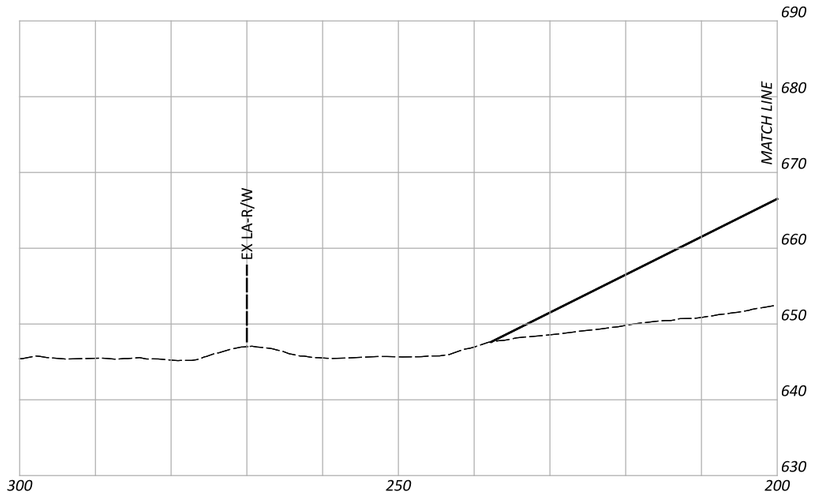
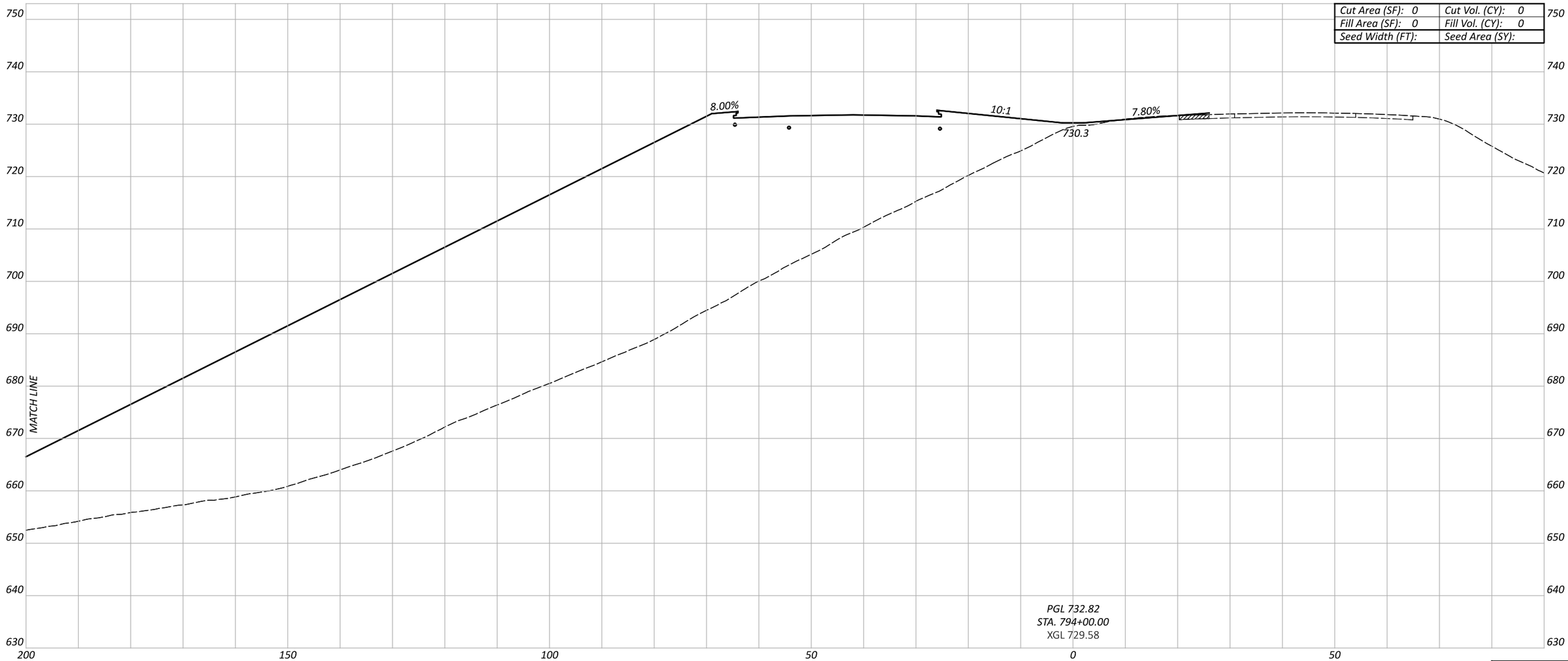
Sta. 794+00

References

Proposed cross-section at Sta. 794+00





Cut Area (SF): 0	Cut Vol. (CY): 0
Fill Area (SF): 0	Fill Vol. (CY): 0
Seed Width (FT):	Seed Area (SY):

Sheet Totals		
Seeding	Cut	Fill

SHEET TITLE
SHEET SUB-TITLE

CTY-RTE-SECTION

MODEL: CLX_RW_U533 - 794+00.00 [Sheet] PAPERSIZE: 34x22 (in.) DATE: 3/7/2024 TIME: 2:51:17 PM USER: kzimmer
pw:\\ohiodot-pw.bentley.com:ohiodot-pw-02\Documents\01 Active Projects\District 10\Meigs\119143\400-Engineering\Roadway\Sheets\119143_XS001.dgn

DESIGN AGENCY

DESIGNER
XXX

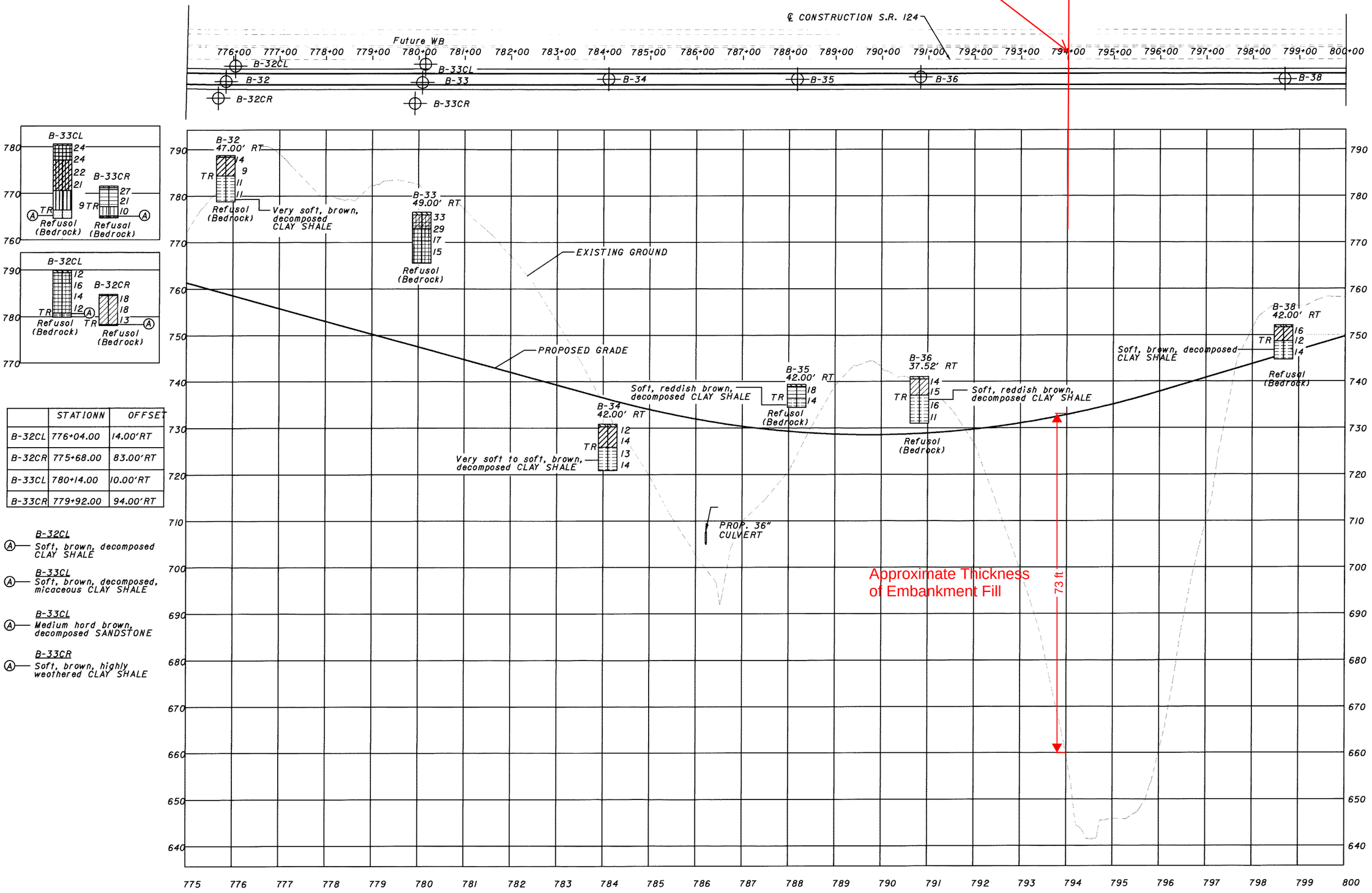
REVIEWER
XXX MM-DD-YY

PROJECT ID
0

SHEET P.0 | TOTAL 0

Sta. 794+00

From "Geotech - 19718/Soil Profile Begin 5 pts.pdf"



	STATIONN	OFFSET
B-32CL	776+04.00	14.00'RT
B-32CR	775+68.00	83.00'RT
B-33CL	780+14.00	10.00'RT
B-33CR	779+92.00	94.00'RT

Ⓐ **B-32CL**
Soft, brown, decomposed CLAY SHALE

Ⓐ **B-33CL**
Soft, brown, decomposed, micaceous CLAY SHALE

Ⓐ **B-33CL**
Medium hord brown, decomposed SANDSTONE

Ⓐ **B-33CR**
Soft, brown, highly weathered CLAY SHALE

200' 100' 0' 50' HORIZONTAL SCALE IN FEET

CALCULATED W.I.N. | CHECKED S.S.S.

DATE 1/24/01

REVIEWED B.M.

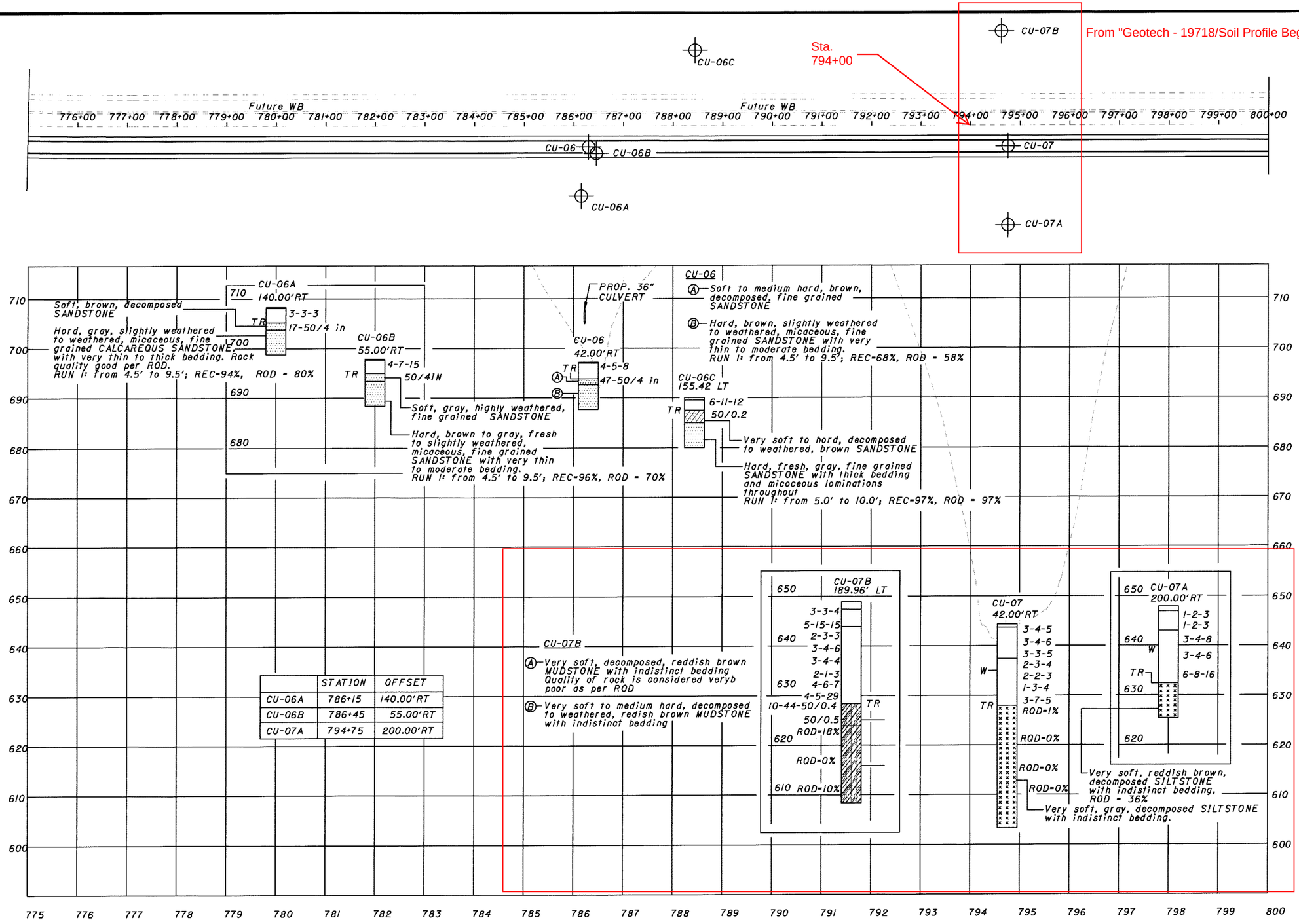
DRAWN E.D.S.

SOIL PROFILE

MEG-124-22.72

12 / 67

From "Geotech - 19718/Soil Profile Begin 5 pts.pdf"



	STATION	OFFSET
CU-06A	786+15	140.00'RT
CU-06B	786+45	55.00'RT
CU-07A	794+75	200.00'RT

CU-07B
A Very soft, decomposed, reddish brown MUDSTONE with indistinct bedding Quality of rock is considered veryb poor as per ROD
B Very soft to medium hard, decomposed to weathered, redish brown MUDSTONE with indistinct bedding

Note: Historic Borings CU-07, CU-07A, and CU-07B were used along with the more recent borings designated as B-002-0-23, B-002-1-23, and B-002-2-23 to develop the subsurface profile along Sta. 794+00.

HORIZONTAL SCALE IN FEET
0' 50' 100' 200'

CALCULATED W.I.N.
CHECKED S.S.S.
DATE 1/24/01
REVIEWED B.M.
DRAWN E.D.S.

SOIL PROFILE

MEG-124-22.72

From "Geotech - 19718/Soil Profile Begin 5 pts.pdf"

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 5/13/99 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 5/14/99 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-07 Station & Offset 794+75.00, 42.00' RT Surface Elev. 644.33ft

Elev. (ft)	Depth (ft)	Std. Pen. / RQD	Rec. (ft)	Lass (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
644.3	0														
643.7					TOPSOIL										
		3-4-5			Stiff, brown SILTY CLAY, trace sand, moist.	1	--	--	--	--	--	--	--	19	VISUAL
		3-4-6				2	--	--	--	--	--	--	--	14	VISUAL
	5														
		3-3-5				3	0	1	3	--	97*	36	16	22	A-6b
637.4					Medium stiff to stiff, brown to gray SILT AND CLAY, moist.										
		2-3-4				4	--	--	--	--	--	--	--	21	VISUAL
		2-2-3				5	1	1	7	--	91*	31	12	22	A-6a
	10														
		1-3-4				6	--	--	--	--	--	--	--	18	VISUAL
		3-7-5				7	--	--	--	--	--	--	--	13	VISUAL
	15														
627.8		ROD = 1%	4.7	0.8	Note: Auger refusal on bedrock at 16.5 feet. Began coring rock. Very soft, gray, decomposed SILTSTONE, with indistinct bedding, very poor condition as per ROD.										
					RUN 1 FROM 16.5 FEET TO 22.0 FEET										
	20														
623.3					U.C. Strength at 20.5 feet = 100 psi										
		ROD = 0%	0.1	7.4											
	25				Note: Color change to reddish brown at 25.0 feet.										
					RUN 2 FROM 22.0 FEET TO 29.5 FEET Run 2 bedrock quality very poor as per ROD.										
	30				Note: Used roller bit method of drilling from 29.5 feet to 32.0 feet because core barrel locked at 29.5 feet. No rock sample recovery between these depths.										
		ROD = 0%	0.3	4.8											
					RUN 3 FROM 32.0 FEET TO 37.0 FEET Run 3 bedrock quality very poor as per ROD.										
	35														
		ROD = 0%	3.7	0.3											
					RUN 4 FROM 37.0 FEET TO 41.0 FEET Run 4 bedrock quality very poor as per ROD.										
	40														
603.3					TERMINATION DEPTH = 41.0 FEET										

*Silt and clay combined

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.

42/67	MEG-124-22.72	SOIL PROFILE	DRAWN E.D.S.	REVIEWED B.M.	DATE 1/24/01	CALCULATED W.I.N. / CHECKED S.S.S.	PRIME ENGINEERING & ARCHITECTURE, INC. COLUMBUS (614) 457-2100 AKRON (330) 666-5432

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 4/14/99 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 4/14/99 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-07A Station & Offset 794+75.00, 200.00' RT Surface Elev. 647.87ft

Elev. (ft)	Depth (ft)	Std. Pen./ROD	Rec. (ft)	Loss (ft)	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
647.9	0														
647.4					TOPSOIL										
		1-2-3			Medium stiff, brown SANDY SILT, some clay, moist.	1	--	--	--	--	--	--	--	24	VISUAL
		1-2-3				2	0	5	32	37	25	29	10	30	A-4a
643.0	5				Stiff to very stiff, brown SILT AND CLAY, trace sand, moist.										
		3-4-8				3	--	--	--	--	--	--	--	20	VISUAL
		3-4-6				4	0	1	9	--	90 *	36	16	23	A-6a
	10														
		6-8-16				5	--	--	--	--	--	--	--	15	VISUAL
632.4	15														
		ROD = 36%	6.9	0.1	Note: Auger refused on bedrock at 15.5 feet. Began coring rock. Very soft, reddish brown, decomposed SILTSTONE with indistinct bedding, very poor condition as per ROD.										
					Note: Siltstone changing to soft, weathered to highly weathered, and grey at 16.4 feet.										
	20														
					U.C. Strength at 21.2 feet = 196 psi										
625.4					TERMINATION DEPTH = 22.5 FEET										

*Silt and clay combined

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.

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 3/31/99 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 3/31/99 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-09 Station & Offset 813+30.00, 42.00' RT Surface Elev. 767.23ft

Elev. (ft)	Depth (ft)	Std. Pen./ROD	Rec. (ft)	Loss (ft)	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
767.2	0														
766.6					TOPSOIL										
		6-16-18			Very soft, highly weathered to decomposed, brown CLAY SHALE.	1	--	--	--	--	--	--	--	11	VISUAL
		50/4in				2	--	--	--	--	--	--	--	6	VISUAL
	5														
		50/5in				3	--	--	--	--	--	--	--	7	VISUAL
		50/4in				4	--	--	--	--	--	--	--	6	VISUAL
757.2	10														
		ROD = 0%	5.0	0.0	Note: Auger refusal on bedrock at 10.0 feet. Began coring rock. Very soft, highly weathered to decomposed, brown CLAY SHALE with horizontal laminar bedding (fissile) to 11.5 feet; indistinct bedding from 11.5 feet to 15.0 feet. Rock in very poor condition as per ROD. U.C. Strength at 10.9 feet = 166 psi										
752.2	15				TERMINATION DEPTH = 15.0 FEET										

*Silt and clay combined

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.

MEG-124-22.72

SOIL PROFILE

DRAWN	REVIEWED	DATE	CALCULATED	CHECKED
E.D.S.	B.M.	1/24/01	W.J.N.	S.S.S.

