
		3																
		4	4 4 4	10	100	SS-2	2.75	-	-	-	-	-	-	-	-	23	A-6a (V)	
@6.0'; CONTAINS ORGANICS, DAMP		5																
		6																
		7	6 6 8	18	100	SS-3	3.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
@8.5'; HARD, NO ORGANICS		8																
		9	8 9 12	27	100	SS-4	4.25	-	-	-	-	-	-	-	-	15	A-6a (V)	
	752.9	10																
CLAYSTONE, GRAY, HIGHLY WEATHERED.		TR 11																
		12	12 13 17	38	100	SS-5	-	-	-	-	-	-	-	-	-	8	Rock (V)	
		13																
		14	20 30 45	96	100	SS-6	-	-	-	-	-	-	-	-	-	6	Rock (V)	
	748.9	15																
CLAYSTONE, GRAY, MODERATELY TO SEVERELY WEATHERED, VERY WEAK; RQD 58%, REC 100%. @15.0'-20.0'; SLAKE DURABILITY INDEX = 23.0%		16																
		17																
		18	55		100	NQ2-1											CORE	
@18.5'-18.9'; UCS = 50 PSI		19																
		20																
		21																
		22	60		100	NQ2-2											CORE	
		23																
		24																
@24.5'-25.0'; UCS = 230 PSI	738.9	25																
INTERBEDDED SANDSTONE (75%) AND SHALE (25%), RQD 72%, REC. 100%; **SANDSTONE**, GRAY, SLIGHTLY WEATHERED, SLIGHTLY TO MODERATELY STRONG; **SHALE**, GRAY, SLIGHTLY WEATHERED, SLIGHTLY TO MODERATELY STRONG.		26																
		27																
		28	72		100	NQ2-3											CORE	
		29																
	733.9	EOB																

NOTES: CAVED AT 15'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1284+28, 61' RT.	EXPLORATION ID B-020-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501204	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 755.9 (MSL) EOB: 33.5 ft.	PAGE 1 OF 2
START: 11/16/23 END: 11/16/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.207538, -82.057048	

MATERIAL DESCRIPTION AND NOTES	ELEV. 755.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (12")	754.9	1	3 3 6	12	100	SS-1	2.00	1	7	17	36	39	40	24	16	37	A-6b (10)	
STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, CONTAINS ORGANICS, MOIST		2																
		3																
@3.5'; VERY STIFF, DAMP		4	4 3 4	9	100	SS-2	2.25	-	-	-	-	-	-	-	-	13	A-6b (V)	
		5																
@6.0'; NO ORGANICS		6	5 5 4	12	100	SS-3	2.75	6	8	16	30	40	40	23	17	20	A-6b (10)	
	747.4	7																
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, CONTAINS ORGANICS, DAMP		8	7 7 6	17	100	SS-4	4.50	2	11	15	40	32	35	22	13	19	A-6a (9)	
@10.0'; LITTLE SAND		9	7 8 7	19	100	SS-5	4.25	1	3	15	41	40	37	22	15	20	A-6a (10)	
	744.4	10																
HARD, BROWN, **CLAY**, SOME SILT, TRACE SAND, CONTAINS ORGANICS, DAMP		11	8 8 7	19	100	SS-6	4.25	0	1	9	34	56	48	26	22	16	A-7-6 (14)	
	742.9	12																
HARD, BROWN, **SILTY CLAY**, LITTLE SAND, DAMP		13	7 7 9	20	100	SS-7	4.50	0	0	14	43	43	39	22	17	16	A-6b (11)	
		14																
		15	8 8 10	23	100	SS-8	4.50	0	0	11	47	42	39	21	18	12	A-6b (11)	
	738.9	16																
SHALE, GRAY, HIGHLY WEATHERED.		TR 17	10 15 50/4"	-	94	SS-9	-	-	-	-	-	-	-	-	-	9	Rock (V)	
	737.4	18																
INTERBEDDED SANDSTONE (50%) AND SHALE (50%), RQD 63%, REC. 100%; **SANDSTONE**, GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY STRONG; **SHALE**, GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY STRONG. @18.5'-23.5'; SLAKE DURABILITY INDEX = 71.5% @21.7'-22.3'; UCS = 10,260 PSI ON SANDSTONE		19	60		100	NQ2-1											CORE	
		20																
		21																
		22																
		23																
		24																
		25																
@25.5'-26.0'; UCS = 6,060 PSI ON SANDSTONE		26	67		100	NQ2-2											CORE	
	727.4	27																
		28																
		29																

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1284+28, 61' RT.	START: 11/16/23	END: 11/16/23	PG 2 OF 2	B-020-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
INTERBEDDED SANDSTONE (75%) AND SHALE (25%), RQD 77%, REC. 100%; **SANDSTONE**, GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY STRONG; **SHALE**, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG. *(continued)*	725.9	31 32 33	77		100	NQ2-3											CORE	
	722.4	EOB																

NOTES: CAVED AT 18'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1285+32, 90' RT.	EXPLORATION ID B-021-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501204	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 762.0 (MSL) EOB: 24.0 ft.	PAGE 1 OF 1
START: 11/18/23 END: 11/18/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.207255, -82.056971	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	762.0																	
TOPSOIL (3")	761.8																	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, DAMP		1	3 5 7	15	100	SS-1	-	0	14	63	16	7	NP	NP	NP	9	A-3a (0)	
		2																
		3																
		4	4 6 6	15	100	SS-2	-	0	9	66	17	8	NP	NP	NP	6	A-3a (0)	
	756.0	5																
VERY STIFF, BROWN, **CLAY**, TRACE SAND, TRACE GRAVEL, MOIST		6																
		7	2 3 3	8	100	SS-3	2.25	-	-	-	-	-	-	-	-	32	A-7-6 (V)	
	753.5	8																
SANDSTONE, GRAY, HIGHLY WEATHERED. @9.0'; AUGER REFUSAL ENCOUNTERED	753.0	TR 9	50/3"	-	100	SS-4	-	-	-	-	-	-	-	-	-	8	Rock (V)	
SANDSTONE, GRAY, SLIGHTLY WEATHERED, STRONG; RQD 81%, REC 97%. @10.5'-11.0'; UCS = 9,490 PSI	750.0	10 11 12	81		97	NQ2-1											CORE	
CLAYSTONE, BROWN AND GRAY, MODERATELY WEATHERED, VERY WEAK; RQD 17%, REC 100%. @12.0'-17.0'; SLAKE DURABILITY INDEX = 1.2% @15.0'-15.5'; UCS = 80 PSI	745.0	13 14 15 16 17	17		100	NQ2-2											CORE	
SHALE, GRAY, MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG; RQD 86%, REC 100%.		18 19 20 21 22	80		100	NQ2-3											CORE	
@23.5'-24.0'; UCS = 5,720 PSI	738.0	23 EOB 24	100		100	NQ2-4											CORE	

NOTES: CAVED AT 9'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1286+58, 65' RT.	EXPLORATION ID B-022-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501204	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 831.3 (MSL) EOB: 60.0 ft.	PAGE 1 OF 2
START: 11/18/23 END: 11/18/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.206981, -82.056703	

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
TOPSOIL (3")	831.1																	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, CONTAINS ORGANICS, MOIST		1	3 3 4	9	89	SS-1	2.75	12	14	19	34	21	34	23	11	23	A-6a (4)	
	827.8	2																
SANDSTONE, BROWN, HIGHLY WEATHERED.		3 TR	60/2"	-	100	SS-2	-	-	-	-	-	-	-	-	-	4	Rock (V)	
	826.3	4																
SANDSTONE, BROWN, SLIGHTLY WEATHERED, STRONG; RQD 83%, REC 100%.		5	73		100	NQ2-1											CORE	
@8.0'-8.8'; UCS = 11,330 PSI @8.0'-13.0'; SLAKE DURABILITY INDEX = 86.9%		6 7 8 9 10 11 12	92		100	NQ2-2											CORE	
@15.0'-15.5'; SLIGHTLY STRONG, UCS = 3,290 PSI		13 14 15 16 17 18	90		100	NQ2-3											CORE	
@18.0'-18.6'; UCS = 2,900 PSI		19 20 21 22 23 24	82		100	NQ2-4											CORE	
		25 26 27 28 29	82		100	NQ2-5											CORE	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1286+58, 65' RT.	START: 11/18/23	END: 11/18/23	PG 2 OF 2	B-022-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SANDSTONE, BROWN, SLIGHTLY WEATHERED, STRONG; RQD 83%, REC 100%. *(continued)*	801.3	31	69		100	NQ2-6											CORE	
@35.0'; GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG.		35	60		100	NQ2-7											CORE	
@40.0'; BROWN AND GRAY, FERRIFEROUS.		40	100		100	NQ2-8											CORE	
@50.0'; GRAY.		50	85		100	NQ2-9											CORE	
			83		100	NQ2-10											CORE	
		55	97		100	NQ2-11											CORE	
	773.3																	
SHALE, GRAY, MODERATELY WEATHERED, WEAK TO SLIGHTLY STRONG, CONTAINS COAL SEAMS; RQD 21%, REC 100%.	771.3	59	21		100	NQ2-12											CORE	
		EOB 60																

NOTES: CAVED AT 33'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1287+85, 39' RT.	EXPLORATION ID B-023-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501204	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 863.7 (MSL) EOB: 72.0 ft.	PAGE 1 OF 3
START: 11/20/23 END: 11/20/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.206696, -82.056448	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	863.7																	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	863.2		5 5 6	14	100	SS-1	4.50	5	9	19	35	32	34	20	14	18	A-6a (8)	
@3.5'; VERY STIFF			7 7 6	17	100	SS-2	4.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
@6.0'; HARD, CONTAINS ROCK FRAGMENTS			7 7 8	19	100	SS-3	4.50	-	-	-	-	-	-	-	-	7	A-6a (V)	
	854.2	TR	8 10 50/1"	-	100	SS-4	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
INTERBEDDED SHALE (75%) AND SANDSTONE (25%), RQD 13%, REC. 40%; **SHALE**, GRAY, MODERATELY WEATHERED, VERY WEAK; **SANDSTONE**, GRAY, MODERATELY WEATHERED, MODERATELY STRONG.	848.7		13		40	NQ2-1											CORE	
CLAYSTONE, RED AND GRAY, MODERATELY WEATHERED, VERY WEAK; RQD 45%, REC 90%.			38		80	NQ2-2											CORE	
@22.2'-22.7'; UCS = 740 PSI	838.7		52		100	NQ2-3											CORE	
SHALE, GRAY, MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 40%, REC 100%.	833.7		40		100	NQ2-4											CORE	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1287+85, 39' RT.	START: 11/20/23	END: 11/20/23	PG 2 OF 3	B-023-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
INTERBEDDED SANDSTONE (75%) AND SHALE (25%), RQD 63%, REC. 100%; **SANDSTONE**, GRAY, SLIGHTLY TO MODERATELY WEATHERED, MODERATELY STRONG; **SHALE**, GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG. @30.0'-35.0'; SLAKE DURABILITY INDEX = 85.5% @34.0'-34.6'; UCS = 6,550 PSI ON SANDSTONE	833.7	31 32 33 34 35	60		100	NQ2-5											CORE	
@36.0'-36.5'; UCS = 5,510 PSI ON SANDSTONE		36 37 38 39 40	65		100	NQ2-6											CORE	
SANDSTONE, BROWN AND GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 95%, REC 100%. @42.0'-42.6'; UCS = 3,260 PSI	823.7	41 42 43 44 45	90		100	NQ2-7											CORE	
@45.5'; STRONG. @46.0'-46.8'; UCS = 9,090 PSI		46 47 48 49 50	88		100	NQ2-8											CORE	
		51 52 53 54 55	100		100	NQ2-9											CORE	
		56 57 58 59 60	97		100	NQ2-10											CORE	
		61																

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1287+85, 39' RT.	START: 11/20/23	END: 11/20/23	PG 3 OF 3	B-023-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SANDSTONE, BROWN AND GRAY, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 95%, REC 100%. *(continued)*	801.6	63	100		100	NQ2-11											CORE	
		64																
		65																
		66	95		100	NQ2-12											CORE	
		67																
		68																
		69																
		70																
	791.7	71	88		100	NQ2-13											CORE	
	EOB	72																

NOTES: CAVED AT 50'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1420+74, 42' RT.	EXPLORATION ID B-035-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 730.0 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 11/28/23 END: 11/28/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.172135, -82.042893	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	730.0																	
	729.5																	
VERY STIFF, BROWN AND RED-BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, CONTAINS ROCK FRAGMENTS, DAMP		1	4 4 8	15	100	SS-1	2.75	13	10	24	25	28	32	19	13	13	A-6a (5)	
		2																
		3																
		4	3 4 5	12	100	SS-2	2.75	-	-	-	-	-	-	-	-	19	A-6a (V)	
		5																
@6.0'; NO GRAVEL		6	6 6 7	17	100	SS-3	2.75	0	2	20	43	35	34	19	15	17	A-6a (10)	
		7																
		8																
@8.5'; HARD, LIGHT BROWN		9	7 8 8	20	100	SS-4	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
		10																
		11																
		12	8 9 9	23	100	SS-5	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
	716.5	13																
CLAYSTONE, LIGHT BROWN, VERY WEAK.		TR 14	12 18 35	68	100	SS-6	-	-	-	-	-	-	-	-	-	6	Rock (V)	
	715.0	15																
SHALE, BROWN, SEVERELY TO HIGHLY WEATHERED, VERY WEAK TO WEAK, VERY THIN TO THIN BEDDED, ARGILLACEOUS; RQD 59%, REC 100%.		16																
@17.0'-17.6'; UCS = 180 PSI		17	58		100	NQ2-1											CORE	
		18																
		19																
		20																
@20.2'-20.7'; UCS = 120 PSI @20.0'-25.0'; SLAKE DURABILITY INDEX = 4.9% @21.0'; GRAY TO RED-GRAY, HIGHLY WEATHERED, WEAK, THIN TO MEDIUM BEDDED.		21	65		100	NQ2-2											CORE	
		22																
		23																
		24																
		25																
@27.0'; RED-GRAY TO DARK GRAY, HIGHLY TO MODERATELY WEATHERED, THIN BEDDED.		26	55		100	NQ2-3											CORE	
		27																
		28																
	700.0	29 EOB																

NOTES: CAVED AT 15'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / TOM	DRILL RIG: CME 55 #393	STATION / OFFSET: 1420+17, 24' LT.	EXPLORATION ID B-035-1-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / TOM	HAMMER: CME AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 11/4/22	ELEVATION: 750.3 (MSL) EOB: 35.0 ft.	PAGE 1 OF 2
START: 4/17/24 END: 4/17/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 79.3	LAT / LONG: 39.172350, -82.042757	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT (2")	750.3																	
CONCRETE (5")	750.1																	
HARD, BROWN, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL, (FILL), DAMP	749.7	1	11	22	78	SS-1	4.50	15	18	28	16	23	25	15	10	12	A-4a (1)	
		2	11 6															
		3																
@3.5'; VERY STIFF		4	4	16	72	SS-2	2.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		5	6 6															
	744.3	6																
MEDIUM DENSE, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, (FILL), DAMP		7	2	11	100	SS-3	-	4	5	39	32	20	NP	NP	NP	15	A-4a (3)	
		8	4 4															
		9	4	12	78	SS-4	-	-	-	-	-	-	-	-	-	19	A-4a (V)	
		10	4 5															
@11.0'; LOOSE		11	2	9	100	SS-5	-	-	-	-	-	-	-	-	-	18	A-4a (V)	
		12	3 4															
	736.8	13																
VERY STIFF, BROWN AND RED, **CLAY**, "AND" SILT, LITTLE SAND, TRACE GRAVEL, (FILL), DAMP		14	3	13	89	SS-6	3.50	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		15	5 5															
		16			100	ST-7	-	5	3	7	44	41	42	22	20	22	A-7-6 (12)	
		17																
		18																
		19	4	12	100	SS-8	3.00	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
		20	4 5															
		21																
		22																
		23																
@23.5'; STIFF		24	2	7	100	SS-9	2.00	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		25	2 3															
		26																
		27																
	721.8	28																
HARD, RED, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP		29	6	34	100	SS-10	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
			10 16															

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1420+17, 24' LT.	START: 4/17/24	END: 4/17/24	PG 2 OF 2	B-035-1-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
HARD, RED, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP *(continued)*	720.3	31																
		32			100	ST-11	-	4	5	30	26	35	28	15	13	11	A-6a (6)	
		33																
@33.5'; VERY STIFF, CONTAINS ROCK FRAGMENTS		34	13 14 27	54	-	SS-12	4.00	-	-	-	-	-	-	-	-	10	A-6a (V)	
	715.3	EOB 35																

NOTES: CAVED AT 4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 9/10/24 10:48 - O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB OHIO INC\REPORTS\LAB REPORTS\MAST

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1421+78, 52' RT.	EXPLORATION ID B-036-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 697.2 (MSL) EOB: 35.0 ft.	PAGE 1 OF 2
START: 11/22/23 END: 11/22/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.171863, -82.042785	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (5")	697.2																	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	696.8		2 3 3	8	100	SS-1	3.50	1	3	12	45	39	39	22	17	21	A-6b (11)	
STIFF, BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, MOIST	694.2		3 3 4	9	100	SS-2	2.00	3	4	12	26	55	52	25	27	27	A-7-6 (17)	
@6.0'; VERY STIFF, RED-BROWN, DAMP	689.2		7 6 6	15	100	SS-3	3.00	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
VERY STIFF, RED-BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, DAMP			5 6 8	18	100	SS-4	3.75	1	7	20	31	41	37	19	18	15	A-6b (11)	
@11.0'; HARD, MOIST			7 7 10	22	100	SS-5	4.50	-	-	-	-	-	-	-	-	20	A-6b (V)	
@13.0'; DAMP			8 8 9	22	100	SS-6	4.50	-	-	-	-	-	-	-	-	10	A-6b (V)	
			9 9 11	26	100	SS-7	4.50	-	-	-	-	-	-	-	-	10	A-6b (V)	
	678.7	TR																
CLAYSTONE, RED-GRAY, VERY WEAK.	677.2		12 15 30	58	100	SS-8	-	-	-	-	-	-	-	-	-	9	Rock (V)	
SHALE, BROWN TO GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK TO WEAK; RQD 48%, REC 100%. @20.0'-25.0'; SLAKE DURABILITY INDEX = 41.1%			40		100	NQ2-1											CORE	
@26.2'-26.6'; UCS = 370 PSI			53		100	NQ2-2											CORE	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1421+78, 52' RT.	START: 11/22/23	END: 11/22/23	PG 2 OF 2	B-036-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SHALE, BROWN TO GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK TO WEAK; RQD 48%, REC 100%. *(continued)* @30.0'; GRAY, HIGHLY TO MODERATELY WEATHERED, SLIGHTLY STRONG.	667.2	31 32 33 34	52		100	NQ2-3											CORE	
	662.2	EOB 35																

NOTES: CAVED AT 25'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 9/10/24 10:48 - O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB OHIO INC\REPORTS\LAB REPORTS\MAST

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1423+49, 81' RT.	EXPLORATION ID B-037-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 674.5 (MSL) EOB: 55.0 ft.	PAGE 1 OF 2
START: 11/29/23 END: 11/29/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.171396, -82.042647	

MATERIAL DESCRIPTION AND NOTES	ELEV. 674.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (8")	673.8																	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, LITTLE CLAY, TRACE GRAVEL, DAMP		1	3 4 6	13	83	SS-1	-	1	8	57	20	14	NP	NP	NP	13	A-3a (0)	
		2																
		3																
		4	6 6 9	19	100	SS-2	-	-	-	-	-	-	-	-	-	14	A-3a (V)	
		5																
@5.5'; LOOSE		6																
		7	3 3 3	8	100	SS-3	-	1	9	56	19	15	NP	NP	NP	19	A-3a (0)	
	666.5	W 666.5																
LOOSE, BROWN, **SANDY SILT**, LITTLE CLAY, WET		8																
	664.5	9	2 3 3	8	83	SS-4	-	0	0	64	22	14	NP	NP	NP	24	A-4a (0)	
MEDIUM DENSE, GRAY, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, WET	FS 663.0	10	3 4 5	12	89	SS-5	-	0	9	84	3	4	NP	NP	NP	28	A-3 (0)	
LOOSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, CONTAINS WOOD FRAGMENTS, WET	661.5	11																
		12	4 3 5	10	100	SS-6	-	0	3	83	7	7	NP	NP	NP	-	A-3a (0)	
LOOSE, GRAY, **FINE SAND**, TRACE COARSE SAND, TRACE SILT, TRACE CLAY, TRACE GRAVEL, CONTAINS WOOD FRAGMENTS, WET		13																
		14	3 4 4	10	83	SS-7	-	3	9	82	1	5	NP	NP	NP	-	A-3 (0)	
@14.5'; MEDIUM DENSE, LITTLE COARSE SAND	FS	15	4 3 6	12	89	SS-8	-	3	14	77	1	5	NP	NP	NP	-	A-3 (0)	
		16																
		17	3 5 6	14	100	SS-9	-	-	-	-	-	-	-	-	-	30	A-3 (V)	
	656.5	18																
VERY STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST		19	3 6 6	15	100	SS-10	3.25	0	1	5	50	44	40	22	18	25	A-6b (11)	
		20																
		21																
		22	6 8 9	22	100	SS-11	2.75	-	-	-	-	-	-	-	-	24	A-6b (V)	
		23																
		24	4 6 10	20	100	SS-12	2.75	-	-	-	-	-	-	-	-	25	A-6b (V)	
		25																
@26.0'; STIFF		26																
		27	4 8 10	23	72	SS-13	1.25	-	-	-	-	-	-	-	-	31	A-6b (V)	
		28																
@28.5'; VERY STIFF, DAMP		29	5 9 11	26	100	SS-14	2.75	-	-	-	-	-	-	-	-	19	A-6b (V)	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1423+49, 81' RT.	START: 11/29/23	END: 11/29/23	PG 2 OF 2	B-037-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	644.5																	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	644.0	31	6 8 12	26	100	SS-15	3.00	9	9	15	34	33	33	19	14	12	A-6a (8)	
@33.5'; HARD		32 33 34	6 14 20	44	100	SS-16	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
CLAYSTONE, RED-BROWN, SEVERELY WEATHERED, VERY WEAK.	638.5	TR 35 36 37	11 21 36	73	83	SS-17	-	-	-	-	-	-	-	-	-	7	Rock (V)	
SHALE, RED-BROWN AND BROWN, SEVERELY WEATHERED.	636.0	38 39	39 50/3"	-	100	SS-18	-	-	-	-	-	-	-	-	-	12	Rock (V)	
SHALE, RED-BROWN AND BROWN, SEVERELY TO HIGHLY WEATHERED, VERY WEAK TO WEAK, VERY THIN TO MEDIUM BEDDED; RQD 78%, REC 100%. @40.0'-45.0'; SLAKE DURABILITY INDEX = 14.5% @42.0'-42.6'; UCS = 110 PSI	634.5	40 41 42 43 44 45	80		100	NQ2-1											CORE	
@45.5'-46.0'; UCS = 110 PSI		46 47 48 49 50	78		100	NQ2-2											CORE	
	619.5	EOB 51 52 53 54 55	75		100	NQ2-3											CORE	

NOTES: CAVED AT 10.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1424+23, 67' RT.	EXPLORATION ID B-038-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 679.9 (MSL) EOB: 55.0 ft.	PAGE 1 OF 2
START: 11/30/23 END: 11/30/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.171225, -82.042498	

MATERIAL DESCRIPTION AND NOTES	ELEV. 679.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (7")	679.3																	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, LITTLE CLAY, DAMP		1	4 7 11	23	72	SS-1	-	0	7	65	17	11	NP	NP	NP	11	A-3a (0)	
		2																
		3																
		4	6 10 12	28	83	SS-2	-	-	-	-	-	-	-	-	-	12	A-3a (V)	
	674.4	5																
VERY STIFF, BROWN, **SANDY SILT**, SOME CLAY, MOIST		6																
		7	2 3 3	8	89	SS-3	3.75	0	3	42	30	25	25	17	8	21	A-4a (4)	
	671.9	W 671.9 8																
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, MOIST		9	3 3 4	9	83	SS-4	2.50	0	0	26	42	32	32	19	13	23	A-6a (9)	
	668.9	10																
LOOSE, BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, WET		11																
		12	2 2 4	8	89	SS-5	-	-	-	-	-	-	-	-	-	33	A-3a (V)	
		13																
		14	2 3 2	6	89	SS-6	-	0	4	85	4	7	NP	NP	NP	29	A-3a (0)	
	664.4	15																
LOOSE, BROWN, **GRAVEL WITH SAND AND SILT**, TRACE CLAY, WET		16																
		17	2 3 5	10	100	SS-7	-	-	-	-	-	-	-	-	-	19	A-2-4 (V)	
		18																
		19	3 3 4	9	100	SS-8	-	-	-	-	-	-	-	-	-	39	A-2-4 (V)	
	658.9	20																
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, WET		21																
		22	3 4 6	13	100	SS-9	-	-	-	-	-	-	-	-	-	29	A-3a (V)	
@23.5'; LOOSE		23																
		24	3 3 4	9	100	SS-10	-	-	-	-	-	-	-	-	-	32	A-3a (V)	
		25																
		26																
		27	2 2 4	8	89	SS-11	-	-	-	-	-	-	-	-	-	29	A-3a (V)	
		28																
		29	2 2 3	6	83	SS-12	-	0	9	78	5	8	NP	NP	NP	18	A-3a (0)	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1424+23, 67' RT.	START: 11/30/23	END: 11/30/23	PG 2 OF 2	B-038-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, WET *(continued)*	649.9	31	3 3 5	10	100	SS-13	-	-	-	-	-	-	-	-	-	21	A-3a (V)	
@33.5'; MEDIUM DENSE		32																
		33																
		34	3 5 4	12	89	SS-14	-	-	-	-	-	-	-	-	-	25	A-3a (V)	
	644.4	35																
CLAYSTONE, RED-BROWN AND BROWN, SEVERELY WEATHERED, VERY WEAK.		TR 36																
		37	10 27 38	83	100	SS-15	-	-	-	-	-	-	-	-	-	14	Rock (V)	
		38																
		39	31 40 50/1"	-	100	SS-16	-	-	-	-	-	-	-	-	-	9	Rock (V)	
	639.9	40																
SHALE, RED-BROWN AND GRAY, HIGHLY WEATHERED, WEAK, VERY THIN TO MEDIUM BEDDED; RQD 83%, REC 100%.		41																
@42.0'-42.5'; UCS = 90 PSI		42	82		100	NQ2-1											CORE	
		43																
		44																
@45.0'-50.0'; SLAKE DURABILITY INDEX = 0.7%		45																
		46																
		47	77		100	NQ2-2											CORE	
@47.4'-47.9'; UCS = 100 PSI		48																
		49																
		50																
		51																
		52	92		100	NQ2-3											CORE	
		53																
		54																
	624.9	EOB 55																

NOTES: CAVED AT 11'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1425+51, 132' RT.	EXPLORATION ID B-039-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN: 0501190	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 676.8 (MSL) EOB: 55.0 ft.	PAGE 1 OF 2
START: 11/30/23 END: 11/30/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.170832, -82.042536	

MATERIAL DESCRIPTION AND NOTES	ELEV. 676.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (9")	676.1																	
VERY STIFF, BROWN AND RED-BROWN, **CLAY**, "AND" SILT, SOME SAND, TRACE GRAVEL, MOIST			2 3 3	8	100	SS-1	2.75	2	4	19	39	36	47	24	23	33	A-7-6 (15)	
@3.5'; DAMP			3 3 3	8	100	SS-2	3.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
@6.0'; TRACE SAND, MOIST	668.8	W 668.8	3 4 4	10	100	SS-3	3.00	1	0	6	45	48	45	23	22	29	A-7-6 (14)	
STIFF, BROWN, **SILTY CLAY**, TRACE SAND, MOIST			3 3 4	9	100	SS-4	1.50	0	1	9	55	35	37	21	16	25	A-6b (10)	
			2 2 2	5	83	SS-5	1.50	-	-	-	-	-	-	-	-	25	A-6b (V)	
	660.8		2 3 2	6	89	SS-6	1.50	-	-	-	-	-	-	-	-	25	A-6b (V)	
STIFF, BROWN, **CLAY**, "AND" SILT, TRACE SAND, TRACE GRAVEL, MOIST			3 4 5	12	100	SS-7	2.00	-	-	-	-	-	-	-	-	26	A-7-6 (V)	
			3 4 6	13	100	SS-8	1.75	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
	655.8																	
LOOSE, BROWN, **FINE SAND**, TRACE COARSE SAND, TRACE CLAY, TRACE SILT, WET			1 2 2	5	72	SS-9	-	-	-	-	-	-	-	-	-	30	A-3 (V)	
			2 2 2	5	78	SS-10	-	-	-	-	-	-	-	-	-	27	A-3 (V)	
@26.0'; MEDIUM DENSE			3 4 7	14	89	SS-11	-	0	6	85	4	5	NP	NP	NP	20	A-3 (0)	
			3 5 9	18	100	SS-12	-	-	-	-	-	-	-	-	-	17	A-3 (V)	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1425+51, 132' RT.	START: 11/30/23	END: 11/30/23	PG 2 OF 2	B-039-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
LOOSE, BROWN, **FINE SAND**, TRACE COARSE SAND, TRACE CLAY, TRACE SILT, WET *(continued)*																		
@31.0'; LOOSE		31	1 1 3	5	67	SS-13	-	-	-	-	-	-	-	-	-	22	A-3 (V)	
F-S		32																
@33.5'; VERY LOOSE		33																
		34	2 1 2	4	61	SS-14	-	-	-	-	-	-	-	-	-	32	A-3 (V)	
	640.8	35																
SHALE, RED-BROWN.		TR 36	7 21 30	65	100	SS-15	1.75	1	4	43	22	30	25	15	10	22	Rock (V)	
		37																
		38																
		39	40 50/5"	-	100	SS-16	-	-	-	-	-	-	-	-	-	6	Rock (V)	
	636.8	40																
SHALE, RED-BROWN-GRAY, SEVERELY TO MODERATELY WEATHERED, VERY WEAK TO WEAK, VERY THIN TO MEDIUM BEDDED; RQD 77%, REC 100%.		41																
@40.0'-45.0'; SLAKE DURABILITY INDEX = 5.6%		42	68		100	NQ2-1											CORE	
		43																
		44																
@44.4'-45.0'; UCS = 90 PSI		45																
		46																
@46.0'-46.5'; UCS = 140 PSI		47	77		100	NQ2-2											CORE	
		48																
		49																
		50																
		51																
		52	87		100	NQ2-3											CORE	
		53																
		54																
	621.8	EOB 55																

NOTES: CAVED AT 13'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / TOM	DRILL RIG: CME 55 #393	STATION / OFFSET: 1425+96, 24' LT.	EXPLORATION ID B-039-1-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / TOM	HAMMER: CME AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 11/4/22	ELEVATION: 743.4 (MSL) EOB: 90.0 ft.	PAGE 1 OF 3
START: 4/15/24 END: 4/15/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 79.3	LAT / LONG: 39.170883, -82.041969	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
ASPHALT (2")	743.4																	
CONCRETE (8")	743.2																	
HARD, BROWN, **SILT AND CLAY**, "AND" SAND, LITTLE GRAVEL, (FILL), DAMP	742.6	1	13 8 6	19	56	SS-1	4.50	13	15	22	25	25	28	17	11	12	A-6a (3)	
		2																
		3																
@3.5'; VERY STIFF, BROWN AND RED		4	5 6 7	17	78	SS-2	4.00	-	-	-	-	-	-	-	-	12	A-6a (V)	
		5																
		6																
@6.0'; TRACE GRAVEL		7	3 5 5	13	67	SS-3	3.50	7	17	23	26	27	30	18	12	14	A-6a (4)	
		8																
		9	5 5 7	16	89	SS-4	3.00	-	-	-	-	-	-	-	-	14	A-6a (V)	
		10																
		11																
@11.0'; LITTLE SAND, CONTAINS ROCK FRAGMENTS		12	3 5 5	13	67	SS-5	4.00	1	4	15	51	29	31	20	11	13	A-6a (8)	
		13																
		14	3 4 6	13	100	SS-6	3.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
		15																
		16																
		17	4 6 6	16	67	SS-7	4.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
	724.9	18																
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, SOME SILT, TRACE CLAY, (FILL), CONTAINS ROCK FRAGMENTS, DAMP		19	10 10 10	26	100	SS-8	-	0	2	63	25	10	NP	NP	NP	10	A-3a (0)	
		20																
		21																
		22																
		23																
		24	9 8 9	22	100	SS-9	-	-	-	-	-	-	-	-	-	11	A-3a (V)	
		25																
		26																
		27																
	714.9	28																
		29	6 6 8	19	89	SS-10	4.00	5	4	19	47	25	30	19	11	12	A-6a (V)	

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1425+96, 24' LT.	START: 4/15/24	END: 4/15/24	PG 2 OF 3	B-039-1-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, (FILL), CONTAINS ROCK FRAGMENTS, DAMP *(continued)*		31																
		32																
		33																
		34	8 12 8	26	89	SS-11	-	-	-	-	-	-	-	-	-	10	A-6a (V)	
	708.4	35																
VERY STIFF, BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, (FILL), CONTAINS ROCK FRAGMENTS, DAMP		36																
		37			54	ST-12	-	1	3	40	25	31	26	16	10	15	A-4a (4)	
		38																
		39	8 7 6	17	100	SS-13	3.00	-	-	-	-	-	-	-	-	14	A-4a (V)	
		40																
		41																
		42																
		43																
		44	4 10 14	32	100	SS-14	2.50	-	-	-	-	-	-	-	-	19	A-4a (V)	
	696.4	45																
VERY STIFF, RED AND GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, (FILL), DAMP		46																
		47																
		48																
		49	3 3 4	9	78	SS-15	4.00	15	4	20	38	23	28	17	11	17	A-6a (V)	
		50																
		51																
		52																
		53																
		54	6 6 15	28	89	SS-16	4.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
		55																
		56																
		57																
		58																
	684.9	59																
BROWN, SANDSTONE BOULDERS, (FILL)		60	12 14 24	50	100	SS-17	-	-	-	-	-	-	-	-	-	9	Rock (V)	
		61																

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1425+96, 24' LT.	START: 4/15/24	END: 4/15/24	PG 3 OF 3	B-039-1-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
BROWN, SANDSTONE BOULDERS, (FILL) *(continued)*	681.3	63	50/4"	-	100	SS-18	-	-	-	-	-	-	-	-	-	10	Rock (V)	
		64																
		65																
		66																
		67																
		68																
		69	50/3"	-	100	SS-19	1.50	-	-	-	-	-	-	-	-	13	Rock (V)	
@70.0'; ENCOUNTERED AUGER REFUSAL		70																
		71			100	RC-20	-	-	-	-	-	-	-	-	-	-	Rock (V)	
		72																
	669.9	73																
STIFF, BROWN, **CLAY**, "AND" SILT, TRACE SAND, DAMP		74	4 5 6	15	100	SS-21	2.00	-	-	-	-	-	-	-	-	14	A-7-6 (V)	
		75																
		76																
		77																
		78																
		79	5 6 6	16	100	SS-22	3.50	0	0	6	47	47	43	23	20	25	A-7-6 (V)	
	662.4	80																
BROWN, **SILT AND CLAY**, LITTLE SAND, MOIST		81			100	ST-23	-	0	0	19	51	30	31	18	13	22	A-6a (9)	
	659.9	82																
		83																
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, TRACE SILT, TRACE CLAY, TRACE GRAVEL, MOIST		84	4 5 10	20	100	SS-24	-	-	-	-	-	-	-	-	-	24	A-3a (V)	
		85																
		86																
		87			42	ST-25	-	1	25	61	7	6	NP	NP	NP	21	A-3a (0)	
		88																
	653.4	89	6 9 11	26	100	SS-26	-	-	-	-	-	-	-	-	-	28	A-3a (V)	
		EOB 90																

NOTES: CAVED AT 4'; GROUNDWATER MEASURED AT 45.0' AFTER CORING THROUGH ROCKFILL (BOULDERS)

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1022+17, 127' RT.	EXPLORATION ID B-042-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500315	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 970.3 (MSL) EOB: 45.0 ft.	PAGE 1 OF 2
START: 1/4/24 END: 1/4/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.272233, -82.091568	

MATERIAL DESCRIPTION AND NOTES	ELEV. 970.3	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
TOPSOIL (5")	969.9																	
VERY STIFF, BROWN, **SILTY CLAY**, "AND" SAND, TRACE GRAVEL, (FILL), DAMP	967.3	1	6 7 7	18	100	SS-1	3.25	1	31	7	39	22	36	20	16	10	A-6b (8)	
MEDIUM DENSE, BROWN, **GRAVEL AND/OR STONE FRAGMENTS**, CONTAINS ROCK FRAGMENTS, (FILL), DAMP	964.8	4	8 10 10	26	100	SS-2	-	-	-	-	-	-	-	-	-	5	A-1-a (V)	
VERY STIFF, RED AND GRAY, **CLAY**, "AND" SILT, LITTLE SAND, TRACE GRAVEL, DAMP		7	8 8 9	22	100	SS-3	3.00	7	7	5	37	44	48	23	25	21	A-7-6 (16)	
@8.5'; MOIST		9	9 8 9	22	100	SS-4	3.75	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
@11.0'; BROWN, TRACE SAND, NO GRAVEL		12	6 6 5	14	100	SS-5	2.75	0	3	6	45	46	41	23	18	26	A-7-6 (11)	
		14	6 5 5	13	100	SS-6	3.25	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
@16.0'; BROWN AND GRAY, SOME SILT, LITTLE SAND, DAMP		17	8 10 10	26	100	SS-7	4.00	0	15	5	30	50	52	26	26	18	A-7-6 (17)	
@18.5'; HARD, BROWN, "AND" SILT	949.3	19	9 9 10	24	100	SS-8	4.25	0	18	2	52	28	45	23	22	14	A-7-6 (14)	
CLAYSTONE, BROWN, SEVERELY WEATHERED.		TR 21	15 15 19	44	100	SS-9	4.50	-	-	-	-	-	-	-	-	14	Rock (V)	
		24	19 20 25	58	100	SS-10	2.50	-	-	-	-	-	-	-	-	15	Rock (V)	
		27	25 27 34	78	100	SS-11	4.50	-	-	-	-	-	-	-	-	5	Rock (V)	
	940.3	29	30 38 50/5"	-	88	SS-12	-	-	-	-	-	-	-	-	-	10	Rock (V)	

PID: 119141	SFN:	PROJECT: ATH-US 33-18.70	STATION / OFFSET: 1022+17, 127' RT.	START: 1/4/24	END: 1/4/24	PG 2 OF 2	B-042-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
CLAYSTONE, RED, MODERATELY WEATHERED, VERY WEAK; RQD 56%, REC 100%.	940.3	31	48		100	NQ2-1											CORE	
@31.5'-32.0'; UCS = 80 PSI		32																
		33																
	936.3	34																
SHALE, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 15%, REC 100%.		35																
		36	14		100	NQ2-2											CORE	
@37.5'; BROWN.		37																
		38																
	930.3	39																
CLAYSTONE, RED, SEVERELY WEATHERED, WEAK; RQD 0%, REC 100%.		40																
	928.3	41																
SHALE, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 100%, REC 100%.	927.3	42	30		100	NQ2-3											CORE	
CLAYSTONE, RED TO GRAY, MODERATELY WEATHERED, WEAK; RQD 25%, REC 100%.		43																
		44																
	925.3	45 EOB																

NOTES: CAVED AT 30'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 9/11/24 15:01 - O:\PROJECT\2023\COL-05\2305005 9COL_ATH MEG-033-18-70 00-00_HNTB OHIO INC\REPORTS\LAB REPORTS\MAST

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1022+17, 127' RT.	EXPLORATION ID B-042-0A-23	
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33		
PID: 119141 SFN: 0500315	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/3/23	ELEVATION: 970.3 (MSL) EOB: 14.0 ft.	PAGE 1 OF 1	
START: 1/4/24 END: 1/4/24	SAMPLING METHOD:	ENERGY RATIO (%): 76.8	LAT / LONG: 39.272233, -82.091568		

MATERIAL DESCRIPTION AND NOTES	ELEV. 970.3	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
Auger down to 7.0'	963.3	1 2 3 4 5 6 7																
RED, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, MOIST	961.3	8 9			67	ST-1	-	1	2	3	34	60	60	26	34	32	A-7-6 (20)	
	958.3	10 11																
BROWN, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	956.3	12 13 EOB 14			83	ST-2	-	2	0	6	55	37	37	23	14	23	A-6a (10)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1021+77, 13' RT.	EXPLORATION ID B-044-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500315	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 969.3 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 1/5/24 END: 1/5/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.272560, -82.091494	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	969.3 / 968.8																	
HARD, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		1–3	9 9 10	24	100	SS-1	4.25	1	7	4	60	28	40	27	13	15	A-6a (9)	
	965.8	TR																
CLAYSTONE, BROWN, SEVERELY WEATHERED.		4–5	12 14 17	40	100	SS-2	4.50	-	-	-	-	-	-	-	-	10	Rock (V)	
		6–8	22 27 33	77	100	SS-3	-	-	-	-	-	-	-	-	-	8	Rock (V)	
		9–10	20 27 38	83	100	SS-4	-	-	-	-	-	-	-	-	-	7	Rock (V)	
		11–13	22 26 30	72	100	SS-5	-	-	-	-	-	-	-	-	-	9	Rock (V)	
	954.3	14–15	35 36 41	99	100	SS-6	-	-	-	-	-	-	-	-	-	7	Rock (V)	
CLAYSTONE, GRAY, SEVERELY TO MODERATELY WEATHERED, VERY WEAK; RQD 37%, REC 100%.		15–19	48		100	NQ2-1											CORE	
@20.0'; MODERATELY WEATHERED.		20–24	37		100	NQ2-2											CORE	
@24.5'-25.0'; UCS = 130 PSI @25.0'; GRAY AND RED.		25–29	27		100	NQ2-3											CORE	
	939.3	EOB																

NOTES: CAVED AT 11'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1021+17, 121' LT.	EXPLORATION ID B-045-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500315	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 973.6 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1
START: 1/3/24 END: 1/3/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.272961, -82.091449	

MATERIAL DESCRIPTION AND NOTES	ELEV. 973.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (4")	973.3																	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP		1	4	9	100	SS-1	2.50	13	11	18	39	19	38	24	14	18	A-6a (6)	
		2	4															
		3	3															
	970.1																	
SANDSTONE, BROWN, HIGHLY WEATHERED.		TR 4	20	74	100	SS-2	-	-	-	-	-	-	-	-	-	8	Rock (V)	
		5	26															
			32															
		6																
		7	30	96	100	SS-3	-	-	-	-	-	-	-	-	-	7	Rock (V)	
			37															
		8	38															
		9																
			40	122	100	SS-4	-	-	-	-	-	-	-	-	-	8	Rock (V)	
@10.0'; AUGER REFUSAL ENCOUNTERED	963.6	10	46															
			49															
SANDSTONE, BROWN, SLIGHTLY TO MODERATELY WEATHERED, SLIGHTLY STRONG; RQD 68%, REC 100%. @10.0'-10.5'; UCS = 2,210 PSI		11																
		12	45		100	NQ2-1											CORE	
	960.3	13																
SHALE, GRAY, MODERATELY WEATHERED, WEAK; RQD 35%, REC 100%.		14																
		15																
		16																
		17	38		100	NQ2-2											CORE	
		18																
		19																
		20																
@20.0'; SLIGHTLY WEATHERED, SLIGHTLY STRONG.		21																
		22																
		23	43		100	NQ2-3											CORE	
	948.6	24																
		EOB 25																

NOTES: CAVED AT 17'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1158+55, 109' RT.	EXPLORATION ID B-047-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500317	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 897.6 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 1/10/24 END: 1/10/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.238327, -82.075024	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (3")	897.6																	
GRAVEL (6")	897.4																	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, (FILL), DAMP	896.9	1	5 5 4	12	100	SS-1	3.25	6	6	16	40	32	35	21	14	20	A-6a (9)	
	894.6	2																
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, LITTLE SILT, LITTLE CLAY, (FILL), DAMP		3																
	892.1	4	5 6 6	15	100	SS-2	3.00	0	2	65	20	13	NP	NP	NP	13	A-3a (0)	
VERY STIFF, BROWN, **SILT AND CLAY**, TRACE SAND, DAMP		5																
		6	8 10 10	26	100	SS-3	3.00	0	3	7	69	21	34	21	13	14	A-6a (9)	
		7																
		8																
		9	9 9 11	26	83	SS-4	3.25	-	-	-	-	-	-	-	-	18	A-6a (V)	
		10																
@11.0'; CONTAINS ROCK FRAGMENTS		11	15 16 20	46	100	SS-5	4.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
	884.1	12																
		13																
SANDSTONE, BROWN, SEVERELY WEATHERED.	882.6	TR 14	44 45 50/4"	-	19	SS-6	3.50	-	-	-	-	-	-	-	-	14	Rock (V)	
SANDSTONE, BROWN, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 38%, REC 100%.	880.6	15																
		16																
		17																
SHALE, BROWN, MODERATELY WEATHERED, VERY WEAK; RQD 33%, REC 100%.		18	23		100	NQ2-1											CORE	
		19																
	875.7	20																
CLAYSTONE, RED, HIGHLY WEATHERED, VERY WEAK; RQD 70%, REC 100%.		21																
		22	58		100	NQ2-2											CORE	
@24.2'-24.7'; UCS = 100 PSI		23																
@25.2'-25.7'; UCS = 110 PSI		24																
		25																
		26																
		27	80		100	NQ2-3											CORE	
		28																
	867.6	29																
		EOB																

NOTES: CAVED AT 10'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1158+55, 109' RT.	EXPLORATION ID B-047-0A-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500317	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/3/23	ELEVATION: 897.6 (MSL) EOB: 9.0 ft.	PAGE 1 OF 1
START: 1/10/24 END: 1/10/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 76.8	LAT / LONG: 39.238327, -82.075024	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Auger down to 1.0'	897.6																	
		1																
		2			100	ST-1	-	3	3	25	45	24	29	18	11	21	A-6a (7)	
		3																
	892.6	4																
BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, MOIST		5																
	890.6	6																
BROWN, **CLAY**, "AND" SILT, TRACE SAND, MOIST		7																
	888.6	8			100	ST-2	-	0	1	9	46	44	42	21	21	24	A-7-6 (13)	
	EOB	9																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1158+83, 8' RT.	EXPLORATION ID B-048-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500317	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 899.0 (MSL) EOB: 40.0 ft.	PAGE 1 OF 2
START: 1/10/24 END: 1/10/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.238366, -82.074658	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	899.0																	
	898.5																	
MEDIUM DENSE, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP		1	5	14	100	SS-1	1.75	4	4	56	23	13	NP	NP	NP	12	A-4a (0)	
		2	6 5															
		3																
		4	8	23	100	SS-2	3.00	-	-	-	-	-	-	-	-	17		
		5	8 10															
		6																
@6.0'; NO GRAVEL		7	8	22	100	SS-3	3.50	0	3	61	21	15	NP	NP	NP	13	A-4a (0)	
		8	8 9															
		9	9	22	100	SS-4	4.00	0	2	54	25	19	NP	NP	NP	6	A-4a (2)	
		10	9 8															
	888.5																	
VERY STIFF, RED AND BROWN, **CLAY**, "AND" SILT, LITTLE SAND, DAMP		11	12	36	100	SS-5	4.00	0	1	10	39	50	47	22	25	21	A-7-6 (15)	
		12	12 16															
		13																
@13.5'; HARD		14	14	33	100	SS-6	4.25	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		15	14 12															
	883.0																	
CLAYSTONE, RED, HIGHLY WEATHERED, VERY WEAK.		TR 16	15	46	100	SS-7	-	0	4	1	67	28	41	26	15	15	Rock (V)	
		17	16 20															
		18																
		19	20	60	100	SS-8	4.00	-	-	-	-	-	-	-	-	19	Rock (V)	
		20	22 25															
		21																
		22	30	96	100	SS-9	4.00	-	-	-	-	-	-	-	-	15	Rock (V)	
		23	35 40															
		24																
		25	40	114	100	SS-10	4.00	-	-	-	-	-	-	-	-	15	Rock (V)	
	874.0		44 45															
CLAYSTONE, RED, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK; RQD 44%, REC 100%.		26																
		27																
		28	42		100	NQ2-1											CORE	
		29																
@29.1'-29.8'; UCS = 110 PSI																		

PID: 119141	SFN:	PROJECT: ATH-US 33-18.70	STATION / OFFSET: 1158+83, 8' RT.	START: 1/10/24	END: 1/10/24	PG 2 OF 2	B-048-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
CLAYSTONE, RED, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK; RQD 44%, REC 100%. *(continued)*	869.0	31	65		100	NQ2-2											CORE	
SANDSTONE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, MODERATELY STRONG; RQD 100%, REC 100%. @34.4'-35.0'; UCS = 5,630 PSI	865.7	32 33 34 35																
SHALE, GRAY, SLIGHTLY WEATHERED, SLIGHTLY STRONG; RQD 50%, REC 100%.	863.0	36 37 38	68		100	NQ2-3											CORE	
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 78%, REC 100%.	860.5	39																
	859.0	EOB 40																

NOTES: CAVED AT 25'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 9/11/24 15:01 - O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB OHIO INC\REPORTS\LAB REPORTS\MAST

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1159+16, 96' LT.	EXPLORATION ID B-049-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500317	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 896.6 (MSL) EOB: 45.0 ft.	PAGE 1 OF 2
START: 1/10/24 END: 1/10/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.238397, -82.074276	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (5")	896.6																	
STIFF, BROWN, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, CONTAINS ORGANICS, (FILL), DAMP	896.2	1	7 7 9	20	100	SS-1	1.50	-	-	-	-	-	-	-	-	20	A-6b (V)	
@3.5'; VERY STIFF, DAMP		4	8 8 7	19	100	SS-2	3.50	2	9	23	33	33	36	20	16	19	A-6b (9)	
MEDIUM DENSE, BROWN AND GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, (FILL), DAMP	891.1	6	7 7 6	17	100	SS-3	4.00	1	1	62	21	15	NP	NP	NP	18	A-4a (0)	
VERY STIFF, BROWN AND GRAY, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP	888.6	9	5 5 6	14	100	SS-4	3.25	-	-	-	-	-	-	-	-	20	A-6a (V)	
@11.0'; MOIST		11	5 5 7	15	100	SS-5	2.50	1	1	7	56	35	35	20	15	23	A-6a (10)	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST	883.6	14	6 6 5	14	100	SS-6	2.50	0	1	10	47	42	39	21	18	23	A-6b (11)	
@18.5'; HARD, BROWN AND RED, DAMP		17	7 6 8	18	100	SS-7	2.75	-	-	-	-	-	-	-	-	22	A-6b (V)	
		19	12 12 13	32	100	SS-8	4.50	-	-	-	-	-	-	-	-	16	A-6b (V)	
	875.6	TR																
CLAYSTONE, BROWN AND GRAY, SEVERELY WEATHERED.		22	13 15 18	42	100	SS-9	4.50	-	-	-	-	-	-	-	-	12	Rock (V)	
		24	14 15 19	44	100	SS-10	4.50	-	-	-	-	-	-	-	-	14	Rock (V)	
		27	22 26 31	73	100	SS-11	4.00	-	-	-	-	-	-	-	-	14	Rock (V)	
	866.6	29	34 42 50/4"	-	100	SS-12	4.00	-	-	-	-	-	-	-	-	7	Rock (V)	

PID: 119141	SFN:	PROJECT: ATH-US 33-18.70	STATION / OFFSET: 1159+16, 96' LT.	START: 1/10/24	END: 1/10/24	PG 2 OF 2	B-049-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
CLAYSTONE, RED AND GRAY, MODERATELY TO SEVERELY WEATHERED, VERY WEAK; RQD 40%, REC 100%.	866.6	31																
	864.1	32																
SHALE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, MODERATELY STRONG; RQD 57%, REC 100%. @32.9'-33.4'; UCS = 5,590 PSI		33	35		100	NQ2-1											CORE	
		34																
		35																
		36																
		37	53		100	NQ2-2											CORE	
@38.3'-38.8'; UCS = 4,490 PSI		38																
		39																
		40																
		41																
		42	73		100	NQ2-3											CORE	
		43																
		44																
	851.6 EOB	45																

NOTES: CAVED AT 28'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-18.70	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1159+16, 96' LT.	EXPLORATION ID B-049-0A-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119141 SFN: 0500317	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/3/23	ELEVATION: 676.8 (MSL) EOB: 17.0 ft.	PAGE 1 OF 1
START: 1/10/24 END: 1/10/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 76.8	LAT / LONG: 39.238397, -82.074276	

MATERIAL DESCRIPTION AND NOTES	ELEV. 676.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
Auger down to 1.0'	675.8	1																
BROWN, **SANDY SILT**, LITTLE CLAY, MOIST	673.8	2 3			100	ST-1	-	1	1	31	49	18	NP	NP	NP	16	A-4a (6)	
	671.8	4 5																
BROWN AND GRAY, **SANDY SILT**, LITTLE CLAY, MOIST	669.8	6 7			42	ST-2	-	0	1	45	37	17	NP	NP	NP	24	A-4a (4)	
	661.8	8 9 10 11 12 13 14																
BROWN, **SILT AND CLAY**, "AND" SAND, TRACE GRAVEL, MOIST	659.8	15 16			8	ST-3	-	1	2	43	21	33	32	19	13	22	A-6a (5)	
		EOB 17																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1317+19, 78' RT.	EXPLORATION ID B-050-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/3/23	ELEVATION: 888.1 (MSL) EOB: 14.0 ft.	PAGE 1 OF 1
START: 1/11/24 END: 1/11/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 76.8	LAT / LONG: 39.198758, -82.055313	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
GRAVEL (12")	888.1																	
	887.1																	
MEDIUM DENSE, RED AND BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, (FILL), DAMP		1	5	23	100	SS-1	-	-	-	-	-	-	-	-	-	8	A-2-7 (V)	
	885.1	2	8 10															
VERY STIFF, RED, **CLAY**, DAMP		3																
		4	8	26	100	SS-2	3.50	-	-	-	-	-	-	-	-	10	A-7-6 (V)	
		5	10 10															
@6'-14'; VERY SOFT		6																
		7																
		8																
		9																
		10																
		11																
		12																
		13																
	874.1	EOB 14																

