Technical Design Memo

Client:	Ohio Department of Transportation, District 10
Project:	**MOE-78-8.30 (Task Order 10-2)** **PID 117973**
HDR Project No:	10398341
Rev:	1
Calculation No:	2
Page:	1 of 111
Title:	Landslide Remediation Analyses and Design
Purpose:	Prepare slope stability analyses for the design of a landslide repair along the eastbound travel lane of State Route 78 (SR 78) in Monroe County, Ohio.
Originator:	DCM
Date:	3/26/2024
Checked by:	MM
Date:	3/28/2024
QC Review by:	DMV/AKB
Date:	4/3/2024

Summary

1. A landslide has occurred on the slope below SR 78 near mile marker 8.30 in Monroe County, Ohio. The project location is shown on the attached Site Vicinity and Topographic Map. A soldier pile and lagging retaining wall was originally recommended under Task Order 10-BB (2021 District 10/5 Geotechnical Engineering Services Contract). However, the presence of a previously unknown gas transmission line installed under the landslide within the claystone bedrock prohibited the construction of the rock socketed drilled shafts. As such, HDR was tasked under the 2023 District 10 General Engineering Services Contract with designing an earthwork solution.

Based on observations gathered during the site reconnaissance performed on March 12, 2023, coupled with the findings from the geotechnical explorations performed on March 23, 2023, the slope instability may be mitigated by excavation of the failed slide mass and reconstruction of the slope. The slope reconstruction is anticipated to include the construction of a shear key at the toe of the slope and the installation of slope drains along the benched excavation to create a stable configuration. The recommended earthwork repair also allows for continued vehicle use of the westbound lane of SR 78 during construction. Presented herein are the discussion and evaluation of the existing conditions at the site, as well as the proposed geometry of the shear key and

benching required to stabilize the slope. This design assumes that the topography and slope geometry as presented in the surveyed cross sections are representative of the current field conditions.

2. The geotechnical exploration program consisted of a series of 3 test borings, designated as Borings B-001-0-23, B-002-0-23, and B-003-0-23, and 3 dynamic cone penetrometer (DCP) soundings, designated as D-001-1-23 and D-002-1-23 (where 2 tests were performed), to characterize the subsurface profile in the vicinity of the existing landslide and develop a repair. The second test at the D-002-1-23 location was performed to confirm the relatively shallow refusal depth encountered in the initial test. The test borings were drilled within the eastbound lane of SR 78 and the 3 DCPs were performed near the toe of the slope below the roadway at the locations shown on the attached Boring Location Plan. Typed boring and DCP sounding logs are also included. The soil profile, as encountered in the borings, generally consisted of very stiff to hard embankment fill. The overburden soils were underlain by interbedded sandstone, siltstone, and claystone bedrock. Free water was not in any of the test borings. As the borings were backfilled upon completion given their locations within the roadway, delayed water level readings were not obtained.

The generalized soil profile developed for the design section is primarily based on the findings from Boring B-002-0-23 and D-002-1-23, located near the design section at Sta. 441+75. The soil profile is assumed to be depicted as shown graphically on the attached Slope/W output plots based on the generalized soil conditions as encountered in the explorations, as well as field observations gathered during our site reconnaissance.

3. Monroe County lies within the unglaciated Allegheny (Kanawha) Plateaus section of the Appalachian Plateaus province of southeast Ohio. The physiographic features within this region have been predominantly influenced by processes of erosion and uplift. Drainage-ways have cut steep, V-shaped valleys and narrow ridgetops throughout most of Monroe County, with the northwestern parts of the county drained by Seneca Fork Wills Creek and its tributaries. The project site is drained directly by South Fork running along the toe of the slope below SR 78, which drains to Seneca Fork Wills Creek approximately 9 miles northwest of the project site in neighboring Noble County. The surficial materials within Monroe County predominantly consist of colluvium, residuum derived from local bedrock, alluvial materials deposited along streams, and a silt mantle deposited in place by wind (loess). The bedrock at the project site is mapped as transitioning between the Permian-Pennsylvanian-age Dunkard Group, to the underlying Pennsylvanian-age Monongahela Group near Elevation 1140 feet. The Dunkard Group consists of mudstone, shale, and siltstone, with minor amounts of sandstone, limestone, and coal. The Monongahela Group consists of shale, siltstone, and mudstone, with minor amounts of limestone and coal.

4. The main coal seams of note within the Dunkard Group are the Washington No. 12 coals, and notable seams within the Monongahela Group include the Pittsburgh No. 8, Pomeroy (Redstone) No. 8a, Meigs Creek (Sewickley) No. 9, Uniontown No. 10, and Waynesburg No. 11 coals. Most of the mining in Monroe County occurred in the northeastern portion of the county, and no

significant mining activity is mapped at the project site according to information from the Ohio Department of Natural Resources. The closest documented mining is mapped further than 2 miles from the project site.

5. No base flood elevation has been established based on review of FEMA flood maps for the area to determine the highwater elevation along the slope located below the roadway. The project site is mapped in an area designated as an area of minimal flood hazard (Zone X).

6. HDR is unaware of any prior geotechnical explorations at the MOE-78-8.30 project site. A search of the available records on ODOT's Transportation Information Mapping System (TIMS) reveals only the geographical locations of known landslide and rockfall activity in the project area. The nearest borings from prior studies were performed approximately 0.3 mile east and 0.2 mile west of the project site.

7. In accordance with ODOT Geotechnical Design Manual (GDM) recommendations, an initial set of soil strength parameters were selected based on the boring logs, laboratory tests, and published correlations of soil strength with SPT N_{60} values. A statistical basis for selecting the initial soil parameters was performed and is in the attached printed spreadsheets entitled "Soil Strength Parameter Determination". Following development of the soil strength parameters, cross-sections perpendicular to the roadway centerline were reviewed, and the section at Station 441+75 was selected for design.

The developed soil parameters and subsurface profile were then entered into the Slope/W slope stability modeling software to re-create the landslide observed in the field by simulating a series of trial searches to determine the critical mode of failure based on a Morgenstern-Price stability model. In addition, the Slope/W optimization feature was utilized, which generates a hybrid circular and translational failure shape. Recognizing that a landslide had already occurred, strength parameters within the existing soil layers were adjusted to generate a reasonable slip surface (FS < 1.0) that is consistent with the field observations and engineering judgment.

Limited groundwater information was available from the borings and published sources. However, ponded water was observed near the toe of the slope during drilling operations. Based on the available information, on-site observations, and engineering judgment, groundwater was modeled from 6-inches above the bottom of the northern drainage ditch to the left of the existing roadway to the ground surface above the toe of the embankment slope on the right, exiting the slope near El. 1143.8.

Bedrock elevations were determined primarily by bedrock depths as encountered at each of the boring locations. Additional bedrock depth information along the slope below SR 78 was estimated based on the slope of the existing terrain, exposed bedrock outcrops in the cuts above the roadway, limited data available on published bedrock topography maps, overburden soil thicknesses encountered in the soil borings and refusal depths of the DCP tests. Bedrock strength was determined through laboratory testing performed on selected rock core samples. The results

of those laboratory tests as well as the "Rock Strength Parameter Determination" spreadsheet are included in the attachments.

8. Excavation and removal of the failed soil materials along the lower portion of the slope, construction of a shear key along the toe, and reconstruction of the slope using dumped rock fill are recommended to stabilize the slope below SR 78. As shown on the design cross-section in the attachments, the benched excavation is not anticipated to impact traffic along SR 78 westbound as there is an approximate 4-foot clearance between the centerline of SR 78 and the beginning of the benched excavation to allow for a concrete barrier and 2-foot ledge above the proposed slope crest of the temporary 1H:1V slope.

The temporary 1H:1V slope extends from near the crest of the embankment slope to an initial 9-foot-wide construction bench located at El. 1146.5. An additional 8-foot-wide construction bench is located at El. 1140.5 at the base of a 1H:1V sloe below the initial bench. A final 1H:1V slope extends from this lower bench to the bottom of the 18-foot wide shear key at approximate El. 1135.5 to key the reconstructed embankment into the toe of the exiting slope. Per the Request for Task Order, dated March 15, 2024, it is preferred that excavation of the shear key be limited to the top of rock with minimal to no rock excavation performed. This benching scheme was developed in general accordance with Section 800 of the ODOT Geotechnical Design Manual (GDM). However, although design efforts were made, portions of the existing slide mass may not be removed given the excavation limitations due to the presence of the gas transmission line.

The embankment is to be reestablished utilizing Type C dumped rock fill from the bottom of the shear key (approximate El. 1135.5). The face of the slope is to be constructed at an approximate 4H:1V angle from the toe of the slope, with some variation as needed to tie into the existing grades of the adjacent stable slopes, to El. 1143.5. Above El. 1143.5, the embankment is to be reconstructed at a 2H:1V slope utilizing Item 203 Embankment Fill. The stability analyses for this slope configuration indicate a FS > 1.30 for both short term (undrained) and long term (drained) conditions. Details of the shear key and excavation benching are shown on the attached design cross-sections.

Construction of a drainage gallery will be necessary to drain the rock shear key. The gallery should extend toward South Fork at the southwestern end of the embankment, daylighting below the toe of the slope. Slope drains should also be established on the back of each bench to assist with internal drainage of the embankment.

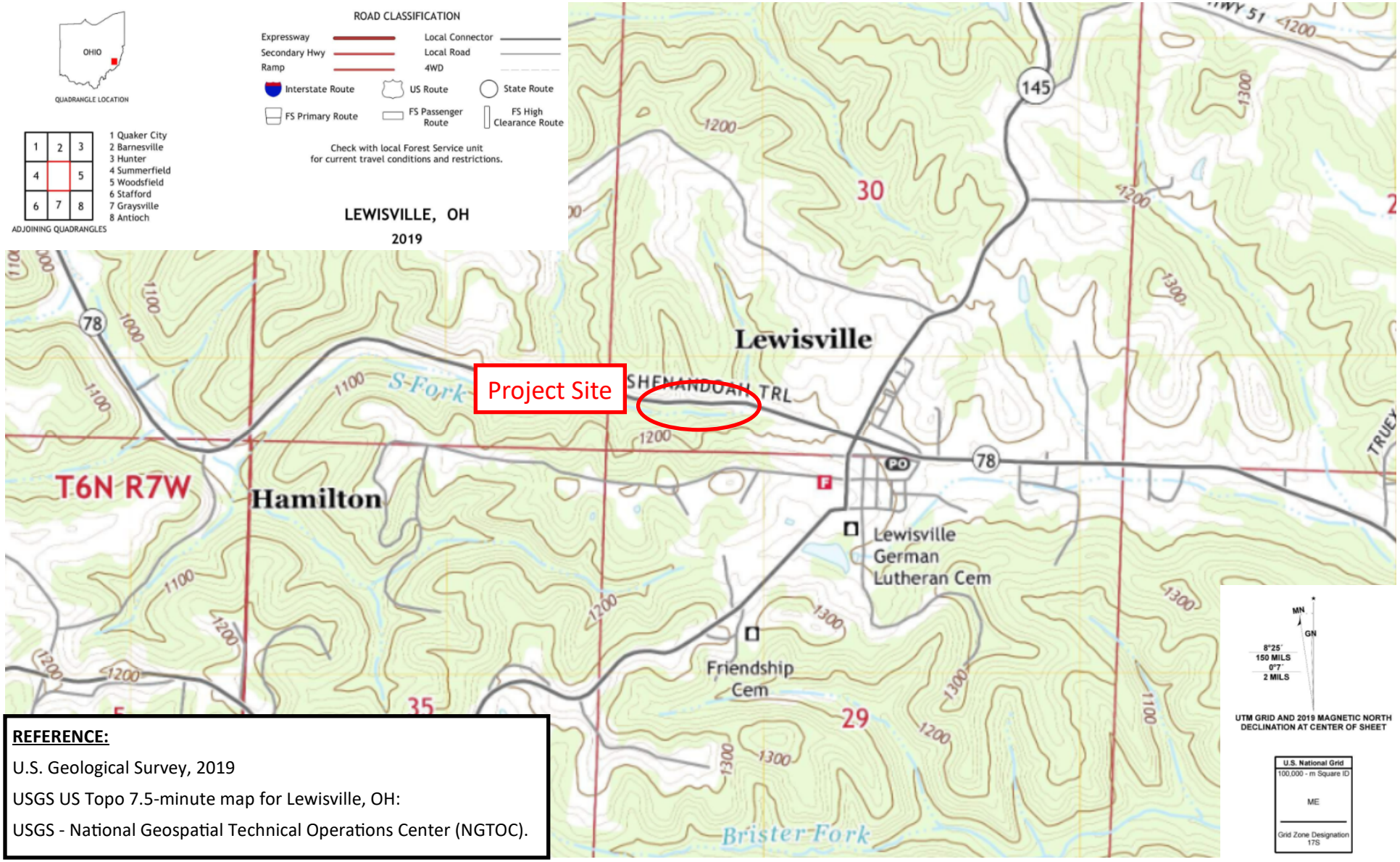
9. Upon establishing the criteria remediating the slope, analyses were performed to evaluate the constructability of the shear key and temporary benching scheme. The Factors of Safety were determined to be greater than the target Factor of Safety of 1.20 under short term (undrained) conditions for the temporary slopes. The temporary excavation is not to be left exposed any longer than necessary, with reconstruction of the slope to begin shortly after the excavation has been made. As such, it is also recommended that when excavating for the shear key, no more than 50 feet along the back of the key be excavated without replacing with dumped rock fill.

Finally, drainage and run-off should also be diverted away from the excavation during construction.

Should a higher factor of safety be required during construction, other cut-slope stability measures/configurations or sheet piling may be needed to maintain the slope during construction of the shear key and sidehill benches. Determination of temporary shoring (if necessary) is to be determined by the contractor.

Site Vicinity and Topographic Map

Site Vicinity and Topographic Map



REFERENCE:

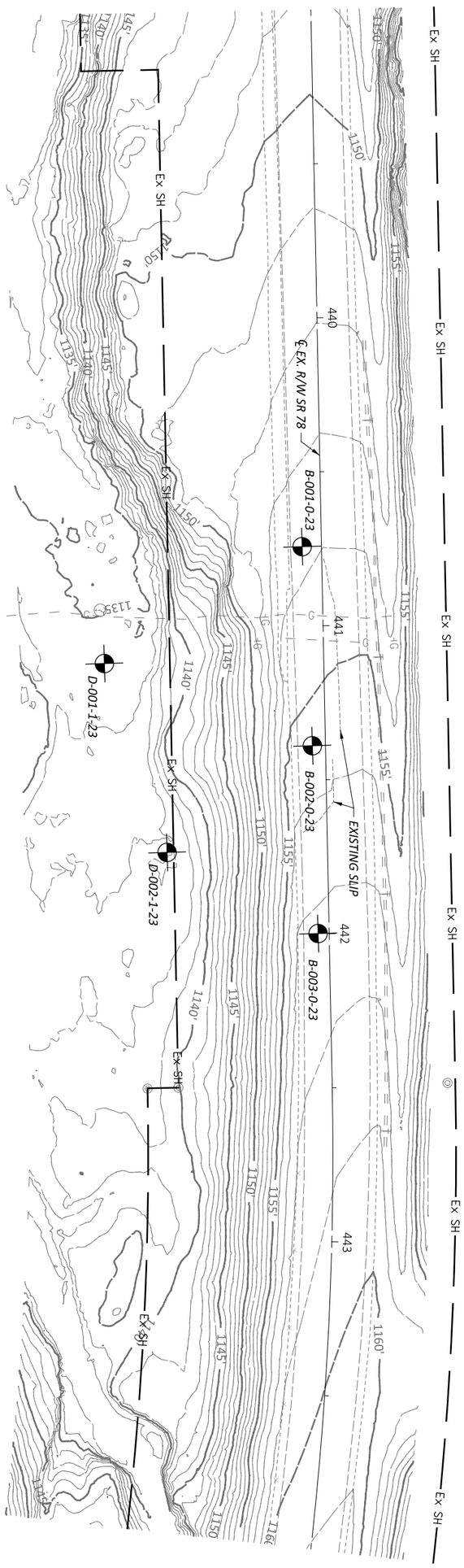
U.S. Geological Survey, 2019

USGS US Topo 7.5-minute map for Lewisville, OH:

USGS - National Geospatial Technical Operations Center (NGTOC).

Boring Location Plan

MODEL: CLX_78 - Plan 1IP900 [Sheet] PAPERSIZE: 34x22 (in.) DATE: 5/15/2023 TIME: 3:05:18 PM USER: CWAHLBRI
pw:\\ohiodot-pw.bentley.com:ohiodot-pw-02\Documents\01 Active Projects\District 10\Monroe\117973\402-Engineering_HDR\Geotechnical\Sheets\117973_IP900.dgn



BORING LOCATION PLAN
SR 78

HORIZONTAL SCALE IN FEET
0 20
10 40

DESIGNER	REVIEWER	PROJECT ID	SHEET	TOTAL
AKB	DMV 05/15/23	117973	1	1

DESIGN AGENCY
HDR

Boring Logs
and
Rock Core Photos

9999 Carver Road, Suite 210, Cincinnati, OH 45242-5583 **hdrinc.com**
(513) 984-7500

PROJECT: MOE-78-08.30	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 440+74, 6' RT.	EXPLORATION ID B-001-0-23
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: HDR / AKB	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR 78	
PID: 117973 SFN:	DRILLING METHOD: 2.25" HSA / NQ2	CALIBRATION DATE: 3/7/22	ELEVATION: 1153.7 (MSL) EOB: 26.7 ft.	PAGE 1 OF 1
START: 3/23/23 END: 3/23/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.766396, -81.223613	

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 (42")	1153.7																	
	1150.2	1	27 5 3	12	28	SS-1	-	-	-	-	-	-	-	-	-	-		
VERY STIFF TO HARD, BROWN AND RED-BROWN, **SILT AND CLAY**, SOME SAND, LITTLE ROCK FRAGMENTS, DAMP (FILL)	1147.7	4	6 7 10	25	33	SS-2	4.5+	12	16	12	35	25	37	22	15	14	A-6a (7)	
SANDSTONE, BROWN, SEVERELY WEATHERED, WEAK.	1147.0	TR 6	50/3"	-	100	SS-3	-	-	-	-	-	-	-	-	-	6	Rock (V)	
SANDSTONE, BROWN, HIGHLY WEATHERED, MODERATELY STRONG, FINE TO MEDIUM GRAINED, THIN TO MEDIUM BEDDED, JOINT DISCONTINUITIES, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 0%, REC 100%.	1144.0	7	0		100	NQ2-1											CORE	
SILTSTONE, BROWN, MODERATELY WEATHERED, VERY WEAK, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 37%, REC 100%. @9.7' - 11.7: highly fractured	1138.2	12	33		100	NQ2-2											CORE	
SILTSTONE, RED-BROWN, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 62%, REC 97%. @18.6' - 18.9': gray limestone seam @18.9' - 19.6': dark gray	1133.3	17	62		97	NQ2-3											CORE	
CLAYSTONE, RED-BROWN, HIGHLY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 92%, REC 100%.	1130.3	23	93		100	NQ2-4											CORE	
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY FRACTURED, NARROW APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 100%, REC 100%. @26.2' - 26.6': qu = 4374 psi, γ = 166 pcf	1127.0	EOB 26																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 12.5 LB. BENTONITE POWDER; 47 LB. CEMENT MIXED WITH 25 GAL. WATER; SURFACE PATCHED WITH QUICKCRETE

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 5/15/23 08:23 - C:\PWWORKING\EAST01\D3228934\MOE-78-8.30 BORING LOGS.GPJ

PROJECT: MOE-78-08.30	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 441+39, 4' RT.	EXPLORATION ID B-002-0-23
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: HDR / AKB	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR 78	
PID: 117973 SFN:	DRILLING METHOD: 2.25" HSA / NQ2	CALIBRATION DATE: 3/7/22	ELEVATION: 1155.5 (MSL) EOB: 28.7 ft.	PAGE 1 OF 2
START: 3/23/23 END: 3/23/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.766397, -81.223383	

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 (48")	1155.5																	
	1151.5		22 12 7	27	56	SS-1	-	-	-	-	-	-	-	-	-	-		
VERY STIFF, BROWN, **SILT AND CLAY**, SOME ROCK FRAGMENTS, SOME SAND (FILL)	1148.5		7 6 11	25	67	SS-2	2.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
			6 5 7	17	94	SS-3	2.50	26	14	10	31	19	36	21	15	14	A-6a (5)	
SANDSTONE, BROWN, SEVERELY WEATHERED, WEAK.	1146.8	TR	35 50/4"	-	100	SS-4	-	-	-	-	-	-	-	-	-	7	Rock (V)	
SANDSTONE, BROWN AND GRAY, HIGHLY WEATHERED, MODERATELY STRONG, FINE TO MEDIUM GRAINED, THIN TO MEDIUM BEDDED, JOINT DISCONTINUITIES, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 14%, REC 100%.	1144.5		19		100	NQ2-1											CORE	
SILTSTONE, BROWN, MODERATELY WEATHERED, WEAK TO SLIGHTLY STRONG, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 0%, REC 100%.	1141.9 1141.0																	
SANDSTONE, GRAY, MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 82%, REC 100%.	1137.9		73		100	NQ2-2											CORE	
SILTSTONE, GRAY AND BROWN, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY TO MODERATELY FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 54%, REC 100%. @16.7' - 17.1': qu = 694 psi, γ = 162 pcf	1133.5																	
SILTSTONE, RED-BROWN, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, GOOD SURFACE; RQD 81%, REC 100%. @20.7' - 21.4': gray limestone layer	1130.8		78		96	NQ2-3											CORE	
CLAYSTONE, RED-BROWN, HIGHLY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 56%, REC	1126.8	EOB																

PID: 117973	SFN:	PROJECT: MOE-78-08.30	STATION / OFFSET: 441+39, 4' RT.	START: 3/23/23	END: 3/23/23	PG 2 OF 2	B-002-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 1125.5	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
88%.																		
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY FRACTURED, NARROW APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 100%, REC 100%.																		
@26.8' - 27.2': qu = 4517 psi, γ = 166 pcf																		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 12.5 LB. BENTONITE POWDER; 47 LB. CEMENT MIXED WITH 25 GAL. WATER; SURFACE PATCHED WITH QUICKCRETE

PROJECT: MOE-78-08.30	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 442+00, 4' RT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: HDR / AKB	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR 78
PID: 117973 SFN:	DRILLING METHOD: 2.25" HSA / NQ2	CALIBRATION DATE: 3/7/22	ELEVATION: 1157.3 (MSL) EOB: 27.2 ft.
START: 3/23/23 END: 3/23/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.766395, -81.223166

EXPLORATION ID B-003-0-23

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 (30")	1157.3																	
	1154.8																	
VERY STIFF, BROWN, **CLAY**, "AND" SILT, TRACE ROCK FRAGMENTS, TRACE SAND, DAMP (FILL)			5 6 6	17	50	SS-1	3.50	1	2	7	45	45	41	23	18	21	A-7-6 (11)	
			4 5 7	17	33	SS-2	2.50	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
	1150.8																	
		TR	10 12 50/4"	-	75	SS-3A	1.75	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
SANDSTONE, BROWN, SEVERELY WEATHERED, WEAK.	1150.1					SS-3B	-	-	-	-	-	-	-	-	-	10	Rock (V)	
SANDSTONE, BROWN, MODERATELY TO HIGHLY WEATHERED, WEAK, THIN BEDDED, JOINT DISCONTINUITIES, HIGHLY FRACTURED, OPEN APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, POOR SURFACE; RQD 0%, REC 100%.	1148.9																	
SANDSTONE, GRAY AND BROWN, MODERATELY WEATHERED, MODERATELY STRONG, THIN TO MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 70%, REC 100%. @11.3' - 11.7': qu = 5763 psi, γ = 162 pcf	1143.1		58		100	NQ2-1											CORE	
SILTSTONE, GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, THIN BEDDED, JOINT DISCONTINUITIES, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, DISINTEGRATED STRUCTURE, VERY POOR TO POOR SURFACE; RQD 14%, REC 100%.	1137.8		51		100	NQ2-2											CORE	
SILTSTONE, RED-BROWN, MODERATELY WEATHERED, VERY WEAK, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 91%, REC 100%. @22.5' - 23.2': gray limestone layer, moderately strong	1133.1																	
CLAYSTONE, RED-BROWN, HIGHLY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 60%, REC 80%.	1130.6		50		83	NQ2-3											CORE	
	1130.1	EOB																
SANDSTONE, GRAY, MODERATELY WEATHERED, MODERATELY STRONG, THIN BEDDED, JOINT DISCONTINUITIES, FRACTURED, OPEN APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR																		

PID: 117973	SFN:	PROJECT: MOE-78-08.30	STATION / OFFSET: 442+00, 4' RT.	START: 3/23/23	END: 3/23/23	PG 2 OF 2	B-003-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 1127.3	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
SURFACE; RQD 0%, REC 100%.																		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 12.5 LB. BENTONITE POWDER; 47 LB. CEMENT MIXED WITH 25 GAL. WATER; SURFACE PATCHED WITH QUICKCRETE

B-001-0-23

Run #	Depth (ft)		Recovery		RQD	
NQ2-1	6.7	9.7	36 in. / 36 in.	100%	0 in. / 36 in.	0%
NQ2-2	9.7	14.7	60 in. / 60 in.	100%	20 in. / 60 in.	33%
NQ2-3	14.7	19.7	58 in. / 60 in.	97%	37 in. / 60 in.	62%

MOE-78-8.30 PID 117973

Note: Rock core box dropped prior to photo.

