DESIGN MEMORANDUM

TO: Mark Seger, P.E., District 6
COPY: Jeffrey Hipp, P.E., District 6 DGE
FROM: Dorothy A. Adams, P.E., Office of Geotechnical Engineering
DATE: August 28, 2023
SUBJECT: PID 115675, Bridge UNI-33-9.10 L&R, US 33 over Raymond Road, Design Memorandum

BRIDGE NO. UNI-33-9.10 L&R
US 33 OVER CR 191 RAYMOND ROAD

INTRODUCTION

It is understood that the existing twin 3-span structures will have the decks replaced and the existing spread footings at the abutments will be converted to integral abutments supported on driven piles. The purpose of this subsurface exploration was to evaluate the foundation soils at the abutments to see what length and size of pile foundations will be required under the anticipated new loading from the bridge rehabilitation and also to evaluate settlement and stability at the existing approach embankments.

GEOLOGY AND OBSERVATIONS OF THE PROJECT

The project is located within the Central Ohio Clayey Till Plain Physiographic region which is characterized by moderate relief with well-defined moraines and relatively flat ground moraines between. Intermorainal lake basins which contain silt, clay, or till are present in variable sizes. Granular soils are present beneath the cohesive soils found at the ground surface. The glacially deposited overburden soils are underlain by dolomite with minor amounts of shale from the Salina Group of Silurian Age. The contact with the Tymochtee Dolomite is immediately to the north.

The field reconnaissance was completed by personnel from the Office of Geotechnical Engineering (OGE) on January 30, 2023. The existing structures were noted as being in poor condition with patching and heavy spalling of the existing decks. Evidence of minor settlement at the rear abutment of WB 33 was noted during the structural inspection. The existing pavement was in fair condition with evidence of cracking and occasional sealing. The approach embankments were in good condition with no signs of instability with minor erosion along the pavement of US 33. The adjacent land usage was predominately wooded within the right-of-way along US 33 and along the west side of Raymond Road. In addition, there was a commercial property on the east side of Raymond Road north of US 33 and a church property on the east side of Raymond Road south of US 33.

EXPLORATION AND FINDINGS

Four (4) historic borings, B-1, B-8, B-9, and B-16, were drilled in 1963 for the existing structures. These borings were renamed B-001-2-63, B-008-0-63, B-009-0-63, and B-016-0-63 for the current exploration. The historic borings were drilled to depths between 35.5 and 55.0 feet. Refusal was encountered in all four borings and bedrock was cored in Boring B-008-0-63 between depths of 46.5 and 55.0 feet. The natural soils encountered consisted primarily of layers of cohesive soil (A-4a, A-6a, and A-6b). Some granular layers (A-1-a, A-1-b, A-2-4, and A-4a) were also encountered, particularly below depths of 12.0 feet.

No water levels were reported during the drilling of the historic borings.

Three (3) SPT borings, B-001-0-23, B-002-0-23 and B-004-0-23, were completed as part of the subsurface exploration between March 6 and March 16, 2023, with a truck mounted CME 55 rotary drill rig. In addition, three (3) CPT soundings, C-001-1-23, C-003-0-23, and C-003-1-23, were advanced on February 7, 2023, near the westbound rear abutment. Borings B-001-0-23 and B-002-0-23 were advanced though the existing pavement on US 33 near the westbound and eastbound rear abutments, respectively, to depths of 80.0 and 99.5 feet. Boring B-004-0-23 was advanced in the median of US 33 between the forward abutments to a depth of 74.5 feet. The borings were advanced with 3 ¼-inch I.D. hollow stem augers within the soil. Split-spoon (disturbed) samples were collected in accordance with the Standard Penetration Test (AASHTO T206) at continuous, 2.5-foot, and 5.0-foot intervals within the overburden soils. The hammer system used was calibrated on April 18, 2022, with a maximum drill rod energy ratio (ER) of 86.7%. Only Boring B-002-0-23 was advanced into bedrock and sampled (AASHTO T225) using an N series wireline core barrel, water method.

At the road surface, the borings encountered 17 to 18 inches of asphalt concrete. Boring B-004-0-23 encountered 6 inches of topsoil below the ground surface. Below the surface material, the embankment fill encountered in the borings consisted of very stiff to hard cohesive soils (A-6a and A-6b). The natural soils beneath the embankment consisted primarily of very stiff to hard cohesive soils (A-4a, A-6a, and A-6b), to either the top of rock or the completion depth of the borings. Layers of dense to very dense granular soils (A-1-a, A-1-b, and A-2-4) were also encountered, generally below depths of 43 to 53 feet. Cobbles were also encountered in Boring B-002-0-23 between depths of 18.5 and 20.0 feet (elevations 1005.4 and 1006.9) and also 43.5 and 45.0 feet (elevations 980.4 and 981.9). Ten feet of bedrock was cored in Boring B-002-0-23 and consisted of strong dolomite.

Water levels were first observed between depths of 43.5 and 53.5 feet (elevations 971.9 and 975.9) in the borings, where the granular layers were first encountered. The project and historic borings are attached.

The CPT soundings were advanced using a 15 square centimeter cone that had a sleeve area of 225 square centimeters and 1 ¾-inches diameter pushed with an A.P. van Den Berg unit mounted on a Hyson 23-ton crawler in accordance with ASTM D-5778, using probe serial numbers 201039, 090304 and 160701, which were calibrated on November 16, 2020, August 19, 2020, and January 29, 2019, respectively. The tip resistance (q_c), sleeve friction (f_s), and induced pore pressure (u_2) were measured at 2-centimeter intervals. Pore pressure dissipation tests were performed at selected soundings at depths within representative strata for water table depth estimation.

Sounding C-001-1-23, completed through the approach embankment, encountered low resistance material with tip resistance below 100 tsf and sleeve friction below 3 tsf to a depth of approximately 46 feet (elevation 977.9), where both tip resistance and sleeve friction increased. A dissipation test was completed at 49.75 feet but unable to be run long enough to obtain a static water level. Soundings C-003-0-23 and C-003-1-23 were completed at the base of the embankment below the westbound rear abutment north of US 33. C-003-0-23 encountered low tip resistance and sleeve friction in the upper soils and was terminated at a shallow depth due to encountering an obstruction. C-003-1 was offset from C-003-0-23 due to the shallow termination. This sounding encountered low tip resistance and sleeve friction to a depth of 16 feet before both tip resistance and sleeve friction increased, generally varying between 100 and 500 tsf for tip resistance and between 3 and 9 tsf for sleeve friction, terminating at a depth of approximately 34 feet. A dissipation test was completed in C-003-0-23 at approximately 19 feet (elevation 974.0), indicating artesian head pressure

in the lower sand layer. A static water elevation of 991.4 feet was estimated in the sounding. The CPT exploration report is attached.

ANALYSES AND RECOMMENDATIONS

The purpose of this subsurface exploration was two-fold: 1) to evaluate the foundation soils at the abutments to see what length and size of pile foundations will be required under the anticipated new loading from the bridge rehabilitation and 2) to evaluate settlement and stability at the existing approach embankments.

1) Pile Foundations

HP 10 x 42 pile foundations were evaluated for use at the abutments. The following table presents the assumptions made and the results of the pile analyses.

Substructure	Bottom of Pile Cap Elevation (ft)	Factored Axial Load (kips/pile)	Resistance Factor Applied	Design UBV (R_{ndr}, kips/pile)	Estimated Pile Length (ft)	Estimated Pile Tip Elev. (ft)
Rear Abutment	1014.0	145	0.7	207	45.0	971.5
Forward Abutment	1010.25	145	0.7	207	40.0	974.3

A wave equation driveability analysis was performed and confirmed that the piles will not be overstressed during driving.