AUGER REFUSAL ENCOUNTERED AT 14.0'

BORING ENCOUNTERED SOFT ZONE AT 6.0'. AUGERS DROPPED (WITHOUT ROTATION) TO A DEPTH OF 14.0'

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 9/10/24 10:49 - O:\PROJECT\2023\COL-05\2305005\COL_ATH MEG-033-18-70 00-00_HNTB OHIO INC\REPORTS\LAB REPORTS\MAST

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1317+19, 65' RT.	EXPLORATION ID B-050-0A-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 888.1 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 1/11/24 END: 1/11/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.198758, -82.055313	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
GRAVEL (12")	888.1 / 887.1																	
VERY STIFF, RED, **SILT AND CLAY**, SOME SAND, SOME GRAVEL, (FILL), MOIST	885.1	1	5 8 11	24	100	SS-1	3.00	22	20	10	16	32	33	20	13	21	A-6a (4)	
HARD, RED, **CLAY**, "AND" SILT, TRACE SAND, TRACE GRAVEL, DAMP		2																
		3																
		4	7 12 12	31	100	SS-2	4.50	2	3	2	47	46	42	24	18	16	A-7-6 (12)	
		5																
@6.0-14.0'; VERY SOFT		6																
		7	11 14 17	40	100	SS-3	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
	879.6	8																
CLAYSTONE, BROWN AND RED, SEVERELY WEATHERED.		TR 9	19 21 26	60	100	SS-4	4.00	-	-	-	-	-	-	-	-	12	Rock (V)	
		10																
		11																
		12	17 22 25	60	100	SS-5	4.50	-	-	-	-	-	-	-	-	15	Rock (V)	
		13																
		14	35 43 40	106	100	SS-6	4.50	-	-	-	-	-	-	-	-	6	Rock (V)	
	873.1	15																
CLAYSTONE, BROWN, MODERATELY WEATHERED, VERY WEAK; RQD 23%, REC 100%. @16.1'-16.5'; UCS = 30 PSI		16																
		17																
		18	25		100	NQ2-1											CORE	
		19																
		20																
		21																
		22	42		100	NQ2-2											CORE	
	864.6	23																
SHALE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 74%, REC 100%. @24.3'-25.0'; UCS = 6,280 PSI		24																
		25																
		26																
		27	68		100	NQ2-3											CORE	
		28																
	858.1	29 EOB																

NOTES: CAVED AT 12'; BORING WAS OFFSET 13' EAST FROM BORING B-050-0-23

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1317+19, 65' RT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 888.1 (MSL) EOB: 6.0 ft.
START: 1/11/24 END: 1/11/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	COORD: Not Recorded

EXPLORATION ID: B-050-0B-23

PAGE: 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	888.1																	
	887.1	1																
RED, **SILT AND CLAY**, TRACE SAND, TRACE GRAVEL, DAMP	885.1	2 3			-	ST-1	-	1	1	3	59	36	29	18	11	16	A-6a (8)	
RED, **CLAY**, "AND" SILT, TRACE SAND, TRACE GRAVEL, MOIST	882.1	4 5			-	ST-2	-	3	1	0	39	57	55	27	28	27	A-7-6 (18)	
		EOB 6																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 9/10/24 10:49 - O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB OHIO INC\REPORTS\LAB REPORTS\MAST

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1317+99, 3' RT.	EXPLORATION ID B-051-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 889.7 (MSL) EOB: 35.0 ft.	PAGE 1 OF 2
START: 1/12/24 END: 1/12/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.198551, -82.055076	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
GRAVEL (12")	889.7																	
	888.7																	
VERY STIFF, GRAY AND RED, **CLAY**, SOME SILT, TRACE SAND, TRACE GRAVEL, (FILL), DAMP		1	6 5 5	13	100	SS-1	3.00	6	5	4	30	55	49	25	24	19	A-7-6 (15)	
		2																
		3																
@3.5'; RED, NO GRAVEL		4	6 6 5	14	100	SS-2	3.50	0	2	2	30	66	59	29	30	28	A-7-6 (20)	
	884.2	5																
HARD, RED, **SILT AND CLAY**, TRACE SAND, MOIST		6																
		7	8 10 9	24	100	SS-3	4.50	-	-	-	-	-	-	-	-	20	A-6a (V)	
		8																
@8.5'; DAMP		9	9 9 10	24	100	SS-4	4.50	0	7	2	48	43	31	19	12	19	A-6a (9)	
		10																
@11.0'; VERY STIFF		11	7 8 8	20	100	SS-5	3.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		12																
@13.5'; SOME GRAVEL, SOME SAND, MOIST		13	8 8 9	22	100	SS-6	4.00	23	21	11	14	31	31	18	13	20	A-6a (3)	
	873.7	14																
SHALE, RED, SEVERELY WEATHERED.		TR 15																
		16	19 24 32	72	100	SS-7	4.50	-	-	-	-	-	-	-	-	7	Rock (V)	
		17																
		18																
	869.7	19	40 42 45	111	22	SS-8	4.50	-	-	-	-	-	-	-	-	8	Rock (V)	
SHALE, BROWN, SEVERELY WEATHERED, VERY WEAK; RQD 9%, REC 100%.		20																
		21																
		22	0		100	NQ2-1											CORE	
		23																
	864.2	24																
SANDSTONE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, MODERATELY STRONG; RQD 87%, REC 100%.		25																
@25.7'-26.2'; UCS = 6,180 PSI		26																
		27	80		100	NQ2-2											CORE	
		28																
	859.7	29																

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1317+99, 3' RT.	START: 1/12/24	END: 1/12/24	PG 2 OF 2	B-051-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SHALE, GRAY, HIGHLY WEATHERED, WEAK; RQD 17%, REC 100%.	859.7	31																
	857.7	32																
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 83%, REC 100%. @32.3'-32.7'; UCS = 5,370 PSI		33	65		100	NQ2-3											CORE	
	854.7	34																
		EOB 35																

NOTES: CAVED AT 14'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1318+39, 68' LT.	EXPLORATION ID B-052-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 890.3 (MSL) EOB: 35.0 ft.	PAGE 1 OF 2
START: 1/12/24 END: 1/12/24	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.198456, -82.054814	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
GRAVEL (12")	890.3																	
	889.3																	
MEDIUM DENSE, RED AND BROWN, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, TRACE CLAY, TRACE SILT, (FILL), DAMP		1	5 5 7	15	100	SS-1	3.00	27	35	19	9	10	NP	NP	NP	7	A-1-b (0)	
		2																
		3																
		4	5 6 5	14	100	SS-2	-	8	46	37	4	5	NP	NP	NP	6	A-1-b (0)	
	884.8	5																
VERY STIFF, RED, **ELASTIC CLAY**, TRACE SILT, TRACE SAND, DAMP		6																
		7	6 6 7	17	100	SS-3	3.00	0	1	1	6	92	82	40	42	37	A-7-5 (20)	
@8.5'; MOIST		8																
		9	7 7 8	19	100	SS-4	2.50	0	0	1	8	91	104	40	64	42	A-7-5 (20)	
	879.8	10																
CLAYSTONE, BROWN AND GRAY, SEVERELY WEATHERED.		11	TR															
		12	16 19 23	54	100	SS-5	4.50	-	-	-	-	-	-	-	-	13	Rock (V)	
		13																
		14	20 19 24	55	100	SS-6	4.50	-	-	-	-	-	-	-	-	14	Rock (V)	
		15																
		16	27 29 34	81	100	SS-7	4.25	-	-	-	-	-	-	-	-	13	Rock (V)	
	871.8	17																
SANDSTONE, GRAY, SEVERELY WEATHERED.		18																
	870.3	19	40 47 50/2"	-	36	SS-8	-	-	-	-	-	-	-	-	-	4	Rock (V)	
SANDSTONE, TAN, SLIGHTLY WEATHERED, STRONG; RQD 51%, REC 100%.		20																
		21																
		22	55		100	NQ2-1											CORE	
@22.8'-23,4'; UCS = 8,150 PSI		23																
		24																
		25																
@25.0'; MODERATELY STRONG.		26																
@25.1'-25.8'; UCS = 5,150 PSI		27	47		100	NQ2-2											CORE	
		28																
	860.3	29																

PID: 119142	SFN:	PROJECT: ATH-US 33-23.23	STATION / OFFSET: 1318+39, 68' LT.	START: 1/12/24	END: 1/12/24	PG 2 OF 2	B-052-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
SHALE, BROWN TO GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG; RQD 48%, REC 100%.	860.3	31 32 33 34	48		100	NQ2-3											CORE	
	855.3	EOB 35																

NOTES: CAVED AT 12'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1318+39, 68' LT.
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 5/3/23	ELEVATION: 890.3 (MSL) EOB: 9.0 ft.
START: 1/12/24 END: 1/12/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 76.8	LAT / LONG: 39.198456, -82.054814

EXPLORATION ID: B-052-0A-23

PAGE: 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	890.3	1 2 3 4 5 6 7																
RED, **CLAY**, "AND" SILT, TRACE SAND, MOIST	883.3				-	ST-1	-	0	0	2	51	47	49	20	29	31	A-7-6 (17)	
	881.3	EOB 8 9																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1529+78, 462' RT.	EXPLORATION ID B-058-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 662.7 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 12/5/23 END: 12/5/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.145100, -82.026247	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (8")	662.0																	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	662.7		2 3 3	8	100	SS-1	2.50	1	2	29	40	28	31	19	12	19	A-6a (7)	
@3.5'; STIFF, NO GRAVEL, MOIST			3 4 4	10	83	SS-2	2.00	0	3	29	34	34	33	20	13	22	A-6a (8)	
		W 656.7	4 3 5	10	100	SS-3	2.00	0	2	24	38	36	34	19	15	23	A-6a (10)	
@6.5'; DAMP			3 5 6	14	100	SS-4	1.25	0	3	32	34	31	30	18	12	20	A-6a (7)	
	654.7	TR																
SANDSTONE, GRAY, SEVERELY WEATHERED.			9 21 40	78	89	SS-5	-	-	-	-	-	-	-	-	-	24	Rock (V)	
	652.7		39 50/3"	-	100	SS-6	-	-	-	-	-	-	-	-	-	10	Rock (V)	
SANDSTONE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, MODERATELY STRONG; RQD 83%, REC 100%. @12.0'-12.5'; UCS = 4,680 PSI			73		100	NQ2-1											CORE	
			93		100	NQ2-2											CORE	
	642.7	EOB																

NOTES: CAVED AT 4.2'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

PROJECT: ATH-US 33-23.23	DRILLING FIRM / OPERATOR: CTL / H. BROWN	DRILL RIG: MOBILE B-57 TRACK	STATION / OFFSET: 1529+19, 430' RT.	EXPLORATION ID B-059-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: CTL / H. BROWN	HAMMER: MOBILE AUTOMATIC	ALIGNMENT: US 33	
PID: 119142 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 5/3/23	ELEVATION: 663.8 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 12/11/23 END: 12/11/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 76.8	LAT / LONG: 39.145281, -82.026280	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
TOPSOIL (6")	663.8																	
VERY STIFF, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, MOIST	663.3		4 4 4	10	100	SS-1	3.50	7	12	34	28	19	29	20	9	21	A-4a (2)	
MEDIUM DENSE, BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, MOIST	660.3	W 659.8	3 4 6	13	83	SS-2	-	2	22	37	24	15	NP	NP	NP	18	A-4a (1)	
			5 6 6	15	100	SS-3	-	-	-	-	-	-	-	-	-	15	A-4a (V)	
MEDIUM DENSE, BROWN AND GRAY, **COARSE AND FINE SAND**, SOME SILT, LITTLE CLAY, TRACE GRAVEL, DAMP	657.3		3 5 5	13	100	SS-4	-	1	13	51	21	14	NP	NP	NP	17	A-3a (0)	
SANDSTONE, GRAY, SEVERELY WEATHERED.	655.8	TR	38 50/4"	-	100	SS-5	-	-	-	-	-	-	-	-	-	12	Rock (V)	
	653.8		50/2"	-	100	SS-6	-	-	-	-	-	-	-	-	-	10	Rock (V)	
SANDSTONE, GRAY, SLIGHTLY TO MODERATELY WEATHERED, STRONG; RQD 90%, REC 100%. @11.3'-12.0'; UCS = 9,200 PSI			80		100	NQ2-1											CORE	
	643.8	EOB	100		100	NQ2-2											CORE	

NOTES: CAVED AT 3.6'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED BENTONITE GROUT

APPENDIX C

LABORATORY TEST RESULTS

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

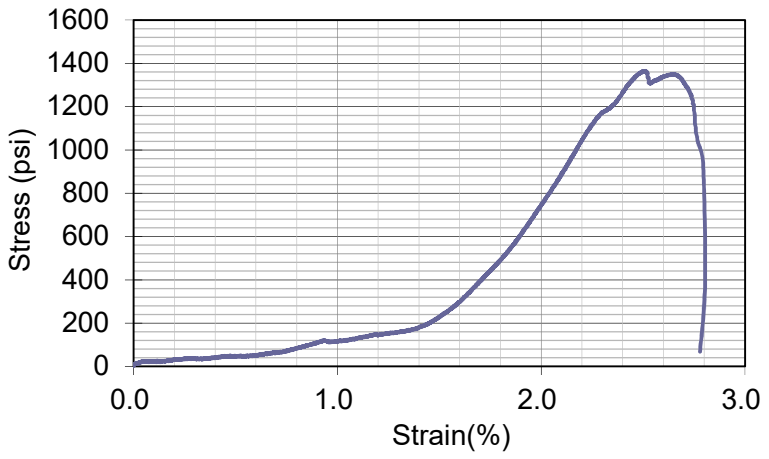
BORING NUMBER	B-007-0-23	TOP DEPTH(FT)	12.4	BOTTOM DEPTH(FT)	12.9
SAMPLE NUMBER	NQ2-3	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.975	1.959
2	3.968	1.956
3	3.974	1.961
AVERAGE	3.972	1.959

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	418.2
UNIT WEIGHT(LBS/FT^3)	133.1

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
1,360
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.50
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

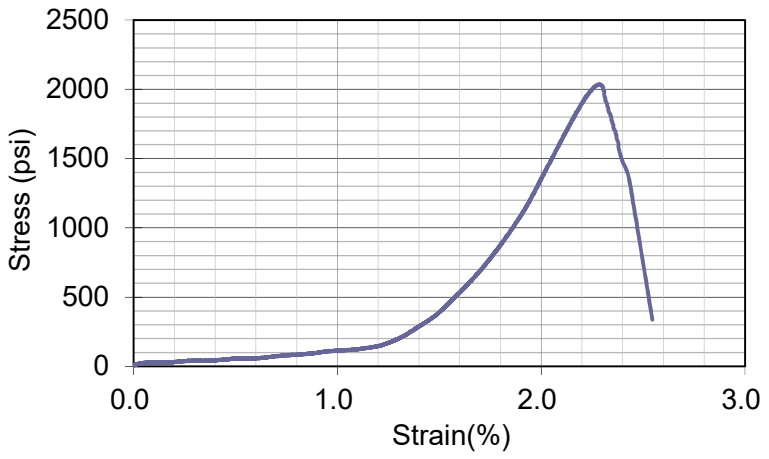
BORING NUMBER	B-007-0-23	TOP DEPTH(FT)	16.0	BOTTOM DEPTH(FT)	16.5
SAMPLE NUMBER	NQ2-4	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.975	1.984
2	3.979	1.983
3	3.973	1.981
AVERAGE	3.976	1.983

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	444.3
UNIT WEIGHT(LBS/FT^3)	137.9

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
2,040
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.01
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

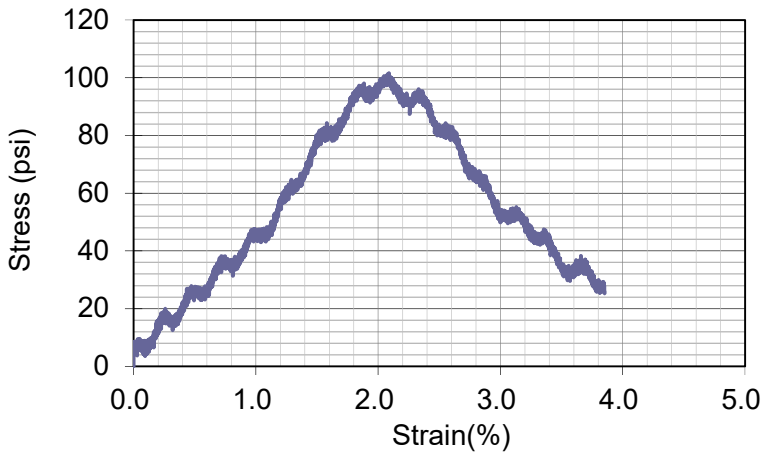
BORING NUMBER	B-008-0-23	TOP DEPTH(FT)	25.7	BOTTOM DEPTH(FT)	26.2
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Gray, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.011	1.988
2	4.020	1.980
3	4.009	1.989
AVERAGE	4.013	1.986

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	456.8
UNIT WEIGHT(LBS/FT^3)	140

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
100
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.34
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

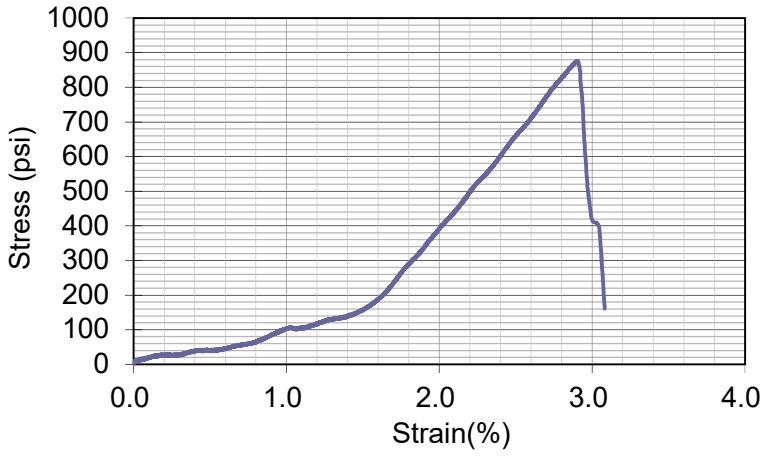
BORING NUMBER	B-008-0-23	TOP DEPTH(FT)	31.5	BOTTOM DEPTH(FT)	32.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone With Shale Layers, Gray, Moderately Weathered, Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.009	1.919
2	4.010	1.950
3	4.012	1.923
AVERAGE	4.010	1.931

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	2.9
MASS (GRAMS)	494.2
UNIT WEIGHT(LBS/FT^3)	160.3

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
880
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.57
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

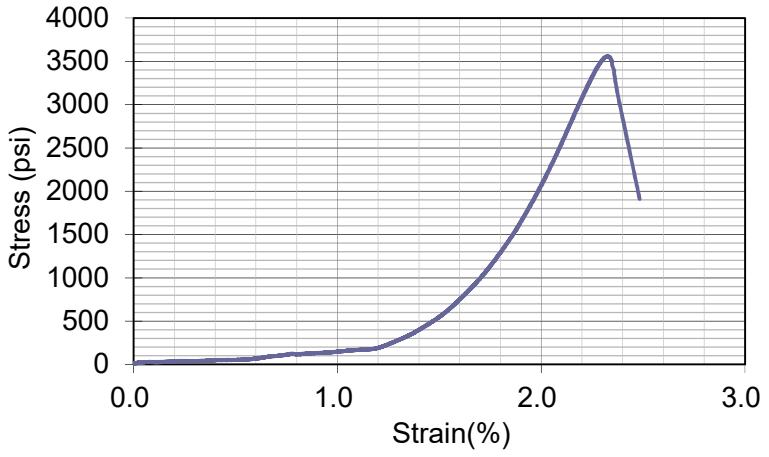
BORING NUMBER	B-009-0-23	TOP DEPTH(FT)	23.3	BOTTOM DEPTH(FT)	23.9
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.996	1.941
2	3.993	1.949
3	3.997	1.940
AVERAGE	3.995	1.943

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	445.0
UNIT WEIGHT(LBS/FT^3)	143

RATE OF LOADING (in/min)
0.08
COMPRESSIVE STRENGTH (PSI)
3,560
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.11
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

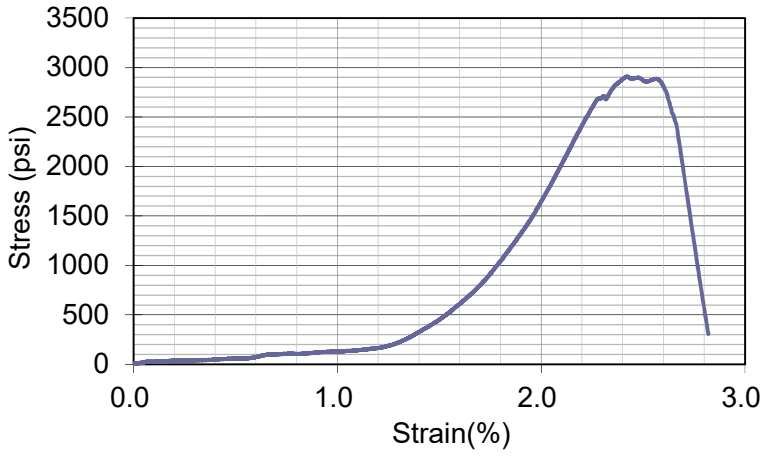
BORING NUMBER	B-009-0-23	TOP DEPTH(FT)	26.8	BOTTOM DEPTH(FT)	27.3
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.995	1.934
2	3.989	1.932
3	3.994	1.941
AVERAGE	3.993	1.936

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	2.9
MASS (GRAMS)	445.9
UNIT WEIGHT(LBS/FT^3)	144.6

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
2,910
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.45
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

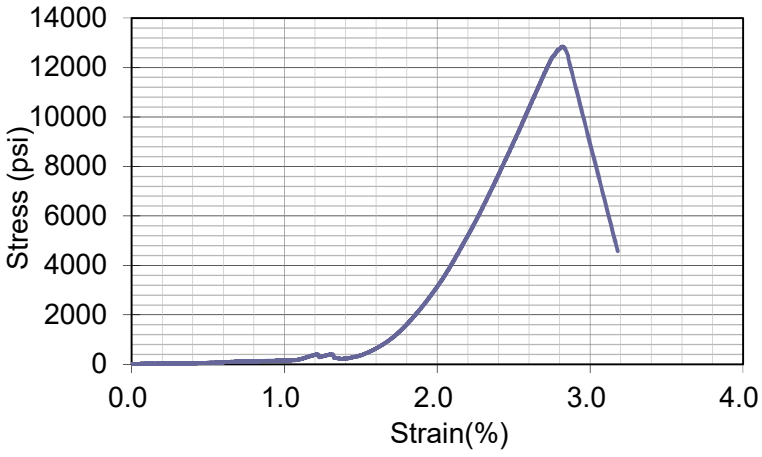
BORING NUMBER	B-010-0-23	TOP DEPTH(FT)	15.2	BOTTOM DEPTH(FT)	15.7
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.006	1.980
2	4.009	1.979
3	4.002	1.977
AVERAGE	4.006	1.979

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	524.7
UNIT WEIGHT(LBS/FT^3)	162.3

RATE OF LOADING (in/min)
0.08
COMPRESSIVE STRENGTH (PSI)
12,850
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.73
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

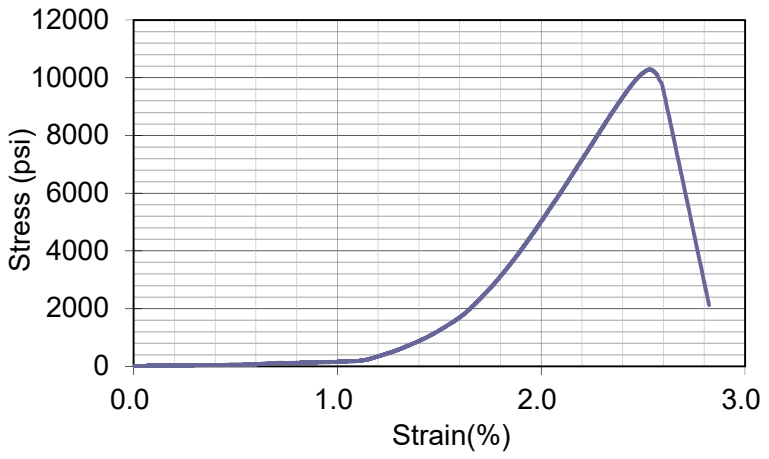
BORING NUMBER	B-010-0-23	TOP DEPTH(FT)	16.7	BOTTOM DEPTH(FT)	17.2
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.014	1.975
2	4.017	1.974
3	4.016	1.971
AVERAGE	4.016	1.973

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	509.6
UNIT WEIGHT(LBS/FT^3)	158.1

RATE OF LOADING (in/min)
0.08
COMPRESSIVE STRENGTH (PSI)
10,290
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.67
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

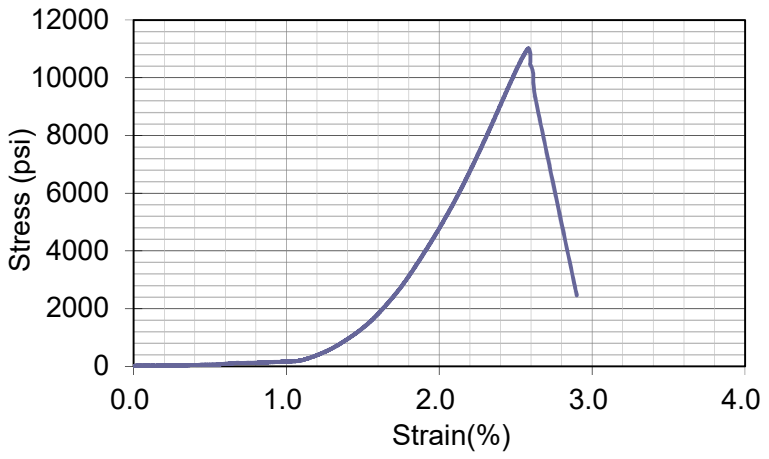
BORING NUMBER	B-011-0-23	TOP DEPTH(FT)	17.7	BOTTOM DEPTH(FT)	18.3
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.008	1.981
2	4.007	1.976
3	4.007	1.975
AVERAGE	4.007	1.977

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	512.6
UNIT WEIGHT(LBS/FT^3)	158.7

RATE OF LOADING (in/min)
0.08
COMPRESSIVE STRENGTH (PSI)
11,020
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.63
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

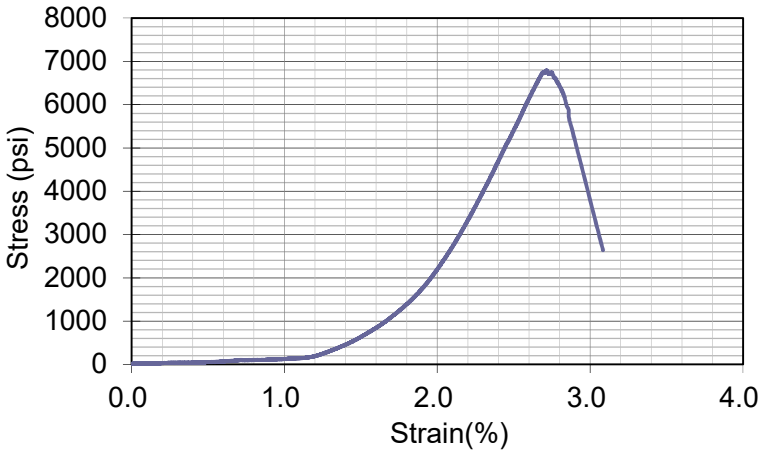
BORING NUMBER	B-011-0-23	TOP DEPTH(FT)	22.0	BOTTOM DEPTH(FT)	22.5
SAMPLE NUMBER	NQ2-3	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.001	1.974
2	4.001	1.975
3	4.003	1.975
AVERAGE	4.002	1.975

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	480.5
UNIT WEIGHT(LBS/FT^3)	149.4

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
6,790
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.26
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

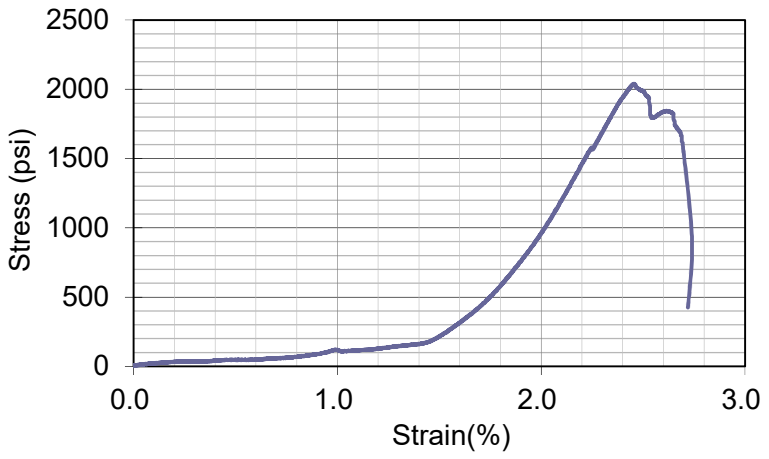
BORING NUMBER	B-012-0-23	TOP DEPTH(FT)	23.0	BOTTOM DEPTH(FT)	23.4
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.983	1.969
2	3.978	1.970
3	3.973	1.941
AVERAGE	3.978	1.960

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	424.8
UNIT WEIGHT(LBS/FT^3)	134.8

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
2,040
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.48
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

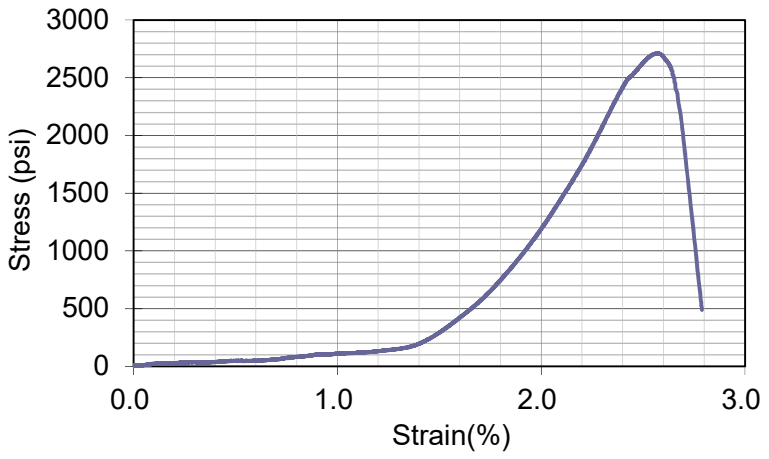
BORING NUMBER	B-012-0-23	TOP DEPTH(FT)	26.4	BOTTOM DEPTH(FT)	27.0
SAMPLE NUMBER	NQ2-3	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.985	1.983
2	3.985	1.953
3	3.991	1.964
AVERAGE	3.987	1.967

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	427.1
UNIT WEIGHT(LBS/FT^3)	134.3

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
2,710
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.12
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

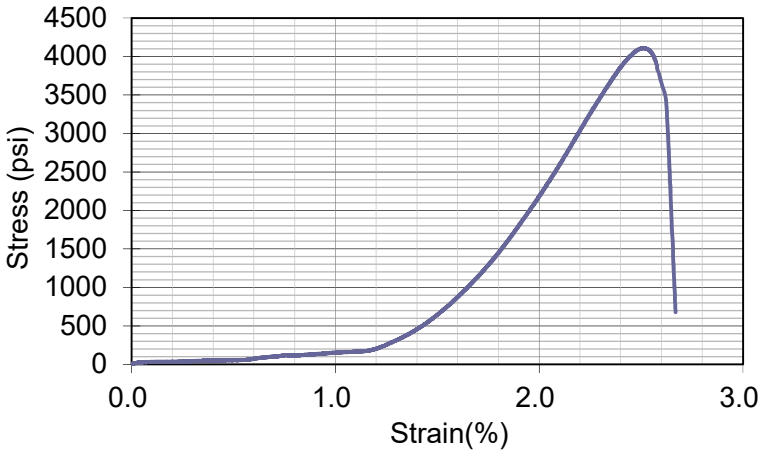
BORING NUMBER	B-012-0-23	TOP DEPTH(FT)	33.6	BOTTOM DEPTH(FT)	34.1
SAMPLE NUMBER	NQ2-4	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.986	1.968
2	3.987	1.970
3	3.986	1.965
AVERAGE	3.986	1.968

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	441.5
UNIT WEIGHT(LBS/FT^3)	138.8

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
4,110
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.06
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

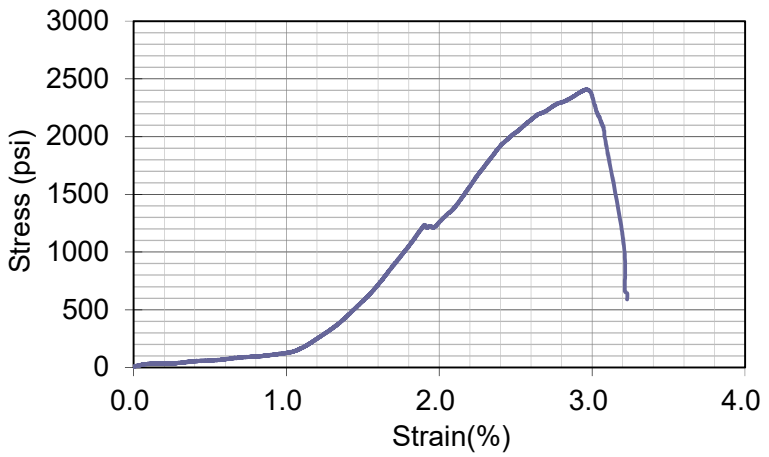
BORING NUMBER	B-018-0-23	TOP DEPTH(FT)	5.8	BOTTOM DEPTH(FT)	6.4
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Tan, Slightly Weathered, Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.043	1.963
2	4.035	1.963
3	4.038	1.972
AVERAGE	4.039	1.966

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	503.4
UNIT WEIGHT(LBS/FT^3)	156.4

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
2,410
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.14
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

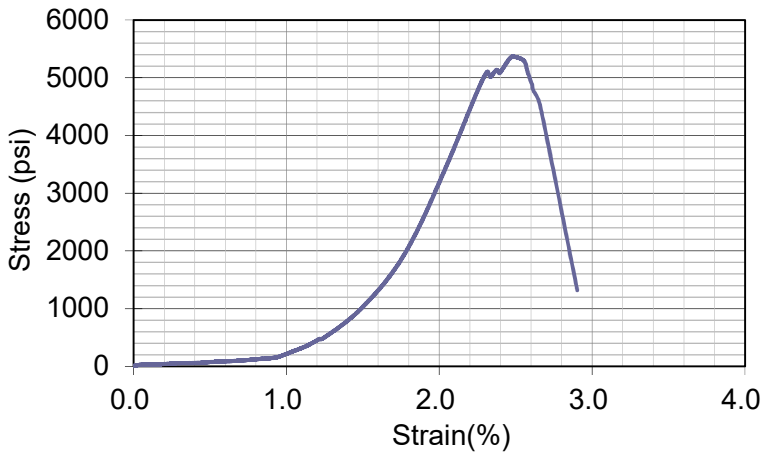
BORING NUMBER	B-018-0-23	TOP DEPTH(FT)	16.4	BOTTOM DEPTH(FT)	16.9
SAMPLE NUMBER	NQ2-3	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.013	1.966
2	4.020	1.966
3	4.018	1.971
AVERAGE	4.017	1.968

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	484.5
UNIT WEIGHT(LBS/FT^3)	151.1

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
5,370
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.08
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

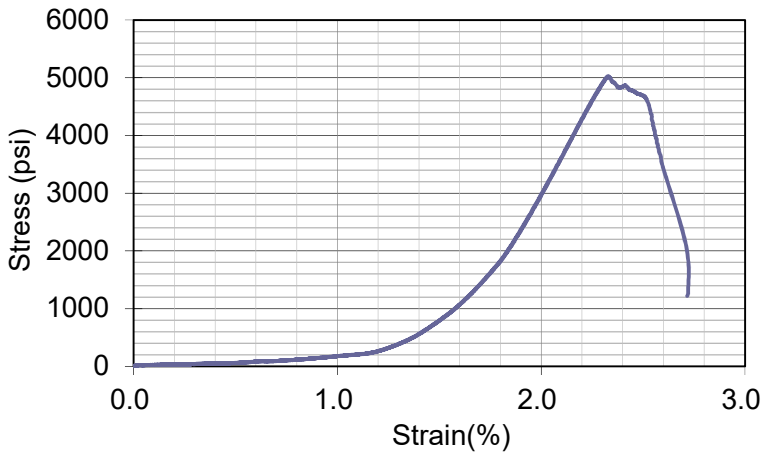
BORING NUMBER	B-018-0-23	TOP DEPTH(FT)	21.0	BOTTOM DEPTH(FT)	21.5
SAMPLE NUMBER	NQ2-4	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.035	1.975
2	4.034	1.974
3	4.036	1.971
AVERAGE	4.035	1.973

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	488.2
UNIT WEIGHT(LBS/FT^3)	150.7

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
5,030
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.55
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

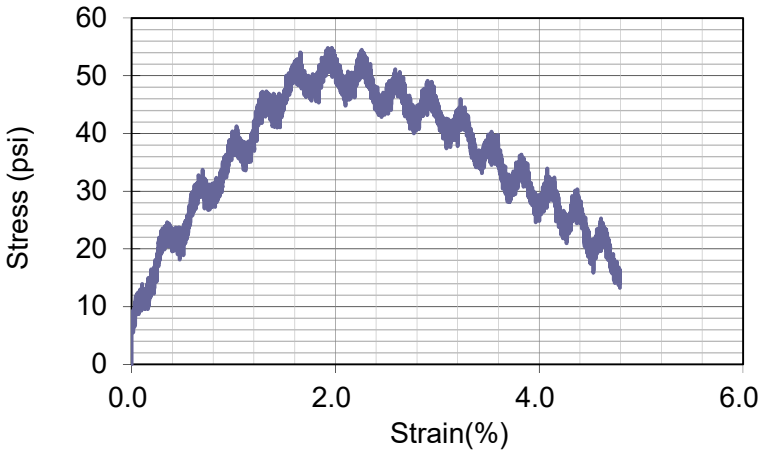
BORING NUMBER	B-019-0-23	TOP DEPTH(FT)	18.5	BOTTOM DEPTH(FT)	18.9
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Gray, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.022	2.032
2	4.025	2.019
3	4.014	2.032
AVERAGE	4.020	2.028

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.2
MASS (GRAMS)	483.0
UNIT WEIGHT(LBS/FT^3)	141.7

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
50
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.94
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

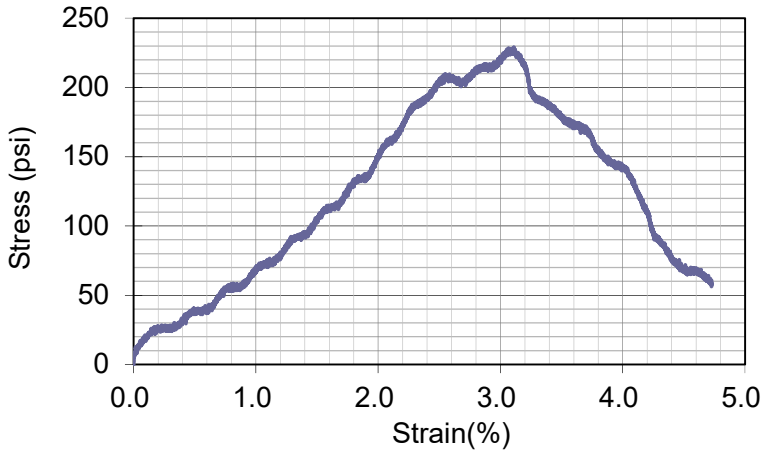
BORING NUMBER	B-019-0-23	TOP DEPTH(FT)	24.5	BOTTOM DEPTH(FT)	25.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Gray, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.028	2.002
2	4.025	1.985
3	4.023	1.989
AVERAGE	4.025	1.992

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	460.1
UNIT WEIGHT(LBS/FT^3)	139.7

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
230
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.54
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

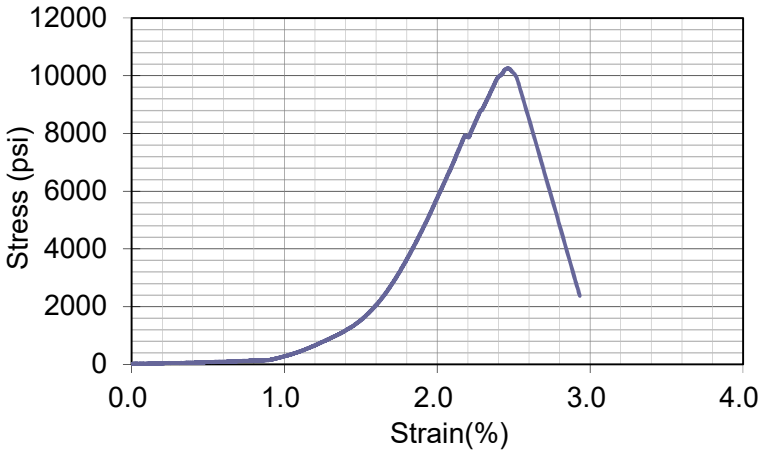
BORING NUMBER	B-020-0-23	TOP DEPTH(FT)	21.7	BOTTOM DEPTH(FT)	22.3
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.945	1.973
2	3.958	1.974
3	3.944	1.975
AVERAGE	3.949	1.974

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	531.2
UNIT WEIGHT(LBS/FT^3)	167.4

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
10,260
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.06
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

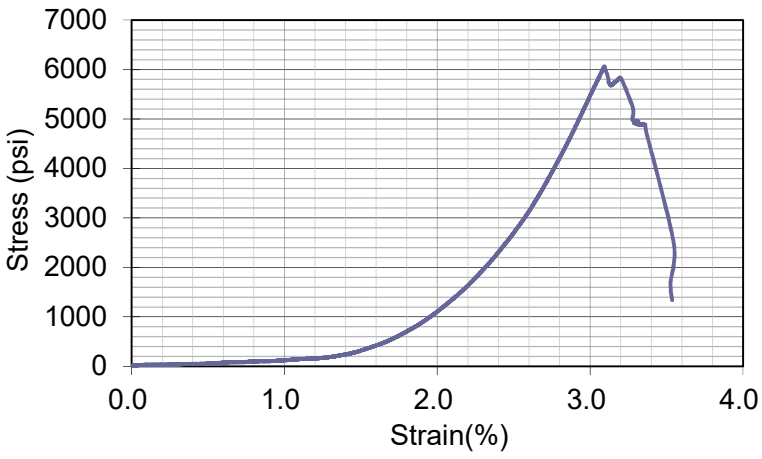
BORING NUMBER	B-020-0-23	TOP DEPTH(FT)	25.5	BOTTOM DEPTH(FT)	26.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.986	1.977
2	3.990	1.975
3	3.985	1.968
AVERAGE	3.987	1.973

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	526.4
UNIT WEIGHT(LBS/FT^3)	164.5

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
6,060
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.24
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

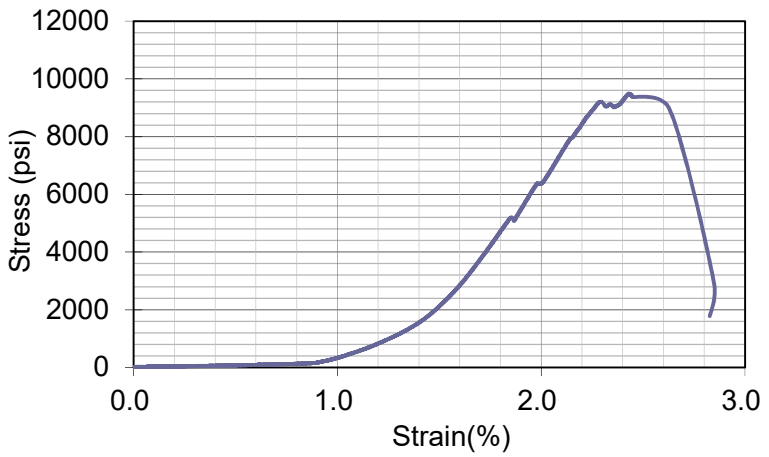
BORING NUMBER	B-021-0-23	TOP DEPTH(FT)	10.5	BOTTOM DEPTH(FT)	11.0
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.978	1.974
2	3.974	1.968
3	3.976	1.971
AVERAGE	3.976	1.971

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	548.2
UNIT WEIGHT(LBS/FT^3)	172.1

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
9,490
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.06
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

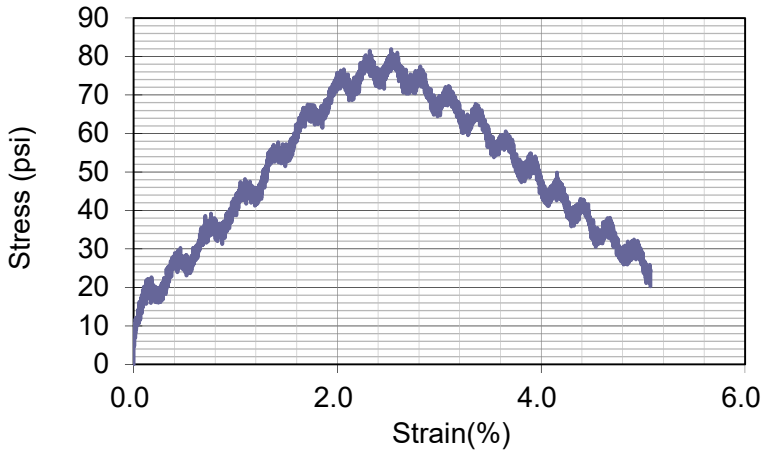
BORING NUMBER	B-021-0-23	TOP DEPTH(FT)	15.0	BOTTOM DEPTH(FT)	15.5
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Gray, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.006	2.001
2	4.001	2.003
3	4.005	2.000
AVERAGE	4.004	2.001

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	484.0
UNIT WEIGHT(LBS/FT^3)	146.4

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
80
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
2.47
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

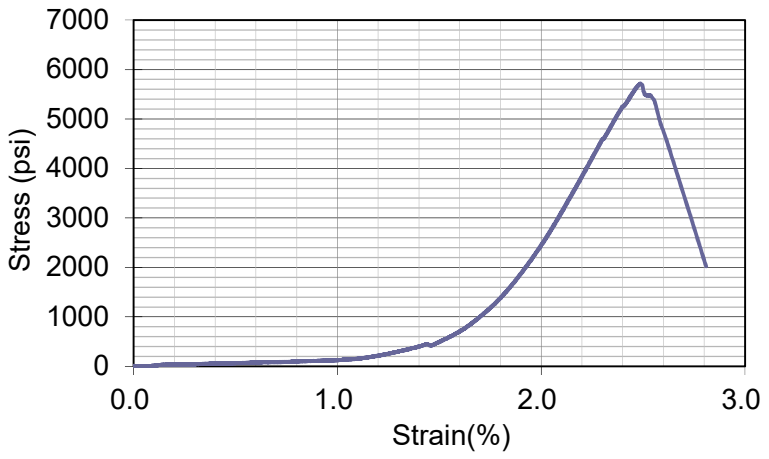
BORING NUMBER	B-021-0-23	TOP DEPTH(FT)	23.5	BOTTOM DEPTH(FT)	24.0
SAMPLE NUMBER	NQ2-4	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.033	1.952
2	4.027	1.953
3	4.028	1.957
AVERAGE	4.029	1.954

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	524.0
UNIT WEIGHT(LBS/FT^3)	165.2

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
5,720
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.19
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

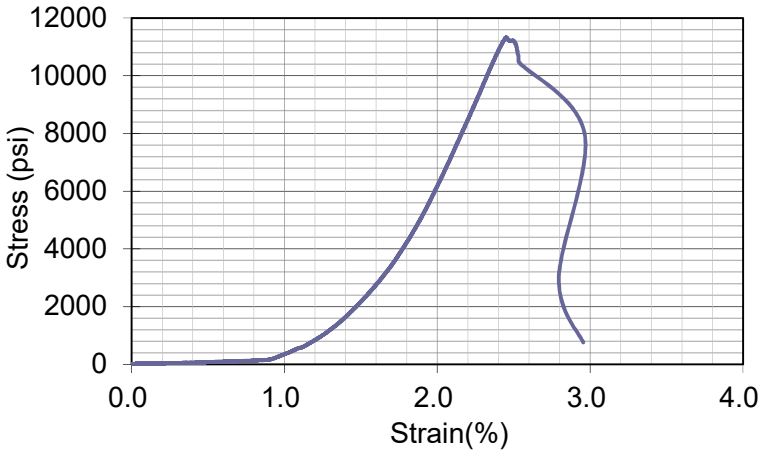
BORING NUMBER	B-022-0-23	TOP DEPTH(FT)	8.0	BOTTOM DEPTH(FT)	8.8
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.011	1.975
2	4.018	1.978
3	4.015	1.976
AVERAGE	4.015	1.976

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	516.1
UNIT WEIGHT(LBS/FT^3)	159.6

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
11,330
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
0.99
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

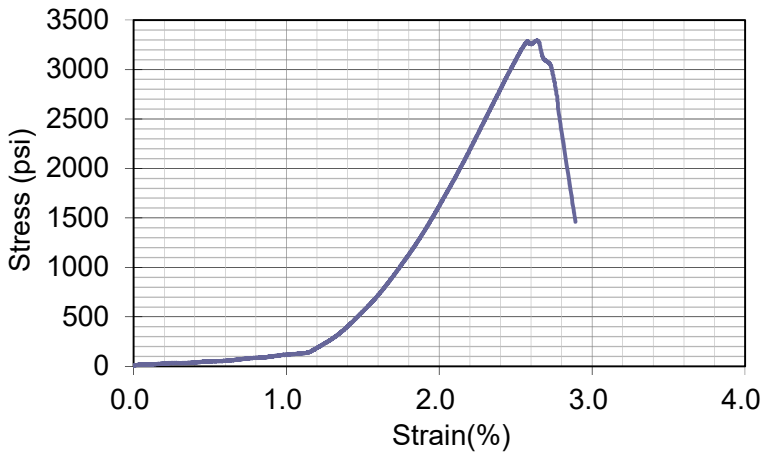
BORING NUMBER	B-022-0-23	TOP DEPTH(FT)	15.0	BOTTOM DEPTH(FT)	15.5
SAMPLE NUMBER	NQ2-3	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered,Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.020	1.963
2	4.020	1.964
3	4.020	1.969
AVERAGE	4.020	1.965

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	464.5
UNIT WEIGHT(LBS/FT^3)	145.1

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
3,290
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.47
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

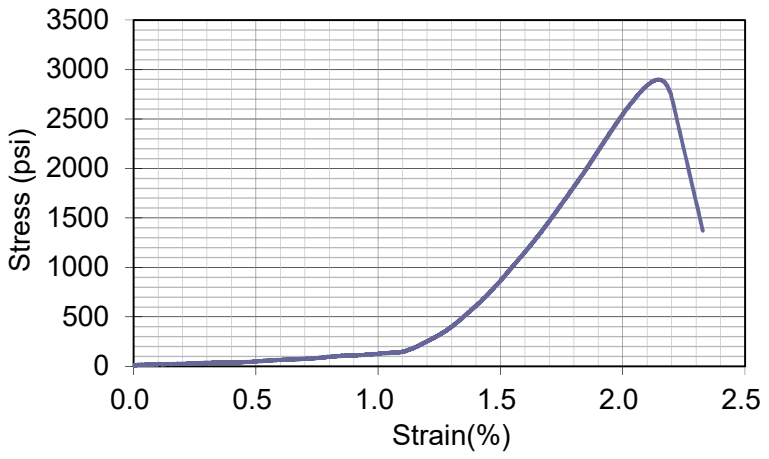
BORING NUMBER	B-022-0-23	TOP DEPTH(FT)	18.0	BOTTOM DEPTH(FT)	18.6
SAMPLE NUMBER	NQ2-4	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered,Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.032	1.974
2	4.030	1.976
3	4.028	1.969
AVERAGE	4.030	1.973

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	436.3
UNIT WEIGHT(LBS/FT^3)	134.9

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
2,900
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
0.99
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

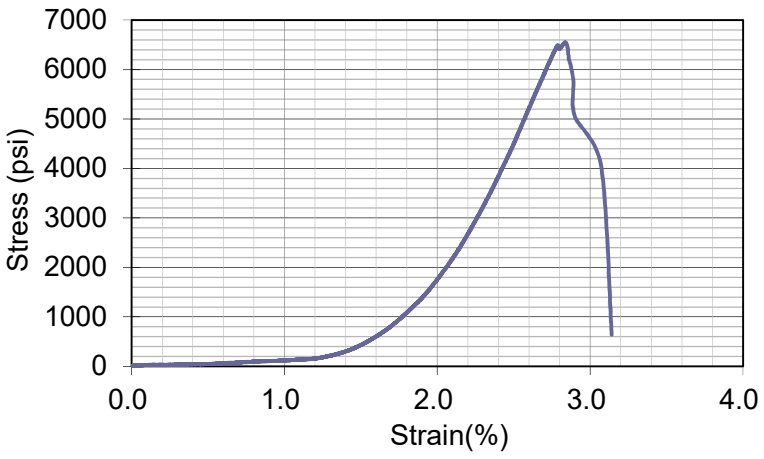
BORING NUMBER	B-023-0-23	TOP DEPTH(FT)	34.0	BOTTOM DEPTH(FT)	34.6
SAMPLE NUMBER	NQ2-5	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered,Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.991	1.975
2	3.995	1.969
3	3.991	1.974
AVERAGE	3.992	1.973