B-001-0-23

Run #	Depth (ft)		Recovery		RQD	
NQ2-3	14.7	19.7	58 in. / 60 in.	97%	37 in. / 60 in.	62%
NQ2-4	19.7	26.7	84 in. / 84 in.	100%	78 in. / 84 in.	93%

MOE-78-8.30 PID 117973

B-002-0-23

Run #	Depth (ft)		Recovery		RQD	
NQ2-1	8.7	14.5	70 in. / 70 in.	100%	13 in. / 70 in.	19%
NQ2-2	14.5	19.7	62 in. / 62 in.	100%	45 in. / 62 in.	73%

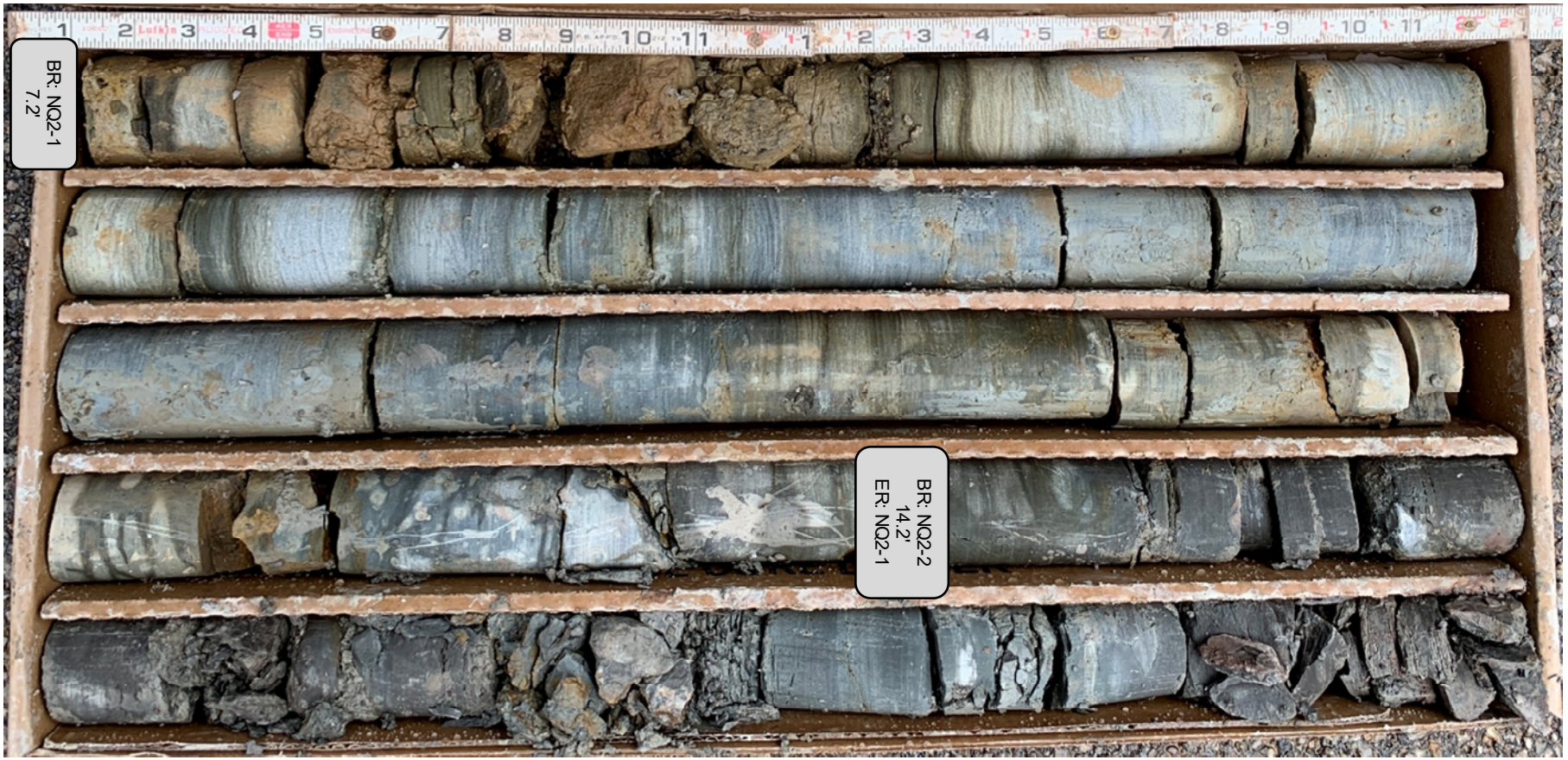
MOE-78-8.30 PID 117973

B-002-0-23

Run #	Depth (ft)		Recovery		RQD	
NQ2-2	14.5	19.7	62 in. / 62 in.	100%	45 in. / 62 in.	73%
NQ2-3	19.7	28.7	104 in. / 108 in.	96%	84 in. / 108 in.	78%

MOE-78-8.30 PID 117973

B-003-0-23



Run #	Depth (ft)		Recovery		RQD	
NQ2-1	7.2	14.2	84 in. / 84 in.	100%	49 in. / 84 in.	58%
NQ2-2	14.2	24.2	120 in. / 120 in.	100%	61 in. / 120 in.	51%

MOE-78-8.30 PID 117973

B-003-0-23

Run #	Depth (ft)		Recovery		RQD	
NQ2-2	14.2	24.2	120 in. / 120 in.	100%	61 in. / 120 in.	51%
NQ2-3	24.2	27.2	30 in. / 36 in.	83%	18 in. / 36 in.	50%

MOE-78-8.30 PID 117973

DCP Logs

Dynamic Cone Penetration Test Log

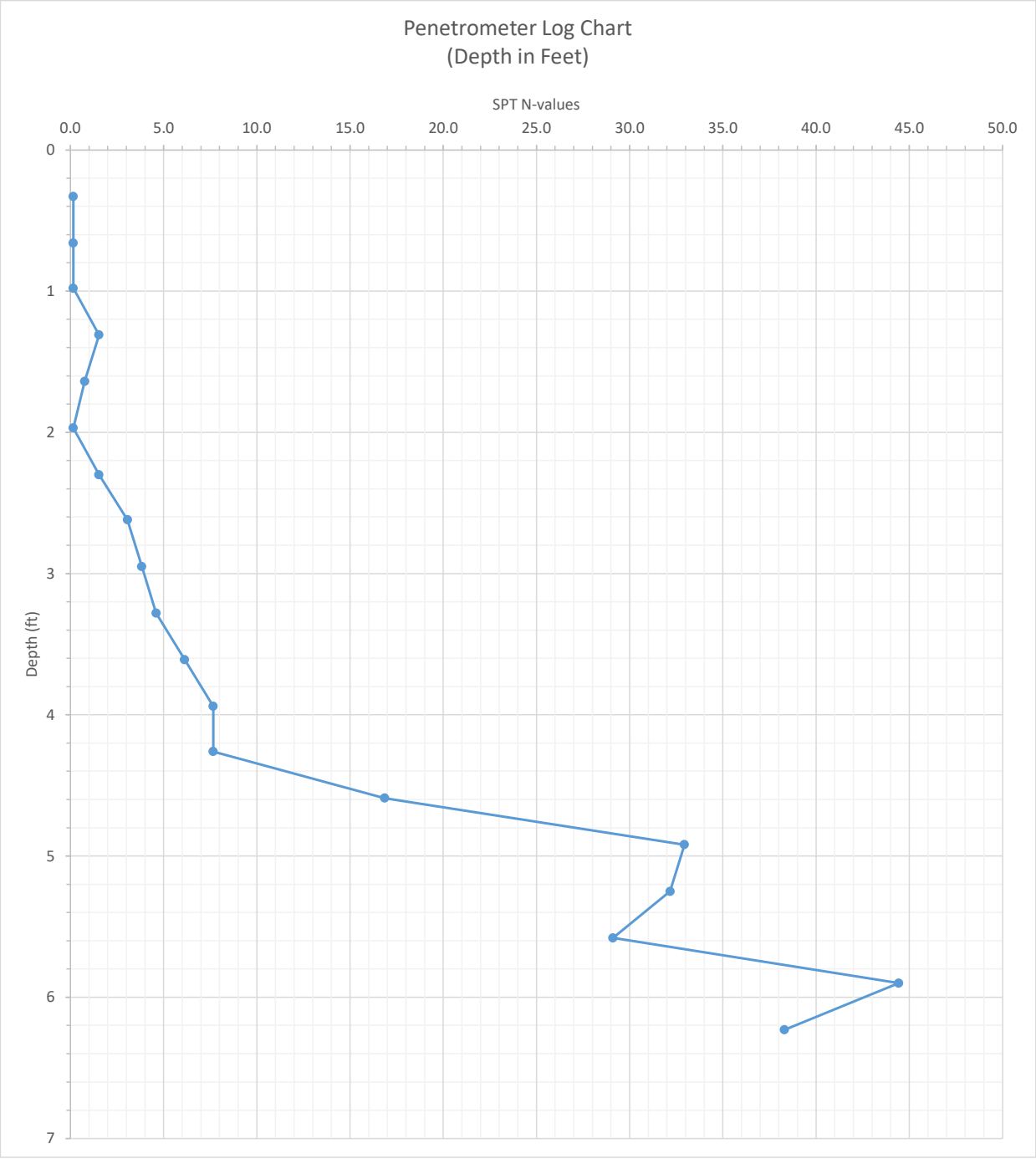
Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662152 -81.2234885
Location:	D-001-1-23	**North / East:**	645828.6 2327320.9
Station, Offset:	441+11, 71' RT	**Date:**	3/22/2023
Elevation:	1135.3	**Sheet:**	1 of 2
Notes:	Staked Location		

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value
3.94	0.33	10	0.2	0.2
7.87	0.66	20	0.2	0.2
11.81	0.98	30	0.2	0.2
15.75	1.31	40	2	1.5
19.69	1.64	50	1	0.8
23.62	1.97	60	0.2	0.2
27.56	2.3	70	2	1.5
31.5	2.62	80	4	3.1
35.43	2.95	90	5	3.8
39.37	3.28	100	6	4.6
43.31	3.61	110	8	6.1
47.24	3.94	120	10	7.7
51.18	4.26	130	10	7.7
55.12	4.59	140	22	16.9
59.06	4.92	150	43	32.9
62.99	5.25	160	42	32.2
66.93	5.58	170	38	29.1
70.87	5.9	180	58	44.4
74.8	6.23	190	50	38.3

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value

Dynamic Cone Penetration Test Log

Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662152 -81.2234885
Location:	D-001-1-23	**North / East:**	645828.624 2327320.934
Station, Offset:	441+11, 71' RT	**Date:**	3/22/2023
Elevation:	1135.32	**Sheet:**	2 of 2
Notes:	Staked Location		



Dynamic Cone Penetration Test Log

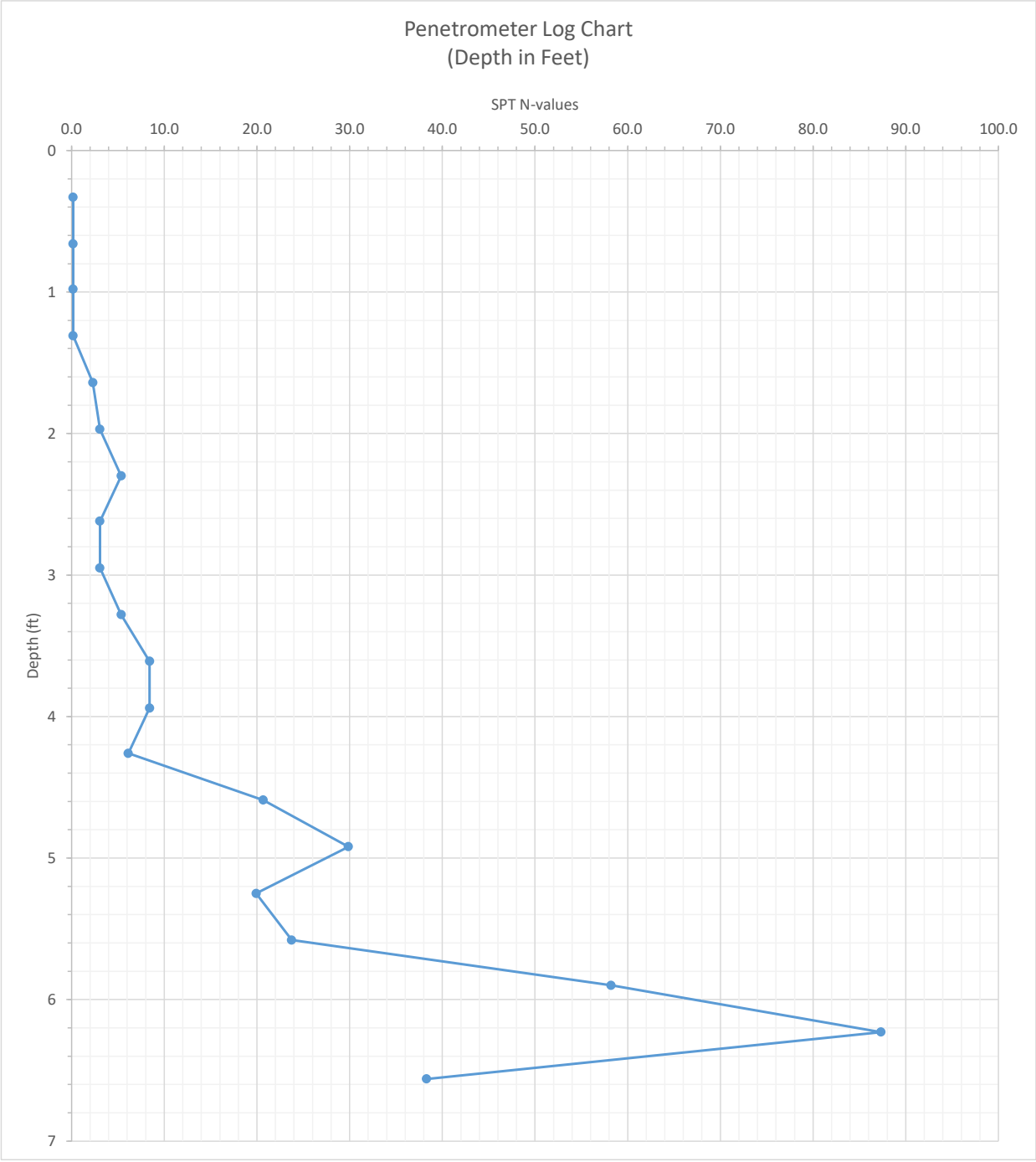
Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.766264 -81.223267
Location:	D-002-1-23	**North / East:**	645847.1 2327382.8
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	1 of 2
Notes:	Test 1, Staked Location		

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value
3.94	0.33	10	0.2	0.2
7.87	0.66	20	0.2	0.2
11.81	0.98	30	0.2	0.2
15.75	1.31	40	0.2	0.2
19.69	1.64	50	3	2.3
23.62	1.97	60	4	3.1
27.56	2.3	70	7	5.4
31.5	2.62	80	4	3.1
35.43	2.95	90	4	3.1
39.37	3.28	100	7	5.4
43.31	3.61	110	11	8.4
47.24	3.94	120	11	8.4
51.18	4.26	130	8	6.1
55.12	4.59	140	27	20.7
59.06	4.92	150	39	29.9
62.99	5.25	160	26	19.9
66.93	5.58	170	31	23.7
70.87	5.9	180	76	58.2
74.8	6.23	190	114	87.3
78.74	6.56	200	50	38.3

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value

Dynamic Cone Penetration Test Log

Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662635 -81.2232674
Location:	D-002-1-23	**North / East:**	645847.086 2327382.847
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	2 of 2
Notes:	Test 1, Staked Location		



Dynamic Cone Penetration Test Log

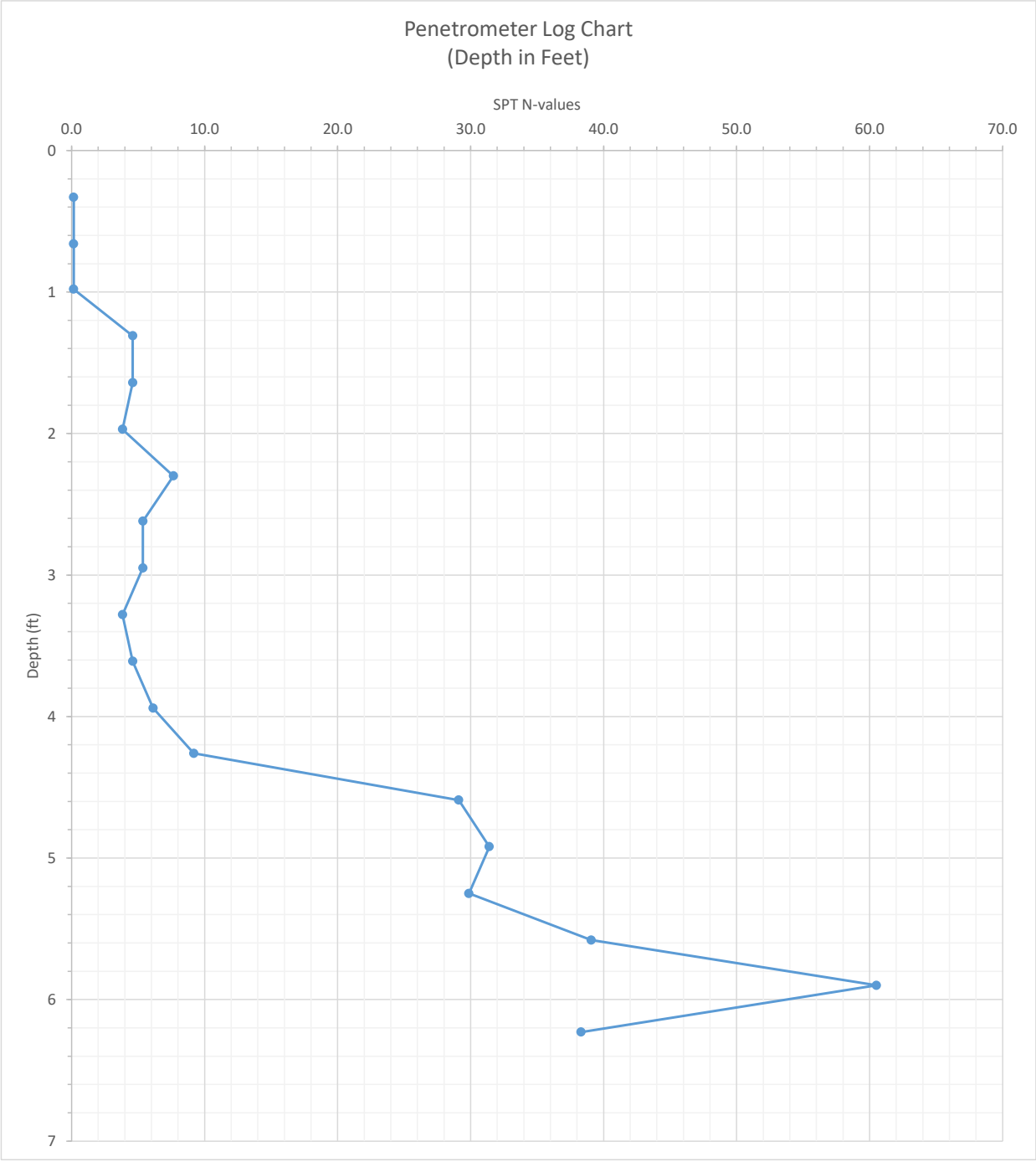
Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.766264 -81.223267
Location:	D-002-1-23	**North / East:**	645847.1 2327382.8
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	1 of 2
Notes:	Test 2, Offset 5' East		

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value
3.94	0.33	10	0.2	0.2
7.87	0.66	20	0.2	0.2
11.81	0.98	30	0.2	0.2
15.75	1.31	40	6	4.6
19.69	1.64	50	6	4.6
23.62	1.97	60	5	3.8
27.56	2.3	70	10	7.7
31.5	2.62	80	7	5.4
35.43	2.95	90	7	5.4
39.37	3.28	100	5	3.8
43.31	3.61	110	6	4.6
47.24	3.94	120	8	6.1
51.18	4.26	130	12	9.2
55.12	4.59	140	38	29.1
59.06	4.92	150	41	31.4
62.99	5.25	160	39	29.9
66.93	5.58	170	51	39.1
70.87	5.9	180	79	60.5
74.8	6.23	190	50	38.3