Orient the H-piles so the webs are parallel to the centerline of bearing, in accordance with BDM 2020 Section 306.2.2.5. Due to the boulders encountered in the borings, it is recommended that steel pile points be used.

2) Embankment Settlement and Stability

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

No assessment of the settlement was performed, either. The minor settlement observed at the rear abutment was not observed at any other part of the structure. In addition, no change to the external loads from the bridge are anticipated.

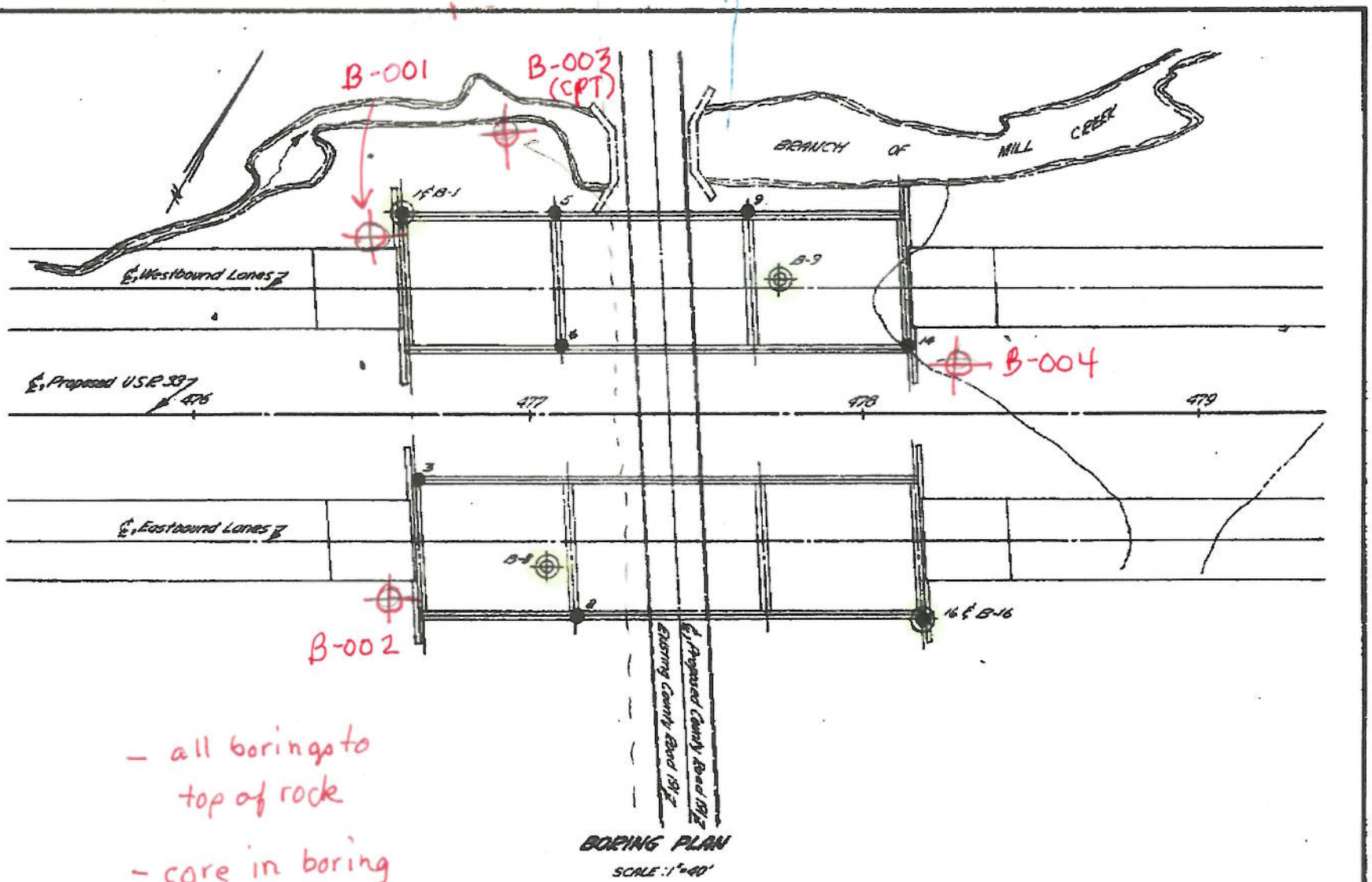
CLOSING REMARKS

If you have any questions regarding these recommendations, or if any changes are made to the design assumptions, please contact me at (614) 275-1356 or Alex Dettloff at (614) 275-1308.

Thank you,

DAA

pc: Reading File, File
Attachments: Boring Location Plan, Boring Logs, CPT Exploration Report



Sheet 4 of 23 Sheets

PROJECT: UNI-33-9.12	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET:
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: ODOT / MCLEISH	HAMMER: CME AUTOMATIC	ALIGNMENT: CL US33
PID: 115675 SFN: 8000905	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 4/18/22	ELEVATION: 1025.4 (MSL) EOB: 80.0 ft.
START: 3/8/23 END: 3/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 40.246720, -83.394310

EXPLORATION ID B-001-0-23

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
ASPHALT (18")	1025.4																	
	1023.9																	
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, DAMP @1.5' - 3.0'; NOT ENOUGH MATERIAL TO TEST			4 5 4	13	17	SS-1	2.75	-	-	-	-	-	-	-	-	13	A-6b (V)	
@3.5'; STIFF, MOIST			2 4 4	12	44	SS-2	2.00	5	3	8	29	55	36	19	17	22	A-6b (11)	
@6.0'; VERY STIFF, DAMP			5 6 7	19	100	SS-3	3.50	-	-	-	-	-	-	-	-	16	A-6b (V)	
			3 6 7	19	100	SS-4	3.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
	1014.4																	
VERY STIFF, BROWN AND GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, DAMP			2 4 7	16	100	SS-5	3.00	5	4	8	32	51	33	21	12	21	A-6a (9)	
			3 5 6	16	100	SS-6	2.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
			4 7 10	25	100	SS-7	4.00	-	-	-	-	-	-	-	-	19	A-6a (V)	
@18.5'; HARD			5 7 7	20	100	SS-8	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
@21.0'; VERY STIFF			3 5 5	14	89	SS-9	3.50	3	4	8	36	49	30	19	11	18	A-6a (8)	
@23.5'; HARD			3 7 8	22	78	SS-10	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
@26.0'; VERY STIFF			5 7 7	20	100	SS-11	3.50	-	-	-	-	-	-	-	-	19	A-6a (V)	
			3 6 8	20	83	SS-12	2.50	-	-	-	-	-	-	-	-	19	A-6a (V)	
			3 5 7	17	89	SS-13	3.50	6	3	7	32	52	32	19	13	19	A-6a (9)	
			5 7 10	25	67	SS-14	3.00	-	-	-	-	-	-	-	-	18	A-6a (V)	
		▽ 983.4																
@43.5'; GRAY, SOME SAND, MOIST			1 4 6	14	83	SS-15	2.50	4	3	20	32	41	34	19	15	22	A-6a (10)	
@48.5'; HARD, DAMP			11 18 18	52	100	SS-16	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
	971.9	W 971.9																
VERY DENSE, GRAY, **STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, WET			16 19 26	65	78	SS-17	-	63	13	7	11	6	19	15	4	10	A-1-b (0)	
	966.9																	
HARD, GRAY, **SANDY SILT**, SOME STONE FRAGMENTS, LITTLE CLAY, MOIST			18 24 24	69	78	SS-18	4.50	30	14	13	30	13	17	13	4	9	A-4a (2)	

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 4/27/23 10:36 - X:\GINT\PROJECTS\601043.GPJ