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	521.7
UNIT WEIGHT(LBS/FT^3)	162.9

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
6,550
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.15
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

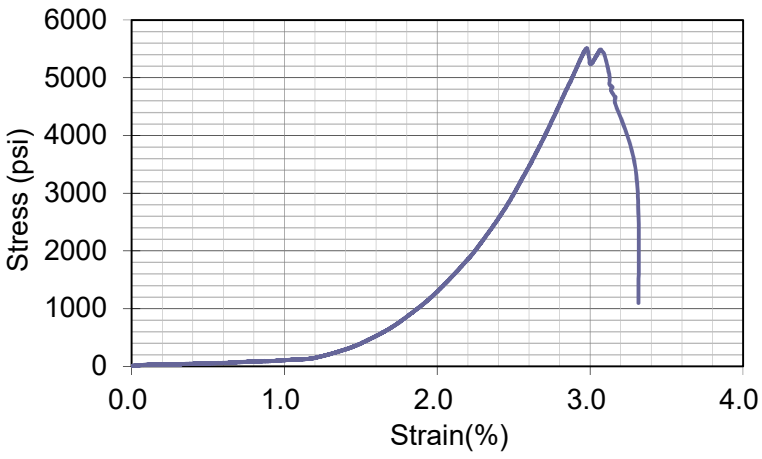
BORING NUMBER	B-023-0-23	TOP DEPTH(FT)	36.0	BOTTOM DEPTH(FT)	36.5
SAMPLE NUMBER	NQ2-6	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered,Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.985	1.967
2	3.986	1.970
3	3.986	1.967
AVERAGE	3.986	1.968

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	502.5
UNIT WEIGHT(LBS/FT^3)	157.9

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
5,510
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.57
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

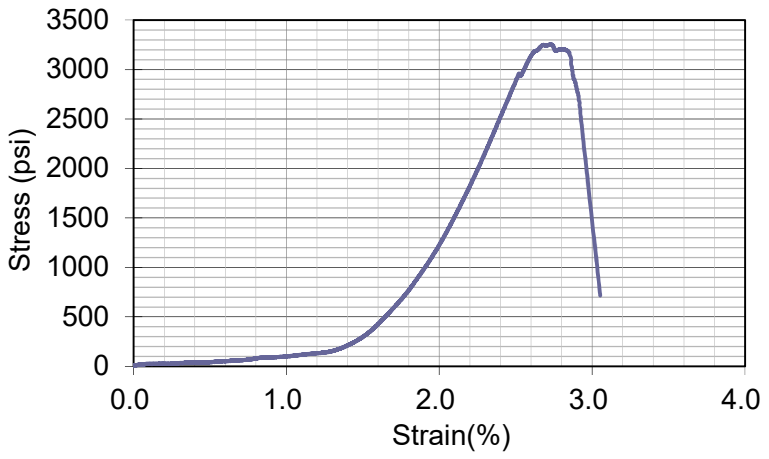
BORING NUMBER	B-023-0-23	TOP DEPTH(FT)	42.0	BOTTOM DEPTH(FT)	42.6
SAMPLE NUMBER	NQ2-7	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered,Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.991	1.978
2	3.991	1.979
3	3.987	1.980
AVERAGE	3.990	1.979

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	460.6
UNIT WEIGHT(LBS/FT^3)	143

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
3,260
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.20
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

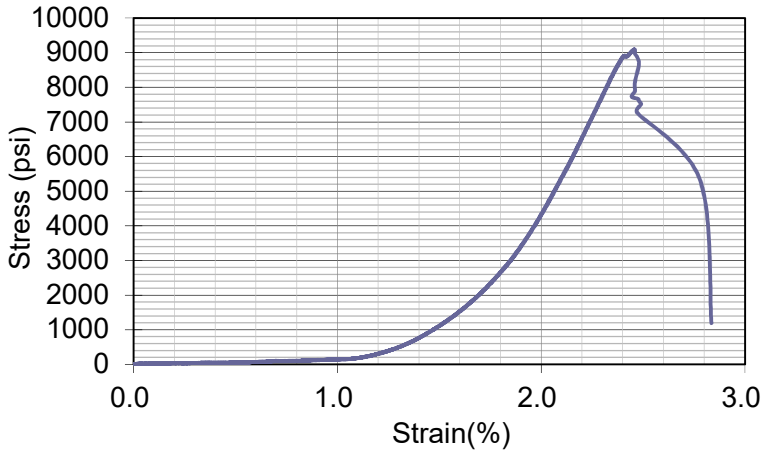
BORING NUMBER	B-023-0-23	TOP DEPTH(FT)	46.0	BOTTOM DEPTH(FT)	46.8
SAMPLE NUMBER	NQ2-8	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.001	1.983
2	3.999	1.979
3	4.000	1.980
AVERAGE	4.000	1.981

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	519.4
UNIT WEIGHT(LBS/FT^3)	160.6

RATE OF LOADING (in/min)
0.08
COMPRESSIVE STRENGTH (PSI)
9,090
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.27
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

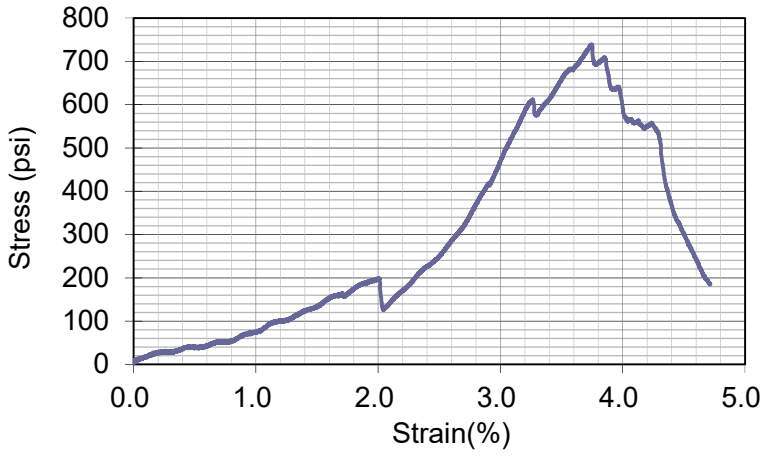
BORING NUMBER	B-023-0-23	TOP DEPTH(FT)	22.2	BOTTOM DEPTH(FT)	22.7
SAMPLE NUMBER	NQ-3	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Gray, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.070	1.985
2	4.064	1.966
3	4.067	1.995
AVERAGE	4.067	1.982

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	499.7
UNIT WEIGHT(LBS/FT^3)	151.7

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
740
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.95
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

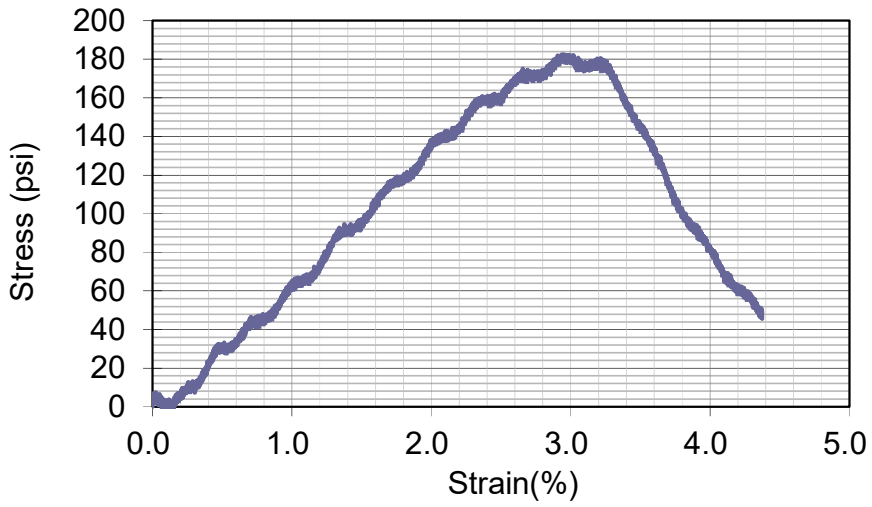
BORING NUMBER	B-035-0-23	TOP DEPTH(FT)	17.0	BOTTOM DEPTH(FT)	17.6
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Brown, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.969	2.000
2	3.968	1.984
3	3.971	1.986
AVERAGE	3.969	1.990

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	469.4
UNIT WEIGHT(LBS/FT^3)	144.9

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
180
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.45
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

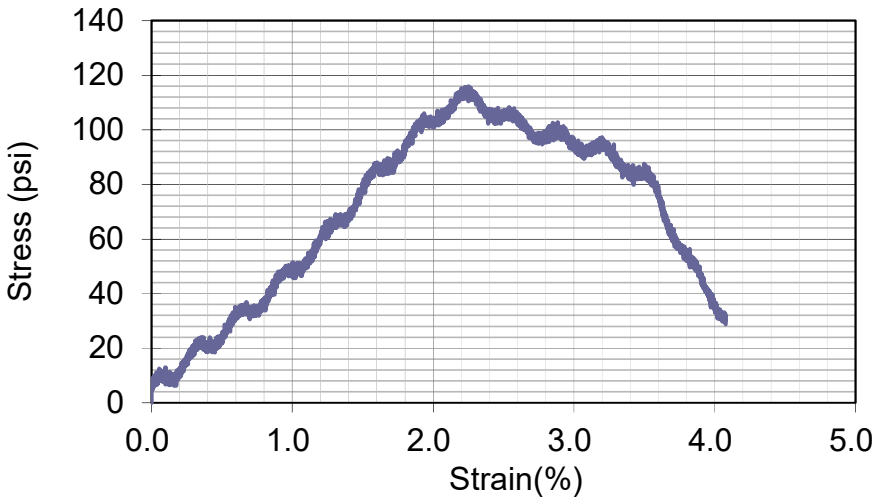
BORING NUMBER	B-035-0-23	TOP DEPTH(FT)	20.2	BOTTOM DEPTH(FT)	20.7
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Brown, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.006	2.015
2	4.013	1.983
3	4.001	2.000
AVERAGE	4.007	1.999

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	501.9
UNIT WEIGHT(LBS/FT^3)	152

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
120
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.74
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

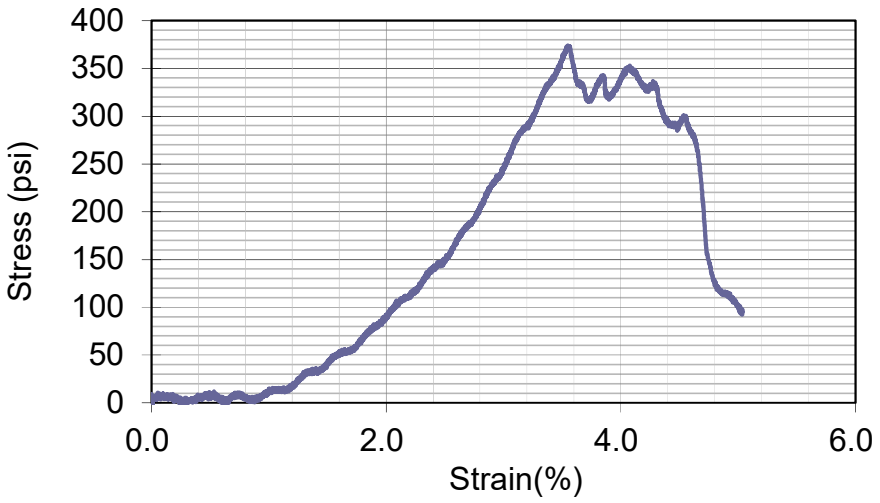
BORING NUMBER	B-036-0-23	TOP DEPTH(FT)	26.2	BOTTOM DEPTH(FT)	26.6
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Gray, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.044	1.951
2	4.066	1.943
3	4.047	1.960
AVERAGE	4.052	1.951

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	481.9
UNIT WEIGHT(LBS/FT^3)	151.5

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
370
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
2.03
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

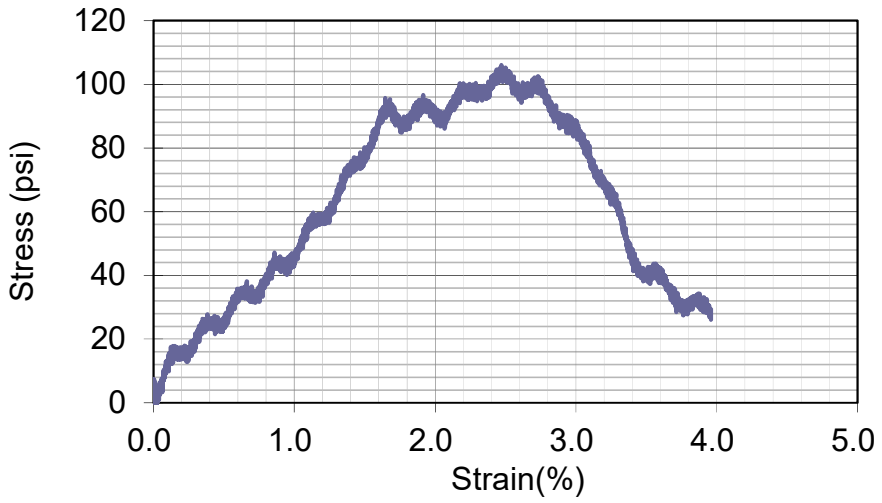
BORING NUMBER	B-037-0-23	TOP DEPTH(FT)	42.0	BOTTOM DEPTH(FT)	42.6
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Red, Slightly Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.066	2.008
2	4.074	2.009
3	4.075	1.986
AVERAGE	4.072	2.001

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	490.6
UNIT WEIGHT(LBS/FT^3)	146

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
110
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.40
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

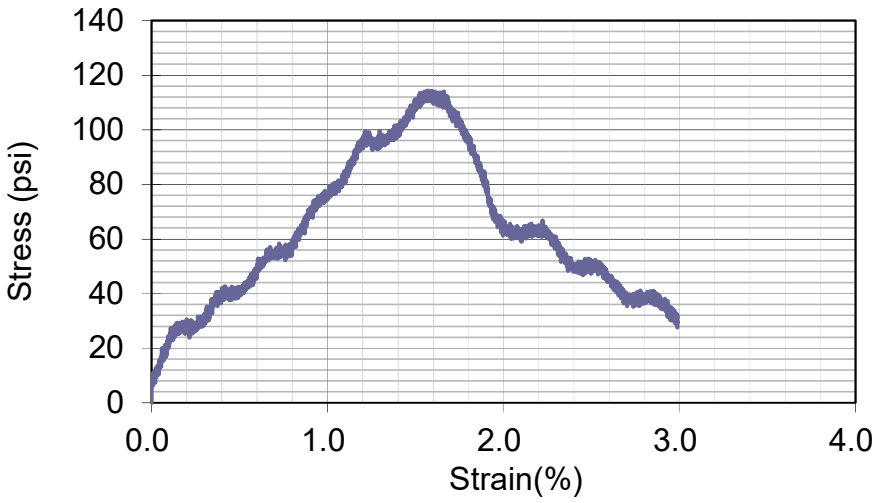
BORING NUMBER	B-037-0-23	TOP DEPTH(FT)	45.5	BOTTOM DEPTH(FT)	46.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Red, Slightly Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.995	2.006
2	3.996	2.008
3	3.998	2.000
AVERAGE	3.996	2.005

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.2
MASS (GRAMS)	466.9
UNIT WEIGHT(LBS/FT^3)	141

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
110
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.08
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

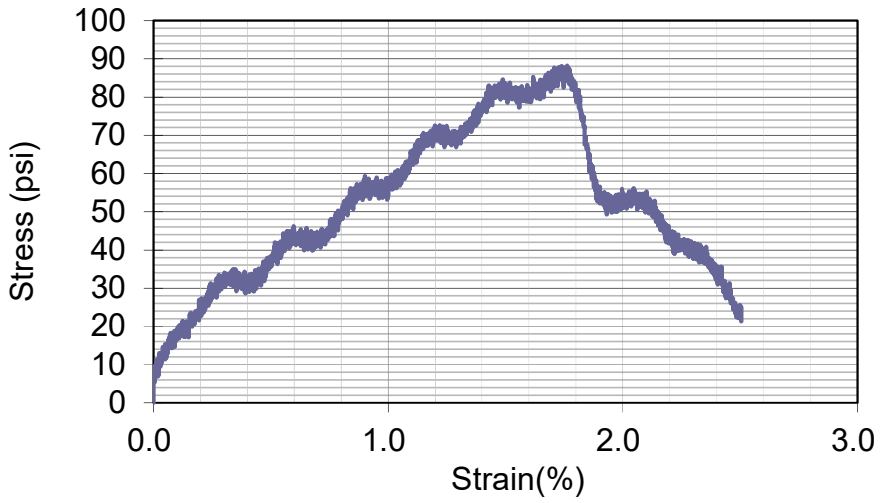
BORING NUMBER	B-038-0-23	TOP DEPTH(FT)	42.0	BOTTOM DEPTH(FT)	42.5
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Red, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.016	1.989
2	4.015	1.973
3	4.020	2.018
AVERAGE	4.017	1.993

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	465.8
UNIT WEIGHT(LBS/FT^3)	141.5

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
90
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
0.97
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

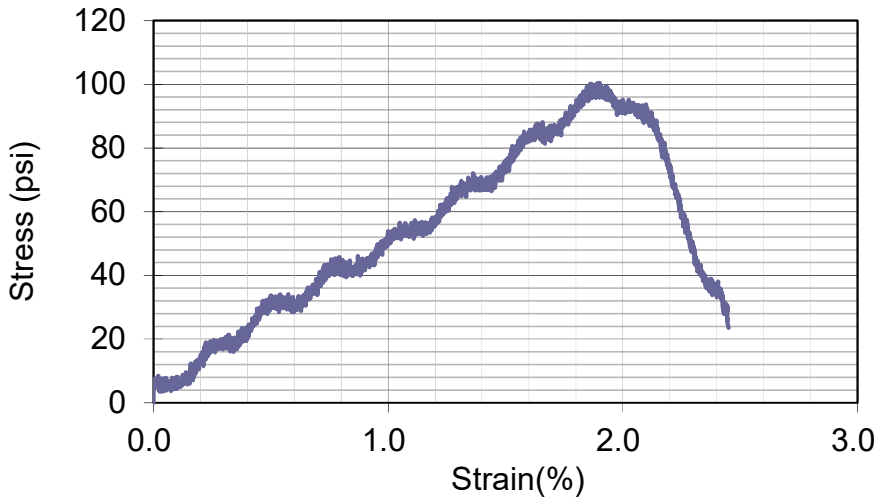
BORING NUMBER	B-038-0-23	TOP DEPTH(FT)	47.4	BOTTOM DEPTH(FT)	47.9
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Red, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.038	2.018
2	4.036	2.004
3	4.046	2.009
AVERAGE	4.040	2.010

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.2
MASS (GRAMS)	463.1
UNIT WEIGHT(LBS/FT^3)	137.6

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
100
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
0.97
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

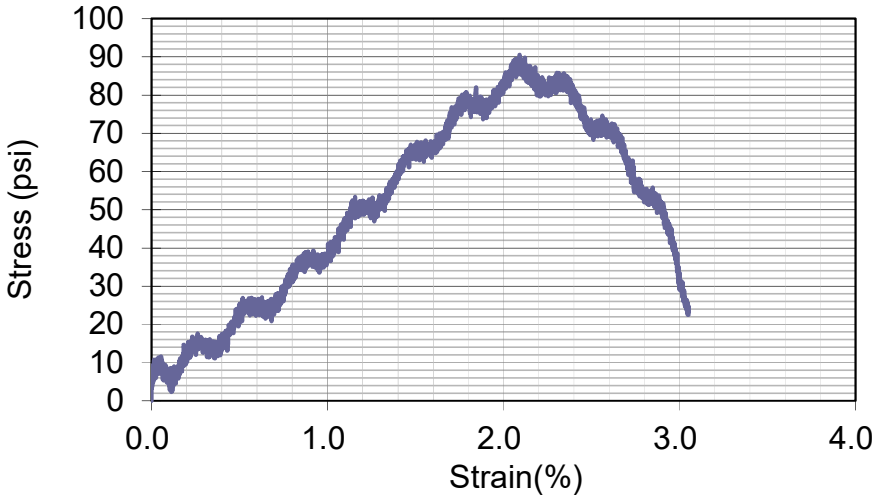
BORING NUMBER	B-039-0-23	TOP DEPTH(FT)	44.4	BOTTOM DEPTH(FT)	45.0
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Red, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.045	2.001
2	4.047	2.015
3	4.043	1.993
AVERAGE	4.045	2.003

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.2
MASS (GRAMS)	470.8
UNIT WEIGHT(LBS/FT^3)	140.7

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
90
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.55
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

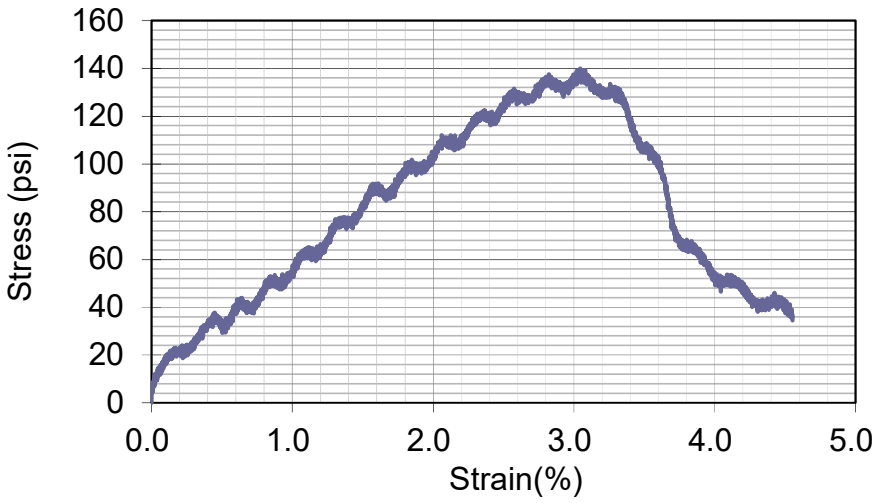
BORING NUMBER	B-039-0-23	TOP DEPTH(FT)	46.0	BOTTOM DEPTH(FT)	46.5
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Red, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.030	2.015
2	4.058	2.004
3	4.049	2.011
AVERAGE	4.046	2.010

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.2
MASS (GRAMS)	473.8
UNIT WEIGHT(LBS/FT^3)	140.6

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
140
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.85
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	2/1/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

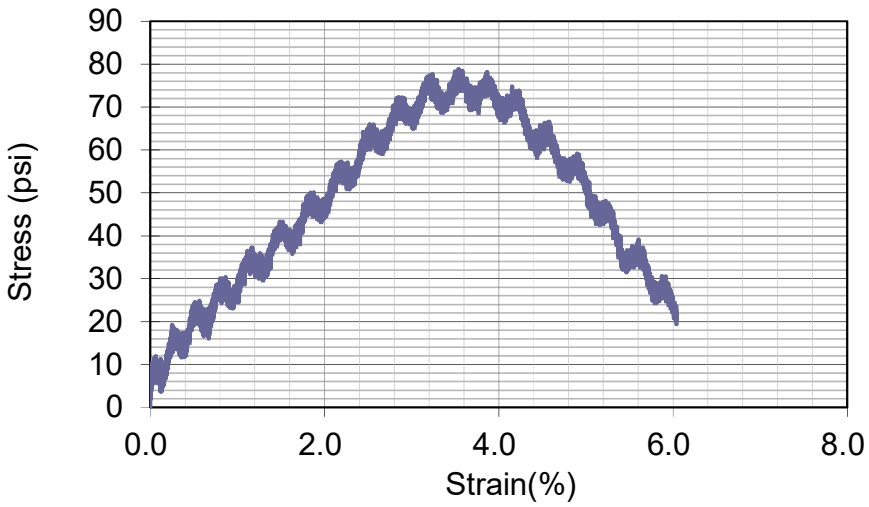
BORING NUMBER	B-042-0-23	TOP DEPTH(FT)	31.5	BOTTOM DEPTH(FT)	32.0
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Red, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.060	1.983
2	4.040	1.974
3	4.049	1.973
AVERAGE	4.050	1.977

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	487.1
UNIT WEIGHT(LBS/FT^3)	149.3

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
80
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
2.76
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

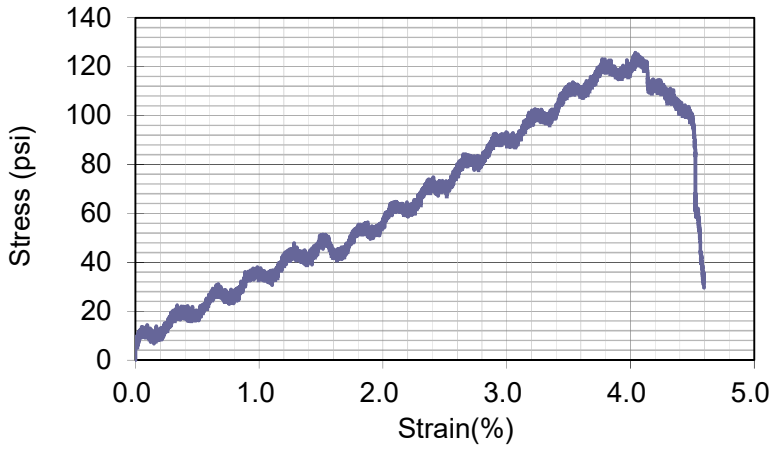
BORING NUMBER	B-044-0-23	TOP DEPTH(FT)	24.5	BOTTOM DEPTH(FT)	25.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monogahela
DESCRIPTION	Claystone, Gray, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.038	1.975
2	4.040	1.986
3	4.041	1.948
AVERAGE	4.040	1.970

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	480.3
UNIT WEIGHT(LBS/FT^3)	148.6

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
130
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.93
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

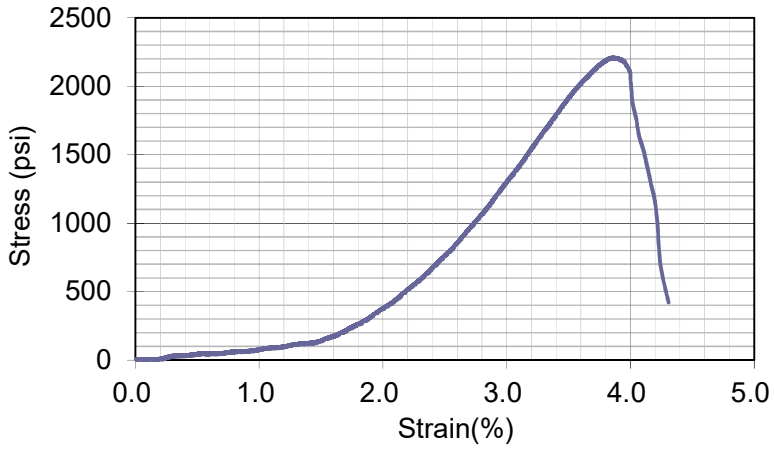
BORING NUMBER	B-045-0-23	TOP DEPTH(FT)	10.0	BOTTOM DEPTH(FT)	10.5
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly to Moderately Weathered, Slightly Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.026	1.961
2	4.030	1.965
3	4.033	1.965
AVERAGE	4.030	1.964

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	495.3
UNIT WEIGHT(LBS/FT^3)	154.6

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
2,210
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.88
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

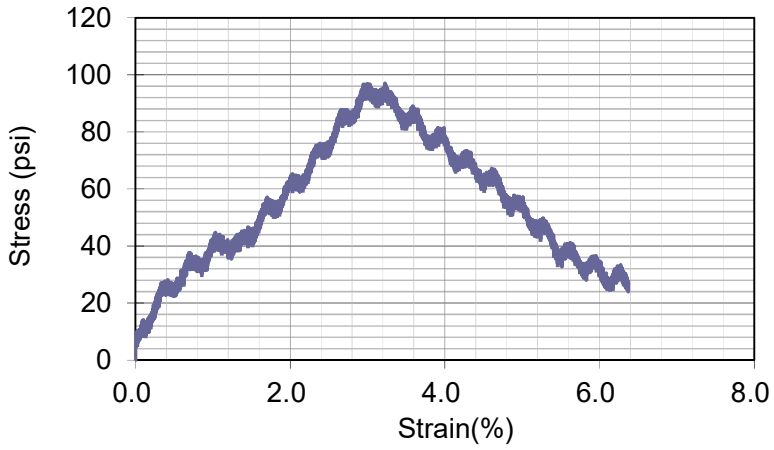
BORING NUMBER	B-047-0-23	TOP DEPTH(FT)	24.2	BOTTOM DEPTH(FT)	24.7
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Red, Highly Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.090	1.987
2	4.092	1.996
3	4.070	2.001
AVERAGE	4.084	1.995

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	480.4
UNIT WEIGHT(LBS/FT^3)	143.4

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
100
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
2.74
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

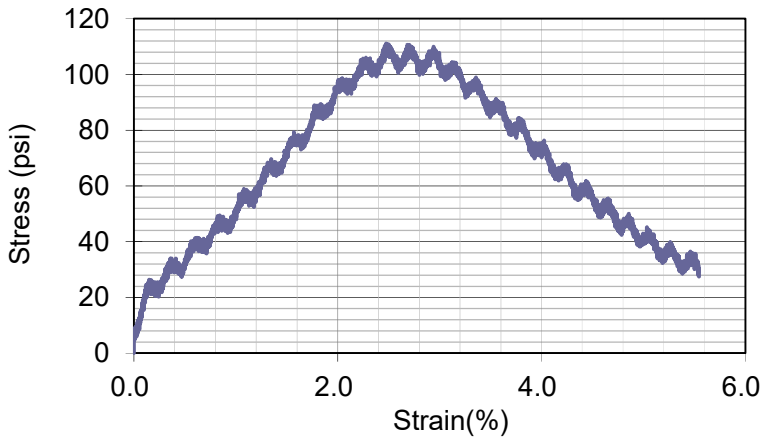
BORING NUMBER	B-047-0-23	TOP DEPTH(FT)	25.2	BOTTOM DEPTH(FT)	25.7
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Red, Highly Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.044	2.017
2	4.036	2.022
3	4.040	2.028
AVERAGE	4.040	2.022

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.2
MASS (GRAMS)	472.9
UNIT WEIGHT(LBS/FT^3)	138.8

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
110
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
2.57
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

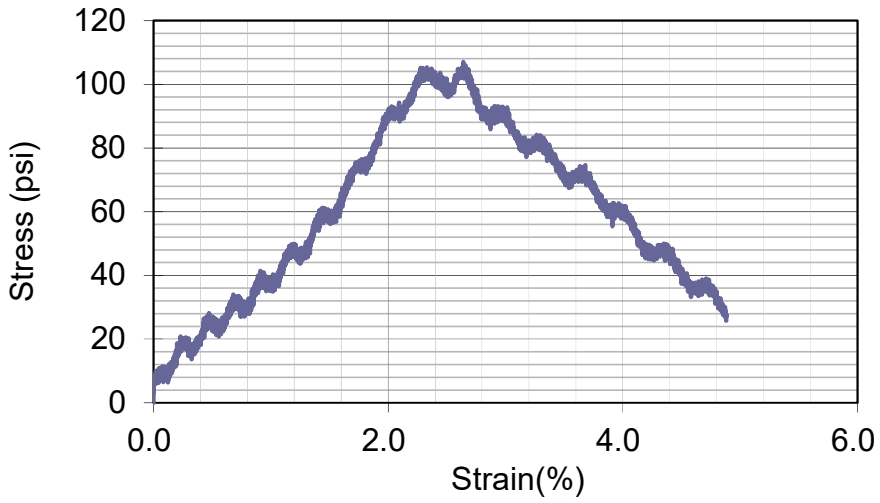
BORING NUMBER	B-048-0-23	TOP DEPTH(FT)	29.1	BOTTOM DEPTH(FT)	29.8
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Red, Slightly to Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.063	2.020
2	4.057	2.021
3	4.060	2.018
AVERAGE	4.060	2.020

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.2
MASS (GRAMS)	515.2
UNIT WEIGHT(LBS/FT^3)	150.9

RATE OF LOADING (in/min)
0.12
COMPRESSIVE STRENGTH (PSI)
110
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.76
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

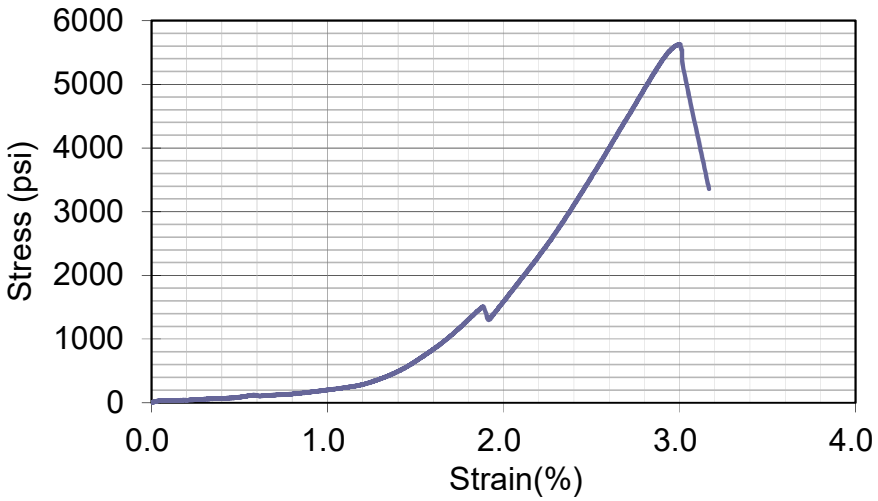
BORING NUMBER	B-048-0-23	TOP DEPTH(FT)	34.4	BOTTOM DEPTH(FT)	35.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly to Moderately Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.058	1.953
2	4.058	1.942
3	4.062	1.949
AVERAGE	4.059	1.948

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	520.1
UNIT WEIGHT(LBS/FT^3)	163.8

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
5,630
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.16
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

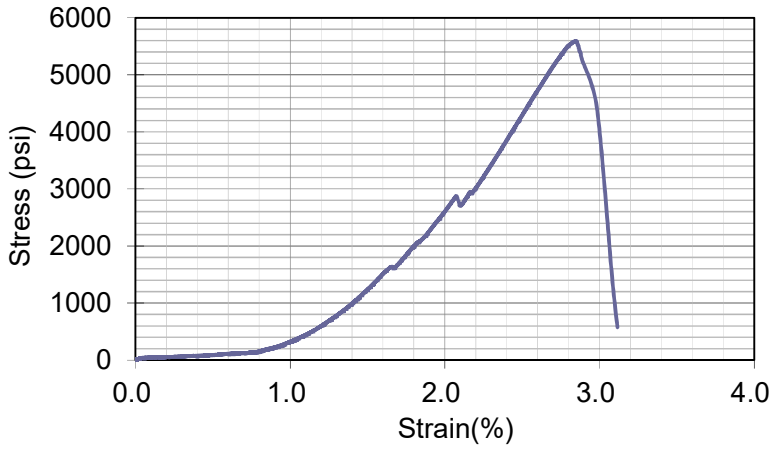
BORING NUMBER	B-049-0-23	TOP DEPTH(FT)	32.9	BOTTOM DEPTH(FT)	33.4
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Gray, Slightly to Moderately Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.047	1.962
2	4.053	1.967
3	4.050	1.968
AVERAGE	4.050	1.966

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	526.6
UNIT WEIGHT(LBS/FT^3)	163.2

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
5,590
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.24
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

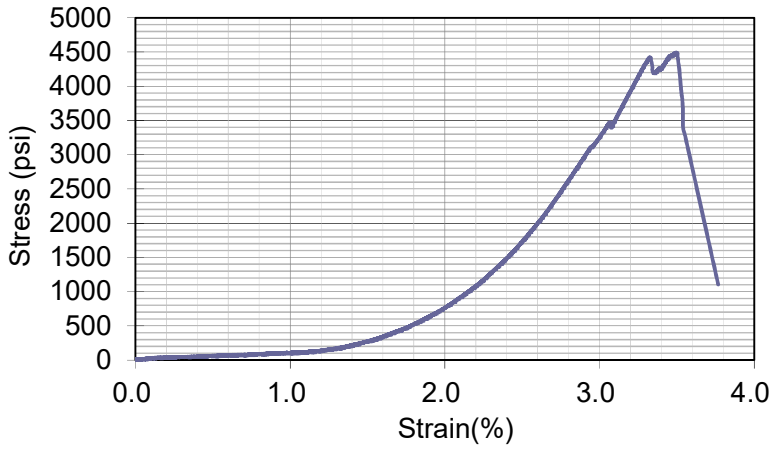
BORING NUMBER	B-049-0-23	TOP DEPTH(FT)	38.3	BOTTOM DEPTH(FT)	38.8
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119141
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	18.70/00.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Gray, Slightly to Moderately Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.038	1.974
2	4.039	1.970
3	4.044	1.975
AVERAGE	4.040	1.973

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	516.7
UNIT WEIGHT(LBS/FT^3)	159.3

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
4,490
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.35
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

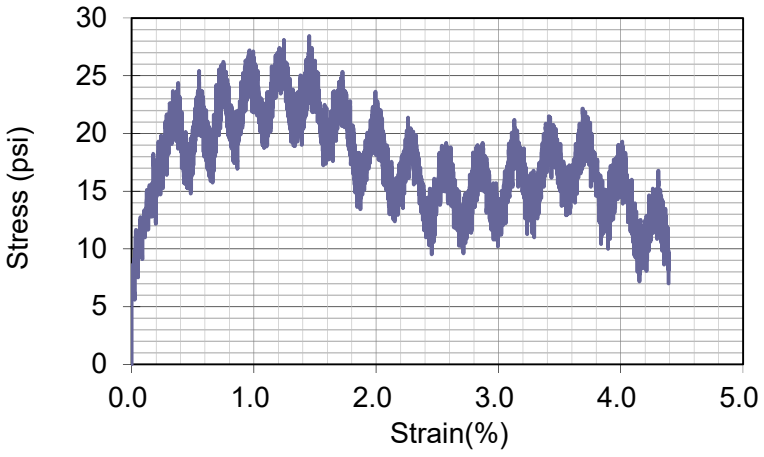
BORING NUMBER	B-050-0A-23	TOP DEPTH(FT)	16.1	BOTTOM DEPTH(FT)	16.5
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Dunkard
DESCRIPTION	Claystone, Brown, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.836	1.992
2	3.844	1.995
3	3.837	1.993
AVERAGE	3.839	1.993

LENGTH/DIAMETER	1.9
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	426.7
UNIT WEIGHT(LBS/FT^3)	135.7

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
30
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.79
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/3/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

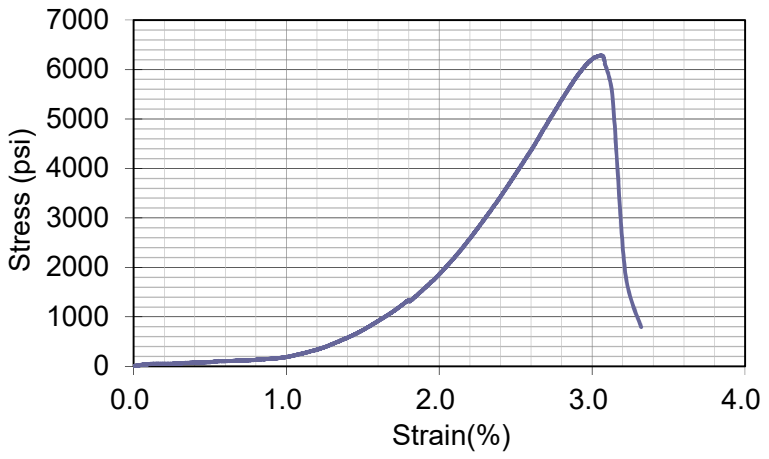
BORING NUMBER	B-050-0A-23	TOP DEPTH(FT)	24.3	BOTTOM DEPTH(FT)	25.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Dunkard
DESCRIPTION	Shale, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.037	1.951
2	4.035	1.955
3	4.034	1.950
AVERAGE	4.035	1.952

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	489.4
UNIT WEIGHT(LBS/FT^3)	154.4

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
6,280
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.23
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

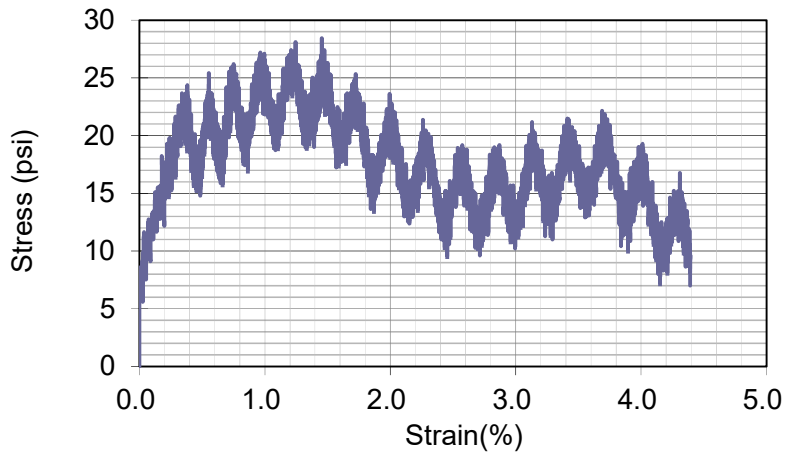
BORING NUMBER	B-050-0A-23	TOP DEPTH(FT)	16.1	BOTTOM DEPTH(FT)	16.5
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Claystone, Brown, Moderately Weathered, Very Weak
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.836	1.992
2	3.844	1.995
3	3.837	1.993
AVERAGE	3.839	1.993

LENGTH/DIAMETER	1.9
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	426.7
UNIT WEIGHT(LBS/FT^3)	135.7

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
30
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.79
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

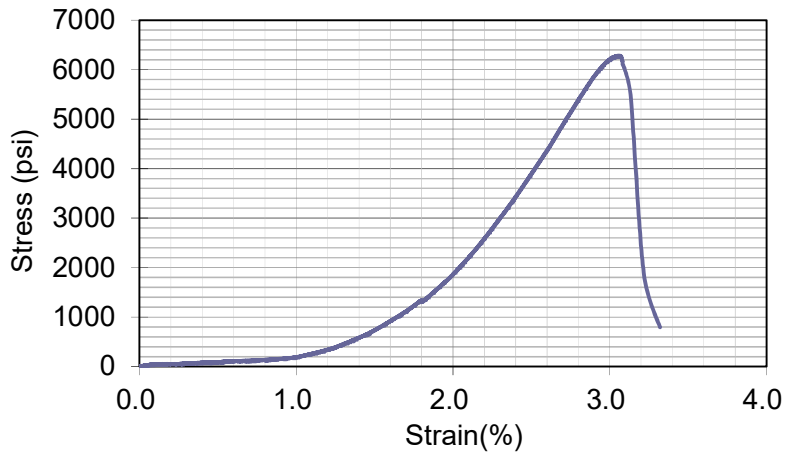
BORING NUMBER	B-050-0A-23	TOP DEPTH(FT)	24.3	BOTTOM DEPTH(FT)	25.0
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Shale, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.037	1.951
2	4.035	1.955
3	4.034	1.950
AVERAGE	4.035	1.952

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	489.4
UNIT WEIGHT(LBS/FT^3)	154.4

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
6,280
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.23
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

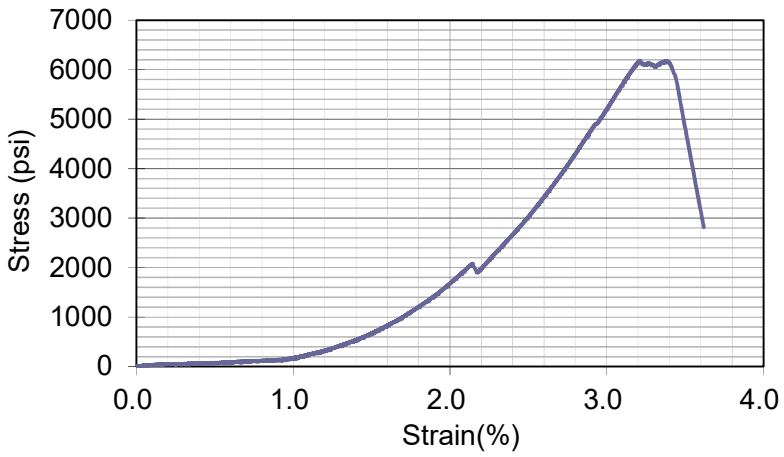
BORING NUMBER	B-051-0-23	TOP DEPTH(FT)	25.7	BOTTOM DEPTH(FT)	26.2
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.040	1.967
2	4.040	1.973
3	4.039	1.967
AVERAGE	4.040	1.969

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	526.4
UNIT WEIGHT(LBS/FT^3)	163

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
6,180
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.80
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

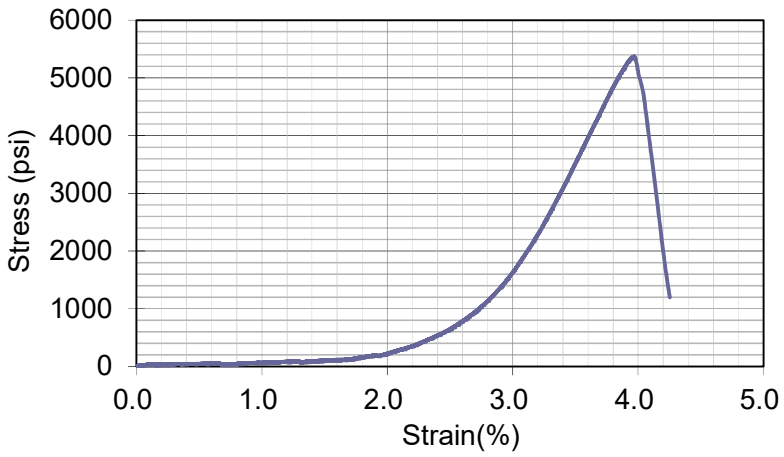
BORING NUMBER	B-051-0-23	TOP DEPTH(FT)	32.3	BOTTOM DEPTH(FT)	32.7
SAMPLE NUMBER	NQ2-3	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.052	1.974
2	4.053	1.986
3	4.056	1.984
AVERAGE	4.054	1.981

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	518.3
UNIT WEIGHT(LBS/FT^3)	158

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
5,370
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.85
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

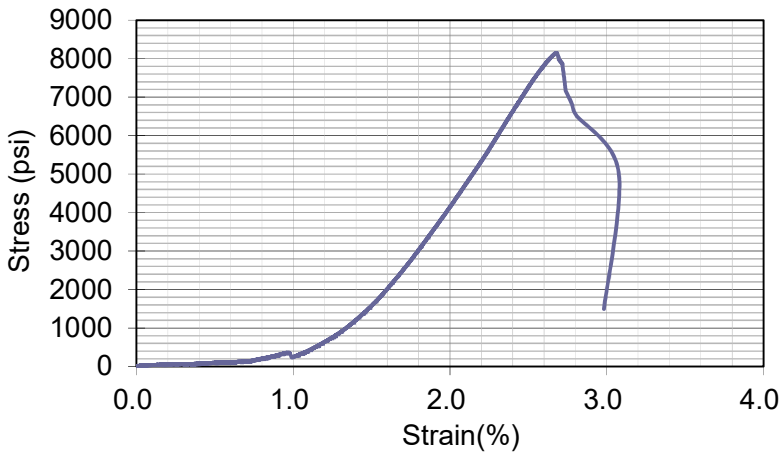
BORING NUMBER	B-052-0-23	TOP DEPTH(FT)	22.8	BOTTOM DEPTH(FT)	23.4
SAMPLE NUMBER	NQ2-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.042	1.974
2	4.035	1.978
3	4.036	1.976
AVERAGE	4.038	1.976

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	505.6
UNIT WEIGHT(LBS/FT^3)	155.5

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
8,150
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.18
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

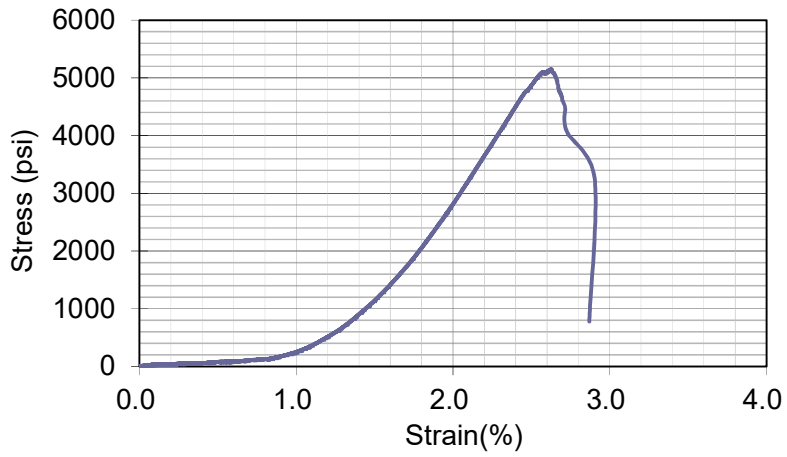
BORING NUMBER	B-052-0-23	TOP DEPTH(FT)	25.1	BOTTOM DEPTH(FT)	25.8
SAMPLE NUMBER	NQ2-2	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

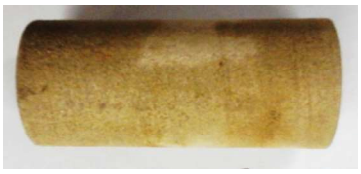
FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Brown, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	4.036	1.967
2	4.033	1.966
3	4.040	1.967
AVERAGE	4.036	1.967

LENGTH/DIAMETER	2.1
CORRECTION FACTOR	1
AREA(IN^2)	3.0
MASS (GRAMS)	479.3
UNIT WEIGHT(LBS/FT^3)	148.9

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
5,150
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.57
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room





BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

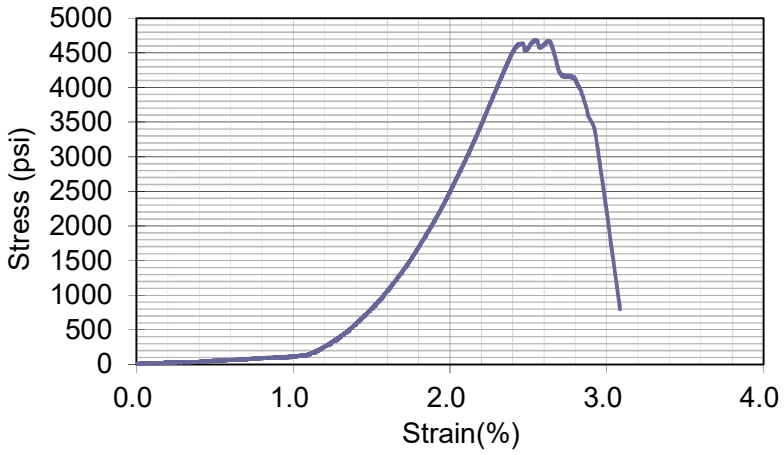
BORING NUMBER	B-058-0-23	TOP DEPTH(FT)	12.0	BOTTOM DEPTH(FT)	12.5
SAMPLE NUMBER	NQ-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Moderately Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.991	1.974
2	3.989	1.980
3	3.980	1.980
AVERAGE	3.987	1.978

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	490.1
UNIT WEIGHT(LBS/FT^3)	152.4

RATE OF LOADING (in/min)
0.10
COMPRESSIVE STRENGTH (PSI)
4,680
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.13
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

PROJECT NO:	23050059COL
DATE:	9/11/2024

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE - ASTM D 7012

Method C

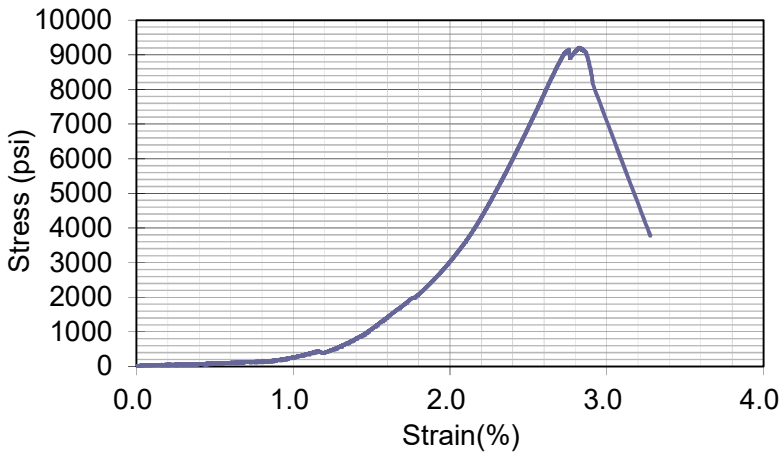
BORING NUMBER	B-059-0-23	TOP DEPTH(FT)	11.3	BOTTOM DEPTH(FT)	12.0
SAMPLE NUMBER	NQ-1	DISTRICT	10	PID NO.	119142
COUNTY	ATH/MEG	ROUTE	US 33	SECTION	23.23/0.00

FORMATION	Conemaugh and Monongahela
DESCRIPTION	Sandstone, Gray, Slightly Weathered, Strong
MOISTURE CONDITION	As Received

MEASUREMENT	LENGTH(INCHES)	DIAMETER(INCHES)
1	3.979	1.980
2	3.976	1.979
3	3.980	1.980
AVERAGE	3.978	1.980

LENGTH/DIAMETER	2.0
CORRECTION FACTOR	1
AREA(IN^2)	3.1
MASS (GRAMS)	514.2
UNIT WEIGHT(LBS/FT^3)	160

RATE OF LOADING (in/min)
0.09
COMPRESSIVE STRENGTH (PSI)
9,200
Equip. ID - 68897
NON-CONFORMANCES - None
TIME OF TEST (MINUTES)
1.66
LOADING DIRECTION
PERP. TO BEDDING
TECHNICIAN - MW
TEMPERATURE - Room



BEFORE TESTING

AFTER TESTING

Physical Appearance after Test - Sample sheared through middle portion - No signs of cracking, spalling or shearing at the platen-specimen interface

≤ Prepared in accordance with ASTM D 4543: **Yes; see report**

≤ Received sample preserved in accordance with SGE: **Yes**

≤ Sampled preserved after preparation: **N; Tested immediately after preparation.**

APPENDIX D

ATH-00021-02.072- DESIGN CALCULATIONS

Rock Mass Rating (RMR)

HNTB, Ohio Inc.
ATH/MEG-033-18.70/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SM
Date: 4-Oct-2024
Boring/Fnd: B-044-0-23, Pier
Sample/Depth SS-4 & SS-5, 8.5'-13.5'

Field RQD (%) = 0
Lab q_u (psi) = 130 NQ-2, 24.5'-25.0'
Lab γ (pcf) = 148.6 NQ-2, 24.5'-25.0'

Geomechanics Classification of Rock Masses

	PARAMETER	RANGES OF VALUES							Rating
1	Strength of Intact Rock Material	Point Load Strength Index	> 175 ksf	85 - 175 ksf	45 - 85 ksf	20 - 45 ksf	For this low range - uniaxial compressive test is preferred			**0**
			> 1,200 psi	600 to 1,200 psi	300 to 600 psi	150 to 300 psi				
		Uniaxial Compressive Strength	> 4320 ksf	2160 - 4320 ksf	1080 - 2160 ksf	520 - 1080 ksf	215 - 520 ksf	70 - 215 ksf	20 - 70 ksf	
			> 30,000 psi	15,000 to 30,000 psi	7,500 to 15,000 psi	3,600 to 7,500 psi	1,500 to 3,600 psi	500 to 1,500 psi	150 to 500 psi	
	Relative Rating		15	12	7	4	2	1	0	
2	Drill Core Quality (RQD)	90% to 100%	75% to 90%		50% to 75%		25% to 50%		< 25%	**3**
	Relative Rating	20	17		13		8		3	
3	Spacing of Joints	> 10 ft	3 to 10 ft.		1 to 3 ft.		2 in. to 1 ft.		< 2 in.	**5**
	Relative Rating	30	25		20		10		5	
4	Condition of Joints	- Very rough surfaces - Not continous - No separation - Hard joint wall rock	- Slightly rough surfaces - Separation <0.05" - Hard joint wall rock		- Slightly rough surfaces - Separation <0.05" - Soft joint wall rock		- Slickensides surfaces or - Gouge <0.2" thick or - Joints open 0.05-0.2" - Continous joints		- Soft gouge >0.2" thick or - Joints open >0.2" - Continuous joints	**12**
	Relative Rating	25	20		12		6		0	
5	Groundwater Conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None		< 400 gallons/hr.		400 to 2,000 gallons/hr.		> 2,000 gallons/hr.	**7**
		Ratio = joint water pressure / major principal stress	0		0.0 to 0.2		0.2 to 0.5		> 0.5	
		General Conditions	Completely Dry		Moist Only (interstitial water)		Water under Moderate Pressure		Severe Water Problems	
	Relative Rating		10		7		4		0	
									Rock Mass Rating (RMR) =	**27**

AASHTO Table 10.4.6.4-2 - Geomechanics Rating Adjustment for Joint Orientations

Strike and Dip Orientations of Joints		Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	
Ratings	Tunnels	0	-2	-5	-10	-12	**0**
	Foundations	0	-2	-7	-15	-25	
	Slopes	0	-5	-25	-50	-60	
						Adjusted Rock Mass Rating (RMR) =	**27**

AASHTO Table 10.4.6.4-3 - Geomechanics Rock Mass Classes Determined from Total Ratings

RMR	100 to 81	81 to 61	61 to 41	41 to 21	< 20	**Class:**
Class No.	I	II	III	IV	V	**IV**
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock	

ODOT GDM 1303.3.3 - Calculated Rock Mass Parameters

RMR =	27	see Adjusted Rock Mass Rating above	
c' =	2.81	c' = (0.104 x RMR) (ksf)	drained shear strength of rock mass
ϕ' =	19	ϕ' = ((RMR/2) + 5) (deg.)	internal friction angle of rock mass
s =	0.00030	s = exp((RMR-100)/9)	rock mass material constant defining intactness (quality) of rock mass
m =	0.7374	m=exp((RMR-100)/28)*m_i	rock mass material constant defining the shape of the Mohr's circle for uniaxial comp.
m_i =	10	Sandstone, m_i = 15	rock mass constant m for intact rock (where s = 100)
		Claystone/Shale, m_i = 10	
		Limestone/Dolomite, m_i = 7	
		Coal, m_i = 1	
E_m =	55555.94	$E_m = 144*145*10^{((RMR-10)/40)}$ (ksf)	

LRFD Strength Limit State Design for Bearing Resistance of Rock using Spread Footings

HNTB, Ohio Inc.
ATH/MEG-033-18.70/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-044-0-23, Pier
Footing Elevation: 962.8

ODOT GDM 1303.3.3 - Bearing Resistance of Bedrock (Moderately Strong or Less Strength Rock)

Does foundation bedrock meet ALL of following three conditions:

- bedrock surface under footing is not steeply sloping such that discontinuities would control the bearing resistance (a bedrock slope of 2H:1V or less)
- the foundation bedrock has a Rock Mass rating (RMR) ≤ 70
- the foundation bedrock is moderately strong or less in strength (qu ≤ 7500 psi)

if YES to all three conditions, then use the Terzaghi/Vesic/Munfakh method to calculate nominal bearing resistance in accordance with AASHTO LRFD 10.6.3.1.2a

Footing Parameters:

B =	13.0	footing width, ft.
D =	6.2	footing depth, ft.