PRIME ENGINEERING & ARCHITECTURE, INC.
COLUMBUS: (614) 457-2100 AKRON: (330) 666-5432

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 7/5/00 Sampler: Type SS Dia. 2.0" Water Elev. 632.6ft
Date Completed 7/6/00 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-07B Station & Offset 794+60.79 189.96' LT Surface Elev. 648.94ft

Elev. (ft)	Depth (ft)	Std. Pen./ ROD	Rec. (ft)	Loss (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	OOOT Class
648.9	0														
647.4	2	3 - 3 - 4			TOPSOIL Medium stiff to very stiff, reddish brown SILTY CLAY (A-6b), little sand, trace to some rock fragments, trace roots, moist.	1	--	--	--	--	--	--	--	16	VISUAL
643.9	4	5 - 15 - 15			Note: Encountered a sandstone cobble at 4.5 feet. Soft to hard, brown and gray SANDY SILT (A-4a), some to little clay, no to little gravel and rock fragments, moist to wet.	2	--	--	--	--	--	--	--	9	VISUAL
	6														
	8	2 - 3 - 3				3	--	--	--	--	--	--	--	19	VISUAL
	10	3 - 4 - 6				4	--	--	--	--	--	--	--	21	VISUAL
	12	3 - 4 - 4				5	--	--	--	--	--	--	--	21	VISUAL
	14	2 - 1 - 3			Note: Pushed a Shelby Tube from 14 to 16 feet next to original test boring.	6A 6B	0 --	1 --	12 --	48 --	40 --	30 --	10 --	21 21	A-4a VISUAL
	16	4 - 6 - 7			Note: Encountered groundwater at 16.3 feet during drilling.	7	--	--	--	--	--	--	--	14	VISUAL
	18														
	20	4 - 5 - 29				8A	1	6	11	--	82 *	31	10	24	A-4a
628.4						8B	--	--	--	--	--	--	--	14	VISUAL
	22	10-44-50/0.4			Very soft, decomposed, reddish brown MUDSTONE with indistinct bedding. The quality of the mudstone in all three runs is considered very poor as per ROD.	9	--	--	--	--	--	--	--	9	VISUAL
	24	50/0.5			Note: Augered to 25.0 feet and began coring.	10	--	--	--	--	--	--	--	10	VISUAL
623.9	26	ROD = 18%	4.7	0.8	Very soft to medium hard, decomposed to weathered, reddish brown MUDSTONE with indistinct bedding. U.C. Strength of dec. mudstone at 25.8 feet = 152 psi										
	28														
	30														
	32	ROD = 0%	4.0	1.0											
	34														
	36	ROD = 10%	3.5	1.5											
	38														
608.4	40				TERMINATION DEPTH = 40.5 FEET										

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 (*Indicates silt & clay combined)

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 7/27/00 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 7/27/00 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-08 Station & Offset 812+63.51 128.85' RT Surface Elev. 775.52ft

Elev. (ft)	Depth (ft)	Std. Pen./ ROD	Rec. (ft)	Loss (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	OOOT Class
775.5	0														
774.9	2	6 - 9 - 6			TOPSOIL Stiff, brown CLAY (A-7-6), some sand, trace rock fragments, trace roots, moist.	1	2	6	20	--	72 *	52	28	19	A-7-6
	4	4 - 4 - 6				2	--	--	--	--	--	--	--	19	VISUAL
	6														
769.0		5 - 11 - 16				3	--	--	--	--	--	--	--	12	VISUAL
	8				Medium dense, brown COARSE AND FINE SAND (A-3a), little silt, trace rock fragments, moist.										
767.0		7 - 11 - 17			Very stiff, brown CLAY (A-7-6), little sand, moist.	4	--	--	--	--	--	--	--	21	VISUAL
	10														
764.0	12	8 - 21 - 34				5	--	--	--	--	--	--	--	15	VISUAL
					Very soft, decomposed, brown and black SANDSTONE.										
761.5	14	15 - 43 - 22				6A	--	--	--	--	--	--	--	8	VISUAL
					Very soft, decomposed to highly weathered, brown CLAY SHALE.	6B	--	--	--	--	--	--	--	12	VISUAL
	16	60/0.5				7	--	--	--	--	--	--	--	9	VISUAL
	18														
	20	39 - 56				8	--	--	--	--	--	--	--	10	VISUAL
		24 - 31 - 48				9	--	--	--	--	--	--	--	11	VISUAL
753.0	22				TERMINATION DEPTH = 22.5 FEET										

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 (*Indicates silt & clay combined)

61/67	MEG-124-22.72	SOIL PROFILE	DRAWN E.D.S.	REVIEWED B.M.	DATE 1/24/01	CALCULATED W.I.N. / CHECKED S.S.S.

PRIME ENGINEERING & ARCHITECTURE, INC.
COLUMBUS: (614) 457-2100 AKRON: (330) 666-5432

PROJECT: MEG-33-13.96	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: CME 55 TRUCK	STATION / OFFSET: 794+91, 12' RT.	EXPLORATION ID B-002-0-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: ODOT / BINKLEY	HAMMER: CME AUTOMATIC	ALIGNMENT: US 33	
PID: 119143 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/7/23	ELEVATION: 732.6 (ft) EOB: 50.0 ft.	PAGE 1 OF 1
START: 11/7/23 END: 11/7/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81	LAT / LONG: 39.029228, -81.940185	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL (3")	732.6																	
HARD, BROWN, **SILT AND CLAY**, SOME STONE FRAGMENTS, LITTLE SAND, DAMP	732.3		2 9 7	22	39	SS-1	4.50	29	4	15	29	23	30	18	12	14	A-6a (4)	
@3.5'; VERY STIFF, BROWN AND GRAY			2 2 4	8	33	SS-2	3.50	28	4	9	31	28	32	19	13	13	A-6a (6)	
			5 5 5	13	44	SS-3	3.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
@8.5'; HARD			0 3 3	8	39	SS-4	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
	722.6																	
VERY STIFF, BROWN AND RED, **SANDY SILT**, SOME STONE FRAGMENTS, LITTLE CLAY, DAMP			6 30 34	86	61	SS-5	3.50	33	3	19	26	19	26	17	9	9	A-4a (2)	
@13.5'; HARD			3 4 6	13	56	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
@15.0'; VERY STIFF			4 11 8	26	61	SS-7	4.00	-	-	-	-	-	-	-	-	9	A-4a (V)	
@18.5'; HARD	712.6		5 10 8	24	56	SS-8	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
HARD, GRAY AND BROWN, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP			2 7 11	24	50	SS-9	4.50	47	4	9	25	15	28	17	11	6	A-6a (1)	
	709.1																	
VERY STIFF, BROWN AND BLACK, **CLAY**, SOME STONE FRAGMENTS, SOME SILT, LITTLE SAND, DAMP			4 4 8	16	67	SS-10	2.00	24	6	5	22	43	45	24	21	22	A-7-6 (11)	
@25.0'; REDDISH BROWN AND BROWN			6 9 13	30	67	SS-11	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
	704.1																	
HARD, RED AND GRAY, **SILT AND CLAY**, SOME STONE FRAGMENTS, LITTLE SAND, DAMP			8 23 27	67	67	SS-12	4.50	26	3	8	34	29	31	18	13	10	A-6a (7)	
@33.5'; SPOON BLOCKED BY STONE FRAGMENTS			28 33 16	66	17	SS-13	4.50	-	-	-	-	-	-	-	-	4	A-6a (V)	
@38.5'; POOR RECOVERY			10 15 15	40	33	SS-14	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
@43.5'; RED, POOR RECOVERY			4 15 19	46	39	SS-15	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
		▽ 685.5																
@48.5'; GRAY, POOR RECOVERY	682.6	EOB	5 11 8	26	22	SS-16	4.50	-	-	-	-	-	-	-	-	7	A-6a (V)	

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

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

PROJECT: MEG-33-13.96	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: ACKER REBEL XL	STATION / OFFSET: 794+99, 93' LT.	EXPLORATION ID B-002-1-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: ODOT / BINKLEY	HAMMER: ACKER AUTOMATIC	ALIGNMENT: US 33	
PID: 119143 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/7/23	ELEVATION: 683.8 (ft) EOB: 28.0 ft.	PAGE 1 OF 1
START: 11/8/23 END: 11/8/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 39.029453, -81.939948	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
683.8																		
TOPSOIL (2")	683.7																	
VERY STIFF, RED AND GRAY, **SILT AND CLAY**, SOME STONE FRAGMENTS, TRACE SAND, DAMP		1–3	2 (2 2)	6	17	SS-1	3.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
		4–5	1 (2 2)	6	28	SS-2	1.00	25	3	5	32	35	33	18	15	16	A-6a (8)	
		6–7	5 (3 4)	11	33	SS-3	4.00	-	-	-	-	-	-	-	-	14	A-6a (V)	
	675.3	8																
STIFF, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, MOIST		9–10	1 (3 5)	12	61	SS-4	2.00	5	5	23	40	27	28	18	10	18	A-4a (6)	
	672.8	11																
VERY STIFF, GRAY, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP		12–13	5 (5 3)	12	67	SS-5	3.50	45	6	8	26	15	30	19	11	8	A-6a (1)	
@13.5'; STIFF, BROWN AND RED, SOME STONE FRAGMENTS, TRACE SAND		14–15	3 (5 7)	18	67	SS-6	1.00	25	3	6	37	29	33	21	12	14	A-6a (7)	
	667.8	16																
HARD, BROWN, **SANDY SILT**, SOME CLAY, SOME STONE FRAGMENTS, DAMP		17–18	5 (4 12)	24	78	SS-7	4.50	21	2	27	29	21	24	18	6	12	A-4a (3)	
	665.3	19																
VERY STIFF, BROWN AND GRAY, **SILT AND CLAY**, SOME STONE FRAGMENTS, LITTLE SAND, DAMP		20–23	4 (6 7)	20	78	SS-8	3.00	25	3	11	32	29	33	19	14	14	A-6a (7)	
@28.0'; AUGER REFUSAL, ENCOUNTERED CULVERT	655.8	24–25	4 (3 5)	12	72	SS-9	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
	EOB	28																

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

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

PROJECT: MEG-33-13.96	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: ACKER REBEL XL	STATION / OFFSET: 794+16, 77' LT.	EXPLORATION ID B-002-2-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: ODOT / BENNING	HAMMER: ACKER AUTOMATIC	ALIGNMENT: US 33	
PID: 119143 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/7/23	ELEVATION: 690.1 (ft) EOB: 44.0 ft.	PAGE 1 OF 1
START: 11/28/23 END: 11/29/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 39.029548, -81.940218	

MATERIAL DESCRIPTION AND NOTES	ELEV. 690.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL (18")	688.6	1																
VERY STIFF, DARK RED AND GRAY, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP		2	3 4 4	12	28	SS-1	2.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
@3.5'; STIFF		3																
		4	3 3 4	11	50	SS-2	1.50	40	3	8	27	22	31	20	11	9	A-6a (3)	
@6.0'; POOR RECOVERY, AUGER CUTTINGS TAKEN		5																
		6																
		7	10 4 3	11	6	SS-3	-	-	-	-	-	-	-	-	-	11	A-6a (V)	
	681.6	8																
MEDIUM STIFF, BROWN AND RED, **SANDY SILT**, SOME CLAY, LITTLE STONE FRAGMENTS, DAMP		9	2 2 2	6	39	SS-4	0.50	16	3	23	32	26	27	18	9	14	A-4a (5)	
	679.1	10																
MEDIUM STIFF, BROWN, **SILT AND CLAY**, SOME STONE FRAGMENTS, SOME SAND, POOR RECOVERY, AUGER CUTTINGS TAKEN, DAMP		11	5 2 3	8	11	SS-5	-	-	-	-	-	-	-	-	-	12	A-6a (V)	
@13.5'; VERY STIFF		12																
		13																
		14	2 3 5	12	67	SS-6	3.25	22	4	17	29	28	30	19	11	16	A-6a (5)	
@16.0'; HARD, TRACE ROOTS		15																
		16	9 9 11	30	78	SS-7	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
		17																
		18																
		19	5 8 9	26	39	SS-8	4.5+	-	-	-	-	-	-	-	-	10	A-6a (V)	
		20																
		21																
		22																
		23																
@23.5'; VERY STIFF, BROWN AND GRAY, "AND" STONE FRAGMENTS, LITTLE SAND		24	3 6 6	18	39	SS-9	3.00	38	1	16	20	25	32	18	14	11	A-6a (3)	
		25																
		26																
		27																
		28																
@28.5'; BROWN AND REDDISH BROWN, SOME STONE FRAGMENTS		29	4 40 60	150	100	SS-10	2.75	34	2	16	20	28	31	20	11	14	A-6a (3)	
		30																
		31																
		32																
		33																
		34	4 7 8	23	33	SS-11	3.00	-	-	-	-	-	-	-	-	12	A-6a (V)	
		35																
		36																
		37																
		38																
	651.6 TR	39	5 29 101	195	100	SS-12	-	-	-	-	-	-	-	-	-	9	Rock (V)	
SANDSTONE, BROWN, HIGHLY WEATHERED, WEAK, FINE GRAINED.		40																
		41																
		42																
		43																
	646.1 EOB	44	82	-	100	SS-13	-	-	-	-	-	-	-	-	-	5	Rock (V)	

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

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

SEEDING	
END WIDTH	SQ. YDS.

END AREA		VOLUME	
CUT	FILL	CUT	FILL

CALCULATED SAC

CHECKED CMK

WESTBOUND CROSS SECTIONS - S.R. 124 STA. 794+00

MEG-124-22.72

346
823

240 220 200 180 160 140 120 100 80 60 40 20 0

Historic cross-section

660 650 730 720 710 700 690 680 670 660 650

LA-R/W

2% 3%

643.0

NEASE CREEK CHANNEL

MATCH LINE

9.6%

730.1

732.82

704.00

659.65

2%

B-002-2-23

B-002-1-23

Ground surface at El. 690.1' (B-002-2-23)

Ground surface at El. 683.8' (B-002-1-23)

Top of Rock at El. 651.6' (B-002-2-23)

CU-07B

Adjusted ground surface from El. 648.9' to El. 644.2' (CU-07B)

Adjusted Top of Rock from El. 628.4' to El. 623.7' (CU-07B)

506

2439 SHEET TOTAL

SHEET TOTAL

19718CXK.DGN

SEEDING	
END WIDTH	SQ. YDS.

END AREA		VOLUME	
CUT	FILL	CUT	FILL

CALCULATED SAC
CHECKED CMK

Historic cross-section

B-002-0-23

Ground surface at El. 732.6' (B-002-0-23)

732.82
794+00.00
659.65

CU-07

Adjusted ground surface from El. 644.3' to El. 651.7' (CU-07)

Adjusted Top of Rock from El. 627.8' to El. 634.8' (CU-07)

NEASE CREEK CHANNEL

CU-07A

Adjusted ground surface from El. 647.9' to El. 644.8' (CU-07A)

Adjusted Top of Rock from El. 632.4' to El. 629.2' (CU-07A)

SHEET TOTAL

SHEET TOTAL

156 26217

156 26217

EASTBOUND CROSS SECTIONS - S.R. 124
STA. 794+00

MEG-124-22.72

347
823

19718GXL.DGN

Soil Parameter Determination

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

ODOT District 10
MEG-33-13.96

Soil Strength Parameter Determination

Computed By = AKB
Checked By = MM

Layer		Undrained Shear Strength (Su) (psf) PPR	N-values Sowers	N-values T and P	Tested Values	Dry Unit Weight (pcf) Correlation	Dry Unit Weight (pcf) Tested	Moist Unit Wt. (pcf) Correlation	Moist Unit Wt. (pcf) Tested	Adopted Short Term Parameters	Long-Term Strength Values	N_{60} Value	ODOT GB-7 Correlations Cohesion (psf)	ODOT GB-7 Correlations phi (deg)	Tested Cohesion (psf)	Tested phi (deg)	Adopted Long Term Strength Parameters	Consolidation Values ODOT GB-7 Correlations eo	ODOT GB-7 Correlations Cc	Adopted Consolidation Parameters
Layer 1	Max	4500	2275	1729		110		125			Max	13	136	23				Max	0.787	0.207	
	Min	500	450	798		95		110		S_u= 1400 psf	Min	6	75	21			c' = 110 psf	Min	0.543	0.153	eo = 0.681 Ko = 0.63
MEDIUM STIFF TO STIFF EMBANKMENT FILL	Average	2865	1532	1321		101		120		Φ = 0 deg	Average	10	112	22			Φ' = 22 deg	Average	0.681	0.181	Cc = 0.181 Es = N/A ksf
	Std Dev	1285	559	350		6		6			Std Dev	3	23	1				Std Dev	0.100	0.019	Cr = 0.018
										Y_{dry} = 100 pcf							Y_{dry} = 100 pcf				Cv = 0.13 ft²/day
	Avg + Std	4151	2091	1671		107		126		Y_{moist} = 120 pcf	Avg + Std	13	134	23			Y_{moist} = 120 pcf	Avg + Std	0.781	0.200	σ_p' = 18 ksf
	Avg - Std	1580	972	971		95		115			Avg - Std	7	89	22				Avg - Std	0.580	0.162	
Layer 2	Max	4500	4000	3990		120		135			Max	30	200	26				Max	0.476	0.315	
	Min	1000	1800	2128		115		130		S_u = 3000 psf	Min	16	153	24			c' = 175 psf	Min	0.378	0.126	eo = 0.444 Ko = 0.58
	Average	3500	3025	3026		117		132		Φ = 0 deg	Average	23	176	25			Φ' = 25 deg	Average	0.444	0.203	Cc = 0.203 Es = N/A ksf
	Std Dev	1363	1018	602		3		3			Std Dev	5	15	1				Std Dev	0.046	0.071	Cr = 0.020
VERY STIFF EMBANKMENT FILL										Y_{dry} = 115 pcf							Y_{dry} = 115 pcf				Cv = 0.11 ft²/day
	Avg + Std	4863	4043	3628		119		134		Y_{moist} = 130 pcf	Avg + Std	27	191	26			Y_{moist} = 130 pcf	Avg + Std	0.490	0.274	σ_p' = 18 ksf
	Avg - Std	2137	2007	2424		114		129			Avg - Std	18	161	24				Avg - Std	0.398	0.132	
Layer 3	Max	4500	4000	4000		135		145			Max	67	250	28				Max	0.476	0.198	
	Min	3000	3150	2394		115		130		S_u = 3700 psf	Min	18	160	24			c' = 215 psf	Min	0.257	0.189	eo = 0.362 Ko = 0.55
	Average	4313	3894	3663		125		138		Φ = 0 deg	Average	40	217	27			Φ' = 27 deg	Average	0.362	0.194	Cc = 0.194 Es = N/A ksf
	Std Dev	530	301	568		8		5			Std Dev	19	37	1				Std Dev	0.084	0.006	Cr = 0.019
VERY STIFF TO HARD EMBANKMENT FILL										Y_{dry} = 125 pcf							Y_{dry} = 125 pcf				Cv = 0.12 ft²/day
	Avg + Std	4843	4194	4230		133		143		Y_{moist} = 140 pcf	Avg + Std	58	254	28			Y_{moist} = 140 pcf	Avg + Std	0.446	0.200	σ_p' = 18 ksf
	Avg - Std	3782	3593	3095		117		132			Avg - Std	21	180	25				Avg - Std	0.278	0.187	
Layer 4	Max	N/A	1750	1330		105		125			Max	10	114	23				Max	0.787	0.234	
	Min	N/A	300	532		95		110		S_u = 930 psf	Min	4	50	20			c' = 85 psf	Min	0.616	0.171	eo = 0.756 Ko = 0.64
	Average	N/A	933	931		97		118		Φ = 0 deg	Average	7	86	21			Φ' = 21 deg	Average	0.756	0.194	Cc = 0.194 Es = N/A ksf
	Std Dev	N/A	496	260		3		5			Std Dev	2	21	1				Std Dev	0.056	0.028	Cr = 0.019
MEDIUM STIFF TO STIFF COHESIVE										Y_{dry} = 95 pcf							Y_{dry} = 95 pcf				Cv = 0.48 ft²/day
	Avg + Std	N/A	1429	1191		100		123		Y_{moist} = 120 pcf	Avg + Std	9	107	22			Y_{moist} = 120 pcf	Avg + Std	0.812	0.221	OCR = 1
	Avg - Std	N/A	436	671		93		113			Avg - Std	5	64	21				Avg - Std	0.700	0.166	
Layer 5	Max	N/A	2100	1729		110		125			Max	13	136	23				Max	0.616	0.234	
	Min	N/A	975	1330		105		125		S_u = 1650 psf	Min	10	114	23			c' = 125 psf	Min	0.543	0.234	eo = 0.580 Ko = 0.61
	Average	N/A	1731	1563		108		125		Φ = 0 deg	Average	12	127	23			Φ' = 23 deg	Average	0.580	0.234	Cc = 0.234 Es = N/A ksf
	Std Dev	N/A	530	167		3		0			Std Dev	1	9	0				Std Dev	0.042	N/A	Cr = 0.023
STIFF COHESIVE										Y_{dry} = 110 pcf							Y_{dry} = 110 pcf				Cv = 0.38 ft²/day
	Avg + Std	N/A	2262	1730		110		125		Y_{moist} = 125 pcf	Avg + Std	13	136	23			Y_{moist} = 125 pcf	Avg + Std	0.622	N/A	OCR = 1
	Avg - Std	N/A	1201	1395		105		125			Avg - Std	10	118	23				Avg - Std	0.537	N/A	
Layer 6	Max	3000	4000	4000		125		135			Max	34	200	27				Max	0.476	0.189	
	Min	3000	2550	3059		115		130		S_u = 3300 psf	Min	23	177	25			c' = 185 psf	Min	0.358	0.189	eo = 0.416 Ko = 0.56
	Average	3000	3517	3417		120		133		Φ = 0 deg	Average	27	186	26			Φ' = 26 deg	Average	0.416	0.189	Cc = 0.189 Es = N/A ksf
	Std Dev	N/A	837	509		5		3			Std Dev	6	13	1				Std Dev	0.059	N/A	Cr = 0.019
VERY STIFF TO HARD COHESIVE										Y_{dry} = 120 pcf							Y_{dry} = 120 pcf				Cv = 0.50 ft²/day
	Avg + Std	N/A	4354	3926		125		136		Y_{moist} = 135 pcf	Avg + Std	33	198	27			Y_{moist} = 135 pcf	Avg + Std	0.475	N/A	OCR = 1
	Avg - Std	N/A	2680	2908		115		130			Avg - Std	21	173	25				Avg - Std	0.357	N/A	

c = 260 psf,
phi = 19 degrees

c = 235 psf,
phi = 18 degrees

Ko = 1 - sin(phi)
Assumed Cc/Cr = 10
OCR selected as 1 considering the native materials to be normally consolidated. Preconsolidation pressure for existing fill selected based on correlations with LI in NAVFAC DM 7.1, Chapter 3, Figure 3. Cv values selected based on correlations with LL in USACE EM 1110-1-1904.