PID: 115675	SFN: 8000905	PROJECT: UNI-33-9.12	STATION / OFFSET:	START: 3/8/23	END: 3/13/23	PG 2 OF 2	B-001-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 965.4	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, GRAY, **SANDY SILT**, SOME STONE FRAGMENTS, LITTLE CLAY, MOIST *(continued)*		61																
		62																
		63																
@63.5'; VERY STIFF		64	32 41 38	114	28	SS-19	2.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
		65																
		66																
		67																
		68																
@68.5'; HARD, REDDISH BROWN, DAMP		69	38 46 62	156	100	SS-20	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		70																
		71																
		72																
		73																
		74	17 37 42	114	100	SS-21	4.50	24	9	17	32	18	22	13	9	9	A-4a (3)	
		75																
		76																
		77																
		78																
		79	10 33 59	133	100	SS-22	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
	945.4	EOB 80																

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 2 BAGS BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 4/27/23 10:37 - X:\GINT\PROJECTS\601043.GPJ

PROJECT: UNI-33-9.12	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET:	EXPLORATION ID B-002-0-23
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: ODOT / MCLEISH	HAMMER: CME AUTOMATIC	ALIGNMENT: CL US33	
PID: 115675 SFN: 8000905	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 4/18/22	ELEVATION: 1025.4 (MSL) EOB: 99.5 ft.	PAGE 1 OF 2
START: 3/6/23 END: 3/7/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 40.246480, -83.394140	

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 (17")	1025.4																	
	1024.0																	
VERY STIFF, MOTTLED BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL AND STONE FRAGMENTS, DAMP		1																
		2	5 4 5	13	44	SS-1	3.00	10	7	8	30	45	33	17	16	15	A-6b (10)	
		3																
@3.5'; MOIST		4	2 3 4	10	56	SS-2	2.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
		5																
		6	3 3 4	10	89	SS-3	3.00	-	-	-	-	-	-	-	-	19	A-6b (V)	
		7																
		8																
		9	2 3 4	10	67	SS-4	2.50	5	4	8	31	52	38	18	20	22	A-6b (12)	
		10																
		11																
		12	3 4 5	13	56	SS-5	2.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
		13																
		14	3 3 4	10	89	SS-6	3.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
		15																
		16																
		17	4 5 7	17	100	SS-7	3.50	-	-	-	-	-	-	-	-	20	A-6b (V)	
		18																
@18.5' - 20.0'; ENCOUNTERED BOULDERS/COBBLES		19	8 8 10	26	11	SS-8	3.00	-	-	-	-	-	-	-	-	17	A-6b (V)	
		20																
		21																
		22	4 6 9	22	100	SS-9	3.50	9	4	8	32	47	34	17	17	17	A-6b (11)	
		23																
@23.5'; DAMP		24	5 9 12	30	100	SS-10	3.50	-	-	-	-	-	-	-	-	16	A-6b (V)	
		25																
		26																
		27	6 6 8	20	100	SS-11	4.00	-	-	-	-	-	-	-	-	17	A-6b (V)	
		28																
@28.5'; HARD, BROWN, TRACE SAND		29	8 9 11	29	100	SS-12	4.50	3	2	5	34	56	37	19	18	18	A-6b (11)	
		30																
		31																
		32																
		33																
		34	5 7 11	26	100	SS-13	3.50	-	-	-	-	-	-	-	-	20	A-6b (V)	
		35																
		36																
		37																
		38																
@38.5'; LITTLE SAND		39	7 8 11	27	100	SS-14	4.50	4	3	8	32	53	36	19	17	18	A-6b (11)	
		40																
		41																
		42																
		43																
@43.5' - 45.0'; ENCOUNTERED BOULDERS/COBBLES		44	10 17 15	46	17	SS-15	3.00	-	-	-	-	-	-	-	-	9	A-6b (V)	
		45																
		46																
		47																
		48																
	976.9																	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, LITTLE STONE FRAGMENTS, DAMP		49	10 12 18	43	100	SS-16	4.50	11	7	9	35	38	28	16	12	11	A-6a (8)	
		50																
		51																
		52																
		53																
	971.9																	
DENSE, GRAY, **GRAVEL AND STONE FRAGMENTS**, "AND" SAND, TRACE SILT, TRACE CLAY, WET		54	4 14 20	49	100	SS-17	-	53	27	9	8	3	17	13	4	11	A-1-a (0)	
		55																
		56																
		57																
		58																
	966.9																	
VERY DENSE, GRAY, **STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP		59	37 35 26	88	100	SS-18	-	45	13	8	25	9	NP	NP	NP	9	A-2-4 (0)	

W 971.9

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 4/27/23 10:37 - X:\GINT\PROJECTS\601043.GPJ

PID: 115675	SFN: 8000905	PROJECT: UNI-33-9.12	STATION / OFFSET:	START: 3/6/23	END: 3/7/23	PG 2 OF 2	B-002-0-23

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
VERY DENSE, GRAY, **STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP *(continued)*	965.4	61 62 63																
	961.9																	
HARD, GRAY, **SANDY SILT**, SOME GRAVEL AND STONE FRAGMENTS, SOME CLAY, DAMP		64 65 66 67 68	30 40 36	110	100	SS-19	4.5+	23	11	14	31	21	22	13	9	8	A-4a (3)	
@68.5'; BROWN		69 70 71 72 73	17 38 61	143	100	SS-20	4.5+	-	-	-	-	-	-	-	-	8	A-4a (V)	
		74 75 76 77 78	20 31 34	94	100	SS-21	4.5+	25	10	14	31	20	22	13	9	12	A-4a (3)	
		79 80 81 82 83	24 60	-	100	SS-22	4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	
		84 85 86 87 88 89	25 50	-	100	SS-23	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)	
@89.5'; AUGER REFUSAL	935.9	TR																
DOLOMITE, GRAY, MODERATELY WEATHERED, STRONG, VERY THIN TO THIN BEDDED, VUGGY, SLIGHTLY CRYSTALLINE, JOINT, MODERATELY FRACTURED, SLIGHTLY ROUGH, NARROW; RQD 28%, REC 100%.		90 91 92 93 94	25		100	NQ2-1											CORE	
@92.7' - 93.1'; VERTICAL FRACTURE																		
@94.5'; SLIGHTLY VUGGY, SLIGHTLY ARGILLACEOUS.		95 96 97 98 99	30		100	NQ2-2											CORE	
@97.0'; YELLOWISH BROWN.																		
@98.1'; LIGHT OLIVE BROWN.	925.9	EOB																

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 70 GAL. BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 4/27/23 10:37 - X:\GINT\PROJECTS\601043.GPJ

PROJECT: UNI-33-9.12	DRILLING FIRM / OPERATOR: ODOT / CAREY	DRILL RIG: CME 55 TRUCK	STATION / OFFSET:	EXPLORATION ID B-004-0-23	
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: ODOT / MCLEISH	HAMMER: CME AUTOMATIC	ALIGNMENT: CL US33		
PID: 115675 SFN: 8000905	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 4/18/22	ELEVATION: 1019.4 (MSL) EOB: 74.5 ft.	PAGE 1 OF 2	
START: 3/13/23 END: 3/16/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 87	LAT / LONG: 40.246830, -83.393730		