$q_n = c'N_c+\gamma DN_q+0.5\gamma_t BN_\gamma$ nominal bearing resistance

where

c' =	2.81	drained shear strength of rock mass, ksf
ϕ' =	19	internal friction angle of rock mass, deg.
N_c =	13.5	cohesion bearing capacity factor
γ =	0.058	unit weight of soil above footing, kcf
N_q =	5.5	surcharge bearing capacity factor
γt =	0.149	unit weight of rock below footing, kcf
N_γ =	4.4	soil density factor

hence,

q_n = 44.1 ksf

and,

φ_b =	0.45	strength limit state resistance factor
q_R =	**19.9**	**strength limit state factored resistance, $\varphi_b * q_n$, ksf**

Rock Mass Rating (RMR)

HNTB, Ohio Inc. | Engineer: SM | Field RQD (%) = 0

ATH/MEG-033-18.70/0.00 | Date: 4-Oct-2024 | Lab q_u (psi) = 200 | GDM Table 400-6, Very Weak Rock

Athens and Meigs County | **Boring/Fnd: B-045-0-23, Forward Abut.** | Lab γ (pcf) = 140.0 | Assumed

CTL Project No.: 23050059COL | **Sample/Depth SS-2, SS-3 and SS-4**

Geomechanics Classification of Rock Masses

	PARAMETER	RANGES OF VALUES							Rating
1	Strength of Intact Rock Material	Point Load Strength Index	> 175 ksf	85 - 175 ksf	45 - 85 ksf	20 - 45 ksf	For this low range - uniaxial compressive test is preferred		**0**
			> 1,200 psi	600 to 1,200 psi	300 to 600 psi	150 to 300 psi			
		Uniaxial Compressive Strength	> 4320 ksf	2160 - 4320 ksf	1080 - 2160 ksf	520 - 1080 ksf	215 - 520 ksf	70 - 215 ksf	20 - 70 ksf
			> 30,000 psi	15,000 to 30,000 psi	7,500 to 15,000 psi	3,600 to 7,500 psi	1,500 to 3,600 psi	500 to 1,500 psi	150 to 500 psi
	Relative Rating		15	12	7	4	2	1	0
2	Drill Core Quality (RQD)	90% to 100%	75% to 90%		50% to 75%		25% to 50%		< 25%	**3**
	Relative Rating	20	17		13		8		3
3	Spacing of Joints	> 10 ft	3 to 10 ft.		1 to 3 ft.		2 in. to 1 ft.		< 2 in.	**5**
	Relative Rating	30	25		20		10		5
4	Condition of Joints	- Very rough surfaces - Not continous - No separation - Hard joint wall rock	- Slightly rough surfaces - Separation <0.05" - Hard joint wall rock		- Slightly rough surfaces - Separation <0.05" - Soft joint wall rock		- Slickensides surfaces or - Gouge <0.2" thick or - Joints open 0.05-0.2" - Continous joints		- Soft gouge >0.2" thick or - Joints open >0.2" - Continuous joints	**12**
	Relative Rating	25	20		12		6		0
5	Groundwater Conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None		< 400 gallons/hr.		400 to 2,000 gallons/hr.		> 2,000 gallons/hr.	**7**
		Ratio = joint water pressure / major principal stress	0		0.0 to 0.2		0.2 to 0.5		> 0.5	
		General Conditions	Completely Dry		Moist Only (interstitial water)		Water under Moderate Pressure		Severe Water Problems	
	Relative Rating		10		7		4		0	

Rock Mass Rating (RMR) = **27**

AASHTO Table 10.4.6.4-2 - Geomechanics Rating Adjustment for Joint Orientations

	Strike and Dip Orientations of Joints	Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	
Ratings	Tunnels	0	-2	-5	-10	-12	**0**
	Foundations	0	-2	-7	-15	-25	
	Slopes	0	-5	-25	-50	-60	

Adjusted Rock Mass Rating (RMR) = 27

AASHTO Table 10.4.6.4-3 - Geomechanics Rock Mass Classes Determined from Total Ratings

RMR	100 to 81	81 to 61	61 to 41	41 to 21	< 20	**Class:**
Class No.	I	II	III	IV	V	**IV**
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock	

ODOT GDM 1303.3.3 - Calculated Rock Mass Parameters

RMR =	27	see Adjusted Rock Mass Rating above	
c' =	2.81	c' = (0.104 x RMR) (ksf)	drained shear strength of rock mass
ϕ' =	19	ϕ' = ((RMR/2) + 5) (deg.)	internal friction angle of rock mass
s =	0.00030	s = exp((RMR-100)/9)	rock mass material constant defining intactness (quality) of rock mass
m =	1.1062	$m=\exp((RMR-100)/28)*m_i$	rock mass material constant defining the shape of the Mohr's circle for uniaxial comp.
m_i =	15	Sandstone, m_i = 15	rock mass constant m for intact rock (where s = 100)
		Claystone/Shale, m_i = 10	
		Limestone/Dolomite, m_i = 7	
		Coal, m_i = 1	
E_m =	55555.94	$E_m = 144*145*10^{((RMR-10)/40)}$ (ksf)	

LRFD Strength Limit State Design for Bearing Resistance of Rock using Spread Footings

HNTB, Ohio Inc.
ATH/MEG-033-18.70/0.00

Athens and Meigs County

CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
B-045-0-23, Forward
Boring/Fnd: Abut.
Footing Elevation: 969.28

ODOT GDM 1303.3.3 - Bearing Resistance of Bedrock (Moderately Strong or Less Strength Rock)

Does foundation bedrock meet ALL of following three conditions:

- bedrock surface under footing is not steeply sloping such that discontinuities would control the bearing resistance (a bedrock slope of 2H:1V or less)
- the foundation bedrock has a Rock Mass rating (RMR) ≤ 70
- the foundation bedrock is moderately strong or less in strength (qu ≤ 7500 psi)

if YES to all three conditions, then use the Terzaghi/Vesic/Munfakh method to calculate nominal bearing resistance in accordance with AASHTO LRFD 10.6.3.1.2a

Footing Parameters

B =	11.0	footing width, ft.	(From Stage 2 Plans)
D =	6.5	footing depth, ft.	(From Stage 2 Plans)

$q_n = c'N_c+\gamma DN_q+0.5\gamma_t BN_\gamma$ nominal bearing resistance

where

c' =	2.81	drained shear strength of rock mass, ksf
ϕ' =	19	internal friction angle of rock mass, deg.
N_c =	13.5	cohesion bearing capacity factor
γ =	0.058	unit weight of soil above footing, kcf
N_q =	5.5	surcharge bearing capacity factor
γt =	0.140	unit weight of rock below footing, kcf
N_γ =	4.4	soil density factor

hence,

q_n = 43.4 ksf

and,

φ_b =	0.45	strength limit state resistance factor
q_R =	**19.5**	**strength limit state factored resistance, φ_b * q_n, ksf**

Soil Parameters

Project: ATH-MEG-033-18.70/0.00
Boring No.: B-042-0-23
Location: ATH-MEG-033-18.70/0.00
Date: 10/4/24

Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Liquidity Index (W-PL)/PI	Gs	Bearing Capacity Index (BCI)	Sand Fraction (BCI)	Clay Fraction (BCI)	e_0	C_c	C_r	C_v (cm^2/sec)	Su (psf)	Pre-Consolidation Stress Ó'p (psf)	Reference
1	969.8	967.3	2.5	A-6b	122	18	10	36	16	-0.3	2.7										
			Avg	A-6b	122	18	10	36	16	-0.3	2.7	67.4	0.67	0.33	0.27	0.2703	0.054	0.0200	2250	12228.3	1,2,3
2	967.3	964.8	2.5	A-1-a	128	26	5				2.65										
			Avg	A-1-a	128	26	5				2.65	113.2	1	0				0.0281			4
3	964.8	959.8	5.0	A-7-6	121	22	21	48	23	-0.1	2.6										
						22	24														
				ST			32	60	26	0.2											
			Avg	A-7-6	121	22	26	54	25	0.1	2.6				0.79	0.25	0.061	0.0002	2750	6000.0	5
4	959.8	954.3	5.5	A-7-6	127	14	26	41	23	0.2	2.6										
						13	24														
				ST			23	37	23												
			Avg	A-7-6	127	14	24	39	23	0.1	2.6				0.55	0.16	0.027	0.0011	1750	5400	6

Soils/bedrock layers encountered below elevation 954.3 are considered incompressible

Reference Key

1 Skempton (1957), FHWA-IF-03-017- GEC-N0.7, TABLE 3.7 used for computing Ó'p if no consolidation data is available
2 Kulhawy and Mayne (1990) per GEC 5 (2016), Figure 6-36 used for computing C_c and C_r if no consolidation data is available
3 FHWA GEC 5 (2016) Figure 6-37, Reloading (lower bound) curve used for C_v computation of Cohesive soil if no consolidation data is available
4 FHWA GEC 5 (2016) Figure 6-37, Virgin Compression used for C_v computation of granular soils if no consolidation data is available
5 Laboratory Consolidation Test Result B-042-0-23, ST-1, 7'-9'
6 Laboratory Consolidation Test Result B-042-0-23, ST-1, 12'-14'

Settlement Calculations

Location **ATH-MEG-033-18.70/0.00**
Boring No. **B-042-0-23**

Embankment Geometry

B_1 = 15 ft
B_2 = 40 ft

Emb. Fill Ht. 20 ft
Unit Wt. = 125 pcf
q = 2500 psf

Soil Parameters

	Elevation		
Top of Embankment	989.8		
		Emb. Fill	
		Unit Wt. =	125 pcf
Existing Grade	969.8	Height =	20 ft
		N_{60} Avg =	18 bpf
	Layer A	Unit Wt. =	122 pcf
	967.3		
		N_{60} Avg =	26 bpf
	Layer B	Unit Wt. =	128 pcf
	964.8		
		N_{60} Avg =	22 bpf
	Layer C	Unit Wt. =	121 pcf
	959.8		
		N_{60} Avg =	14 bpf
	Layer D	Unit Wt. =	127 pcf
	954.3		
		Incompressible Layer	

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	σ'_o (psf)	B_1 / z	B_2 / z	I*	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	$\sigma'p$ (psf)	σ'_f (psf)	Consolidation	Settlement (in) **
A	2.5	122	1.25	152.5	12.0	32.0	1.00	18	0.67	0.33	67.4	12,228.26	2,652.50	OC	0.55
B	2.5	128	3.75	465	4.0	10.7	1.00	26	1	0	113.2			NC	0.21
C	5	121	7.5	927.5	2.0	5.3	0.98	22				6,000.00	3,377.50	OC	1.15
D	5.5	127	12.75	1579.25	1.2	3.1	0.96	14				5,400.00	3,979.25	OC	0.72
														Total:	2.63

0.4" @ Elev.= 962.6

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).

**The settlement value of granular soils (layers A & B) is computed based on the Hough Method and LRFD Equation 10.6.2.4.2b-2.

**The settlement value of cohesive soils (layers C & D) is computed based on LRFD Equation 10.6.2.4.3-1

==========

APILE for Windows, Version 2019.9.5

Serial Number : 136154516

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

==========

This program is licensed to :

CTL Engineering, Inc.
Columbus, OH

Path to file locations : O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB Ohio Inc\Design\Foundation Design Calculations and Analysis\Bridge 1 -Pleasant Hill Road Over US 33\Final Report\
Name of input data file : Bridge 1 Rear Abutment HP14x73.ap9d
Name of output file : Bridge 1 Rear Abutment HP14x73.ap9o
Name of plot output file : Bridge 1 Rear Abutment HP14x73.ap9p

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Time and Date of Analysis

Date: October 01, 2024 Time: 13:27:02

****
* INPUT INFORMATION *
****

ATH-MEG-033-18.70/0.00

DESIGNER : CTL

JOB NUMBER : 23050059COL

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 21.40 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 21.50 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 1.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 56.40 IN.
- TIP AREA OF PILE = 21.40 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	122.00	0.00	8.00**

2.50	CLAY	0.80*	122.00	0.00	8.00**
2.50	SAND	0.80*	65.60	34.00	36.00**
5.00	SAND	0.80*	65.60	34.00	36.00**
5.00	CLAY	0.80*	58.60	0.00	8.00**
10.00	CLAY	0.80*	58.60	0.00	8.00**
10.00	CLAY	0.80*	64.60	0.00	8.00**
15.50	CLAY	0.80*	64.60	0.00	8.00**
15.50	CLAY	0.80*	62.60	0.00	8.00**
20.50	CLAY	0.80*	62.60	0.00	8.00**
20.50	CLAY	0.80*	77.60	0.00	8.00**
29.50	CLAY	0.80*	77.60	0.00	8.00**

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

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	2.25	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.25	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.12	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.12	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.83	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.83	0.00	0.00	0.00	0.00

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

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
2.50	1.000	1.000
2.50	1.000	1.000
5.00	1.000	1.000
5.00	1.000	1.000

10.00	1.000	1.000
10.00	1.000	1.000
15.50	1.000	1.000
15.50	1.000	1.000
20.50	1.000	1.000
20.50	1.000	1.000
29.50	1.000	1.000

1

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

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

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.5	1.5
1.00	6.0	1.5	7.4
2.00	12.0	2.0	13.9
3.00	17.9	2.8	20.7
4.00	21.4	2.9	24.3
5.00	22.4	3.1	25.4
6.00	29.4	3.4	32.7
7.00	42.3	3.6	45.9
8.00	55.2	3.6	58.8
9.00	68.2	3.3	71.5
10.00	81.1	3.0	84.1
11.00	90.7	2.7	93.4
12.00	96.9	2.4	99.3
13.00	103.1	2.3	105.5
14.00	109.4	2.4	111.8
15.00	115.7	2.9	118.5
16.00	122.0	3.3	125.3
17.00	127.4	3.7	131.1
18.00	131.8	4.1	135.9
19.00	136.3	4.1	140.4
20.00	140.8	3.7	144.5

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN

IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

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

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.2651E+01	0.2872E-01
			0.4418E+01	0.5565E-01
			0.6627E+01	0.1023E+00
			0.7952E+01	0.1436E+00
			0.8836E+01	0.1795E+00
			0.7952E+01	0.3591E+00
			0.7952E+01	0.5386E+00
			0.7952E+01	0.8976E+00
			0.7952E+01	0.3591E+01
2	10	0.1275E+01		
			0.0000E+00	0.0000E+00
			0.2651E+01	0.2872E-01
			0.4418E+01	0.5565E-01
			0.6627E+01	0.1023E+00
			0.7952E+01	0.1436E+00
			0.8836E+01	0.1795E+00
			0.7952E+01	0.3591E+00
			0.7952E+01	0.5386E+00
			0.7952E+01	0.8976E+00
			0.7952E+01	0.3591E+01
3	10	0.2458E+01		
			0.0000E+00	0.0000E+00
			0.2651E+01	0.2872E-01
			0.4418E+01	0.5565E-01
			0.6627E+01	0.1023E+00
			0.7952E+01	0.1436E+00
			0.8836E+01	0.1795E+00
			0.7952E+01	0.3591E+00
			0.7952E+01	0.5386E+00
			0.7952E+01	0.8976E+00
			0.7952E+01	0.3591E+01
4	10	0.2500E+01		
			0.0000E+00	0.0000E+00

		0.2651E+01	0.2872E-01
		0.4418E+01	0.5565E-01
		0.6627E+01	0.1023E+00
		0.7952E+01	0.1436E+00
		0.8836E+01	0.1795E+00
		0.8836E+01	0.3591E+00
		0.8836E+01	0.5386E+00
		0.8836E+01	0.8976E+00
		0.8836E+01	0.3591E+01
5	10	0.3775E+01	
		0.0000E+00	0.0000E+00
		0.9153E+00	0.2872E-01
		0.1526E+01	0.5565E-01
		0.2288E+01	0.1023E+00
		0.2746E+01	0.1436E+00
		0.3051E+01	0.1795E+00
		0.3051E+01	0.3591E+00
		0.3051E+01	0.5386E+00
		0.3051E+01	0.8976E+00
		0.3051E+01	0.3591E+01
6	10	0.4958E+01	
		0.0000E+00	0.0000E+00
		0.4714E+00	0.2872E-01
		0.7857E+00	0.5565E-01
		0.1179E+01	0.1023E+00
		0.1414E+01	0.1436E+00
		0.1571E+01	0.1795E+00
		0.1571E+01	0.3591E+00
		0.1571E+01	0.5386E+00
		0.1571E+01	0.8976E+00
		0.1571E+01	0.3591E+01
7	10	0.5000E+01	
		0.0000E+00	0.0000E+00
		0.4740E+00	0.2872E-01
		0.7901E+00	0.5565E-01
		0.1185E+01	0.1023E+00
		0.1422E+01	0.1436E+00
		0.1580E+01	0.1795E+00
		0.1422E+01	0.3591E+00
		0.1422E+01	0.5386E+00
		0.1422E+01	0.8976E+00
		0.1422E+01	0.3591E+01
8	10	0.7525E+01	
		0.0000E+00	0.0000E+00
		0.5729E+01	0.2872E-01
		0.9549E+01	0.5565E-01
		0.1432E+02	0.1023E+00
		0.1719E+02	0.1436E+00
		0.1910E+02	0.1795E+00

0.1719E+02 0.3591E+00
0.1719E+02 0.5386E+00
0.1719E+02 0.8976E+00
0.1719E+02 0.3591E+01
9 10 0.9958E+01
0.0000E+00 0.0000E+00
0.5729E+01 0.2872E-01
0.9549E+01 0.5565E-01
0.1432E+02 0.1023E+00
0.1719E+02 0.1436E+00
0.1910E+02 0.1795E+00
0.1719E+02 0.3591E+00
0.1719E+02 0.5386E+00
0.1719E+02 0.8976E+00
0.1719E+02 0.3591E+01
10 10 0.1000E+02
0.0000E+00 0.0000E+00
0.5729E+01 0.2872E-01
0.9549E+01 0.5565E-01
0.1432E+02 0.1023E+00
0.1719E+02 0.1436E+00
0.1910E+02 0.1795E+00
0.1719E+02 0.3591E+00
0.1719E+02 0.5386E+00
0.1719E+02 0.8976E+00
0.1719E+02 0.3591E+01
11 10 0.1278E+02
0.0000E+00 0.0000E+00
0.2765E+01 0.2872E-01
0.4609E+01 0.5565E-01
0.6913E+01 0.1023E+00
0.8296E+01 0.1436E+00
0.9218E+01 0.1795E+00
0.8296E+01 0.3591E+00
0.8296E+01 0.5386E+00
0.8296E+01 0.8976E+00
0.8296E+01 0.3591E+01
12 10 0.1546E+02
0.0000E+00 0.0000E+00
0.2817E+01 0.2872E-01
0.4695E+01 0.5565E-01
0.7042E+01 0.1023E+00
0.8451E+01 0.1436E+00
0.9390E+01 0.1795E+00
0.8451E+01 0.3591E+00
0.8451E+01 0.5386E+00
0.8451E+01 0.8976E+00
0.8451E+01 0.3591E+01
13 10 0.1550E+02

0.0000E+00 0.0000E+00
0.2817E+01 0.2872E-01
0.4694E+01 0.5565E-01
0.7041E+01 0.1023E+00
0.8450E+01 0.1436E+00
0.9388E+01 0.1795E+00
0.8450E+01 0.3591E+00
0.8450E+01 0.5386E+00
0.8450E+01 0.8976E+00
0.8450E+01 0.3591E+01
14 10 0.1803E+02
0.0000E+00 0.0000E+00
0.1960E+01 0.2872E-01
0.3266E+01 0.5565E-01
0.4900E+01 0.1023E+00
0.5879E+01 0.1436E+00
0.6533E+01 0.1795E+00
0.5879E+01 0.3591E+00
0.5879E+01 0.5386E+00
0.5879E+01 0.8976E+00
0.5879E+01 0.3591E+01
15 10 0.2046E+02
0.0000E+00 0.0000E+00
0.2094E+01 0.2872E-01
0.3490E+01 0.5565E-01
0.5235E+01 0.1023E+00
0.6282E+01 0.1436E+00
0.6980E+01 0.1795E+00
0.6282E+01 0.3591E+00
0.6282E+01 0.5386E+00
0.6282E+01 0.8976E+00
0.6282E+01 0.3591E+01
16 10 0.2050E+02
0.0000E+00 0.0000E+00
0.2094E+01 0.2872E-01
0.3490E+01 0.5565E-01
0.5235E+01 0.1023E+00
0.6282E+01 0.1436E+00
0.6980E+01 0.1795E+00
0.6282E+01 0.3591E+00
0.6282E+01 0.5386E+00
0.6282E+01 0.8976E+00
0.6282E+01 0.3591E+01
17 10 0.2503E+02
0.0000E+00 0.0000E+00
0.2094E+01 0.2872E-01
0.3490E+01 0.5565E-01
0.5235E+01 0.1023E+00
0.6282E+01 0.1436E+00

		0.6980E+01	0.1795E+00
		0.6282E+01	0.3591E+00
		0.6282E+01	0.5386E+00
		0.6282E+01	0.8976E+00
		0.6282E+01	0.3591E+01
18	10	0.2946E+02	
		0.0000E+00	0.0000E+00
		0.2094E+01	0.2872E-01
		0.3490E+01	0.5565E-01
		0.5235E+01	0.1023E+00
		0.6282E+01	0.1436E+00
		0.6980E+01	0.1795E+00
		0.6282E+01	0.3591E+00
		0.6282E+01	0.5386E+00
		0.6282E+01	0.8976E+00
		0.6282E+01	0.3591E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.2312E+00	0.8976E-02
0.4624E+00	0.1795E-01
0.9249E+00	0.3591E-01
0.1850E+01	0.2334E+00
0.2775E+01	0.7540E+00
0.3330E+01	0.1311E+01
0.3700E+01	0.1795E+01
0.3700E+01	0.2693E+01
0.3700E+01	0.3591E+01

LOAD VERSUS SETTLEMENT CURVE

****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1607E+00	0.1338E-03	0.2576E-02	0.1000E-03
0.1607E+01	0.1338E-02	0.2576E-01	0.1000E-02
0.8033E+01	0.6689E-02	0.1288E+00	0.5000E-02
0.1612E+02	0.1338E-01	0.2576E+00	0.1000E-01
0.3233E+02	0.2678E-01	0.5152E+00	0.2000E-01
0.6889E+02	0.6459E-01	0.9909E+00	0.5000E-01
0.9330E+02	0.9979E-01	0.1131E+01	0.8000E-01

0.1080E+03	0.1230E+00	0.1225E+01	0.1000E+00
0.1397E+03	0.2301E+00	0.1693E+01	0.2000E+00
0.1290E+03	0.5279E+00	0.2323E+01	0.5000E+00
0.1295E+03	0.8281E+00	0.2821E+01	0.8000E+00
0.1297E+03	0.1028E+01	0.3020E+01	0.1000E+01
0.1304E+03	0.2028E+01	0.3700E+01	0.2000E+01

Soil Parameters

Project: **ATH-MEG-033-18.70/0.00**
Location: **Rear Abutment**
Date: **10/4/2024**
Boring No.: **B-042-0-23**

Bottom of Pile Cap Elevation (feet) 969.8

Pile Type			
HP 14x73			
Ultimate Capacity (Skin Friction) (kips)	**Depth (feet)**	**Elevation (Feet)**	
0	0	969.80	
6	1	968.80	
12	2	967.80	
17.9	3	966.80	
21.4	4	965.80	
22.4	5	964.80	
29.4	6	963.80	
42.3	7	962.80	Downdrag
55.2	8	961.80	Downdrag
68.2	9	960.80	
81.1	10	959.80	
90.7	11	958.80	
96.9	12	957.80	
103.1	13	956.80	
109.4	14	955.80	
115.7	15	954.80	
122	16	953.80	
127.4	17	952.80	
131.8	18	951.80	
136.3	19	950.80	
140.8	20	949.80	

Downdrag Calculation

Project: **ATH-MEG-033-18.70/0.00**
Location: **Rear Abutment**
Boring No.: **B-042-0-23**
Date: **10/4/24**

Measuring from bottom of pile, 0.4 inch settlement occurs at and below elevation = 962.6 feet

Compute Skin Friction using the Ultimate data from A-pile Analysis

From Apile Results

HP 14x73

Unfactored Downdrag Load	44.9	Kips	
Load Factor for Downdrag	1.05		ODOT BDM 305.3.2.2
Factored Downdrag Load	47.2	Kips	

Soil Parameters

Time Rate of Settlement Determination

Project: **ATH-MEG-033-18.70/0.00**
Boring No.: **B-042-0-23**
Date: **10/4/24**

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
969.8	967.3	1	0.55	2.5	0.0200	1.86	480	142.848	1.00	0.0	
967.3	964.8	2	0.21	1.25	0.0281	2.6133	480	802.8058	1.00	0.0	
964.8	959.8	1	1.15	5	0.0002	0.016033	480	0.307836	0.62	0.4	
959.8	954.3	1	0.72	5.5	0.0011	0.101115	480	1.604464	0.98	0.0	
	Net=		2.63	in					Total	0.4	in

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
969.8	967.3	1	0.55	2.5	0.0200	1.86	700	208.32	1.00	0.0	
967.3	964.8	2	0.21	1.25	0.0281	2.6133	700	1170.758	1.00	0.0	
964.8	959.8	1	1.15	5	0.0002	0.016033	700	0.448927	0.73	0.3	
959.8	954.3	1	0.72	5.5	0.0011	0.101115	700	2.339843	1.00	0.0	
	Net=		2.63	in					Total	0.3	in

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
Bridge No. ATH-00021-02.072- Pleasant Hill Road over US 33
Rear Abutment

Boring No	B-042-0-23		
Bottom of Foundation Elevation	969.8	feet	(From structural engineer)
Top of Augerable Rock Elevation	949.3	feet	(From boring)
Top of Coreable Rock Elevation	940.3	feet	(From boring)

From Bottom of Footing Elevation to 967.3 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	122	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2250	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 967.3 to 964.8 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	128	pcf	ODOT GDM Table 400-4
Friction Angle=	39	degrees	ODOT GDM Section 404.2
k =	90	pci	From L-pile

From 964.8 to 959.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	121	pcf	Laboratory Consolidation Test Result B-042-0-23, ST-1, 7'-9'
Undrained Cohesion =	2700	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 959.8 to 954.3 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	127	pcf	Laboratory Consolidation Test Result B-042-0-23, ST-1, 12'-14'
Undrained Cohesion =	1600	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 954.3 to 949.3 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	3100	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 949.3 to 940.3 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	32	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	2910	psi	GDM Table 400-6, Very Weak Rock
RQD =	0%		Assumed

APPENDIX E

ATH-C0016-05.908- DESIGN CALCULATIONS

Soil Parameters

Project: ATH-MEG-033-18.70/0.00
Boring No.: B-047-0-23
Location: Rear Abutment
Date: 10/4/24

Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Liquidity Index (W-PL)/PI	Gs	Bearing Capacity Index (BCI)	Sand Fraction (BCI)	Clay Fraction (BCI)	e_0	C_c	C_r	C_v (cm^2/sec)	Su (psf)	Pre-Consolidation Stress σ'p (psf)	Reference
1	897.6	894.6	3	A-6a	126	12	20	35	21		2.72										
				ST				29	18												
			Avg	A-6a	126	12	20	32	20	0.0	2.72				0.522	0.19	0.037	0.0012	1500	3000.0	1
2	894.6	892.1	2.5	A-3a	125	15	13				2.65										
			Avg	A-3a	125	15	13				2.65	66.84	0.8	0.2				0.0281			2
3	892.1	886.6	5.5	A-6a	123	26	14	34	21		2.7										
						26	18														
				ST				42	21												
			Avg	A-6a	123	26	16	38	21	-0.3	2.7				0.67	0.2	0.033	0.0007	3250	6000.0	3

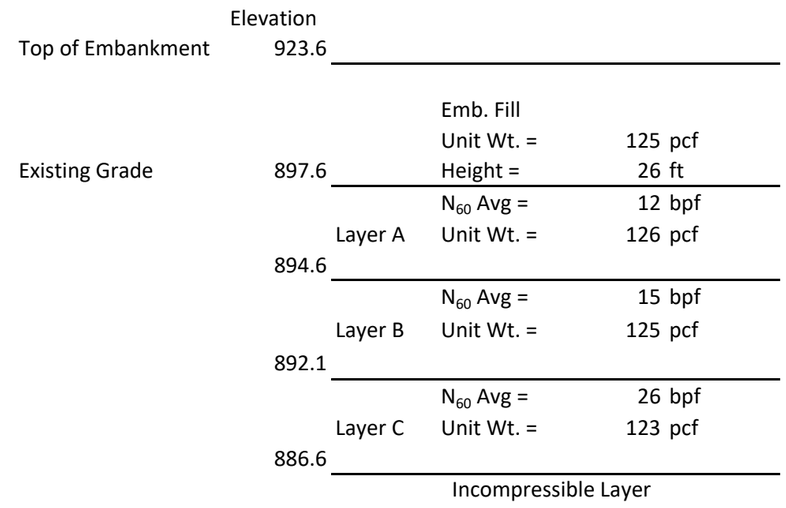
Soils/bedrock layers encountered below elevation 886.6 are considered incompressible

Reference Key

1 Laboratory Consolidation Test Result B-047-0-23, ST, 1'-3'
2 FHWA GEC 5 (2016) Figure 6-37, Virgin Compression used for C_v computation of granular soils if no consolidation data is available
3 Laboratory Consolidation Test Result B-047-0-23, ST, 7'-9'

Settlement Calculations

Location **ATH-MEG-033-18.70/0.00**
Boring No. **B-047-0-23**



Embankment Geometry

B_1 = 22 ft

B_2 = 52 ft

Emb. Fill Ht. 26 ft
Unit Wt. = 125 pcf
q = 3250 psf

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	σ'_o (psf)	B_1 / z	B_2 / z	I*	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	$\sigma'p$ (psf)	σ'_f (psf)	Consolidation	Settlement (in) **
A	3	126	1.5	189	14.7	34.7	1.00	12				3,000.00	3,439.00	OC	1.32
B	2.5	125	4.25	534.25	5.2	12.2	1.00	15	0.8	0.2	66.84			NC	0.38
C	5.5	123	8.25	1028.75	2.7	6.3	0.98	26				6,000.00	4,213.75	OC	0.80
														Total	2.50
														0.4" @ Elev.=	889.4

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).

**The settlement value of granular soils (Layer B) is computed based on the Hough Method and LRFD Equation 10.6.2.4.2b-2.

**The settlement value of Cohesive soils (Layers A & C) is computed based on LRFD Equation 10.6.2.4.3-1

==========

APILE for Windows, Version 2019.9.5

Serial Number : 136154516

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

==========

This program is licensed to :

CTL Engineering, Inc.
Columbus, OH

Path to file locations : O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB Ohio Inc\Design\Foundation Design Calculations and Analysis\Bridge 2-Pleasanton Road Over US 33\Final Report\
Name of input data file : Bridge 2 Rear Abutment HP14x73.ap9d
Name of output file : Bridge 2 Rear Abutment HP14x73.ap9o
Name of plot output file : Bridge 2 Rear Abutment HP14x73.ap9p

---

Time and Date of Analysis

Date: September 11, 2024 Time: 17:15:53

1

****
* INPUT INFORMATION *
****

ATH-MEG-033-18.70/0.00

DESIGNER : CTL

JOB NUMBER : 23050059COL

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 21.40 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 27.70 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 1.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 56.40 IN.
- TIP AREA OF PILE = 21.40 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	125.00	0.00	8.00**

6.60	CLAY	0.80*	125.00	0.00	8.00**
6.60	CLAY	0.80*	57.60	0.00	8.00**
13.20	CLAY	0.80*	57.60	0.00	8.00**
13.20	CLAY	0.80*	63.60	0.00	8.00**
16.20	CLAY	0.80*	63.60	0.00	8.00**
16.20	SAND	0.80*	62.60	32.00	28.00**
18.70	SAND	0.80*	62.60	32.00	28.00**
18.70	CLAY	0.80*	60.60	0.00	8.00**
24.20	CLAY	0.80*	60.60	0.00	8.00**
24.20	CLAY	0.80*	72.60	0.00	8.00**
26.70	CLAY	0.80*	72.60	0.00	8.00**
26.70	CLAY	0.80*	77.60	0.00	8.00**
30.00	CLAY	0.80*	77.60	0.00	8.00**

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

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.25	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.25	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	5.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	5.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.87	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.87	0.00	0.00	0.00	0.00

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

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

6.60	1.000	1.000
6.60	1.000	1.000
13.20	1.000	1.000
13.20	1.000	1.000
16.20	1.000	1.000
16.20	1.000	1.000
18.70	1.000	1.000
18.70	1.000	1.000
24.20	1.000	1.000
24.20	1.000	1.000
26.70	1.000	1.000
26.70	1.000	1.000
30.00	1.000	1.000

1

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

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

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.7	1.7
1.00	5.2	1.7	6.9
2.00	10.4	2.4	12.8
3.00	15.6	3.3	19.0
4.00	20.8	3.3	24.2
5.00	26.0	3.3	29.4
6.00	31.2	3.3	34.6
7.00	36.4	3.3	39.8
8.00	41.6	3.3	45.0
9.00	46.8	3.3	50.2
10.00	52.1	3.3	55.4
11.00	57.3	3.3	60.6
12.00	62.5	3.3	65.7
13.00	67.8	3.0	70.8
14.00	73.2	2.7	75.9
15.00	78.8	2.5	81.4
16.00	84.7	2.9	87.6
17.00	90.7	3.4	94.1
18.00	95.1	3.9	99.0

19.00	97.9	4.5	102.4
20.00	106.1	4.5	110.7
21.00	119.7	4.4	124.1
22.00	133.3	4.3	137.6
23.00	146.8	4.5	151.3
24.00	159.7	5.3	164.9
25.00	172.2	6.0	178.2
26.00	182.1	6.4	188.5

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

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

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.2307E+01	0.2872E-01
			0.3845E+01	0.5565E-01
			0.5768E+01	0.1023E+00
			0.6922E+01	0.1436E+00
			0.7691E+01	0.1795E+00
			0.6922E+01	0.3591E+00
			0.6922E+01	0.5386E+00
			0.6922E+01	0.8976E+00
			0.6922E+01	0.3591E+01
2	10	0.3325E+01		
			0.0000E+00	0.0000E+00
			0.2307E+01	0.2872E-01
			0.3845E+01	0.5565E-01
			0.5768E+01	0.1023E+00
			0.6922E+01	0.1436E+00
			0.7691E+01	0.1795E+00
			0.6922E+01	0.3591E+00
			0.6922E+01	0.5386E+00
			0.6922E+01	0.8976E+00
			0.6922E+01	0.3591E+01
3	10	0.6558E+01		

0.0000E+00 0.0000E+00
0.2307E+01 0.2872E-01
0.3845E+01 0.5565E-01
0.5768E+01 0.1023E+00
0.6922E+01 0.1436E+00
0.7691E+01 0.1795E+00
0.6922E+01 0.3591E+00
0.6922E+01 0.5386E+00
0.6922E+01 0.8976E+00
0.6922E+01 0.3591E+01
4 10 0.6600E+01
0.0000E+00 0.0000E+00
0.2307E+01 0.2872E-01
0.3845E+01 0.5565E-01
0.5768E+01 0.1023E+00
0.6922E+01 0.1436E+00
0.7691E+01 0.1795E+00
0.6922E+01 0.3591E+00
0.6922E+01 0.5386E+00
0.6922E+01 0.8976E+00
0.6922E+01 0.3591E+01
5 10 0.9925E+01
0.0000E+00 0.0000E+00
0.2307E+01 0.2872E-01
0.3845E+01 0.5565E-01
0.5768E+01 0.1023E+00
0.6922E+01 0.1436E+00
0.7691E+01 0.1795E+00
0.6922E+01 0.3591E+00
0.6922E+01 0.5386E+00
0.6922E+01 0.8976E+00
0.6922E+01 0.3591E+01
6 10 0.1316E+02
0.0000E+00 0.0000E+00
0.2435E+01 0.2872E-01
0.4059E+01 0.5565E-01
0.6088E+01 0.1023E+00
0.7305E+01 0.1436E+00
0.8117E+01 0.1795E+00
0.7305E+01 0.3591E+00
0.7305E+01 0.5386E+00
0.7305E+01 0.8976E+00
0.7305E+01 0.3591E+01
7 10 0.1320E+02
0.0000E+00 0.0000E+00
0.2431E+01 0.2872E-01
0.4051E+01 0.5565E-01
0.6077E+01 0.1023E+00
0.7292E+01 0.1436E+00

0.8102E+01 0.1795E+00
0.7292E+01 0.3591E+00
0.7292E+01 0.5386E+00
0.7292E+01 0.8976E+00
0.7292E+01 0.3591E+01
8 10 0.1473E+02
0.0000E+00 0.0000E+00
0.2534E+01 0.2872E-01
0.4223E+01 0.5565E-01
0.6334E+01 0.1023E+00
0.7601E+01 0.1436E+00
0.8445E+01 0.1795E+00
0.7601E+01 0.3591E+00
0.7601E+01 0.5386E+00
0.7601E+01 0.8976E+00
0.7601E+01 0.3591E+01
9 10 0.1616E+02
0.0000E+00 0.0000E+00
0.2640E+01 0.2872E-01
0.4400E+01 0.5565E-01
0.6600E+01 0.1023E+00
0.7920E+01 0.1436E+00
0.8801E+01 0.1795E+00
0.7920E+01 0.3591E+00
0.7920E+01 0.5386E+00
0.7920E+01 0.8976E+00
0.7920E+01 0.3591E+01
10 10 0.1620E+02
0.0000E+00 0.0000E+00
0.2640E+01 0.2872E-01
0.4400E+01 0.5565E-01
0.6600E+01 0.1023E+00
0.7920E+01 0.1436E+00
0.8800E+01 0.1795E+00
0.8800E+01 0.3591E+00
0.8800E+01 0.5386E+00
0.8800E+01 0.8976E+00
0.8800E+01 0.3591E+01
11 10 0.1748E+02
0.0000E+00 0.0000E+00
0.1972E+01 0.2872E-01
0.3287E+01 0.5565E-01
0.4930E+01 0.1023E+00
0.5916E+01 0.1436E+00
0.6573E+01 0.1795E+00
0.6573E+01 0.3591E+00
0.6573E+01 0.5386E+00
0.6573E+01 0.8976E+00
0.6573E+01 0.3591E+01

12 10 0.1866E+02
0.0000E+00 0.0000E+00
0.1272E+01 0.2872E-01
0.2121E+01 0.5565E-01
0.3181E+01 0.1023E+00
0.3817E+01 0.1436E+00
0.4241E+01 0.1795E+00
0.4241E+01 0.3591E+00
0.4241E+01 0.5386E+00
0.4241E+01 0.8976E+00
0.4241E+01 0.3591E+01
13 10 0.1870E+02
0.0000E+00 0.0000E+00
0.1274E+01 0.2872E-01
0.2124E+01 0.5565E-01
0.3186E+01 0.1023E+00
0.3823E+01 0.1436E+00
0.4248E+01 0.1795E+00
0.3823E+01 0.3591E+00
0.3823E+01 0.5386E+00
0.3823E+01 0.8976E+00
0.3823E+01 0.3591E+01
14 10 0.2148E+02
0.0000E+00 0.0000E+00
0.6008E+01 0.2872E-01
0.1001E+02 0.5565E-01
0.1502E+02 0.1023E+00
0.1802E+02 0.1436E+00
0.2003E+02 0.1795E+00
0.1802E+02 0.3591E+00
0.1802E+02 0.5386E+00
0.1802E+02 0.8976E+00
0.1802E+02 0.3591E+01
15 10 0.2416E+02
0.0000E+00 0.0000E+00
0.5440E+01 0.2872E-01
0.9066E+01 0.5565E-01
0.1360E+02 0.1023E+00
0.1632E+02 0.1436E+00
0.1813E+02 0.1795E+00
0.1632E+02 0.3591E+00
0.1632E+02 0.5386E+00
0.1632E+02 0.8976E+00
0.1632E+02 0.3591E+01
16 10 0.2420E+02
0.0000E+00 0.0000E+00
0.5454E+01 0.2872E-01
0.9090E+01 0.5565E-01
0.1363E+02 0.1023E+00

0.1636E+02 0.1436E+00
0.1818E+02 0.1795E+00
0.1636E+02 0.3591E+00
0.1636E+02 0.5386E+00
0.1636E+02 0.8976E+00
0.1636E+02 0.3591E+01
17 10 0.2548E+02
0.0000E+00 0.0000E+00
0.4451E+01 0.2872E-01
0.7418E+01 0.5565E-01
0.1113E+02 0.1023E+00
0.1335E+02 0.1436E+00
0.1484E+02 0.1795E+00
0.1335E+02 0.3591E+00
0.1335E+02 0.5386E+00
0.1335E+02 0.8976E+00
0.1335E+02 0.3591E+01
18 10 0.2666E+02
0.0000E+00 0.0000E+00
0.3042E+01 0.2872E-01
0.5070E+01 0.5565E-01
0.7605E+01 0.1023E+00
0.9127E+01 0.1436E+00
0.1014E+02 0.1795E+00
0.9127E+01 0.3591E+00
0.9127E+01 0.5386E+00
0.9127E+01 0.8976E+00
0.9127E+01 0.3591E+01
19 10 0.2670E+02
0.0000E+00 0.0000E+00
0.3042E+01 0.2872E-01
0.5070E+01 0.5565E-01
0.7605E+01 0.1023E+00
0.9127E+01 0.1436E+00
0.1014E+02 0.1795E+00
0.9127E+01 0.3591E+00
0.9127E+01 0.5386E+00
0.9127E+01 0.8976E+00
0.9127E+01 0.3591E+01
20 10 0.2838E+02
0.0000E+00 0.0000E+00
0.3042E+01 0.2872E-01
0.5070E+01 0.5565E-01
0.7605E+01 0.1023E+00
0.9127E+01 0.1436E+00
0.1014E+02 0.1795E+00
0.9127E+01 0.3591E+00
0.9127E+01 0.5386E+00
0.9127E+01 0.8976E+00

0.9127E+01 0.3591E+01
21 10 0.2996E+02
0.0000E+00 0.0000E+00
0.3042E+01 0.2872E-01
0.5070E+01 0.5565E-01
0.7605E+01 0.1023E+00
0.9127E+01 0.1436E+00
0.1014E+02 0.1795E+00
0.9127E+01 0.3591E+00
0.9127E+01 0.5386E+00
0.9127E+01 0.8976E+00
0.9127E+01 0.3591E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.4022E+00	0.8976E-02
0.8045E+00	0.1795E-01
0.1609E+01	0.3591E-01
0.3218E+01	0.2334E+00
0.4827E+01	0.7540E+00
0.5792E+01	0.1311E+01
0.6436E+01	0.1795E+01
0.6436E+01	0.2693E+01
0.6436E+01	0.3591E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2308E+00	0.1715E-03	0.4481E-02	0.1000E-03
0.2308E+01	0.1715E-02	0.4481E-01	0.1000E-02
0.1156E+02	0.8577E-02	0.2240E+00	0.5000E-02
0.2324E+02	0.1718E-01	0.4481E+00	0.1000E-01
0.4639E+02	0.3438E-01	0.8962E+00	0.2000E-01
0.9554E+02	0.8044E-01	0.1724E+01	0.5000E-01
0.1287E+03	0.1212E+00	0.1968E+01	0.8000E-01
0.1475E+03	0.1476E+00	0.2131E+01	0.1000E+00
0.1846E+03	0.2615E+00	0.2946E+01	0.2000E+00
0.1721E+03	0.5574E+00	0.4042E+01	0.5000E+00
0.1730E+03	0.8579E+00	0.4907E+01	0.8000E+00

0.1733E+03	0.1058E+01	0.5253E+01	0.1000E+01
0.1745E+03	0.2059E+01	0.6436E+01	0.2000E+01

Project:	**ATH-MEG-033-18.70/0.00**
Location:	**Rear Abutment**
Date:	**10/4/2024**
Boring No.:	**B-047-0-23**

Bottom of Pile Cap Elevation (feet)	910.75

Pile Type			
HP 14x73			
Ultimate Capacity (Skin Friction) (kips)	**Depth (feet)**	**Elevation (Feet)**	
0	0	910.75	
5.2	1	909.75	
10.4	2	908.75	
15.6	3	907.75	
20.8	4	906.75	
26	5	905.75	
31.2	6	904.75	
36.4	7	903.75	
41.6	8	902.75	
46.8	9	901.75	
52.1	10	900.75	
57.3	11	899.75	
62.5	12	898.75	
67.8	13	897.75	
73.2	14	896.75	
78.8	15	895.75	
84.7	16	894.75	
90.7	17	893.75	
95.1	18	892.75	
97.9	19	891.75	
106.1	20	890.75	
119.7	21	889.75	Downdrag
133.3	22	888.75	Downdrag
146.8	23	887.75	
159.7	24	886.75	
172.2	25	885.75	
182.1	26	884.75	

Downdrag Calculation

Project: **ATH-MEG-033-18.70/0.00**
Location: **Rear Abutment**
Boring No.: **B-047-0-23**
Date: **10/4/24**

Measuring from bottom of pile, 0.4 inch settlement occurs at and below elevation = 889.4 feet

Compute Skin Friction using the Ultimate data from A-pile Analysis

From Apile Results

HP 14x73

Unfactored Downdrag Load	125.1	Kips
Load Factor for Downdrag	1.05	ODOT BDM 305.3.2.2
Factored Downdrag Load	131.3	Kips

Time Rate of Settlement Determination

Project: **ATH-MEG-033-18.70/0.00**
Boring No.: **B-047-0-23**
Date: **10/4/24**

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
897.6	894.6	1	1.32	3	0.0012	0.110992	98	1.208577	0.96	0.1	
894.6	892.1	2	0.38	1.25	0.0281	2.6133	98	163.9062	1.00	0.0	
892.1	886.6	1	0.80	5.5	0.0007	0.062203	98	0.201517	0.51	0.4	
	Net=		2.50	in					Total	0.4	in

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
897.6	894.6	1	1.32	3	0.0012	0.110992	150	1.849863	0.99	0.0	
894.6	892.1	2	0.38	1.25	0.0281	2.6133	150	250.8768	1.00	0.0	
892.1	886.6	1	0.80	5.5	0.0007	0.062203	150	0.308444	0.62	0.3	
	Net=		2.50	in					Total	0.3	in

Soil Parameters

Project: ATH-MEG-033-18.70/0.00
Boring No.: B-049-0-23
Location: Forward Abutment
Date: 10/4/24

Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Liquidity Index (W-PL)/PI	e_0	C_c	C_r	C_v (cm^2/sec)	Pre-Consolidation Stress σ'p (psf)	Reference
1	885.0	875.6	9.4	A6a/A-6b	133	15	23	35	20							
						14	23	42	39							
						18	22									
						32	16									
			Avg	A6a/A-6b	133	20	21	39	30	-0.9	0.67	0.17	0.035	0.0014	5000.0	1

Soils/bedrock layers encountered below elevation 875.6 are considered incompressible

Reference Key

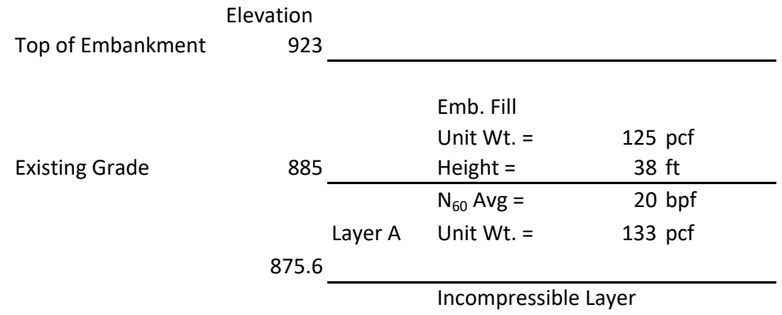
1 Laboratory Consolidation Test Result B-049-0-23, ST, 5'-7'