Layers 1 and 4 were modified by reducing the phi angle while increasing the cohesion based on Hall's Thesis which states for each 1 deree reduction of the phi angle, 50 psf of cohesion may be added (up to 150 psf)

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)	LI
Max	13	67	4.5	45	6	23	40	35	33	20	15	18	Max	4500	2275	1729	136	23	14.0	728.6	110	125	0.207	2.72	0.787	0.00
Min	6	6	0.5	5	3	5	26	15	27	18	9	8	Min	500	450	798	75	21	2.0	671.8	95	110	0.153	2.72	0.543	-1.00
Average	10	39	2.9	26	4	13	31	26	30	19	11	12	Average	2865	1532	1321	112	22	7.7	691.6	101	120	0.181	2.72	0.681	-0.47
Std Dev	3	19	1.3	14	1	8	5	6	2	1	2	3	Std Dev	1285	559	350	23	1	4.0	20.8	6	6	0.019	0.00	0.100	0.39
Avg + Std	13	58	4.2	40	5	21	36	32	32	19	13	15	Avg + Std	4151	2091	1671	134	23	11.8	712.4	107	126	0.200	2.72	0.781	-0.08
Avg - Std	7	19	1.6	12	3	6	26	20	28	18	9	9	Avg - Std	1580	972	971	89	22	3.7	670.8	95	115	0.162	2.72	0.580	-0.87

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)	LI
US 33	732.6	B-002-0-23	3.5	-	5	SS-2	8	33	3.5	28	4	9	31	28	32	19	13	13	A-6a	Cohesive	1	3500	1400	1064	100	22	4.0	728.6	95	110	0.198	2.72	0.787	-0.46
US 33	732.6	B-002-0-23	6	-	7.5	SS-3	13	44	3.5	-	-	-	-	-	-	-	-	10	A-6a	Cohesive	1	3500	2275	1729	136	23	7.0	725.6	105	125		2.72	0.616	
US 33	732.6	B-002-0-23	8.5	-	10	SS-4	8	39	4.5	-	-	-	-	-	-	-	-	12	A-6a	Cohesive	1	4500	1400	1064	100	22	9.0	723.6	95	120		2.72	0.787	
US 33	732.6	B-002-0-23	13.5	-	15	SS-6	13	56	4.5	-	-	-	-	-	-	-	-	9	A-4a	Cohesive	1	4500	975	1729	136	23	14.0	718.6	110	125		2.72	0.543	
US 33	683.8	B-002-1-23	1.5	-	3	SS-1	6	17	3	-	-	-	-	-	-	-	-	15	A-6a	Cohesive	1	3000	1050	798	75	21	2.0	681.8	95	110		2.72	0.787	
US 33	683.8	B-002-1-23	3.5	-	5	SS-2	6	28	1	25	3	5	32	35	33	18	15	16	A-6a	Cohesive	1	1000	1050	798	75	21	4.0	679.8	95	110	0.207	2.72	0.787	-0.13
US 33	683.8	B-002-1-23	6	-	7.5	SS-3	11	33	4	-	-	-	-	-	-	-	-	14	A-6a	Cohesive	1	4000	1925	1463	121	23	7.0	676.8	105	125		2.72	0.616	
US 33	683.8	B-002-1-23	8.5	-	10	SS-4	12	61	2	5	5	23	40	27	28	18	10	18	A-4a	Cohesive	1	2000	900	1596	129	23	9.0	674.8	105	125	0.162	2.72	0.616	0.00
US 33	683.8	B-002-1-23	11	-	12.5	SS-5	12	67	3.5	45	6	8	26	15	30	19	11	8	A-6a	Cohesive	1	3500	2100	1596	129	23	12.0	671.8	110	125	0.18	2.72	0.543	-1.00
US 33	690.1	B-002-2-23	1.5	-	3	SS-1	12	28	2.5	-	-	-	-	-	-	-	-	10	A-6a	Cohesive	1	2500	2100	1596	129	23	2.0	688.1	100	120		2.72	0.697	
US 33	690.1	B-002-2-23	3.5	-	5	SS-2	11	50	1.5	40	3	8	27	22	31	20	11	9	A-6a	Cohesive	1	1500	1925	1463	121	23	4.0	686.1	100	120	0.189	2.72	0.697	-1.00
US 33	690.1	B-002-2-23	6	-	7.5	SS-3	11	6	-	-	-	-	-	-	-	-	-	11	A-6a	Cohesive	1	N/A	1925	1463	121	23	7.0	683.1	105	125		2.72	0.616	
US 33	690.1	B-002-2-23	8.5	-	10	SS-4	6	39	0.5	16	3	23	32	26	27	18	9	14	A-4a	Cohesive	1	500	450	798	75	21	9.0	681.1	95	120	0.153	2.72	0.787	-0.44
US 33	690.1	B-002-2-23	11	-	12.5	SS-5	8	11	-	-	-	-	-	-	-	-	-	12	A-6a	Cohesive	1	N/A	1400	1064	100	22	12.0	678.1	95	120		2.72	0.787	
US 33	690.1	B-002-2-23	13.5	-	15	SS-6	12	67	3.25	22	4	17	29	28	30	19	11	16	A-6a	Cohesive	1	3250	2100	1596	129	23	14.0	676.1	110	125	0.18	2.72	0.543	-0.27

ODOT District 10
MEG-33-13.96

Soil Strength Parameter Determination

Computed By = AKB
Checked By = MM

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)	LI
Max	30	78	4.5	47	6	27	37	43	45	24	21	22	Max	4500	4000	3990	200	26	26.0	716.6	120	135	0.315	2.72	0.476	-0.10
Min	16	50	1.0	21	2	5	22	15	24	17	6	6	Min	1000	1800	2128	153	24	14.0	664.8	115	130	0.126	2.65	0.378	-1.00
Average	23	66	3.5	28	4	12	29	27	33	20	13	13	Average	3500	3025	3026	176	25	19.5	694.8	117	132	0.203	2.70	0.444	-0.61
Std Dev	5	10	1.4	11	2	9	6	11	8	3	5	5	Std Dev	1363	1018	602	15	1	4.0	23.1	3	3	0.071	0.03	0.046	0.40
Avg + Std	27	75	4.9	39	5	21	35	38	40	23	18	18	Avg + Std	4863	4043	3628	191	26	23.5	717.9	119	134	0.274	2.73	0.490	-0.21
Avg - Std	18	56	2.1	18	2	3	23	17	25	17	7	8	Avg - Std	2137	2007	2424	161	24	15.5	671.7	114	129	0.132	2.67	0.398	-1.01

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)	LI
US 33	732.6	B-002-0-23	15	-	16.5	SS-7	26	61	4	-	-	-	-	-	-	-	-	9	A-4a	Cohesive	2	4000	1950	3458	187	25	16.0	716.6	115	130		2.72	0.476	
US 33	732.6	B-002-0-23	18.5	-	20	SS-8	24	56	4.5	-	-	-	-	-	-	-	-	9	A-4a	Cohesive	2	4500	1800	3192	180	25	19.0	713.6	115	130		2.72	0.476	
US 33	732.6	B-002-0-23	20	-	21.5	SS-9	24	50	4.5	47	4	9	25	15	28	17	11	6	A-6a	Cohesive	2	4500	4000	3192	180	25	21.0	711.6	120	135	0.162	2.72	0.414	-1.00
US 33	732.6	B-002-0-23	23.5	-	25	SS-10	16	67	2	24	6	5	22	43	45	24	21	22	A-7-6	Cohesive	2	2000	4000	2128	153	24	24.0	708.6	120	135	0.315	2.65	0.378	-0.10
US 33	732.6	B-002-0-23	25	-	26.5	SS-11	30	67	4.5	-	-	-	-	-	-	-	-	18	A-7-6	Cohesive	2	4500	4000	3990	200	26	26.0	706.6	120	135		2.65	0.378	
US 33	683.8	B-002-1-23	13.5	-	15	SS-6	18	67	1	25	3	6	37	29	33	21	12	14	A-6a	Cohesive	2	1000	3150	2394	160	24	14.0	669.8	115	130	0.207	2.72	0.476	-0.58
US 33	683.8	B-002-1-23	16	-	17.5	SS-7	24	78	4.5	21	2	27	29	21	24	18	6	12	A-4a	Cohesive	2	4500	1800	3192	180	25	17.0	666.8	115	130	0.126	2.72	0.476	-1.00
US 33	683.8	B-002-1-23	18.5	-	20	SS-8	20	78	3	25	3	11	32	29	33	19	14	14	A-6a	Cohesive	2	3000	3500	2660	167	25	19.0	664.8	115	130	0.207	2.72	0.476	-0.36

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)	LI
Max	67	78	4.5	38	3	16	34	29	32	18	14	12	Max	4500	4000	4000	250	28	49.0	703.6	135	145	0.198	2.72	0.476	-0.50
Min	18	17	3.0	26	1	8	20	25	31	18	13	4	Min	3000	3150	2394	160	24	17.0	666.1	115	130	0.189	2.72	0.257	-0.62
Average	40	42	4.3	32	2	12	27	27	32	18	14	9	Average	4313	3894	3663	217	27	31.9	684.8	125	138	0.194	2.72	0.362	-0.56
Std Dev	19	21	0.5	8	1	6	10	3	1	0	1	3	Std Dev	530	301	568	37	1	11.7	13.7	8	5	0.006	0.00	0.084	0.08
Avg + Std	58	63	4.8	40	3	18	37	30	32	18	14	11	Avg + Std	4843	4194	4230	254	28	43.5	698.5	133	143	0.200	2.72	0.446	-0.48
Avg - Std	21	21	3.8	24	1	6	17	24	31	18	13	6	Avg - Std	3782	3593	3095	180	25	20.2	671.1	117	132	0.187	2.72	0.278	-0.64

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)	LI
US 33	732.6	B-002-0-23	28.5	-	30	SS-12	67	67	4.5	26	3	8	34	29	31	18	13	10	A-6a	Cohesive	3	4500	4000	4000	250	28	29.0	703.6	130	140	0.189	2.72	0.306	-0.62
US 33	732.6	B-002-0-23	33.5	-	35	SS-13	66	17	4.5	-	-	-	-	-	-	-	-	4	A-6a	Cohesive	3	4500	4000	4000	250	28	34.0	698.6	130	140		2.72	0.306	
US 33	732.6	B-002-0-23	38.5	-	40	SS-14	40	33	4.5	-	-	-	-	-	-	-	-	8	A-6a	Cohesive	3	4500	4000	4000	250	28	39.0	693.6	130	140		2.72	0.306	
US 33	732.6	B-002-0-23	43.5	-	45	SS-15	46	39	4.5	-	-	-	-	-	-	-	-	9	A-6a	Cohesive	3	4500	4000	4000	250	28	44.0	688.6	135	145		2.72	0.257	
US 33	732.6	B-002-0-23	48.5	-	50	SS-16	26	22	4.5	-	-	-	-	-	-	-	-	7	A-6a	Cohesive	3	4500	4000	3458	187	25	49.0	683.6	125	140		2.72	0.358	
US 33	690.1	B-002-2-23	16	-	17.5	SS-7	30	78	4.5	-	-	-	-	-	-	-	-	12	A-6a	Cohesive	3	4500	4000	3990	200	26	17.0	673.1	115	130		2.72	0.476	
US 33	690.1	B-002-2-23	18.5	-	20	SS-8	26	39	4.5	-	-	-	-	-	-	-	-	10	A-6a	Cohesive	3	4500	4000	3458	187	25	19.0	671.1	115	130		2.72	0.476	
US 33	690.1	B-002-2-23	23.5	-	25	SS-9	18	39	3	38	1	16	20	25	32	18	14	11	A-6a	Cohesive	3	3000	3150	2394	160	24	24.0	666.1	120	135	0.198	2.72	0.414	-0.50

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 4

	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)	LI
Max	10	N/A	N/A	1	5	32	97	40	36	20	16	30	Max	N/A	1750	1330	114	23	15.0	646.9	105	125	0.234	2.72	0.787	1.10
Min	4	N/A	N/A	0	1	3	37	25	29	19	10	14	Min	N/A	300	532	50	20	2.0	633.3	95	110	0.171	2.70	0.616	0.10
Average	7	N/A	N/A	0	2	14	68	33	32	20	12	21	Average	N/A	933	931	86	21	7.2	639.4	97	118	0.194	2.71	0.756	0.39
Std Dev	2	N/A	N/A	1	2	13	30	11	3	1	3	4	Std Dev	N/A	496	260	21	1	4.2	4.5	3	5	0.028	0.01	0.056	0.48
Avg + Std	9	N/A	N/A	1	4	26	98	43	35	20	15	24	Avg + Std	N/A	1429	1191	107	22	11.5	644.0	100	123	0.221	2.72	0.812	0.87
Avg - Std	5	N/A	N/A	0	0	1	38	22	28	19	9	17	Avg - Std	N/A	436	671	64	21	3.0	634.9	93	113	0.166	2.70	0.700	-0.08

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)	LI
US 33	644.3	CU-07	1	-	2.5	1	9	-	-	-	-	-	-	-	-	-	-	19	A-6b	Cohesive	4	N/A	1575	1197	107	22	2.0	642.3	100	120		2.70	0.685	
US 33	644.3	CU-07	3.5	-	5	2	10	-	-	-	-	-	-	-	-	-	-	14	A-6b	Cohesive	4	N/A	1750	1330	114	23	4.0	640.3	100	120		2.70	0.685	
US 33	644.3	CU-07	6	-	7.5	3	8	-	-	0	1	3	97		36	20	16	22	A-6b	Cohesive	4	N/A	1400	1064	100	22	7.0	637.3	95	120	0.234	2.70	0.773	0.13
US 33	644.3	CU-07	7.5	-	9	4	7	-	-	-	-	-	-	-	-	-	-	21	A-6a	Cohesive	4	N/A	1225	931	88	22	8.0	636.3	95	120		2.72	0.787	
US 33	644.3	CU-07	9	-	10.5	5	5	-	-	1	1	7	91		31	19	12	22	A-6a	Cohesive	4	N/A	875	665	63	21	10.0	634.3	95	120	0.189	2.72	0.787	0.25
US 33	644.3	CU-07	10.5	-	12	6	7	-	-	-	-	-	-	-	-	-	-	18	A-6a	Cohesive	4	N/A	1225	931	88	22	11.0	633.3	95	120		2.72	0.787	
US 33	647.9	CU-07A	1	-	2.5	1	5	-	-	-	-	-	-	-	-	-	-	24	A-4a	Cohesive	4	N/A	375	665	63	21	2.0	645.9	95	110		2.72	0.787	
US 33	647.9	CU-07A	3.5	-	5	2	5	-	-	0	5	32	37	25	29	19	10	30	A-4a	Cohesive	4	N/A	375	665	63	21	4.0	643.9	95	110	0.171	2.72	0.787	1.10
US 33	648.9	CU-07B	1.5	-	3	1	7	-	-	-	-	-	-	-	-	-	-	16	A-6b	Cohesive	4	N/A	1225	931	88	22	2.0	646.9	95	110		2.70	0.773	
US 33	648.9	CU-07B	6.5	-	8	3	6	-	-	-	-	-	-	-	-	-	-	19	A-4a	Cohesive	4	N/A	450	798	75	21	7.0	641.9	95	120		2.72	0.787	
US 33	648.9	CU-07B	9	-	10.5	4	10	-	-	-	-	-	-	-	-	-	-	21	A-4a	Cohesive	4	N/A	750	1330	114	23	10.0	638.9	105	125		2.72	0.616	
US 33	648.9	CU-07B	11.5	-	13	5	8	-	-	-	-	-	-	-	-	-	-	21	A-4a	Cohesive	4	N/A	600	1064	100	22	12.0	636.9	95	120		2.72	0.787	
US 33	648.9	CU-07B	14	-	15.5	6A	4	-	-	0	1	12	48	40	30	20	10	21	A-4a	Cohesive	4	N/A	300	532	50	20	15.0	633.9	95	115	0.18	2.72	0.787	0.10

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 5

	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)	LI
Max	13	N/A	N/A	0	1	9	90	N/A	36	20	16	23	Max	N/A	2100	1729	136	23	17.0	640.9	110	125	0.234	2.72	0.616	0.19
Min	10	N/A	N/A	0	1	9	90	N/A	36	20	16	13	Min	N/A	975	1330	114	23	7.0	630.3	105	125	0.234	2.72	0.543	0.19
Average	12	N/A	N/A	0	1	9	90	N/A	36	20	16	18	Average	N/A	1731	1563	127	23	11.8	635.5	108	125	0.234	2.72	0.580	0.19
Std Dev	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5	Std Dev	N/A	530	167	9	0	4.6	5.2	3	0	N/A	0.00	0.042	N/A
Avg + Std	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22	Avg + Std	N/A	2262	1730	136	23	16.3	640.7	110	125	N/A	2.72	0.622	N/A
Avg - Std	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	13	Avg - Std	N/A	1201	1395	118	23	7.2	630.4	105	125	N/A	2.72	0.537	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)	LI
US 33	644.3	CU-07	13.5	-	15	7	12	-	-	-	-	-	-	-	-	-	-	13	A-6a	Cohesive	5	N/A	2100	1596	129	23	14.0	630.3	110	125		2.72	0.543	
US 33	647.9	CU-07A	6	-	7.5	3	12	-	-	-	-	-	-	-	-	-	-	20	A-6a	Cohesive	5	N/A	2100	1596	129	23	7.0	640.9	105	125		2.72	0.616	
US 33	647.9	CU-07A	8.5	-	10	4	10	-	-	0	1	9	90		36	20	16	23	A-6a	Cohesive	5	N/A	1750	1330	114	23	9.0	638.9	105	125	0.234	2.72	0.616	0.19
US 33	648.9	CU-07B	16.5	-	18	7	13	-	-	-	-	-	-	-	-	-	-	14	A-4a	Cohesive	5	N/A	975	1729	136	23	17.0	631.9	110	125		2.72	0.543	

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 6

	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)	LI
Max	34	33	3.0	1	6	11	82	N/A	31	21	10	24	Max	3000	4000	4000	200	27	34.0	656.1	125	135	0.189	2.72	0.476	0.30
Min	23	33	3.0	1	6	11	82	N/A	31	21	10	12	Min	3000	2550	3059	177	25	14.0	628.9	115	130	0.189	2.72	0.358	0.30
Average	27	33	3.0	1	6	11	82	N/A	31	21	10	17	Average	3000	3517	3417	186	26	22.7	639.6	120	133	0.189	2.72	0.416	0.30
Std Dev	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6	Std Dev	N/A	837	509	13	1	10.3	14.5	5	3	N/A	0.00	0.059	N/A
Avg + Std	33	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23	Avg + Std	N/A	4354	3926	198	27	32.9	654.1	125	136	N/A	2.72	0.475	N/A
Avg - Std	21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11	Avg - Std	N/A	2680	2908	173	25	12.4	625.2	115	130	N/A	2.72	0.357	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)	LI
US 33	647.9	CU-07A	13.5	-	15	5	24	-	-	-	-	-	-	-	-	-	-	15	A-6a	Cohesive	6	N/A	4000	3192	180	25	14.0	633.9	115	130		2.72	0.476	
US 33	648.9	CU-07B	19	-	20.5	8A	34	-	-	1	6	11	82		31	21	10	24	A-4a	Cohesive	6	N/A	2550	4000	200	27	20.0	628.9	125	135	0.189	2.72	0.358	0.30
US 33	690.1	B-002-2-23	33.5	-	35	SS-11	23	33	3	-	-	-	-	-	-	-	-	12	A-6a	Cohesive	6	3000	4000	3059	177	25	34.0	656.1	120	135		2.72	0.414	