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")	1019.4																	
VERY STIFF, BROWN AND GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE STONE FRAGMENTS, DAMP	1018.9		6 6 6	17	78	SS-1	4.00	6	4	9	31	50	32	20	12	17	A-6a (9)	
@3.5'; STIFF			3 3 5	12	83	SS-2	2.00	-	-	-	-	-	-	-	-	20	A-6a (V)	
@6.0'; VERY STIFF			3 5 7	17	89	SS-3	3.00	-	-	-	-	-	-	-	-	18	A-6a (V)	
			2 4 5	13	100	SS-4	2.50	-	-	-	-	-	-	-	-	19	A-6a (V)	
			3 5 9	20	100	SS-5	3.50	6	4	9	32	49	32	19	13	17	A-6a (9)	
			3 4 5	13	89	SS-6	2.50	-	-	-	-	-	-	-	-	19	A-6a (V)	
			3 6 8	20	100	SS-7	4.00	-	-	-	-	-	-	-	-	16	A-6a (V)	
			5 7 9	23	100	SS-8	4.50	-	-	-	-	-	-	-	-	18	A-6a (V)	
			4 6 8	20	100	SS-9	4.00	5	4	8	30	53	33	19	14	17	A-6a (10)	
@23.5' - 25.0'; POOR RECOVERY, RESAMPLED WITH A 3" SPLITSPOON			6 10 12	32	56	SS-10	4.00	-	-	-	-	-	-	-	-	16	A-6a (V)	
			3 6 7	19	100	SS-11	3.00	-	-	-	-	-	-	-	-	20	A-6a (V)	
	990.9																	
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, TRACE SAND, TRACE STONE FRAGMENTS, DAMP			3 5 7	17	100	SS-12	3.00	3	3	5	33	56	36	20	16	19	A-6b (10)	
			3 5 6	16	28	SS-13	2.50	-	-	-	-	-	-	-	-	17	A-6b (V)	
	980.9																	
VERY STIFF, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, MOIST			2 5 7	17	56	SS-14	2.50	7	16	35	21	21	24	17	7	21	A-4a (1)	
	975.9	W 975.9																
VERY DENSE, GRAY, **STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, WET			45 37 26	91	78	SS-15	-	45	12	17	18	8	16	14	2	13	A-2-4 (0)	
			8 24 22	66	78	SS-16	-	46	14	14	20	6	15	13	2	8	A-2-4 (0)	
	965.9																	
HARD, GRAY, **SANDY SILT**, SOME STONE FRAGMENTS, LITTLE CLAY, DAMP			8 20 35	79	83	SS-17	4.5+	30	16	14	28	12	17	13	4	9	A-4a (1)	
			19 30 46	110	100	SS-18	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)	

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 4/27/23 10:38 - X:\GINT\PROJECTS\601043.GPJ

PID: 115675	SFN: 8000905	PROJECT: UNI-33-9.12	STATION / OFFSET:	START: 3/13/23	END: 3/16/23	PG 2 OF 2	B-004-0-23

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
HARD, GRAY, **SANDY SILT**, SOME STONE FRAGMENTS, LITTLE CLAY, DAMP *(continued)*	959.4	▽ 958.4																
		61																
		62																
		63																
		64	26 27 45	104	100	SS-19	4.5+	21	10	16	35	18	21	14	7	9	A-4a (4)	
		65																
		66																
		67																
		68																
		69	32 36 46	118	100	SS-20	4.5+	-	-	-	-	-	-	-	-	10	A-4a (V)	
		70																
		71																
		72																
		73																
	944.9	74 EOB	46 78	-	100	SS-21	4.5+	-	-	-	-	-	-	-	-	9	A-4a (V)	

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

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 2 BAGS BENTONITE GROUT

STANDARD ODOT SOIL BORING LOG (11 X 17) - OH DOT.GDT - 4/27/23 10:38 - X:\GINT\PROJECTS\601043.GPJ

B-001-2-63
GSE = 985.4 ft NAVD 88

State of Ohio
Department of Highways
Testing Laboratory

LOG OF BORING

Date Started 1-31-63 Sampler: Type SS Dia. 1 3/8" Water Elev. ____
Date Completed 2-1-63 Casing: Length 20' Dia. 3 1/2"

Project Identification: UNION
INT-33-9.58
INT-33- L
OVER COUNTY ROAD 191

Boring No. B-1 Station & Offset 476+61, 60' Lt. (REAR ABUTMENT) Surface Elev. 986.0

Elev	Depth	Std. Pen. (N)	Description	Field No.	Lab. Nos. So	Physical Characteristics % Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTD Class.
986.0	0													
	2													
983.5	4	2/2	Brown and Gray Sandy Clay	1	3454	0	2	35	13	50	31	12	23	
981.0	6	12/16	Brown Gravelly Silt	2	3455	28	5	7	19	41	26	10	30	
978.5	8	16/19	Gray Gravelly Silt	3	3456	23	5	6	22	44	27	8	14	
976.0	10													
	12	21/29	Gray Sandy Gravelly Silt	4	3457	35	6	9	18	32	22	7	13	
973.5	14	23/36	Gray Silty Gravel	5	3458	V	I	S	U	A	L		14	
971.0	16	33/30	Gray Sandy Gravel	6	3459	V	I	S	U	A	L		12	
968.5	18		No Sample Recovered (Hole Caved)											
966.0	20	36/28	Gray Gravelly Silt	7	3460	26	4	6	35	29	NP	NP	12	
	22													
	24													
961.0	26	28/35	Brown Sandy Gravelly Silt	8	3461	33	6	12	19	30	23	9	10	
	28													
956.0	30	59/*	Brown Sandy Gravelly Silt	9	3462	32	8	16	17	27	23	10	10	
	32													
	34													
951.0	36	49/*	Brown Silty Sandy Gravel	10	3463	48	6	10	14	22	24	9	11	

Particle Sizes: Agg. = >2.00mm, Coarse Sand = 2.00 - 0.42mm, Fine Sand = 0.42 - 0.074mm, Silt = 0.074 - 0.005mm, Clay = < 0.005mm

*BEDROCK

Boring No. B-1 Station & Offset 476+61, 60' lt. Surface Elev. 986.0 Project: UNI-33- L

Elev.	Depth	Std. Pen. (N)	Description	Field No.	Lab. Nos. So.	Physical Characteristics % Agg.	% C.S.	% F.S.	% Slt	% Clay	L.L.	P.I.	W.C.	SHTD. Class.
	38													
946.0 945.5	40	76/+	Brown Silty Sandy Gravel	11	3464	42	7	13	15	23	20	5	9	
			BOTTOM OF BORING											
	42													
	44		*REFUSAL											
	46													
	48													
	50													
	52													
	54													
	56													
	58													
	60													
	62													
	64													
	66													
	68													
	70													
	72													
	74													
	76													
	78													
	80													

B-008-0-63
GSE = 986.1 ft NAVD 88

State of Ohio
Department of Highways
Testing Laboratory

LOG OF BORING

Date Started 2-4-63 Sampler: Type SS Dia. 1 3/8" Water Elev. ____
Date Completed 2-5-63 Casing: Length 20' Dia. 3 1/2"

Project Identification: UNION
UNI-33-8.58
UNI-33- R
OVER COUNTY ROAD 191

Boring No. B-8 Station & Offset 477+05, 45' Rt. (REAR PIER) Surface Elev. 986.7

Elev	Depth	Std. Pen. (N)	Description	Field No.	Lab. Nos.	Physical Characteristics % Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTL Class
986.7	0													
	2													
984.2		2/4	Brown Clayey Gravel	1	4716	46	5	9	11	29	PL	22	25	
	4													
981.7														
	6	7/13	Brown Gravelly Silt	2	4717			V	I	S	U	A	L	12
979.2														
	8	13/15	Gray Gravelly Clay	3	4718	45	5	5	15	30	30	15	16	
976.7	10													
		8/20	Gray Sandy Gravelly Silt	4	4719	29	8	11	25	27	23	8	16	
	12													
974.2														
	14	23/21	Brown Sandy Gravel	5				V	I	S	U	A	L	
971.7														
	16	33/30	Gray Sandy Gravel	6	4720	68	15	8	4	5	NP	NP	8	
969.2														
	18		No Sample Recovered (Hole Caved)											
966.7	20													
		38/* (0.5')	Gray Gravelly Clay	7	4721	28	4	7	26	35	22	11	16	
	22													
	24													
961.7														
	26	31/43	Gray Sandy Gravelly Clay	8	4722	27	7	16	17	33	26	11	13	
	28													
956.7	30													
		73/* (0.5')	Gray Sandy Gravelly Silt	9	4723			V	I	S	U	A	L	8
	32													
	34													
951.7														
	36	42/70	Brown Sandy Gravelly Clay	10	4724	38	7	13	16	26	23	28	10	