Settlement Calculations

Location **ATH-MEG-033-18.70/0.00**
Boring No. **B-049-0-23**

Embankment Geometry

B_1 = 22 ft
B_2 = 76 ft



Emb. Fill Ht. 38 ft
Unit Wt. = 125 pcf
q = 4750 psf

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	Ϭ'$_o$ (psf)	B_1 / z	B_2 / z	I*	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	Ϭ'p (psf)	Ϭ'$_f$ (psf)	Consolidation	Settlement (in) **
A	9.4	132.9	4.7	624.63	4.7	16.2	1.00	20				5,000.00	5,374.63	OC	2.50
														Total	2.50
														0.4" @ Elev.=	877.1

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).
**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1

==========

APILE for Windows, Version 2019.9.5

Serial Number : 136154516

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

==========

This program is licensed to :

CTL Engineering, Inc.
Columbus, OH

Path to file locations : O:\PROJECT\2023\COL-05\23050059COL_ATH MEG-033-18-70 00-00_HNTB Ohio Inc\Design\Foundation Design Calculations and Analysis\Bridge 2-Pleasanton Road Over US 33\Memos\Memo 3\HP 14x73\
Name of input data file : Bridge 2 Forward Abutment HP14x73.ap9d
Name of output file : Bridge 2 Forward Abutment HP14x73.ap9o
Name of plot output file : Bridge 2 Forward Abutment HP14x73.ap9p

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Time and Date of Analysis

Date: September 11, 2024 Time: 16:48:54

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****
* INPUT INFORMATION *
****

ATH-MEG-033-18.70/0.00

DESIGNER : CTL

JOB NUMBER : 23050059COL

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 21.40 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 35.40 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 1.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 56.40 IN.
- TIP AREA OF PILE = 21.40 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	125.00	0.00	8.00**

12.50	CLAY	0.80*	125.00	0.00	8.00**
12.50	CLAY	0.80*	62.60	0.00	8.00**
25.00	CLAY	0.80*	62.60	0.00	8.00**
25.00	CLAY	0.80*	61.60	0.00	8.00**
26.40	CLAY	0.80*	61.60	0.00	8.00**
26.40	CLAY	0.80*	70.60	0.00	8.00**
31.90	CLAY	0.80*	70.60	0.00	8.00**
31.90	CLAY	0.80*	65.60	0.00	8.00**
34.40	CLAY	0.80*	65.60	0.00	8.00**
34.40	CLAY	0.80*	77.60	0.00	8.00**
40.00	CLAY	0.80*	77.60	0.00	8.00**

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

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.88	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.88	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.68	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.68	0.00	0.00	0.00	0.00

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

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
12.50	1.000	1.000
12.50	1.000	1.000
25.00	1.000	1.000
25.00	1.000	1.000

26.40	1.000	1.000
26.40	1.000	1.000
31.90	1.000	1.000
31.90	1.000	1.000
34.40	1.000	1.000
34.40	1.000	1.000
40.00	1.000	1.000

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

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

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.7	1.7
1.00	5.2	1.7	6.9
2.00	10.4	2.4	12.8
3.00	15.6	3.3	19.0
4.00	20.8	3.3	24.2
5.00	26.0	3.3	29.4
6.00	31.2	3.3	34.6
7.00	36.4	3.3	39.8
8.00	41.6	3.3	45.0
9.00	46.8	3.3	50.2
10.00	52.1	3.3	55.4
11.00	57.3	3.3	60.6
12.00	62.8	3.3	66.1
13.00	68.7	3.3	72.0
14.00	74.6	3.3	77.9
15.00	80.5	3.3	83.8
16.00	86.3	3.3	89.7
17.00	92.2	3.3	95.6
18.00	98.1	3.3	101.4
19.00	104.0	3.3	107.3
20.00	109.9	3.3	113.2
21.00	115.8	3.3	119.1
22.00	121.6	3.3	125.0
23.00	127.5	3.3	130.8
24.00	133.4	3.1	136.5

25.00	139.7	2.9	142.6
26.00	146.5	2.8	149.3
27.00	153.5	2.6	156.1
28.00	160.6	2.6	163.2
29.00	167.8	2.7	170.5
30.00	175.0	2.8	177.9
31.00	182.4	3.4	185.8
32.00	189.8	4.0	193.8
33.00	196.0	4.4	200.4
34.00	201.1	4.3	205.5

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

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

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.2307E+01	0.2872E-01
			0.3845E+01	0.5565E-01
			0.5768E+01	0.1023E+00
			0.6922E+01	0.1436E+00
			0.7691E+01	0.1795E+00
			0.6922E+01	0.3591E+00
			0.6922E+01	0.5386E+00
			0.6922E+01	0.8976E+00
			0.6922E+01	0.3591E+01
2	10	0.6275E+01		
			0.0000E+00	0.0000E+00
			0.2307E+01	0.2872E-01
			0.3845E+01	0.5565E-01
			0.5768E+01	0.1023E+00
			0.6922E+01	0.1436E+00
			0.7691E+01	0.1795E+00
			0.6922E+01	0.3591E+00
			0.6922E+01	0.5386E+00
			0.6922E+01	0.8976E+00

0.6922E+01 0.3591E+01
3 10 0.1246E+02
0.0000E+00 0.0000E+00
0.2608E+01 0.2872E-01
0.4346E+01 0.5565E-01
0.6520E+01 0.1023E+00
0.7824E+01 0.1436E+00
0.8693E+01 0.1795E+00
0.7824E+01 0.3591E+00
0.7824E+01 0.5386E+00
0.7824E+01 0.8976E+00
0.7824E+01 0.3591E+01
4 10 0.1250E+02
0.0000E+00 0.0000E+00
0.2608E+01 0.2872E-01
0.4346E+01 0.5565E-01
0.6520E+01 0.1023E+00
0.7824E+01 0.1436E+00
0.8693E+01 0.1795E+00
0.7824E+01 0.3591E+00
0.7824E+01 0.5386E+00
0.7824E+01 0.8976E+00
0.7824E+01 0.3591E+01
5 10 0.1878E+02
0.0000E+00 0.0000E+00
0.2608E+01 0.2872E-01
0.4346E+01 0.5565E-01
0.6520E+01 0.1023E+00
0.7824E+01 0.1436E+00
0.8693E+01 0.1795E+00
0.7824E+01 0.3591E+00
0.7824E+01 0.5386E+00
0.7824E+01 0.8976E+00
0.7824E+01 0.3591E+01
6 10 0.2496E+02
0.0000E+00 0.0000E+00
0.2967E+01 0.2872E-01
0.4944E+01 0.5565E-01
0.7416E+01 0.1023E+00
0.8900E+01 0.1436E+00
0.9888E+01 0.1795E+00
0.8900E+01 0.3591E+00
0.8900E+01 0.5386E+00
0.8900E+01 0.8976E+00
0.8900E+01 0.3591E+01
7 10 0.2500E+02
0.0000E+00 0.0000E+00
0.2982E+01 0.2872E-01
0.4970E+01 0.5565E-01

0.7455E+01 0.1023E+00
0.8946E+01 0.1436E+00
0.9940E+01 0.1795E+00
0.8946E+01 0.3591E+00
0.8946E+01 0.5386E+00
0.8946E+01 0.8976E+00
0.8946E+01 0.3591E+01
8 10 0.2573E+02
0.0000E+00 0.0000E+00
0.3032E+01 0.2872E-01
0.5053E+01 0.5565E-01
0.7580E+01 0.1023E+00
0.9095E+01 0.1436E+00
0.1011E+02 0.1795E+00
0.9095E+01 0.3591E+00
0.9095E+01 0.5386E+00
0.9095E+01 0.8976E+00
0.9095E+01 0.3591E+01
9 10 0.2636E+02
0.0000E+00 0.0000E+00
0.3076E+01 0.2872E-01
0.5127E+01 0.5565E-01
0.7691E+01 0.1023E+00
0.9229E+01 0.1436E+00
0.1025E+02 0.1795E+00
0.9229E+01 0.3591E+00
0.9229E+01 0.5386E+00
0.9229E+01 0.8976E+00
0.9229E+01 0.3591E+01
10 10 0.2640E+02
0.0000E+00 0.0000E+00
0.3079E+01 0.2872E-01
0.5132E+01 0.5565E-01
0.7699E+01 0.1023E+00
0.9238E+01 0.1436E+00
0.1026E+02 0.1795E+00
0.9238E+01 0.3591E+00
0.9238E+01 0.5386E+00
0.9238E+01 0.8976E+00
0.9238E+01 0.3591E+01
11 10 0.2918E+02
0.0000E+00 0.0000E+00
0.3200E+01 0.2872E-01
0.5333E+01 0.5565E-01
0.8000E+01 0.1023E+00
0.9600E+01 0.1436E+00
0.1067E+02 0.1795E+00
0.9600E+01 0.3591E+00
0.9600E+01 0.5386E+00

		0.9600E+01	0.8976E+00
		0.9600E+01	0.3591E+01
12	10	0.3186E+02	
		0.0000E+00	0.0000E+00
		0.3258E+01	0.2872E-01
		0.5429E+01	0.5565E-01
		0.8144E+01	0.1023E+00
		0.9773E+01	0.1436E+00
		0.1086E+02	0.1795E+00
		0.9773E+01	0.3591E+00
		0.9773E+01	0.5386E+00
		0.9773E+01	0.8976E+00
		0.9773E+01	0.3591E+01
13	10	0.3190E+02	
		0.0000E+00	0.0000E+00
		0.3255E+01	0.2872E-01
		0.5425E+01	0.5565E-01
		0.8138E+01	0.1023E+00
		0.9766E+01	0.1436E+00
		0.1085E+02	0.1795E+00
		0.9766E+01	0.3591E+00
		0.9766E+01	0.5386E+00
		0.9766E+01	0.8976E+00
		0.9766E+01	0.3591E+01
14	10	0.3318E+02	
		0.0000E+00	0.0000E+00
		0.2268E+01	0.2872E-01
		0.3779E+01	0.5565E-01
		0.5669E+01	0.1023E+00
		0.6803E+01	0.1436E+00
		0.7558E+01	0.1795E+00
		0.6803E+01	0.3591E+00
		0.6803E+01	0.5386E+00
		0.6803E+01	0.8976E+00
		0.6803E+01	0.3591E+01
15	10	0.3436E+02	
		0.0000E+00	0.0000E+00
		0.2297E+01	0.2872E-01
		0.3828E+01	0.5565E-01
		0.5742E+01	0.1023E+00
		0.6891E+01	0.1436E+00
		0.7657E+01	0.1795E+00
		0.6891E+01	0.3591E+00
		0.6891E+01	0.5386E+00
		0.6891E+01	0.8976E+00
		0.6891E+01	0.3591E+01
16	10	0.3440E+02	
		0.0000E+00	0.0000E+00
		0.2297E+01	0.2872E-01

		0.3828E+01	0.5565E-01
		0.5742E+01	0.1023E+00
		0.6891E+01	0.1436E+00
		0.7657E+01	0.1795E+00
		0.6891E+01	0.3591E+00
		0.6891E+01	0.5386E+00
		0.6891E+01	0.8976E+00
		0.6891E+01	0.3591E+01
17	10	0.3723E+02	
		0.0000E+00	0.0000E+00
		0.2297E+01	0.2872E-01
		0.3828E+01	0.5565E-01
		0.5742E+01	0.1023E+00
		0.6891E+01	0.1436E+00
		0.7657E+01	0.1795E+00
		0.6891E+01	0.3591E+00
		0.6891E+01	0.5386E+00
		0.6891E+01	0.8976E+00
		0.6891E+01	0.3591E+01
18	10	0.3996E+02	
		0.0000E+00	0.0000E+00
		0.2297E+01	0.2872E-01
		0.3828E+01	0.5565E-01
		0.5742E+01	0.1023E+00
		0.6891E+01	0.1436E+00
		0.7657E+01	0.1795E+00
		0.6891E+01	0.3591E+00
		0.6891E+01	0.5386E+00
		0.6891E+01	0.8976E+00
		0.6891E+01	0.3591E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.2714E+00	0.8976E-02
0.5428E+00	0.1795E-01
0.1086E+01	0.3591E-01
0.2171E+01	0.2334E+00
0.3257E+01	0.7540E+00
0.3908E+01	0.1311E+01
0.4343E+01	0.1795E+01
0.4343E+01	0.2693E+01
0.4343E+01	0.3591E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2628E+00	0.1903E-03	0.3024E-02	0.1000E-03
0.2628E+01	0.1903E-02	0.3024E-01	0.1000E-02
0.1318E+02	0.9521E-02	0.1512E+00	0.5000E-02
0.2649E+02	0.1907E-01	0.3024E+00	0.1000E-01
0.5252E+02	0.3814E-01	0.6047E+00	0.2000E-01
0.1062E+03	0.8794E-01	0.1163E+01	0.5000E-01
0.1423E+03	0.1312E+00	0.1328E+01	0.8000E-01
0.1623E+03	0.1590E+00	0.1438E+01	0.1000E+00
0.1978E+03	0.2750E+00	0.1988E+01	0.2000E+00
0.1832E+03	0.5693E+00	0.2727E+01	0.5000E+00
0.1838E+03	0.8697E+00	0.3311E+01	0.8000E+00
0.1840E+03	0.1070E+01	0.3545E+01	0.1000E+01
0.1848E+03	0.2070E+01	0.4343E+01	0.2000E+01

Project:	**ATH-MEG-033-18.70/0.00**
Location:	**Forward Abutment**
Date:	**10/4/2024**
Boring No.:	**B-049-0-23**

Bottom of Pile Cap Elevation (feet)	910

Pile Type			
HP 14x73			
Ultimate Capacity (Skin Friction) (kips)	**Depth (feet)**	**Elevation (Feet)**	
0	0	910.00	
5.2	1	909.00	
10.4	2	908.00	
15.6	3	907.00	
20.8	4	906.00	
26	5	905.00	
31.2	6	904.00	
36.4	7	903.00	
41.6	8	902.00	
46.8	9	901.00	
52.1	10	900.00	
57.3	11	899.00	
62.8	12	898.00	
68.7	13	897.00	
74.6	14	896.00	
80.5	15	895.00	
86.3	16	894.00	
92.2	17	893.00	
98.1	18	892.00	
104	19	891.00	
109.9	20	890.00	
115.8	21	889.00	
121.6	22	888.00	
127.5	23	887.00	
133.4	24	886.00	
139.7	25	885.00	
146.5	26	884.00	
153.5	27	883.00	
160.6	28	882.00	
167.8	29	881.00	
175	30	880.00	
182.4	31	879.00	
189.8	32	878.00	Downdrag
196	33	877.00	Downdrag
201.1	34	876.00	

Downdrag Calculation

Project: **ATH-MEG-033-18.70/0.00**
Location: **Forward Abutment**
Boring No.: **B-049-0-23**
Date: **10/4/24**

Measuring from bottom of pile, 0.4 inch settlement occurs at and below elevation = 877.1 feet

Compute Skin Friction using the Ultimate data from A-pile Analysis

From Apile Results

HP 14x73

Unfactored Downdrag Load	195.3	Kips	
Load Factor for Downdrag	1.05		ODOT BDM 305.3.2.2
Factored Downdrag Load	205.1	Kips	

Time Rate of Settlement Determination

Project: **ATH-MEG-033-18.70/0.00**
Boring No.: **B-049-0-23**
Date: **10/4/24**

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
885	875.6	1	2.50	9.4	0.0014	0.134369	405	0.615885	0.82	0.4	
	Net=		2.50	in					Total	0.4	in

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
885	875.6	2	2.50	9.4	0.0014	0.134369	600	0.912423	0.91	0.2	
	Net=		2.50	in					Total	0.2	in

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
Pleasanton Rd over US 33 (Bridge 2)
Rear Abutment

Boring No	B-047-0-23		
Bottom of Foundation Elevation	910.8	feet	(From structural engineer)
Top of Augerable Rock Elevation	884.1	feet	(From boring)
Top of Coreable Rock Elevation	882.6	feet	(From boring)

From Bottom of Footing Elevation to 897.6 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 500-2, Unknown Soils
Undrained Cohesion =	2500	psf	ODOT GDM Table 500-2, Unknown Soils
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 897.6 to 894.6 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	126	pcf	Laboratory Consolidation Test Result B-047-0-23, ST, 1'-3'
Undrained Cohesion =	1500	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 894.6 to 892.1 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Friction Angle=	33	degrees	ODOT GDM Section 404.2
k =	90	pci	From L-pile

From 892.1 to 886.6 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	123	pcf	Laboratory Consolidation Test Result B-047-0-23, ST, 7'-9'
Undrained Cohesion =	3200	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 886.6 to 884.1 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	135	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	5700	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.004		From L-pile
k =	2000	pci	From L-pile

From 884.1 to 882.6 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	155	pcf	ODOT GDM Table 400-5, Sandstone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	65	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	5880	psi	GDM Table 400-6, Very Weak Rock
RQD =	0%		Assumed

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
Pleasanton Rd over US 33 (Bridge 2)
Pier

Boring No	B-048-0-23		
Bottom of Foundation Elevation	894.5	feet	(From structural engineer)
Top of Augerable Rock Elevation	883	feet	(From boring)
Top of Coreable Rock Elevation	874	feet	(From boring)

From Bottom of Footing Elevation to 888.5 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2700	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 888.5 to 883.0 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	128	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	4300	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.004		From L-pile
k =	2000	pci	From L-pile

From 883.0 to 874.0 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	140	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	33.7	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	3020	psi	ODOT GDM Table 400-6, very weak rock
RQD =	0%		Assumed

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
Pleasanton Rd over US 33 (Bridge 2)
Forward Abutment

Boring No	B-049-0-23		
Bottom of Foundation Elevation	910.0	feet	(From structural engineer)
Top of Augerable Rock Elevation	875.6	feet	(From boring)
Top of Coreable Rock Elevation	866.6	feet	(From boring)

From Bottom of Footing Elevation to 885.0 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 500-2, Unknown Soils
Undrained Cohesion =	2500	psf	ODOT GDM Table 500-2, Unknown Soils
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 885.0 to 883.6

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	124	pcf	Laboratory Consolidation Test Result B-049-0-23, ST, 7'-9'
Undrained Cohesion =	1800	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 883.6 to 878.1

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	133	pcf	Laboratory Consolidation Test Result B-049-0-23, ST, 1'-3'
Undrained Cohesion =	2000	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 878.1 to 875.6

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	128	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	4000	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.004		From L-pile
k =	2000	pci	From L-pile

From 875.6 to 866.6 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	140	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	32.8	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	2950	psi	ODOT GDM Table 400-6, very weak rock
RQD =	0%		Assumed

APPENDIX F

ATH-00033-23250R- DESIGN CALCULATIONS

Rock Mass Rating (RMR)

HNTB, Ohio Inc.
ATH/MEG-033-23.23/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-007-0-23, Rear Abt.
Sample/Depth NQ-3, 11'-16'

Field RQD (%) = 88
Lab q_u (psi) = 1360
Lab γ (pcf) = 137.9

Geomechanics Classification of Rock Masses

	PARAMETER	RANGES OF VALUES							Rating
1	Strength of Intact Rock Material	Point Load Strength Index	> 175 ksf	85 - 175 ksf	45 - 85 ksf	20 - 45 ksf	For this low range - uniaxial compressive test is preferred		**1**
			> 1,200 psi	600 to 1,200 psi	300 to 600 psi	150 to 300 psi			
		Uniaxial Compressive Strength	> 4320 ksf	2160 - 4320 ksf	1080 - 2160 ksf	520 - 1080 ksf	215 - 520 ksf	70 - 215 ksf	20 - 70 ksf
			> 30,000 psi	15,000 to 30,000 psi	7,500 to 15,000 psi	3,600 to 7,500 psi	1,500 to 3,600 psi	500 to 1,500 psi	150 to 500 psi
	Relative Rating		15	12	7	4	2	1	0
2	Drill Core Quality (RQD)	90% to 100%	75% to 90%		50% to 75%		25% to 50%		< 25%	**17**
	Relative Rating	20	17		13		8		3	
3	Spacing of Joints	> 10 ft	3 to 10 ft.		1 to 3 ft.		2 in. to 1 ft.		< 2 in.	**20**
	Relative Rating	30	25		20		10		5	
4	Condition of Joints	- Very rough surfaces - Not continous - No separation - Hard joint wall rock	- Slightly rough surfaces - Separation <0.05" - Hard joint wall rock		- Slightly rough surfaces - Separation <0.05" - Soft joint wall rock		- Slickensides surfaces or - Gouge <0.2" thick or - Joints open 0.05-0.2" - Continous joints		- Soft gouge >0.2" thick or - Joints open >0.2" - Continuous joints	**12**
	Relative Rating	25	20		12		6		0	
5	Groundwater Conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None		< 400 gallons/hr.		400 to 2,000 gallons/hr.		> 2,000 gallons/hr.	**7**
		Ratio = joint water pressure / major principal stress	0		0.0 to 0.2		0.2 to 0.5		> 0.5	
		General Conditions	Completely Dry		Moist Only (interstitial water)		Water under Moderate Pressure		Severe Water Problems	
	Relative Rating		10		7		4		0	

Rock Mass Rating (RMR) = 57

AASHTO Table 10.4.6.4-2 - Geomechanics Rating Adjustment for Joint Orientations

Strike and Dip Orientations of Joints		Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	
Ratings	Tunnels	0	-2	-5	-10	-12	**0**
	Foundations	0	-2	-7	-15	-25	
	Slopes	0	-5	-25	-50	-60	

Adjusted Rock Mass Rating (RMR) = 57

AASHTO Table 10.4.6.4-3 - Geomechanics Rock Mass Classes Determined from Total Ratings

RMR	100 to 81	81 to 61	61 to 41	41 to 21	< 20	**Class:**
Class No.	I	II	III	IV	V	**III**
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock	

ODOT GDM 1303.3.3 - Calculated Rock Mass Parameters

RMR =	57	see Adjusted Rock Mass Rating above	
c' =	5.93	c' = (0.104 x RMR) (ksf)	drained shear strength of rock mass
ϕ' =	34	ϕ' = ((RMR/2) + 5) (deg.)	internal friction angle of rock mass
s =	0.00841	s = exp((RMR-100)/9)	rock mass material constant defining intactness (quality) of rock mass
m =	3.2295	$m=\exp((RMR-100)/28)*m_i$	rock mass material constant defining the shape of the Mohr's circle for uniaxial comp.
m_i =	15	Sandstone, $m_i = 15$	rock mass constant m for intact rock (where s = 100)
		Claystone/Shale, $m_i = 10$	
		Limestone/Dolomite, $m_i = 7$	
		Coal, $m_i = 1$	
E_m =	312414.00	$E_m = 144*145*10^{((RMR-10)/40)}$ (ksf)	

LRFD Strength Limit State Design for Bearing Resistance of Rock using Spread Footings

HNTB, Ohio Inc.
ATH/MEG-033-23.23/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-007-0-23, Rear Abt.
Footing Elevation: 823.6

ODOT GDM 1303.3.3 - Bearing Resistance of Bedrock (Moderately Strong or Less Strength Rock)

Does foundation bedrock meet ALL of following three conditions:

- bedrock surface under footing is not steeply sloping such that discontinuities would control the bearing resistance (a bedrock slope of 2H:1V or less)
- the foundation bedrock has a Rock Mass rating (RMR) ≤ 70
- the foundation bedrock is moderately strong or less in strength (qu ≤ 7500 psi)

if YES to all three conditions, then use the Terzaghi/Vesic/Munfakh method to calculate nominal bearing resistance in accordance with AASHTO LRFD 10.6.3.1.2a

Footing Parameters

B =	3.5	footing width, ft.	(From Stage 2 Plans)
D =	4.0	footing depth, ft.	(From Stage 2 Plans)

$q_n = c'N_c+\gamma DN_q+0.5\gamma_t BN_\gamma$ nominal bearing resistance

where

c' =	5.93	drained shear strength of rock mass, ksf
ϕ' =	34	internal friction angle of rock mass, deg.
N_c =	40.4	cohesion bearing capacity factor
γ =	0.058	unit weight of soil above footing, kcf
N_q =	27.7	surcharge bearing capacity factor
γt =	0.138	unit weight of rock below footing, kcf
N_γ =	38.0	soil density factor

hence,

q_n = 254.8 ksf

and,

φ_b =	0.45	strength limit state resistance factor
q_R =	**114.7**	**strength limit state factored resistance, $\varphi_b * q_n$, ksf**

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 1

Boring No	B-008-0-23		
Proposed Bottom of Foundation	781	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	773.3	feet	(From Boring)
Top of Coreable Rock Elevation	757.5	feet	(From Boring)
Rock Socket Length	20.8	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
773.3	757.5	15.8	Rock	3.4	2.12	0.29	576	**0.8**	34.9	**OK**	0.55	0.4	0.4	0.3
757.5	752.5	5	Rock	14.4	2.12	1.00	576	**5.5**	34.9	**OK**	0.55	3.0	0.4	2.2

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient — **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength — **(4.0 ksi as per ODOT BDM Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ — **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive — **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift — **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 43 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 3.36 ksf — **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 14.4 ksf — **Compressive Strength of claystone (psi)= 100**
(B-008-0-23, Compressive Strength Test Result, NQ-1, 25.7'-26.2')

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 1

Boring No B-008-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
880	126.7	316.8	0.50	158.4

Reference Key

(1) Compressive Strength Test Result, NQ-2, 31.5'-32.0'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 2

Boring No	B-009-0-23		
Proposed Bottom of Foundation	763.73	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	744.3	feet	(From Boring)
Top of Coreable Rock Elevation	743.5	feet	(From Boring)
Rock Socket Length	8.3	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
744.3	743.5	0.8	Rock	15.7	2.12	0.29	576	**1.7**	34.9	**OK**	0.55	0.9	0.4	0.7
743.5	736.0	7.5	Rock	216.0	2.12	1.00	576	**21.4**	34.9	**OK**	0.55	11.8	0.4	8.6

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max $= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 200.0 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 15.70 ksf **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 216.0 ksf **Compressive Strength of Shale (psi)= 1500 ODOT GDM Table 400-6, slightly strong rock**

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 2

Boring No B-009-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
2910	419.0	1047.6	0.50	523.8

Reference Key

(1) Compressive Strength Test Result, NQ-2, 26.8'-27.3'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 3

Boring No	B-010-0-23		
Proposed Bottom of Foundation	753.41	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	745.8	feet	(From Boring)
Top of Coreable Rock Elevation	744.6	feet	(From Boring)
Rock Socket Length	11.2	feet	(Provided by Structural Engineer)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
745.8	744.6	1.2	Rock	12.7	2.12	0.29	576	**1.5**	34.9	**OK**	0.55	0.8	0.4	0.6
744.6	734.6	10	Rock	216.0	2.12	1.00	576	**21.4**	34.9	**OK**	0.55	11.8	0.4	8.6

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient — **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength — **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ — **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive — **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift — **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 162.0 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 12.72 ksf — **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 216.0 ksf — **Compressive Strength of shale (psi)= 1500 (ODOT GDM Table 400-6, slightly strong rock)**

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 3

Boring No B-010-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
10290	1481.8	3704.4	0.50	1852.2

Reference Key

(1) Compressive Strength Test Result, NQ-2, 16.7'-17.2'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 4

Boring No	B-011-0-23		
Proposed Bottom of Foundation	753.35	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	740.8	feet	(From Boring)
Top of Coreable Rock Elevation	740.3	feet	(From Boring)
Rock Socket Length	10.4	feet	(Provided by Structural Engineer)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
740.8	740.3	0.5	Rock	9.4	2.12	0.29	576	**1.3**	34.9	**OK**	0.55	0.7	0.4	0.5
740.3	730.4	9.916	Rock	216.0	2.12	1.00	576	**21.4**	34.9	**OK**	0.55	11.8	0.4	8.6

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per ODOT BDM Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 120 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 9.42 ksf **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 216.0 ksf **Compressive Strength of shale (psi)= 1500 (ODOT GDM Table 400-6, slightly strong rock)**

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 4

Boring No B-011-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
6635	955.4	2388.6	0.50	1194.3

Reference Key

(1) Composite strength of interbedded shale (50%) and sandstone (50%) per ODOT BDM Section 305.4.2
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Compressive Strength of shale (psi)= 2,250 **(ODOT GDM Table 400-6, slightly to moderately strong rock)**
Compressive Strength of sandstone (psi)= 11,020 **(Compressive strength test result B-011-0-23, NQ-2, 17.7'-18.3')**
Composite Strength-interbedded rock (psi)= 6635 **(50% Shale & 50% Sandstone)**

Rock Mass Rating (RMR)

HNTB, Ohio Inc.
ATH/MEG-033-23.23/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-012-0-23, Forward Abt.
Sample/Depth NQ-5, 35'-40'

Field RQD (%) = 93
Lab q_u (psi) = 4110
Lab γ (pcf) = 138.8

Geomechanics Classification of Rock Masses

	PARAMETER	RANGES OF VALUES							Rating
1	Strength of Intact Rock Material	Point Load Strength Index	> 175 ksf	85 - 175 ksf	45 - 85 ksf	20 - 45 ksf	For this low range - uniaxial compressive test is preferred		**4**
			> 1,200 psi	600 to 1,200 psi	300 to 600 psi	150 to 300 psi			
		Uniaxial Compressive Strength	> 4320 ksf	2160 - 4320 ksf	1080 - 2160 ksf	520 - 1080 ksf	215 - 520 ksf	70 - 215 ksf	20 - 70 ksf
			> 30,000 psi	15,000 to 30,000 psi	7,500 to 15,000 psi	3,600 to 7,500 psi	1,500 to 3,600 psi	500 to 1,500 psi	150 to 500 psi
	Relative Rating		15	12	7	4	2	1	0
2	Drill Core Quality (RQD)	90% to 100%	75% to 90%		50% to 75%		25% to 50%		< 25%	**20**
	Relative Rating	20	17		13		8		3	
3	Spacing of Joints	> 10 ft	3 to 10 ft.		1 to 3 ft.		2 in. to 1 ft.		< 2 in.	**20**
	Relative Rating	30	25		20		10		5	
4	Condition of Joints	- Very rough surfaces - Not continous - No separation - Hard joint wall rock	- Slightly rough surfaces - Separation <0.05" - Hard joint wall rock		- Slightly rough surfaces - Separation <0.05" - Soft joint wall rock		- Slickensides surfaces or - Gouge <0.2" thick or - Joints open 0.05-0.2" - Continous joints		- Soft gouge >0.2" thick or - Joints open >0.2" - Continuous joints	**12**
	Relative Rating	25	20		12		6		0	
5	Groundwater Conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None		< 400 gallons/hr.		400 to 2,000 gallons/hr.		> 2,000 gallons/hr.	**7**
		Ratio = joint water pressure / major principal stress	0		0.0 to 0.2		0.2 to 0.5		> 0.5	
		General Conditions	Completely Dry		Moist Only (interstitial water)		Water under Moderate Pressure		Severe Water Problems	
	Relative Rating		10		7		4		0	
									Rock Mass Rating (RMR) =	**63**

AASHTO Table 10.4.6.4-2 - Geomechanics Rating Adjustment for Joint Orientations

	Strike and Dip Orientations of Joints	Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	
Ratings	Tunnels	0	-2	-5	-10	-12	**0**
	Foundations	0	-2	-7	-15	-25	
	Slopes	0	-5	-25	-50	-60	
						Adjusted Rock Mass Rating (RMR) =	**63**

AASHTO Table 10.4.6.4-3 - Geomechanics Rock Mass Classes Determined from Total Ratings

RMR	100 to 81	81 to 61	61 to 41	41 to 21	< 20	**Class:**
Class No.	I	II	III	IV	V	**II**
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock	

ODOT GDM 1303.3.3 - Calculated Rock Mass Parameters

RMR =	63	see Adjusted Rock Mass Rating above	
c' =	6.55	c' = (0.104 x RMR) (ksf)	drained shear strength of rock mass
ϕ' =	37	ϕ' = ((RMR/2) + 5) (deg.)	internal friction angle of rock mass
s =	0.01639	s = exp((RMR-100)/9)	rock mass material constant defining intactness (quality) of rock mass
m =	4.0013	m=exp((RMR-100)/28)*m_i	rock mass material constant defining the shape of the Mohr's circle for uniaxial comp.
m_i =	15	Sandstone, m_i = 15	rock mass constant m for intact rock (where s = 100)
		Claystone/Shale, m_i = 10	
		Limestone/Dolomite, m_i = 7	
		Coal, m_i = 1	
E_m =	441296.51	$E_m = 144*145*10^{((RMR-10)/40)}$ (ksf)	

LRFD Strength Limit State Design for Bearing Resistance of Rock using Spread Footings

HNTB, Ohio Inc.
ATH/MEG-033-23.23/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-012-0-23, Forward Abt.
Footing Elevation: 816.5

ODOT GDM 1303.3.3 - Bearing Resistance of Bedrock (Moderately Strong or Less Strength Rock)

Does foundation bedrock meet ALL of following three conditions:

- bedrock surface under footing is not steeply sloping such that discontinuities would control the bearing resistance (a bedrock slope of 2H:1V or less)
- the foundation bedrock has a Rock Mass rating (RMR) ≤ 70
- the foundation bedrock is moderately strong or less in strength (qu ≤ 7500 psi)

if YES to all three conditions, then use the Terzaghi/Vesic/Munfakh method to calculate nominal bearing resistance in accordance with AASHTO LRFD 10.6.3.1.2a

Footing parameters:

B =	3.5	footing width, ft.	(From Stage 2 Plans)
D =	4.0	footing depth, ft.	(From Stage 2 Plans)

$q_n = c'N_c+\gamma DN_q+0.5\gamma_t BN_\gamma$ nominal bearing resistance

where

c' =	6.55	drained shear strength of rock mass, ksf
ϕ' =	37	internal friction angle of rock mass, deg.
N_c =	53.0	cohesion bearing capacity factor
γ =	0.058	unit weight of soil above footing, kcf
N_q =	40.3	surcharge bearing capacity factor
γt =	0.139	unit weight of rock below footing, kcf
N_γ =	61.0	soil density factor

hence,

q_n =	**371.7**	**ksf**

and,

φ_b =	0.45	strength limit state resistance factor
q_R =	**167.2**	**strength limit state factored resistance, φ_b * q_n, ksf**

L-PILE Soil and Rock Parameters

ATH/MEG-23.23/0.00
ATH-00033-23250R - Eastbound US33 over Pratts Fork Creek
Pier 1

Boring No	B-008-0-23		
Bottom of Foundation Elevation	781.0	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	773.3	feet	(From boring)
Top of Coreable Rock Elevation	757.5	feet	(From boring)

From Bottom of Footing Elevation to 781.3 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 500-2
Undrained Cohesion =	2500	psf	ODOT GDM Table 500-2
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 781.3 to 775.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2800	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 775.8 to 773.3 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	122	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1800	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 773.3 to 757.5 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	140	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	23.4	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	18000	psi	GDM Table 400-6, Very Weak Rock
RQD =	10%		Assumed

Below 757.5 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	140	pcf	Laboratory Test of B-008-0-23, NQ-1
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	100	psi	Laboratory Test of B-008-0-23, NQ-1
Initial Rock Modulus =	18000	psi	GDM Table 400-6, Very Weak Rock
RQD =	80%		B-008-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH/MEG-23.23/0.00
ATH-00033-23250R - Eastbound US33 over Pratts Fork Creek
Pier 2

Boring No	B-009-0-23		
Bottom of Foundation Elevation	763.7	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	744.3	feet	(From boring)
Top of Coreable Rock Elevation	743.5	feet	(From boring)

From Bottom of Footing Elevation to 756.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	120	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1300	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 756.8 to 751.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	122	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1900	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 751.8 to 744.3 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Friction Angle =	33	Degrees	ODOT GDM Section 404.2
k =	90	pci	From L-pile

From 744.3 to 743.5 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	109.0	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	18000	psi	GDM Table 400-6, very weak rock
RQD =	10%		Assumed

Below 743.5 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	1500	psi	ODOT GDM Table 400-6, slightly strong rock
Initial Rock Modulus =	140000	psi	ODOT GDM Table 400-6, slightly strong rock
RQD =	87%		B-009-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
ATH-00033-23250R - Eastbound US33 over Pratts Fork Creek
Pier 3

Boring No	B-010-0-23		
Bottom of Foundation Elevation	753.4	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	745.8	feet	(From boring)
Top of Coreable Rock Elevation	744.6	feet	(From boring)

From Bottom of Footing Elevation to 748.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	118	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1100	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 748.8 to 745.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	120	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1600	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 745.8 to 744.6 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	88.3	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	18000	psi	GDM Table 400-6, Very Weak Rock
RQD =	10%		Assumed

Below 744.6 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	1500	psi	ODOT GDM Table 400-6, slightly strong rock
Initial Rock Modulus =	140000	psi	ODOT GDM Table 400-6, slightly strong rock
RQD =	35%		B-010-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
ATH-00033-23250R - Eastbound US33 over Pratts Fork Creek
Pier 4

Boring No	B-011-0-23		
Bottom of Foundation Elevation	753.4	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	740.8	feet	(From boring)
Top of Coreable Rock Elevation	740.3	feet	(From boring)

From Bottom of Footing Elevation to 749.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 500-2
Undrained Cohesion =	2500	psf	ODOT GDM Table 500-2
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 749.8 to 743.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	118	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1000	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 743.8 to 740.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	120	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1500	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 740.8 to 740.3 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	65.4	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	18000	psi	GDM Table 400-6, Very Weak Rock
RQD =	10%		Assumed

Below 740.3 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	1500	psi	ODOT GDM Table 400-6, slightly strong rock
Initial Rock Modulus =	140000	psi	ODOT GDM Table 400-6, slightly strong rock
RQD =	78%		B-011-0-23, NQ-1

APPENDIX G

ATH-00033-24250R- DESIGN CALCULATIONS

Rock Mass Rating (RMR)

HNTB, Ohio Inc.
ATH/MEG-033-23.23/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-018-0-23, Rear Abt.
Sample/Depth NQ-1, 5'-10'

Field RQD (%) = 18
q_u (psi) = 2410
γ (pcf) = 156.4

Geomechanics Classification of Rock Masses

	PARAMETER	RANGES OF VALUES							Rating
1	Strength of Intact Rock Material	Point Load Strength Index	> 175 ksf	85 - 175 ksf	45 - 85 ksf	20 - 45 ksf	For this low range - uniaxial compressive test is preferred		**2**
			> 1,200 psi	600 to 1,200 psi	300 to 600 psi	150 to 300 psi			
		Uniaxial Compressive Strength	> 4320 ksf	2160 - 4320 ksf	1080 - 2160 ksf	520 - 1080 ksf	215 - 520 ksf	70 - 215 ksf	20 - 70 ksf
			> 30,000 psi	15,000 to 30,000 psi	7,500 to 15,000 psi	3,600 to 7,500 psi	1,500 to 3,600 psi	500 to 1,500 psi	150 to 500 psi
	Relative Rating		15	12	7	4	2	1	0
2	Drill Core Quality (RQD)	90% to 100%	75% to 90%		50% to 75%		25% to 50%		< 25%	**3**
	Relative Rating	20	17		13		8		3	
3	Spacing of Joints	> 10 ft	3 to 10 ft.		1 to 3 ft.		2 in. to 1 ft.		< 2 in.	**10**
	Relative Rating	30	25		20		10		5	
4	Condition of Joints	- Very rough surfaces - Not continous - No separation - Hard joint wall rock	- Slightly rough surfaces - Separation <0.05" - Hard joint wall rock		- Slightly rough surfaces - Separation <0.05" - Soft joint wall rock		- Slickensides surfaces or - Gouge <0.2" thick or - Joints open 0.05-0.2" - Continous joints		- Soft gouge >0.2" thick or - Joints open >0.2" - Continuous joints	**12**
	Relative Rating	25	20		12		6		0	
5	Groundwater Conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None		< 400 gallons/hr.		400 to 2,000 gallons/hr.		> 2,000 gallons/hr.	**7**
		Ratio = joint water pressure / major principal stress	0		0.0 to 0.2		0.2 to 0.5		> 0.5	
		General Conditions	Completely Dry		Moist Only (interstitial water)		Water under Moderate Pressure		Severe Water Problems	
	Relative Rating		10		7		4		0	
									Rock Mass Rating (RMR) =	**34**

AASHTO Table 10.4.6.4-2 - Geomechanics Rating Adjustment for Joint Orientations

Strike and Dip Orientations of Joints		Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	
Ratings	Tunnels	0	-2	-5	-10	-12	**0**
	Foundations	0	-2	-7	-15	-25	
	Slopes	0	-5	-25	-50	-60	

Adjusted Rock Mass Rating (RMR) = 34

AASHTO Table 10.4.6.4-3 - Geomechanics Rock Mass Classes Determined from Total Ratings

RMR	100 to 81	81 to 61	61 to 41	41 to 21	< 20	**Class:**
Class No.	I	II	III	IV	V	**IV**
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock	

ODOT GDM 1303.3.3 - Calculated Rock Mass Parameters

RMR =	34	see Adjusted Rock Mass Rating above	
c' =	3.54	c' = (0.104 x RMR) (ksf)	drained shear strength of rock mass
ϕ' =	22	ϕ' = ((RMR/2) + 5) (deg.)	internal friction angle of rock mass
s =	0.00065	s = exp((RMR-100)/9)	rock mass material constant defining intactness (quality) of rock mass
m =	0.9469	m=exp((RMR-100)/28)*m_i	rock mass material constant defining the shape of the Mohr's circle for uniaxial comp.
m_i =	10	Sandstone, m_i = 15	rock mass constant m for intact rock (where s = 100)
		Claystone/Shale, m_i = 10	
		Limestone/Dolomite, m_i = 7	
		Coal, m_i = 1	
E_m =	33884.31	E_m = Sqrt(q_u(mpa)/100)*$10^{((RMR-10)/40)}$ *144*145* (ksf)	

LRFD Strength Limit State Design for Bearing Resistance of Rock using Spread Footings

HNTB, Ohio Inc.
ATH/MEG-033-23.23/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-018-0-23, Rear Abt.
Footing Elevation: 836.3

ODOT GDM 1303.3.3 - Bearing Resistance of Bedrock (Moderately Strong or Less Strength Rock)

Does foundation bedrock meet ALL of following three conditions:

- bedrock surface under footing is not steeply sloping such that discontinuities would control the bearing resistance (a bedrock slope of 2H:1V or less)
- the foundation bedrock has a Rock Mass rating (RMR) ≤ 70
- the foundation bedrock is moderately strong or less in strength (qu ≤ 7500 psi)

if YES to all three conditions, then use the Terzaghi/Vesic/Munfakh method to calculate nominal bearing resistance in accordance with AASHTO LRFD 10.6.3.1.2a

Footing parameters

B =	7.8	footing width, ft.	(From Stage 2 Plans)
D =	8.2	footing depth, ft.	(From Stage 2 Plans)

$q_n = c'N_c+\gamma DN_q+0.5\gamma_t BN_\gamma$ nominal bearing resistance

where

c' =	3.54	drained shear strength of rock mass, ksf
ϕ' =	22	internal friction angle of rock mass, deg.
N_c =	16.9	cohesion bearing capacity factor
γ =	0.058	unit weight of soil above footing, kcf
N_q =	7.8	surcharge bearing capacity factor
γt =	0.156	unit weight of rock below footing, kcf
N_γ =	7.1	soil density factor

hence,

q_n = 67.8 ksf

and,

φ_b =	0.45	strength limit state resistance factor
q_R =	**30.5**	**strength limit state factored resistance, $\varphi_b * q_n$, ksf**

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 1

Boring No	B-019-0-23		
Proposed Bottom of Foundation Elevation	781.8	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	758.8	feet	(From Stage 2 plans - see note below Table 18 in the Structure Foundation Exploration Report)
Top of Coreable Rock Elevation	748.9	feet	(From Boring)
Rock Socket Length	20	feet	(From Stage 2 plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
758.8	748.9	9.9	Rock	4.1	2.12	0.29	576	**0.9**	34.9	**OK**	0.55	0.5	0.4	0.3
748.9	738.8	10.1	Rock	7.2	2.12	1.00	576	**3.9**	34.9	**OK**	0.55	2.1	0.4	1.6

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per ODOT BDM Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max $= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 53 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 4.12 ksf **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 7.2 ksf **Compressive Strength of claystone (psi)= 50**
(B-019-0-23, Compressive Strength Test Result, NQ-1, 18.5'-18.9')

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 1

Boring No B-019-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
230	33.1	82.8	0.50	41.4

Reference Key

(1) Compressive Strength Test Result, NQ-2, 24.5'-25.0'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 2

Boring No	B-020-0-23		
Proposed Bottom of Foundation Elevation	753.1	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	738.6	feet	(From Stage 2 plans - Boring shows top of augerable rock at elevation 738.9)
Top of Coreable Rock Elevation	737.4	feet	(From Boring)
Rock Socket Length	10	feet	(From Stage 2 plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
738.6	737.4	1.2	Rock	7.1	2.12	0.29	576	**1.1**	34.9	**OK**	0.55	0.6	0.4	0.4
737.4	728.6	8.8	Rock	695.5	2.12	1.00	576	**38.4**	34.9	**No Good**	0.55	19.2	0.4	14.0

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient — **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength — **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ — **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max $= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive — **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift — **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 90.0 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 7.07 ksf — **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 695.5 ksf — **(Composite strength of interbedded shale (50%) and sandstone (50%) per ODOT BDM Section 305.4.2)**

Compressive Strength of shale (psi)= 1,500 (ODOT GDM Table 400-6, slightly strong rock)
Compressive Strength of sandstone (psi)= 8,160 (Average compressive strength test result NQ-1, 21.7'-22.3' & NQ-2, 25.5'-26.0')
Composite Strength (psi) = 4830

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 2

Boring No B-020-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [2] (ksf)	Resistance Factor, Tip Resistance [3]	Factored Unit Tip Resistance, q_p (ksf)
3,780	544.3	1360.8	0.50	680.4

Reference Key

(1) Composite strength of interbedded shale (50%) and sandstone (50%) per ODOT BDM Section 305.4.2

(2) AASHTO 10.8.3.5.4c-1

(3) AASHTO Table 10.5.5.2.4-1

Compressive Strength of shale (psi)= 1,500 **(ODOT GDM Table 400-6, slightly strong rock)**
Compressive Strength of sandstone (psi)= 6,060 **(Compressive strength test result B-020-0-23, NQ-2, 25.5'-26.0')**
Composite Strength (psi) = 3780

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 3

Boring No	B-021-0-23		
Proposed Bottom of Foundation Elevation	755.5	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	753.5	feet	(From Boring)
Top of Coreable Rock Elevation	753	feet	(From Boring)
Rock Socket Length	10	feet	(From Stage 2 plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
753.5	753	0.5	Rock	15.7	2.12	0.29	576	**1.7**	34.9	**OK**	0.55	0.9	0.4	0.7
753	750	3	Rock	1366.6	2.12	1.00	576	**53.8**	34.9	**No Good**	0.55	19.2	0.4	14.0
750	745	5	Rock	11.5	2.12	1.00	576	**4.9**	34.9	**OK**	0.55	2.7	0.4	2.0
745	743.5	1.5	Rock	823.7	2.12	1.00	576	**41.8**	34.9	**No Good**	0.55	23.0	0.4	16.7

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 200.0 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 15.70 ksf **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 1366.6 ksf **Compressive Strength of sandstone (psi)= 9,490 (B-021-0-23, Compressive Strength Test Result, NQ-1, 10.5'-11.0')**
$q_{u\,3}$ (ksf)= 11.5 ksf **Compressive Strength of claystone (psi)= 80 (B-021-0-23, Compressive Strength Test Result, NQ-2, 15.0'-15.5')**
$q_{u\,4}$ (ksf)= 823.7 ksf **Compressive Strength of claystone (psi)= 5,720 (B-021-0-23, Compressive Strength Test Result, NQ-4, 23.5'-24.0')**

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 3

Boring No B-021-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
5720	823.7	2059.2	0.50	1029.6

Reference Key

(1) Compressive Strength Test Result, NQ-4, 23.5'-24.0'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 4

Boring No	B-022-0-23		
Proposed Bottom of Foundation Elevation	818.3	feet	(From Stage 2 plans)
Top of Augerable Rock Elevation	827.8	feet	(From Boring)
Top of Coreable Rock Elevation	826.3	feet	(From Boring)
Rock Socket Length	12	feet	(From Stage 2 plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
818.3	806.3	12	Rock	445.7	2.12	1.00	576	**30.7**	34.9	**OK**	0.55	16.9	0.4	12.3

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient — **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength — **(4.0 ksi as per ODOT BDM Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ — **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max $= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive — **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift — **(AASHTO TABLE 10.5.5.2.4-1)**

$q_{u\ avg}$(ksf)= 445.7 ksf

Compressive Strength of sandstone (psi)= 3,290 (B-022-0-23, Compressive Strength Test Result, NQ-3, 15.0'-15.5')
Compressive Strength of sandstone (psi)= 2,900 (B-022-0-23, Compressive Strength Test Result, NQ-4, 18.0'-18.8')
Average Strength (psi)= 3095

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 4

Boring No B-022-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
2900	417.6	1044.0	0.50	522.0

Reference Key

(1) Compressive Strength Test Result from NQ-4
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Rock Mass Rating (RMR)

HNTB, Ohio Inc.
ATH/MEG-033-23.23/0.00
Athens and Meigs County
CTL Project No.: 23050059COL

Engineer: SR/SM
Date: 4-Oct-2024
Boring/Fnd: B-023-0-23, Forward Abt.
Sample/Depth NQ-3, 20'-25'

Field RQD (%) = 38
q_u (psi) = 740
γ (pcf) = 130.0

Geomechanics Classification of Rock Masses

	PARAMETER	RANGES OF VALUES							Rating
1	Strength of Intact Rock Material	Point Load Strength Index	> 175 ksf	85 - 175 ksf	45 - 85 ksf	20 - 45 ksf	For this low range - uniaxial compressive test is preferred		**1**
			> 1,200 psi	600 to 1,200 psi	300 to 600 psi	150 to 300 psi			
		Uniaxial Compressive Strength	> 4320 ksf	2160 - 4320 ksf	1080 - 2160 ksf	520 - 1080 ksf	215 - 520 ksf	70 - 215 ksf	20 - 70 ksf
			> 30,000 psi	15,000 to 30,000 psi	7,500 to 15,000 psi	3,600 to 7,500 psi	1,500 to 3,600 psi	500 to 1,500 psi	150 to 500 psi
	Relative Rating		15	12	7	4	2	1	0
2	Drill Core Quality (RQD)	90% to 100%	75% to 90%		50% to 75%		25% to 50%		< 25%	**8**
	Relative Rating	20	17		13		8		3	
3	Spacing of Joints	> 10 ft	3 to 10 ft.		1 to 3 ft.		2 in. to 1 ft.		< 2 in.	**10**
	Relative Rating	30	25		20		10		5	
4	Condition of Joints	- Very rough surfaces - Not continous - No separation - Hard joint wall rock	- Slightly rough surfaces - Separation <0.05" - Hard joint wall rock		- Slightly rough surfaces - Separation <0.05" - Soft joint wall rock		- Slickensides surfaces or - Gouge <0.2" thick or - Joints open 0.05-0.2" - Continous joints		- Soft gouge >0.2" thick or - Joints open >0.2" - Continuous joints	**12**
	Relative Rating	25	20		12		6		0	
5	Groundwater Conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None		< 400 gallons/hr.		400 to 2,000 gallons/hr.		> 2,000 gallons/hr.	**7**
		Ratio = joint water pressure / major principal stress	0		0.0 to 0.2		0.2 to 0.5		> 0.5	
		General Conditions	Completely Dry		Moist Only (interstitial water)		Water under Moderate Pressure		Severe Water Problems	
	Relative Rating		10		7		4		0	
									Rock Mass Rating (RMR) =	**38**

AASHTO Table 10.4.6.4-2 - Geomechanics Rating Adjustment for Joint Orientations

Strike and Dip Orientations of Joints		Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	
Ratings	Tunnels	0	-2	-5	-10	-12	**0**
	Foundations	0	-2	-7	-15	-25	
	Slopes	0	-5	-25	-50	-60	
					Adjusted Rock Mass Rating (RMR) =		**38**

AASHTO Table 10.4.6.4-3 - Geomechanics Rock Mass Classes Determined from Total Ratings

RMR	100 to 81	81 to 61	61 to 41	41 to 21	< 20	**Class:**
Class No.	I	II	III	IV	V	**IV**
Description	Very Good Rock	Good Rock	Fair Rock	Poor Rock	Very Poor Rock	

ODOT GDM 1303.3.3 - Calculated Rock Mass Parameters

RMR =	38	see Adjusted Rock Mass Rating above	
c' =	3.95	c' = (0.104 x RMR) (ksf)	drained shear strength of rock mass
ϕ' =	24	ϕ' = ((RMR/2) + 5) (deg.)	internal friction angle of rock mass
s =	0.00102	s = exp((RMR-100)/9)	rock mass material constant defining intactness (quality) of rock mass
m =	1.0923	m=exp((RMR-100)/28)*m_i	rock mass material constant defining the shape of the Mohr's circle for uniaxial comp.
m_i =	10	Sandstone, m_i = 15	rock mass constant m for intact rock (where s = 100)
		Claystone/Shale, m_i = 10	
		Limestone/Dolomite, m_i = 7	
		Coal, m_i = 1	
E_m =	23637.74	E_m = Sqrt(q_u(mpa)/100)*$10^{((RMR-10)/40)*144*145*}$ (ksf)	