ODOT District 10
MEG-33-13.96

Rock Strength Parameter Determination

Computed By = MM
Checked By = DCM

CORED BEDROCK, INCOMPLETE TEST RESULTS (STRENGTH VALUES ONLY)

Project	Exploration ID	Sample Depth (ft)	Sample ID	Rock Type	Color	Unit Weight (pcf) Range	Unit Weight (pcf) USE	Geologic Strength Descriptor	Compressive Strength, Qu Based on Rock Type (psi)	Compressive Strength, Qu Based on GSD (psi)	Compressive Strength, Qu USE (psi)	Compressive Strength, Qu USE (MPa)	GSD Ei Modulus (psi)	GSD Ei Modulus (MPa)	GSI Range	GSI USE	Em (Hoek & Brown) Modulus (GPa)	Em (Hoek & Brown) Modulus (psi)	Lesser of Ei vs Em (psi)
MEG-124-22.72	CU-07	20.5	R-1	Siltstone	Gray	160 - 170	160	Very Weak	3600 - 8100	200	100	0.7	18000	124	5-15	10	0.1	12043	12043
MEG-124-22.72	CU-07A	21.2	R-1	Siltstone	Gray	160 - 170	160	Weak	3600 - 8100	750	196	1.4	68000	469	5-15	10	0.1	16860	16860
MEG-124-22.72	CU-07B	25.8	R-1	Claystone	Reddish Brown	130 - 165	130	Very Weak	15 - 1400	200	152	1	18000	124	5-15	10	0.1	14848	14848
				Siltstone / Claystone	Maximum	160			Siltstone / Claystone	Maximum	196					Siltstone / Claystone	Maximum		16860
					Minimum	130				Minimum	100						Minimum		12043
					Average	150				Average	149						Average		14584
					Std Dev	17				Std Dev	48						Std Dev		2419
					Adopted Value	150				Adopted Value	150						Adopted Value		14600

* Assumed typical unit weight values
* In accordance with the GDM, Claystone bedrock type was used for tested Mudstone bedrock samples

BEDROCK CORE QUALITY

Project	Exploration ID	Rock Type	Depth Range (ft.) From	Depth Range (ft.) To	Thickness (ft)	Layer RQD (%)	Weighted RQD*(length / Total Length)
MEG-124-22.72	CU-07	Siltstone	16.5	22	5.5	1	0.1
MEG-124-22.72	CU-07	Siltstone	22	29.5	7.5	0	0.0
MEG-124-22.72	CU-07	Siltstone	32	37	5	0	0.0
MEG-124-22.72	CU-07	Siltstone	37	41	4	0	0.0
MEG-124-22.72	CU-07A	Siltstone	15.5	22.5	7	36	5.7
MEG-124-22.72	CU-07B	Claystone	25	30.5	5.5	18	2.2
MEG-124-22.72	CU-07B	Claystone	30.5	35.5	5	0	0.0
MEG-124-22.72	CU-07B	Claystone	35.5	40.5	5	10	1.1
				Siltstone / Claystone	44.5	RQD SUM	9
				Maximum	7.5	36	
				Minimum	4	0	
				Average	5.6	8.1	
				Adopted Value			9

Table 400-5: Rock Properties of Typical Rock Types Found in Ohio (Masada and Han, 2013)

Rock Type	Unit Weight (pcf)	Unconfined Compressive Strength (psi)	Slake Durability Index (%)
Claystone	130-165	15-1400	0-60
Shale	155-165 (unweathered) 150-160 (weathered)	2100-4600 (unweathered) 100-400 (weathered)	20-90
Siltstone	160-170	3600-8100	65-90
Sandstone	155-165	1800-7800	85-100
Friable Sandstone	125-140	<3600	<85
Limestone	155-170	3500-16400	95-100
Dolomite	165-175	4100-10300	95-100
Coal	80-85	1300-7000	NA
Underclay	125-135	200-400	0-20

Per ODOT GDM

Table 400-6: Estimated Bedrock Strength Characteristics from Visual Description

Geologic Strength Descriptor	Q_u (psi)	E_i (psi)	Historic Hardness Descriptor (used prior to 2007)
Very Weak	200	18000	Very Soft
Very Weak to Weak	360	32000	Very Soft to Soft
Weak	750	68000	Soft
Weak to Slightly Strong	1125	100000	Soft to Medium
Slightly Strong	1500	140000	Medium / Medium-Firm
Slightly Strong to Moderately Strong	2250	200000	Medium to Moderately Hard
Moderately Strong	3600	320000	Moderately Hard
Moderately Strong to Strong	5000	450000	Moderately Hard to Hard
Strong	7500	680000	Hard
Strong to Very Strong	10000	900000	Hard to Very Hard
Very Strong	15000	1400000	Very Hard
Very Strong to Extremely Strong	20000	1800000	
Extremely Strong	30000	2700000	

Per ODOT GDM

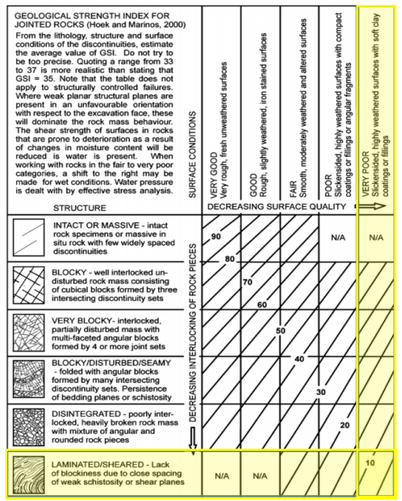


Figure 10.4.6.4-1—Determination of *GSI* for Jointed Rock Mass (Hoek and Marinos, 2000)

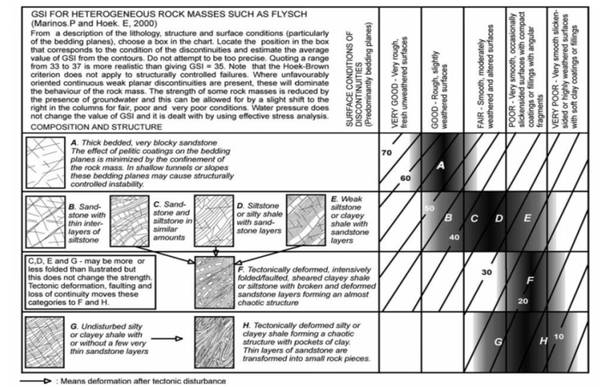


Figure 10.4.6.4-2—Determination of *GSI* for Tectonically Deformed Heterogeneous Rock Masses (Marinos and Hoek 2000)

Per AASHTO LRFD Bridge Design Manual

Table 10.4.6.5-1—Estimation of E_m Based on GSI

Expression	Notes/Remarks	Reference
$E_m(GPa) = \sqrt{\frac{q_u}{100}}\,10^{\frac{GSI-10}{40}}$ for $q_u \le 100$ MPa $E_m(GPa) = 10^{\frac{GSI-10}{40}}$ 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.		

Per AASHTO LRFD Bridge Design Manual

ODOT District 10
MEG-33-13.96

Weathered Rock Strength Parameter Determination

Computed By = MM
Checked By = DCM

WEATHERED BEDROCK WITH SPT

Hammer Efficiency 90 %

Project	Exploration ID	Sample Depth (ft)	Sample ID	Rock Type	Color	Moist Unit Weight (pcf) GDM Range	Moist Unit Weight (pcf) USE	No. Refusal Blows	Refusal Distance (in)	N90	N90	Compressive Strength, Qu (ksf)	Compressive Strength, Qu (psi)	Compressive Strength, Qu (MPa)
MEG-33-13.96	B-002-2-23	38.5	SS-12	Sandstone	Brown	155 - 165	155	195	12	195	195	18	125	0.9
MEG-33-13.96	B-002-2-23	43.5	SS-13	Sandstone	Brown	155 - 165	155	82	6	164	164	15	105	0.7
				Sandstone	Maximum		155			Maximum		18	125	
					Minimum		155			Minimum		15	105	
					Average		155			Average		17	115	
					Std Dev		0			Std Dev		2	14	
					Adopted Value		155			Adopted Value		17	115	

* Assumed typical unit weight values

*Qu (ksf) = 0.092*N90 (ODOT GDM Section 404.3)*

Table 400-5: Rock Properties of Typical Rock Types Found in Ohio (Masada and Han, 2013)

Rock Type	Unit Weight (pcf)	Unconfined Compressive Strength (psi)	Slake Durability Index (%)
Claystone	130-165	15-1400	0-60
Shale	155-165 (unweathered) 150-160 (weathered)	2100-4600 (unweathered) 100-400 (weathered)	20-90
Siltstone	160-170	3600-8100	65-90
Sandstone	155-165	1800-7800	85-100
Friable Sandstone	125-140	<3600	<85
Limestone	155-170	3500-16400	95-100
Dolomite	165-175	4100-10300	95-100
Coal	80-85	1300-7000	NA
Underclay	125-135	200-400	0-20

Per ODOT GDM

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 5/13/99 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 5/14/99 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-07 Station & Offset 794+75.00, 42.00' RT Surface Elev. 644.33ft

Elev. (ft)	Depth (ft)	Std. Pen. / RQD	Rec. (ft)	Lass (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
644.3	0														
643.7					TOPSOIL										
		3-4-5			Stiff, brown SILTY CLAY, trace sand, moist.	1	--	--	--	--	--	--	--	19	VISUAL
		3-4-6				2	--	--	--	--	--	--	--	14	VISUAL
	5				Layer 4										
		3-3-5				3	0	1	3	--	97*	36	16	22	A-6b
637.4					Medium stiff to stiff, brown to gray SILT AND CLAY, moist.										
		2-3-4				4	--	--	--	--	--	--	--	21	VISUAL
		2-2-3				5	1	1	7	--	91*	31	12	22	A-6a
	10														
		1-3-4				6	--	--	--	--	--	--	--	18	VISUAL
		3-7-5				7	--	--	--	--	--	--	--	13	VISUAL
	15				Layer 5										
627.8		ROD = 1%	4.7	0.8	Note: Auger refusal on bedrock at 16.5 feet. Began coring rock. Very soft, gray, decomposed SILTSTONE, with indistinct bedding, very poor condition as per ROD.										
					RUN 1 FROM 16.5 FEET TO 22.0 FEET										
	20														
623.3					U.C. Strength at 20.5 feet = 100 psi										
		ROD = 0%	0.1	7.4											
	25														
					Note: Color change to reddish brown at 25.0 feet.										
					RUN 2 FROM 22.0 FEET TO 29.5 FEET Run 2 bedrock quality very poor as per ROD.										
	30														
					Note: Used roller bit method of drilling from 29.5 feet to 32.0 feet because core barrel locked at 29.5 feet. No rock sample recovery between these depths.										
		ROD = 0%	0.3	4.8											
	35				RUN 3 FROM 32.0 FEET TO 37.0 FEET Run 3 bedrock quality very poor as per ROD.										
		ROD = 0%	3.7	0.3											
	40				RUN 4 FROM 37.0 FEET TO 41.0 FEET Run 4 bedrock quality very poor as per ROD.										
603.3					TERMINATION DEPTH = 41.0 FEET										

*Silt and clay combined

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

MEG-124-22.72

SOIL PROFILE

DRAWN	REVIEWED	DATE	CALCULATED
E.D.S.	B.M.	1/24/01	W.I.N.
			CHECKED S.S.S.

PRIME ENGINEERING & ARCHITECTURE, INC.
COLUMBUS: (614) 457-2100 AKRON: (330) 666-5432

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 4/14/99 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 4/14/99 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-07A Station & Offset 794+75.00, 200.00' RT Surface Elev. 647.87ft

Elev. (ft)	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	OOOT Class
647.9	0														
647.4					TOPSOIL										
		1-2-3			Medium stiff, brown SANDY SILT, some clay, moist.	1	--	--	--	--	--	--	--	24	VISUAL
		1-2-3			Layer 4	2	0	5	32	37	25	29	10	30	A-4a
643.0	5				Stiff to very stiff, brown SILT AND CLAY, trace sand, moist.										
		3-4-8				3	--	--	--	--	--	--	--	20	VISUAL
		3-4-6			Layer 5	4	0	1	9	--	90 *	36	16	23	A-6a
	10														
		6-8-16			Layer 6	5	--	--	--	--	--	--	--	15	VISUAL
632.4	15	ROD = 36%	6.9	0.1	Note: Auger refused on bedrock at 15.5 feet. Began coring rock. Very soft, reddish brown, decomposed SILTSTONE with indistinct bedding, very poor condition as per ROD.										
					Note: Siltstone changing to soft, weathered to highly weathered, and grey at 16.4 feet.										
	20				U.C. Strength at 21.2 feet = 196 psi										
625.4					TERMINATION DEPTH = 22.5 FEET										

*Silt and clay combined

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.

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 3/31/99 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 3/31/99 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-09 Station & Offset 813+30.00, 42.00' RT Surface Elev. 767.23ft

Elev. (ft)	Depth (ft)	Std. Pen./ RQD	Rec. (ft)	Loss (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	OOOT Class
767.2	0														
766.6					TOPSOIL										
		6-16-18			Very soft, highly weathered to decomposed, brown CLAY SHALE.	1	--	--	--	--	--	--	--	11	VISUAL
		50/4in				2	--	--	--	--	--	--	--	6	VISUAL
	5	50/5in				3	--	--	--	--	--	--	--	7	VISUAL
		50/4in				4	--	--	--	--	--	--	--	6	VISUAL
757.2	10	ROD = 0%	5.0	0.0	Note: Auger refusal on bedrock at 10.0 feet. Began coring rock. Very soft, highly weathered to decomposed, brown CLAY SHALE with horizontal laminar bedding (fissile) to 11.5 feet; indistinct bedding from 11.5 feet to 15.0 feet. Rock in very poor condition as per ROD. U.C. Strength at 10.9 feet = 166 psi										
752.2	15				TERMINATION DEPTH = 15.0 FEET										

*Silt and clay combined

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.

43/67	MEG-124-22.72	SOIL PROFILE	DRAWN E.D.S.	REVIEWED B.M.	DATE 1/24/01	CALCULATED W.J.N. / CHECKED S.S.S.

PRIME ENGINEERING & ARCHITECTURE, INC.
COLUMBUS: (614) 457-2100 AKRON: (330) 666-5432

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 7/5/00 Sampler: Type SS Dia. 2.0" Water Elev. 632.6ft
Date Completed 7/6/00 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-07B Station & Offset 794+60.79 189.96' LT Surface Elev. 648.94ft

Elev. (ft)	Depth (ft)	Std. Pen./ ROD	Rec. (ft)	Loss (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	OOOT Class
648.9	0				TOPSOIL										
647.4	2	3 - 3 - 4			Medium stiff to very stiff, reddish brown SILTY CLAY (A-6b), little sand, trace to some rock fragments, trace roots, moist.	1	--	--	--	--	--	--	--	16	VISUAL
	4	5 - 15 - 15		Omit		2	--	--	--	--	--	--	--	9	VISUAL
643.9	6				Note: Encountered a sandstone cobble at 4.5 feet. Soft to hard, brown and gray SANDY SILT (A-4a), some to little clay, no to little gravel and rock fragments, moist to wet.										
	8	2 - 3 - 3				3	--	--	--	--	--	--	--	19	VISUAL
	10	3 - 4 - 6			Layer 4	4	--	--	--	--	--	--	--	21	VISUAL
	12	3 - 4 - 4				5	--	--	--	--	--	--	--	21	VISUAL
	14	2 - 1 - 3			Note: Pushed a Shelby Tube from 14 to 16 feet next to original test boring.	6A 6B	0 --	1 --	12 --	48 --	40 --	30 --	10 --	21 21	A-4a VISUAL
	16 ▽														
	18	4 - 6 - 7			Note: Encountered groundwater at 16.3 feet during drilling. Layer 5	7	--	--	--	--	--	--	--	14	VISUAL
	20	4 - 5 - 29			Layer 6	8A	1	6	11	--	82 *	31	10	24	A-4a
628.4						8B	--	--	--	--	--	--	--	14	VISUAL
	22	10-44-50/0.4			Very soft, decomposed, reddish brown MUDSTONE with indistinct bedding. The quality of the mudstone in all three runs is considered very poor as per ROD.	9	--	--	--	--	--	--	--	9	VISUAL
	24	50/0.5			Note: Augered to 25.0 feet and began coring.	10	--	--	--	--	--	--	--	10	VISUAL
623.9	26	ROD = 18%	4.7	0.8	Very soft to medium hard, decomposed to weathered, reddish brown MUDSTONE with indistinct bedding. U.C. Strength of dec. mudstone at 25.8 feet = 152 psi										
	28														
	30														
	32	ROD = 0%	4.0	1.0											
	34														
	36	ROD = 10%	3.5	1.5											
	38														
608.4	40														
					TERMINATION DEPTH = 40.5 FEET										

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 (*Indicates silt & clay combined)

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory

LOG OF BORING

Date Started 7/27/00 Sampler: Type SS Dia. 2.0" Water Elev. ft
Date Completed 7/27/00 Casing: Length Dia. 3.25"

Project: MEG-124-22.72
Project No.: 99011
Location: Meigs County, Ohio

Boring No. CU-08 Station & Offset 812+63.51 128.85' RT Surface Elev. 775.52ft

Elev. (ft)	Depth (ft)	Std. Pen./ ROD	Rec. (ft)	Loss (ft)	Description	Sample No.	Physical Characteristics % Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	OOOT Class
775.5	0														
774.9	2	6 - 9 - 6			TOPSOIL Stiff, brown CLAY (A-7-6), some sand, trace rock fragments, trace roots, moist.	1	2	6	20	--	72 *	52	28	19	A-7-6
	4	4 - 4 - 6				2	--	--	--	--	--	--	--	19	VISUAL
	6														
769.0		5 - 11 - 16				3	--	--	--	--	--	--	--	12	VISUAL
	8				Medium dense, brown COARSE AND FINE SAND (A-3a), little silt, trace rock fragments, moist.										
767.0	10	7 - 11 - 17			Very stiff, brown CLAY (A-7-6), little sand, moist.	4	--	--	--	--	--	--	--	21	VISUAL
764.0	12	8 - 21 - 34				5	--	--	--	--	--	--	--	15	VISUAL
					Very soft, decomposed, brown and black SANDSTONE.										
761.5	14	15 - 43 - 22				6A	--	--	--	--	--	--	--	8	VISUAL
					Very soft, decomposed to highly weathered, brown CLAY SHALE.	6B	--	--	--	--	--	--	--	12	VISUAL
	16	60/0.5				7	--	--	--	--	--	--	--	9	VISUAL
	18														
	20	39 - 56				8	--	--	--	--	--	--	--	10	VISUAL
	22	24 - 31 - 48				9	--	--	--	--	--	--	--	11	VISUAL
753.0															
					TERMINATION DEPTH = 22.5 FEET										

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 (*Indicates silt & clay combined)

61/67	MEG-124-22.72	SOIL PROFILE	DRAWN E.D.S.	REVIEWED B.M.	DATE 1/24/01	CALCULATED W.I.N. / CHECKED S.S.S.