Particle Sizes: Agg. = >2.00mm, Coarse Sand = 2.00 - 0.42mm, Fine Sand = 0.42 - 0.074mm, Silt = 0.074 - 0.005mm, Clay = < 0.005mm

* Refusal

Boring No. B-8 Station & Offset 477+05, 45' Rt. Surface Elev. 986.7 Project: INT-33- R

Elev.	Depth	Std. Pen. (N)	Rec. ft.	Loss ft.	Description	Field No.	Lab. Nos. So.	Physical Characteristics % Agg.	% G.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	$HTL Costs
946.7	40	68/* (0.5)			Brown Sandy Gravelly Silt	11	4725	32	7	17	19	25	21	5	11	
941.7	45				Gray Gravel (Driller's Description)											
939.7	48		2.8	0.7	TOP OF ROCK											
	50															
	52		5.0	0.0	Dolomite, gray, hard, dense, few shale partings, broken, becomes argillaceous below 51.0'. Core loss 2%.											
931.7	54															
	56				BOTTOM OF BORING											
	58				* Refusal											
	60															
	62															
	64															
	66															
	68															
	70															
	72															
	74															
	76															
	78															
	80															

B-009-0-63
GSE = 984.5 ft NAVD 88

State of Ohio
Department of Highways
Testing Laboratory

LOG OF BORING

Date Started 2-5-63 Sampler: Type SS Dia. 1 3/8" Water Elev. ____
Date Completed 2-6-63 Casing: Length 30' Dia. 3 1/2"

Project Identification: UNION
UNI-33-8.58
UNI-33- L
OVER COUNTY ROAD 191

Boring No. B-9 Station\|Offset 477+75, 40' Lt. (FORWARD PIER) Surface Elev. 985.1

Elev.	Depth	Std. Pen. (N)	Description	Field No.	Lab. Nos.,So.	Physical Characteristics % Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTL Class
985.1	0													
	2													
982.6	4	2/3	Brown Sandy Silt	1	4736	0	2	23	34	41	31	5	27	
980.1	6	4/9	Brown & Gray Gravelly Clay	2	4737	31	3	8	24	34	33	13	18	
977.6	8	12/19	Gray Gravelly Clay	3	4738	40	4	5	18	33	30	13	13	
975.1	10	18/20	Gray Silty Sandy Gravel	4	4739			V	I	S	U	A	L	26
972.6	12													
	14	15/36	Gray Silty Gravel	5	4740	65	1	2	21	11	NP	NP	18	
970.1	16	50/37	Gray Gravel	6				V	I	S	U	A	L	
967.6	18	21/45	Gray Gravelly Silt	7	4741	36	3	5	24	32	21	9	11	
965.1	20	34/32	Gray Silty Gravel	8	4742	54	6	7	18	15	20	7	10	
	22													
	24													
961.1	26	40/47	Brown Silty Gravel	9	4743	54	4	10	15	17	21	8	9	
	28													
956.1 955.6	30	52/*	Brown Silty Gravel	10	4744	60	5	9	15	11	20	5	9	
	32		BOTTOM OF BORING											
	34		* Refusal											
	36													

Particle Sizes Agg = >2.00mm, Coarse Sand = 2.00 - 0.42mm, Fine Sand = 042 - 0.074mm, Silt = 0.074 - 0.005mm, Clay = < 0.005mm

B-016-0-63
GSE = 988.4 ft NAVD 88

State of Ohio
Department of Highways
Testing Laboratory

LOG OF BORING

Date Started 2-7-63 Sampler: Type SS Dia. 1 3/8" Water Elev. ____
Date Completed 2-7-63 Casing: Length 20' Dia. 3 1/2"

Project Identification: UNION
UNI-33-8.58
UNI-33- R
OVER COUNTY ROAD 191

Boring No. B-16 Station & Offset 478+18, 60' Rt. (FORWARD ABUTMENT) Surface Elev. 989.0

Elev	Depth	Std. Pen. (N)	Description	Field No.	Lab. Nos. So.	Physical Characteristics % Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	Pl.	W.C.	SHTE Class
989.0	0													
	2													
986.5	4	9/13	Brown Sandy Gravelly Clay	1	4726	25	7	10	16	42	35	17	14	
984.0	6	3/3	Brown & Gray Sandy Clay	2	4727	8	12	36	4	40	34	17	25	
981.5	8	12/11	Brown Clayey Silt (Driller's Descreption) No Sample Recovered											
979.0	10	15/15	Gray Gravelly Clay	3	4728	35	6	7	14	38	PL=	15	14	
976.5	12	28/25	Gray Silty Sandy Gravel	4	4729	54	6	20	6	14	NP	NP	13	
974.0	14	20/16	Gray Sandy Gravel	5				V	I	S	U	A	L	
971.5	16	58* (0.4')	Gray Gravel (Driller's Description) No Sample Recovered											
969.0	18	34/40	Gray Silty Sandy Gravel	6	4730	41	10	11	22	16	NP	NP	11	
	20													
	22													
964.0	24	24/51	Gray Sandy Gravelly Silt	7	4731	32	8	11	21	28	NP	NP	10	
	26													
959.0	28	50/* (0.5')	Brown & Gray Sandy Gravelly Silt	8	4732	29	6	12	30	23	NP	NP	10	
	30													
	32													
954.0	34	41/10* (0.1')	Brown Silty Sandy Gravel	9	4733	42	6	12	18	22	PL=	15	9	
	36													

Particle Sizes: Agg.= >2.00mm, Coarse Sand=2.00 - 0.42mm, Fine Sand=0.42-0.074mm, Silt=0.074-0.005mm, Clay= <0.005mm
* Refusal

Boring No. B-16 Station & Offset 478+18, 60' Rt. Surface Elev. 989.0 Project: UNI-33- R

Elev.	Depth	Std. Pen. (N)	Description	Field No.	Lab. Nos.	Physical Characteristics % Agg.	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	SHTL. Class.
	38													
949.0	40													
	42	59/* (0.5)	Brown Silty Sandy Gravel	10	4734	46	6	12	16	20	NP	NP	11	
	44													
944.0		53/*												
943.5	46	(0.5)	Brown & Gray Silty Sandy Gravel	11	4745	41	6	13	21	19	21	6	10	
			BOTTOM OF BORING											
	48		* Refusal											
	50													
	52													
	54													
	56													
	58													
	60													
	62													
	64													
	66													
	68													
	70													
	72													
	74													
	76													
	78													
	80													

CONE PENETRATION TEST SOUNDINGS REPORT

Office of Geotechnical Engineering
Division of Engineering

Project: UNI-33-9.12

PID: 115675

Date: April 19, 2023

Number of Soundings: 3

Equipment: A.P. van den Berg, 23 Ton Crawler, Hyson 200kN

Sounding ID	Completion Date	Probe SN	Calibration Date	Elevation	Latitude	Longitude	Surface Material	Depth (ft.)
C-001-1-23	2/7/2023	201039	11/16/2020	1023.9	40.246716	-83.394341	Asphalt (11.5")	49.75
C-003-0-23	2/7/2023	090304	8/19/2020	993.0	40.246928	-83.3944	Off Road	18.94
C-003-1-23	2/7/2023	160701	1/29/2019	993.1	40.246925	-83.394409	Off Road	33.75

Project Information

Sounding C-001-1-23 was completed within the road through a pre-cored hole. All other soundings were completed off road. The static water level was not reported for sounding C-001-1-23 due to the dissipation test not reaching t_{50}. The static water levels for C-003-0-23 and C-003-1-23 were determined by pore pressure response from a dissipation test and observed water levels. The soundings were terminated due to excessive tip resistance. The latitude, longitude, and elevation values are from a Trimble Geo7x GPS with an external Trimble Tornado antenna connected to the ODOT VRS network. The elevation value for C-001-1-23 is from the USGS 3DEP map service.