LRFD Strength Limit State Design for Bearing Resistance of Rock using Spread Footings

HNTB, Ohio Inc. | Engineer: SR/SM
ATH/MEG-033-23.23/0.00 | Date: 4-Oct-2024
Athens and Meigs County | **Boring/Fnd: B-023-0-23, Forward Abt.**
CTL Project No.: 23050059COL | **Footing Elevation: 843.3**

ODOT GDM 1303.3.3 - Bearing Resistance of Bedrock (Moderately Strong or Less Strength Rock)

Does foundation bedrock meet ALL of following three conditions:

- bedrock surface under footing is not steeply sloping such that discontinuities would control the bearing resistance (a bedrock slope of 2H:1V or less)
- the foundation bedrock has a Rock Mass rating (RMR) ≤ 70
- the foundation bedrock is moderately strong or less in strength (qu ≤ 7500 psi)

if YES to all three conditions, then use the Terzaghi/Vesic/Munfakh method to calculate nominal bearing resistance in accordance with AASHTO LRFD 10.6.3.1.2a

Footing Parameters:

B =	7.8	footing width, ft.	(From Stage 2 Plans)
D =	8.3	footing depth, ft.	(From Stage 2 Plans)

$q_n = c'N_c+\gamma DN_q+0.5\gamma_t BN_\gamma$ nominal bearing resistance

where

c' =	3.95	drained shear strength of rock mass, ksf
ϕ' =	24	internal friction angle of rock mass, deg.
N_c =	19.3	cohesion bearing capacity factor
γ =	0.058	unit weight of soil above footing, kcf
N_q =	9.6	surcharge bearing capacity factor
γt =	0.130	unit weight of rock below footing, kcf
N_γ =	9.4	soil density factor

hence,

q_n = 85.8 ksf

and,

φ_b =	0.45	strength limit state resistance factor
q_R =	**38.6**	**strength limit state factored resistance, $\varphi_b * q_n$, ksf**

L-PILE Soil and Rock Parameters

ATH/MEG-33-23.23/0.00
ATH-00033-24250R - Eastbound US33 over Tributary to Pratts Fork Creek
Pier 1

Boring No	B-019-0-23		
Bottom of Pile Cap Elevation	781.8	feet	(From stage 2 plans)
Top of Augerable Rock Elevation	752.9	feet	(From boring)
Top of Coreable Rock Elevation	748.9	feet	(From boring)

From Bottom of Footing Elevation to 763.4 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 500-2
Undrained Cohesion =	2500	psf	ODOT GDM Table 500-2
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 763.4 to 757.9 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	120	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1300	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 757.9 to 752.9 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2800	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 752.9 to 748.9 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	140	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	28.6	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	2570	psi	GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 748.9 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	141.7	pcf	Laboratory Test of B-019-0-23, NQ-1
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	50	psi	Laboratory Test of B-019-0-23, NQ-1
Initial Rock Modulus =	4500	psi	GDM Table 400-6, very weak rock
RQD =	55%		B-019-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH/MEG-33-23.23/0.00
ATH-00033-24250R - Eastbound US33 over Tributary to Pratts Fork Creek
Pier 2

Boring No	B-020-0-23		
Bottom of Pile Cap Elevation	753.1	feet	(From stage 2 plans)
Top of Augerable Rock Elevation	738.9	feet	(From boring)
Top of Coreable Rock Elevation	737.4	feet	(From boring)

From Bottom of Footing Elevation to 747.4 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	120	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1300	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 747.4 to 738.9 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2400	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 738.9 to 737.4 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	49.1	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	4410	psi	GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 737.4 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	167.4	pcf	Laboratory Test of B-020-0-23, NQ-1
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	5880	psi	(Composite strength of interbedded shale (50%) and sandstone (50%) per ODOT BDM Section 305.4.2)
			Compressive Strength of shale (psi)= 1,500 (ODOT GDM Table 400-6, slightly strong rock)
			Compressive Strength of sandstone (psi)= 10,260 (Compressive strength test result NQ-1, 21.7'-22.3')
			Composite Strength (psi) = 5,880
Initial Rock Modulus =	140000	psi	ODOT GDM Table 400-6, slightly strong rock
RQD =	60%		B-020-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
ATH-00033-24250R - Eastbound US33 over Tributary to Pratts Fork Creek
Pier 3

Boring No	B-021-0-23		
Bottom of Pile Cap Elevation	755.5	feet	(From stage 2 plans)
Top of Augerable Rock Elevation	753.5	feet	(From boring)
Top of Coreable Rock Elevation	753	feet	(From boring)

From Bottom of Footing Elevation to 753.5 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	118	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1000	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 753.5 to 753.0 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	160	pcf	ODOT GDM Table 400-5, Sandstone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	109.0	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	9810	psi	ODOT GDM Table 400-6, very weak rock
RQD =	0%		Assumed

From 753.0 to 750.0 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	172.1	pcf	Laboratory Test of B-021-0-23, NQ-1
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	9490.0	psi	Laboratory Test of B-021-0-23, NQ-1
Initial Rock Modulus =	320000	psi	ODOT GDM Table 400-6, moderately strong rock
RQD =	81%		B-021-0-23, NQ-1

Below 750.0 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	146.4	pcf	Laboratory Test of B-021-0-23, NQ-2
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	80	psi	Laboratory Test of B-021-0-23, NQ-2
Initial Rock Modulus =	7200	psi	ODOT GDM Table 400-6, very weak rock
RQD =	17%		B-021-0-23, NQ-2

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
ATH-00033-24250R - Eastbound US33 over Tributary to Pratts Fork Creek
Pier 4

Boring No	B-022-0-23		
Bottom of Pile Cap Elevation	818.3	feet	(From stage 2 plans)
Top of Augerable Rock Elevation	827.8	feet	(From boring)
Top of Coreable Rock Elevation	826.3	feet	(From boring)

Below 818.3 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	145.1	pcf	Laboratory Test of B-022-0-23, NQ-3
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	3290	psi	Laboratory Test of B-022-0-23, NQ-3
Initial Rock Modulus =	140000	psi	ODOT GDM Table 400-6, slightly strong rock
RQD =	90%		B-022-0-23, NQ-3

Soil Parameters

Project: ATH/MEG-033-18.70/00.00
Bridge No. ATH-00033-24.250R
Boring No.: B-018-0-23, B-019-0-23, B-020-0-23
Date: 9/13/24

								Total Stress		Effective Stress		
Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)	Reference
1	845.4	755.9	89.5	A-6a/A-7-6	122	41	8					
						12	17					
						10	23					
						18	17					
						27	15					
						12	37					
						9	13					
						12	20					
						17	19					
						19	20					
						19	16					
						20	16					
						23	12					
			Avg	A-6a/A-7-6	122	18	18	2250	0	210	24	1,2,3

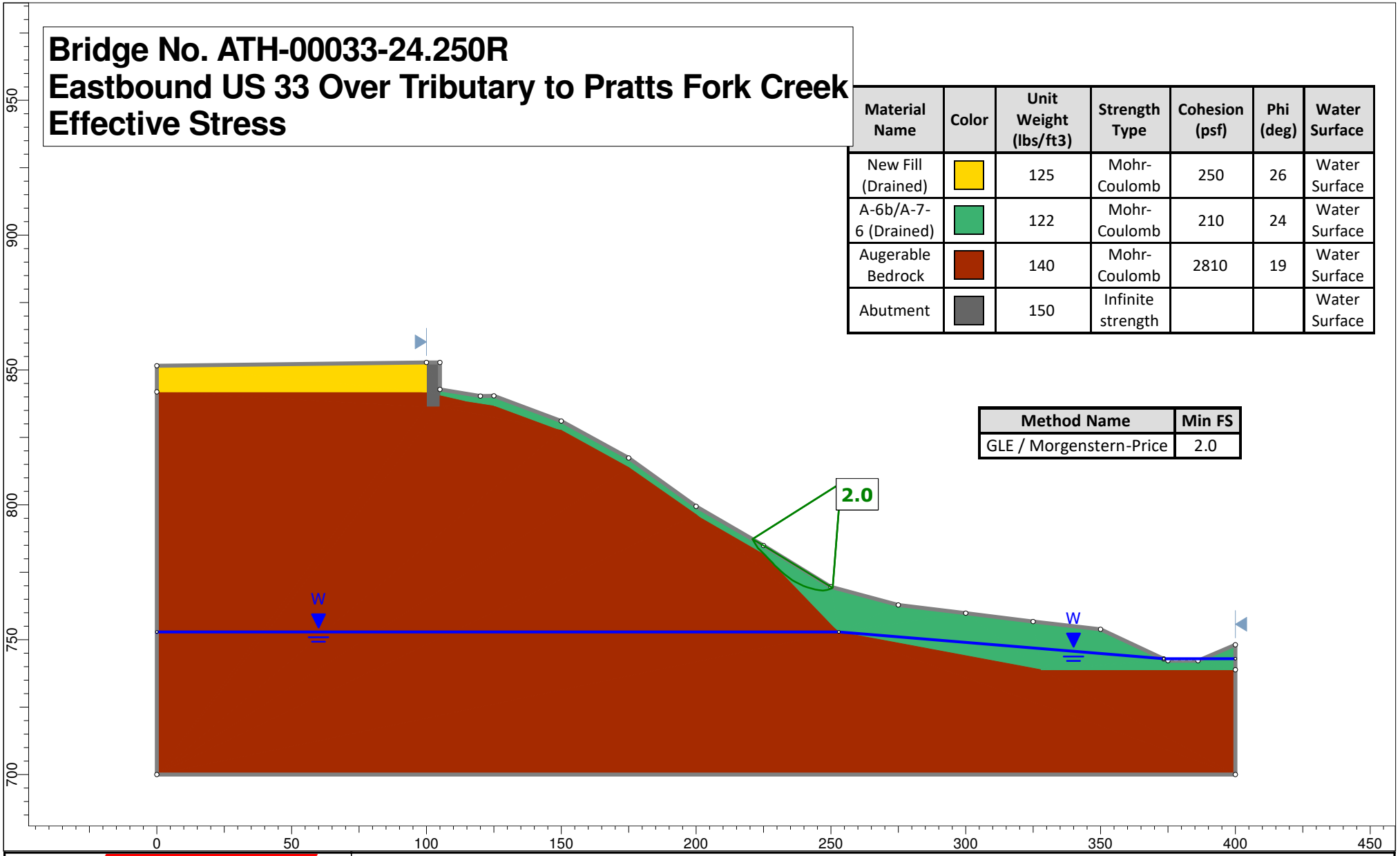
Reference Key

1 Total stress and effective stress cohesion estimated according to ODOT GDM Section 404.1
2 Total stess friction angle of cohesive soils estimated to be 0
3 Effective stress friction angle for cohesive soils estimated using GB7 Table 2

Bridge No. ATH-00033-24.250R
Eastbound US 33 Over Tributary to Pratts Fork Creek
Effective Stress

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
New Fill (Drained)		125	Mohr-Coulomb	250	26	Water Surface
A-6b/A-7-6 (Drained)		122	Mohr-Coulomb	210	24	Water Surface
Augerable Bedrock		140	Mohr-Coulomb	2810	19	Water Surface
Abutment		150	Infinite strength			Water Surface

Method Name	Min FS
GLE / Morgenstern-Price	2.0



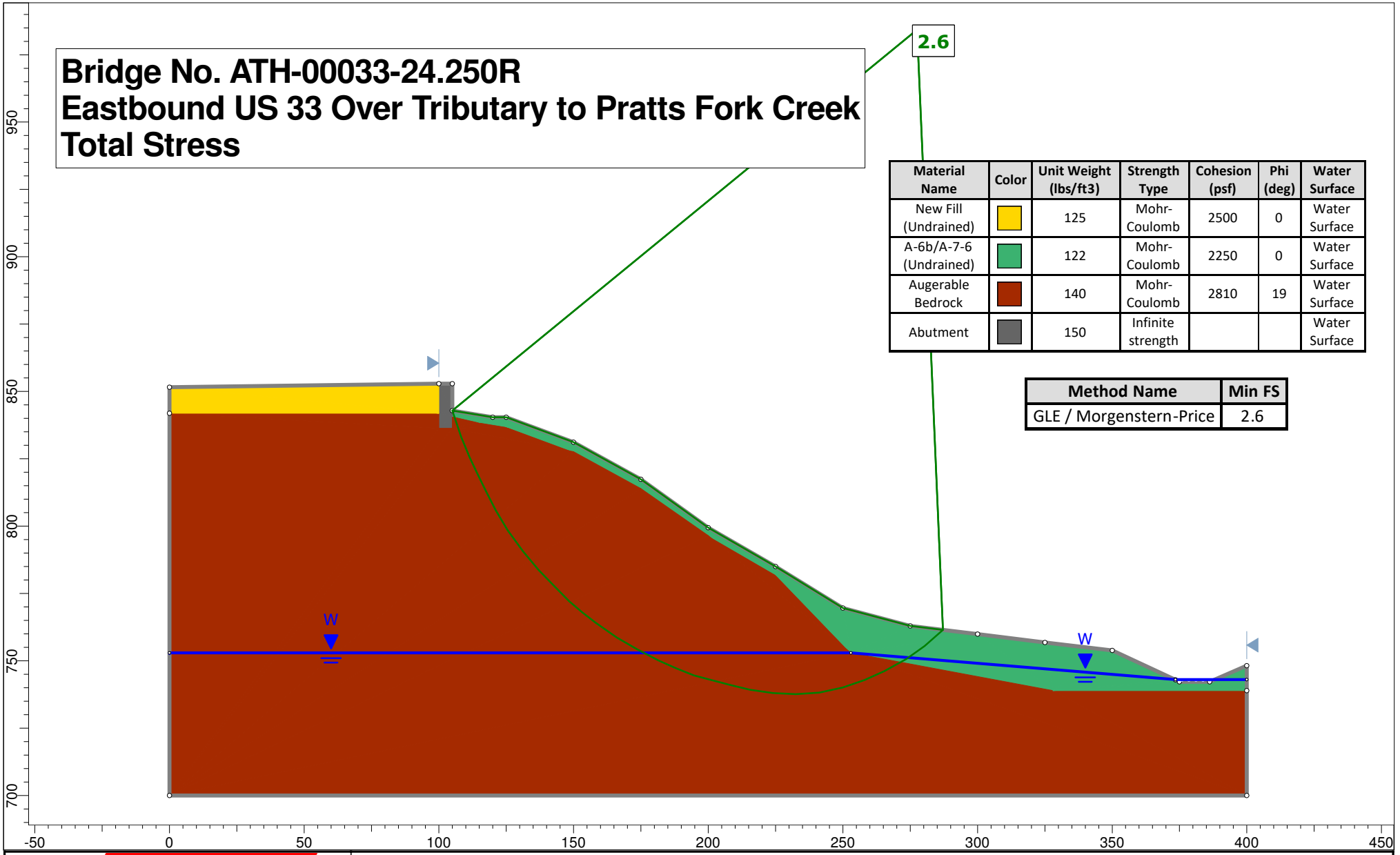
Project	Bridge No. ATH-00033-24.250R		
Group	Group 1	Scenario	Master Scenario
Drawn By	CTL Engineering, Inc.	Company	CTL Engineering, Inc.
Date	9/13/2024, 11:55:53 AM	File Name	ATH-00033-24.250R.slmd

Bridge No. ATH-00033-24.250R
Eastbound US 33 Over Tributary to Pratts Fork Creek
Total Stress

2.6

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
New Fill (Undrained)		125	Mohr-Coulomb	2500	0	Water Surface
A-6b/A-7-6 (Undrained)		122	Mohr-Coulomb	2250	0	Water Surface
Augerable Bedrock		140	Mohr-Coulomb	2810	19	Water Surface
Abutment		150	Infinite strength			Water Surface

Method Name	Min FS
GLE / Morgenstern-Price	2.6



Project	Bridge No. ATH-00033-24.250R		
Group	Group 1	Scenario	Master Scenario
Drawn By	CTL Engineering, Inc.	Company	CTL Engineering, Inc.
Date	9/13/2024, 11:55:53 AM	File Name	ATH-00033-24.250R.slmd

CTL ENGINEERING INC

SLIDEINTERPRET 10.0

APPENDIX H

ATH-00033-24950- DESIGN CALCULATIONS

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Rear Abutment

Boring No	B-050-0A-23		
Proposed Bottom of Foundation	884.0	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	879.6	feet	(From Boring)
Top of Coreable Rock Elevation	873.1	feet	(From Boring)
Rock Socket Length	15	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
879.6	873.1	6.5	Rock	4.6	2.12	0.29	576	**0.9**	34.9	**OK**	0.55	0.5	0.4	0.4
873.1	864.6	8.5	Rock	4.3	2.12	1.00	576	**3.0**	34.9	**OK**	0.55	1.7	0.4	1.2

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per ODOT BDM Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max $= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 59 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 4.63 ksf **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 4.3 ksf **Compressive Strength of claystone (psi)= 30**
(B-050-0A-23, Compressive Strength Test Result, NQ-1, 16.1'-16.5')

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Rear Abutment

Boring No B-050-0A-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
6280	904.3	2260.8	0.50	1130.4

Reference Key

(1) Compressive Strength Test Result, NQ-2, 24.3'-25.0'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier

Boring No	B-051-0-23		
Proposed Bottom of Foundation	889.5	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	873.7	feet	(From Boring)
Top of Coreable Rock Elevation	869.7	feet	(From Boring)
Rock Socket Length	9.5	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
873.7	869.7	4	Rock	5.6	2.12	0.29	576	**1.0**	34.9	**OK**	0.55	0.6	0.4	0.4
869.7	864.2	5.5	Rock	28.8	2.12	1.00	576	**7.8**	34.9	**OK**	0.55	4.3	0.4	3.1

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 71.5 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 5.61 ksf **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 28.8 ksf **Compressive Strength of Shale (psi)= 200 ODOT GDM Table 400-6, very weak rock**

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier

Boring No B-051-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
6180	889.9	2224.8	0.50	1112.4

Reference Key

(1) Compressive Strength Test Result, NQ-2, 25.7'-26.2'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Forward Abutment

Boring No	B-052-0-23		
Proposed Bottom of Foundation	885	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	879.8	feet	(From Boring)
Top of Coreable Rock Elevation	870.3	feet	(From Boring)
Rock Socket Length	14.5	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
879.8	870.3	9.5	Rock	6.8	2.12	0.29	576	**1.1**	34.9	**OK**	0.55	0.6	0.4	0.4
870.3	865.3	5	Rock	1173.6	2.12	1.00	576	**49.9**	34.9	**No Good**	0.55	19.2	0.4	14.0

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient — **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength — **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ — **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive — **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift — **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 86.3 bpf
Energy ratio of SPT hammer= 76.8%
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 6.77 ksf — **(ODOT GDM 404.3)**
$q_{u\,2}$ (ksf)= 1173.6 ksf — **Compressive Strength of sandstone (psi)= 8,150**
(B-052-0-23, Compressive Strength Test Result, NQ-1, 22.8'-23.4')

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Forward Abutment

Boring No B-052-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
5150	741.6	1854.0	0.50	927.0

Reference Key

(1) Compressive Strength Test Result, NQ-2, 25.1'-25.8'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Soil Parameters

Project: ATH-MEG-033-23.23/0.00
Boring No.: B-050-0A-23
Location: Rear Abutment
Date: 10/4/24

Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Liquidity Index (W-PL)/PI	Gs	Bearing Capacity Index (BCI)	Sand Fraction (BCI)	Clay Fraction (BCI)	e_0	C_c	C_r	C_v (cm^2/sec)	Su (psf)	Pre-Consolidation Stress σ'p (psf)	Reference
1	888.1	885.1	3	A-6a	134	24	21	33	20		2.8										
				ST				29	18												
			Avg	A-6a	134	24	21	31	19	0.2	2.8				0.52	0.07	0.030	0.0038		8000.0	1
2	885.1	879.6	5.5	A-7-6	119	31	16	42	24		2.8										
						40	20	55	27												
			Avg	A-7-6	119	36	18	49	26	-0.3	2.8				0.83	0.24	0.056	0.0019		6000.0	2

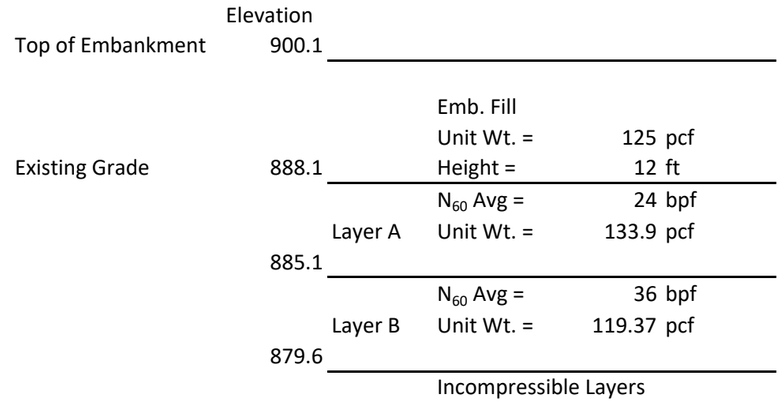
Bedrock layers encountered below elevation 879.6 are considered incompressible

Reference Key

1 Laboratory Consolidation Test Result B-050-0-23, ST, 1'-3'
2 Laboratory Consolidation Test Result B-050-0-23, ST 4'-6'

Settlement Calculations

Location **ATH-MEG-033-23.23/0.00**
Boring No. **B-050-0A-23**



Emb. Fill Ht. 12 ft
Unit Wt. = 125 pcf
q = 1500 psf

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	$б'_o$ (psf)	B_1 / z	B_2 / z	I*	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	$б'_p$ (psf)	$б'_f$ (psf)	Consolidation	Settlement (in) **
B	4.4	119.37	18.3	2295.7	1.3	0.7	0.64	36				6,000.0	3,795.7		0.65

Total 0.65

0.4" @ Elev.= 882.3

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).
**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1

Downdrag Calculations

Location ATH-MEG-033-23.23/0.00
Boring No. B-050-0A-23

	Layer A	**Layer B**		
Top Elevation	888.1	885.1		
Bottom Elevation	885.1	879.6		
N_{60} Avg. =	24	36	bpf	
$S_u = c_u$ =	3	4.5	ksf	
p_a =	2.12	2.12	ksf	
S_u / p_a =	1.4	2.1		
α =	0.55	0.49		AASHTO 10.8.3.5.1B-2 & AASHTO 10.8.3.5.1b-3
q_s =	1.65	2.19	ksf	AASHTO 10.8.3.5.1b-1
Load Factor =			1.05	ODOT BDM 305.3.2.2 and ODOT GDM 1304.5

Bottom of Pier Cap Elev.	0.4" Settlement Elev.	Length in Layer A (feet)	Length in Layer B (feet)	Shaft Dia. (ft)	P (ft)	$A_{S\,A}$ (ft^2)	$A_{S\,B}$ (ft^2)	$q_{S\,A}$ (ksf)	$q_{S\,B}$ (ksf)	Unfactored Downdrag (kips)
884	880.4	0	1.70	4	6.3	NA	10.7	NA	2.19	23.4

From AASHTO C10.8.1.6.2:
Shaft length assumed to not contribute to nominal side resistance should also be assumed to not contribute to downdrag loads.

Time Rate of Settlement Determination

Project: **ATH-MEG-033-23.23/0.00**
Boring No.: **B-050-0A-23**
Date: **10/4/24**

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
884	879.6	1	0.65	4.4	0.0019	0.174193	7	0.062983	0.31	0.4	
	Net=		0.65	in					Total	0.4	in

Soil Parameters

Project: ATH-MEG-033-23.23/0.00
Boring No.: B-052-0-23
Location: Forward Abutment
Date: 10/4/24

Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Liquidity Index (W-PL)/PI	Gs	Bearing Capacity Index (BCI)	Sand Fraction (BCI)	Clay Fraction (BCI)	e_0	C_c	C_r	C_v (cm^2/sec)	Su (psf)	Pre-Consolidation Stress σ'p (psf)	Reference
1	890.3	884.8	5.5	A-1-b	125	15	7				2.65		0.9	0.1							
						14	6						0.9	0.1							
			Avg	A-1-b	125	15	7				2.65	72.1	0.9	0.1				0.0281			2
2	884.8	879.8	5.0	A-7-5	128	17	37	82	40		2.6										
						19	42	104	40	0.0											
			Avg	A-7-5	128	18	40	93	40	0.0	2.6				0.68	0.17	0.028	0.0020		4000.0	1

Soils/bedrock layers encountered below elevation 879.8 are considered incompressible

Reference Key

1 Laboratory Consolidation Test Result B-052-0-23, ST-1, 7'-9'

2 FHWA GEC 5 (2016) Figure 6-37, Virgin Compression used for C_v computation of granular soils if no consolidation data is available

Settlement Calculations

Location **ATH-MEG-033-23.23/0.00**
Boring No. **B-052-0-23**

Embankment Geometry

	Elevation			
Top of Embankment	914.6			
		Emb. Fill		
		Unit Wt. =	125	pcf
Existing Grade	890.3	Height =	24.3	ft
		N_{60} Avg =	15	bpf
		Layer A Unit Wt. =	125	pcf
	884.8			
		N_{60} Avg =	18	bpf
		Layer B Unit Wt. =	127.7	pcf
	879.8			
		Incompressible Layers		

Emb. Fill Ht. 12 ft
Unit Wt. = 125 pcf
q = 1500 psf

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	σ'_o (psf)	B_1 / z	B_2 / z	I*	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	$\sigma'p$ (psf)	σ'_f (psf)	Consolidation	Settlement (in) **
A	0.2	125	17.4	2175	1.4	0.69	0.68	14	0.895	0.105	69.13			NC	0.01
B	5	127.7	20	2506.75	1.2	0.6	0.57	18				4,000.0	4,006.8	OC	0.21
														Total	0.21
														0.4" @ Elev.=	889.4

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).
**The settlement value of granular soils (layer A) is computed based on the Hough Method and LRFD Equation 10.6.2.4.2b-2.
**The settlement value of Cohesive soils (layer B) is computed based on LRFD Equation 10.6.2.4.3-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
ATH-00033-24950- Rainbow Lake Rd. (CR 89) over US 33
Rear Abutment

Boring No	B-050-0A-23		
Bottom of Foundation Elevation	884.0	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	879.6	feet	(From boring)
Top of Coreable Rock Elevation	873.1	feet	(From boring)

From Bottom of Footing Elevation to 879.6 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	119	pcf	Laboratory Consolidation Test Result B-050-0-23, ST 4'-6'
Undrained Cohesion =	4400	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.004		From L-pile
k =	2000	pci	From L-pile

From 879.6 to 873.1 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	135	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	32.2	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	2890	psi	GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 873.1 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	135.7	pcf	Laboratory Test of B-050-0-23, NQ-1
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	30	psi	Laboratory Test of B-050-0-23, NQ-1
Initial Rock Modulus =	2700	psi	GDM Table 400-6, very weak rock
RQD =	25%		B-050-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
ATH-00033-24950- Rainbow Lake Rd. (CR 89) over US 33
Pier

Boring No	B-051-0-23		
Bottom of Foundation Elevation	889.5	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	873.7	feet	(From boring)
Top of Coreable Rock Elevation	869.7	feet	(From boring)

From Bottom of Footing Elevation to 884.2 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	122	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1700	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 884.2 to 873.7 feet

Use Soil Type-	Stiff Clay with Free Water (Reese)		
Effective Unit Weight =	125	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2800	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 873.7 to 869.7 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	39.0	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	3500	psi	GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 869.7 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	150.0	pcf	ODOT GDM Table 400-5, Shale
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	200	psi	ODOT GDM Table 400-6, very weak rock
Initial Rock Modulus =	18000	psi	ODOT GDM Table 400-6, very weak rock
RQD =	0%		B-051-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
ATH-00033-24950- Rainbow Lake Rd. (CR 89) over US 33
Forward Abutment

Boring No	B-052-0-23		
Bottom of Foundation Elevation	885	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	871.8	feet	(From boring)
Top of Coreable Rock Elevation	870.3	feet	(From boring)

From Bottom of Footing Elevation to 879.8 feet

Use Soil Type-	Stiff Clay w/o Free Water (Reese)		
Effective Unit Weight =	128	pcf	Laboratory Consolidation Test Result B-052-0-23, ST-1, 7'-9'
Undrained Cohesion =	2200	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 879.8 to 871.8 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	140	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	26.9	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	2420	psi	ODOT GDM Table 400-6, very weak rock
RQD =	0%		Assumed

From 871.8 to 870.3 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	155	pcf	ODOT GDM Table 400-5, Sandstone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	107.4	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	9660	psi	ODOT GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 870.3 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	155.5	pcf	Laboratory Test of B-052-0-23, NQ-1
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	8150	psi	Laboratory Test of B-052-0-23, NQ-1
Initial Rock Modulus =	680000	psi	ODOT GDM Table 400-6, strong rock
RQD =	55%		B-052-0-23, NQ-1

APPENDIX I

MEG-00033-01510R- DESIGN CALCULATIONS

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 1

Boring No	B-036-0-23		
Proposed Bottom of Foundation Elevation	687	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	678.7	feet	(From Boring)
Top of Coreable Rock Elevation	677.2	feet	(From Boring)
Rock Socket Length	10	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
678.7	677.2	1.5	Rock	4.6	2.12	0.29	576	**0.9**	34.9	**OK**	0.55	0.5	0.4	0.4
677.2	668.7	8.5	Rock	53.3	2.12	1.00	576	**10.6**	34.9	**OK**	0.55	5.8	0.4	4.3

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer

** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure

C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**

f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per ODOT BDM Section C304.2.1)**

$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**

$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**

0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N= 58.0 bpf

Energy ratio of SPT hammer= 76.8%

$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)= 4.55 ksf **(ODOT GDM Section 404.3)**

q_{u2} (ksf)= 53.3 ksf **Compressive Strength of shale (psi)= 370**

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 1

Boring No B-036-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
370	53.3	133.2	0.50	66.6

Reference Key

(1) Compressive Strength Test Result, NQ-2, 26.2'-26.6'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 2

Boring No	B-037-0-23		
Proposed Bottom of Foundation Elevation	671	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	638.5	feet	(From Boring)
Top of Coreable Rock Elevation	634.5	feet	(From Boring)
Rock Socket Length	27	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
638.5	634.5	4	Rock	10.1	2.12	0.29	576	**1.3**	34.9	**OK**	0.55	0.7	0.4	0.5
634.5	611.5	23	Rock	15.8	2.12	1.00	576	**5.8**	34.9	**OK**	0.55	3.2	0.4	2.3

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max $= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N=	128.5	bpf	
Energy ratio of SPT hammer=	76.8%		
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)=	10.09	ksf	**(ODOT GDM Section 404.3)**
$q_{u\,2}$ (ksf)= 15.8	ksf		**Compressive Strength of shale (psi)= 110**
			(B-037-0-23, Compressive Strength Test Result, NQ-1, 42.0'-42.6')

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 2

Boring No B-037-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
110	15.8	39.6	0.50	19.8

Reference Key

(1) Compressive Strength Test Result, NQ-2, 45.5'-46.0'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Drilled Shaft - Side Resistance in Rock

ATH/MEG-033-23.23/0.00
Pier 3

Boring No	B-038-0-23		
Proposed Bottom of Foundation Elevation	683	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	644.4	feet	(From Boring)
Top of Coreable Rock Elevation	639.9	feet	(From Boring)
Rock Socket Length	28	feet	(From Stage 2 Plans)

LRFD Side Resistance

											Compressive		Uplift	
Top Elev.	**Bottom Elev.**	**Layer Thickness (feet)**	**Material**	**q_u (ksf)**	**P_a (ksf)**	**C**	**f'_c (ksf)**	**q_s (ksf)**	**$q_s$max (ksf)**	**Check**	**Resistance Factor**	**Factored Side Resistance (ksf)**	**Resistance Factor**	**Factored Side Resistance (ksf)**
644.4	639.9	4.5	Rock	26.1	2.12	0.29	576	**2.2**	34.9	**OK**	0.55	1.2	0.4	0.9
639.9	616.4	23.5	Rock	13.0	2.12	1.00	576	**5.2**	34.9	**OK**	0.55	2.9	0.4	2.1

* Side Friction within upper several feet of rock should be neglected per ODOT BDM section 305.4.2- To be determined by the structural engineer
** Side Resistance should be neglected within the scour zone - To be determined by the Structural Engineer

Notes

P_a(ksf)= Atmospheric Pressure
C = regression Coefficient **(C=1 for corable rock and for augerable rock lowerbound value per AASHTO TABLE 10.8.3.5.4b-1)**
f'_c(ksi)= Concrete Compressive Strength **(4.0 ksi as per BDM 2020, Section C304.2.1)**
$q_s = CP_a(q_u/P_a)^{0.5}$ **(AASHTO Equation 10.8.3.5.4b-1)**
$q_s$max$= P_a(f'_c/P_a)^{0.5}$

Resistance Factor= 0.55 Compressive **(AASHTO TABLE 10.5.5.2.4-1)**
0.40 Uplift **(AASHTO TABLE 10.5.5.2.4-1)**

Mean blowcount for augerable rock N=	332.5	bpf	
Energy ratio of SPT hammer=	76.8%		
$q_{u\,1}$ (ksf)= 0.092x(76.8/90xN)=	26.10	ksf	**(ODOT GDM Section 404.3)**
$q_{u\,2}$ (ksf)= 13.0 ksf			**Compressive Strength of shale (psi)= 90**
			(B-038-0-23, Compressive Strength Test Result, NQ-1, 42.0'-42.5')

Drilled Shaft - Tip Resistance

ATH/MEG-033-23.23/0.00
Pier 3

Boring No B-038-0-23

Unconfined Compressive Strength, $q_{u\,(1)}$ (psi)	Unconfined Compressive Strength, q_u (ksf)	Nominal Unit Tip Resistance, q_p [(2)] (ksf)	Resistance Factor, Tip Resistance [(3)]	Factored Unit Tip Resistance, q_p (ksf)
100	14.4	36.0	0.50	18.0

Reference Key

(1) Compressive Strength Test Result, NQ-2, 47.4'-47.9'
(2) AASHTO 10.8.3.5.4c-1
(3) AASHTO Table 10.5.5.2.4-1

Soil Parameters

Project: ATH-MEG-033-23.23/0.00
Boring No.: B-035-0-23 and B-035-1-23
Location: Rear Abutment
Date: 9/13/24

Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Gs	e_0	C_c	C_r	C_v (cm^2/sec)	Su (psf)	Pre-Consolidation Stress σ'p (psf)	Reference
A	736.3	730.0	6.3	A-7-6	123.7	13	19										
							22	42	22	2.7	0.73	0.21	0.055			6000.0	
						12	16										
			Avg	A-7-6	123.7	13	19	42	22	2.7	0.73	0.21	0.055	0.0017		6000.0	1
B	730.0	721.5	8.5	A-6a	122	15	13	32	19	2.7							
						12	19										
						17	17	34	19								
			Avg	A-6a	122	15	16	33	19	2.7	0.43	0.192	0.038	0.0200	1875	11588	2,3,4
C	721.5	716.5	5.0	A-6a	140.3	20	17										
							11	28	15	2.6	0.35	0.09	0.027			5000	
						23	13										
			Avg	A-6a	140.3	22	14	28	15	2.6	0.35	0.09	0.027	0.0020		5000	5

Bedrock layers encountered below elevation 716.5 are considered incompressible

Reference Key

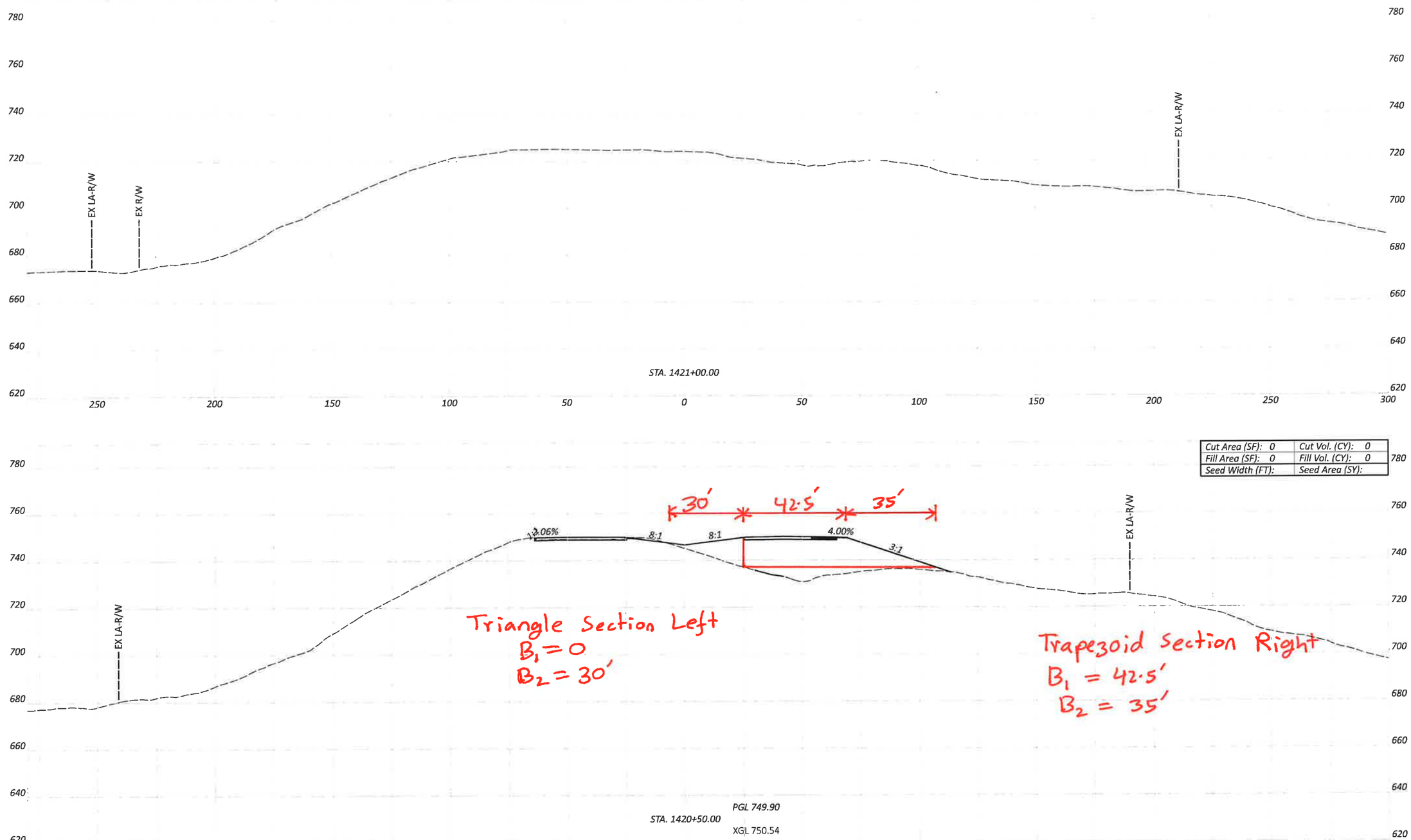
1 Laboratory consolidation test results for boring B-035-1-23, ST-7_15'-17'

2 Skempton (1957), FHWA-IF-03-017- GEC-N0.7, TABLE 3.7 used for computing σ'p if no consolidation data is available

3 Kulhawy and Mayne (1990) per GEC 5 (2016), Figure 6-36 used for computing C_c and C_r if no consolidation data is available

4 FHWA GEC 5 (2016) Figure 6-37, Reloading (lower bound) curve used for C_v computation of Cohesive soil if no consolidation data is available

5 Laboratory consolidation test results for boring B-035-1-23, ST-11_31'-33'



CROSS SECTIONS
U.S. 33

CTY-RTE-SECTION

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DESIGN AGENCY

DESIGNER: XXX
REVIEWER: XXX MM-DD-YY
PROJECT ID: 0
SHEET: P.0
TOTAL: 0

Sheet Totals

Seeding	Cut	Fill

Settlement below the left corner of the Proposed Bridge 6 RA

Location **ATH-MEG-033-23.23/0.00**
Boring No. **B-035-0-23 and B-035-1-23**

Right Trapezoid section
Embankment Geometry
B_1 = 42.5 ft
B_2 = 35 ft

Left Triangle section
Embankment Geometry
B_1 = 0 ft
B_2 = 30 ft

Emb. Fill Ht. 12.8 ft
Unit Wt. = 125 pcf
q = 1600 psf

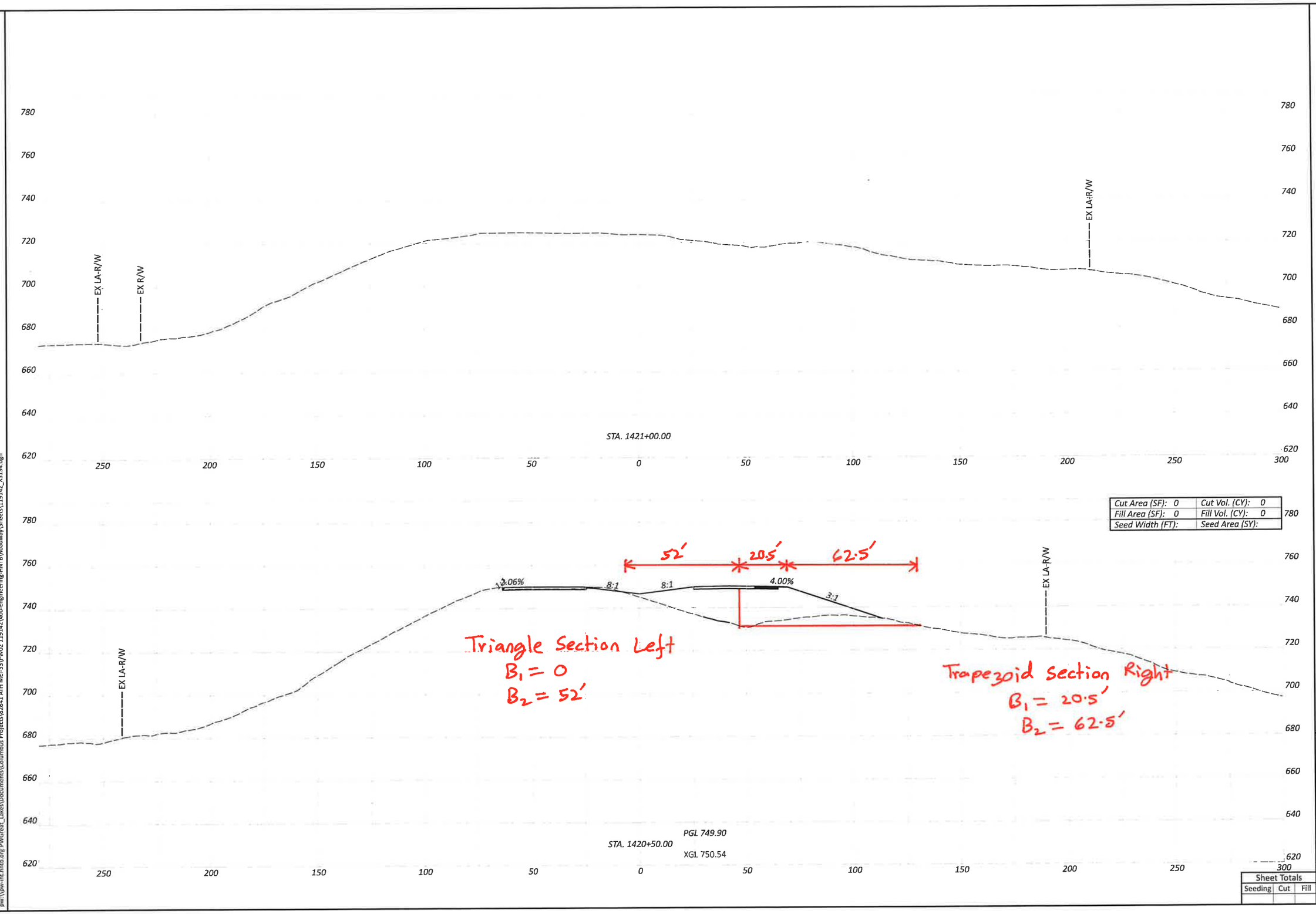
	Elevation		
Top of Embankment	749.8		
		Emb. Fill Unit Wt. =	125 pcf
Existing Grade	737	Height =	12.8 ft
		N_{60} Avg =	13 bpf
		Layer A Unit Wt. =	123.7 pcf
	730.0		
		N_{60} Avg =	15 bpf
		Layer B Unit Wt. =	122 pcf
	721.5		
		N_{60} Avg =	22 bpf
		Layer C Unit Wt. =	140.3 pcf
	716.5	Bedrock	

Layer	Thickness (H_c) (ft)	Unit Weight (pcf)	z (ft)	σ'_o (psf)	B_1 / z	B_2 / z	I*	B_1 / z	B_2 / z	I*	Combined I	N_{60} Avg	σ'_p (psf)	σ'_f (psf)	Consolidation	Settlement (in) **
A	7.0	124	3.5	433.0	12.1	10.0	0.50	0	8.6	0.47	0.97	13	6,000.0	1,185.0	OC	1.17
B	8.5	122	11.25	1384.4	3.8	3.1	0.50	0	2.7	0.39	0.89	15	11,588.4	2,008.4	OC	0.44
C	5	140	18	2253.7	2.4	1.9	0.50	0	1.7	0.33	0.83	22	5,000.0	2,781.7	OC	0.11
															Total	1.71

0.4" @ Elev.= 727.16

*The influence value (I) for embankment loading was computed based on "Influence Values for Vertical Stresses in Semi- Infinite Loading" charts (After Osterberg 1957).

**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1



CROSS SECTIONS
U.S. 33

CTY-RTE-SECTION

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Sheet Totals

Seeding	Cut	Fill

DESIGN AGENCY

DESIGNER: XXX

REVIEWER: XXX MM-DD-YY

PROJECT ID: 0

SHEET: P.0 TOTAL: 0

Settlement below the middle of the Proposed Bridge 6 RA

		Elevation	
	Top of Embankment	749.8	
Location	**ATH-MEG-033-23.23/0.00**		
Boring No.	**B-035-0-23 and B-035-1-23**		Emb. Fill
			Unit Wt. = 125 pcf
Right Trapezoid section	Existing Grade	730.0	
Embankment Geometry			
B_1 = 20.5 ft			N_{60} Avg = 15 bpf
B_2 = 62.5 ft			Layer B Unit Wt. = 122 pcf
Left Triangle section		721.5	
Embankment Geometry			
B_1 = 0 ft			N_{60} Avg = 22 bpf
B_2 = 52 ft			Layer C Unit Wt. = 140.3 pcf
		716.5	
			Bedrock

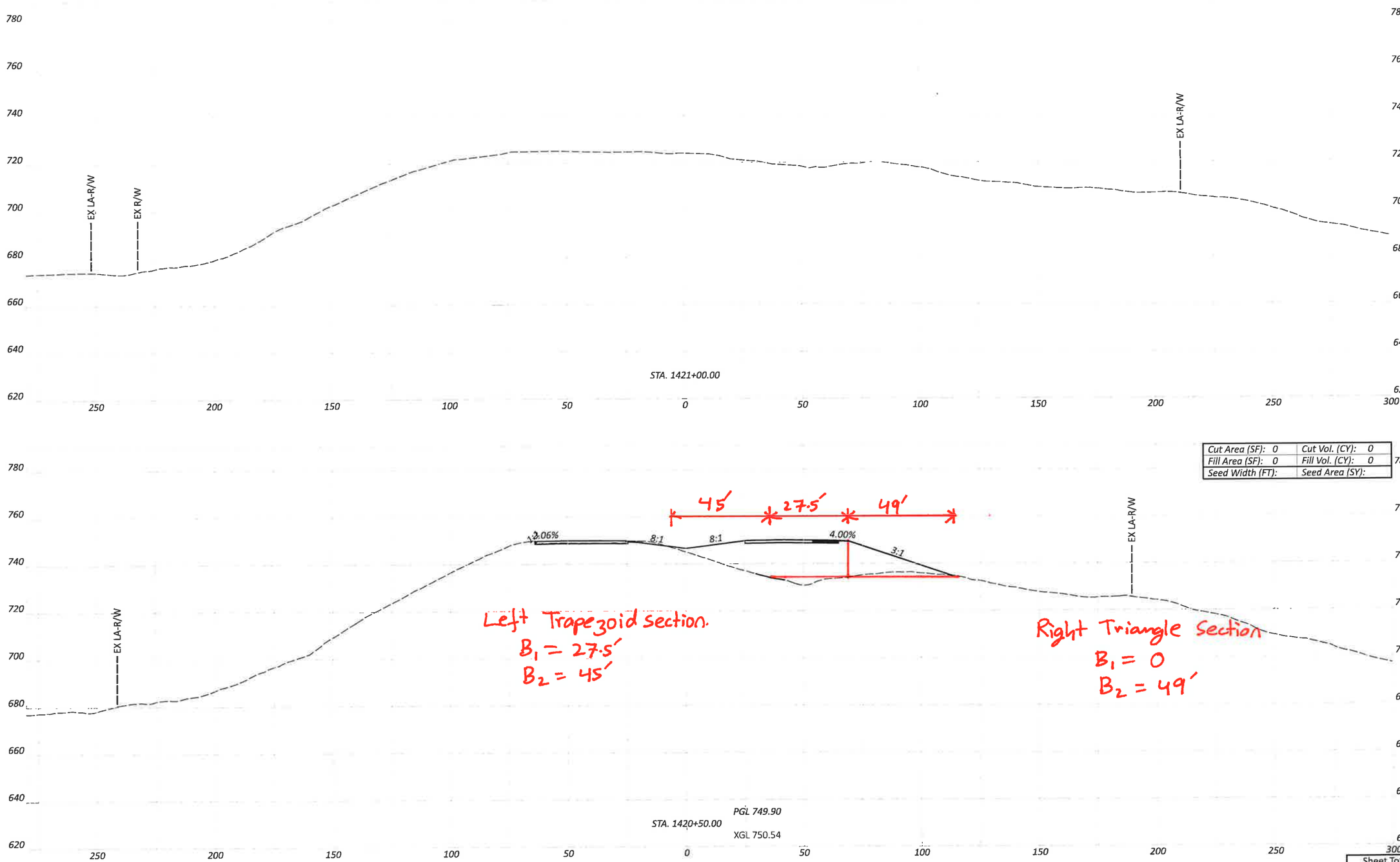
Emb. Fill Ht. = 19.8 ft
Unit Wt. = 125 pcf
q = 2475 psf

Layer	Thickness (H_c) (ft)	Unit Weight (pcf)	z (ft)	$б'_o$ (psf)	B_1 / z	B_2 / z	I*	B_1 / z	B_2 / z	I*	Combined I	N_{60} Avg	б'p (psf)	$б'_f$ (psf)	Consolidation	Settlement (in) **
B	8.5	122	4.25	518.5	4.8	14.7	0.50	0	12.2	0.47	0.97	15	11,588.4	1,681.8	OC	1.38
C	5	140	11	1387.8	1.9	5.7	0.50	0	4.7	0.43	0.93	22	5,000.0	2,452.0	OC	0.30
															Total	1.68

0.4" @ Elev.= 722.14

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).

**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1



CTY-RTE-SECTION

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CROSS SECTIONS
U.S. 33

Sheet Totals		
Seeding	Cut	Fill

DESIGN AGENCY

DESIGNER: XXX
REVIEWER: XXX MM-DD-YY
PROJECT ID: 0
SHEET: P.0
TOTAL: 0

Settlement below the right corner of the Proposed Bridge 6RA

Location **ATH-MEG-033-23.23/0.00**
Boring No. **B-035-0-23 and B-035-1-23**

Right triangle section
Embankment Geometry
B_1 = 0 ft
B_2 = 49 ft

Left trapezoid section
Embankment Geometry
B_1 = 27.5 ft
B_2 = 45 ft

Emb. Fill Ht. 15.3 ft
Unit Wt. = 125 pcf
q = 1912.5 psf

	Elevation				
Top of Embankment	749.8				
		Emb. Fill Unit Wt. =	125	pcf	
Existing Grade	734.5	Height =	15.3	ft	
		N_{60} Avg =	13	bpf	
	Layer A	Unit Wt. =	123.7	pcf	
	730.0				
		N_{60} Avg =	15	bpf	
	Layer B	Unit Wt. =	122	pcf	
	721.5				
		N_{60} Avg =	22	bpf	
	Layer C	Unit Wt. =	140.3	pcf	
	716.5				
		Bedrock			

Layer	Thickness (H_c) (ft)	Unit Weight (pcf)	z (ft)	$б'_o$ (psf)	B_1 / z	B_2 / z	I*	B_1 / z	B_2 / z	I*	Combined I	N_{60} Avg	$б'_p$ (psf)	$б'_f$ (psf)	Consolidation	Settlement (in) **
A	4.5	124	2.25	278.3	0.0	21.8	0.49	12.2	20.0	0.5	0.99	13	6,000.0	1,234.6	OC	1.11
B	8.5	122	8.75	1075.2	0.0	5.6	0.44	3.1	5.1	0.5	0.94	15	11,588.4	2,031.4	OC	0.75
C	5	140	15.5	1944.4	0.0	3.2	0.40	1.8	2.9	0.49	0.89	22	5,000.0	2,881.5	OC	0.21
															Total	2.06

0.4" @ Elev.= 723.72

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).