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value

Dynamic Cone Penetration Test Log

Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662635 -81.2232674
Location:	D-002-1-23	**North / East:**	645847.086 2327382.847
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	2 of 2
Notes:	Test 2, Offset 5' East		



Bedrock Geology and Topography Maps

9999 Carver Road, Suite 210, Cincinnati, OH 45242-5583 **hdrinc.com**
(513) 984-7500

Bedrock Geology Map

Explanation

- PIPd - Dunkard Group (Permian-Pennsylvanian)
- IPm - Monongahela Group
- IPc - Conemaugh Group

Contacts

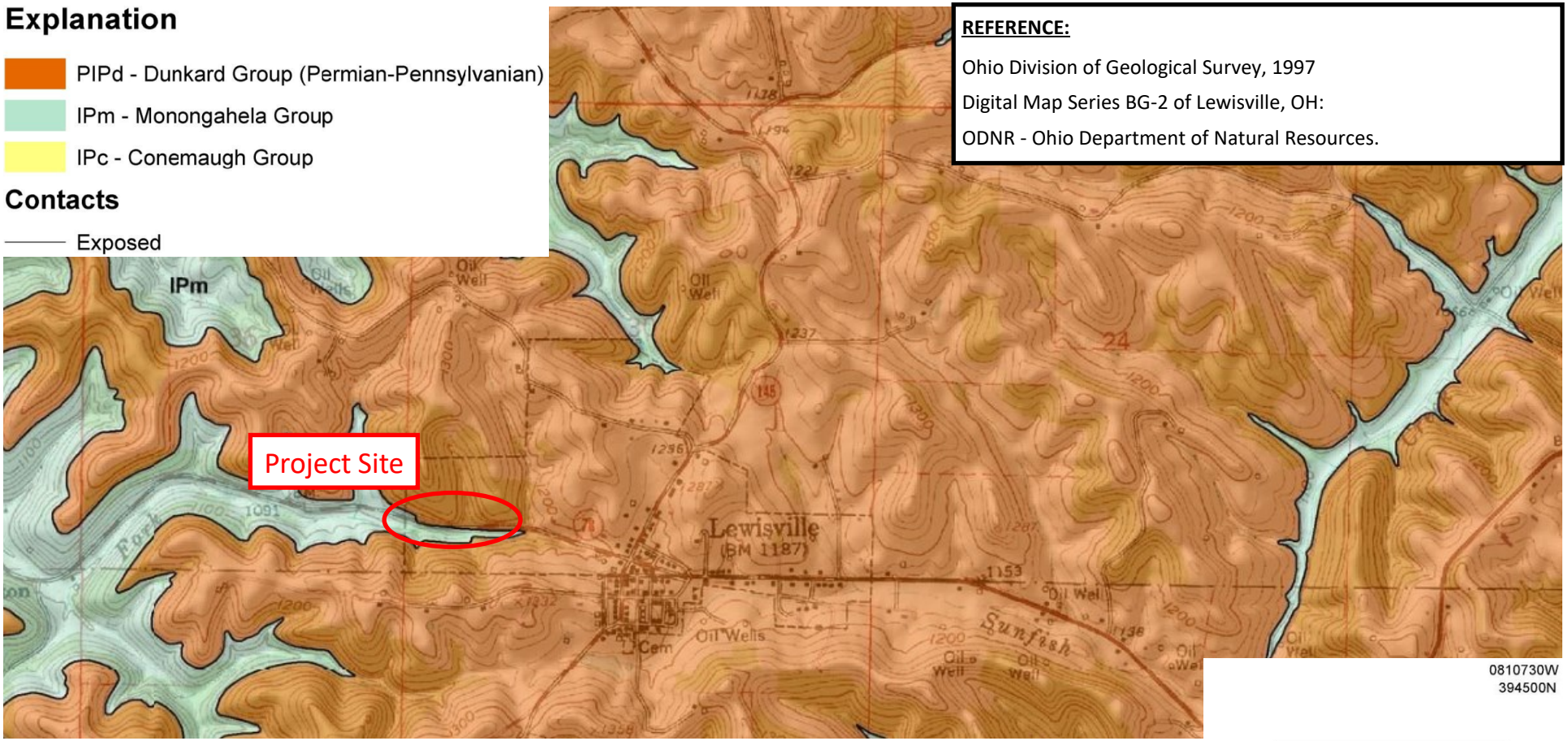
- Exposed

REFERENCE:

Ohio Division of Geological Survey, 1997

Digital Map Series BG-2 of Lewisville, OH:

ODNR - Ohio Department of Natural Resources.

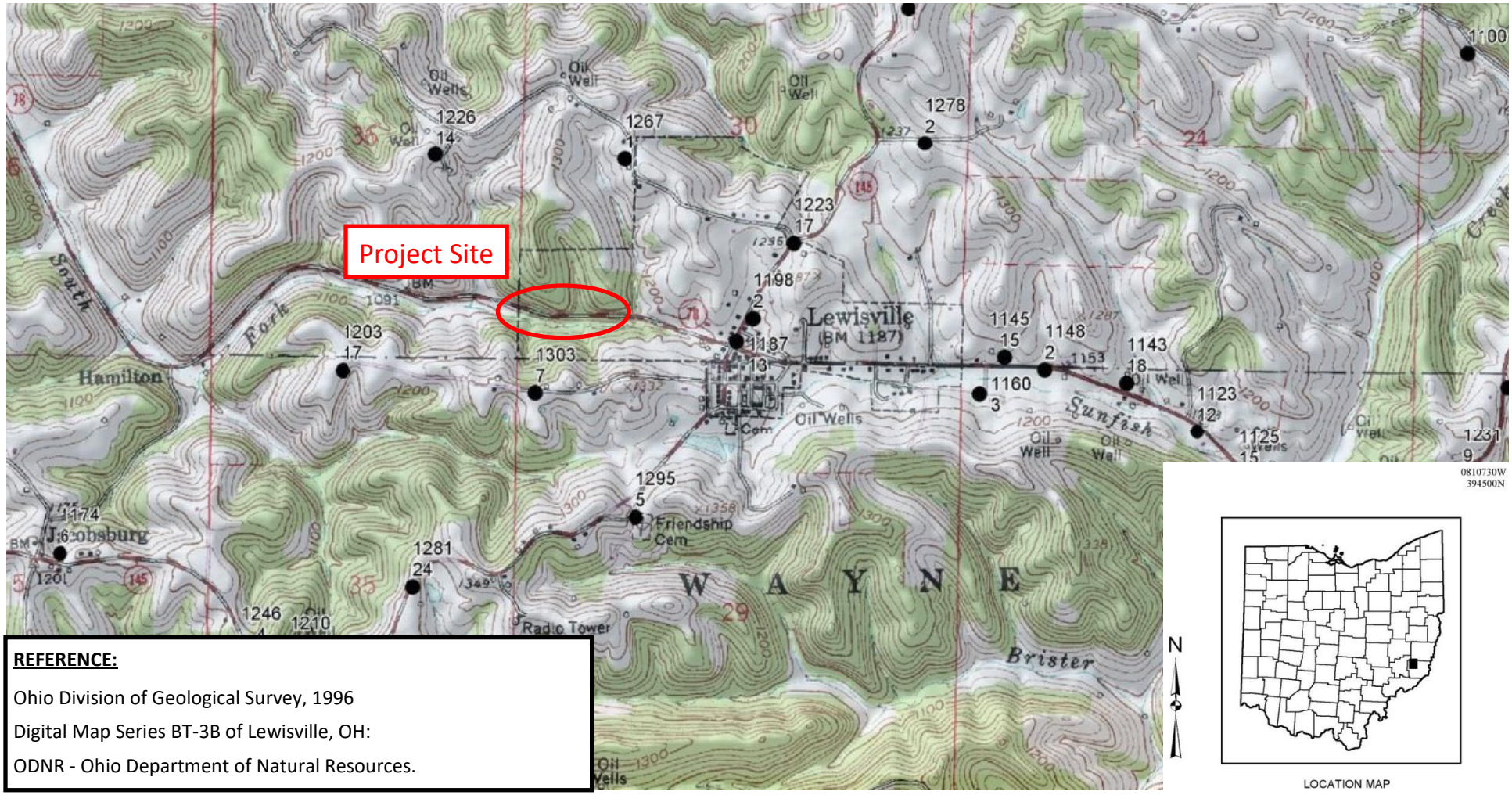


1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet

N

LOCATION MAP

Bedrock Topography Map



REFERENCE:

Ohio Division of Geological Survey, 1996

Digital Map Series BT-3B of Lewisville, OH:

ODNR - Ohio Department of Natural Resources.

LOCATION MAP

1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000

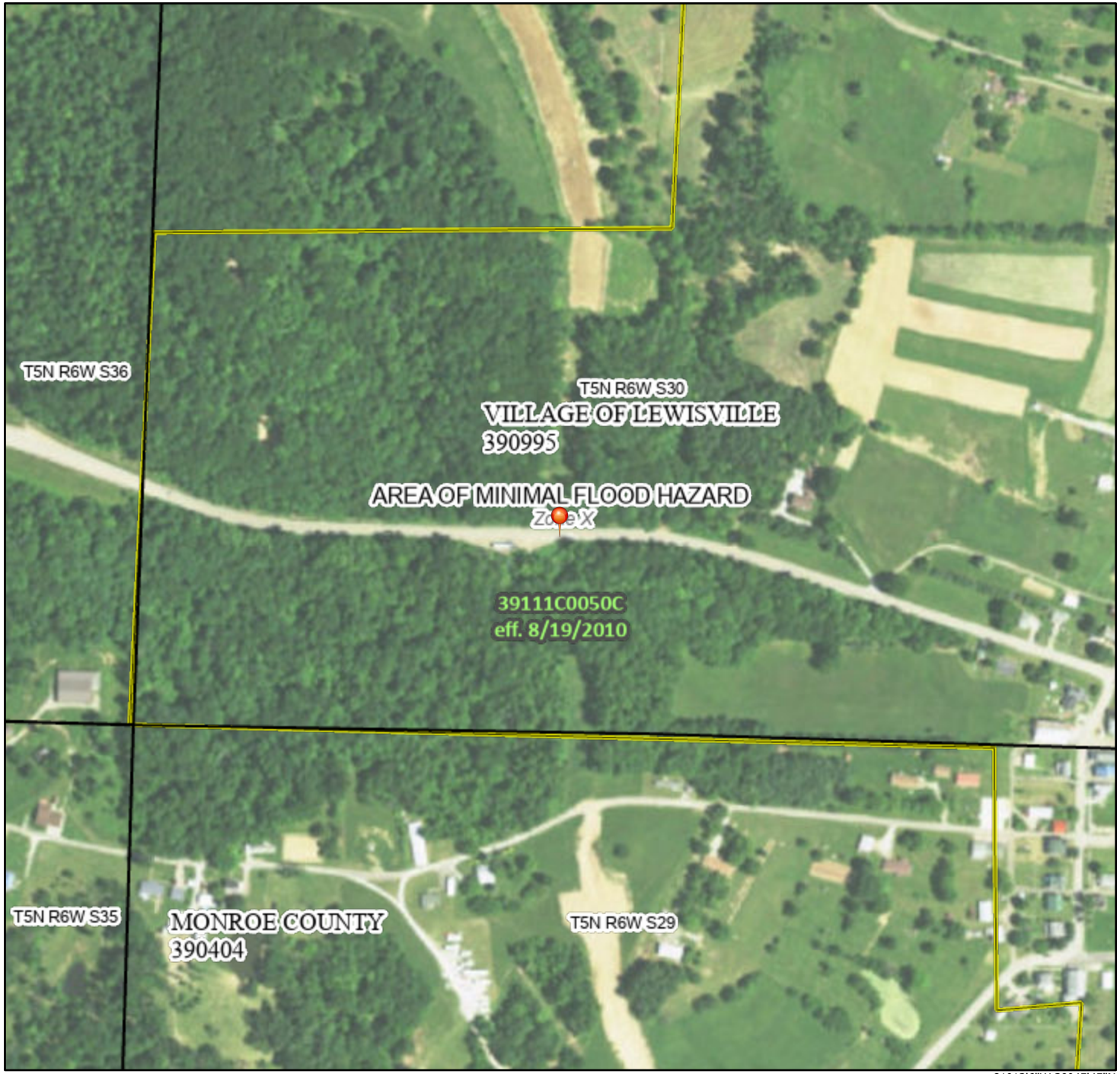
Feet

FEMA Flood Map

National Flood Hazard Layer FIRMette

FEMA

81°13'44"W 39°46'13"N



81°13'6"W 39°45'45"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/25/2023 at 12:05 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Soil Strength Parameter Determination

9999 Carver Road, Suite 210, Cincinnati, OH 45242-5583 **hdrinc.com**
(513) 984-7500

ODOT District 10
MOE-78-8.30

Soil Strength Parameter Determination

Computed By = AKB
Checked By = DMV

Layer		Undrained Shear Strength (Su) (psf)				Dry Unit Weight (pcf)		Moist Unit Wt. (pcf)		Adopted Short Term Parameters		Long-Term Strength Values						Adopted Long Term Strength Parameters (Back-Calculated from SlopeW)	
		PPR	N-values		Tested								N_{60} Value	ODOT GB-7 Correlations		Tested			
			Sowers	T and P	Values	Correlation	Tested	Correlation	Tested					Cohesion (psf)	phi (deg)	Cohesion (psf)	phi (deg)		
Layer 1 VERY STIFF TO HARD COHESIVE	Max	4500	4000	4000		120		130				Max	58	250	28				
	Min	1750	2975	2261		105		125		S_u= 2800 psf		Min	17	157	24			c' = 95 psf	
	Average	2875	3840	3335		108		125		Φ = 0 deg		Average	27	190	26			Φ' = 25 deg	
	Std Dev	971	343	728		5		1				Std Dev	10	27	1				
										Y_{dry} = 105 pcf								Y_{dry} = 105 pcf	
	Avg + Std	3846	4183	4063		113		126		Y_{moist} = 125 pcf		Avg + Std	37	217	27			Y_{moist} = 125 pcf	
	Avg - Std	1904	3497	2608		103		124				Avg - Std	17	162	25				
Layer 2 WEATHERED ROCK	Max	N/A	N/A	N/A		N/A		N/A				Max	87	250	28				
	Min	N/A	N/A	N/A		N/A		N/A		S_u = 4000 psf		Min	38	200	28			c' = 28 psf	
	Average	N/A	N/A	N/A		N/A		N/A		Φ = 0 deg		Average	51	233	28			Φ' = 200 deg	
	Std Dev	N/A	N/A	N/A		N/A		N/A				Std Dev	20	25	0				
										Y_{dry} = 160 pcf								Y_{dry} = 160 pcf	
	Avg + Std	N/A	N/A	N/A		N/A		N/A		Y_{moist} = 165 pcf		Avg + Std	71	258	28			Y_{moist} = 165 pcf	
	Avg - Std	N/A	N/A	N/A		N/A		N/A				Avg - Std	31	208	28				
Layer 3 SOFT TO MEDIUM STIFF COHESIVE	Max	N/A	1575	1197		100		120				Max	9	107	22				
	Min	N/A	0	0		85		105		S_u = 500 psf		Min	0	15	15			c' = 15 psf	
	Average	N/A	619	471		90		107		Φ = 0 deg		Average	4	49	19			Φ' = 15 deg	
	Std Dev	N/A	506	385		5		3				Std Dev	3	31	3				
										Y_{dry} = 90 pcf								Y_{dry} = 90 pcf	
	Avg + Std	N/A	1125	855		95		111		Y_{moist} = 105 pcf		Avg + Std	6	79	21			Y_{moist} = 105 pcf	
	Avg - Std	N/A	113	86		86		104				Avg - Std	1	18	16				

ODOT District 10
MOE-78-8.30

Soil Strength Parameter Determination

Computed By = AKB
Checked By = DMV

Values for Soil Strength Correlation	
Reference	Value
HI PI (Sowers)	0.25
MD PI (Sowers)	0.175
LO PI (Sowers)	0.075
T&P	0.133

Layer 1

	N_{60}	% Rec	HP	% Gr	% CS	% FS	% Silt	% Clay	LL	PL	PI	% WC		Short-Term Cohesion (psf) N-values PPR	Sowers	T & P	Correlated LT Cohesion (psf) per GB-7	phi (deg)	Midpoint Sample Depth (ft.)	Midpoint Sample Elevation (ft.)	Correlated Dry Unit Wt. (pcf) per GB-7	Correlated Moist Unit Wt. (pcf) per GB-7	Correlated C_c	Assumed Specific Gravity (G_s)	Computed Void Ratio (e)
Max	58	94	4.5	26	16	12	45	45	41	23	18	21	Max	4500	4000	4000	250	28	6.0	1154.3	120	130	0.279	2.72	0.616
Min	17	33	1.8	1	2	7	31	19	36	21	15	14	Min	1750	2975	2261	157	24	3.0	1130.3	105	125	0.234	2.65	0.414
Average	27	59	2.9	13	11	10	37	30	38	22	16	17	Average	2875	3840	3335	190	26	4.8	1137.7	108	125	0.252	2.71	0.565
Std Dev	10	24	1.0	13	8	3	7	14	3	1	2	3	Std Dev	971	343	728	27	1	0.8	9.5	5	1	0.024	0.03	0.069
Avg + Std	37	83	3.8	26	18	12	44	43	41	23	18	20	Avg + Std	3846	4183	4063	217	27	5.6	1147.3	113	126	0.276	2.74	0.635
Avg - Std	17	34	1.9	0	3	7	30	16	35	21	14	14	Avg - Std	1904	3497	2608	162	25	4.1	1128.2	103	124	0.228	2.68	0.496

Alignment	Surface Elevation	Exploration ID	From		To	Sample ID	N_{60}	% Rec	HP	% Gr	% CS	% FS	% Silt	% Clay	LL	PL	PI	% WC	ODOT Class.	Soil Type	Layer	Short-Term Cohesion (psf) N-values PPR	Sowers	T & P	Correlated LT Cohesion (psf) per GB-7	phi (deg)	Midpoint Sample Depth (ft.)	Midpoint Sample Elevation (ft.)	Correlated Dry Unit Wt. (pcf) per GB-7	Correlated Moist Unit Wt. (pcf) per GB-7	Correlated C_c	Assumed Specific Gravity (G_s)	Computed Void Ratio (e)
SR 78	1153.7	B-001-0-23	3.5	-	5	SS-2	25	33	4.5	12	16	12	35	25	37	22	15	14	A-6a	Cohesive	1	4500	4000	3325	183	25	4.0	1149.7	105	125	0.243	2.72	0.616
SR 78	1155.5	B-002-0-23	4	-	5.5	SS-2	25	67	2.5	-	-	-	-	-	-	-	-	17	A-6a	Cohesive	1	2500	4000	3325	183	25	5.0	1150.5	105	125		2.72	0.616
SR 78	1155.5	B-002-0-23	5.5	-	7	SS-3	17	94	2.5	26	14	10	31	19	36	21	15	14	A-6a	Cohesive	1	2500	2975	2261	157	24	6.0	1149.5	110	125	0.234	2.72	0.543
SR 78	1157.3	B-003-0-23	2.5	-	4	SS-1	17	50	3.5	1	2	7	45	45	41	23	18	21	A-7-6	Cohesive	1	3500	4000	2261	157	24	3.0	1154.3	105	125	0.279	2.65	0.575
SR 78	1157.3	B-003-0-23	4	-	5.5	SS-2	17	33	2.5	-	-	-	-	-	-	-	-	19	A-7-6	Cohesive	1	2500	4000	2261	157	24	5.0	1152.3	105	125		2.65	0.575
SR 78	1157.3	B-003-0-23	6	-	6.5	SS-3A	Refusal	75	1.75	-	-	-	-	-	-	-	-	16	A-7-6	Cohesive	1	1750	N/A	N/A	250	28	6.0	1151.3				2.65	
SR 78	1135.3	D-001-1-23	4.26	-	4.59		17	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	2975	2261	157	24	4.0	1131.3	105	125		2.72	0.616
SR 78	1135.3	D-001-1-23	4.59	-	4.92		33	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	4000	200	27	5.0	1130.3	115	125		2.72	0.476
SR 78	1135.3	D-001-1-23	4.92	-	5.25		32	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	4000	200	26	5.0	1130.3	115	125		2.72	0.476
SR 78	1135.3	D-001-1-23	5.25	-	5.58		29	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	3857	197	26	5.0	1130.3	105	125		2.72	0.616
SR 78	1136.7	D-002-1-23 T1	4.26	-	4.59		21	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	3675	2793	170	25	4.0	1132.7	105	125		2.72	0.616
SR 78	1136.7	D-002-1-23 T1	4.59	-	4.92		30	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	3990	200	26	5.0	1131.7	105	125		2.72	0.616
SR 78	1136.7	D-002-1-23 T1	4.92	-	5.25		20	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	3500	2660	167	25	5.0	1131.7	105	125		2.72	0.616
SR 78	1136.7	D-002-1-23 T1	5.25	-	5.58		24	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	3192	180	25	5.0	1131.7	105	125		2.72	0.616
SR 78	1136.7	D-002-1-23 T1	5.58	-	5.9		58	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	4000	250	28	6.0	1130.7	120	130		2.72	0.414
SR 78	1136.7	D-002-1-23 T2	4.26	-	4.59		29	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	3857	197	26	4.0	1132.7	105	125		2.72	0.616
SR 78	1136.7	D-002-1-23 T2	4.59	-	4.92		31	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	4000	200	26	5.0	1131.7	115	125		2.72	0.476
SR 78	1136.7	D-002-1-23 T2	4.92	-	5.25		30	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	3990	200	26	5.0	1131.7	105	125		2.72	0.616
SR 78	1136.7	D-002-1-23 T2	5.25	-	5.58		39	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	1	N/A	4000	4000	200	28	5.0	1131.7	115	125		2.72	0.476

Material types for D-001-1-23 and D-002-1-23 are assumed. N-values are correlated N_{SPT} values.