PRIME ENGINEERING & ARCHITECTURE, INC.
COLUMBUS: (614) 457-2100 AKRON: (330) 666-5432

PROJECT: MEG-33-13.96	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: ACKER REBEL XL	STATION / OFFSET: 794+99, 93' LT.	EXPLORATION ID B-002-1-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: ODOT / BINKLEY	HAMMER: ACKER AUTOMATIC	ALIGNMENT: US 33	
PID: 119143 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/7/23	ELEVATION: 683.8 (ft) EOB: 28.0 ft.	PAGE 1 OF 1
START: 11/8/23 END: 11/8/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 39.029453, -81.939948	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL (2")	683.8																	
VERY STIFF, RED AND GRAY, **SILT AND CLAY**, SOME STONE FRAGMENTS, TRACE SAND, DAMP	683.7	1																
Layer 1		2	2 2	6	17	SS-1	3.00	-	-	-	-	-	-	-	-	15	A-6a (V)	
		3																
		4	1 2 2	6	28	SS-2	1.00	25	3	5	32	35	33	18	15	16	A-6a (8)	
		5																
		6	5 3 4	11	33	SS-3	4.00	-	-	-	-	-	-	-	-	14	A-6a (V)	
		7																
	675.3	8																
STIFF, BROWN AND GRAY, **SANDY SILT**, SOME CLAY, TRACE STONE FRAGMENTS, MOIST		9	1 3 5	12	61	SS-4	2.00	5	5	23	40	27	28	18	10	18	A-4a (6)	
	672.8	10																
VERY STIFF, GRAY, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP		11																
		12	5 5 3	12	67	SS-5	3.50	45	6	8	26	15	30	19	11	8	A-6a (1)	
		13																
@13.5'; STIFF, BROWN AND RED, SOME STONE FRAGMENTS, TRACE SAND		14	3 5 7	18	67	SS-6	1.00	25	3	6	37	29	33	21	12	14	A-6a (7)	
	667.8	15																
HARD, BROWN, **SANDY SILT**, SOME CLAY, SOME STONE FRAGMENTS, DAMP		16	5 4 12	24	78	SS-7	4.50	21	2	27	29	21	24	18	6	12	A-4a (3)	
Layer 2		17																
	665.3	18																
VERY STIFF, BROWN AND GRAY, **SILT AND CLAY**, SOME STONE FRAGMENTS, LITTLE SAND, DAMP		19	4 6 7	20	78	SS-8	3.00	25	3	11	32	29	33	19	14	14	A-6a (7)	
This layer was omitted on the design cross-section given the distance Boring B-002-1-23 is from the design cross section (99 feet) in comparison to Boring B-002-2-23 (16 feet) and that this layer was not encountered in B-002-2-23.		20																
		21																
		22																
		23																
		24	4 3 5	12	72	SS-9	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
Omit		25																
		26																
		27																
@28.0'; AUGER REFUSAL, ENCOUNTERED CULVERT	655.8	28																
		EOB																

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

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

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 12/28/23 14:39 - X:\GINT\PROJECTS\601102.GPJ

PROJECT: MEG-33-13.96	DRILLING FIRM / OPERATOR: ODOT / LEWIS	DRILL RIG: ACKER REBEL XL	STATION / OFFSET: 794+16, 77' LT.	EXPLORATION ID B-002-2-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: ODOT / BENNING	HAMMER: ACKER AUTOMATIC	ALIGNMENT: US 33	
PID: 119143 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/7/23	ELEVATION: 690.1 (ft) EOB: 44.0 ft.	PAGE 1 OF 1
START: 11/28/23 END: 11/29/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	LAT / LONG: 39.029548, -81.940218	

MATERIAL DESCRIPTION AND NOTES	ELEV. 690.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
TOPSOIL (18")	688.6	1																
VERY STIFF, DARK RED AND GRAY, **SILT AND CLAY**, "AND" STONE FRAGMENTS, LITTLE SAND, DAMP		2 3	3 4 4	12	28	SS-1	2.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
@3.5'; STIFF		4 5	3 3 4	11	50	SS-2	1.50	40	3	8	27	22	31	20	11	9	A-6a (3)	
Layer 1		6 7																
@6.0'; POOR RECOVERY, AUGER CUTTINGS TAKEN			10 4 3	11	6	SS-3	-	-	-	-	-	-	-	-	-	11	A-6a (V)	
MEDIUM STIFF, BROWN AND RED, **SANDY SILT**, SOME CLAY, LITTLE STONE FRAGMENTS, DAMP	681.6	8 9	2 2 2	6	39	SS-4	0.50	16	3	23	32	26	27	18	9	14	A-4a (5)	
MEDIUM STIFF, BROWN, **SILT AND CLAY**, SOME STONE FRAGMENTS, SOME SAND, POOR RECOVERY, AUGER CUTTINGS TAKEN, DAMP	679.1	10 11	5 2 3	8	11	SS-5	-	-	-	-	-	-	-	-	-	12	A-6a (V)	
@13.5'; VERY STIFF		12 13 14	2 3 5	12	67	SS-6	3.25	22	4	17	29	28	30	19	11	16	A-6a (5)	
@16.0'; HARD, TRACE ROOTS		15 16 17	9 9 11	30	78	SS-7	4.5+	-	-	-	-	-	-	-	-	12	A-6a (V)	
Layer 3		18 19	5 8 9	26	39	SS-8	4.5+	-	-	-	-	-	-	-	-	10	A-6a (V)	
@23.5'; VERY STIFF, BROWN AND GRAY, "AND" STONE FRAGMENTS, LITTLE SAND		20 21 22 23 24	3 6 6	18	39	SS-9	3.00	38	1	16	20	25	32	18	14	11	A-6a (3)	
Original Grade from Cross-Section at 794+00 = ~663.5, or 26.6' depth. Considered to be the bottom of existing embankment fill material.		25 26																
@28.5'; BROWN AND REDDISH BROWN, SOME STONE FRAGMENTS		27 28 29	4 40 60	150	100	SS-10	2.75	34	2	16	20	28	31	20	11	14	A-6a (3)	
Omit		30 31																
Layer 6		32 33	4 7 8	23	33	SS-11	3.00	-	-	-	-	-	-	-	-	12	A-6a (V)	
SANDSTONE, BROWN, HIGHLY WEATHERED, WEAK, FINE GRAINED.	651.6 TR	34 35 36 37 38 39	5 29 101	195	100	SS-12	-	-	-	-	-	-	-	-	-	9	Rock (V)	
	646.1 EOB	40 41 42 43 44	82	-	100	SS-13	-	-	-	-	-	-	-	-	-	5	Rock (V)	

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

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

Source: NAVFAC DM 7.1

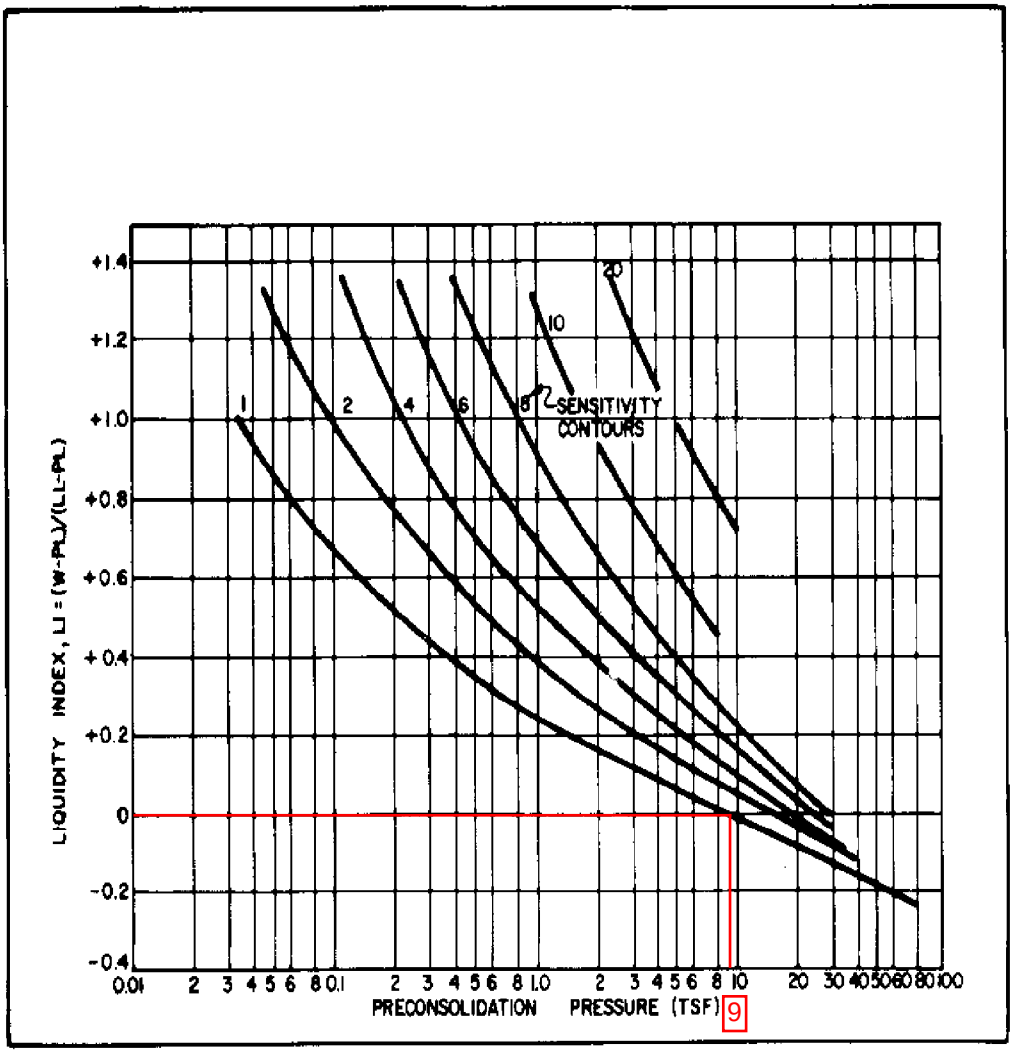


FIGURE 3
Preconsolidation Pressure vs. Liquidity Index

As LI values for the fill are all negative (moisture contents below the plastic limit), the fill was considered to be overconsolidated. Considering a LI of 0, a preconsolidation pressure of 9 tsf (18 ksf) was used in analyses. The underlying native soils were considered to be normally consolidated.

Cv values

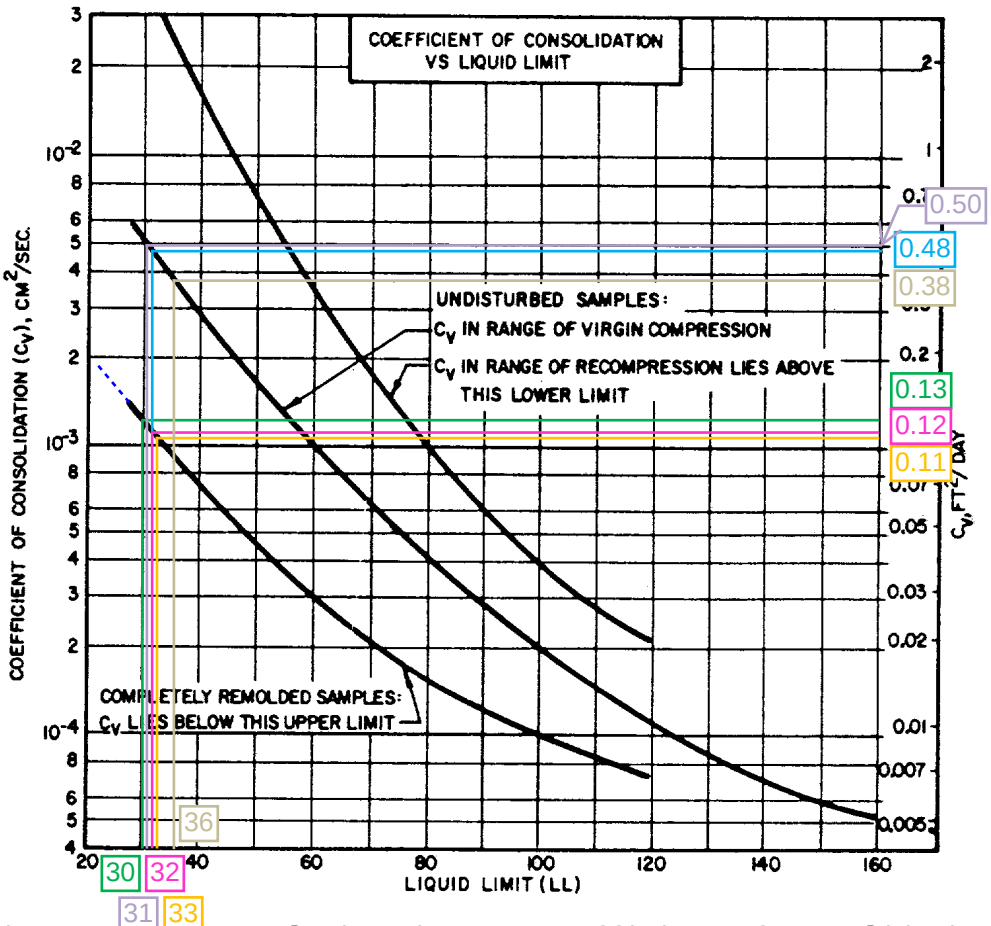
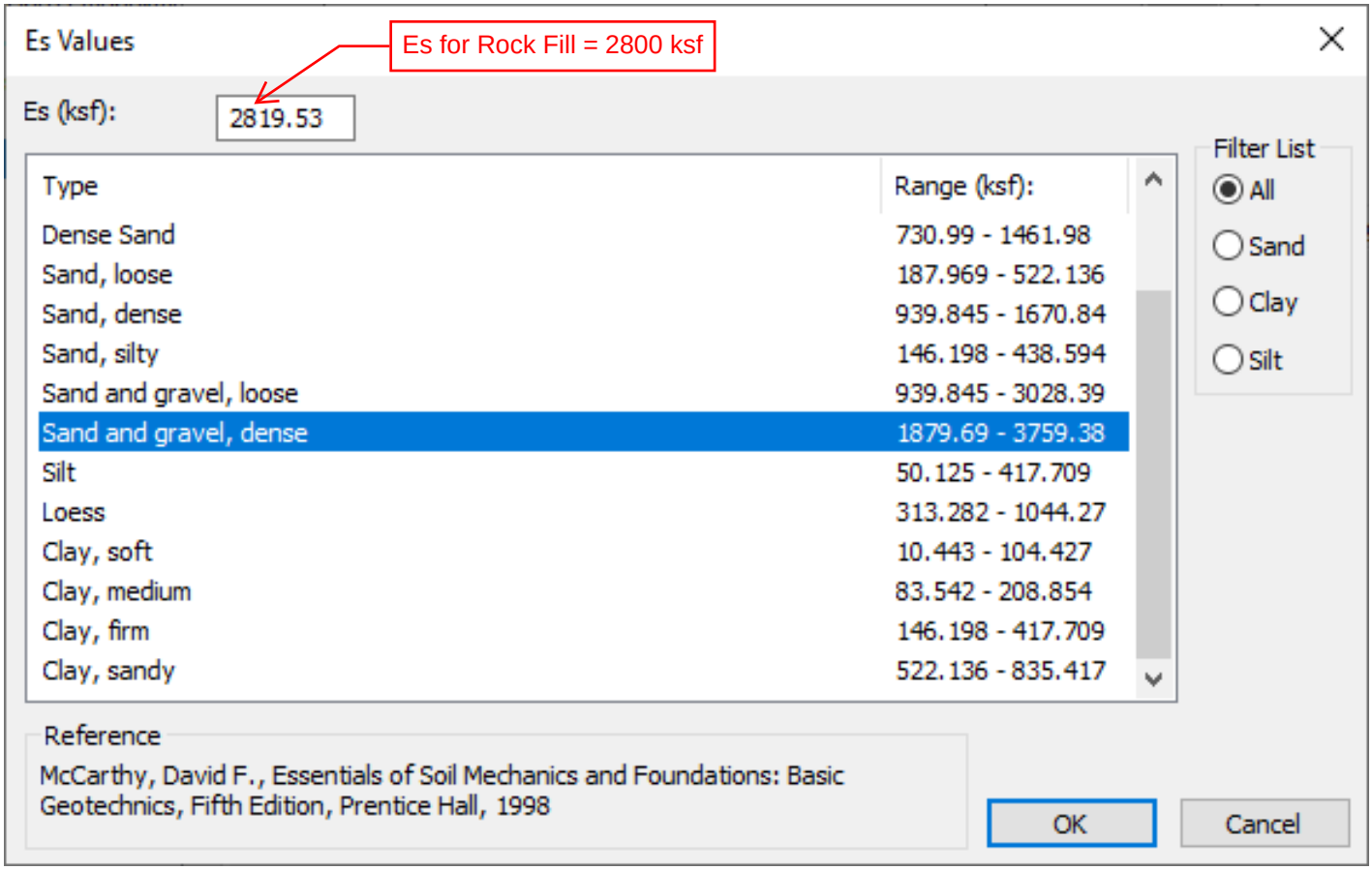


Figure 3-18. Correlations between coefficient of consolidation and liquid limit (NAVFAC DM 7.1)

Layer 1: LL = 30, Cv = 0.13 ft^2/day
Layer 2: LL = 33, Cv = 0.11 ft^2/day
Layer 3: LL = 32, Cv = 0.12 ft^2/day
Layer 4: LL = 32, Cv = 0.48 ft^2/day
Layer 5: LL = 36, Cv = 0.38 ft^2/day
Layer 6: LL = 31, Cv = 0.50 ft^2/day

Source: Settle3 Software



Elastic settlement parameters included in Settle3 for granular layers with "immediate" settlement. This is reflected in the estimated settlement at time = 0 days.

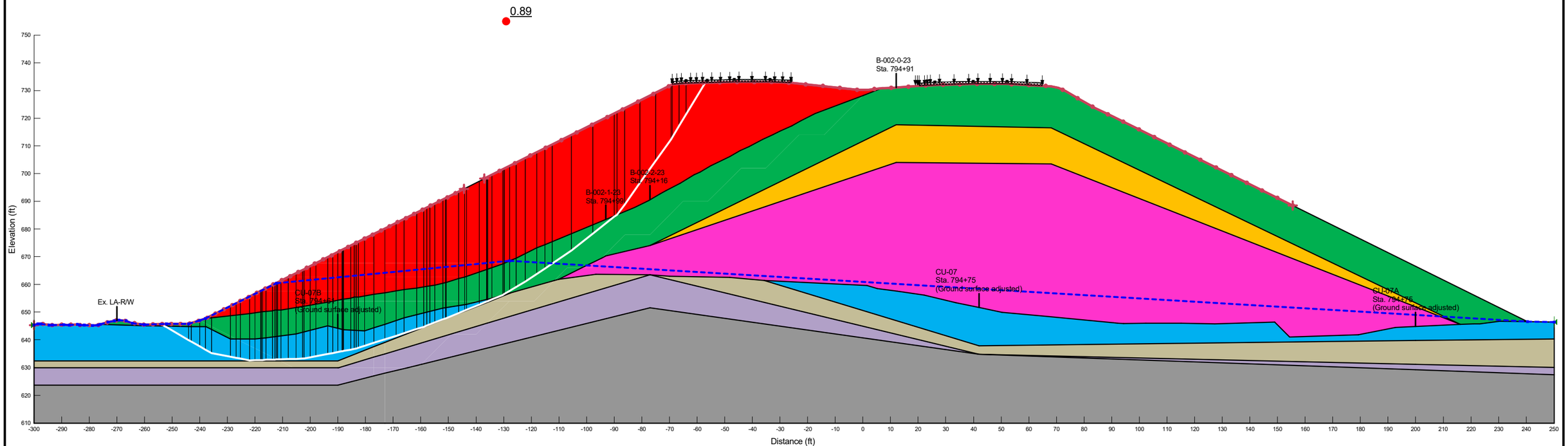
Slope Stability (Rock Surface as Encountered in Boring B-002-2-23)

Option #1

Option 1 : Design a drilled shaft considering the proposed embankment addition

Slope/W Results

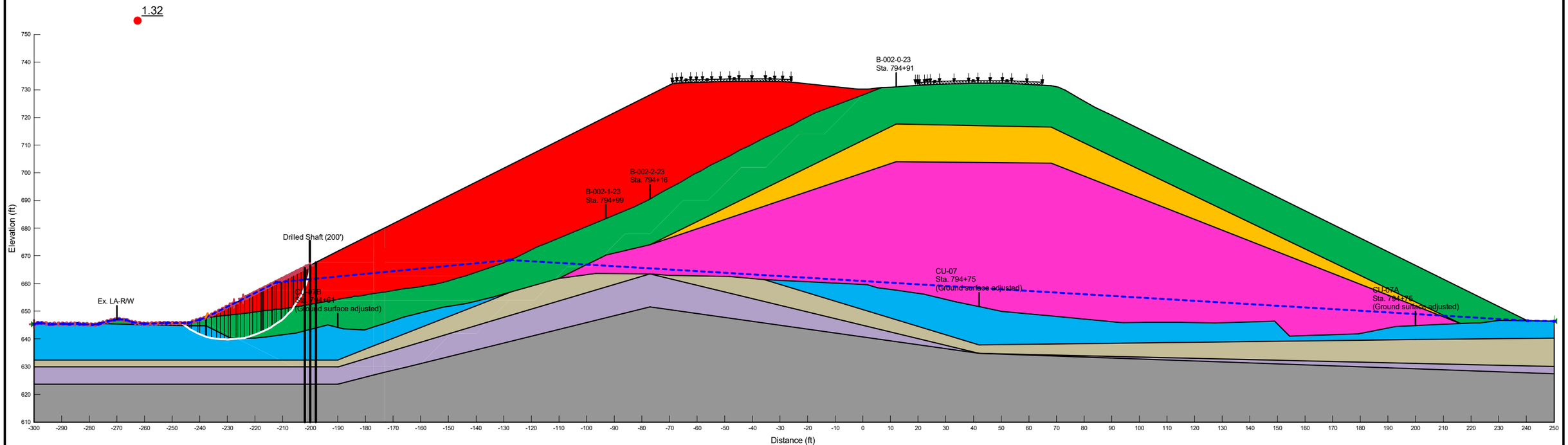
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28