**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1

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

                      APILE for Windows, Version 2019.9.12

                       Serial Number :  136154516

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


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00-00_HNTB Ohio Inc\Design\Foundation Design Calculations and Analysis\Bridge 6 - US33 over
Shade River\Memo 3\Settlement and Downdrag Calculations\
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     Name of output file         : Bridge 6 Rear Abutment HP 10x42.ap9o
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                          Time and Date of Analysis
     ----------------------------------------------------------------------------

               Date:  May 30, 2024     Time:  14:33:45



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



          ATH-MEG-033-18.70/0.00

          DESIGNER   : CTL

          JOB NUMBER : 23050059COL


          METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 12.40 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 19.80 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 1.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 39.60 IN.
- TIP AREA OF PILE = 12.40 IN2
- INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	Nq FACTOR FHWA
0.00	CLAY	0.80*	125.00	0.00	4.80**
5.30	CLAY	0.80*	125.00	0.00	4.80**
5.30	CLAY	0.80*	59.60	0.00	4.80**
13.80	CLAY	0.80*	59.60	0.00	4.80**
13.80	CLAY	0.80*	77.90	0.00	4.80**
18.80	CLAY	0.80*	77.90	0.00	4.80**
18.80	CLAY	0.80*	77.60	0.00	4.80**
21.80	CLAY	0.80*	77.60	0.00	4.80**

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

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.50	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.88	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.88	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.20	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	2.20	0.00	0.00	0.00	0.00

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

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
5.30	1.000	1.000
5.30	1.000	1.000
13.80	1.000	1.000
13.80	1.000	1.000
18.80	1.000	1.000
18.80	1.000	1.000
21.80	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.126 *	0.90 **
5.30	0.126 *	0.90 **
5.30	0.126 *	0.90 **
13.80	0.126 *	0.90 **
13.80	0.126 *	0.90 **
18.80	0.126 *	0.90 **
18.80	0.126 *	0.90 **
21.80	0.126 *	0.90 **

* DEFAULT VALUE = 0.01 D
** DEFAULT VALUE = 0.9

****
* COMPUTATION RESULT *

****

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

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	1.0	1.0
1.00	3.7	1.0	4.6
2.00	7.3	1.9	9.2
3.00	11.0	1.9	12.9
4.00	14.6	1.9	16.6
5.00	18.3	1.8	20.1
6.00	22.0	1.7	23.7
7.00	26.3	1.5	27.8
8.00	30.9	1.5	32.3
9.00	35.5	1.5	36.9
10.00	40.1	1.5	41.6
11.00	44.7	1.5	46.2
12.00	49.3	1.5	50.8
13.00	53.9	1.6	55.5
14.00	58.6	1.8	60.4
15.00	63.0	2.0	65.0
16.00	66.9	2.1	69.0
17.00	70.8	2.1	73.0
18.00	74.8	2.1	76.8

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

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

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.2307E+01	0.2017E-01
			0.3845E+01	0.3908E-01
			0.5768E+01	0.7185E-01
			0.6922E+01	0.1008E+00
			0.7691E+01	0.1261E+00

			0.6922E+01	0.2521E+00
			0.6922E+01	0.3782E+00
			0.6922E+01	0.6303E+00
			0.6922E+01	0.2521E+01
2	10	0.2650E+01		
			0.0000E+00	0.0000E+00
			0.2307E+01	0.2017E-01
			0.3845E+01	0.3908E-01
			0.5768E+01	0.7185E-01
			0.6922E+01	0.1008E+00
			0.7691E+01	0.1261E+00
			0.6922E+01	0.2521E+00
			0.6922E+01	0.3782E+00
			0.6922E+01	0.6303E+00
			0.6922E+01	0.2521E+01
3	10	0.5258E+01		
			0.0000E+00	0.0000E+00
			0.2344E+01	0.2017E-01
			0.3906E+01	0.3908E-01
			0.5859E+01	0.7185E-01
			0.7031E+01	0.1008E+00
			0.7812E+01	0.1261E+00
			0.7031E+01	0.2521E+00
			0.7031E+01	0.3782E+00
			0.7031E+01	0.6303E+00
			0.7031E+01	0.2521E+01
4	10	0.5342E+01		
			0.0000E+00	0.0000E+00
			0.2355E+01	0.2017E-01
			0.3926E+01	0.3908E-01
			0.5888E+01	0.7185E-01
			0.7066E+01	0.1008E+00
			0.7851E+01	0.1261E+00
			0.7066E+01	0.2521E+00
			0.7066E+01	0.3782E+00
			0.7066E+01	0.6303E+00
			0.7066E+01	0.2521E+01
5	10	0.9550E+01		
			0.0000E+00	0.0000E+00
			0.2908E+01	0.2017E-01
			0.4846E+01	0.3908E-01
			0.7269E+01	0.7185E-01
			0.8723E+01	0.1008E+00
			0.9692E+01	0.1261E+00
			0.8723E+01	0.2521E+00
			0.8723E+01	0.3782E+00
			0.8723E+01	0.6303E+00
			0.8723E+01	0.2521E+01
6	10	0.1376E+02		
			0.0000E+00	0.0000E+00
			0.3002E+01	0.2017E-01
			0.5004E+01	0.3908E-01
			0.7506E+01	0.7185E-01
			0.9007E+01	0.1008E+00
			0.1001E+02	0.1261E+00

			0.9007E+01	0.2521E+00
			0.9007E+01	0.3782E+00
			0.9007E+01	0.6303E+00
			0.9007E+01	0.2521E+01
7	10	0.1384E+02		
			0.0000E+00	0.0000E+00
			0.3013E+01	0.2017E-01
			0.5021E+01	0.3908E-01
			0.7532E+01	0.7185E-01
			0.9039E+01	0.1008E+00
			0.1004E+02	0.1261E+00
			0.9039E+01	0.2521E+00
			0.9039E+01	0.3782E+00
			0.9039E+01	0.6303E+00
			0.9039E+01	0.2521E+01
8	10	0.1630E+02		
			0.0000E+00	0.0000E+00
			0.2482E+01	0.2017E-01
			0.4136E+01	0.3908E-01
			0.6204E+01	0.7185E-01
			0.7445E+01	0.1008E+00
			0.8272E+01	0.1261E+00
			0.7445E+01	0.2521E+00
			0.7445E+01	0.3782E+00
			0.7445E+01	0.6303E+00
			0.7445E+01	0.2521E+01
9	10	0.1876E+02		
			0.0000E+00	0.0000E+00
			0.2482E+01	0.2017E-01
			0.4136E+01	0.3908E-01
			0.6204E+01	0.7185E-01
			0.7445E+01	0.1008E+00
			0.8272E+01	0.1261E+00
			0.7445E+01	0.2521E+00
			0.7445E+01	0.3782E+00
			0.7445E+01	0.6303E+00
			0.7445E+01	0.2521E+01
10	10	0.1884E+02		
			0.0000E+00	0.0000E+00
			0.2482E+01	0.2017E-01
			0.4136E+01	0.3908E-01
			0.6204E+01	0.7185E-01
			0.7445E+01	0.1008E+00
			0.8272E+01	0.1261E+00
			0.7445E+01	0.2521E+00
			0.7445E+01	0.3782E+00
			0.7445E+01	0.6303E+00
			0.7445E+01	0.2521E+01
11	10	0.2030E+02		
			0.0000E+00	0.0000E+00
			0.2482E+01	0.2017E-01
			0.4136E+01	0.3908E-01
			0.6204E+01	0.7185E-01
			0.7445E+01	0.1008E+00
			0.8272E+01	0.1261E+00

			0.7445E+01	0.2521E+00
			0.7445E+01	0.3782E+00
			0.7445E+01	0.6303E+00
			0.7445E+01	0.2521E+01
12	10	0.2176E+02		
			0.0000E+00	0.0000E+00
			0.2482E+01	0.2017E-01
			0.4136E+01	0.3908E-01
			0.6204E+01	0.7185E-01
			0.7445E+01	0.1008E+00
			0.8272E+01	0.1261E+00
			0.7445E+01	0.2521E+00
			0.7445E+01	0.3782E+00
			0.7445E+01	0.6303E+00
			0.7445E+01	0.2521E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.1283E+00	0.6303E-02
0.2567E+00	0.1261E-01
0.5133E+00	0.2521E-01
0.1027E+01	0.1639E+00
0.1540E+01	0.5294E+00
0.1848E+01	0.9202E+00
0.2053E+01	0.1261E+01
0.2053E+01	0.1891E+01
0.2053E+01	0.2521E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1276E+00	0.1449E-03	0.2036E-02	0.1000E-03
0.1276E+01	0.1449E-02	0.2036E-01	0.1000E-02
0.6387E+01	0.7244E-02	0.1018E+00	0.5000E-02
0.1285E+02	0.1451E-01	0.2036E+00	0.1000E-01
0.2499E+02	0.2887E-01	0.4073E+00	0.2000E-01
0.4761E+02	0.6702E-01	0.6051E+00	0.5000E-01
0.6336E+02	0.1028E+00	0.7162E+00	0.8000E-01
0.7103E+02	0.1256E+00	0.7902E+00	0.1000E+00
0.7218E+02	0.2265E+00	0.1077E+01	0.2000E+00
0.6990E+02	0.5258E+00	0.1499E+01	0.5000E+00
0.7015E+02	0.8259E+00	0.1753E+01	0.8000E+00
0.7030E+02	0.1026E+01	0.1896E+01	0.1000E+01
0.7045E+02	0.2026E+01	0.2053E+01	0.2000E+01

Project:	**ATH-MEG-033-23.23/0.00**
Location:	**Rear Abutment**
Date:	**9/13/2024**
Boring No.:	**B-035-0-23 and B-035-1-23**
Bottom of Pile Cap Elevation (feet)	735.3

Pile Type HP 10X42			
Ultimate Capacity (Skin Friction) (kips)	**Depth (feet)**	**Elevation (Feet)**	
0	0	735.30	
3.7	1	734.30	
7.3	2	733.30	
11	3	732.30	
14.6	4	731.30	
18.3	5	730.30	
22	6	729.30	
26.3	7	728.30	
30.9	8	727.30	
35.5	9	726.30	
40.1	10	725.30	
44.7	11	724.3	
49.3	12	723.3	
53.9	13	722.30	Downdrag*
58.6	14	721.30	Downdrag*
63	15	720.30	
66.9	16	719.30	
70.8	17	718.30	
74.8	18	717.30	

*Downdrag is computed based on the neutral plane elevation determined from the Settlement calculations performed below the middle of the proposed Bridge 6 RA (Worst Case Scenario)

Downdrag Calculation

Project: **ATH-MEG-033-23.23/0.00**
Location: **Rear Abutment**
Boring No.: **B-035-0-23 and B-035-1-23**
Date: **10/7/24**

Measuring from bottom of pile, 0.4 inch settlement occurs at and below elevation = 722.1 feet

Compute Skin Friction using the Ultimate data from A-pile Analysis

From Apile Results

HP 10X42

Unfactored Downdrag Load*	54.7 Kips	
Load Factor for Downdrag	1.05	ODOT BDM 305.3.2.2
Factored Downdrag Load	57.4 Kips	

*Downdrag is computed based on the neutral plane elevation determined from the Settlement calculations performed below the middle of the proposed Bridge 6 RA (Worst Case Scenario)

Time Rate of Settlement Determination

Project: **ATH-MEG-033-23.23/0.00**
Boring No.: **B-035-0-23 and B-035-1-23**
Date: **9/13/24**

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
734.5	730	1	1.11	4.5	0.0017	0.159694	50	0.394307	0.69	0.3	
730	721.5	1	0.75	8.5	0.0200	1.86	50	1.287197	0.97	0.0	
721.5	716.5	1	0.21	5	0.0020	0.18856	50	0.37712	0.68	0.1	
	Net=		2.06	in					Total	0.4	in

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
734.5	730	1	1.11	4.5	0.0017	0.159694	150	1.182921	0.96	0.0	
730	721.5	1	0.75	8.5	0.0200	1.86	150	3.861592	1.00	0.0	
721.5	716.5	1	0.21	5	0.0020	0.18856	150	1.131359	0.95	0.0	
	Net=		2.06	in					Total	0.1	in

Time Rate of Settlement computed based on Settlement calculations performed below the right corner of the proposed Bridge 6 RA (Worst Case Scenario)

Soil Parameters

Project: ATH-MEG-033-23.23/0.00
Boring No.: B-039-0-23 and B-039-1-23
Location: Forward Abutment
Date: 9/13/24

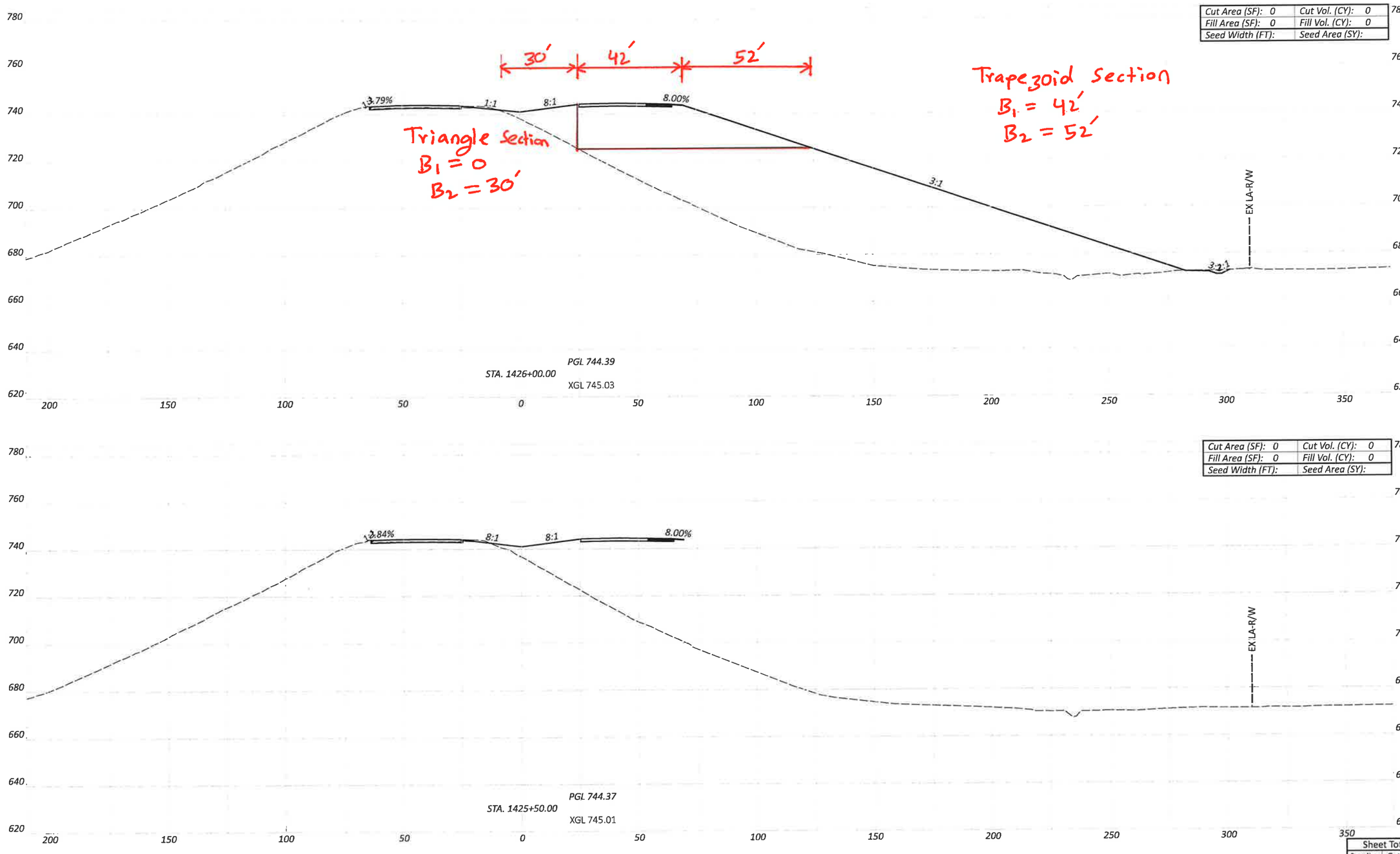
Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Gs	Sand Fraction	Clay Fraction	e_0	C_c	C_r	C_v (cm^2/sec)	Su (psf)	Pre-Consolidation Stress σ'p (psf)	Reference
A	725	714.9	10.1	A-3a	125	22	11	NP	NP	2.65	0.77	0.23							
			Avg	A-3a	125	22	11	NP	NP	2.65	0.77	0.23	0.29			0.1000	0	0.0	1
B	714.9	708.4	6.5	A-6a	125	19 26	12 10	30	19	2.7									
			Avg	A-6a	125	23	11	30	19	2.7			0.3	0.151	0.030	0.0200	2875	19078	2,3,4
C	708.4	696.4	12.0	A-4a	133	17 32	14 19	26	16	2.667			0.39	0.11	0.02	0.0360		6000	
			Avg	A-4a	133	25	17	26	16	2.7			0.39	0.11	0.02	0.0360	3125	6000	5
D	696.4	690.4	6.0	A-6a	118	9	17	28	17	2.7									
			Avg	A-6a	118	9	17	28	17	2.7			0.46	0.151	0.030	0.0200	1125	7465	2,3,4
E	690.4	684.9	5.5	A-6a	128	28	15	28	17	2.7									
			Avg	A-6a	128	28	15	28	17	2.7			0.41	0.151	0.030	0.0200	3500	23225	2,3,4
F	684.9	676.8	8.1	Rock Fill	140														
			Avg	Rock Fill	140														
G	676.8	668.8	8.0	A-7-6	118	8 8 10	33 20 29	47 45	20 23	2.646									
			Avg	A-7-6	118	9	27	46	22	2.6			0.57	0.150	0.027	0.0023	1125	10000	6
H	668.8	660.8	8.0	A-6b/A-6a	128.8	9 5 6	25 25 25	37	21	2.646			0.57			0.0023		10000	
			Avg	A-6b/A-6a	128.8	7	25	37	21	2.6			0.57	0.15	0.027	0.0023	875	10000.0	6
I	660.8	655.8	5.0	A-7-6/A-6a	128.8	12 13	26 25	31	18	2.646			0.57			0.0023		10000	
			Avg	A-7-6/A-6a	128.8	13	26	31	18	2.6			0.57	0.15	0.027	0.0023	1625	10000.0	6
J	655.8	650.8	5.0	A-3	118	5 5	30 27	NP	NP	2.65	0.93	0.07							
			Avg	A-3	118	5	29	NP	NP	2.65	0.93	0.07	0.77			0.1000	0	0.0	1
K	650.8	645.8	5.0	A-3	118	14 18	20 17	NP	NP	2.65	0.93	0.07							
			Avg	A-3	118	16	19	NP	NP	2.65	0.93	0.07	0.5			0.1000	0	0.0	1
L	645.8	640.8	5.0	A-3	118	5 4	22 32	NP	NP	2.65	0.93	0.07							
			Avg	A-3	118	5	27	NP	NP	2.65	0.93	0.07	0.72			0.1000	0	0.0	1

Layers A through F are considered from B-039-1-23 and Layers G through L are considered from B-039-0-23
Bedrock layers encountered below elevation 640.8 are considered incompressible

Reference Key

1 For non-plastic (NP) soils- a higher Cv value was assigned since settlement of NP soils is generally considered practically instantaneous.
2 Skempton (1957), FHWA-IF-03-017- GEC-N0.7, TABLE 3.7 used for computing σ'p if no consolidation data is available
3 Kulhawy and Mayne (1990) per GEC 5 (2016), Figure 6-36 used for computing C_c and C_r if no consolidation data is available
4 FHWA GEC 5 (2016) Figure 6-37, Reloading (lower bound) curve used for C_v computation of Cohesive soil if no consolidation data is available
5 Laboratory Consolidation Test Results B-039-1-23, ST-12, 36'-38'
6 Laboratory Consolidation Test Results B-039-1-23, ST-23, 81'-83'

Cut Area (SF): 0	Cut Vol. (CY): 0
Fill Area (SF): 0	Fill Vol. (CY): 0
Seed Width (FT):	Seed Area (SY):



Cut Area (SF): 0	Cut Vol. (CY): 0
Fill Area (SF): 0	Fill Vol. (CY): 0
Seed Width (FT):	Seed Area (SY):

Sheet Totals		
Seeding	Cut	Fill

SHEET TITLE
SHEET SUB-TITLE

CTY-RTE-SECTION

MODEL: CLP_U033 - 1425+50.00 [Sheet] PAPERSIZE: 34x22 (in.) DATE: 3/8/2024 TIME: 4:37:14 PM USER: sturner
pw:\\pw-int.hntb.org:PWGreat_Lakes\Documents\Columbus Projects\82841 ATH MEI-33\PW02 119142\400-Engineering-HNTB\Roadway\Sheets\119142_XS135.dgn

DESIGN AGENCY

DESIGNER: XXX
REVIEWER: XXX MM-DD-YY
PROJECT ID: 0
SHEET: P.0
TOTAL: 0

Settlement below the left corner of the Proposed Bridge 6 FA

Location **ATH-MEG-033-23.23/0.00**
Boring No. **B-039-0-23 and B-039-1-23**

Trapezoid section
Embankment Geometry
B_1 = 42 ft
B_2 = 52 ft

Triangle section
Embankment Geometry
B_1 = 0 ft
B_2 = 30 ft

Emb. Fill Ht. = 19.4 ft
Unit Wt. = 125 pcf
q = 2425 psf

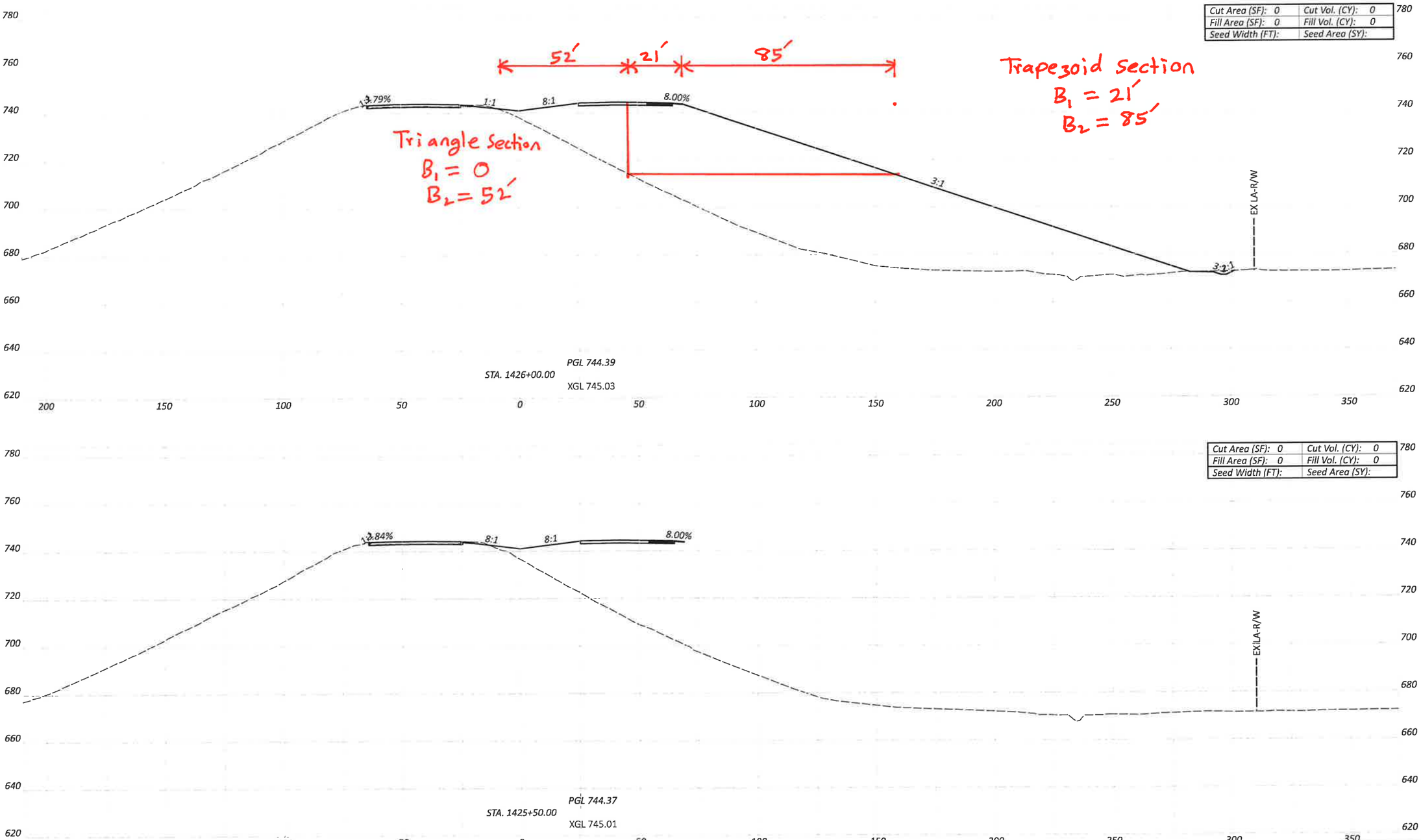
	Elevation			
Top of Embankment	744.4			
			Emb. Fill Unit Wt. =	125 pcf
Existing Grade	725.0		Height =	19.4 ft
			N_{60} Avg =	22 bpf
	714.9	Layer A	Unit Wt. =	125 pcf
			N_{60} Avg =	23 bpf
	708.4	Layer B	Unit Wt. =	125 pcf
			N_{60} Avg =	25 bpf
	702.4	Layer C1	Unit Wt. =	133 pcf
			N_{60} Avg =	25 bpf
	696.4	Layer C2	Unit Wt. =	133 pcf
			N_{60} Avg =	9 bpf
	690.4	Layer D	Unit Wt. =	118 pcf
			N_{60} Avg =	28 bpf
	684.9	Layer E	Unit Wt. =	128 pcf
			N_{60} Avg =	0 bpf
	676.8	Layer F	Unit Wt. =	140 pcf
			N_{60} Avg =	9 bpf
	668.8	Layer G	Unit Wt. =	118 pcf
			N_{60} Avg =	7 bpf
	660.8	Layer H	Unit Wt. =	128.8 pcf
			N_{60} Avg =	13 bpf
	655.8	Layer I	Unit Wt. =	128.8 pcf
			N_{60} Avg =	5 bpf
	650.8	Layer J	Unit Wt. =	118 pcf
			N_{60} Avg =	16 bpf
	645.8	Layer K	Unit Wt. =	118 pcf
			N_{60} Avg =	5 bpf
	640.8	Layer L	Unit Wt. =	118 pcf
			Bedrock	

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	Ó'$_o$ (psf)	B_1 / z	B_2 / z	I*	B_1 / z	B_2 / z	I*	Combined I	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	Ó'p (psf)	Ó'$_f$ (psf)	Consolidation	Settlement (in) **
A	10.1	125	5.05	631	8.3	10.3	0.50	0.0	5.9	0.45	0.95	22	0.77	0.23	84.668	-	2,935	NC	0.96
B	6.5	125	13.35	1669	3.1	3.9	0.50	0.0	2.2	0.41	0.91	23				19,078	3,876	OC	0.65
C1	6.0	133	19.6	2474	2.1	2.7	0.50	0.0	1.5	0.33	0.83	25				6,000	4,475	OC	0.27
C2	6.0	133	25.6	3272	1.6	2.0	0.49	0.0	1.2	0.27	0.76	25				6,000	5,115	OC	0.20
D	6.0	118	31.6	4025	1.3	1.6	0.48	0.0	0.9	0.22	0.70	9				7,465	5,723	OC	0.22
E	5.5	128	37.35	4731	1.1	1.4	0.48	0.0	0.8	0.20	0.68	28				23,225	6,368	OC	0.22
F	8.1	140	44.15	5650	1.0	1.2	0.47	0.0	0.7	0.18	0.65	0				-	7,226	NA	0.00
G	8.0	118	52.2	6689	0.8	1.0	0.44	0.0	0.6	0.16	0.60	9				10,000	8,132	OC	0.14
H	8.0	128.8	60.2	7676	0.7	0.9	0.42	0.0	0.5	0.14	0.56	7				10,000	9,022	OC	0.12
I	5.0	128.8	66.7	8513	0.6	0.8	0.41	0.0	0.4	0.10	0.51	13				10,000	9,738	OC	0.06
J***	5.0	118	71.7	9130	0.6	0.7	0.40	0.0	0.4	0.10	0.50	5	0.93	0.07	43.354	-	10,331	NC	0.07
K***	5.0	118	76.7	9720	0.5	0.7	0.38	0.0	0.4	0.10	0.48	16	0.93	0.07	77.168	-	10,872	NC	0.04
L***	5.0	118	81.7	10310	0.5	0.6	0.37	0.0	0.4	0.10	0.47	5	0.93	0.07	43.354	-	11,438	NC	0.06
																		Total=	3.01

0.4" @ Elev.= 687.0

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).
**The settlement value of granular soils is computed based on the Hough Method and LRFD Equation 10.6.2.4.2b-2.
**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1
***Layers J, K, and L were not considered in the downdrag calculations because these layers will settle right away before the piles are driven.

Cut Area (SF): 0	Cut Vol. (CY): 0
Fill Area (SF): 0	Fill Vol. (CY): 0
Seed Width (FT):	Seed Area (SY):



Cut Area (SF): 0	Cut Vol. (CY): 0
Fill Area (SF): 0	Fill Vol. (CY): 0
Seed Width (FT):	Seed Area (SY):

Sheet Totals		
Seeding	Cut	Fill

SHEET TITLE
SHEET SUB-TITLE

CTY-RTE-SECTION

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DESIGN AGENCY

DESIGNER
XXX

REVIEWER
XXX MM-DD-YY

PROJECT ID
0

SHEET	TOTAL
P.0	0

Settlement below the middle of the Proposed Bridge 6 FA

Location **ATH-MEG-033-23.23/0.00**
Boring No. **B-039-0-23 and B-039-1-23**

Trapezoid section
Embankment Geometry
B_1 = 21 ft
B_2 = 85 ft

Triangle section
Embankment Geometry
B_1 = 0 ft
B_2 = 52 ft

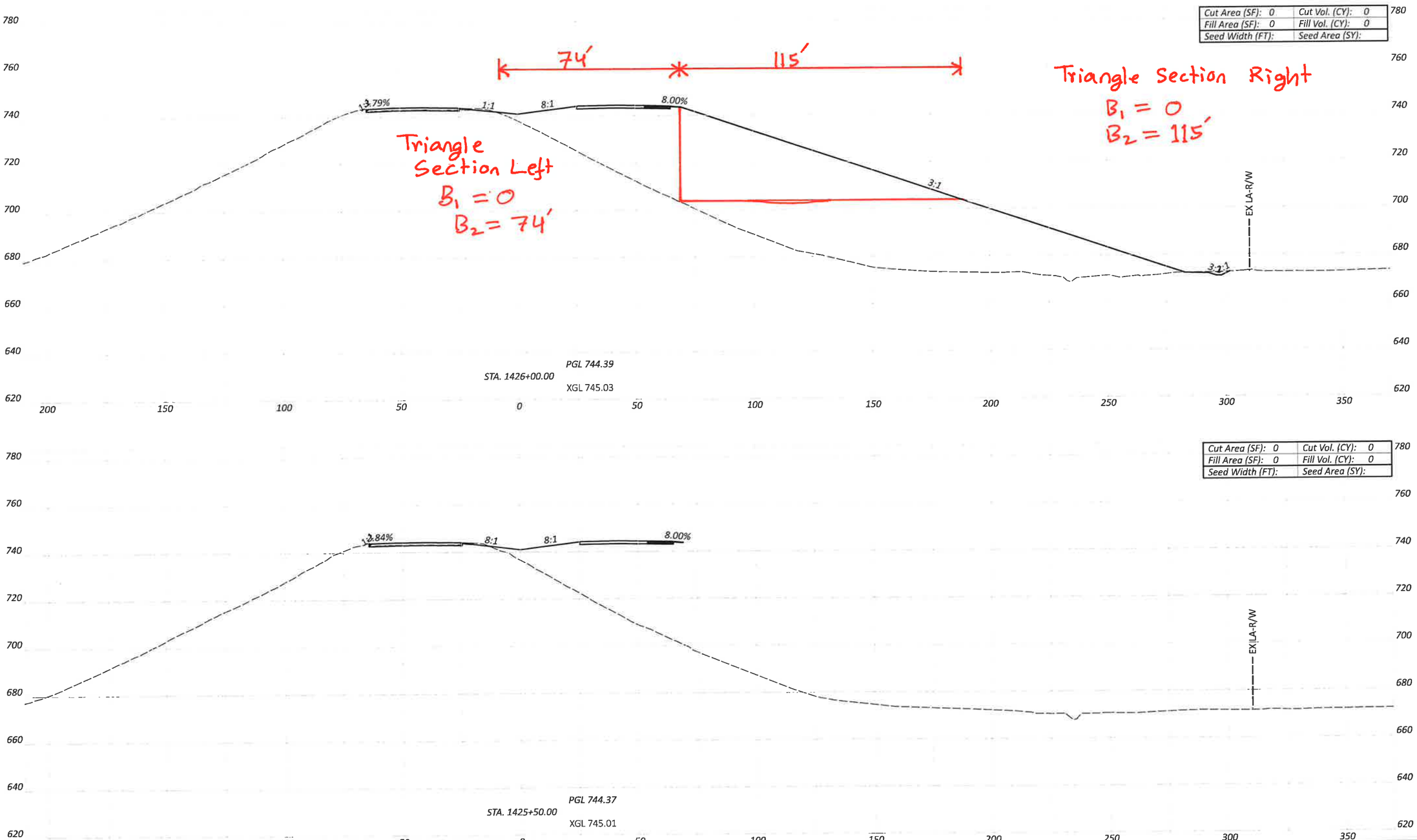
Emb. Fill Ht. = 29.5 ft
Unit Wt. = 125 pcf
q = 3687.5 psf

		Elevation			
Top of Embankment		744.4			
			Emb. Fill		
			Unit Wt. =	125	pcf
Existing Grade		714.9	Height =	29.5	ft
			N_{60} Avg =	23	bpf
		708.4	Layer B Unit Wt. =	125	pcf
			N_{60} Avg =	25	bpf
		702.4	Layer C1 Unit Wt. =	133	pcf
			N_{60} Avg =	25	bpf
		696.4	Layer C2 Unit Wt. =	133	pcf
			N_{60} Avg =	9	bpf
		690.4	Layer D Unit Wt. =	118	pcf
			N_{60} Avg =	28	bpf
		684.9	Layer E Unit Wt. =	128	pcf
			N_{60} Avg =	0	bpf
		676.8	Layer F Unit Wt. =	140	pcf
			N_{60} Avg =	9	bpf
		668.8	Layer G Unit Wt. =	118	pcf
			N_{60} Avg =	7	bpf
		660.8	Layer H Unit Wt. =	128.8	pcf
			N_{60} Avg =	13	bpf
		655.8	Layer I Unit Wt. =	128.8	pcf
			N_{60} Avg =	5	bpf
		650.8	Layer J Unit Wt. =	118	pcf
			N_{60} Avg =	16	bpf
		645.8	Layer K Unit Wt. =	118	pcf
			N_{60} Avg =	5	bpf
		640.8	Layer L Unit Wt. =	118	pcf
			Bedrock		

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	Ϭ'$_o$ (psf)	B_1 / z	B_2 / z	I*	B_1 / z	B_2 / z	I*	Combined I	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	Ϭ'p (psf)	Ϭ'$_f$ (psf)	Consolidation	Settlement (in) **
B	6.5	125	3.25	406	6.5	26.2	0.50	0.0	16.0	0.47	0.97	23				19,078	3,983	OC	1.77
C1	6.0	133	9.5	1212	2.2	8.9	0.49	0.0	5.5	0.45	0.94	25				6,000	4,678	OC	0.61
C2	6.0	133	15.5	2010	1.4	5.5	0.49	0.0	3.4	0.41	0.90	25				6,000	5,328	OC	0.44
D	6.0	118	21.5	2763	1.0	4.0	0.48	0.0	2.4	0.38	0.86	9				7,465	5,915	OC	0.48
E	5.5	128	27.25	3469	0.8	3.1	0.48	0.0	1.9	0.34	0.82	28				23,225	6,492	OC	0.38
F	8.1	140	34.05	4388	0.6	2.5	0.46	0.0	1.5	0.30	0.76	0				-	7,190	NA	0.00
G	8.0	118	42.1	5427	0.5	2.0	0.45	0.0	1.2	0.28	0.72	9				10,000	8,082	OC	0.44
H	8.0	128.8	50.1	6414	0.4	1.7	0.42	0.0	1.0	0.24	0.66	7				10,000	8,829	OC	0.23
I	5.0	128.8	56.6	7251	0.4	1.5	0.42	0.0	0.9	0.23	0.65	13				10,000	9,629	OC	0.13
J***	5.0	118	61.6	7868	0.3	1.4	0.40	0.0	0.8	0.21	0.61	5	0.93	0.07	43.354	-	10,099	NC	0.15
K***	5.0	118	66.6	8458	0.3	1.3	0.39	0.0	0.8	0.21	0.59	16	0.93	0.07	77.168	-	10,634	NC	0.08
L***	5.0	118	71.6	9048	0.3	1.2	0.38	0.0	0.7	0.18	0.56	5	0.93	0.07	43.354	-	11,113	NC	0.12
																		Total=	4.82

0.4" @ Elev.= 669.6

*The influence value (I) for embankment loading was computed based on "Influence Values for Vertical Stresses in Semi- Infinite Loading" charts (After Osterberg 1957).
**The settlement value of granular soils is computed based on the Hough Method and LRFD Equation 10.6.2.4.2b-2.
**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1
***Layers J, K, and L were not considered in the downdrag calculations because these layers will settle right away before the piles are driven.



CTY-RTE-SECTION

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SHEET TITLE
SHEET SUB-TITLE

DESIGN AGENCY

DESIGNER: XXX
REVIEWER: XXX MM-DD-YY
PROJECT ID: 0

Sheet Totals		
Seeding	Cut	Fill

SHEET: P.0
TOTAL: 0

Settlement below the right corner of the Proposed Bridge 6 FA

Location **ATH-MEG-033-23.23/0.00**
Boring No. **B-039-0-23 and B-039-1-23**

Triangle section right
Embankment Geometry
B_1 = 0 ft
B_2 = 115 ft

Triangle section left
Embankment Geometry
B_1 = 0 ft
B_2 = 74 ft

Emb. Fill Ht. 40.4 ft
Unit Wt. = 125 pcf
q = 5050 psf

	Elevation			
Top of Embankment	744.4			
			Emb. Fill Unit Wt. =	125 pcf
Existing Grade	704.0		Height =	40.4 ft
			N_{60} Avg =	25 bpf
	696.4	Layer C2	Unit Wt. =	133 pcf
			N_{60} Avg =	9 bpf
	690.4	Layer D	Unit Wt. =	118 pcf
			N_{60} Avg =	28 bpf
	684.9	Layer E	Unit Wt. =	128 pcf
			N_{60} Avg =	0 bpf
	676.8	Layer F	Unit Wt. =	140 pcf
			N_{60} Avg =	9 bpf
	668.8	Layer G	Unit Wt. =	118 pcf
			N_{60} Avg =	7 bpf
	660.8	Layer H	Unit Wt. =	128.8 pcf
			N_{60} Avg =	13 bpf
	655.8	Layer I	Unit Wt. =	128.8 pcf
			N_{60} Avg =	5 bpf
	650.8	Layer J	Unit Wt. =	118 pcf
			N_{60} Avg =	16 bpf
	645.8	Layer K	Unit Wt. =	118 pcf
			N_{60} Avg =	5 bpf
	640.8	Layer L	Unit Wt. =	118 pcf
			Bedrock	

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	σ'_o (psf)	B_1 / z	B_2 / z	I*	B_1 / z	B_2 / z	I*	Combined I	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	σ'_p (psf)	σ'_f (psf)	Consolidation	Settlement (in) **
C2	7.6	133	3.8	505	0.0	30.3	0.49	0.0	19.5	0.48	0.97	25				6,000	5,404	OC	1.35
D	6.0	118	10.6	1365	0.0	10.8	0.47	0.0	7.0	0.46	0.93	9				7,465	6,061	OC	0.95
E	5.5	128	16.35	2071	0.0	7.0	0.46	0.0	4.5	0.43	0.89	28				23,225	6,565	OC	0.70
F	8.1	140	23.15	2990	0.0	5.0	0.44	0.0	3.2	0.41	0.84	0				-	7,232	NA	0.00
G	8.0	118	31.2	4029	0.0	3.7	0.41	0.0	2.4	0.39	0.80	9				10,000	8,044	OC	0.65
H	8.0	128.8	39.2	5016	0.0	2.9	0.40	0.0	1.9	0.34	0.74	7				10,000	8,728	OC	0.49
I	5.0	128.8	45.7	5853	0.0	2.5	0.39	0.0	1.6	0.32	0.71	13				10,000	9,413	OC	0.24
J***	5.0	118	50.7	6470	0.0	2.3	0.37	0.0	1.5	0.31	0.68	5	0.93	0.07	43.354	-	9,904	NC	0.26
K***	5.0	118	55.7	7060	0.0	2.1	0.36	0.0	1.3	0.27	0.63	16	0.93	0.07	77.168	-	10,242	NC	0.13
L***	5.0	118	60.7	7650	0.0	1.9	0.34	0.0	1.2	0.26	0.60	5	0.93	0.07	43.354	-	10,680	NC	0.20
																		Total=	4.97

0.4" @ Elev.= 663.4

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi- Infinite Loading” charts (After Osterberg 1957).
**The settlement value of granular soils is computed based on the Hough Method and LRFD Equation 10.6.2.4.2b-2.
**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3-1
***Layers K, L, and M were not considered in the downdrag calculations because these layers will settle prior to pile driving.

0.16

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

                      APILE for Windows, Version 2019.9.12

                       Serial Number :  136154516

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

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


     This program is licensed to :

     CTL Engineering, Inc.
     Columbus, OH

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00-00_HNTB Ohio Inc\Design\Foundation Design Calculations and Analysis\Bridge 6 - US33 over
Shade River\Memo 3\Settlement and Downdrag Calculations\
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     Name of output file         : Bridge 6 Forward Abutment HP 14x73.ap9o
     Name of plot output file    : Bridge 6 Forward Abutment HP 14x73.ap9p

     ----------------------------------------------------------------------------
                          Time and Date of Analysis
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               Date:  June 02, 2024     Time:  18:09:20



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



          ATH-MEG-033-18.70/0.00

          DESIGNER   : CTL

          JOB NUMBER : 23050059COL


          METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 21.40 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 90.30 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 1.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 56.40 IN.
- TIP AREA OF PILE = 21.40 IN2
- INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	Nq FACTOR FHWA
0.00	SAND	0.80*	125.00	28.00	22.80**
53.30	SAND	0.80*	125.00	28.00	22.80**
53.30	CLAY	0.80*	55.60	0.00	4.80**
61.30	CLAY	0.80*	55.60	0.00	4.80**
61.30	CLAY	0.80*	66.40	0.00	4.80**
69.30	CLAY	0.80*	66.40	0.00	4.80**
69.30	CLAY	0.80*	66.40	0.00	4.80**
74.30	CLAY	0.80*	66.40	0.00	4.80**
74.30	SAND	0.80*	55.60	28.00	22.80**
89.30	SAND	0.80*	55.60	28.00	22.80**
89.30	CLAY	0.80*	77.60	0.00	4.80**
93.30	CLAY	0.80*	77.60	0.00	4.80**

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

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.12	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.12	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.88	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.88	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.62	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.62	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.68	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.68	0.00	0.00	0.00	0.00

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

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
53.30	1.000	1.000
53.30	1.000	1.000
61.30	1.000	1.000
61.30	1.000	1.000
69.30	1.000	1.000
69.30	1.000	1.000
74.30	1.000	1.000
74.30	1.000	1.000
89.30	1.000	1.000
89.30	1.000	1.000
93.30	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.180 *	0.00
53.30	0.180 *	0.00
53.30	0.180 *	0.90 **
61.30	0.180 *	0.90 **
61.30	0.180 *	0.90 **

69.30	0.180	*	0.90 **
69.30	0.180	*	0.90 **
74.30	0.180	*	0.90 **
74.30	0.180	*	0.00
89.30	0.180	*	0.00
89.30	0.180	*	0.90 **
93.30	0.180	*	0.90 **

* DEFAULT VALUE = 0.01 D
** DEFAULT VALUE = 0.9

1

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

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

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.1	0.1
1.00	0.1	0.2	0.3
2.00	0.3	0.4	0.8
3.00	0.7	0.7	1.4
4.00	1.3	0.9	2.2
5.00	2.1	1.1	3.2
6.00	3.0	1.4	4.3
7.00	4.1	1.6	5.6
8.00	5.3	1.8	7.1
9.00	6.7	1.9	8.6
10.00	8.3	2.0	10.2
11.00	10.0	2.0	12.0
12.00	11.9	2.0	13.9
13.00	14.0	2.0	16.0
14.00	16.2	2.0	18.2
15.00	18.6	2.0	20.6
16.00	21.2	2.0	23.2
17.00	23.9	2.0	25.9
18.00	26.8	2.0	28.8
19.00	29.9	2.0	31.9
20.00	33.1	2.0	35.1
21.00	36.5	2.0	38.5
22.00	40.1	2.0	42.1
23.00	43.8	2.0	45.8
24.00	47.7	2.0	49.7
25.00	51.8	2.0	53.7
26.00	56.0	2.0	58.0
27.00	60.4	2.0	62.4

28.00	64.9	2.0	66.9
29.00	69.7	2.0	71.6
30.00	74.5	2.0	76.5
31.00	79.6	2.0	81.6
32.00	84.8	2.0	86.8
33.00	90.2	2.0	92.2
34.00	95.8	2.0	97.7
35.00	101.5	2.0	103.4
36.00	107.3	2.0	109.3
37.00	113.4	2.0	115.4
38.00	119.6	2.0	121.6
39.00	126.0	2.0	128.0
40.00	132.5	2.0	134.5
41.00	139.2	2.0	141.2
42.00	146.1	2.0	148.1
43.00	153.2	2.0	155.1
44.00	160.4	2.0	162.3
45.00	167.7	2.0	169.7
46.00	175.3	2.0	177.2
47.00	183.0	2.0	185.0
48.00	190.8	2.0	192.8
49.00	198.9	2.0	200.9
50.00	207.1	2.0	209.1
51.00	215.4	2.0	217.4
52.00	224.0	2.0	225.9
53.00	232.7	1.8	234.5
54.00	241.5	1.7	243.3
55.00	248.6	1.6	250.3
56.00	253.9	1.5	255.5
57.00	259.2	1.5	260.7
58.00	264.5	1.5	266.0
59.00	269.8	1.5	271.3
60.00	275.1	1.5	276.6
61.00	280.4	1.4	281.8
62.00	285.7	1.3	287.0
63.00	290.4	1.3	291.6
64.00	294.5	1.2	295.7
65.00	298.6	1.2	299.8
66.00	302.7	1.2	303.9
67.00	306.8	1.2	308.0
68.00	310.9	1.2	312.1
69.00	315.0	1.4	316.5
70.00	319.1	1.7	320.8
71.00	325.0	1.9	326.9
72.00	332.6	2.1	334.7
73.00	340.2	2.2	342.4
74.00	347.8	2.1	349.9
75.00	355.2	2.1	357.3
76.00	364.2	2.0	366.2
77.00	375.0	2.0	377.0
78.00	385.9	2.0	387.8
79.00	396.8	2.0	398.8
80.00	407.8	2.0	409.8
81.00	418.9	2.0	420.9
82.00	430.0	2.0	432.0

83.00	441.3	2.0	443.3
84.00	452.6	2.0	454.6
85.00	464.0	2.0	465.9
86.00	475.4	2.0	477.4
87.00	486.9	2.0	488.9
88.00	498.5	2.0	500.5
89.00	510.2	2.1	512.3

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

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

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.3060E-02	0.2872E-01
			0.5099E-02	0.5565E-01
			0.7649E-02	0.1023E+00
			0.9179E-02	0.1436E+00
			0.1020E-01	0.1795E+00
			0.1020E-01	0.3591E+00
			0.1020E-01	0.5386E+00
			0.1020E-01	0.8976E+00
			0.1020E-01	0.3591E+01
2	10	0.2665E+02		
			0.0000E+00	0.0000E+00
			0.1957E+01	0.2872E-01
			0.3262E+01	0.5565E-01
			0.4892E+01	0.1023E+00
			0.5871E+01	0.1436E+00
			0.6523E+01	0.1795E+00
			0.6523E+01	0.3591E+00
			0.6523E+01	0.5386E+00
			0.6523E+01	0.8976E+00
			0.6523E+01	0.3591E+01
3	10	0.5326E+02		
			0.0000E+00	0.0000E+00
			0.3911E+01	0.2872E-01
			0.6518E+01	0.5565E-01
			0.9777E+01	0.1023E+00
			0.1173E+02	0.1436E+00
			0.1304E+02	0.1795E+00
			0.1304E+02	0.3591E+00

			0.1304E+02	0.5386E+00
			0.1304E+02	0.8976E+00
			0.1304E+02	0.3591E+01
4	10	0.5334E+02		
			0.0000E+00	0.0000E+00
			0.3917E+01	0.2872E-01
			0.6528E+01	0.5565E-01
			0.9792E+01	0.1023E+00
			0.1175E+02	0.1436E+00
			0.1306E+02	0.1795E+00
			0.1175E+02	0.3591E+00
			0.1175E+02	0.5386E+00
			0.1175E+02	0.8976E+00
			0.1175E+02	0.3591E+01
5	10	0.5730E+02		
			0.0000E+00	0.0000E+00
			0.2344E+01	0.2872E-01
			0.3906E+01	0.5565E-01
			0.5859E+01	0.1023E+00
			0.7031E+01	0.1436E+00
			0.7812E+01	0.1795E+00
			0.7031E+01	0.3591E+00
			0.7031E+01	0.5386E+00
			0.7031E+01	0.8976E+00
			0.7031E+01	0.3591E+01
6	10	0.6126E+02		
			0.0000E+00	0.0000E+00
			0.2344E+01	0.2872E-01
			0.3906E+01	0.5565E-01
			0.5859E+01	0.1023E+00
			0.7031E+01	0.1436E+00
			0.7812E+01	0.1795E+00
			0.7031E+01	0.3591E+00
			0.7031E+01	0.5386E+00
			0.7031E+01	0.8976E+00
			0.7031E+01	0.3591E+01
7	10	0.6134E+02		
			0.0000E+00	0.0000E+00
			0.2344E+01	0.2872E-01
			0.3906E+01	0.5565E-01
			0.5859E+01	0.1023E+00
			0.7031E+01	0.1436E+00
			0.7812E+01	0.1795E+00
			0.7031E+01	0.3591E+00
			0.7031E+01	0.5386E+00
			0.7031E+01	0.8976E+00
			0.7031E+01	0.3591E+01
8	10	0.6530E+02		
			0.0000E+00	0.0000E+00
			0.1823E+01	0.2872E-01
			0.3038E+01	0.5565E-01
			0.4557E+01	0.1023E+00
			0.5469E+01	0.1436E+00
			0.6076E+01	0.1795E+00
			0.5469E+01	0.3591E+00

			0.5469E+01	0.5386E+00
			0.5469E+01	0.8976E+00
			0.5469E+01	0.3591E+01
9	10	0.6926E+02		
			0.0000E+00	0.0000E+00
			0.1823E+01	0.2872E-01
			0.3038E+01	0.5565E-01
			0.4557E+01	0.1023E+00
			0.5469E+01	0.1436E+00
			0.6076E+01	0.1795E+00
			0.5469E+01	0.3591E+00
			0.5469E+01	0.5386E+00
			0.5469E+01	0.8976E+00
			0.5469E+01	0.3591E+01
10	10	0.6934E+02		
			0.0000E+00	0.0000E+00
			0.1823E+01	0.2872E-01
			0.3038E+01	0.5565E-01
			0.4557E+01	0.1023E+00
			0.5469E+01	0.1436E+00
			0.6076E+01	0.1795E+00
			0.5469E+01	0.3591E+00
			0.5469E+01	0.5386E+00
			0.5469E+01	0.8976E+00
			0.5469E+01	0.3591E+01
11	10	0.7180E+02		
			0.0000E+00	0.0000E+00
			0.3368E+01	0.2872E-01
			0.5614E+01	0.5565E-01
			0.8421E+01	0.1023E+00
			0.1010E+02	0.1436E+00
			0.1123E+02	0.1795E+00
			0.1010E+02	0.3591E+00
			0.1010E+02	0.5386E+00
			0.1010E+02	0.8976E+00
			0.1010E+02	0.3591E+01
12	10	0.7426E+02		
			0.0000E+00	0.0000E+00
			0.3325E+01	0.2872E-01
			0.5542E+01	0.5565E-01
			0.8313E+01	0.1023E+00
			0.9976E+01	0.1436E+00
			0.1108E+02	0.1795E+00
			0.9976E+01	0.3591E+00
			0.9976E+01	0.5386E+00
			0.9976E+01	0.8976E+00
			0.9976E+01	0.3591E+01
13	10	0.7434E+02		
			0.0000E+00	0.0000E+00
			0.3311E+01	0.2872E-01
			0.5519E+01	0.5565E-01
			0.8278E+01	0.1023E+00
			0.9934E+01	0.1436E+00
			0.1104E+02	0.1795E+00
			0.1104E+02	0.3591E+00