Values for Soil Strength Correlation	
Reference	Value
HI PI (Sowers)	0.25
MD PI (Sowers)	0.175
LO PI (Sowers)	0.075
T&P	0.133

Layer 2

	N_{60}	% Rec	HP	% Gr	% CS	% FS	% Silt	% Clay	LL	PL	PI	% WC		Short-Term Cohesion (psf) N-values PPR	Sowers	T & P	Correlated LT Cohesion (psf) per GB-7	phi (deg)	Midpoint Sample Depth (ft.)	Midpoint Sample Elevation (ft.)	Correlated Dry Unit Wt. (pcf) per GB-7	Correlated Moist Unit Wt. (pcf) per GB-7	Correlated C_c	Assumed Specific Gravity (G_s)	Computed Void Ratio (e)
Max	87	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	Max	N/A	N/A	N/A	250	28	7.0	1150.3	N/A	N/A	N/A	N/A	N/A
Min	38	75	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6	Min	N/A	N/A	N/A	200	28	6.0	1129.3	N/A	N/A	N/A	N/A	N/A
Average	51	92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8	Average	N/A	N/A	N/A	233	28	6.2	1136.5	N/A	N/A	N/A	N/A	N/A
Std Dev	20	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	Std Dev	N/A	N/A	N/A	25	0	0.4	9.3	N/A	N/A	N/A	N/A	N/A
Avg + Std	71	106	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	Avg + Std	N/A	N/A	N/A	258	28	6.7	1145.8	N/A	N/A	N/A	N/A	N/A
Avg - Std	31	77	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6	Avg - Std	N/A	N/A	N/A	208	28	5.8	1127.1	N/A	N/A	N/A	N/A	N/A

Alignment	Surface Elevation	Exploration ID	From		To	Sample ID	N_{60}	% Rec	HP	% Gr	% CS	% FS	% Silt	% Clay	LL	PL	PI	% WC	ODOT Class.	Soil Type	Layer	Short-Term Cohesion (psf) N-values PPR	Sowers	T & P	Correlated LT Cohesion (psf) per GB-7	phi (deg)	Midpoint Sample Depth (ft.)	Midpoint Sample Elevation (ft.)	Correlated Dry Unit Wt. (pcf) per GB-7	Correlated Moist Unit Wt. (pcf) per GB-7	Correlated C_c	Assumed Specific Gravity (G_s)	Computed Void Ratio (e)
SR 78	1153.7	B-001-0-23	6	-	6.25	SS-3	Refusal	100	-	-	-	-	-	-	-	-	-	6	Rock		2	N/A	N/A	N/A	250	28	6.0	1147.7					
SR 78	1155.5	B-002-0-23	7	-	7.83	SS-4	Refusal	100	-	-	-	-	-	-	-	-	-	7	Rock		2	N/A	N/A	N/A	250	28	7.0	1148.5					
SR 78	1157.3	B-003-0-23	6.5	-	7.33	SS-3B	Refusal	75	-	-	-	-	-	-	-	-	-	10	Rock		2	N/A	N/A	N/A	250	28	7.0	1150.3					
SR 78	1135.3	D-001-1-23	5.58	-	5.9		44	-	-	-	-	-	-	-	-	-	-	-	Rock		2	N/A	N/A	N/A	250	28	6.0	1129.3					
SR 78	1135.3	D-001-1-23	5.9	-	6.23		38	-	-	-	-	-	-	-	-	-	-	-	Rock		2	N/A	N/A	N/A	200	28	6.0	1129.3					
SR 78	1136.7	D-002-1-23 T1	5.9	-	6.23		87	-	-	-	-	-	-	-	-	-	-	-	Rock		2	N/A	N/A	N/A	250	28	6.0	1130.7					
SR 78	1136.7	D-002-1-23 T1	6.23	-	6.56		38	-	-	-	-	-	-	-	-	-	-	-	Rock		2	N/A	N/A	N/A	200	28	6.0	1130.7					
SR 78	1136.7	D-002-1-23 T2	5.58	-	5.9		61	-	-	-	-	-	-	-	-	-	-	-	Rock		2	N/A	N/A	N/A	250	28	6.0	1130.7					
SR 78	1136.7	D-002-1-23 T2	5.9	-	6.23		38	-	-	-	-	-	-	-	-	-	-	-	Rock		2	N/A	N/A	N/A	200	28	6.0	1130.7					

Material types for D-001-1-23 and D-002-1-23 are assumed. N-values are correlated N_{SPT} values.

ODOT District 10
MOE-78-8.30

Soil Strength Parameter Determination

Computed By = AKB
Checked By = DMV

Values for Soil Strength Correlation	
Reference	Value
HI PI (Sowers)	0.25
MD PI (Sowers)	0.175
LO PI (Sowers)	0.075
T&P	0.133

Layer 3

	N_{60}	% Rec	HP	% Gr	% CS	% FS	% Silt	% Clay	LL	PL	PI	% WC		Short-Term Cohesion (psf) N-values PPR	Sowers	T & P	Correlated LT Cohesion (psf) per GB-7	phi (deg)	Midpoint Sample Depth (ft.)	Midpoint Sample Elevation (ft.)	Correlated Dry Unit Wt. (pcf) per GB-7	Correlated Moist Unit Wt. (pcf) per GB-7	Correlated C_c	Assumed Specific Gravity (G_s)	Computed Void Ratio (e)
Max	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Max	N/A	1575	1197	107	22	4.0	1136.7	100	120	N/A	2.72	0.997
Min	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Min	N/A	0	0	15	15	0.0	1131.3	85	105	N/A	2.72	0.697
Average	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Average	N/A	619	471	49	19	2.0	1134.3	90	107	N/A	2.72	0.883
Std Dev	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Std Dev	N/A	506	385	31	3	1.3	1.5	5	3	N/A	0.00	0.100
Avg + Std	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Avg + Std	N/A	1125	855	79	21	3.3	1135.8	95	111	N/A	2.72	0.983
Avg - Std	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Avg - Std	N/A	113	86	18	16	0.7	1132.8	86	104	N/A	2.72	0.783

Alignment	Surface Elevation	Exploration ID	From		To	Sample ID	N_{60}	% Rec	HP	% Gr	% CS	% FS	% Silt	% Clay	LL	PL	PI	% WC	ODOT Class.	Soil Type	Layer	Short-Term Cohesion (psf) N-values PPR	Sowers	T & P	Correlated LT Cohesion (psf) per GB-7	phi (deg)	Midpoint Sample Depth (ft.)	Midpoint Sample Elevation (ft.)	Correlated Dry Unit Wt. (pcf) per GB-7	Correlated Moist Unit Wt. (pcf) per GB-7	Correlated C_c	Assumed Specific Gravity (G_s)	Computed Void Ratio (e)
SR 78	1135.3	D-001-1-23	0	-	0.33		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	0.0	1135.3	85	105		2.72	0.997
SR 78	1135.3	D-001-1-23	0.33	-	0.66		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	0.0	1135.3	85	105		2.72	0.997
SR 78	1135.3	D-001-1-23	0.66	-	0.98		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	1.0	1134.3	85	105		2.72	0.997
SR 78	1135.3	D-001-1-23	0.98	-	1.31		2	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	350	266	25	18	1.0	1134.3	85	105		2.72	0.997
SR 78	1135.3	D-001-1-23	1.31	-	1.64		1	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	175	133	15	15	1.0	1134.3	85	105		2.72	0.997
SR 78	1135.3	D-001-1-23	1.64	-	1.97		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	2.0	1133.3	85	105		2.72	0.997
SR 78	1135.3	D-001-1-23	1.97	-	2.3		2	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	350	266	25	18	2.0	1133.3	85	105		2.72	0.997
SR 78	1135.3	D-001-1-23	2.3	-	2.62		3	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	525	399	38	19	2.0	1133.3	90	105		2.72	0.886
SR 78	1135.3	D-001-1-23	2.62	-	2.95		4	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	700	532	50	20	3.0	1132.3	90	105		2.72	0.886
SR 78	1135.3	D-001-1-23	2.95	-	3.28		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	3.0	1132.3	95	110		2.72	0.787
SR 78	1135.3	D-001-1-23	3.28	-	3.61		6	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1050	798	75	21	3.0	1132.3	95	110		2.72	0.787
SR 78	1135.3	D-001-1-23	3.61	-	3.94		8	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1400	1064	100	22	4.0	1131.3	95	110		2.72	0.787
SR 78	1135.3	D-001-1-23	3.94	-	4.26		8	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1400	1064	100	22	4.0	1131.3	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T1	0	-	0.33		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	0.0	1136.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T1	0.33	-	0.66		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	0.0	1136.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T1	0.66	-	0.98		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	1.0	1135.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T1	0.98	-	1.31		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	1.0	1135.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T1	1.31	-	1.64		2	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	350	266	25	18	1.0	1135.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T1	1.64	-	1.97		3	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	525	399	38	19	2.0	1134.7	90	105		2.72	0.886
SR 78	1136.7	D-002-1-23 T1	1.97	-	2.3		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	2.0	1134.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T1	2.3	-	2.62		3	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	525	399	38	19	2.0	1134.7	90	105		2.72	0.886
SR 78	1136.7	D-002-1-23 T1	2.62	-	2.95		3	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	525	399	38	19	3.0	1133.7	90	105		2.72	0.886
SR 78	1136.7	D-002-1-23 T1	2.95	-	3.28		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	3.0	1133.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T1	3.28	-	3.61		8	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1400	1064	100	22	3.0	1133.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T1	3.61	-	3.94		8	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1400	1064	100	22	4.0	1132.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T1	3.94	-	4.26		6	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1050	798	75	21	4.0	1132.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	0	-	0.33		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	0.0	1136.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T2	0.33	-	0.66		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	0.0	1136.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T2	0.66	-	0.98		0	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	0	0	15	15	1.0	1135.7	85	105		2.72	0.997
SR 78	1136.7	D-002-1-23 T2	0.98	-	1.31		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	1.0	1135.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	1.31	-	1.64		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	1.0	1135.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	1.64	-	1.97		4	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	700	532	50	20	2.0	1134.7	90	105		2.72	0.886
SR 78	1136.7	D-002-1-23 T2	1.97	-	2.3		8	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1400	1064	100	22	2.0	1134.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	2.3	-	2.62		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	2.0	1134.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	2.62	-	2.95		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	3.0	1133.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	2.95	-	3.28		4	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	700	532	50	20	3.0	1133.7	90	105		2.72	0.886
SR 78	1136.7	D-002-1-23 T2	3.28	-	3.61		5	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	875	665	63	21	3.0	1133.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	3.61	-	3.94		6	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1050	798	75	21	4.0	1132.7	95	110		2.72	0.787
SR 78	1136.7	D-002-1-23 T2	3.94	-	4.26		9	-	-	-	-	-	-	-	-	-	-	-	A-6a	Cohesive	3	N/A	1575	1197	107	22	4.0	1132.7	100	120		2.72	0.697

Material types for D-001-1-23 and D-002-1-23 are assumed. N-values are correlated N_{SPT} values.

PROJECT: MOE-78-08.30	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 440+74, 6' RT.	EXPLORATION ID B-001-0-23
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: HDR / AKB	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR 78	
PID: 117973 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 3/7/22	ELEVATION: 1153.7 (MSL) EOB: 26.7 ft.	PAGE 1 OF 1
START: 3/23/23 END: 3/23/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.766396, -81.223613	

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 (42")	1153.7																	
Layer 1: Very Stiff to Hard Cohesive			27 5 3	12	28	SS-1	-	-	-	-	-	-	-	-	-	-		
VERY STIFF TO HARD, BROWN AND RED-BROWN, **SILT AND CLAY**, SOME SAND, LITTLE ROCK FRAGMENTS, DAMP (FILL)	1150.2		6 7 10	25	33	SS-2	4.5+	12	16	12	35	25	37	22	15	14	A-6a (7)	
SANDSTONE, BROWN, SEVERELY WEATHERED, WEAK.	1147.7	TR	50/3"	-	100	SS-3	-	-	-	-	-	-	-	-	-	6	Rock (V)	
SANDSTONE, BROWN, HIGHLY WEATHERED, MODERATELY STRONG, FINE TO MEDIUM GRAINED, THIN TO MEDIUM BEDDED, JOINT DISCONTINUITIES, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 0%, REC 100%.	1147.0				100	NQ2-1											CORE	
Layer 2: Weathered Rock (Modeled with bedrock layers)	1144																	
SILTSTONE, BROWN, MODERATELY WEATHERED, VERY WEAK, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 37%, REC 100%. @9.7' - 11.7: highly fractured			33		100	NQ2-2											CORE	
SILTSTONE, RED-BROWN, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 62%, REC 97%. @18.6' - 18.9': gray limestone seam @18.9' - 19.6': dark gray	1138.2		62		97	NQ2-3											CORE	
CLAYSTONE, RED-BROWN, HIGHLY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 92%, REC 100%.	1133.3		93		100	NQ2-4											CORE	
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY FRACTURED, NARROW APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 100%, REC 100%. @26.6' - 26.6': qu = 4734 psi, γ = 166 pcf	1130.3																	
	1127.0	EOB																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 12.5 LB. BENTONITE POWDER; 47 LB. CEMENT MIXED WITH 25 GAL. WATER; SURFACE PATCHED WITH QUICKCRETE

PROJECT: MOE-78-08.30	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 441+39, 4' RT.	EXPLORATION ID B-002-0-23
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: HDR / AKB	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR 78	
PID: 117973 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 3/7/22	ELEVATION: 1155.5 (MSL) EOB: 28.7 ft.	PAGE 1 OF 2
START: 3/23/23 END: 3/23/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.766397, -81.223383	

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 (48")	1155.5																	
Layer 1: Very Stiff to Hard Cohesive																		
VERY STIFF, BROWN, **SILT AND CLAY**, SOME ROCK FRAGMENTS, SOME SAND (FILL)	1151.5		22 12 7	27	56	SS-1	-	-	-	-	-	-	-	-	-	-		
			7 6 11	25	67	SS-2	2.50	-	-	-	-	-	-	-	-	17	A-6a (V)	
			6 5 7	17	94	SS-3	2.50	26	14	10	31	19	36	21	15	14	A-6a (5)	
SANDSTONE, BROWN, SEVERELY WEATHERED, WEAK.	1148.5	TR	35 50/4"	-	100	SS-4	-	-	-	-	-	-	-	-	-	7	Rock (V)	
SANDSTONE, BROWN AND GRAY, HIGHLY WEATHERED, MODERATELY STRONG, FINE TO MEDIUM GRAINED, THIN TO MEDIUM BEDDED, JOINT DISCONTINUITIES, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 14%, REC 100%.	1146.8																	
Layer 2: Weathered Rock (Modeled with bedrock layers)					100	NQ2-1											CORE	
SILTSTONE, BROWN, MODERATELY WEATHERED, WEAK TO SLIGHTLY STRONG, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 0%, REC 100%.	1141.9																	
SANDSTONE, GRAY, MODERATELY WEATHERED, SLIGHTLY TO MODERATELY STRONG, MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 82%, REC 100%.	1141.0		73		100	NQ2-2											CORE	
SILTSTONE, GRAY AND BROWN, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY TO MODERATELY FRACTURED, NARROW TO OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 54%, REC 100%. @16.7' - 17.1': qu = 694 psi, γ = 162 pcf	1137.9																	
SILTSTONE, RED-BROWN, SLIGHTLY TO MODERATELY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, GOOD SURFACE; RQD 81%, REC 100%. @20.7' - 21.4': gray limestone layer	1133.5		78		96	NQ2-3											CORE	
CLAYSTONE, RED-BROWN, HIGHLY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 56%, REC	1130.8																	
	1126.8	EOB																

PID: 117973	SFN:	PROJECT: MOE-78-08.30	STATION / OFFSET: 441+39, 4' RT.	START: 3/23/23	END: 3/23/23	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
88%.	1125.5																	
SANDSTONE, GRAY, SLIGHTLY WEATHERED, MODERATELY STRONG, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, SLIGHTLY FRACTURED, NARROW APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 100%, REC 100%.																		
@26.8' - 27.2': qu = 4517 psi, γ = 166 pcf																		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 12.5 LB. BENTONITE POWDER; 47 LB. CEMENT MIXED WITH 25 GAL. WATER; SURFACE PATCHED WITH QUICKCRETE

PROJECT: MOE-78-08.30	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 442+00, 4' RT.	EXPLORATION ID B-003-0-23
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: HDR / AKB	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SR 78	
PID: 117973 SFN:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 3/7/22	ELEVATION: 1157.3 (MSL) EOB: 27.2 ft.	PAGE 1 OF 2
START: 3/23/23 END: 3/23/23	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.766395, -81.223166	

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 (30")	1157.3																	
	1154.8																	
VERY STIFF, BROWN, **CLAY**, "AND" SILT, TRACE ROCK FRAGMENTS, TRACE SAND, DAMP (FILL)			5 6 6	17	50	SS-1	3.50	1	2	7	45	45	41	23	18	21	A-7-6 (11)	
Layer 1: Very Stiff to Hard Cohesive			4 5 7	17	33	SS-2	2.50	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
	1150.8	TR	10 12 50/4"	-	75	SS-3A	1.75	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
SANDSTONE, BROWN, SEVERELY WEATHERED, WEAK.	1150.1					SS-3B	-	-	-	-	-	-	-	-	-	10	Rock (V)	
SANDSTONE, BROWN, MODERATELY TO HIGHLY WEATHERED, WEAK, THIN BEDDED, JOINT DISCONTINUITIES, HIGHLY FRACTURED, OPEN APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, POOR SURFACE; RQD 0%, REC 100%.	1148																	
Layer 2: Weathered Rock (Modeled with bedrock layers)																		
SANDSTONE, GRAY AND BROWN, MODERATELY WEATHERED, MODERATELY STRONG, THIN TO MEDIUM BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR SURFACE; RQD 70%, REC 100%. @11.3' - 11.7': qu = 5763 psi, γ = 162 pcf	1143.1		58		100	NQ2-1											CORE	
SILTSTONE, GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, THIN BEDDED, JOINT DISCONTINUITIES, FRACTURED TO HIGHLY FRACTURED, OPEN APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, DISINTEGRATED STRUCTURE, VERY POOR TO POOR SURFACE; RQD 14%, REC 100%.	1137.8		51		100	NQ2-2											CORE	
SILTSTONE, RED-BROWN, MODERATELY WEATHERED, VERY WEAK, MEDIUM TO THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR TO GOOD SURFACE; RQD 91%, REC 100%. @22.5' - 23.2': gray limestone layer, moderately strong	1133.1																	
CLAYSTONE, RED-BROWN, HIGHLY WEATHERED, VERY WEAK, THICK BEDDED, JOINT DISCONTINUITIES, MODERATELY FRACTURED TO FRACTURED, NARROW APERTURE WIDTH, SLIGHTLY ROUGH SURFACE, BLOCKY STRUCTURE, POOR TO FAIR SURFACE; RQD 60%, REC 80%.	1130.6		50		83	NQ2-3											CORE	
	1130.1	EOB																
SANDSTONE, GRAY, MODERATELY WEATHERED, MODERATELY STRONG, THIN BEDDED, JOINT DISCONTINUITIES, FRACTURED, OPEN APERTURE WIDTH, VERY ROUGH SURFACE, BLOCKY STRUCTURE, FAIR																		

PID: 117973	SFN:	PROJECT: MOE-78-08.30	STATION / OFFSET: 442+00, 4' RT.	START: 3/23/23	END: 3/23/23	PG 2 OF 2	B-003-0-23

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
SURFACE; RQD 0%, REC 100%.	1127.3																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: TREMIED 12.5 LB. BENTONITE POWDER; 47 LB. CEMENT MIXED WITH 25 GAL. WATER; SURFACE PATCHED WITH QUICKCRETE

Dynamic Cone Penetration Test Log

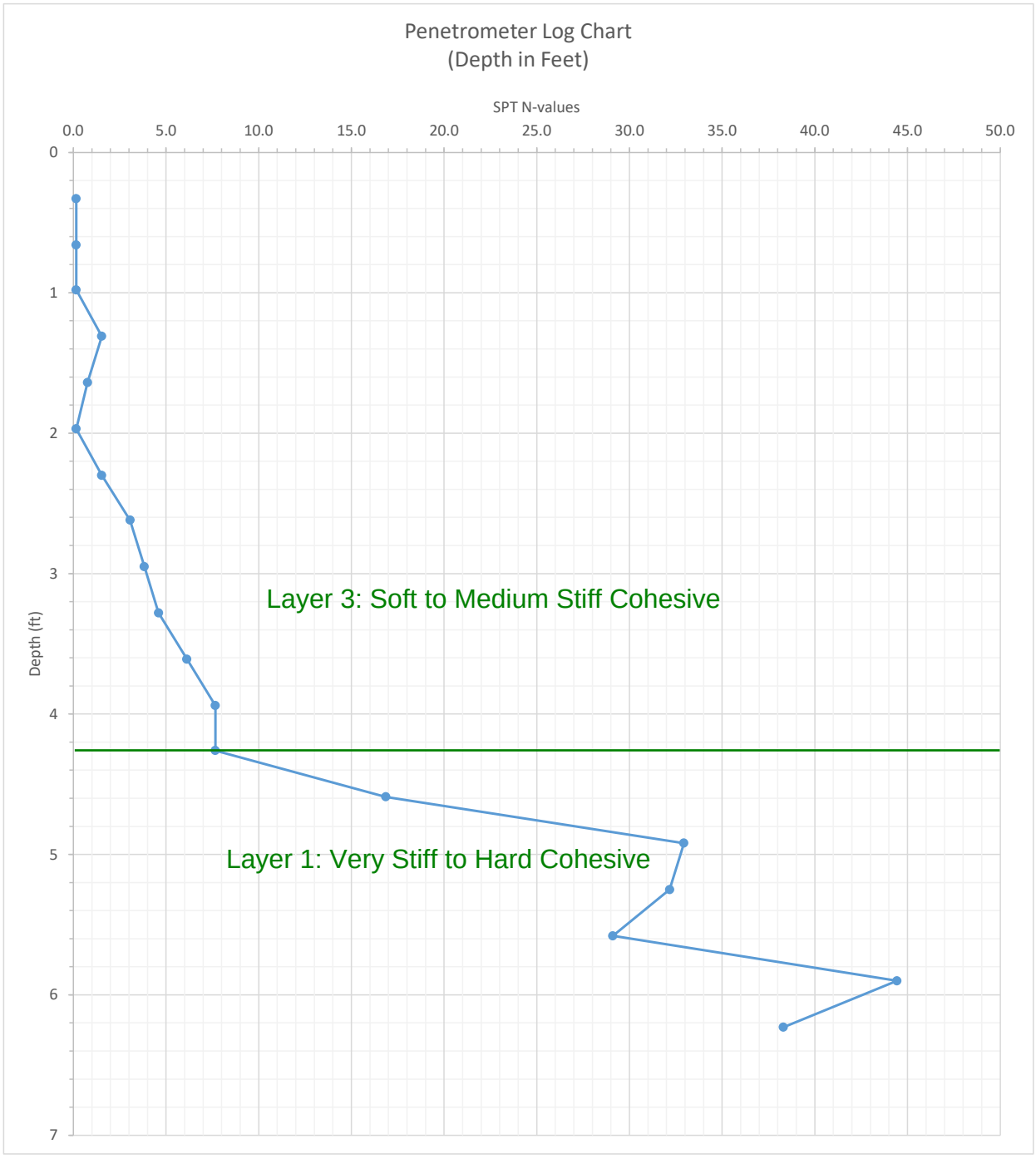
Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662152 -81.2234885
Location:	D-001-1-23	**North / East:**	645828.6 2327320.9
Station, Offset:	441+11, 71' RT	**Date:**	3/22/2023
Elevation:	1135.3	**Sheet:**	1 of 2
Notes:	Staked Location		