01. Sta. 794+00 Option 1 Proposed	
Sta. 794+00 LT Slope Stability.gsz	
10/03/2024	1:423

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28

Minimum offset from the roadway centerline to achieve a Factor of Safety of 1.3 for the lower slope (slope behind the wall)



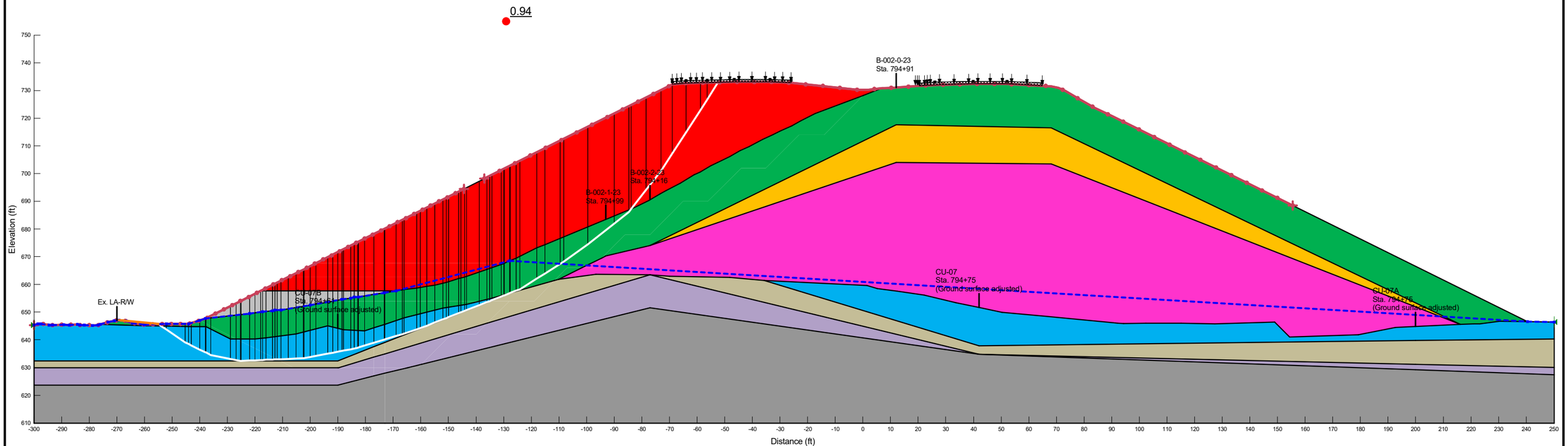
01. Sta. 794+00 Option 1 Proposed (Lower Slope)	
Sta. 794+00 LT Slope Stability.gsz	
10/03/2024	1:423

Option #2

Option 2 : Design a drilled shaft considering the proposed embankment addition and a 10 feet of rock fill starting at the existing toe of slope

Slope/W Results

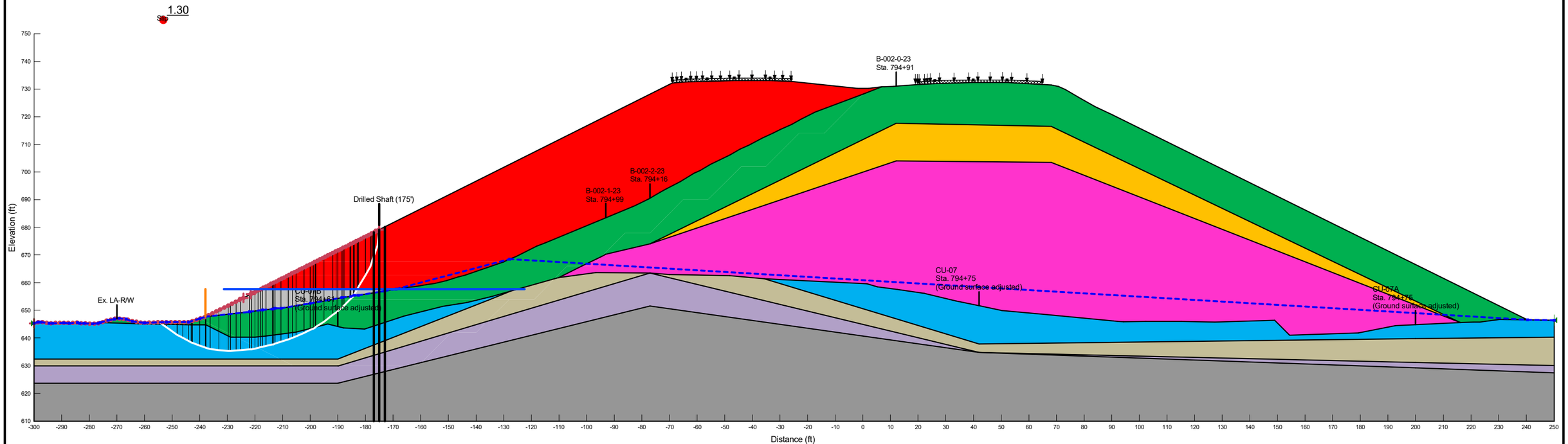
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38



01. Sta. 794+00 Option 2 (10' Rockfill)	
Sta. 794+00 LT Slope Stability.gsz	
10/03/2024	1:423

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38

Minimum offset from the roadway centerline to achieve a Factor of Safety of 1.3 for the lower slope (slope behind the wall)



01. Sta. 794+00 Option 2 (10' Rockfill) (Lower Slope)	
Sta. 794+00 LT Slope Stability.gsz	
10/03/2024	1:423

Slope Stability (Lowered Rock Surface at Boring B-002-2-23)

For conservatism lower rock surface option was used for design of the drilled shafts

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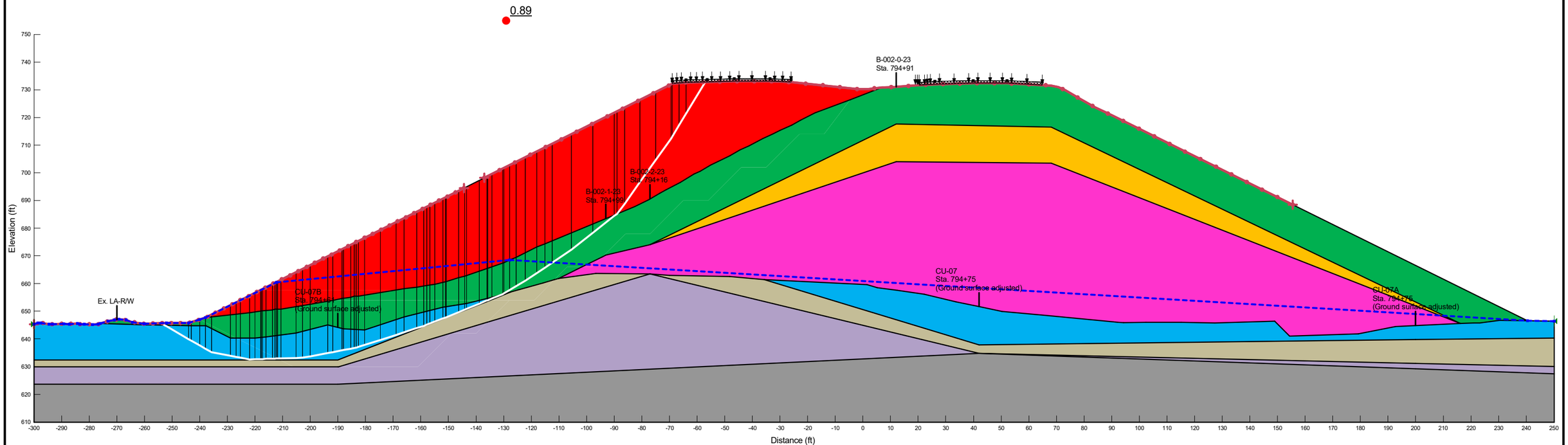
(513) 984-7500
hdrinc.com

Option #1

Slope/W Results

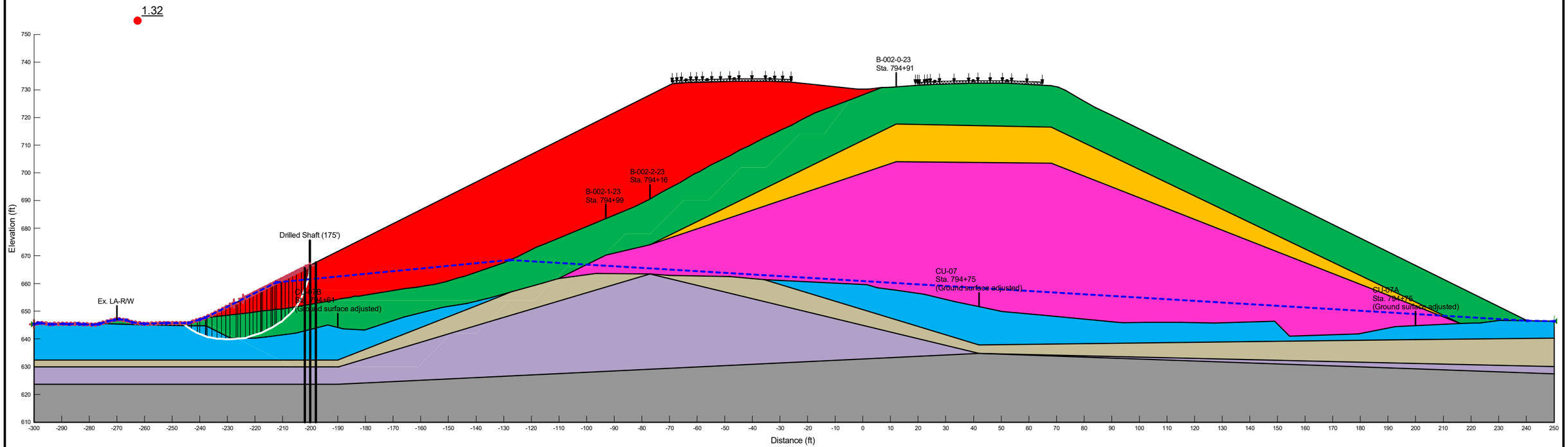
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28



01. Sta. 794+00 Option 1 (Lowered Rock)	
Sta. 794+00 LT Slope Stability.gsz	
10/04/2024	1:423

Minimum offset from the roadway centerline to achieve a Factor of Safety of 1.3 for the lower slope (slope behind the wall)

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28



01. Sta. 794+00 Option 1 (Lowered Rock) (Lower Slope)	
Sta. 794+00 LT Slope Stability.gsz	
10/04/2024	1:423

UA Slope Results

UA Slope Program Version 2.3 - C:\Users\MOMOHAMMED\Desktop\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 1\Option 1_UA Slope_Proposed (Low Rock).ua3*

File Run Options Help

Calculated Results

Factor of Safety: 0.89
Force per Shaft: 0.000 lb
Acting Point X: 0.000 ft Y: 0.000 ft

Analysis Unit System

(•) English ( ) Metric

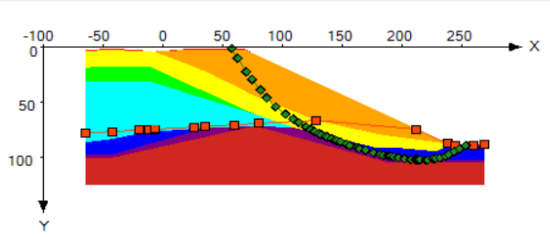
Number of Vertical Sections and Soil Layers

Vertical Section Num: 20 Soil Layer Num: 9

Analysis Method

( ) Total Stress (•) Effective Stress

Chart (Double-Click for More Options)



Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	0.1	0.0	250.0
Layer2	250.0	28.0	125.0
Layer3	260.0	20.0	120.0
Layer4	175.0	25.0	130.0
Layer5	215.0	27.0	140.0
Layer6	235.0	19.0	120.0
Layer7	125.0	23.0	125.0
Layer8	185.0	26.0	135.0
Layer9	4000.0	45.0	140.0

Slope Profile Vertical Sections

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 1
X (ft)	-64.90	-42.00	-20.30	-12.00	-6.90	26.00	35.70	57.40	69.00	77.00	110.10
Y1 (ft)	2.30	1.70	2.40	3.90	4.20	1.20	1.00	1.20	1.80	6.80	23.40
Y2 (ft)	3.30	2.70	3.40	3.90	4.20	2.20	2.00	2.20	2.80	6.80	23.40
Y3 (ft)	3.30	2.70	3.40	3.90	4.20	17.90	22.30	33.50	40.00	44.40	58.60
Y4 (ft)	18.40	18.00	17.60	17.40	19.90	36.00	40.70	51.30	57.00	60.90	73.20
Y5 (ft)	31.50	31.20	31.00	30.90	32.60	43.70	47.00	54.30	58.20	60.90	73.20
Y6 (ft)	86.40	83.30	78.50	77.40	76.70	74.00	73.50	72.30	72.00	71.50	73.20
Y7 (ft)	96.90	97.20	90.60	88.00	86.50	76.50	73.50	72.30	72.00	71.50	73.20
Y8 (ft)	100.70	100.20	95.00	93.00	91.70	83.80	81.50	76.20	73.40	71.50	81.30
Y9 (ft)	101.00	100.20	101.20	101.60	101.90	103.50	103.90	105.00	105.50	105.90	107.50

Coordinates of Crest X: 69.00 ft Y: 2.80 ft Coordinates of Toe X: 240.00 ft Y: 88.00 ft

Drilled Shaft Information

(•) Calculate without Drilled Shaft
( ) Automatic Load Transfer Factor
( ) Manually Defined Load Transfer Factor
[ ] Anchor (On/Off)

Anchor force: 0.00 lb
Anchor angle: 0.00
Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.000 (n)
Xmin 0.00 Diameter: 0.30 ft
Xmax 0.00 CTC Spacing: 0.00 ft
XDelta 0.00 X Coordinate: 0.00 ft

[ ] Auto Save Data

Run

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14
X (ft)	-64.90	-42.00	-20.30	-12.00	-6.90	26.00	35.70	59.30	80.40	127.90	212.20	237.90	244.00	260.00
Y (ft)	78.00	76.60	75.30	74.80	74.50	72.60	72.00	70.60	69.30	66.50	74.60	87.30	89.20	89.50

Slip Surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14
X (ft)	57.40	62.37	69.59	74.48	81.45	86.77	94.30	102.45	109.02	113.70	119.73	123.48	126.70	130.38
Y (ft)	1.20	10.19	22.22	29.31	38.99	46.17	54.17	60.80	65.22	68.37	72.41	74.74	76.60	78.72

Note: Values modified as necessary to calibrate factor of safety with SlopeW

UA Slope Program Version 2.3 - C:\Users\MOMOHAMMED\Desktop\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 1\Option 1_UA Slope_Drilled Shaft (Low Rock).ua3*

File Run Options Help

Calculated Results

Factor of Safety: 1.40
Force per Shaft: 690228.839 lb
Acting Point X: 200.000 ft Y: 90.141 ft

Analysis Unit System

(•) English ( ) Metric

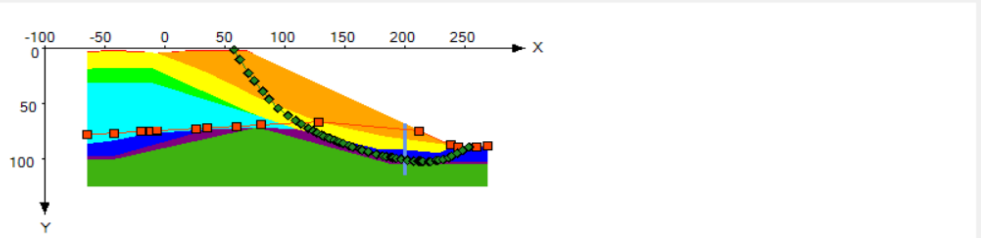
Number of Vertical Sections and Soil Layers

Vertical Section Num: 20 Soil Layer Num: 9

Analysis Method

( ) Total Stress (•) Effective Stress

Chart (Double-Click for More Options)



Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	0.1	0.0	250.0
Layer2	250.0	28.0	125.0
Layer3	260.0	20.0	120.0
Layer4	175.0	25.0	130.0
Layer5	215.0	27.0	140.0
Layer6	235.0	19.0	120.0
Layer7	125.0	23.0	125.0
Layer8	185.0	26.0	135.0
Layer9	4000.0	45.0	140.0

Slope Profile Vertical Sections

	Section 11	Section 12	Section 13	Section 14	Section 15	Section 16	Section 17	Section 18	Section 19	Section 20
X (ft)	10.10	127.40	180.30	190.00	228.90	237.90	244.00	253.40	260.00	269.30
Y1 (ft)	3.40	32.00	58.50	63.30	82.80	87.30	89.20	89.30	89.50	87.90
Y2 (ft)	3.40	32.00	58.50	63.30	82.80	87.30	89.20	89.30	89.50	87.90
Y3 (ft)	8.60	66.30	79.10	80.70	86.30	87.30	89.20	89.30	89.50	87.90
Y4 (ft)	3.20	78.00	91.80	90.80	94.60	90.20	90.20	90.10	89.90	89.60
Y5 (ft)	3.20	78.00	91.80	90.80	94.60	90.20	90.20	90.10	89.90	89.60
Y6 (ft)	3.20	78.00	91.80	90.80	94.60	90.20	90.20	90.10	89.90	89.60
Y7 (ft)	3.20	78.00	98.80	102.60	102.60	102.60	102.60	102.60	102.60	102.60
Y8 (ft)	1.30	86.40	102.20	105.10	105.10	105.10	105.10	105.10	105.10	105.10
Y9 (ft)	07.50	108.30	110.80	111.30	111.30	111.30	111.30	111.30	111.30	111.30

Coordinates of Crest X: 69.00 ft Y: 2.80 ft Coordinates of Toe X: 240.00 ft Y: 88.00 ft

Drilled Shaft Information

( ) Calculate without Drilled Shaft
(•) Automatic Load Transfer Factor
( ) Manually Defined Load Transfer Factor
[ ] Anchor (On/Off)

Anchor force: 0.00 lb
Anchor angle: 0.00
Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.252 (n)
Xmin 0.00 Diameter: 4.00 ft
Xmax 0.00 CTC Spacing: 7.00 ft
XDelta 0.00 X Coordinate: 200.00 ft

[ ] Auto Save Data

Run

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14	Point 15
X (ft)	2.00	-20.30	-12.00	-6.90	26.00	35.70	59.30	80.40	127.90	212.20	237.90	244.00	260.00	269.30
Y (ft)	.60	75.30	74.80	74.50	72.60	72.00	70.60	69.30	66.50	74.60	87.30	89.20	89.50	87.90

Slip Surface

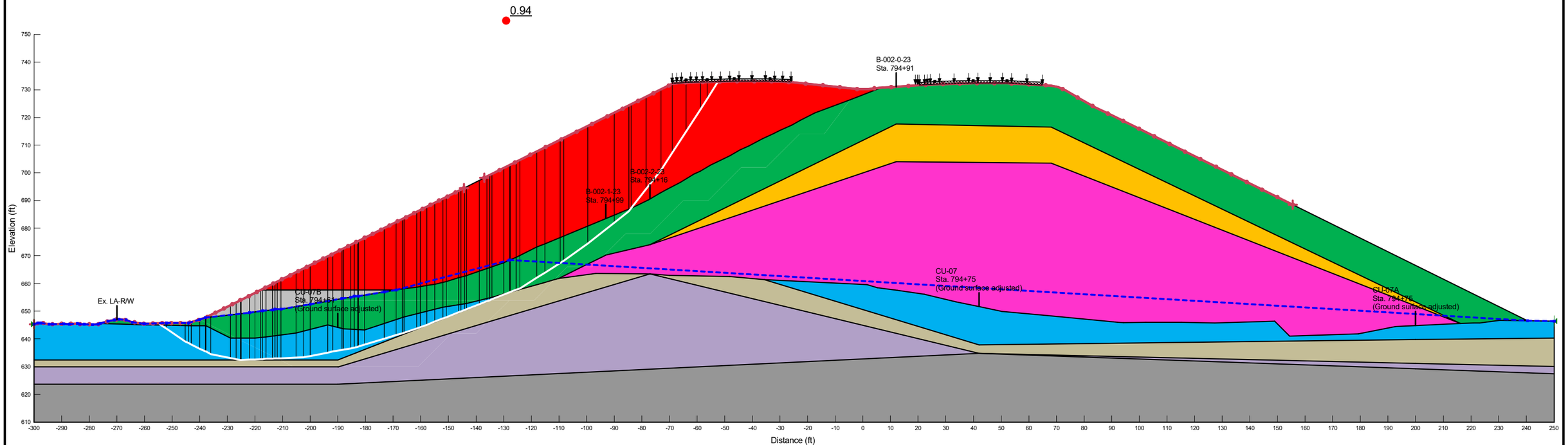
	Point 38	Point 39	Point 40	Point 41	Point 42	Point 43	Point 44	Point 45	Point 46	Point 47	Point 48	Point 49	Point 50
X (ft)	2.50	213.20	214.80	220.17	221.17	226.05	227.85	231.94	236.44	238.95	243.50	248.05	253.40
Y (ft)	2.09	102.12	102.20	102.45	102.31	101.42	101.10	100.36	98.97	97.53	94.93	92.32	89.30