			0.1104E+02	0.5386E+00
			0.1104E+02	0.8976E+00
			0.1104E+02	0.3591E+01
14	10	0.8180E+02		
			0.0000E+00	0.0000E+00
			0.4956E+01	0.2872E-01
			0.8260E+01	0.5565E-01
			0.1239E+02	0.1023E+00
			0.1487E+02	0.1436E+00
			0.1652E+02	0.1795E+00
			0.1652E+02	0.3591E+00
			0.1652E+02	0.5386E+00
			0.1652E+02	0.8976E+00
			0.1652E+02	0.3591E+01
15	10	0.8926E+02		
			0.0000E+00	0.0000E+00
			0.5191E+01	0.2872E-01
			0.8652E+01	0.5565E-01
			0.1298E+02	0.1023E+00
			0.1557E+02	0.1436E+00
			0.1730E+02	0.1795E+00
			0.1730E+02	0.3591E+00
			0.1730E+02	0.5386E+00
			0.1730E+02	0.8976E+00
			0.1730E+02	0.3591E+01
16	10	0.8934E+02		
			0.0000E+00	0.0000E+00
			0.5191E+01	0.2872E-01
			0.8652E+01	0.5565E-01
			0.1298E+02	0.1023E+00
			0.1557E+02	0.1436E+00
			0.1730E+02	0.1795E+00
			0.1557E+02	0.3591E+00
			0.1557E+02	0.5386E+00
			0.1557E+02	0.8976E+00
			0.1557E+02	0.3591E+01
17	10	0.9130E+02		
			0.0000E+00	0.0000E+00
			0.5191E+01	0.2872E-01
			0.8652E+01	0.5565E-01
			0.1298E+02	0.1023E+00
			0.1557E+02	0.1436E+00
			0.1730E+02	0.1795E+00
			0.1557E+02	0.3591E+00
			0.1557E+02	0.5386E+00
			0.1557E+02	0.8976E+00
			0.1557E+02	0.3591E+01
18	10	0.9326E+02		
			0.0000E+00	0.0000E+00
			0.5191E+01	0.2872E-01
			0.8652E+01	0.5565E-01
			0.1298E+02	0.1023E+00
			0.1557E+02	0.1436E+00
			0.1730E+02	0.1795E+00
			0.1557E+02	0.3591E+00

0.1557E+02	0.5386E+00
0.1557E+02	0.8976E+00
0.1557E+02	0.3591E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.1282E+00	0.8976E-02
0.2565E+00	0.1795E-01
0.5129E+00	0.3591E-01
0.1026E+01	0.2334E+00
0.1539E+01	0.7540E+00
0.1847E+01	0.1311E+01
0.2052E+01	0.1795E+01
0.2052E+01	0.2693E+01
0.2052E+01	0.3591E+01

LOAD VERSUS SETTLEMENT CURVE

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1574E+01	0.1355E-02	0.1429E-02	0.1000E-03
0.1583E+02	0.1358E-01	0.1429E-01	0.1000E-02
0.7793E+02	0.6807E-01	0.7143E-01	0.5000E-02
0.1417E+03	0.1299E+00	0.1429E+00	0.1000E-01
0.2351E+03	0.2313E+00	0.2857E+00	0.2000E-01
0.3729E+03	0.4205E+00	0.5496E+00	0.5000E-01
0.4372E+03	0.5366E+00	0.6275E+00	0.8000E-01
0.4654E+03	0.5979E+00	0.6794E+00	0.1000E+00
0.5092E+03	0.7681E+00	0.9392E+00	0.2000E+00
0.5035E+03	0.1061E+01	0.1289E+01	0.5000E+00
0.5038E+03	0.1361E+01	0.1564E+01	0.8000E+00
0.5039E+03	0.1561E+01	0.1675E+01	0.1000E+01
0.5043E+03	0.2562E+01	0.2052E+01	0.2000E+01

Project: ATH-MEG-033-23.23/0.00
Location: Forward Abutment
Date: 9/13/2024
Boring No.: B-039-0-23 and B-039-1-23

Bottom of Pile Cap Elevation (feet) 730.1

Pile Type
HP 14x73

Ultimate Capacity (Skin Friction) (kips)	Depth (feet)	Elevation (Feet)	
0	0	730.10	
0.1	1	729.10	
0.3	2	728.10	
0.7	3	727.10	
1.3	4	726.10	
2.1	5	725.10	
3	6	724.10	
4.1	7	723.10	
5.3	8	722.10	
6.7	9	721.10	
8.3	10	720.10	
10	11	719.10	
11.9	12	718.10	
14	13	717.10	
16.2	14	716.10	
18.6	15	715.10	
21.2	16	714.10	
23.9	17	713.10	
26.8	18	712.10	
29.9	19	711.10	
33.1	20	710.10	
36.5	21	709.10	
40.1	22	708.10	
43.8	23	707.10	
47.7	24	706.10	
51.8	25	705.10	
56	26	704.10	
60.4	27	703.10	
64.9	28	702.10	
69.7	29	701.10	
74.5	30	700.10	
79.6	31	699.10	
84.8	32	698.10	
90.2	33	697.10	
95.8	34	696.10	
101.5	35	695.10	
107.3	36	694.10	
113.4	37	693.10	
119.6	38	692.10	
126	39	691.10	
132.5	40	690.10	
139.2	41	689.10	
146.1	42	688.10	
153.2	43	687.10	
160.4	44	686.10	
167.7	45	685.10	
175.3	46	684.10	
183	47	683.10	
190.8	48	682.10	
198.9	49	681.10	
207.1	50	680.10	
215.4	51	679.10	
224	52	678.10	
232.7	53	677.10	
241.5	54	676.10	
248.6	55	675.10	
253.9	56	674.10	
259.2	57	673.10	
264.5	58	672.10	
269.8	59	671.10	
275.1	60	670.10	
280.4	61	669.10	
285.7	62	668.10	
290.4	63	667.10	
294.5	64	666.10	
298.6	65	665.10	
302.7	66	664.10	Downdrag*
306.8	67	663.10	Downdrag*
310.9	68	662.10	
315	69	661.10	
319.1	70	660.10	
325	71	659.10	
332.6	72	658.10	
340.2	73	657.10	
347.8	74	656.10	
355.2	75	655.10	
364.2	76	654.10	
375	77	653.10	
385.9	78	652.10	
396.8	79	651.10	
407.8	80	650.10	
418.9	81	649.10	
430	82	648.10	
441.3	83	647.10	
452.6	84	646.10	
464	85	645.10	
475.4	86	644.10	
486.9	87	643.10	
498.5	88	642.10	
510.2	89	641.10	

*Downdrag is computed based on the neutral plane elevation determined from the Settlement calculations performed below the right corner of the proposed Bridge 6 FA (Worst Case Scenario)

Downdrag Calculation

Project: **ATH-MEG-033-23.23/0.00**
Location: **Forward Abutment**
Boring No.: **B-039-0-23 and B-039-1-23**
Date: **9/13/24**

Measuring from bottom of pile, 0.4 inch settlement occurs at and below elevation = 663.4 feet

Compute Skin Friction using the Ultimate data from A-Pile Analysis

From A-Pile Results

HP 14x73

Unfactored Downdrag Load	305.6 Kips	
Load Factor for Downdrag	1.05	ODOT BDM 305.3.2.2
Factored Downdrag Load	320.9 Kips	

*Downdrag is computed based on the neutral plane elevation determined from the Settlement calculations performed below the right corner of the proposed Bridge 6 FA (Worst Case Scenario)

Time Rate of Settlement Determination

Project: **ATH-MEG-033-23.23/0.00**
Boring No.: **B-039-0-23 and B-039-1-23**
Date: **9/13/24**

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
704	696.4	1	1.35	7.6	0.0360	3.347482	100	5.795503	1.00	0.0	
696.4	690.4	1	0.95	6	0.0200	1.86	100	5.166667	1.00	0.0	
690.4	684.9	1	0.70	5.5	0.0200	1.86	100	6.14876	1.00	0.0	
684.9	676.8	1	0.00	8.1	0.0000	0	100	0	0.19	0.0	
676.8	668.8	1	0.65	8	0.0023	0.216585	100	0.338415	0.65	0.2	
668.8	660.8	1	0.49	8	0.0023	0.216585	100	0.338415	0.65	0.2	
660.8	655.8	1	0.24	5	0.0023	0.209589	100	0.838357	0.90	0.0	
655.8	650.8	2	0.26	2.5	0.1000	9.3	100	148.8	1.00	0.0	
650.8	645.8	2	0.13	2.5	0.1000	9.3	100	148.8	1.00	0.0	
645.8	640.8	2	0.20	2.5	0.1000	9.3	100	148.8	1.00	0.0	
	Net=		4.97	in					Total	0.4	in

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
704	696.4	1	1.35	7.6	0.0360	3.347482	300	17.38651	1.00	0.0	
696.4	690.4	1	0.95	6	0.0200	1.86	300	15.5	1.00	0.0	
690.4	684.9	1	0.70	5.5	0.0200	1.86	300	18.44628	1.00	0.0	
684.9	676.8	1	0.00	8.1	0.0000	0	300	0	0.19	0.0	
676.8	668.8	1	0.65	8	0.0023	0.216585	300	1.015244	0.93	0.0	
668.8	660.8	1	0.49	8	0.0023	0.216585	300	1.015244	0.93	0.0	
660.8	655.8	1	0.24	5	0.0023	0.209589	300	2.515071	1.00	0.0	
655.8	650.8	2	0.26	2.5	0.1000	9.3	300	446.4	1.00	0.0	
650.8	645.8	2	0.13	2.5	0.1000	9.3	300	446.4	1.00	0.0	
645.8	640.8	2	0.20	2.5	0.1000	9.3	300	446.4	1.00	0.0	
	Net=		4.97	in					Total	0.1	in

Time Rate of Settlement computed based on Settlement calculations performed below the right corner of the proposed Bridge 6 FA (Worst Case Scenario)

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
MEG-00033-01510R - Eastbound US 33 over West Branch of the Shade River and C.R.40 (Burlingham Road)
Pier 1

Boring No	B-036-0-23		
Bottom of Foundation Elevation	687	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	678.7	feet	(From boring)
Top of Coreable Rock Elevation	677.2	feet	(From boring)

From Bottom of Footing Elevation to 678.7 feet

Use Soil Type-	Stiff Clay with Free Water (Reese)		
Effective Unit Weight =	62.6	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2800	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 638.5 to 634.5 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	77.6	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	31.6	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	6300	psi	GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 677.2 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	151.5	pcf	Laboratory Test of B-036-0-23, NQ-2
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	370	psi	Laboratory Test of B-036-0-23, NQ-2
Initial Rock Modulus =	18000	psi	GDM Table 400-6, very weak rock
RQD =	40%		B-036-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
MEG-00033-01510R - Eastbound US 33 over West Branch of the Shade River and C.R.40 (Burlingham Road)
Pier 2

Boring No	B-037-0-23		
Bottom of Foundation Elevation	671	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	638.5	feet	(From boring)
Top of Coreable Rock Elevation	634.5	feet	(From boring)

From Bottom of Footing Elevation to 656.5 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	59.6	pcf	ODOT GDM Table 400-4
Friction Angle =	31	Degrees	ODOT GDM Section 404.2
k =	60	pci	From L-pile

From 656.5 to 644.0 feet

Use Soil Type-	Stiff Clay with Free Water (Reese)		
Effective Unit Weight =	62.6	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	2600	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.005		From L-pile
k =	1000	pci	From L-pile

From 644.0 to 638.5 feet

Use Soil Type-	Stiff Clay with Free Water (Reese)		
Effective Unit Weight =	65.6	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	4300	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.004		From L-pile
k =	2000	pci	From L-pile

From 638.5 to 634.5 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	77.6	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	70.1	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	6300	psi	GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 634.5 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	83.6	pcf	Laboratory Test of B-037-0-23, NQ-1
Strain Factor K_{rm} =	0.00005		From L-pile
Compressive Strength q_u =	110	psi	Laboratory Test of B-037-0-23, NQ-1
Initial Rock Modulus =	9900	psi	ODOT GDM Table 400-6, very weak rock
RQD =	80%		B-037-0-23, NQ-1

L-PILE Soil and Rock Parameters

ATH-33-18.70/MEG-33-0.00
MEG-00033-01510R - Eastbound US 33 over West Branch of the Shade River and C.R.40 (Burlingham Road)
Pier 3

Boring No	B-038-0-23		
Bottom of Foundation Elevation	683	feet	(From Stage 2 Plans)
Top of Augerable Rock Elevation	644.4	feet	(From boring)
Top of Coreable Rock Elevation	639.9	feet	(From boring)

From 683.0 to 674.4 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	57.6	pcf	ODOT GDM Table 400-4
Friction Angle =	36	Degrees	ODOT GDM Section 404.2
k =	60	pci	From L-pile

From 674.4 to 668.9 feet

Use Soil Type-	Stiff Clay with Free Water (Reese)		
Effective Unit Weight =	55.6	pcf	ODOT GDM Table 400-4
Undrained Cohesion =	1000	psf	ODOT GDM Section 404.1
Strain Factor E50 =	0.007		From L-pile
k =	500	pci	From L-pile

From 668.9 to 664.4 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	57.6	pcf	ODOT GDM Table 400-4
Friction Angle =	30	Degrees	ODOT GDM Section 404.2
k =	20	pci	From L-pile

From 664.4 to 658.9 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	59.6	pcf	ODOT GDM Table 400-4
Friction Angle =	32.5	Degrees	ODOT GDM Section 404.2
k =	20	pci	From L-pile

From 658.9 to 644.4 feet

Use Soil Type-	Sand (Reese)		
Effective Unit Weight =	59.6	pcf	ODOT GDM Table 400-4
Friction Angle =	31.5	Degrees	ODOT GDM Section 404.2
k =	20	pci	From L-pile

From 644.4 to 639.9 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	77.6	pcf	ODOT GDM Table 400-5, Claystone
Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	110.4	psi	ODOT GDM Section 404.3
Initial Rock Modulus =	9930	psi	ODOT GDM Table 400-6, very weak rock
RQD =	0%		Assumed

Below 639.9 feet

Use Rock Type-	Weak Rock (Reese)		
Effective Unit Weight =	79.1	pcf	Laboratory Test of B-038-0-23, NQ-1

Strain Factor K_{rm} =	0.0005		From L-pile
Compressive Strength q_u =	90	psi	Laboratory Test of B-038-0-23, NQ-1
Initial Rock Modulus =	8100	psi	ODOT GDM Table 400-6, very weak rock
RQD =	82%		B-038-0-23, NQ-1

Project: ATH-MEG-033-18.70/0.00
Boring No.: B-039-0-23 and B-039-1-23
Location: Forward Abutment
Date: 6/3/24

							Effective Stress		Total Stress		
Layer No.	Top Elev	Bottom Elev	Thickness (feet)	Type	Total Unit Weight (pcf)	N_{60} value (bpf)	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)	Reference
1	744	720	24	Embankment Fill	125		250	26	2500	0	10
2	720	714.9	5.1	A-3a	125	22					
			Avg	A-3a	125	22	0	35	0	35	1,2
3	714.9	708.4	6.5	A-6a	125	19 26					
			Avg	A-6a	125	23	250	24	2875	0	3,4,5,6
4	708.4	696.4	12.0	A-4a	133	17 32					
			Avg	A-4a	133	25	350	26	3125	0	3,4,5,6,7
5	696.4	684.9	11.5	A-6a	122	9 28					
			Avg	A-6a	122	19	280	24	2375	0	3,4,5,6
6	684.9	676.8	8.1	Rock Fill	140						
			Avg	Rock Fill	140		0	45	0	45	9
7	676.8	668.8	8.0	A-7-6	118	8 8 10					
			Avg	A-7-6	118	9	150	22	1125	0	3,4,5,6
8	668.8	655.8	13.0	A-6b/A-7-6	129	9 5 6 12 13					
			Avg	A-6b/A-7-6	129	9	0	33	1120	15	8
9	655.8	640.8	15.0	A-3	122	5 5 14 18 5 4					
			Avg	A-3	122	9	0	28	0	28	1,2

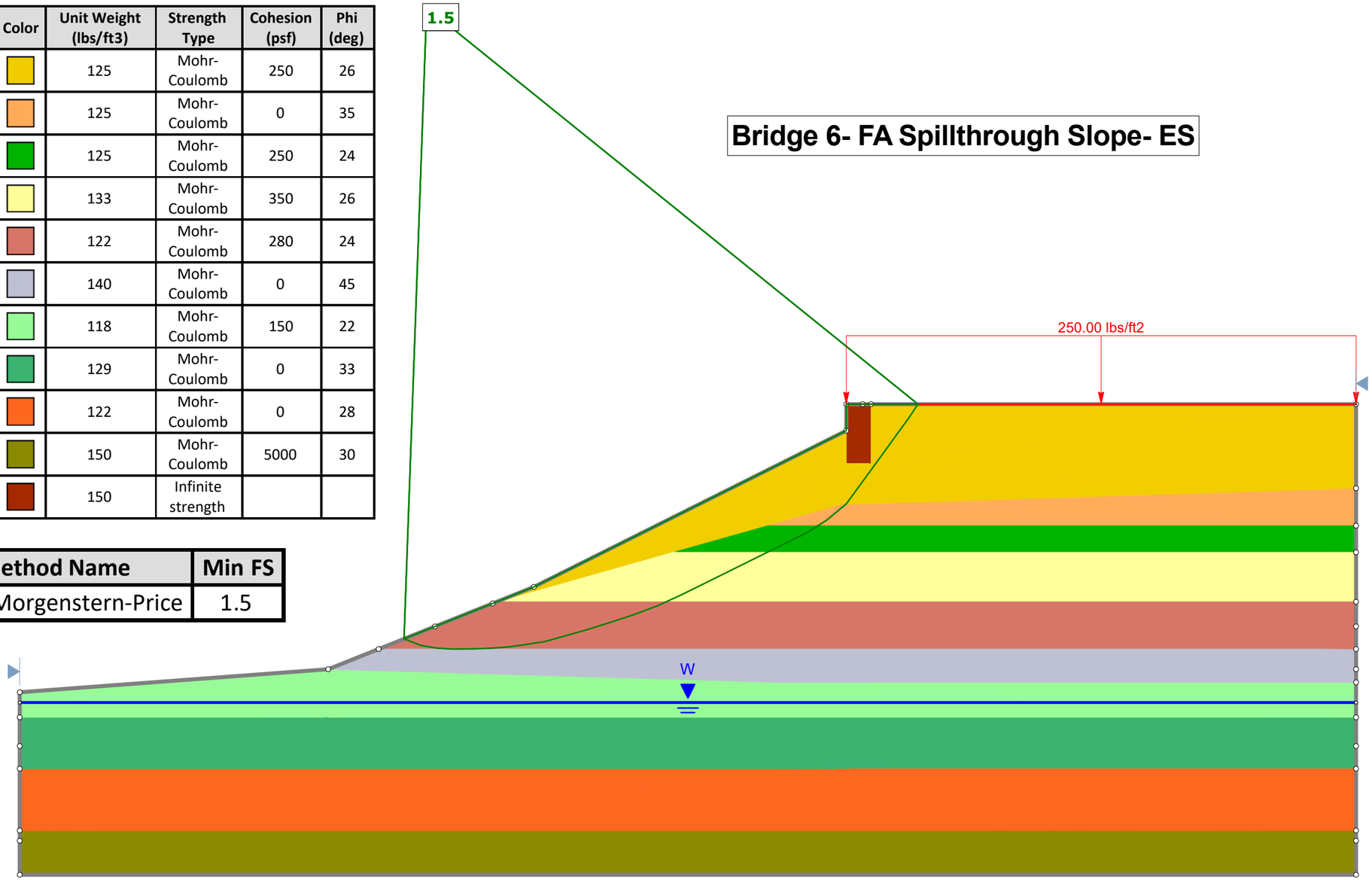
Layers 2 through 6 were taken from Boring B-039-1-23, Layers 7 to 9 were taken from Boring B-039-0-23

Reference Key

1 Non Plastic Soils (Total and Effective Stress) - Friction angle estimated using N-value & soil type according to ODOT GDM Section 404.2
2 Non Plastic Soils (Total and Effective Stress) - Cohesion assumed to be 0
3 Cohesive Soils (Effective Stress)- Cohesion estimated to be 10 to 25 percent of Total Stress Cohesion
4 Cohesive Soils (Total Stress)- Coshesion estimated to be 125 times the N60 value according to ODOT GDM section 404.1
5 Cohesive Soils (Effective Stress)- Friction angle based on the soil type
6 Cohesive Soils (Total Stress)- Friction angle assumed to be 0
7 Total unit weight from laboratory consolidation test, B-039-1-23, ST-36'-38'
8 Laboratory Triaxial Test - B-039-1-23, ST-23, 81'-83'
9 Assumed parameters for Rockfill
10 Assumed Embankment Fill Properties (Unknown), according to ODOT GDM Table 500-2

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Propsed Embankment Fill		125	Mohr-Coulomb	250	26
A-3a (Fill)		125	Mohr-Coulomb	0	35
A-6a(Fill)		125	Mohr-Coulomb	250	24
A-4a (Fill)		133	Mohr-Coulomb	350	26
A-6a (Fill)		122	Mohr-Coulomb	280	24
Rock Fill		140	Mohr-Coulomb	0	45
Clay		118	Mohr-Coulomb	150	22
Silty Clay		129	Mohr-Coulomb	0	33
Fine Sand		122	Mohr-Coulomb	0	28
Bedrock		150	Mohr-Coulomb	5000	30
Abutment		150	Infinite strength		

Method Name	Min FS
GLE / Morgenstern-Price	1.5



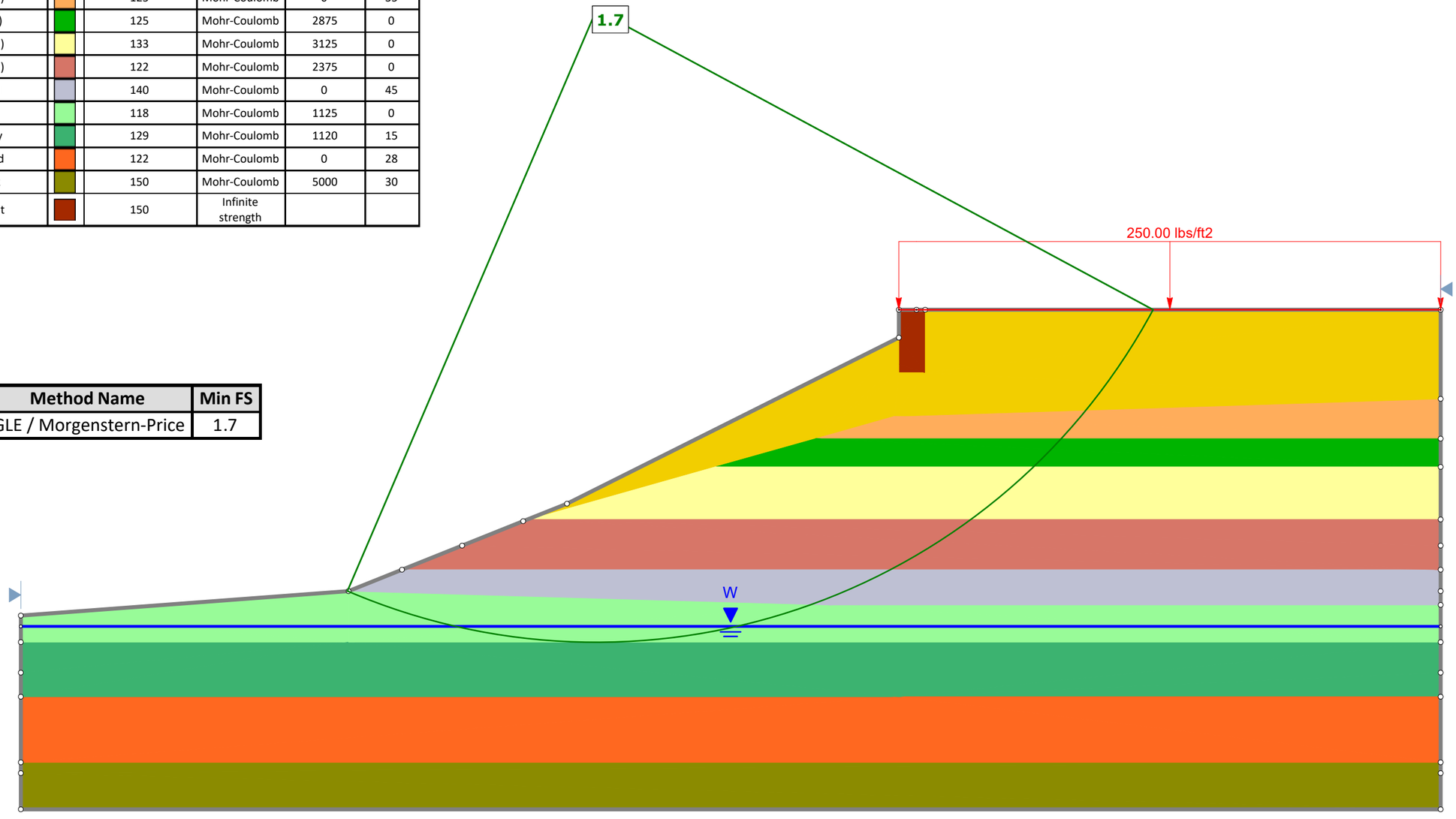
SLIDEINTERPRET 9.019

Project	**ATH/MEG-US33-18.70/00.00**
Analysis Description	Slope Stability Analysis
Drawn By	CTL Engineering
Date	1/8/2024, 3:41:58 PM
File Name	Bridge 6 Forward Abutment Slope Stability ES.slmd

Bridge 6- FA Spillthrough Slope- TS

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Propsed Embankment Fill		125	Mohr-Coulomb	2500	0
A-3a (Fill)		125	Mohr-Coulomb	0	35
A-6a(Fill)		125	Mohr-Coulomb	2875	0
A-4a (Fill)		133	Mohr-Coulomb	3125	0
A-6a (Fill)		122	Mohr-Coulomb	2375	0
Rock Fill		140	Mohr-Coulomb	0	45
Clay		118	Mohr-Coulomb	1125	0
Silty Clay		129	Mohr-Coulomb	1120	15
Fine Sand		122	Mohr-Coulomb	0	28
Bedrock		150	Mohr-Coulomb	5000	30
Abutment		150	Infinite strength		

Method Name	Min FS
GLE / Morgenstern-Price	1.7



SLIDEINTERPRET 9.019

Project	**ATH/MEG-US33-18.70/00.00**
Analysis Description	Slope Stability Analysis
Drawn By	CTL Engineering Inc
Date	1/8/2024, 3:41:58 PM
File Name	Bridge 6 Forward Abutment Slope StabilityTS.slmd

APPENDIX J

ROCK CORE PHOTOS

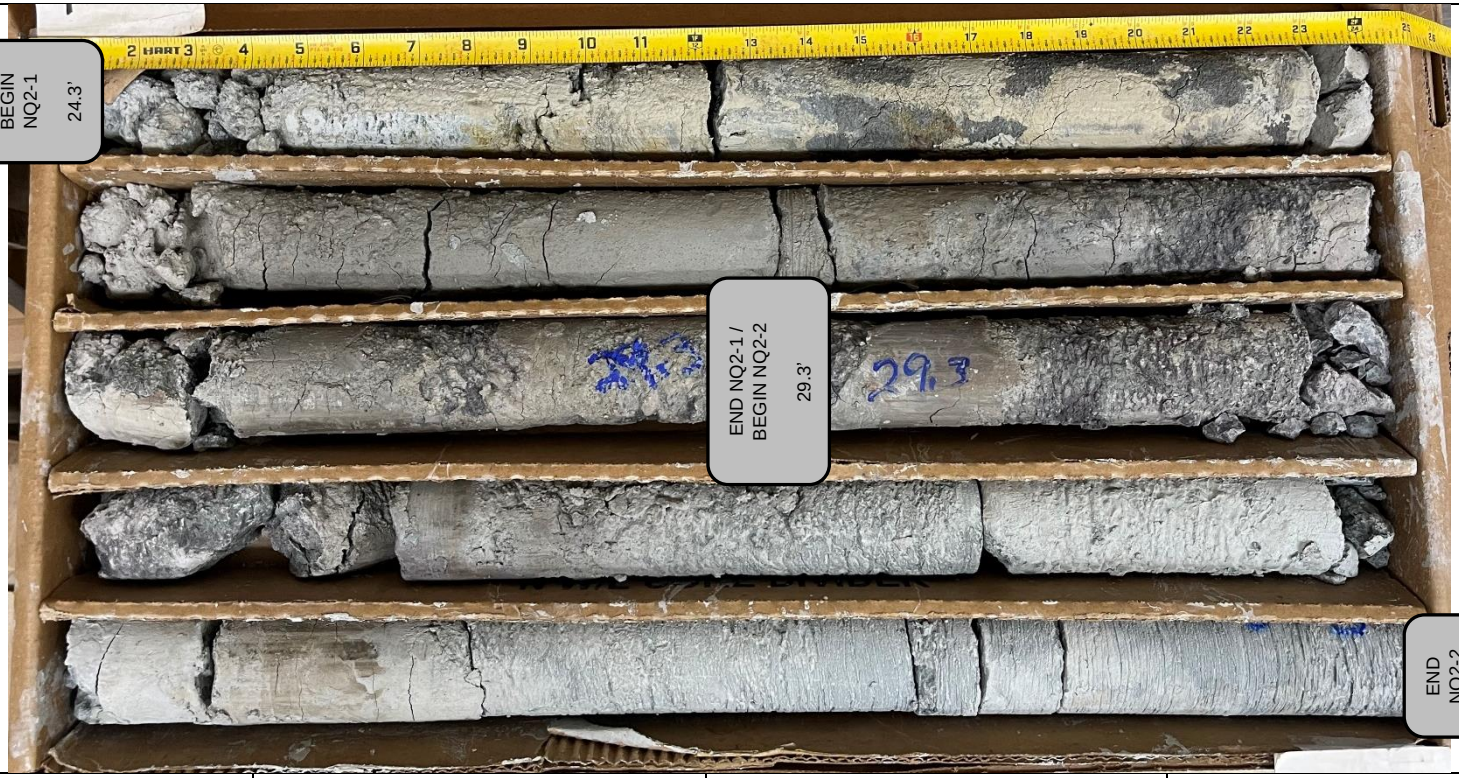
B-007-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	1.0’	6.0’	60/60	100%	46/60	77%
NQ2-2	6.0’	11.0’	60/60	100%	49.5/60	83%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-007-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	11.0’	16.0’	60/60	100%	53/60	88%
NQ2-4	16.0’	21.0’	60/60	100%	53/60	88%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-008-0-23



Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	24.3’	29.3’	60/60	100%	48/60	80%
NQ2-2	29.3’	34.3’	60/60	100%	43/60	72%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-008-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	34.3’	39.3’	60/60	100%	30/60	50%
NQ2-4	39.3’	44.3’	60/60	100%	51/60	85%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-009-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	19.3’	24.3’	60/60	100%	52/60	87%
NQ2-2	24.3’	29.3’	60/60	100%	60/60	100%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-009-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	29.3'	34.3'	60/60	100%	55/60	92%
NQ2-4	34.3'	39.3'	60/60	100%	50/60	83%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-010-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	10.7’	15.7’	60/60	100%	21/60	35%
NQ2-2	15.7’	20.7’	60/60	100%	47/60	78%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-010-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	20.7’	25.7’	60/60	100%	53/60	88%
NQ2-4	25.7’	30.7’	60/60	100%	32/60	53%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-011-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	10.0’	15.0’	60/60	100%	47/60	78%
NQ2-2	15.0’	20.0’	60/60	100%	24/60	40%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-011-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	20.0’	25.0’	60/60	100%	57/60	95%
NQ2-4	25.0’	30.0’	60/60	100%	48/60	80%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-012-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	15.0’	20.0’	60/60	100%	49/60	82%
NQ2-2	20.0’	25.0’	60/60	100%	49/60	82%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-012-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	25.0’	30.0’	60/60	100%	55/60	92%
NQ2-4	30.0’	35.0’	60/60	100%	55/60	92%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-012-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-5	35.0’	40.0’	60/60	100%	58/60	97%
NQ2-6	40.0’	45.0’	60/60	100%	60/60	100%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-012-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-7	45.0’	50.0’	48/60	80%	42/60	70%
NQ2-8	50.0’	55.0’	60/60	100%	20/60	33%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-012-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-9	55.0'	60.0'	60/60	100%	30/60	50%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-018-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	5.0'	10.0'	60/60	100%	11/60	18%
NQ2-2	10.0'	15.0'	60/60	100%	10/60	17%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-018-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	15.0’	20.0’	60/60	100%	34/60	57%
NQ2-4	20.0’	25.0’	60/60	100%	51/60	85%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-019-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	15.0’	20.0’	60/60	100%	33/60	55%
NQ2-2	20.0’	25.0’	60/60	100%	36/60	60%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-019-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	20.0’	25.0’	60/60	100%	43/60	72%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-020-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	18.5’	23.5’	60/60	100%	36/60	60%
NQ2-2	23.5’	28.5’	60/60	100%	40/60	67%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-020-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	28.5’	33.5’	60/60	100%	46/60	77%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-021-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	9.0’	12.0’	35/36	97%	29/36	81%
NQ2-2	12.0’	17.0’	60/60	100%	10/60	17%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-021-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	17.0’	22.0’	60/60	100%	48/60	80%
NQ2-4	22.0’	24.0’	24/24	100%	24/24	100%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-022-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	5.0’	8.0’	36/36	100%	26.4/36	73%
NQ2-2	8.0’	13.0’	60/60	100%	55/60	92%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-022-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	13.0’	18.0’	60/60	100%	54/60	90%
NQ2-4	18.0’	23.0’	60/60	100%	49/60	82%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-022-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-5	23.0’	28.0’	60/60	100%	49/60	82%
NQ2-6	28.0’	33.0’	60/60	100%	41.5/60	69%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-022-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-7	33.0’	38.0’	60/60	100%	36/60	60%
NQ2-8	38.0’	43.0’	60/60	100%	60/60	100%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-022-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-9	43.0’	48.0’	60/60	100%	51/60	85%
NQ2-10	48.0’	53.0’	60/60	100%	50/60	83%
ATH/MEG-US33-23.23/0.00, PID 119142						

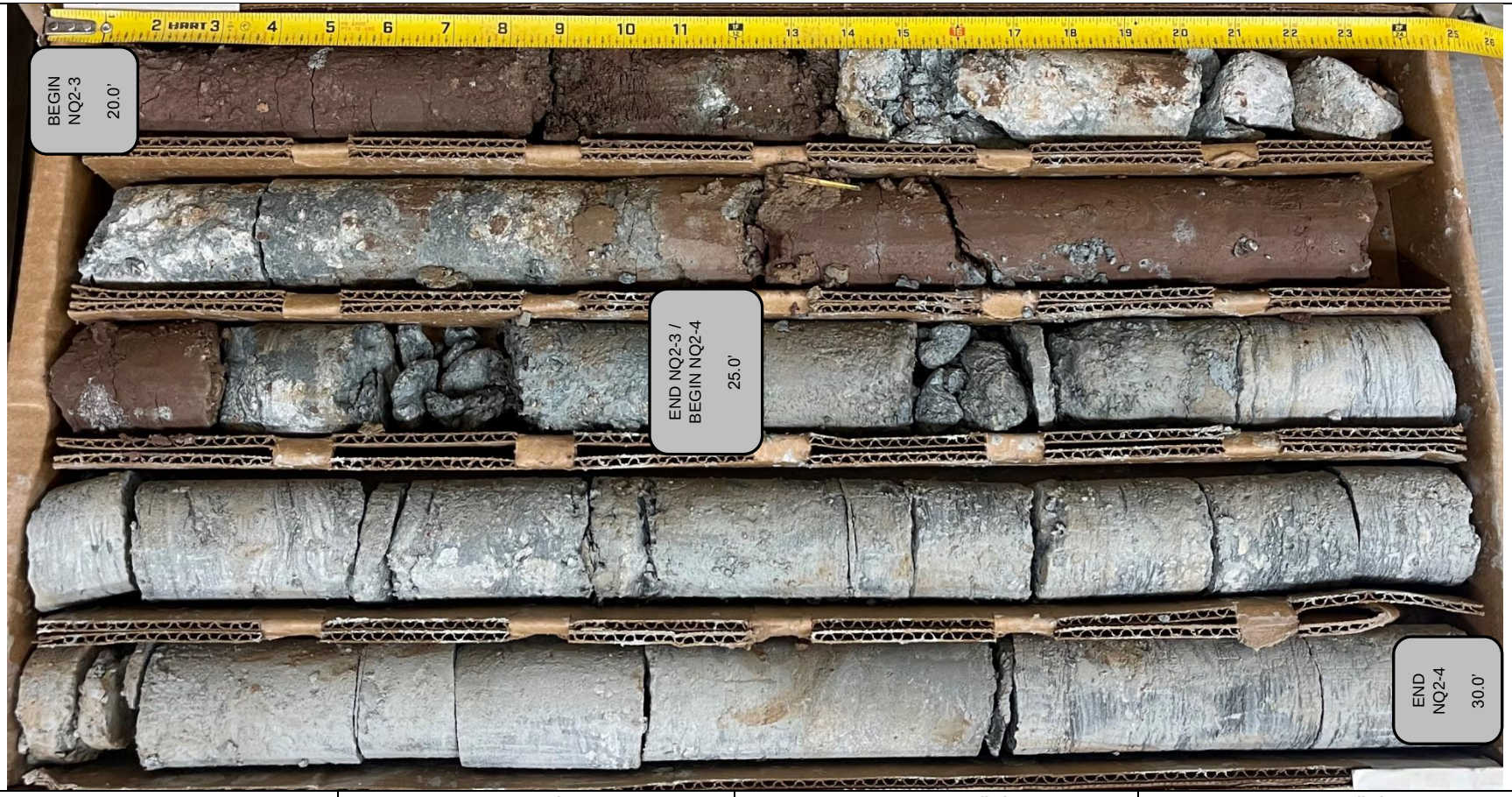
B-022-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-11	53.0’	58.0’	60/60	100%	58/60	97%
NQ2-12	58.0’	60.0’	24/24	100%	5/24	21%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-023-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	10.0’	15.0’	24/60	40%	8/60	13%
NQ2-2	15.0’	20.0’	48/60	80%	23/60	38%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-023-0-23



Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	20.0’	25.0’	60/60	100%	31/60	52%
NQ2-4	25.0’	30.0’	60/60	100%	24/60	40%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-023-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-5	30.0’	35.0’	60/60	100%	36/60	60%
NQ2-6	35.0’	40.0’	60/60	100%	39/60	65%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-023-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-7	40.0’	45.0’	60/60	100%	54/60	90%
NQ2-8	45.0’	50.0’	60/60	100%	53/60	88%
ATH/MEG-US33-23.23/0.00, PID 119142						

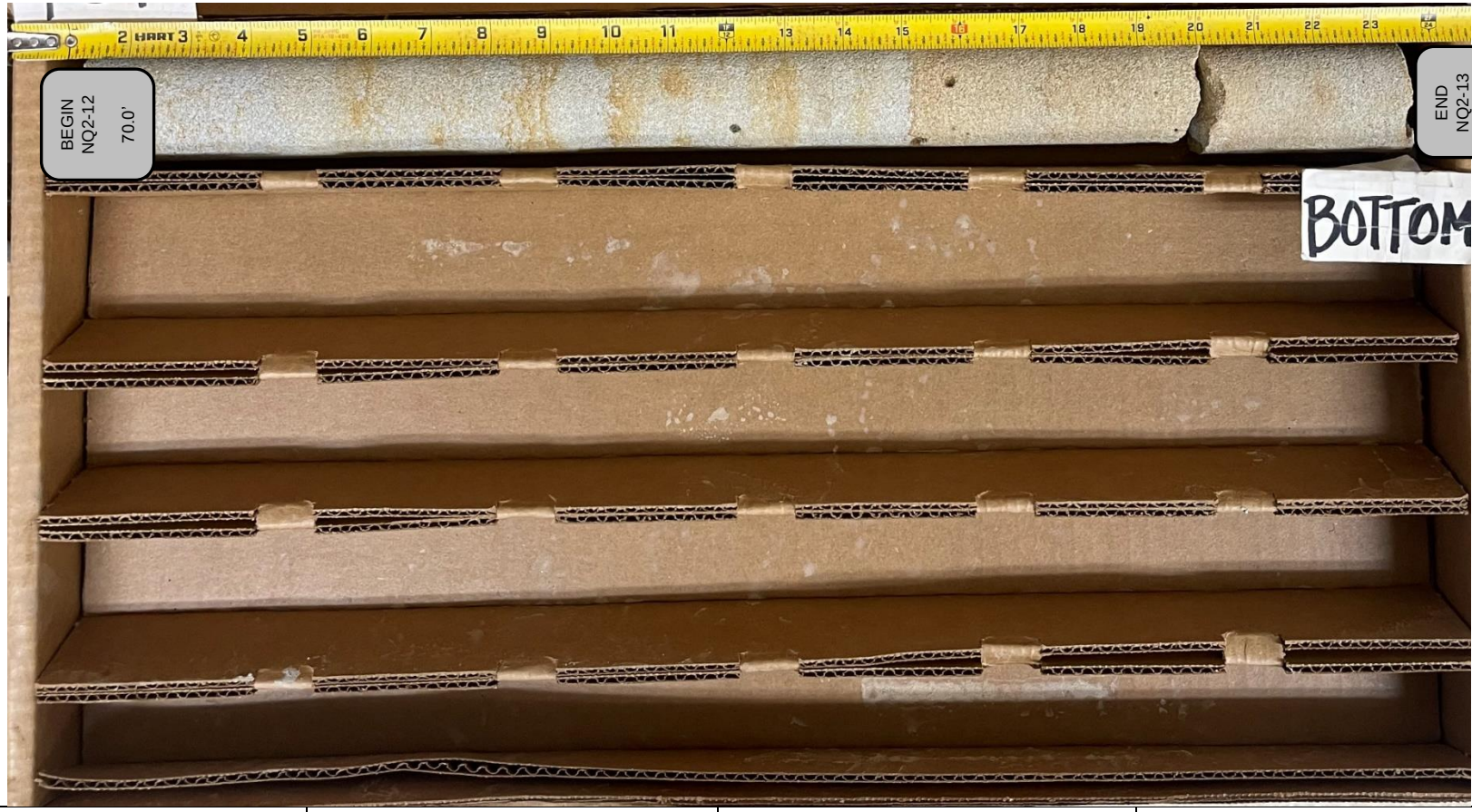
B-023-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-9	50.0’	55.0’	60/60	100%	60/60	100%
NQ2-10	55.0’	60.0’	60/60	100%	58/60	98%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-023-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-11	60.0’	65.0’	60/60	100%	60/60	100%
NQ2-12	65.0’	70.0’	60/60	100%	57/60	95%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-023-0-23



Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-13	70.0'	72.0'	24/24	100%	21/24	88%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-035-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	15.0'	20.0'	60/60	100%	35/60	58%
NQ2-2	20.0'	25.0'	60/60	100%	39/60	65%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-035-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	25.0’	30.0’	60/60	100%	33/60	55%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-036-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	20.0'	25.0'	60/60	100%	24/60	40%
NQ2-2	25.0'	30.0'	60/60	100%	32/60	53%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-036-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	30.0''	35.0'	60/60	100%	31/60	52%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-037-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	40.0’	45.0’	60/60	100%	48/60	80%
NQ2-2	45.0’	50.0’	60/60	100%	47/60	78%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-037-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	50.0’	55.0’	60/60	100%	45/60	75%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-038-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	40.0’	45.0’	60/60	100%	49/60	82%
NQ2-2	45.0’	50.0’	60/60	100%	46/60	77%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-038-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	50.0'	55.0'	60/60	100%	55/60	92%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-039-0-23

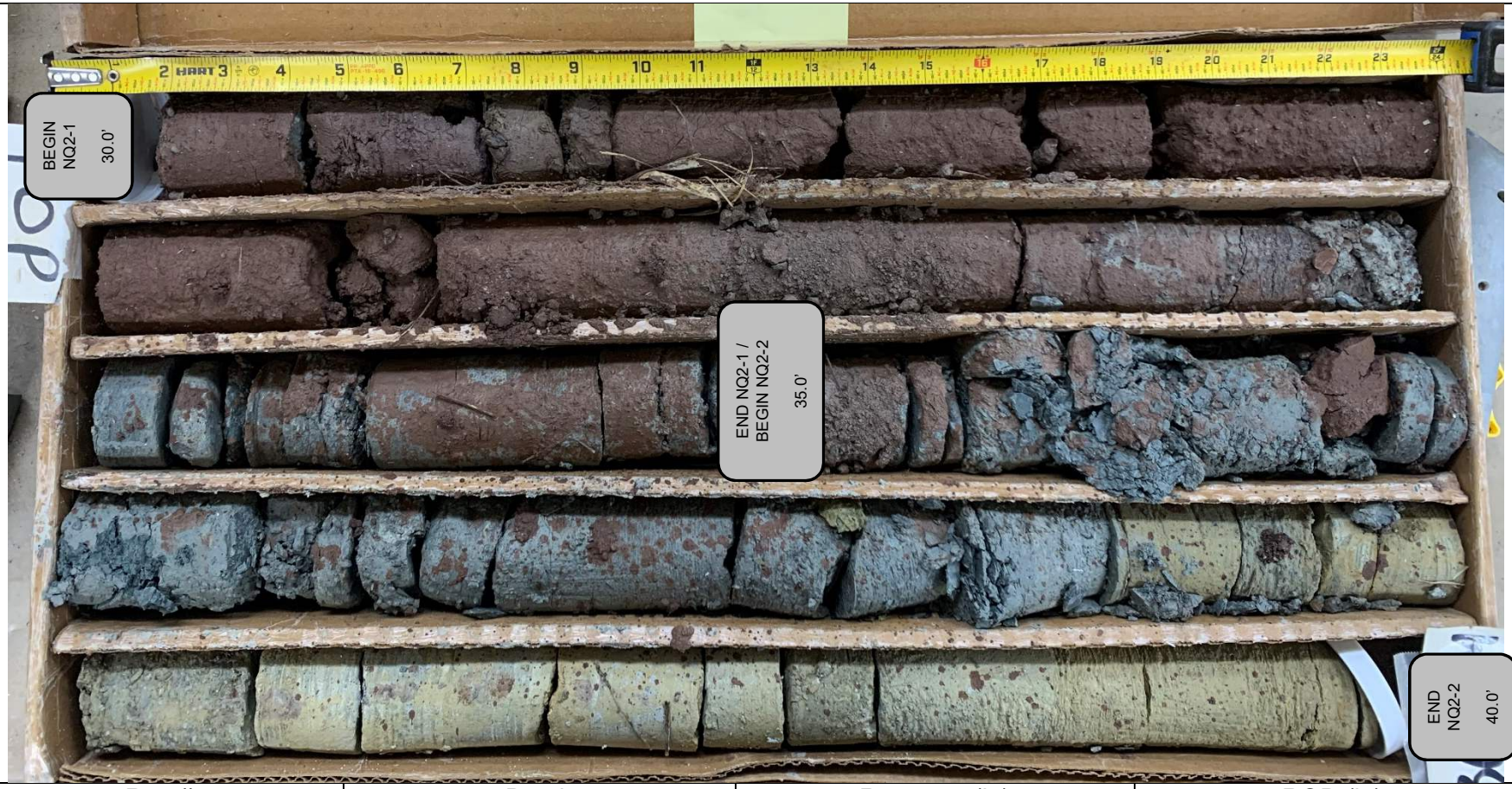
Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	40.0’	45.0’	60/60	100%	41/60	68%
NQ2-2	45.0’	50.0’	60/60	100%	46/60	77%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-039-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	50.0'	55.0'	60/60	100%	52/60	87%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-042-0-23



Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	30.0’	35.0’	60/60	100%	29/60	48%
NQ2-2	35.0’	40.0’	60/60	100%	8.5/60	14%
ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION						

B-042-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	40.0’	45.0’	60/60	100%	18/60	30%

ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION

B-044-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	15.0’	20.0’	60/60	100%	29/60	48%
NQ2-2	20.0’	25.0’	60/60	100%	22/60	37%
ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION						

B-044-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	25.0’	30.0’	60/60	100%	16/60	27%

ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION

B-045-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	10.0’	15.0’	60/60	100%	27/60	45%
NQ2-2	15.0’	20.0’	60/60	100%	23/60	38%
ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION						

GTL ENGINEERING INC.

B-045-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	20.0’	25.0’	60/60	100%	26/60	43%
ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION						

B-047-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	15.0’	20.0’	60/60	100%	13.5/60	23%
NQ2-2	125.0’	30.0’	60/60	100%	35/60	58%

ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION

B-047-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	25.0’	30.0’	60/60	100%	48/60	80%
ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION						

B-048-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	25.0’	30.0’	60/60	100%	25/60	42%
NQ2-2	30.0’	35.0’	60/60	100%	39/60	65%
ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION						

GTL ENGINEERING INC.

B-048-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	35.0’	40.0’	60/60	100%	41/60	68%

ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION

B-049-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	30.0’	35.0’	60/60	100%	21/60	35%
NQ2-2	35.0’	40.0’	60/60	100%	32/60	53%

ATH/MEG-US33-18.70/00.00 STRUCTURE FOUNDATION EXPLORATION

B-050-0A-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	15.0’	20.0’	60/60	100%	15/60	25%
NQ2-2	20.0’	25.0’	60/60	100%	25/60	42%
ATH/MEG-US33-23.23/0.00, PID 119142						

GTL ENGINEERING INC.

B-050A-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	25.0’	30.0’	60/60	100%	41/60	68%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-051-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	20.0’	25.0’	60/60	100%	0/60	0%
NQ2-2	25.0’	30.0’	60/60	100%	48/60	80%
ATH/MEG-US33-23.23/0.00, PID 119142						

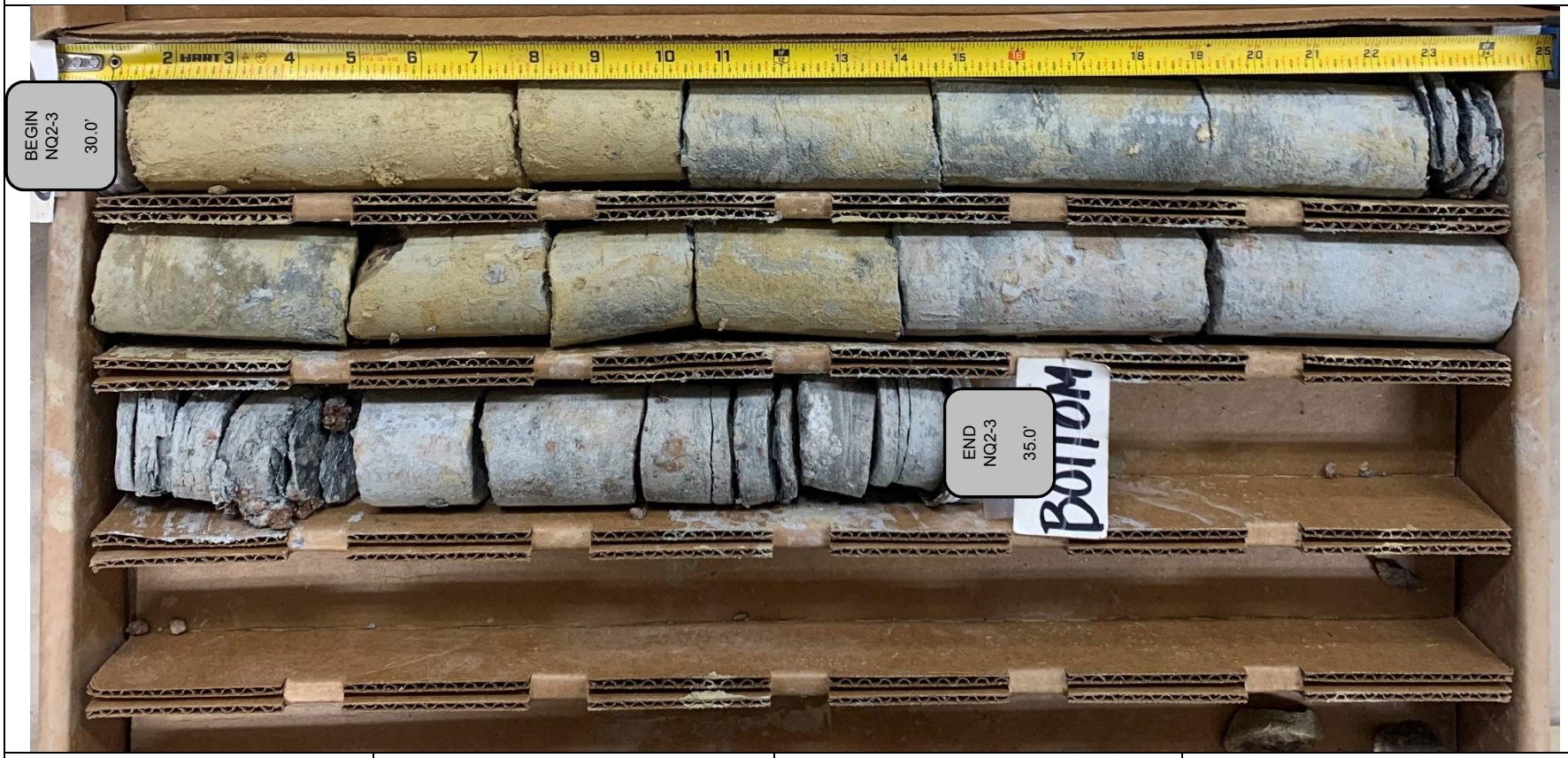
B-051-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	30.0’	35.0’	60/60	100%	39/60	65%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-052-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	20.0’	25.0’	60/60	100%	33/60	55%
NQ2-2	25.0’	30.0’	60/60	100%	28/60	47%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-052-0-23



Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-3	30.0’	35.0’	60/60	100%	29/60	48%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-058-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	10.0’	15.0’	60/60	100%	48/60	80%
NQ2-3	15.0’	20.0’	60/60	100%	60/60	100%
ATH/MEG-US33-23.23/0.00, PID 119142						

B-059-0-23

Run #:	Depth		Recovery (in)		RQD (in)	
NQ2-1	10.0’	15.0’	60/60	100%	43.8/60	73%
NQ2-3	15.0’	20.0’	60/60	100%	55.8/60	93%
ATH/MEG-US33-23.23/0.00, PID 119142						