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value
3.94	0.33	10	0.2	0.2
7.87	0.66	20	0.2	0.2
11.81	0.98	30	0.2	0.2
15.75	1.31	40	2	1.5
19.69	1.64	50	1	0.8
23.62	1.97	60	0.2	0.2
27.56	2.3	70	2	1.5
31.5	2.62	80	4	3.1
35.43	2.95	90	5	3.8
39.37	3.28	100	6	4.6
43.31	3.61	110	8	6.1
47.24	3.94	120	10	7.7
51.18	4.26	130	10	7.7
55.12	4.59	140	22	16.9
59.06	4.92	150	43	32.9
62.99	5.25	160	42	32.2
66.93	5.58	170	38	29.1
70.87	5.9	180	58	44.4
74.8	6.23	190	50	38.3

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value

Dynamic Cone Penetration Test Log

Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662152 -81.2234885
Location:	D-001-1-23	**North / East:**	645828.624 2327320.934
Station, Offset:	441+11, 71' RT	**Date:**	3/22/2023
Elevation:	1135.32	**Sheet:**	2 of 2
Notes:	Staked Location		



Dynamic Cone Penetration Test Log

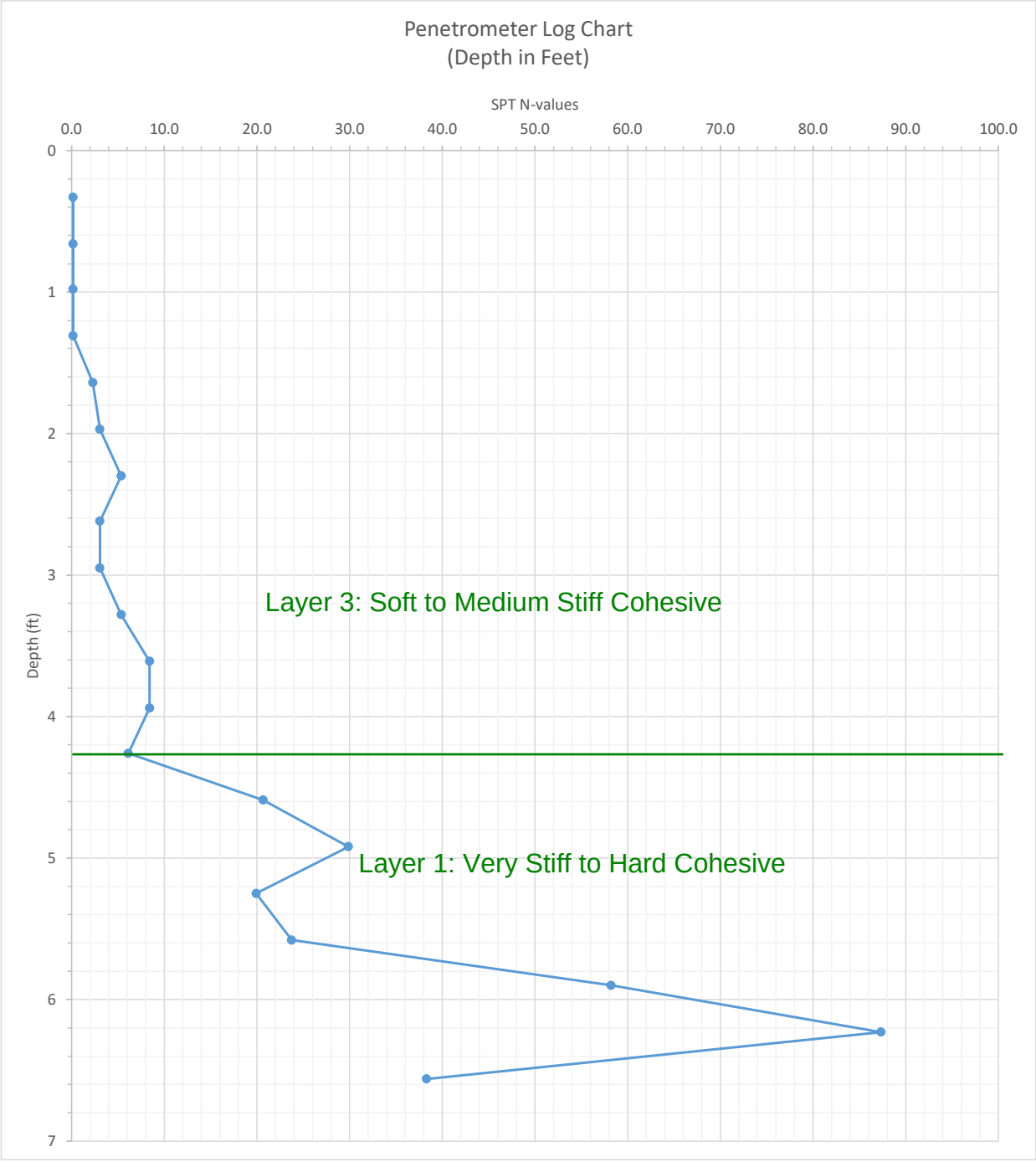
Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.766264 -81.223267
Location:	D-002-1-23	**North / East:**	645847.1 2327382.8
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	1 of 2
Notes:	Test 1, Staked Location		

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value
3.94	0.33	10	0.2	0.2
7.87	0.66	20	0.2	0.2
11.81	0.98	30	0.2	0.2
15.75	1.31	40	0.2	0.2
19.69	1.64	50	3	2.3
23.62	1.97	60	4	3.1
27.56	2.3	70	7	5.4
31.5	2.62	80	4	3.1
35.43	2.95	90	4	3.1
39.37	3.28	100	7	5.4
43.31	3.61	110	11	8.4
47.24	3.94	120	11	8.4
51.18	4.26	130	8	6.1
55.12	4.59	140	27	20.7
59.06	4.92	150	39	29.9
62.99	5.25	160	26	19.9
66.93	5.58	170	31	23.7
70.87	5.9	180	76	58.2
74.8	6.23	190	114	87.3
78.74	6.56	200	50	38.3

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value

Dynamic Cone Penetration Test Log

Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662635 -81.2232674
Location:	D-002-1-23	**North / East:**	645847.086 2327382.847
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	2 of 2
Notes:	Test 1, Staked Location		



Dynamic Cone Penetration Test Log

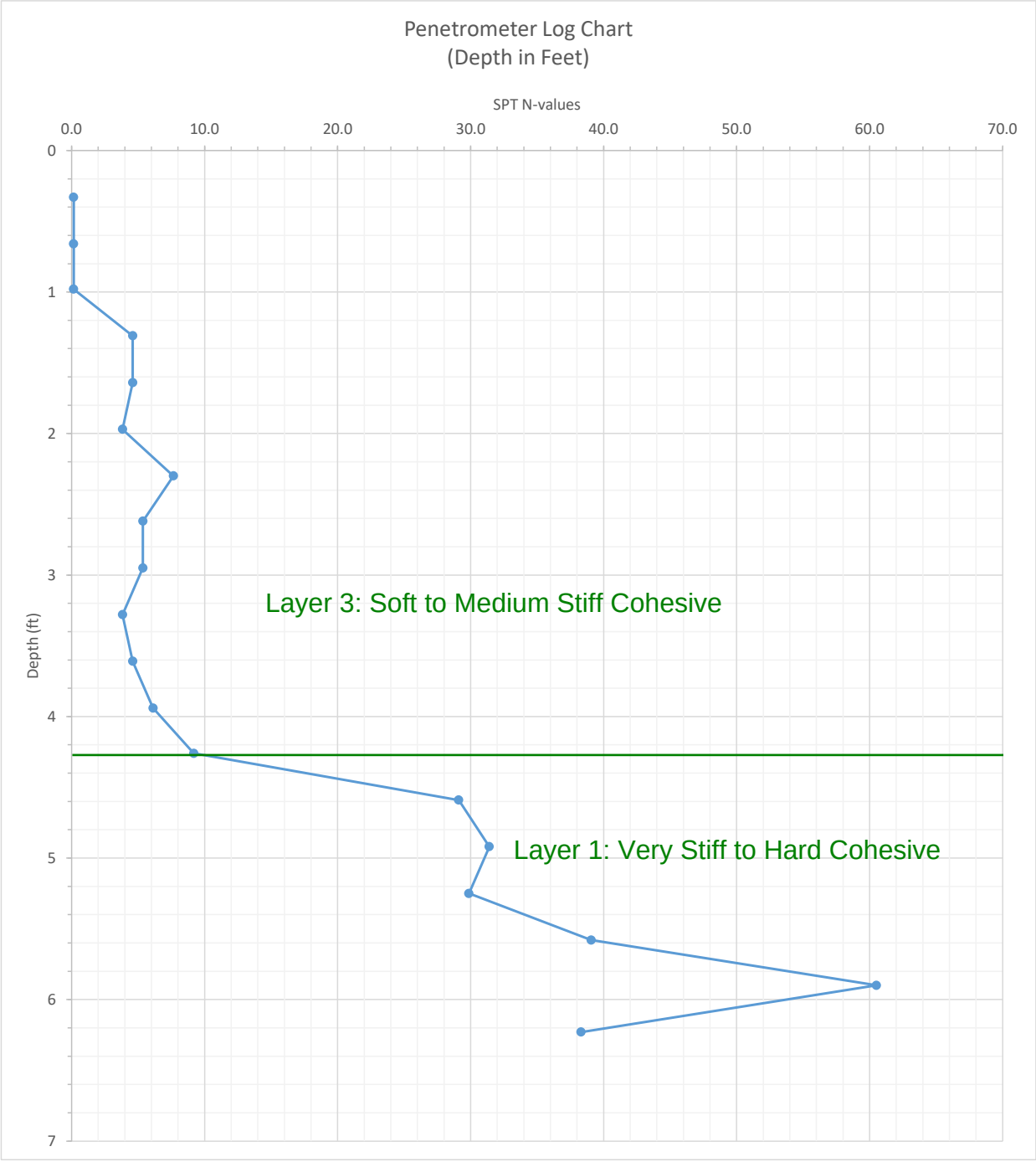
Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.766264 -81.223267
Location:	D-002-1-23	**North / East:**	645847.1 2327382.8
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	1 of 2
Notes:	Test 2, Offset 5' East		

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value
3.94	0.33	10	0.2	0.2
7.87	0.66	20	0.2	0.2
11.81	0.98	30	0.2	0.2
15.75	1.31	40	6	4.6
19.69	1.64	50	6	4.6
23.62	1.97	60	5	3.8
27.56	2.3	70	10	7.7
31.5	2.62	80	7	5.4
35.43	2.95	90	7	5.4
39.37	3.28	100	5	3.8
43.31	3.61	110	6	4.6
47.24	3.94	120	8	6.1
51.18	4.26	130	12	9.2
55.12	4.59	140	38	29.1
59.06	4.92	150	41	31.4
62.99	5.25	160	39	29.9
66.93	5.58	170	51	39.1
70.87	5.9	180	79	60.5
74.8	6.23	190	50	38.3

Depth (in)	Depth (ft)	Depth (cm)	Pre Blows	SPT N-Value

Dynamic Cone Penetration Test Log

Client:	ODOT - District 10	**Operator Name / Company:**	JK / Advanced Materials, LLC
Project Name:	MOE-78-8.30	**Lat / Long:**	39.7662635 -81.2232674
Location:	D-002-1-23	**North / East:**	645847.086 2327382.847
Station, Offset:	441+73, 52' RT	**Date:**	3/22/2023
Elevation:	1136.7	**Sheet:**	2 of 2
Notes:	Test 2, Offset 5' East		



Rock Strength Parameter Determination
and
Laboratory Testing

9999 Carver Road, Suite 210, Cincinnati, OH 45242-5583 **hdrinc.com**
(513) 984-7500

ODOT District 10
MOE-78-8.30

Rock Strength Parameter Determination

Computed By = AKB
Checked By = DMV

BEDROCK TESTING

Project	Exploration ID	Sample Depth (ft)	Sample ID	Rock Type	Color	Moist Unit Weight (pcf)	Compressive Strength (psi)	(MPa)	Er Modulus (psi)	(MPa)	GSI Range	GSI USE	Em (Hoek & Brown) Modulus (GPa)	(psi)	Lesser of Er vs Em (psi)	Em (Yang) Modulus (MPa)	(psi)
MOE-78-8.30	B-001-0-23	26.2 - 26.6	NQ2-4	Sandstone	Gray	166	4374	30.2	455,265	3139	55-65	60	9.8	1416380	455265	498.3	72269
MOE-78-8.30	B-002-0-23	26.8 - 27.2	NQ2-3	Sandstone	Gray	166	4517	31.1	778,793	5370	55-65	60	9.9	1439347	778793	852.4	123627
MOE-78-8.30	B-003-0-23	11.3 - 11.7	NQ2-1	Sandstone	Gray	162	5763	39.7	505,526	3485	45-55	50	6.3	914250	505526	349.0	50620
				Sandstone	Maximum	166	5763						Sandstone	Maximum	778793		
					Minimum	162	4374							Minimum	455265		
					Average	165	4885							Average	579861		
					Std Dev	2	764							Std Dev	174103		
					Adopted Value	165	4800							Adopted Value	579000		

Project	Exploration ID	Sample Depth (ft)	Sample ID	Rock Type	Color	Moist Unit Weight (pcf)	Compressive Strength (psi)	(MPa)	Er Modulus (psi)	(MPa)	GSI Range	GSI USE	Em (Hoek & Brown) Modulus (GPa)	(psi)	Lesser of Er vs Em (psi)	Em (Yang) Modulus (MPa)	(psi)
MOE-78-8.30	B-002-0-23	16.7 - 17.1	NQ2-2	Siltstone	Gray	162	694	4.8	50,625	349	30-40	35	0.9	133789	50625	17.5	2540
				Siltstone	Maximum	162	694						Siltstone	Maximum	50625		
					Minimum	162	694							Minimum	50625		
					Average	162	694							Average	50625		
					Std Dev	N/A	N/A							Std Dev	N/A		
					Adopted Value	160	700							Adopted Value	50600		

krm 0.0005

BEDROCK QUALITY

Upper Sandstone

Project	Exploration ID	Rock Type	Depth Range (ft.) From	To	Thickness (ft)	Layer RQD (%)	Weighted RQD*(Length / Total Length)
MOE-78-8.30	B-001-0-23	Sandstone	6.7	9.7	3	0	0.0
MOE-78-8.30	B-002-0-23	Sandstone	8.7	11	2.3	14	2.4
MOE-78-8.30	B-002-0-23	Sandstone	13.6	14.5	0.9	82	5.6
MOE-78-8.30	B-003-0-23	Sandstone	7.2	8.4	1.2	0	0.0
MOE-78-8.30	B-003-0-23	Sandstone	8.4	14.2	5.8	70	30.8
				Sandstone	13.2	RQD SUM	39
				Maximum	5.8	82	
				Minimum	0.9	0	
				Average	2.6	33.2	
				Adopted Value			40

Lower Sandstone

Project	Exploration ID	Rock Type	Depth Range (ft.) From	To	Thickness (ft)	Layer RQD (%)	Weighted RQD*(Length / Total Length)
MOE-78-8.30	B-001-0-23	Sandstone	23.4	26.7	3.3	100	42.3
MOE-78-8.30	B-002-0-23	Sandstone	24.7	28.7	4	100	51.3
MOE-78-8.30	B-003-0-23	Sandstone	26.7	27.2	0.5	0	0.0
				Sandstone	7.8	RQD SUM	94
				Maximum	4	100	
				Minimum	0.5	0	
				Average	2.6	66.7	
				Adopted Value			95

Project	Exploration ID	Rock Type	Depth Range (ft.) From	To	Thickness (ft)	Layer RQD (%)	Weighted RQD*(Length / Total Length)
MOE-78-8.30	B-001-0-23	Siltstone	9.7	15.5	5.8	37	7.0
MOE-78-8.30	B-001-0-23	Siltstone	15.5	20.4	4.9	62	9.9
MOE-78-8.30	B-002-0-23	Siltstone	11	13.6	2.6	0	0.0
MOE-78-8.30	B-002-0-23	Siltstone	14.5	17.6	3.1	54	5.4
MOE-78-8.30	B-002-0-23	Siltstone	17.6	22	4.4	81	11.6
MOE-78-8.30	B-003-0-23	Siltstone	14.2	19.5	5.3	14	2.4
MOE-78-8.30	B-003-0-23	Siltstone	19.5	24.2	4.7	91	13.9
				Siltstone	30.8	RQD SUM	50
				Maximum	5.8	91	
				Minimum	2.6	0	
				Average	4.4	48.4	
				Adopted Value			50

Project	Exploration ID	Rock Type	Depth Range (ft.) From	To	Thickness (ft)	Layer RQD (%)	Weighted RQD*(Length / Total Length)
MOE-78-8.30	B-001-0-23	Claystone	20.4	23.4	3	92	33.7
MOE-78-8.30	B-002-0-23	Claystone	22	24.7	2.7	56	18.4
MOE-78-8.30	B-003-0-23	Claystone	24.2	26.7	2.5	60	18.3
				Claystone	8.2	RQD SUM	70
				Maximum	3	92	
				Minimum	2.5	56	
				Average	2.7	69.3	
				Adopted Value			70

Table 10.4.6.5-1—Estimation of E_m Based on GSI

Expression	Notes/Remarks	Reference
$E_m\left(GPa\right)=\sqrt{\frac{q_u}{100}}10^{\frac{GSI-10}{40}}$ for $q_u \le 100$ MPa $E_m\left(GPa\right)=10^{\frac{GSI-10}{40}}$ for $q_u \le 100$ MPa	Accounts for rocks with $q_u < 100$ MPa; notes q_u in MPa	Hoek and Brown (1997); Hoek et al. (2002)
$E_m=\frac{E_R}{100}e^{GSI/21.7}$	Reduction factor on intact modulus, based on *GSI*	Yang (2006)

Notes: E_r = modulus of intact rock, E_m = equivalent rock mass modulus, *GSI* = geological strength index, q_u = uniaxial compressive strength, and 1 MPa = 2.09 ksf.

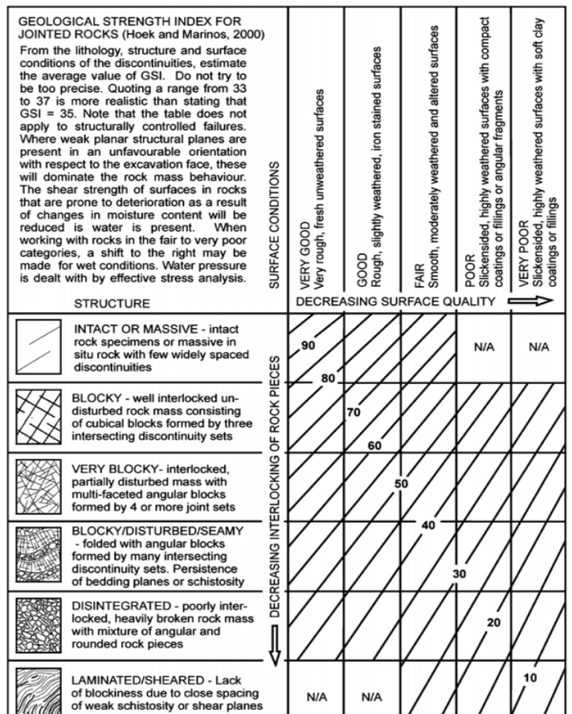


Figure 10.4.6.4-1—Determination of *GSI* for Jointed Rock Mass (Hoek and Marinos, 2000)

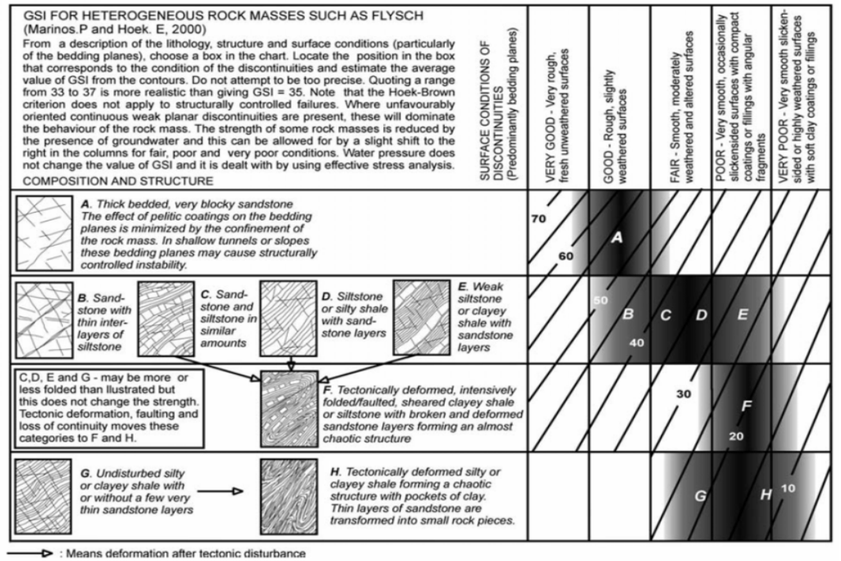


Figure 10.4.6.4-2—Determination of *GSI* for Tectonically Deformed Heterogeneous Rock Masses (Marinos and Hoek 2000)

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5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength of Rock Core (ASTM D7012 Method C)

(Project: MOE-78-8.30, Boring Location: B-001-0-23, NQ2-4, Depth: 26.2 - 26.6ft)

Tested Date: 4/10/2023

Specimen Properties

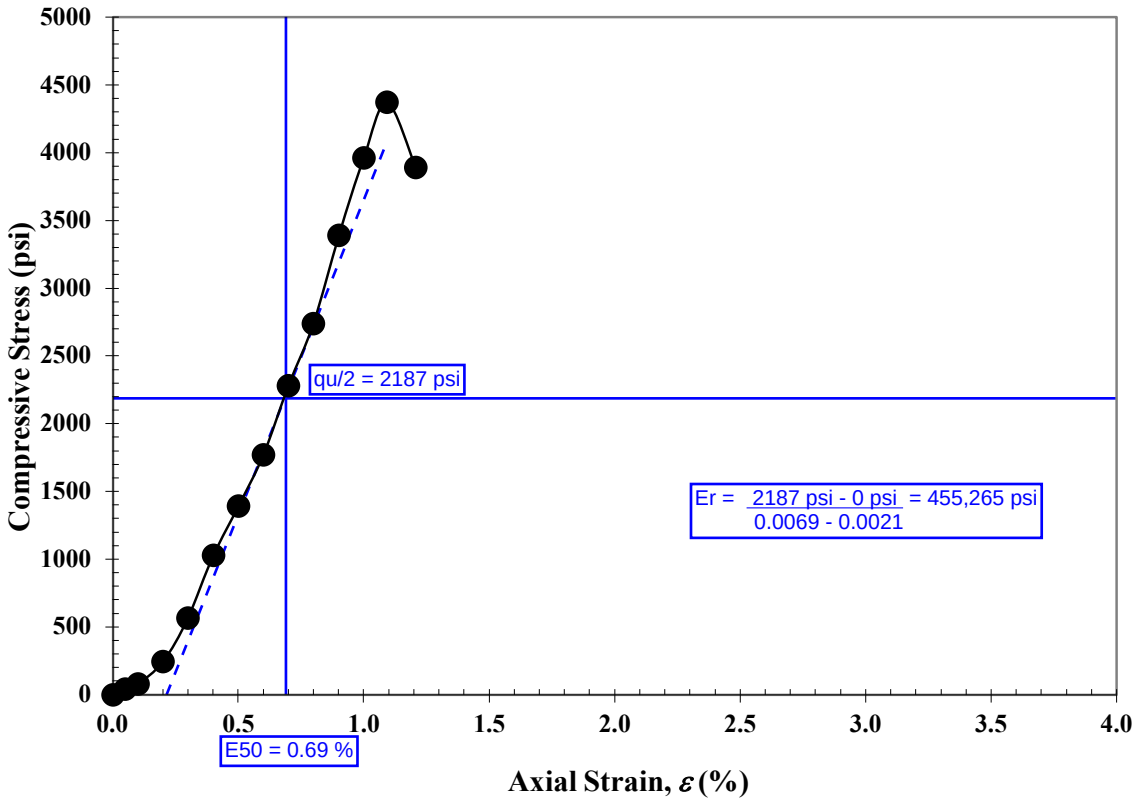
Average Dia., D_{avg} (in):	1.99
Average Height, H_{avg} (in):	4.39
Length to Diameter Ratio:	2.21
Area, A (in^2):	3.11
Volume, V (in^3):	13.67
Wet Mass of Specimen (lb):	1.3
Moisture Content (%):	1.7
Dry Mass of Specimen (lb):	1.3
Wet Unit Weight, γ (lb/ft^3):	166.0
Dry Unit Weight, γ_d (lb/ft^3):	163.2

Final Specimen Figure

Results

Unconfined Compressive Strength (psi): **4374** **30** (MPa)

Strain (%): **1.1**



Notes: Sandstone, gray, slightly weathered, moderately strong, very fine grained.