Note: Values modified as necessary to calibrate factor of safety with SlopeW

Option #2

Slope/W Results

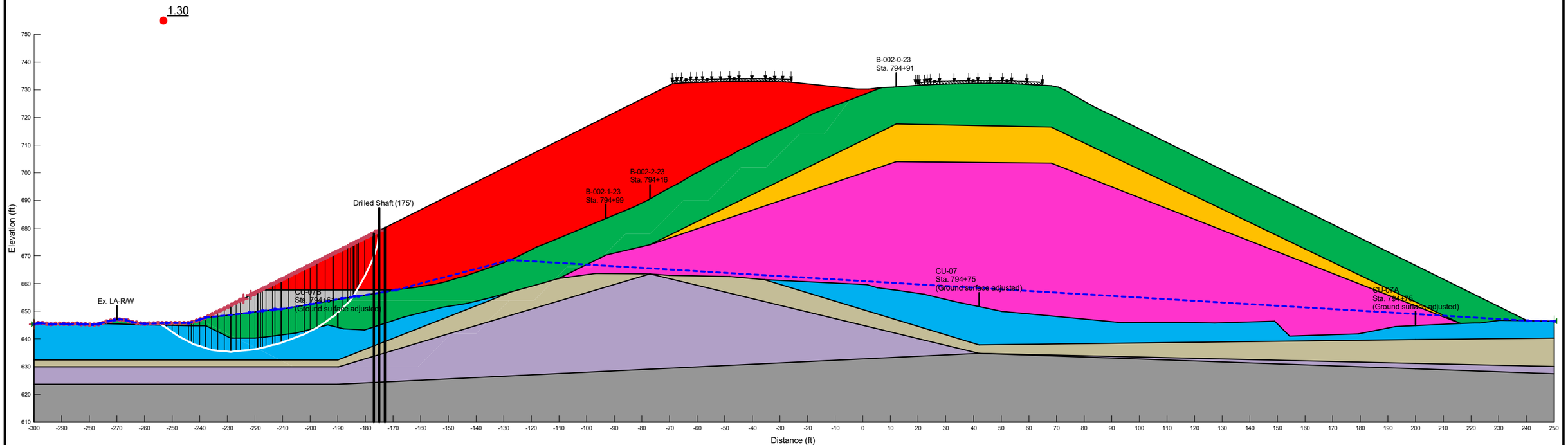
Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38



01. Sta. 794+00 Option 2 (Lowered Rock) (10' Rock fill)	
Sta. 794+00 LT Slope Stability.gsz	
10/04/2024	1:423

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38

Minimum offset from the roadway centerline to achieve a Factor of Safety of 1.3 for the lower slope (slope behind the wall)



01. Sta. 794+00 Option 2 (Lowered Rock) (10' Rock fill) (Lower Slope)
Sta. 794+00 LT Slope Stability.gsz
10/04/2024 1:423

4' Diameter, 4' CTC Spacing
Drilled Shaft Design

UA Slope Results

UA Slope Program Version 2.3 - C:\Users\MOMOHAMMED\Desktop\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\Option 2_10' Rockfill_UA Slope_Proposed FOS=0.94 (Low Rock).ua3*

File Run Options Help

Calculated Results

Factor of Safety: 0.94
Force per Shaft: 0.000 lb
Acting Point X: 0.000 ft Y: 0.000 ft

Analysis Unit System

(•) English ( ) Metric

Number of Vertical Sections and Soil Layers

Vertical Section Num: 20 Soil Layer Num: 10

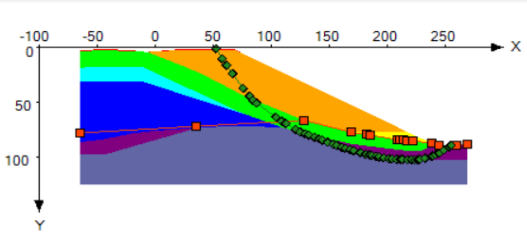
Analysis Method

( ) Total Stress (•) Effective Stress

Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	0.1	0.0	250.0
Layer2	250.0	28.0	125.0
Layer3	0.0	38.0	135.0
Layer4	265.0	19.0	120.0
Layer5	175.0	25.0	130.0
Layer6	215.0	27.0	140.0
Layer7	235.0	19.0	120.0
Layer8	125.0	23.0	125.0
Layer9	185.0	26.0	135.0
Layer10	4000.0	45.0	140.0

Chart (Double-Click for More Options)



Slope Profile Vertical Sections

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 1
X (ft)	-64.90	-42.00	-20.30	-12.00	-6.90	26.00	35.70	52.50	69.00	77.00	110.10
Y1 (ft)	2.30	1.70	2.40	3.90	4.20	1.20	1.00	1.10	1.80	6.80	23.40
Y2 (ft)	3.30	2.70	3.40	3.90	4.20	2.20	2.00	2.10	2.80	6.80	23.40
Y3 (ft)	3.30	2.70	3.40	3.90	4.20	17.90	22.30	30.90	40.00	44.40	58.60
Y4 (ft)	3.30	2.70	3.40	3.90	4.20	17.90	22.30	30.90	40.00	44.40	58.60
Y5 (ft)	18.40	18.00	17.60	17.40	19.90	36.00	40.70	48.90	57.00	60.90	73.20
Y6 (ft)	31.50	31.20	31.00	30.90	32.60	43.70	47.00	52.60	58.20	60.90	73.20
Y7 (ft)	86.40	83.30	78.50	77.40	76.70	74.00	73.50	72.40	72.00	71.50	73.20
Y8 (ft)	96.90	97.20	90.60	88.00	86.50	76.50	73.50	72.40	72.00	71.50	73.20
Y9 (ft)	100.70	100.20	95.00	93.00	91.70	83.80	81.50	77.40	73.40	71.50	81.30

Coordinates of Crest X: 69.00 ft Y: 2.80 ft Coordinates of Toe X: 240.00 ft Y: 88.00 ft

Drilled Shaft Information

(•) Calculate without Drilled Shaft
( ) Automatic Load Transfer Factor
( ) Manually Defined Load Transfer Factor
[ ] Anchor (On/Off)

Anchor force: 0.00 lb
Anchor angle: 0.00
Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.000 (n)
Xmin 0.00 Diameter: 0.30 ft
Xmax 0.00 CTC Spacing: 0.00 ft
XDelta 0.00 X Coordinate: 0.00 ft

[ ] Auto Save Data

Run

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14
X (ft)	-64.90	35.70	127.90	168.80	182.50	185.30	208.65	210.60	213.60	217.30	222.00	237.90	244.00	260.00
Y (ft)	78.00	72.00	66.50	77.30	79.50	80.00	84.13	84.20	84.50	84.80	85.50	87.30	89.20	89.50

Slip Surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14
X (ft)	52.50	57.56	61.36	66.50	75.75	81.19	84.33	87.38	103.92	108.93	112.33	121.06	124.81	128.95
Y (ft)	1.10	10.27	16.17	24.01	37.41	44.29	48.26	50.88	63.67	67.19	69.32	74.78	76.97	78.60

Note: Values modified as necessary to calibrate factor of safety with SlopeW

UA Slope Program Version 2.3 - C:\Users\MOMOHAMMED\Desktop\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\4' Center-Center Spacing\Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).ua3*

File Run Options Help

Calculated Results

Factor of Safety: 5.04
Force per Shaft: 985287.263 lb
Acting Point X: 175.000 ft Y: 82.382 ft

Analysis Unit System

(•) English ( ) Metric

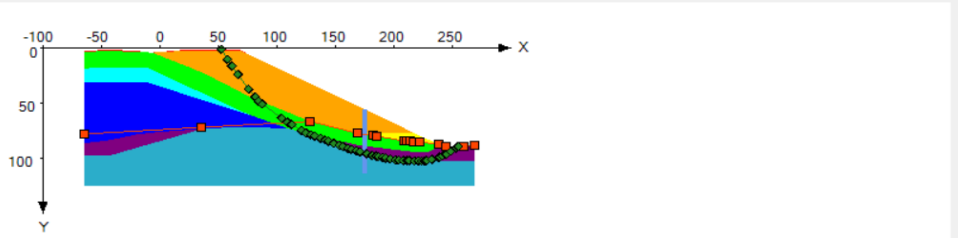
Number of Vertical Sections and Soil Layers

Vertical Section Num: 20 Soil Layer Num: 10

Analysis Method

( ) Total Stress (•) Effective Stress

Chart (Double-Click for More Options)



Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	0.1	0.0	250.0
Layer2	250.0	28.0	125.0
Layer3	0.0	38.0	135.0
Layer4	265.0	19.0	120.0
Layer5	175.0	25.0	130.0
Layer6	215.0	27.0	140.0
Layer7	235.0	19.0	120.0
Layer8	125.0	23.0	125.0
Layer9	185.0	26.0	135.0
Layer10	4000.0	45.0	140.0

Slope Profile Vertical Sections

	Section 11	Section 12	Section 13	Section 14	Section 15	Section 16	Section 17	Section 18	Section 19	Section 20
X (ft)	10.10	127.40	168.90	190.00	217.90	228.90	237.90	244.00	254.90	269.30
Y1 (ft)	3.40	32.00	52.80	63.30	77.30	82.80	87.30	89.20	89.30	87.90
Y2 (ft)	3.40	32.00	52.80	63.30	77.30	82.80	87.30	89.20	89.30	87.90
Y3 (ft)	8.60	66.30	77.30	77.30	77.30	82.80	87.30	89.20	89.30	87.90
Y4 (ft)	8.60	66.30	77.30	80.70	84.90	86.30	87.30	89.20	89.30	87.90
Y5 (ft)	3.20	78.00	88.00	90.80	94.40	94.60	90.20	90.20	90.00	89.60
Y6 (ft)	3.20	78.00	88.00	90.80	94.40	94.60	90.20	90.20	90.00	89.60
Y7 (ft)	3.20	78.00	88.00	90.80	94.40	94.60	90.20	90.20	90.00	89.60
Y8 (ft)	3.20	78.00	94.30	102.60	102.60	102.60	102.60	102.60	102.60	102.60
Y9 (ft)	1.30	86.40	98.80	105.10	105.10	105.10	105.10	105.10	105.10	105.10

Coordinates of Crest X: 69.00 ft Y: 2.80 ft Coordinates of Toe X: 240.00 ft Y: 88.00 ft

Drilled Shaft Information

( ) Calculate without Drilled Shaft
(•) Automatic Load Transfer Factor
( ) Manually Defined Load Transfer Factor
[ ] Anchor (On/Off)

Anchor force: 0.00 lb
Anchor angle: 0.00
Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.000 (n)
Xmin 0.00 Diameter: 4.00 ft
Xmax 0.00 CTC Spacing: 4.00 ft
XDelta 0.00 X Coordinate: 175.00 ft

[ ] Auto Save Data

Run

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14	Point 15
X (ft)	.70	127.90	168.80	182.50	185.30	208.65	210.60	213.60	217.30	222.00	237.90	244.00	260.00	269.30
Y (ft)	.00	66.50	77.30	79.50	80.00	84.13	84.20	84.50	84.80	85.50	87.30	89.20	89.50	87.90

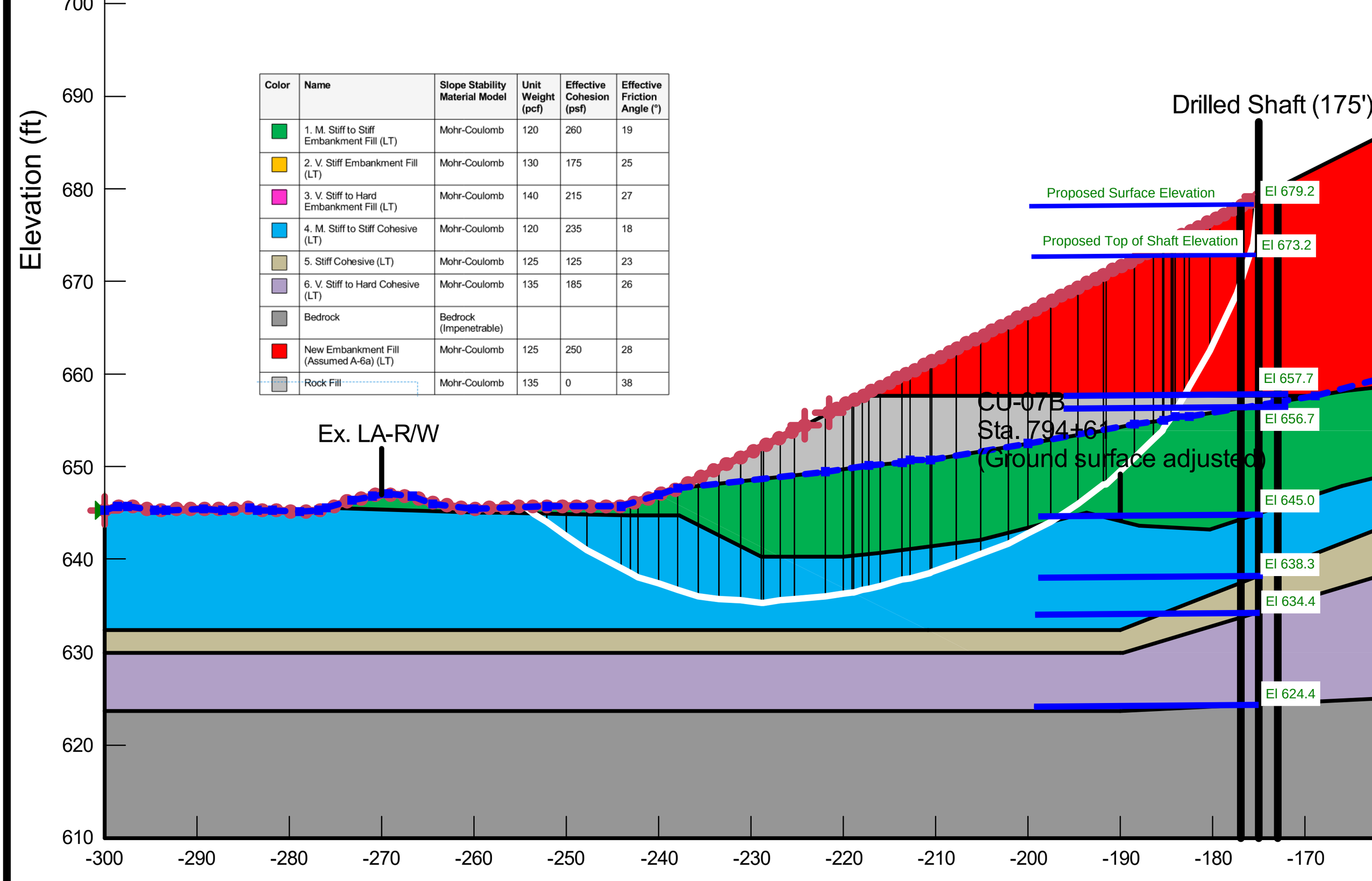
Slip Surface

	Point 38	Point 39	Point 40	Point 41	Point 42	Point 43	Point 44	Point 45	Point 46	Point 47	Point 48	Point 49	Point 50
X (ft)	7.60	221.00	223.50	226.05	227.85	232.45	237.85	238.95	241.50	244.60	248.65	252.98	254.90
Y (ft)	2.27	102.41	102.52	102.38	102.03	101.14	99.55	99.01	97.76	96.24	93.59	90.64	89.30

Note: Values modified as necessary to calibrate factor of safety with SlopeW

LPILE Inputs

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38



Geometry

	Elevation (ft)	
Top of Backfill =	732.2	*at Outside Edge of Shoulder*
Top of Wall =	673.2	*at C/L of Wall*
Existing Ground Surface =	679.2	*at C/L of Wall*
Maintenance Bench =	673.2	*at C/L of Wall*
Slip Plane =	639.5	*at C/L of Wall*

	Horiz. Distance from C/L (ft)	
Start of Wall Backfill =	69.0	*at Outside Edge of Shoulder*
Wall =	175.0	*at C/L of Wall*
Backfill Slope Angle =	2.0	H:1V

Wall Loading Profile

	Top Elev.	Thickness (ft)	Cohesion (psf)	Phi (deg)	Unit Wt (pcf)
New Embankment Fill (Assumed A-6a)	673.2	15.5	250	28	125
Rock Fill	657.7	1.0	0	38	135
Medium Stiff to Stiff Embankment Fill	656.7	11.7	260	19	120
Medium Stiff to Stiff Cohesive	645.0	6.7	235	18	120
Stiff Cohesive	638.3	3.9	125	23	125
Very Stiff to Hard Cohesive	634.4	10.0	185	26	135
Top of Rock	624.4				
Weighted Value		48.8	-	-	-

Earth Pressure Coefficients

	Deg		
Shear Resistance, Φ =	-		
Wall Friction , δ^A =	0.0		
Wall Slope, θ =	90		
Backfill Slope, β =	26.57		
Revised Backfill Slope, β =	26.57		
Backfill Condition	INFINITE		
Horz. Backslope Dist.	106.0	feet	*(C/L of Wall - Edge of Shoulder)*
Wall Height (H)	0.0	feet	*(Top of Wall - Maintenance Bench)*
Slope Height (h)	59.0	feet	*(Top of Backfill - Top of Wall)*
I =		degrees	

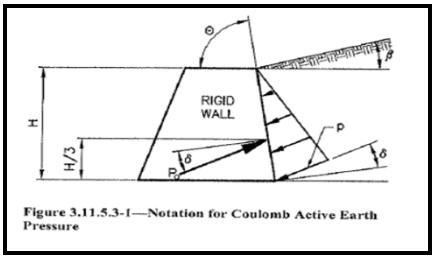


Figure 3.11.5.3-1—Notation for Coulomb Active Earth Pressure

Active Earth Coefficient

$$K_a = \frac{\sin^2(\theta+\Phi)}{(\sin^2(\theta)*\sin(\theta-\delta)*[1+\sqrt{(\sin(\Phi+\delta)*\sin(\Phi-\beta))/(\sin(\theta-\delta)*\sin(\theta+\beta))}]^2)}$$

K_a = -

At-Rest Earth Coefficient

$K_o = (1- \sin(\phi))*(1+\sin(\beta))$

K_o = -

Notes:

A. *Wall friction neglected*

B. *Figure and Equation for Active Earth Pressure from AASHTO 3.11.5.3 (LRFD Design Manual).*

C. *#VALUE!*

Soil Lateral Design Profile

	Top Elev	Depth (ft)	Depth Below Top of Shaft	Cohesion (psf)	Phi (deg)	Unit Wt (pcf)	ε50	k
New Embankment Fill (Assumed A-6a)	679.2	0.0	-6.0	2500	0	125	0.005	N/A
Rock Fill	657.7	21.5	15.5	0	38	135	N/A	225
Medium Stiff to Stiff Embankment Fill	656.7	22.5	16.5	1400	0	57.6	0.007	N/A
Medium Stiff to Stiff Cohesive	645	34.2	28.2	930	0	57.6	0.01	N/A
Stiff Cohesive	638.3	40.9	34.9	1650	0	62.6	0.007	N/A
Very Stiff to Hard Cohesive	634.4	44.8	38.8	3300	0	72.6	0.005	N/A
Bedrock	624.4	54.8	48.8	N/A	N/A	N/A	N/A	N/A

Bedrock Lateral Design Profile

	Top Elev	Depth (ft)	qu (psi)	Em (psi)	Unit Wt (pcf)	RQD (%)	krm
Siltstone/Claystone	624.4	54.8	150	14600	150	0	0.0005

* Rock strength parameters indicate a RQD of 9%, however RQD of 0% was used for LPILE analyses for conservatism.

Depths referenced below the top of wall, starting at the lowered ground surface. ε50 and k values per LPile Technical Manual.