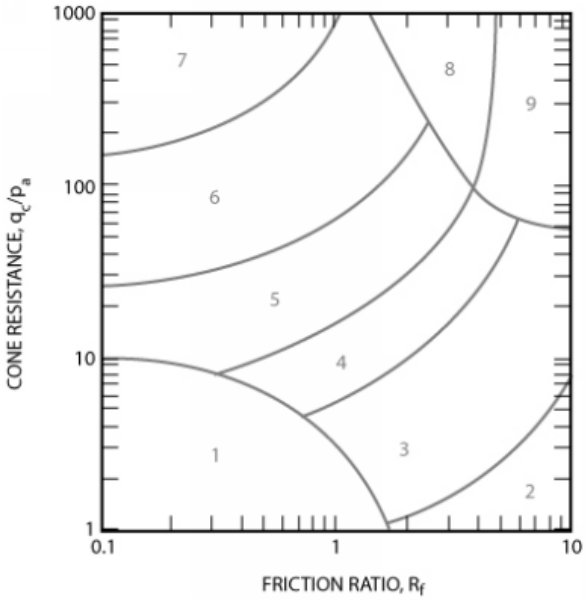
The raw CPT data is available upon request. The included CPT logs are for informational purposes only. The CPT logs have been filtered for negative values, corrected for inclination at depth, and filtered for data spikes. Additionally, for each sounding, the measured values of q_c and f_s were shifted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

Cone Penetration Test Data and Interpretation

These Cone Penetration Test (CPT) Soundings follow ASTM D 5778 and were made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since subsurface conditions outside each CPT sounding are unknown, and soil, rock, and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this sounding will necessarily be the same as or similar to those shown in this report.

The CPT data collected are presented as graphical plots in the report, generated by CPeT-IT software. The plots include interpreted Soil Behavior Type (SBT) based on the method described by Robertson (2010). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed.

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



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

** Heavily overconsolidated or cemented*

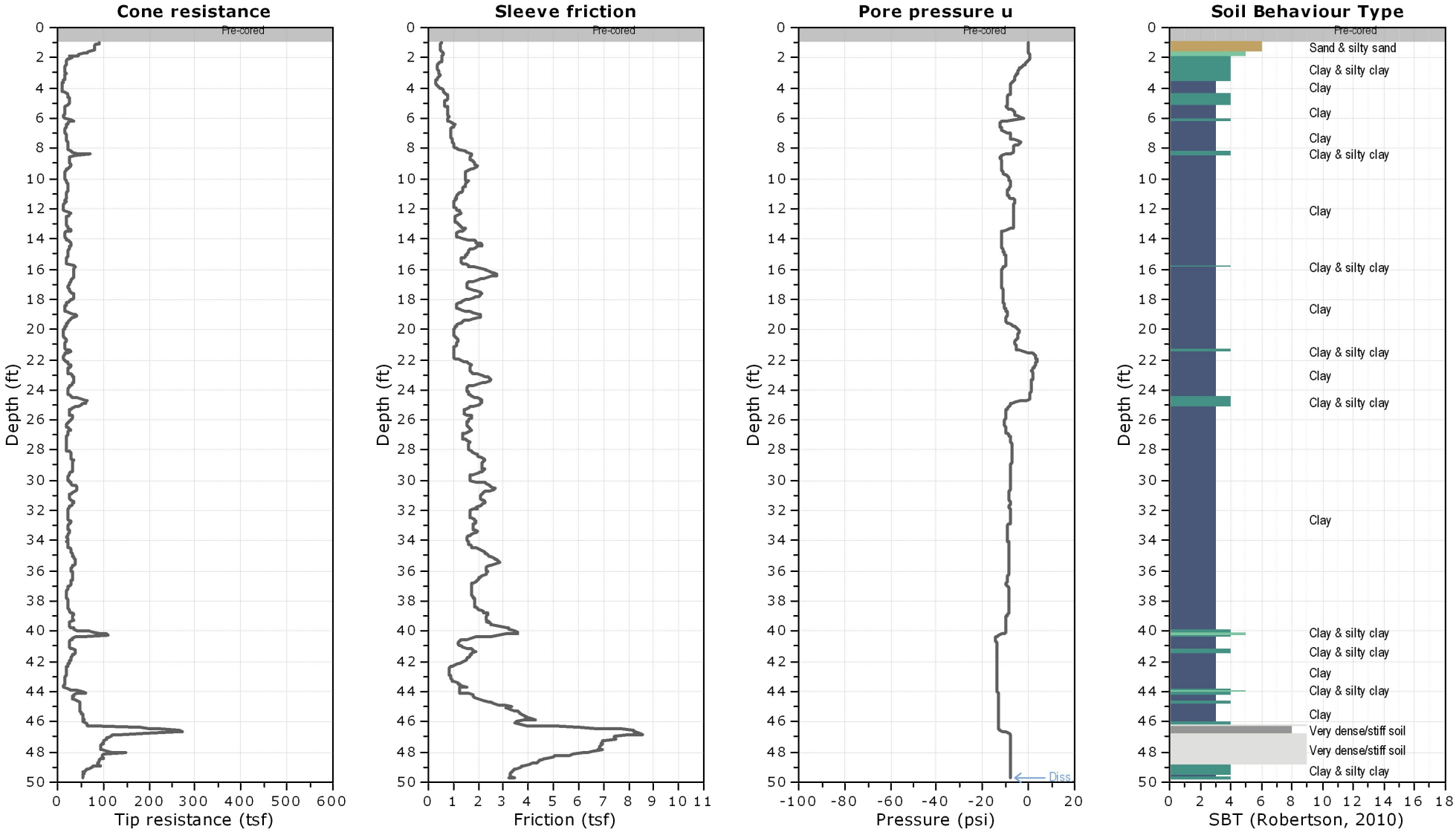
Non-normalized CPT Soil Behavior Type (SBT) chart

Robertson, P.K. and Cabal, K.L, 2016. *Guide to Cone Penetration Testing for Geotechnical Engineering, 6th Edition*. Signal Hill, California: 34.
http://www.greggdrilling.com/wp-content/uploads/2017/07/CPT-Guide-6th-Edition-2016.pdf
Accessed May 21, 2019.