Sample trimming procedure does not conform to ASTM D4543 and the results reported may differ from the results obtained from a test specimen that meets the requirements of Practice D4543.

NEAS
National Engineering & Architectural Services Inc.

5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength of Rock Core (ASTM D7012 Method C)

(Project: MOE-78-8.30, Boring Location: B-002-0-23, NQ2-2, Depth: 16.7 - 17.1ft)

Tested Date: 4/10/2023

Specimen Properties

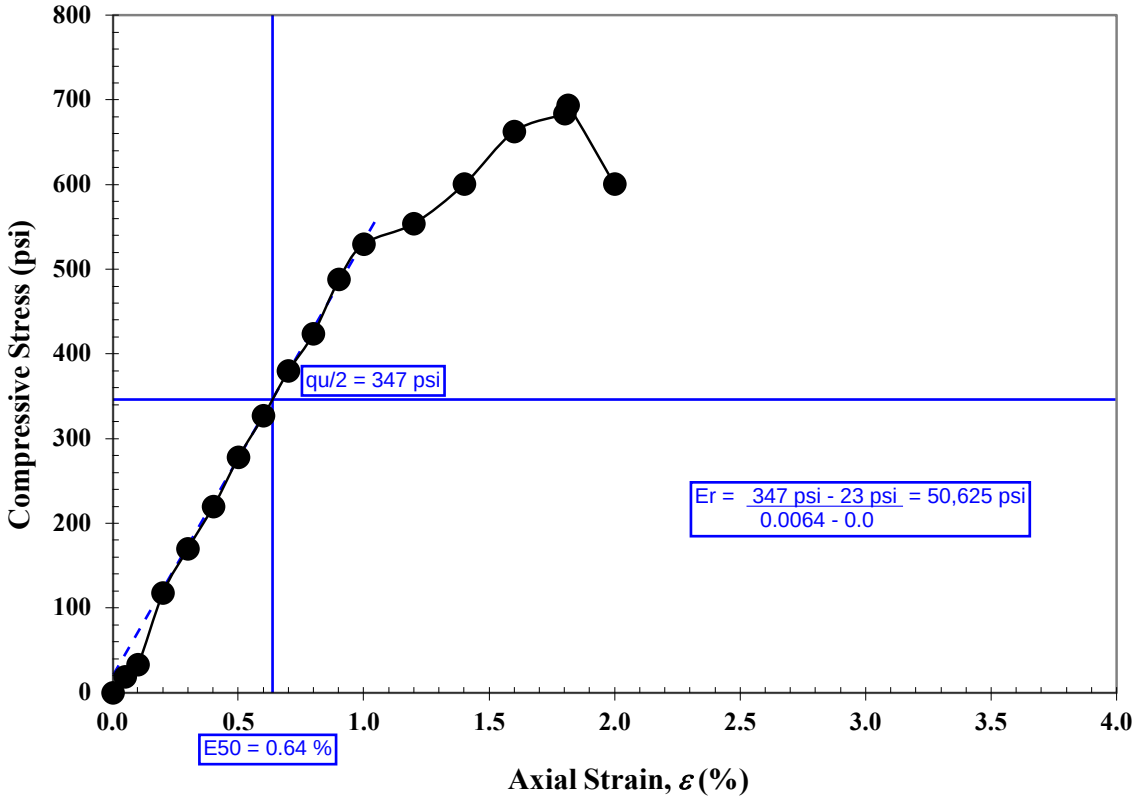
Average Dia., D_{avg} (in):	1.98
Average Height, H_{avg} (in):	4.30
Length to Diameter Ratio:	2.17
Area, A (in^2):	3.08
Volume, V (in^3):	13.24
Wet Mass of Specimen (lb):	1.2
Moisture Content (%):	2.8
Dry Mass of Specimen (lb):	1.2
Wet Unit Weight, γ (lb/ft^3):	162.0
Dry Unit Weight, γ_d (lb/ft^3):	157.5

Final Specimen Figure

Results

Unconfined Compressive Strength (psi): **694** **5** (MPa)

Strain (%): **1.8**



Notes: Siltstone, gray, slightly weathered, very weak.

Sample trimming procedure does not conform to ASTM D4543 and the results reported may differ from the results obtained from a test specimen that meets the requirements of Practice D4543.

NEAS
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5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength of Rock Core (ASTM D7012 Method C)

(Project: MOE-78-8.30, Boring Location: B-002-0-23, NQ2-3, Depth: 26.8 - 27.2ft)

Tested Date: 4/10/2023

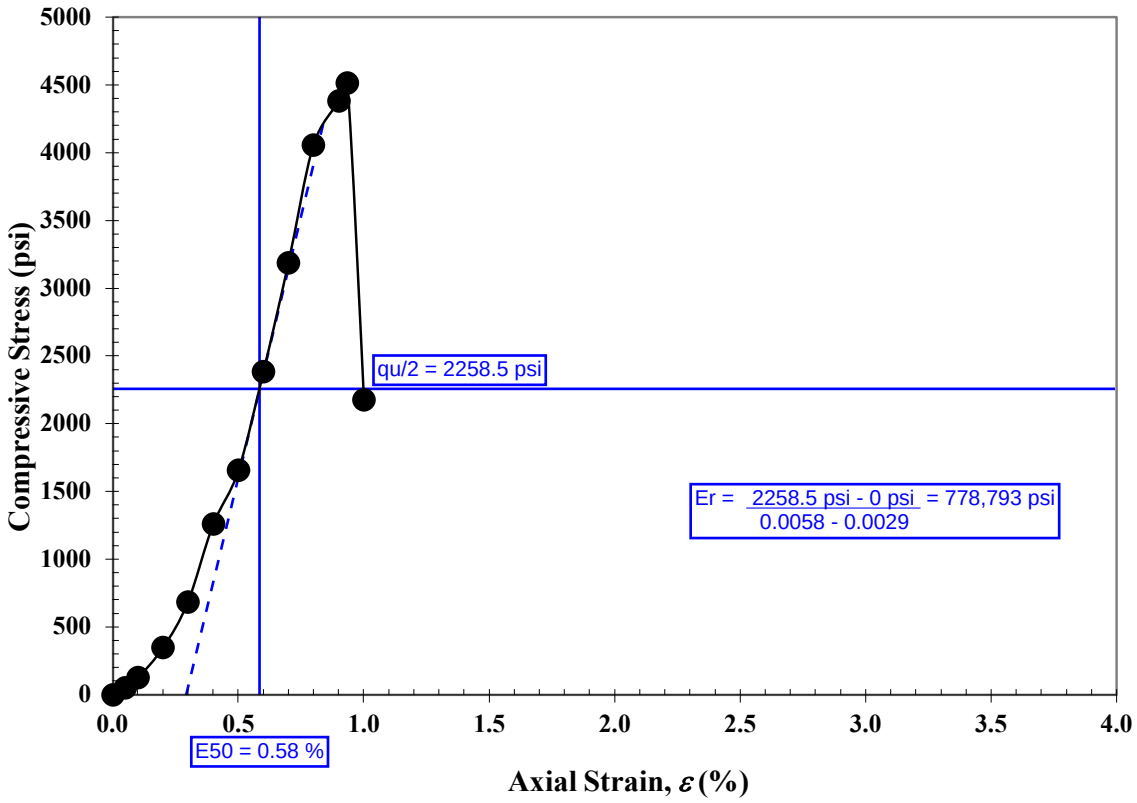
Specimen Properties

Average Dia., D_{avg} (in):	1.98
Average Height, H_{avg} (in):	4.50
Length to Diameter Ratio:	2.27
Area, A (in^2):	3.09
Volume, V (in^3):	13.89
Wet Mass of Specimen (lb):	1.3
Moisture Content (%):	1.1
Dry Mass of Specimen (lb):	1.3
Wet Unit Weight, γ (lb/ft^3):	165.9
Dry Unit Weight, γ_d (lb/ft^3):	164.1

Final Specimen Figure

Results

Unconfined Compressive Strength (psi):	**4517**	**31**	(MPa)
Strain (%):	**0.9**		



Notes: Sandstone, gray, slightly weathered, moderately strong, very fine grained.

NEAS
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5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength of Rock Core (ASTM D7012 Method C)

(Project: MOE-78-8.30, Boring Location: B-003-0-23, NQ2-1, Depth: 11.3 - 11.7ft)

Tested Date: 4/10/2023

Specimen Properties

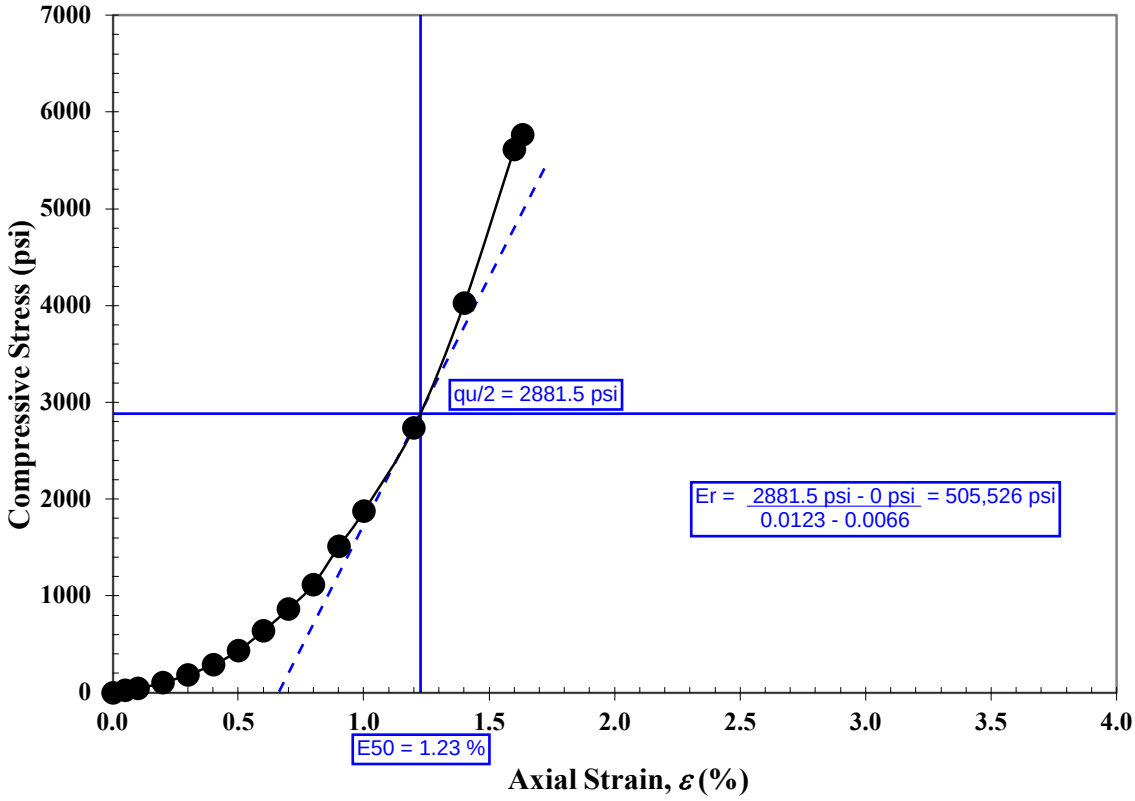
Average Dia., D_{avg} (in):	1.99
Average Height, H_{avg} (in):	4.29
Length to Diameter Ratio:	2.16
Area, A (in^2):	3.10
Volume, V (in^3):	13.30
Wet Mass of Specimen (lb):	1.2
Moisture Content (%):	2.2
Dry Mass of Specimen (lb):	1.2
Wet Unit Weight, γ (lb/ft^3):	161.6
Dry Unit Weight, γ_d (lb/ft^3):	158.2

Final Specimen Figure

Results

Unconfined Compressive Strength (psi): **5763** **40** (MPa)

Strain (%): **1.6**



Notes: Sandstone, gray, slightly weathered, moderately strong, fine grained.

Sample trimming procedure does not conform to ASTM D4543 and the results reported may differ from the results obtained from a test specimen that meets the requirements of Practice D4543.

Slope Stability Analyses

AKB Note: New content begins here.

Station 441+75
Existing Conditions

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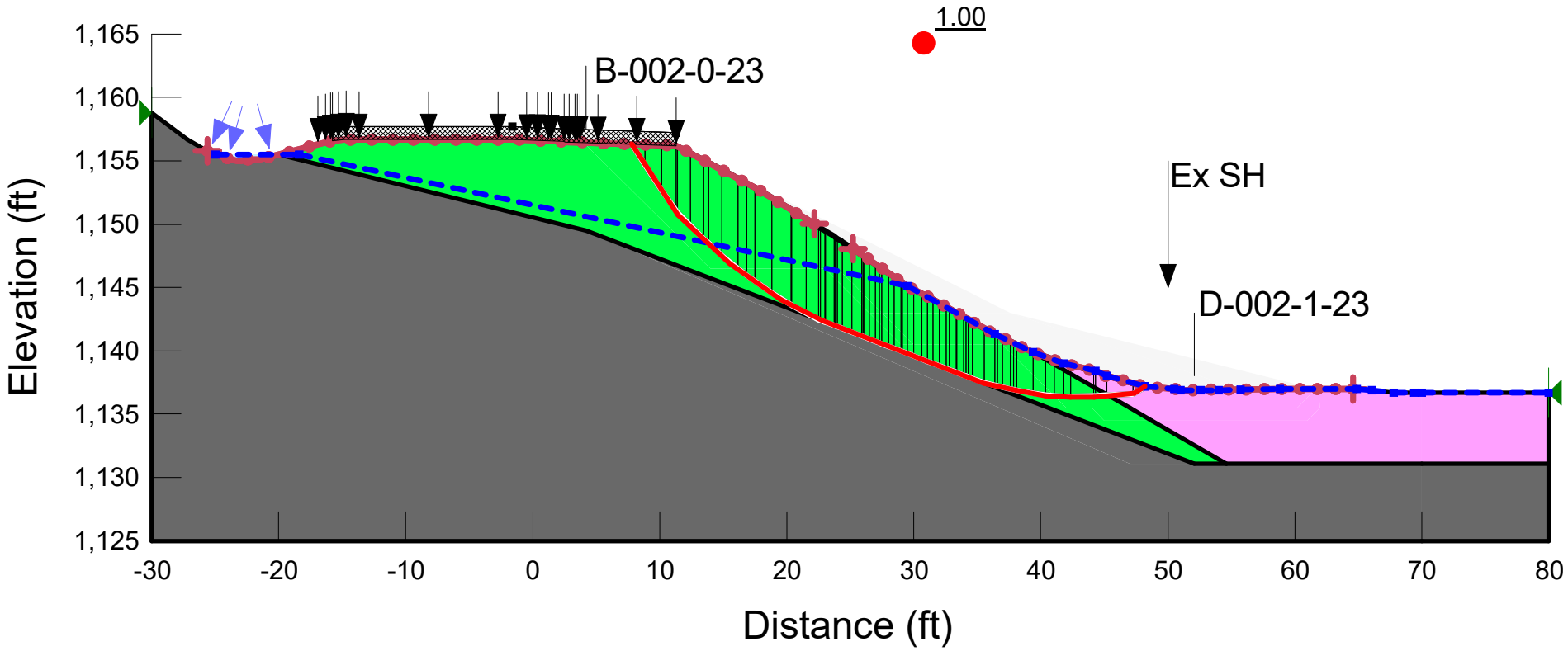
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	125	95	25
	3. Soft to M. Stiff Cohesive (LT)	Mohr-Coulomb	105	15	15
	Bedrock	Bedrock (Impenetrable)			



01_Existing Condition	
20240402_MOE-78-8.30 Slope Stability_EarthWork_revised.gsz	
04/03/2024	1:150

Station 441+75
Post-Construction Stability

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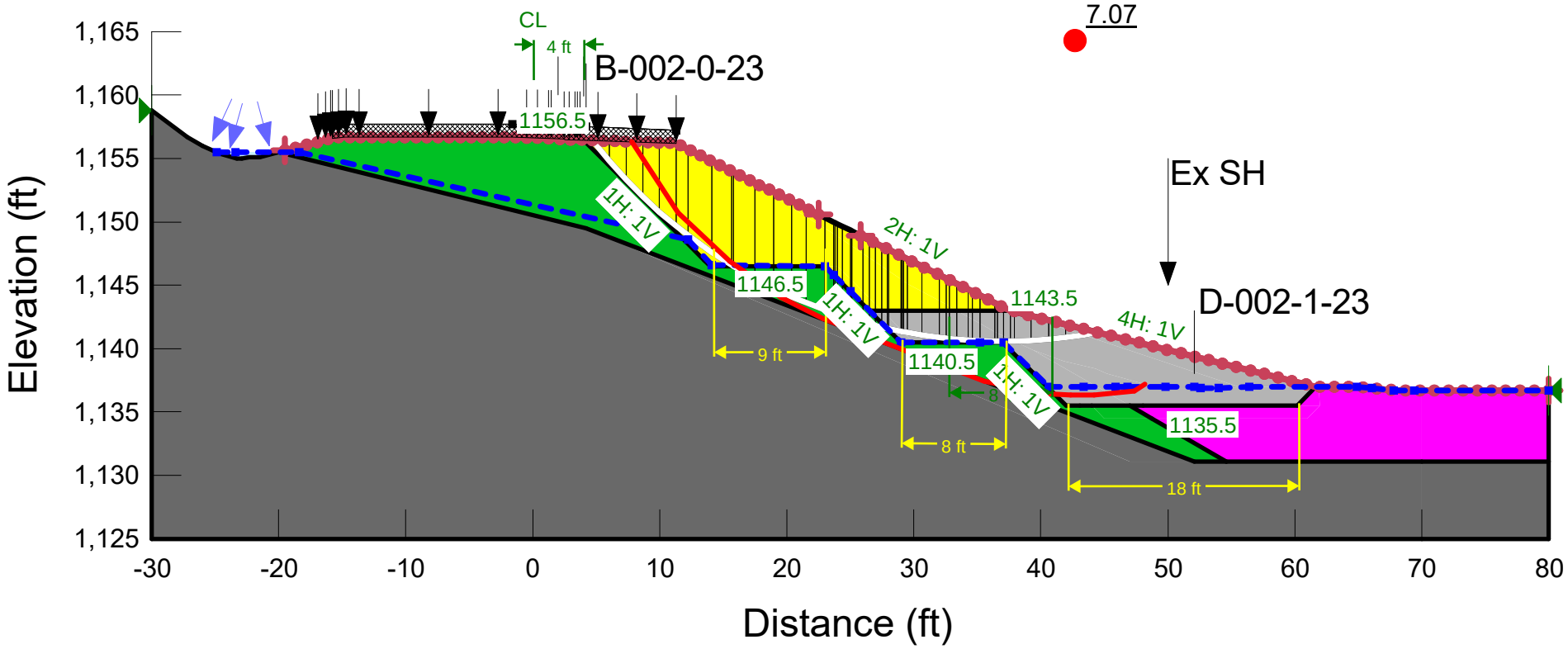
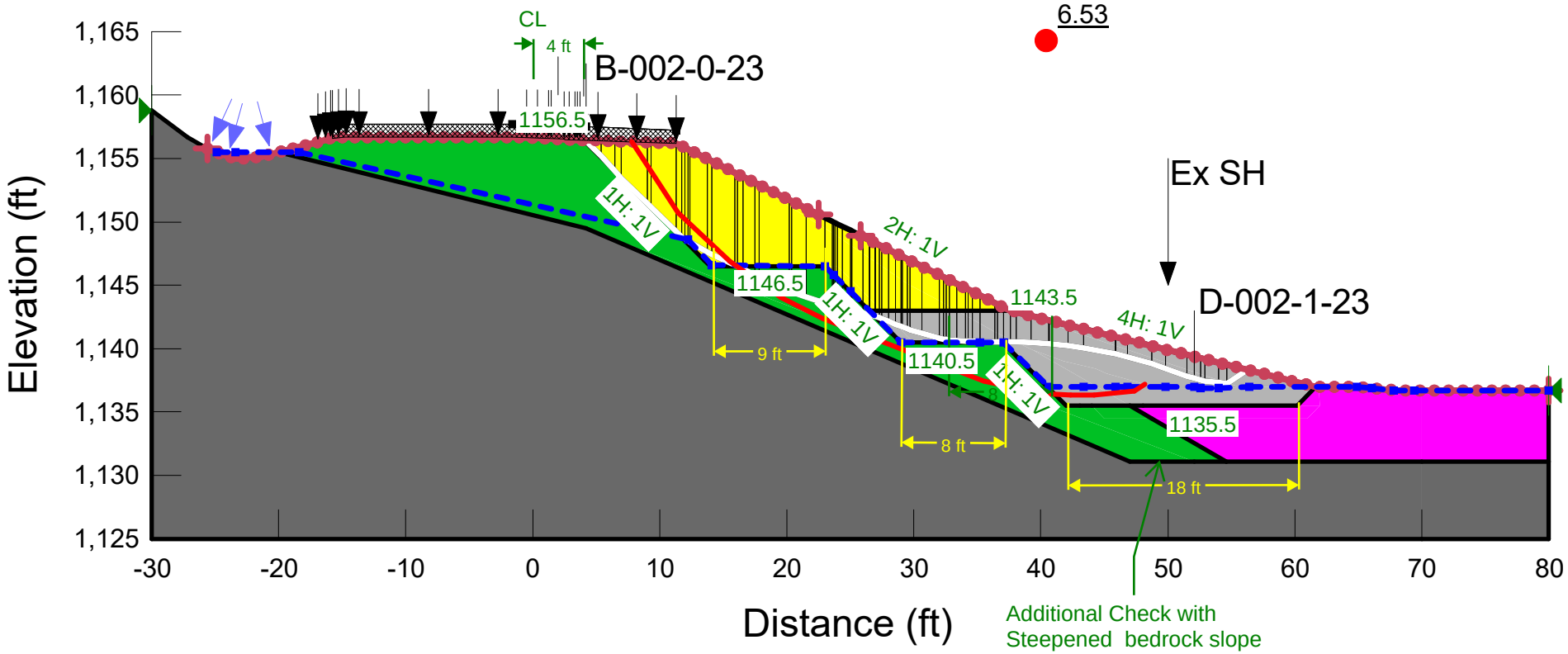
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (ST)	Mohr-Coulomb	125	2,800	0
	3. Soft to M. Stiff Cohesive (ST)	Mohr-Coulomb	105	500	0
	Bedrock	Bedrock (Impenetrable)			
	Dump Rock Fill	Mohr-Coulomb	140	0	36
	Item 203 - Embankment Fill (ST)	Mohr-Coulomb	125	2,000	0