Office of Geotechnical Engineering
Geology, Exploration and, Laboratory Section
http://www.dot.state.oh.us/Divisions/Engineering/Geotechnical

CPT: C-001-1-23
Total depth: 49.75 ft, Date: 2/7/2023
Surface Elevation: 1023.9 ft
Coords: lat 40.246716° lon -83.394341°

Project: UNI-33-9.12
Location: Union County



Dissipation Tests Results

Dissipation tests

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

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

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

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

where:

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

Permeability estimates based on dissipation test

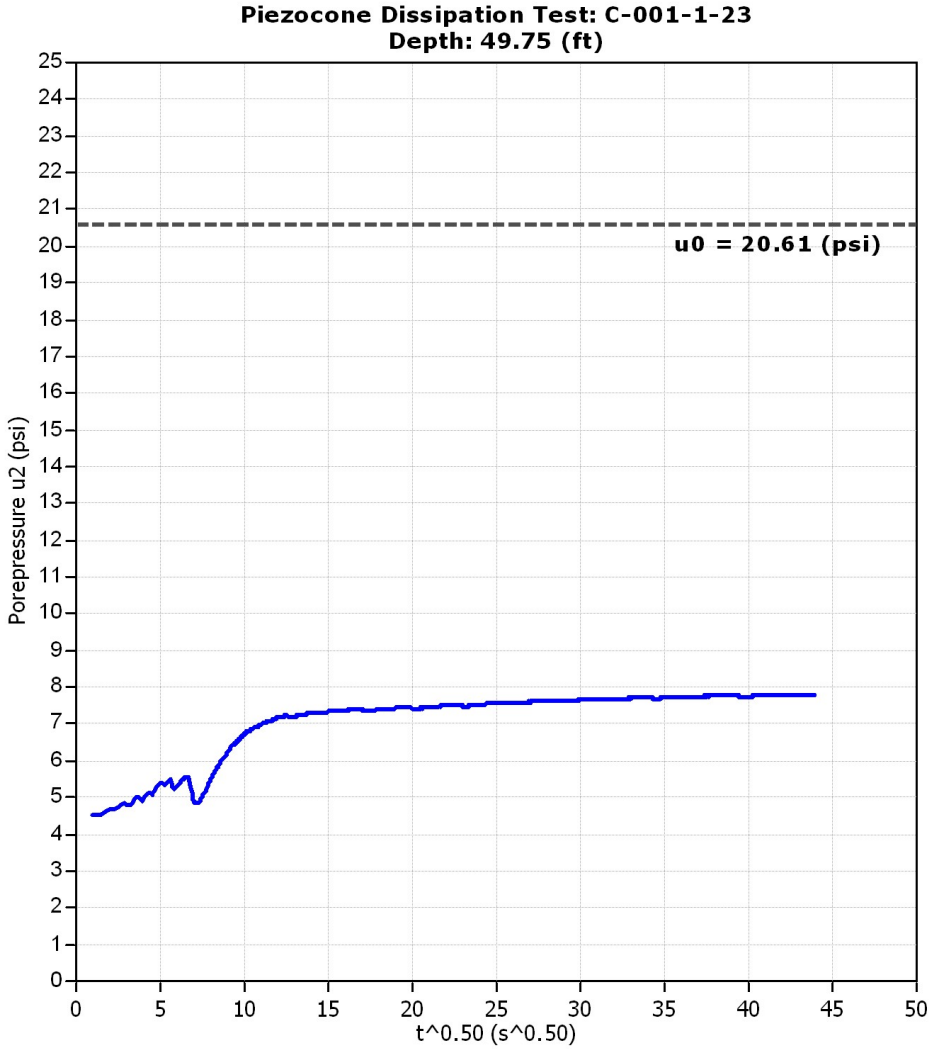
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

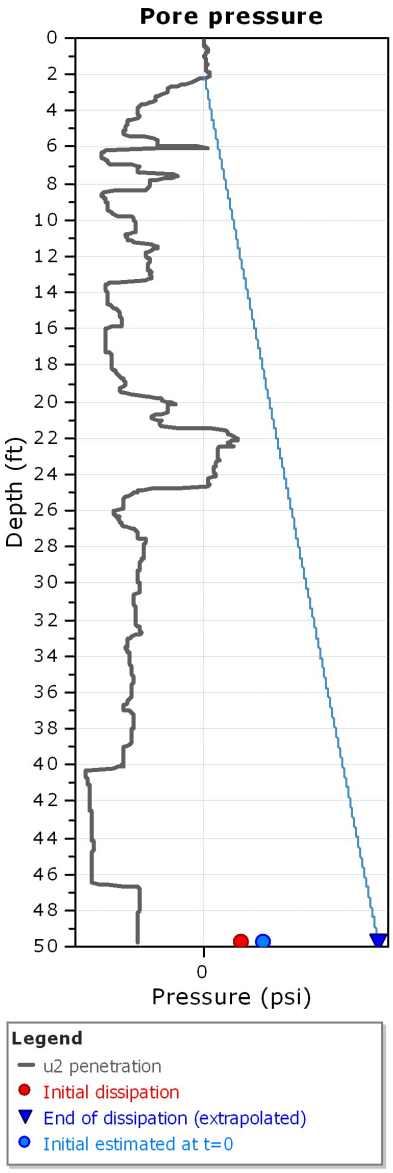
$$k_h = c_h \times \gamma_w / M$$

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

Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/S_u	c_h (ft^2/s)	c_h (ft^2/year)	M (tsf)	k_h (ft/s)
C-001-1-23	49.75	308.3	95075	3.01E-003	455966.47	8.95E-006	282	747.65	3.74E-010

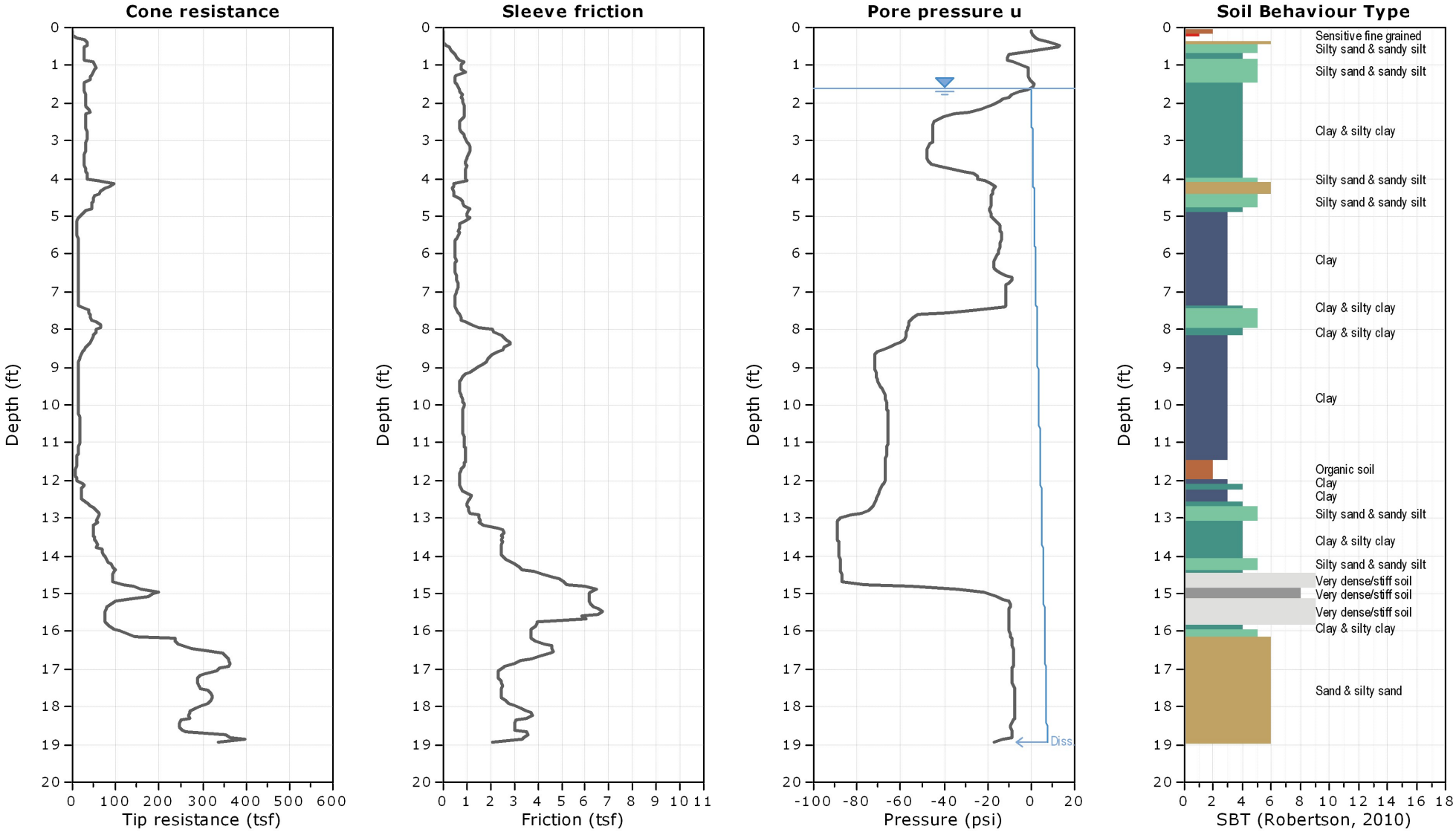

Piezocone Dissipation Test: C-001-1-23
Depth: 49.75 (ft)
u0 = 20.61 (psi)
Porepressure u2 (psi)
t^0.50 (s^0.50)


Pore pressure
Depth (ft)
Pressure (psi)
Legend
u2 penetration
Initial dissipation
End of dissipation (extrapolated)
Initial estimated at t=0

Office of Geotechnical Engineering
Geology, Exploration and, Laboratory Section
http://www.dot.state.oh.us/Divisions/Engineering/Geotechnical

CPT: C-003-0-23
Total depth: 18.94 ft, Date: 2/7/2023
Surface Elevation: 993.0 ft
Coords: lat 40.246928° lon -83.3944°

Project: UNI-33-9.12
Location: Union County



Dissipation Tests Results

Dissipation tests

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

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

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

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

where:

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

Permeability estimates based on dissipation test

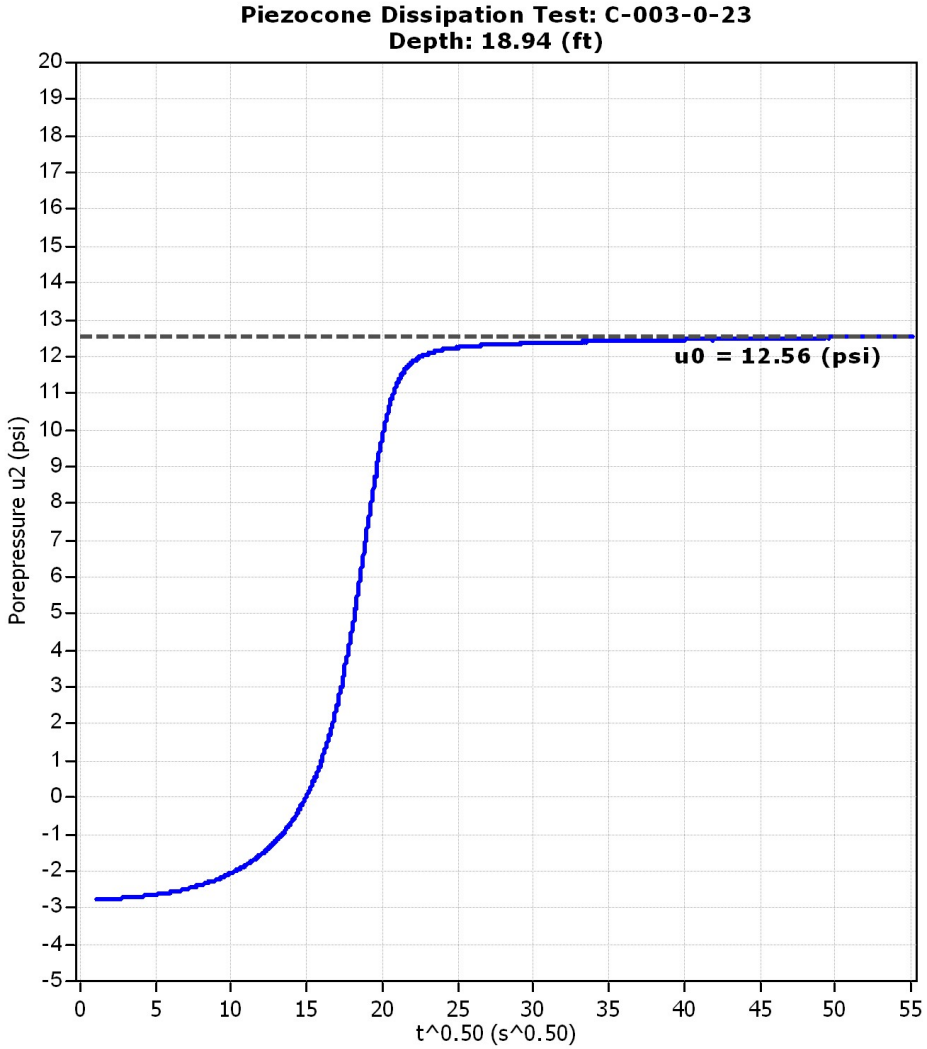
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

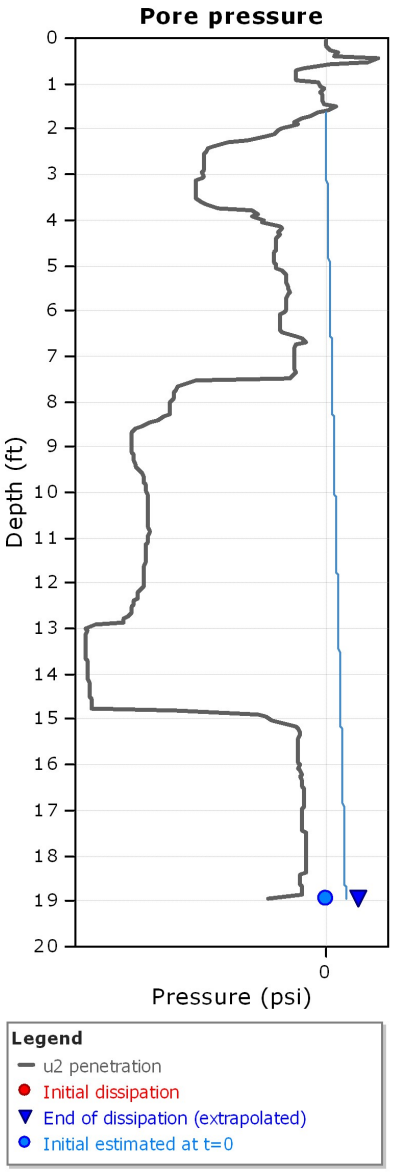
$$k_h = c_h \times \gamma_w / M$$

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

Tabular results

CPTU Borehole	Depth (ft)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/S_u	c_h (ft^2/s)	c_h (ft^2/year)	M (tsf)	k_h (ft/s)
C-003-0-23	18.94	0.0	0	0.00E+000	100.00	0.00E+000	0	1904.04	-1.00E+004


Piezocone Dissipation Test: C-003-0-23
Depth: 18.94 (ft)
u0 = 12.56 (psi)
Porepressure u2 (psi)
t^0.50 (s^0.50)


Pore pressure
Depth (ft)
Pressure (psi)
Legend
u2 penetration
Initial dissipation
End of dissipation (extrapolated)
Initial estimated at t=0

Office of Geotechnical Engineering
Geology, Exploration and, Laboratory Section
http://www.dot.state.oh.us/Divisions/Engineering/Geotechnical

CPT: C-003-1-23
Total depth: 33.75 ft, Date: 2/7/2023
Surface Elevation: 993.1 ft
Coords: lat 40.246925° lon -83.394409°

Project: UNI-33-9.12
Location: Union County