02_Proposed Earthwork (ST)
20240402_MOE-78-8.30 Slope Stability_EarthWork_revised.gsz
04/03/2024 1:150

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (ST)	Mohr-Coulomb	125	2,800	0
	3. Soft to M. Stiff Cohesive (ST)	Mohr-Coulomb	105	500	0
	Bedrock	Bedrock (Impenetrable)			
	Dump Rock Fill	Mohr-Coulomb	140	0	36
	Item 203 - Embankment Fill (ST)	Mohr-Coulomb	125	2,000	0



02_Proposed Earthwork (ST) (2)	
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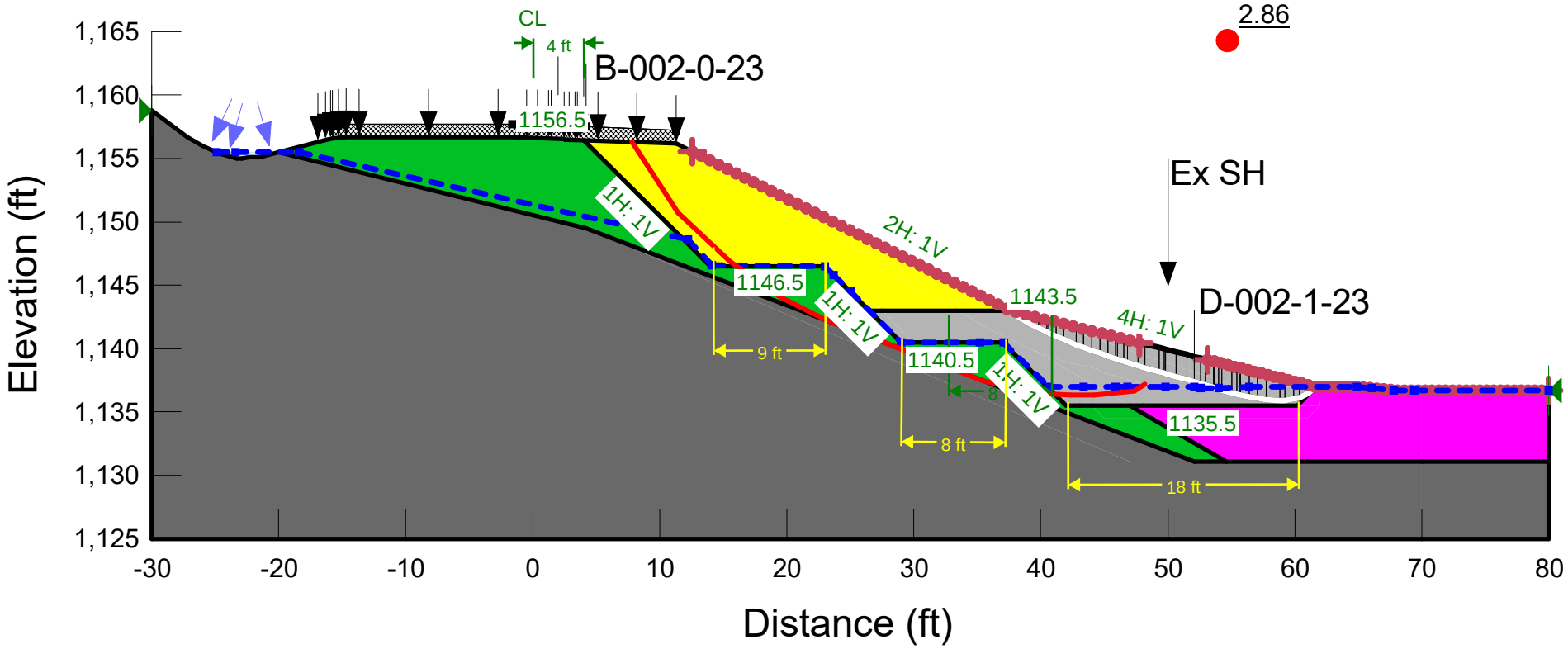
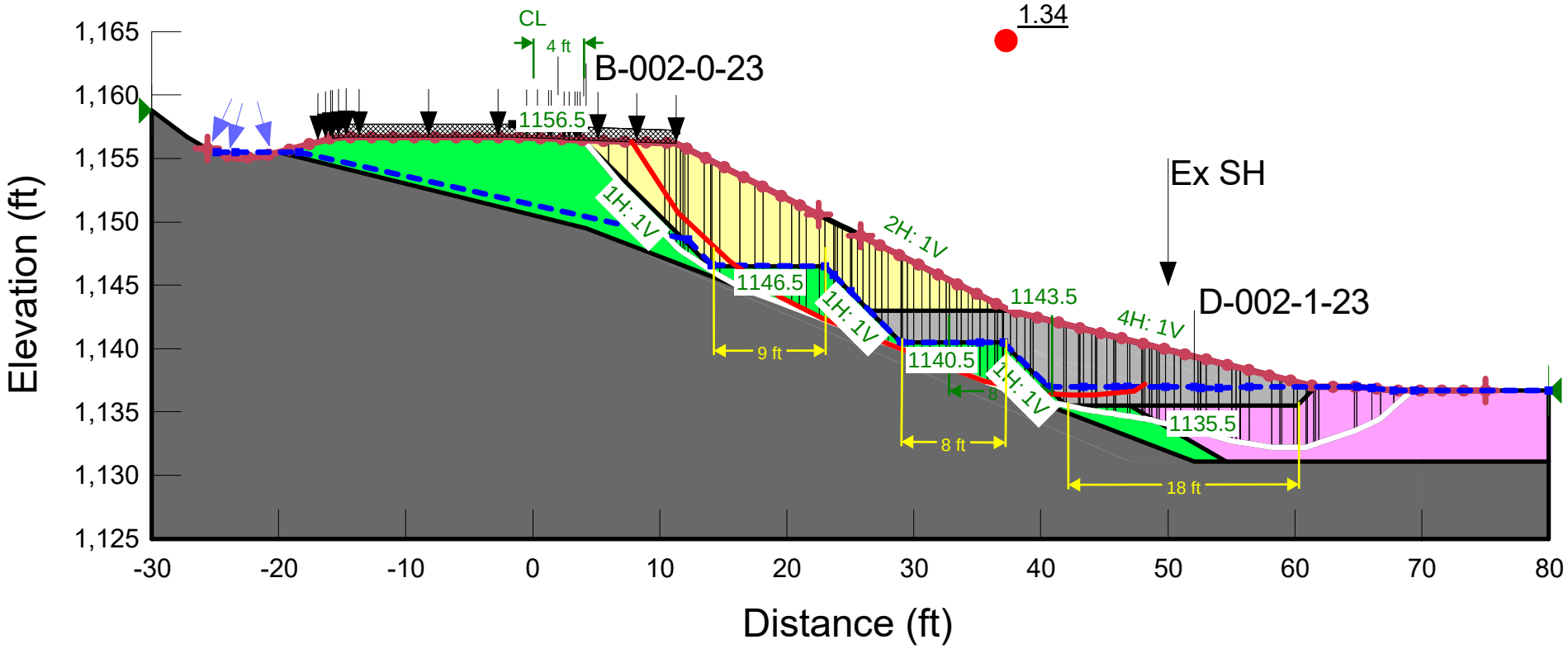
04/03/2024	1:150

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (ST)	Mohr-Coulomb	125	2,800	0
	3. Soft to M. Stiff Cohesive (ST)	Mohr-Coulomb	105	500	0
	Bedrock	Bedrock (Impenetrable)			
	Dump Rock Fill	Mohr-Coulomb	140	0	36
	Item 203 - Embankment Fill (ST)	Mohr-Coulomb	125	2,000	0



02_Proposed Earthwork (ST) (3)
20240402_MOE-78-8.30 Slope Stability_EarthWork_revised.gsz
04/03/2024 1:150

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	125	95	25
	3. Soft to M. Stiff Cohesive (LT)	Mohr-Coulomb	105	15	15
	Bedrock	Bedrock (Impenetrable)			
	Dump Rock Fill	Mohr-Coulomb	140	0	36
	Item 203 - Embankment Fill (LT)	Mohr-Coulomb	125	200	28



02_Proposed Earthwork (LT)	
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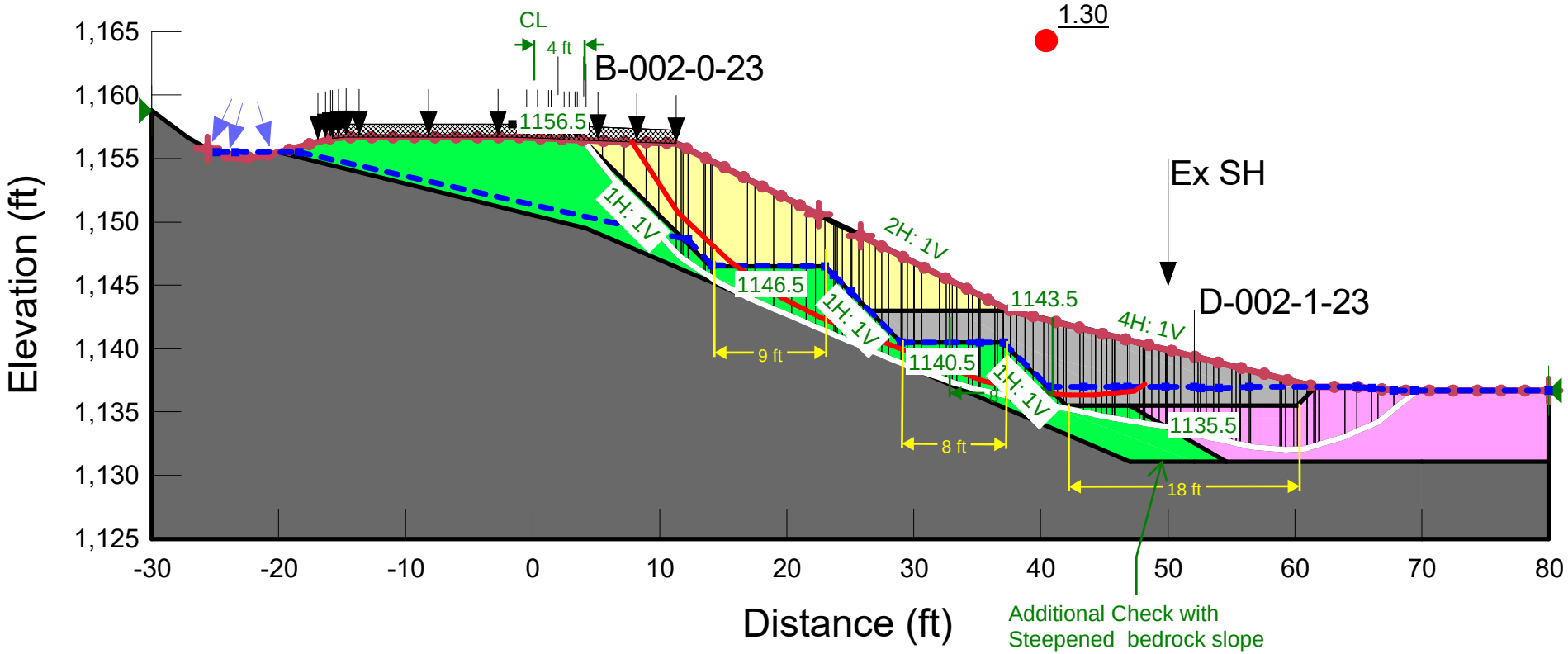
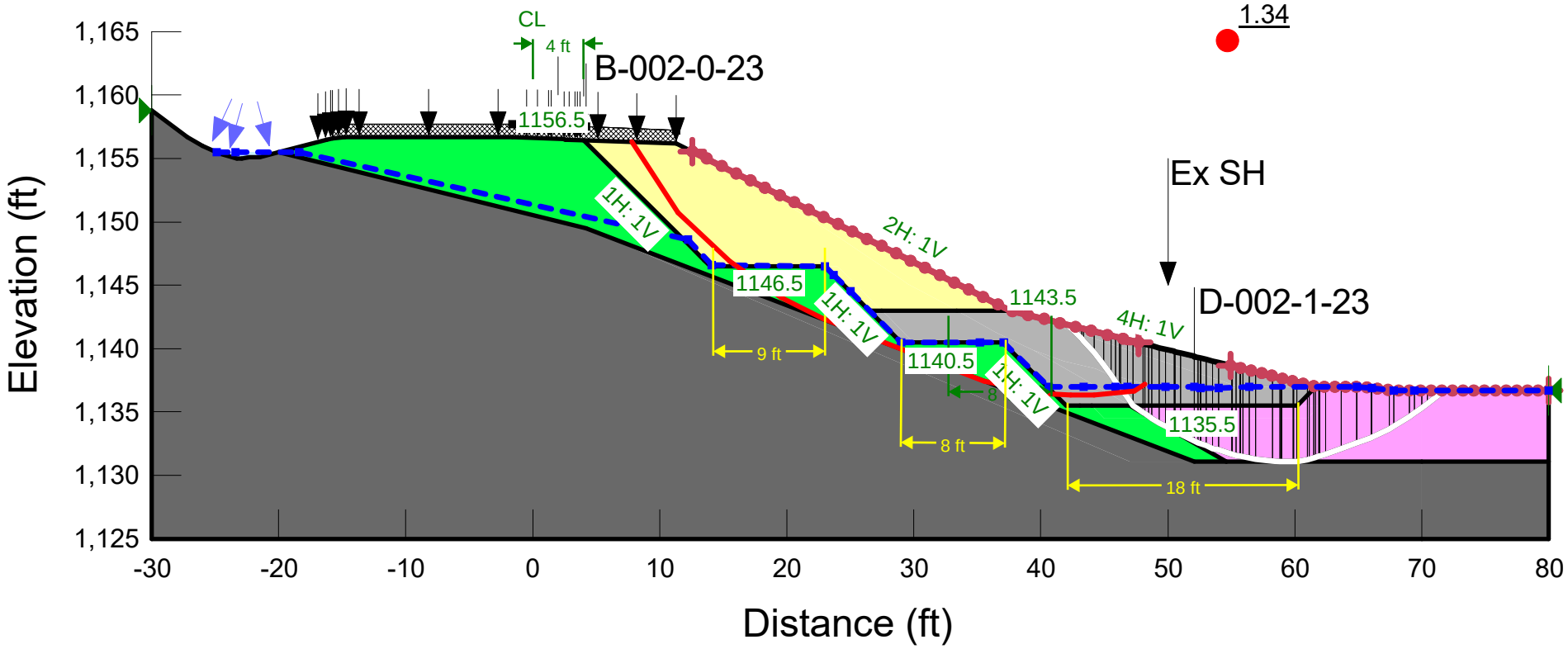
04/03/2024	1:150

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	125	95	25
	3. Soft to M. Stiff Cohesive (LT)	Mohr-Coulomb	105	15	15
	Bedrock	Bedrock (Impenetrable)			
	Dump Rock Fill	Mohr-Coulomb	140	0	36
	Item 203 - Embankment Fill (LT)	Mohr-Coulomb	125	200	28



02_Proposed Earthwork (LT) (2)	
20240402_MOE-78-8.30 Slope Stability_EarthWork_revised.gsz	
04/03/2024	1:150

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	125	95	25
	3. Soft to M. Stiff Cohesive (LT)	Mohr-Coulomb	105	15	15
	Bedrock	Bedrock (Impenetrable)			
	Dump Rock Fill	Mohr-Coulomb	140	0	36
	Item 203 - Embankment Fill (LT)	Mohr-Coulomb	125	200	28



02_Proposed Earthwork (LT) (3)	
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04/03/2024	1:150

Station 441+75
Constructability

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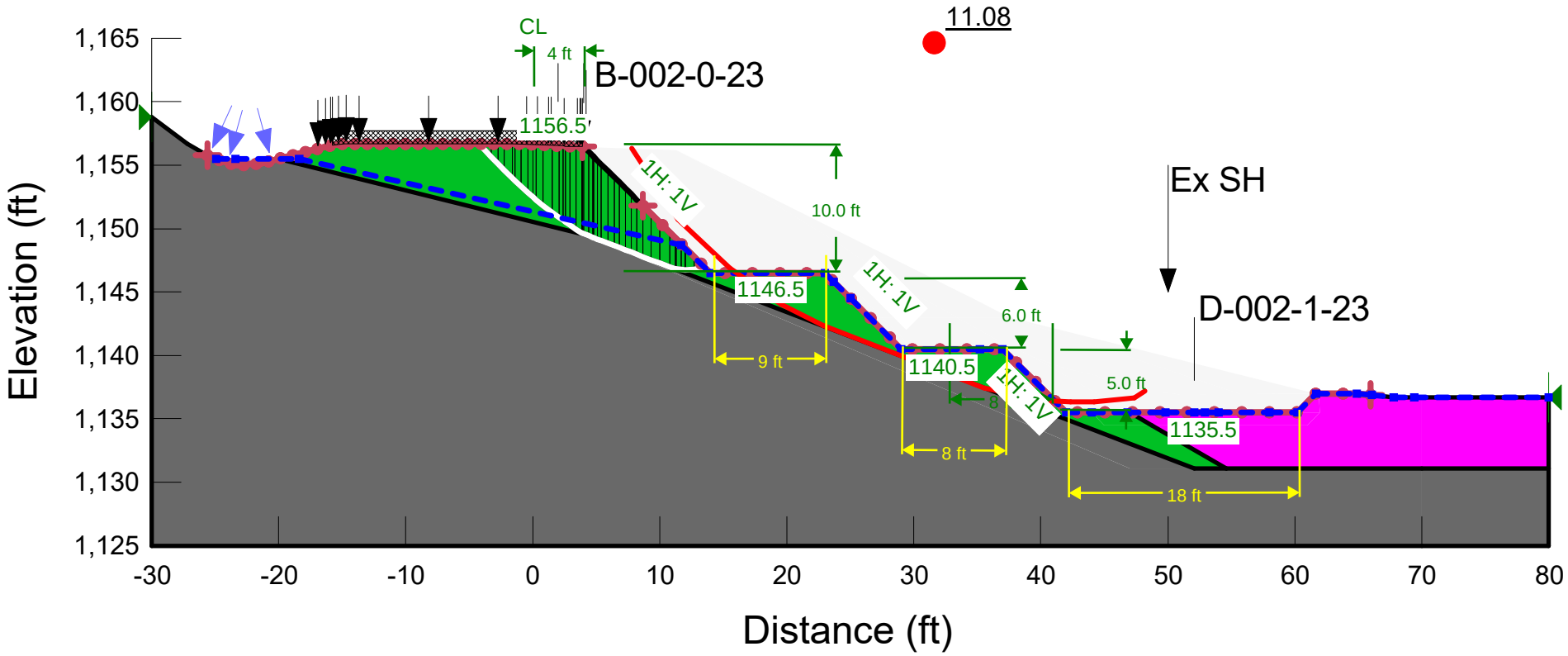
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (ST)	Mohr-Coulomb	125	2,800	0
	3. Soft to M. Stiff Cohesive (ST)	Mohr-Coulomb	105	500	0
	Bedrock	Bedrock (Impenetrable)			



03_Constructability	
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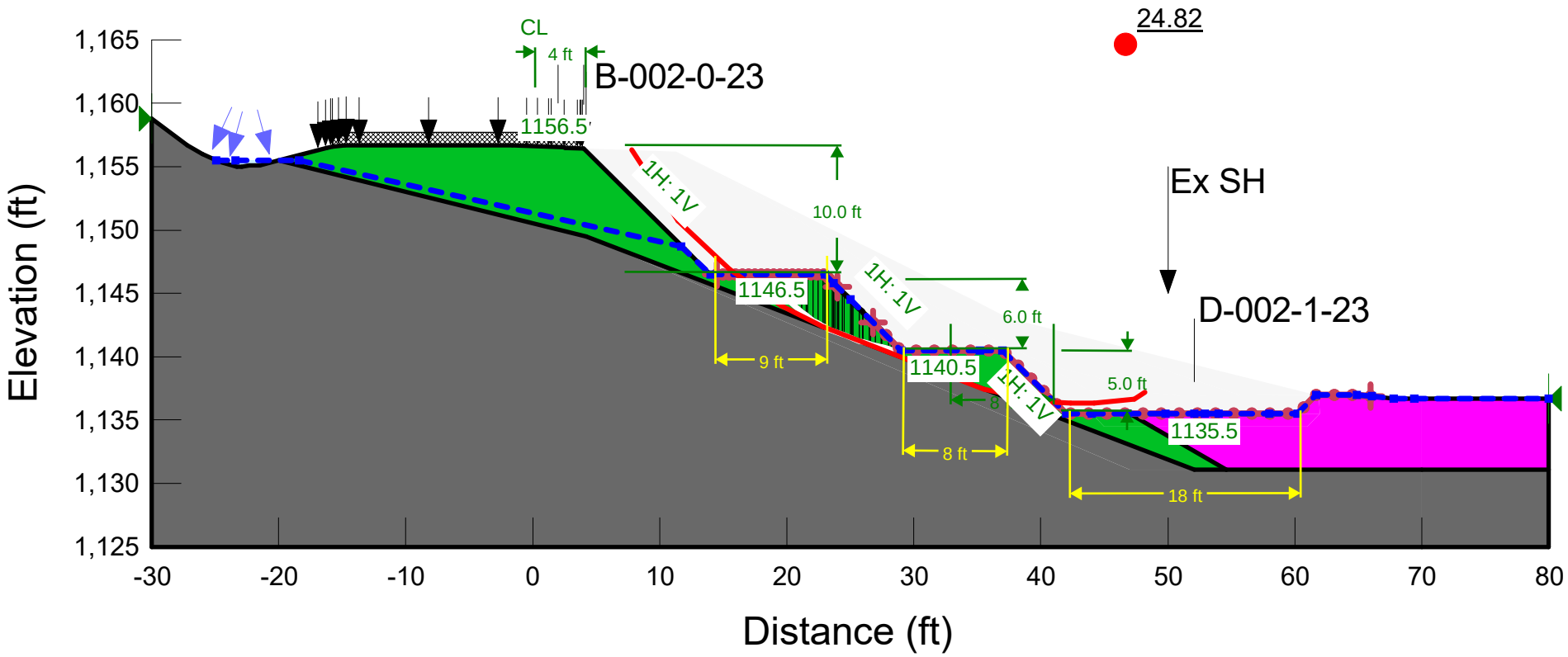
04/03/2024	1:150

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (ST)	Mohr-Coulomb	125	2,800	0
	3. Soft to M. Stiff Cohesive (ST)	Mohr-Coulomb	105	500	0
	Bedrock	Bedrock (Impenetrable)			



03_Constructability (2)	
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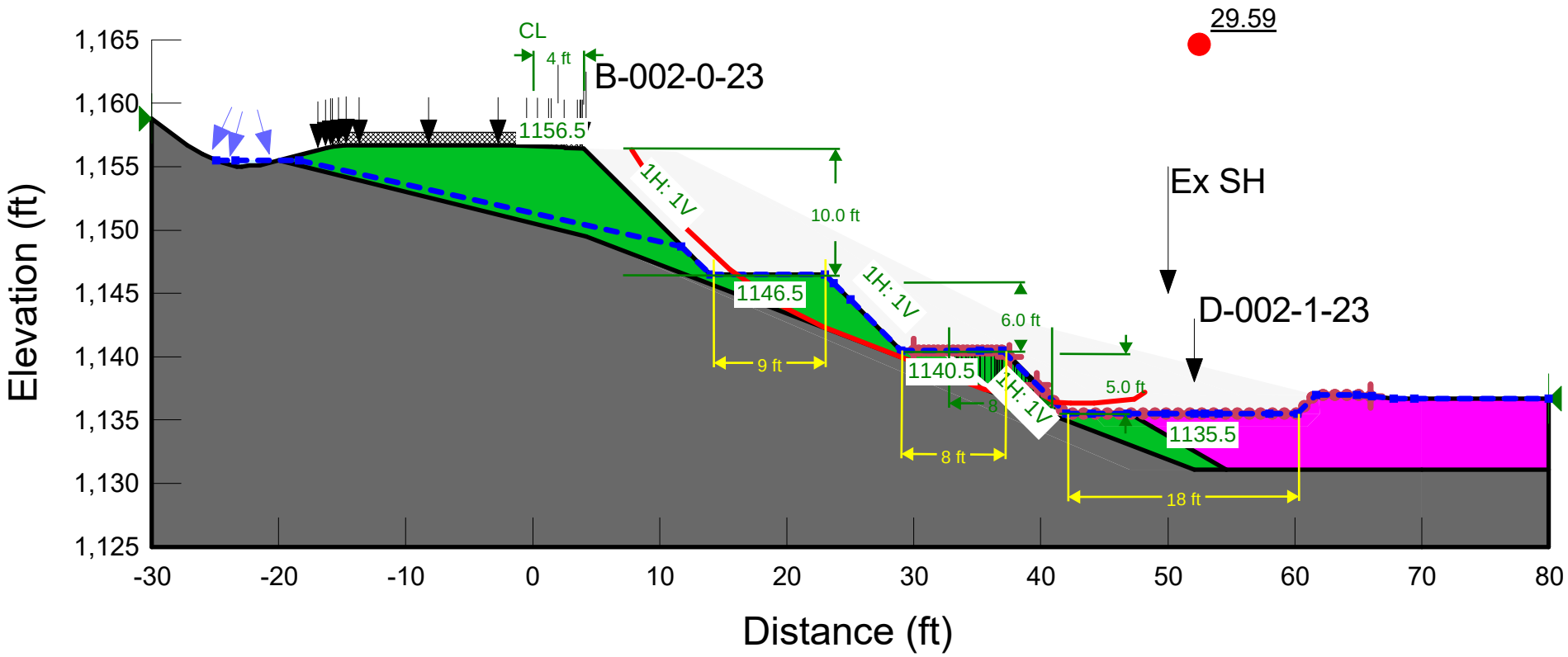
04/03/2024	1:150

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. V. Stiff to Hard Cohesive (ST)	Mohr-Coulomb	125	2,800	0
	3. Soft to M. Stiff Cohesive (ST)	Mohr-Coulomb	105	500	0
	Bedrock	Bedrock (Impenetrable)			



03_Constructability (3)	
20240402_MOE-78-8.30 Slope Stability_EarthWork_revised.gsz	
04/03/2024	1:150

Slope Excavation and Replacement
Design Section Detail

9999 Carver Road, Suite 210, Cincinnati, OH 45242-5583 **hdrinc.com**
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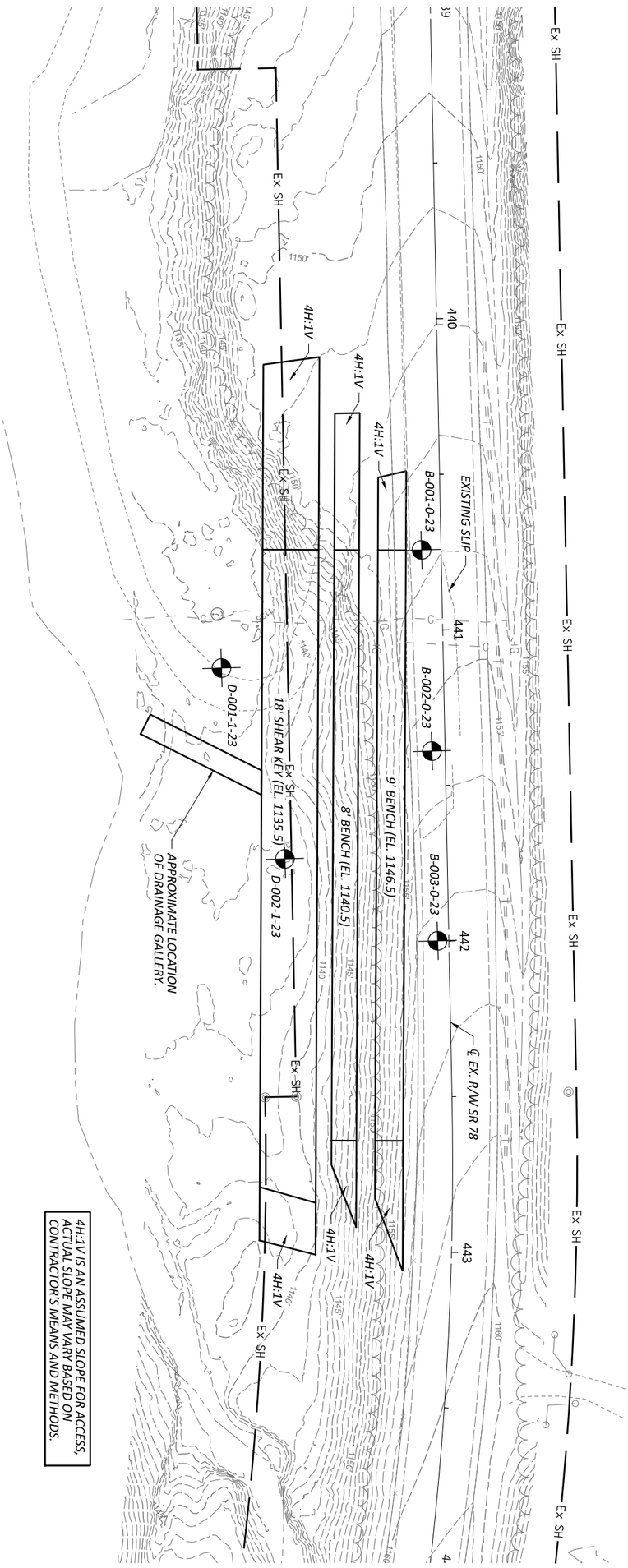
MODEL: 117973_WP001 [Sheet] PAPERSIZE: 34x22 (in.) DATE: 4/4/2024 TIME: 10:24:03 AM USER: DMATCHIS
pw:\\ohiodot-pw.bentley.com:ohiodot-pw-02\Documents\01 Active Projects\District 10\Monroe\117973\402-Engineering_HDR\Geotechnical\Sheets\117973_WP001.dgn



SLOPE EXCAVTION AND REPLACEMENT DETAIL - PLAN
STA. 439+00 TO STA. 444+00

HORIZONTAL SCALE IN FEET
0 20
10 40

DESIGN AGENCY: HDR

DESIGNER: DCM
REVIEWER: AKB 04/04/24
PROJECT ID: 117973
SHEET: P.1 TOTAL: 3

BENCHING OF FOUNDATION SLOPES

ALTHOUGH CROSS-SECTIONS INDICATE SPECIFIC DIMENSIONS FOR PROPOSED BENCHING OF THE EMBANKMENT FOUNDATIONS IN CERTAIN AREAS, NO WAIVER OF THE SPECIFICATIONS IS INTENDED. BENCH ALL OTHER SLOPED EMBANKMENT AREAS AS SET FORTH IN 203.05. NO ADDITIONAL PAYMENT WILL BE MADE FOR BENCHING REQUIRED UNDER THE PROVISIONS OF 203.05.

FIELD VERIFICATION OF QUANTITIES

DUE TO THE NATURE OF THE PROJECT BEING A SLIDE REPAIR, THE CONTRACTOR IS RESPONSIBLE FOR FIELD VERIFICATION OR QUANTITIES PRIOR TO BIDDING AND THEN PRIOR TO CONSTRUCTION. THE ACTUAL WORK LOCATIONS AND QUANTITIES PERFORMED SHALL BE INCORPORATED INTO THE FINAL CHANGE ORDER GOVERNING COMPLETION OF THIS PROJECT.

ITEM 601 - DUMPED ROCK FILL, TYPE C, AS PER PLAN

WHEN EXCAVATING FOR THE SHEAR KEY, NO MORE THAN 50 LINEAR FEET ALONG THE BACK OF THE KEY SHALL BE EXCAVATED WITHOUT REPLACING WITH DUMPED ROCK FILL, TYPE C, AS PER PLAN. THE ENGINEER MAY VARY THE 50 LINEAR FT BASED ON SITE CONDITIONS (STABILITY). NO EXCAVATION SHALL BE LEFT OPEN OVERNIGHT. SCHEDULE WORK SO AS TO HAVE THE SHEAR KEY BACKFILLED AND STABILIZED PRIOR TO LEAVING THE SITE.

IN THIS AREA BETWEEN STATIONS "X" TO "Y" DUMPED ROCK FILL, TYPE C, AS PER PLAN, AS SHOWN ON THE CROSS-SECTIONS, MAY BE PLACED BY THE METHOD OF END DUMPING IF SURFACE WATER IS PRESENT AT THE TIME OF CONSTRUCTION. END DUMPING METHODS MAY BE USED UP TO EN ELEVATION 2 FEET ABOVE THE WATER LEVEL. ABOVE THIS ELEVATION, EMBANKMENT CONSTRUCTION METHODS WILL BE IN ACCORDANCE WITH 203.05 AND 203.07 INCLUSIVE. DURING NORMAL CLEARING AND GRUBBING, WHERE END DUMPING IS PERMITTED, THE REQUIREMENTS OF 201.04 FOR SCALPING SHALE BE WAIVED.

EXCAVATE THE BOTTOM OF THE SHEAR KEY TO ELEVATION AS INDICATED ON THE DESIGN SECTION.

SPRING DRAINS

THE FOLLOWING ESTIMATED QUANTITIES HAVE BEEN CARRIED TO THE GENERAL SUMMARY FOR USE AS DIRECTED BY THE ENGINEER FOR DRAINING ANY SPRINGS SHOWN IN THE PLAN OR ENCOUNTERED DURING CONSTRUCTION. THE FOLLOWING TYPES OF PIPES MAY BE USED: 707.33, 707.41, 707.42 or 707.45 PERFORATED PER 707.31.

SPRING DRAINS SHALL BE CONSTRUCTED AS SHOWN ON STANDARD CONSTRUCTION DRAWING DM-1.1 AND PAID FOR AT THE CONTRACT PRICE FOR:

605, 6" UNCLASSIFIED PIPE UNDERDRAINS FOR SPRINGS
_____ FT.

605, AGGREGATE DRAINS FOR SPRINGS
_____ FT.

611, PRECAST REINFORCED CONCRETE OUTLET
_____ EACH

ITEM 203 - EMBANKMENT, AS PER PLAN

IN ADDITION TO THE REQUIREMENTS OF CMS ITEM 203, THIS ITEM SHALL INCLUDE ITEM 203, EXCAVATION REQUIRED TO BLEND THE EXISTING SLOPES TO THE NEWLY CONSTRUCTED SLOPE AT EACH END OF THE SITE. THIS SHALL BE INCIDENTAL TO ITEM 203, EMBANKMENT, AS PER PLAN.

ITEM 203 - GRANULAR EMBANKMENT, AS PER PLAN (NO. 8 AGGREGATE)

FURNISH DURABLE, NATURAL AGGREGATE NO. 8 SIZE. PLACE THE AGGREGATE AT THE THICKNESS AND SLOPE AS SHOWN ON THE CROSS-SECTIONS AND THE SPECIAL BENCHING SLOPE DRAINS DETAIL.

ITEM 204 - GEOTEXTILE FABRIC, AS PER PLAN

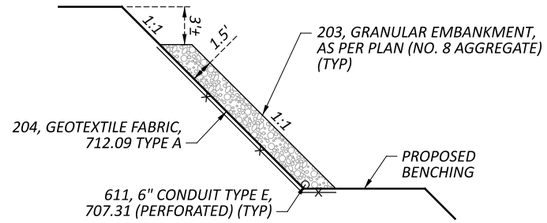
IN ADDITION TO THE REQUIREMENTS OF CMS ITEM 204, THIS ITEM SHALL BE 712.09 TYPE D FABRIC.

PAYMENT FOR THE ABOVE WORK SHALL BE MADE AT THE UNIT PRICE BID FOR ITEM 204, GEOTEXTILE FABRIC, AS PER PLAN AND SHALL INCLUDE ALL LABOR, TOOLS, EQUIPMENT AND MATERIALS NECESSARY TO INSTALL THE FABRIC.

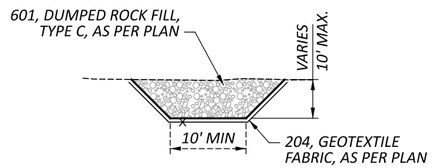
SPECIAL BENCHING SLOPE DRAINS

PLACE SPECIAL BENCHING SLOPE DRAINS AT THE LOCATIONS SHOWN ON THE PLAN AND PROFILE AND CROSS SECTION SHEETS. THESE DRAINS SHALL CONSIST OF ITEM 204, GEOTEXTILE FABRIC, 712.09 TYPE A, AND ITEM 611, CONDUIT TYPE E, 707.31 (PERFORATED). THE TYPE E CONDUIT SHALL BE PERFORATEED AS PER CONDUIT FOR ITEM 605, UNCLASSIFIED PIPE UNDERDRAINS. TRANSVERSE OUTLET DRAINS SHALL BE PROVIDED AT THE LOCATIONS SHOWN ON THE PLAN & PROFILE AND CROSS SECTION SHEETS. THESE OUTLET DRAINS SHALL CONSIST OF ITEM 611 CONDUIT TYPE F, 707.33 WITH ITEM 611 PRECAST REINFORCED CONCRETE OUTLETS AND A TIED CONCRETE BLOCK MAT TYPE 1 GROUTED ACCORDING TO 601.12.

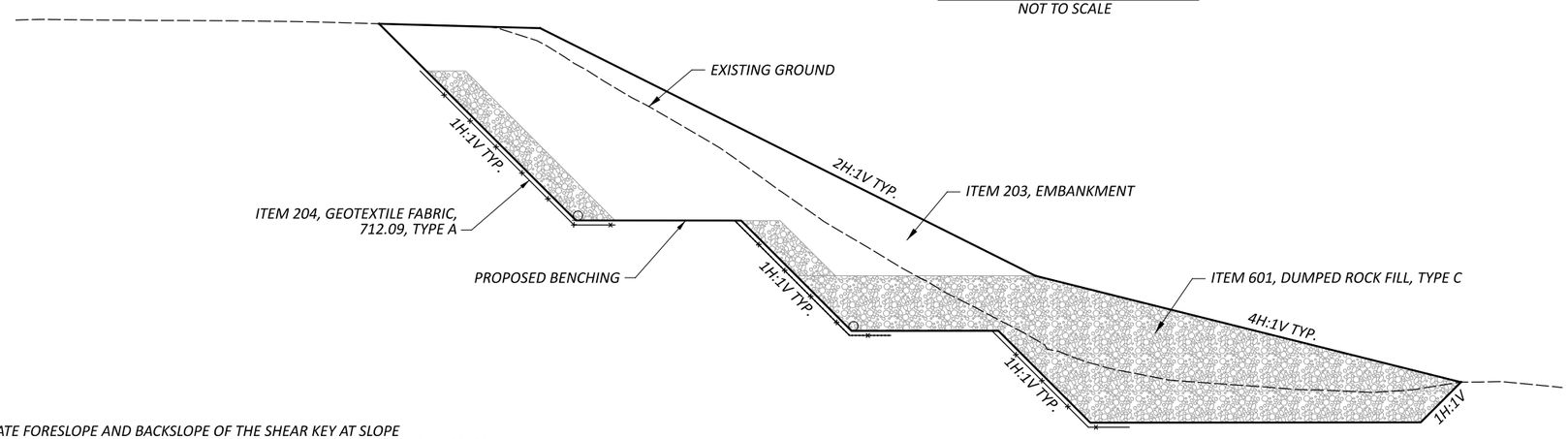
SEE SPECIAL BENCHING SLOPE DRAINS DETAIL ON THIS SHEET FOR ADDITIONAL INFORMATION.



SPECIAL BENCHING SLOPE DRAINS DETAIL
NOT TO SCALE



SECTION A - DRAINAGE GALLERY
NOT TO SCALE



NOTES:

1. EXCAVATE FORESLOPE AND BACKSLOPE OF THE SHEAR KEY AT SLOPE NECESSARY TO MAINTAIN STABILITY AND TO ALLOW FOR CONSTRUCTION ACCESS.
2. INSTALL THE DRAINAGE GALLERY AT THE LOW POINT OF THE EXISTING GROUND SURFACE
3. SLOPE BASE OF DRAINAGE GALLERY AWAY FROM THE ROCK SHEAR KEY AT A MINIMUM OF 20H:1V.

SHEAR KEY
NOT TO SCALE

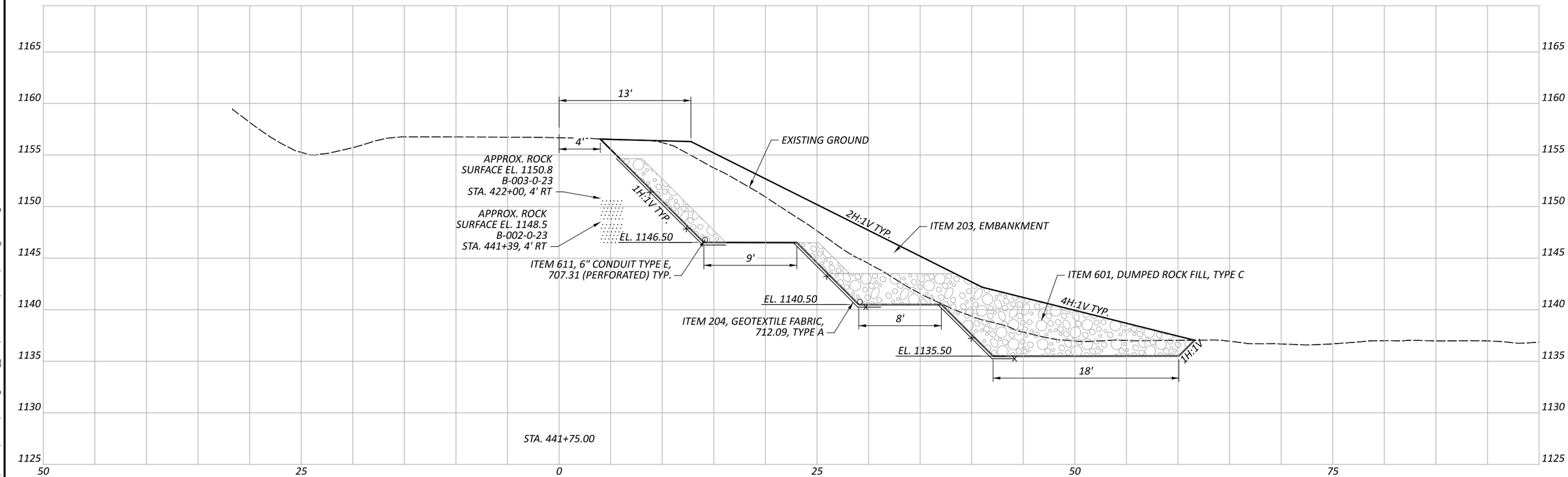
GENERAL NOTES

DESIGN AGENCY

DESIGNER DCM
REVIEWER AKB 04/04/24
PROJECT ID 117973
SHEET P.2 TOTAL 3

MOE-78-8.30

SLOPE EXCAVTION AND REPLACEMENT DETAIL
CRITICAL SECTION STA. 441+75



BORING	STATION	OFFSET	APPROX. SURFACE ELEVATION	APPROX. ROCK SURFACE ELEVATION
B-001-0-23	440+74	6' RT	1153.7	1147.7
B-002-0-23	441+39	4' RT	1155.5	1148.5
B-003-0-23	442+00	4' RT	1157.3	1150.8

DESIGN AGENCY

DESIGNER DCM

REVIEWER AKB 04/04/24

PROJECT ID 117973

SHEET P.3 | TOTAL 3

MOE-78-8.30