Wall Loading Computations

Earth Pressure Model = CONVENTIONAL *(Conventional or UA SLOPE)* UA SLOPE

1) Soil Unit Weight = - pcf *Weighted Average Along Cantilevered Wall Height*

2) Determine Coefficient of Earth Pressure (K)

Restraint Condition = ACTIVE *(Active or At-Rest)*
Ka = -

3) Determine Equivalent Fluid Weight (G_H)

G_H = $(\gamma_m) * (K_a)$
G_H = - *For application to CONVENTIONAL Earth Pressure Model*

4) Artificially Lowered Ground Surface (ODOT GDM Section 903.3.2, pg. 9-14) for FS_{dh} < 1.30

Consider Lowered G. S.? NO
Lowered Ground Surface (ft) = 0.0 = dt (tan(β_{dh})
β_{dh} = 26.57 = steepness of the slope downhill of the drilled shaft
FS_{dh} = 1.30 = Factor of Safety down slope of the proposed wall
d_t = 33.7 = depth below bench to the shear surface at the location of the drilled shaft

5) Modification of p-y curves (ODOT GDM Section 903.2, pg. 9-13)

P_m = $0.64*(S/D)^{0.34}$ *(Ref: Reese, Isenhower, & Wang - 2006)*
D = 4 feet *(shaft diameter or pile flange width)*
Assumed Shaft Spacing = 4 feet *(center-to-center pile spacing)*
P_m = 0.64 *For retaining wall, applies from top of wall to top of rock/bottom of drilled shafts*
For a row of drilled shafts, applies below shear plane to top of rock/bottom of drilled shafts
Reduce p-multiplier? YES *For application above shear plane if using a row of spaced drilled shafts instead of a retaining wal*
FS_{UAS} = 1.30 = Factor of Safety from UASlope including shafts
p-multipler = 0.15 = (P_m - P_m/FS_{UAS}) *From top of wall to bottom of shear plane*

6) Determine Lateral Thrust

Conventional Earth Pressure Theory *UA SLOPE*

Exposed Wall Height (H) = 0 feet Depth from T/Wall to Slip Plane = 33.7 feet
Wall Height (H) + GS_{AL} = 0.0
P = $1/2 * G_H * H^2$
P = - lbs/foot
P_{SH} = P*(Shaft Spacing) *(earth loading)*
P_{SH} = - lbs/shaft Force Per Shaft = 367714 lbs/shaft (See Attached)

7) Resolve horizontal earth force to distributed triangular load (for LPILE)

w = $2*P_{SH}/H$
w = - lbs/foot per shaft (Earth - Service Limit) 21823 lbs/foot per shaft
w = - lbs/inch per shaft (Earth - Service Limit) 1819 lbs/inch per shaft
γ_E = 1.5 *Earth Load Factor*
w = $(2*P_{SH}/H)*\gamma_E$
w = - lbs/inch per shaft (Earth - Strength Limit) 2728 lbs/inch per shaft

8) Determine live-load traffic surcharge force (P_s)

Include traffic surcharge? NO

Surcharge Pressure (q_s) = NA psf
P_s = Ka * qs * H
P_s = NA lbs/foot *(surcharge resolved to distributed load)* NA lbs/foot
P_s = NA lbs/shaft NA lbs/shaft

9) Resolve surcharge to distributed rectangular load (for LPILE)

w = P_S/H
w = 0 lbs/foot per shaft (surcharge - unfactored) 0 lbs/foot per shaft
w = 0 lbs/inch per shaft (surcharge - unfactored) 0 lbs/inch per shaft
γ_S = 1.75 *Surcharge Load Factor - Strength I*
w = $(P_S/L)*\gamma_S$
w = 0 lbs/inch per shaft (Surcharge - Strength I) 0 lbs/inch per shaft

Distributed Lateral Loads for LPILE

CONVENTIONAL

Depth (ft.)	Service (lb/in)	Strength-I (lb/in)
0	0	0
0.0	-	-

Distributed Lateral Loads for LPILE

UA SLOPE

Depth (ft.)	Service (lb/in)	Strength-I (lb/in)
0	0	0
33.7	1819	2728

Steel Beam and Cross-Section Properties

Assumed Pile Shape W 36x262

Pile Availability

AISC Member Producers	1	
Non-Member Producers	1	

Shaft Geometry

Shaft Diameter	48	in
Longest Beam Dimension	40.461957	in
Clear Distance	3.7690213	in

Steel Beam Geometry

Beam Depth (D)	36.9	in
Web Thickness (t_w)	0.84	in
Flange Width (B_f)	16.6	in
Flange Thickness (t_f)	1.44	in
Area of Steel (A_s)	77	in^2

Steel Properties

Yield Strength of Steel	50	ksi
Moment of Inertia (I_{xx}) of Steel	17900	in^4
Modulus of Elasticity of Steel (E)	29000	ksi
Modulus of Elasticity of Steel (E)	29000000	psi
EI (Steel Only)	5.191E+11	$lb*in^2$
Section Modulus (S_x)	972	in^3
Section Modulus (Z_x)	1100	in^3
Shear-Buckling Coefficient (k)	5	
Ratio of Shear-Buckling Resistance (C)	1	
D/t_w	43.928571	
$1.12\sqrt{Ek/F_{yw}}$	60.313846	
$1.40\sqrt{Ek/F_{yw}}$	75.392307	

Determined by AASHTO LRFD Bridge Specifications Eqn's 6.10.9.3.2-4, 6.10.9.3.2-5, and 6.10.9.3.2-6

Shear Capacity Calculation

$V_u \le \phi V_{cr}$

$\phi_v =$ 1 *AASHTO LRFD Bridge Design Spec's 6.5.4.2*

$V_u =$ *shear in web due to factored permanent and construction loads applied to noncompact section (kips)*

$V_{cr} =$ *shear buckling resistance determined from Equation 6.10.9.3.3-1 (AASHTO LRFD Bridge Design Spec's)*

$V_n = V_{cr} = CV_p$

$V_p = 0.58F_{yw}Dt_w$

$V_p =$ *plastic shear force (kips)*

$C =$ *ratio of shear-buckling resistance to shear yield strength determined by AASHTO Eqn's 6.10.9.3.2-4, 6.10.9.3.2-5, 6.10.9.3.2-5, or 6.10.9.3.2-6*

$V_p =$ 0.58 * 50 * 36.9 * 0.84

$V_p =$ 898.9 kips

$\phi V_{cr} = \phi * C * V_p$

$\phi V_{cr} =$ 1 * 1 * 898.9

$\phi V_{cr =}$ 898.9 kips

$V_u =$ 570.47 kips *(from LPILE)*

kips *(from PYWALL)*

$V_u < \phi V_{cr}$ **OK**

Flexure Capacity Calculation

$M_u \le \phi M_n$

$\phi_b =$ 1 *AASHTO LRFD Bridge Design Spec's 6.5.4.2*

$M_u =$ *Moment due to the factored loads*

$M_n =$ *Nominal flexural resistance of a section*

$S_x =$ *Elastic section modulus about the x-axis*

$\phi M_n = \phi * F_y * S_x$

$\phi M_n =$ 1 * 50 * 972

$\phi M_n =$ 48600 in*kips

$M_u =$ 47100 in*kips *(from LPILE)*

$M_u =$ in*kips *(from PYWALL)*

$M_u < \phi M_n$ **OK**

Minimum Pile Length

Top of Wall to Slip Plane =	33.7	ft	
Minimum Pile Length Below Slip Plane =	10	ft	*ODOT Minimum Required Length*
Minimum Required Pile Length =	43.7	ft	

Deflection Criteria

Pile Length Above Rock =	48.8	ft	Exposed Wall Height = 0 ft
Pile Length Above Rock =	585.6	in	Exposed Wall Height = 0 in

1.) *Per the ODOT GDM, pile-head deflection in the service limit state limited to 1% or less of the shaft length above bedrock, or 1% of total drilled shaft length if not embedded in bedrock.*

2.) *Following industry acceptance criteria, limit wall deflection to 1% of exposed wall height where ODOT landslide criteria does not govern. Alternatively, limit wall deflection to 1.5% of the exposed wall height in accordance with NCDOT guidelines. Use 1.5% wall deflection for PYWALL software.*

ODOT Landslide Criteria Governs YES

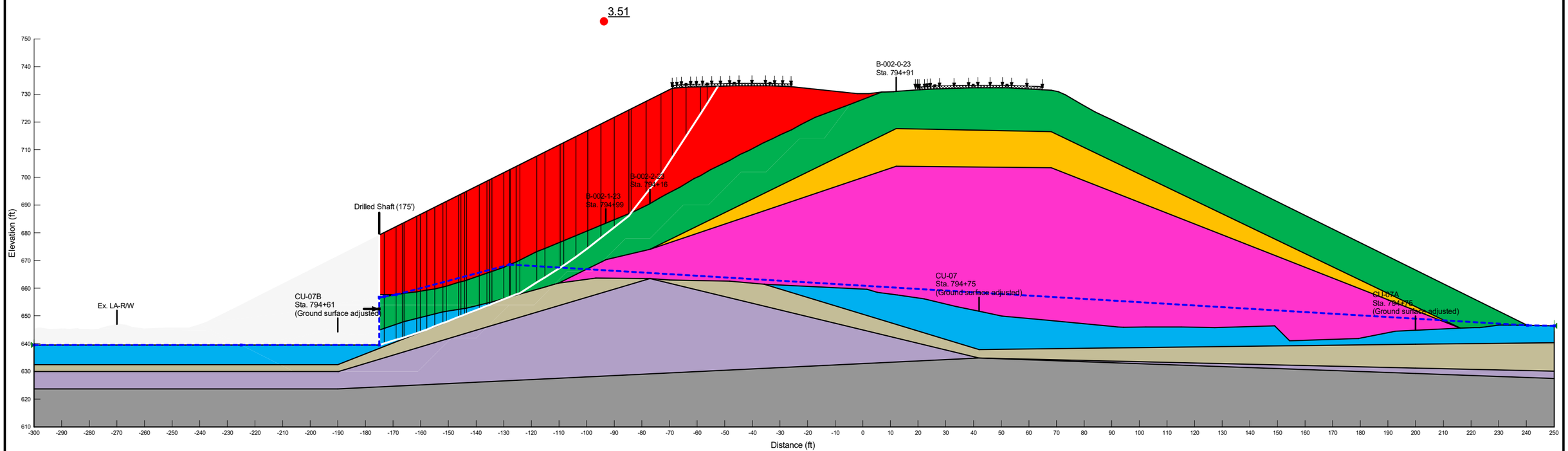
Drilled Shafts Located Within 10 feet of Edge of Pavement NO

1% Wall Height **OR** 2 inches- LPILE	5.856	in	$\delta =$ 3.583	in	*(from LPILE)*
1.5% Wall Height - PYWALL		in	$\delta =$	in	*(from PYWALL)*

Slope/W and UA Slope Incorporation

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38

Point Load
Coordinate: (-175, 652.618) ft
Magnitude: 246,322 lbf

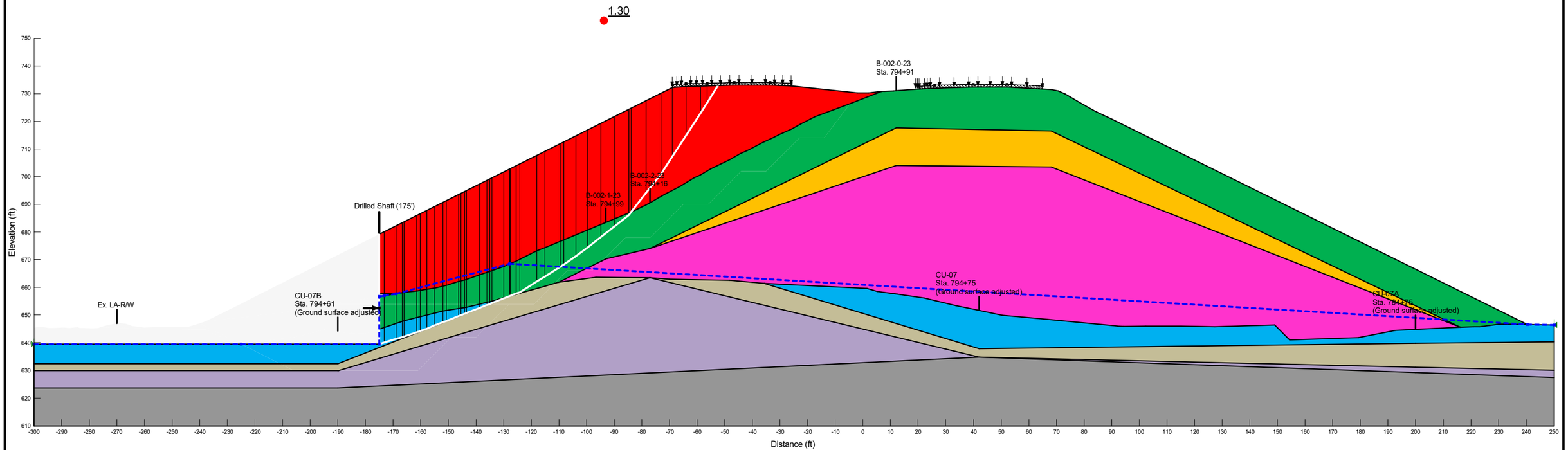


01. Sta. 794+00 Option 2 (Lowered Rock) (10' Rock fill) (3)	
Sta. 794+00 LT Slope Stability.gsz	
10/05/2024	1:423

Required point load to achieve a Factor of Safety of 1.30

Point Load
Coordinate: (-175, 652.618) ft
Magnitude: 132,000 lbf

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38



01. Sta. 794+00 Option 2 (Lowered Rock) (10' Rock fill) (3)	
Sta. 794+00 LT Slope Stability.gsz	
10/07/2024	1:423

UA Slope (Results)

Elevation Origin =	735	ft
Force X-Coordinate =	175	ft
Force Y-Coordinate =	82.382	ft
Diameter =	4	ft
CTC Spacing =	4	ft
Load Transfer Factor =	0.0%	%
Force per Shaft =	985287	lbf
Factor of Safety =	5.04	
Force per Foot of Wall =	246322	lbf (Point Load per foot of wall @ 100% Load Transfer Factor to be used in SlopeW)

$$Force\ per\ Foot\ of\ Wall(lb) = \frac{Force\ per\ Shaft\ (lb)}{CTC\ Spacing\ (ft) * (1 - Load\ Transfer\ Factor)}$$

Slope/W (Inputs)

Point Load X-Coordinate =	-175	ft (-1 = Failure from Right to Left, 1 = Failure from Left to Right)
Point Load Y-Coordinate =	652.618	ft
Point Load =	246322	lbf
Direction =	180	degrees (180 = Load applied right direction, 0 = Load applied left direction)

Slope/W (Results/Calculations)

Calculated Factor of Safety =	3.51	(Calculated Factor of Safety in Slope/W due to applied point load at 2/3 below existing ground surface at shaft location)
Resistance Force (FOS = 3.51) =	246322	lbf (Resistance Force to Achieve a Factor of Safety of 3.51)
Driving Force (FOS = 3.51) =	70177	lbf (Calculated Driving Force to Achieve a Factor of Safety of 3.51)

$$Factor\ of\ Safety = \frac{Resistance\ Force\ (lbf)}{Driving\ Force\ (lbf)}$$

Calculate Resistance Force to Achieve a Desired Factor of safety (Slope/W)

Factor of Safety =	1.3	
Driving Force =	70177	lbf (Calculated Driving Force from Slope/W)
Resistance Force (FOS = 1.30) =	91230	lbf (Resistance Force to Achieve a Factor of Safety of 1.30)
Back Calculated Resistance Force (From Slope/W) =	132,000	lbf (Resistance Force to Achieve a Factor of Safety of 1.30 in Slope/W)

$$Resistance\ Force\ (UA\ Slope) = \frac{Factory\ of\ Safety\ (Slope/W)}{Factory\ of\ Safety\ (UA\ Slope)}$$

Convert Calculated Resistance Force to Achieve a Desired Factor of safety from Slope/W to UA Slope

Resistance Force (UA Slope) =	91929	lbf (Converted Resistance Force per Foot of Wall @ 100% Load Transfer Factor to Achieve a Desired Factor of safety from Slope/W to UA Slope)

* Higher of Resistance Forces to Achieve a Factor of Safety of 1.30 Adopted

Convert Resistance Force per Foot of Wall @ 100% Load Transfer Factor to Force per Shaft (UA Slope)

Force per Shaft (FOS = 1.30) =	367714	lbf (Calculated Force per Shaft to achieve a Factor of Safety of 1.30 in UA Slope)

$$Force\ per\ Shaft = Resistance\ Force\ (lbf, UA\ Slope) * CTC\ Spacing\ (ft) * (1 - Load\ Transfer\ Factor)$$

The UA Slope 2.3 software was utilized to provide the per shaft loading along the proposed drilled shaft wall. However, the factor of safety provided by UA Slope (FS = 5.04) exceeded the required 1.3, indicating the resistance exceeded the applied load. As UA Slope does not allow for a reduction in loading or factor of safety, additional analyses were performed in SlopeW.

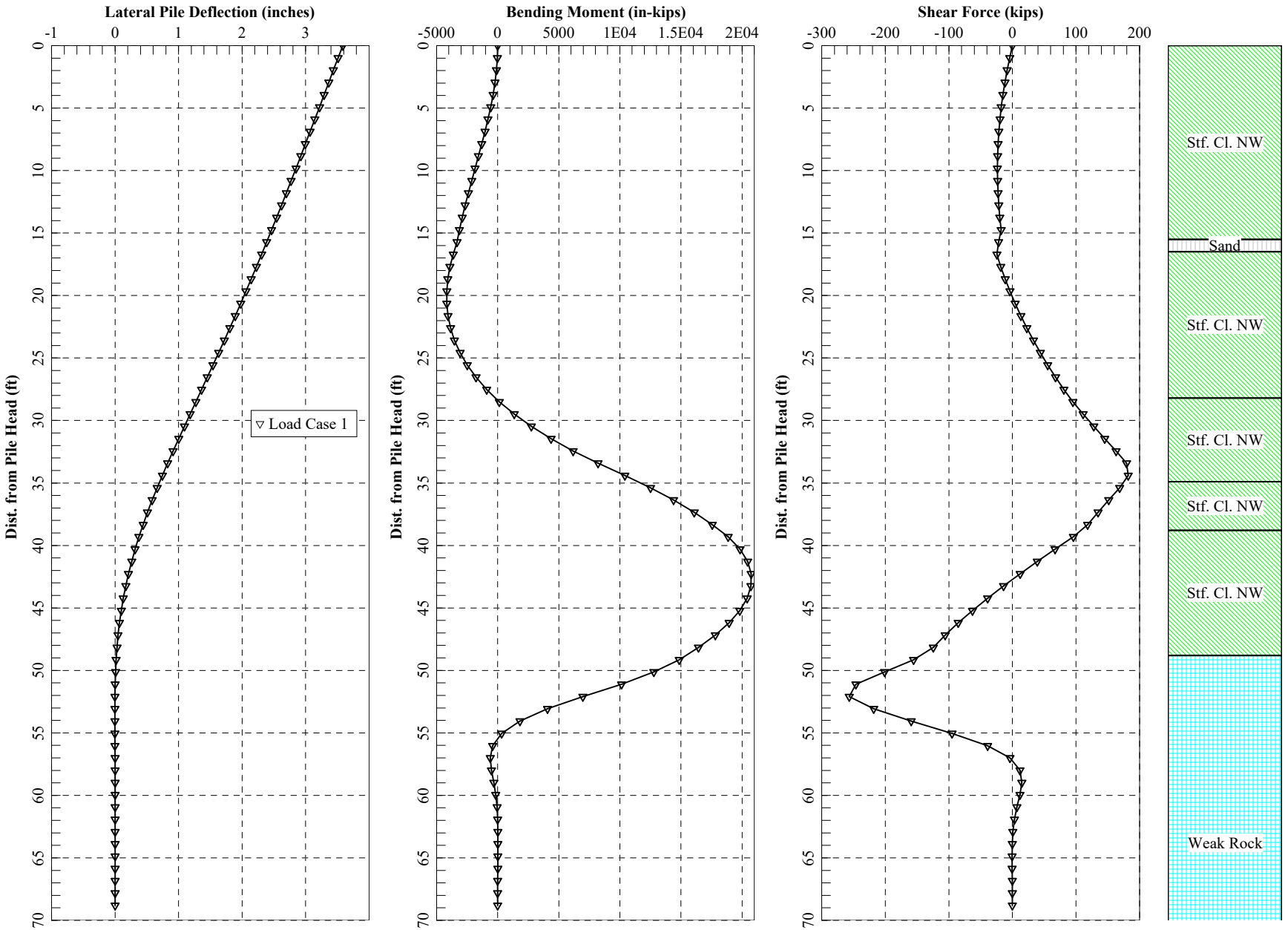
This was accomplished by assigning the proposed slope geometry SlopeW stability model with the proposed fill material used to determine the soil strength parameters and failure surface as the “Parent” analysis. A subsequent model created based on the proposed slope geometry with the drilled shaft wall located at 175 feet left. By assigning the Proposed Slope Geometry SlopeW stability model as the “Parent” analysis, the failure surface was directly translated to the 175-LT wall model, similar to applying the failure surface in UA Slope.

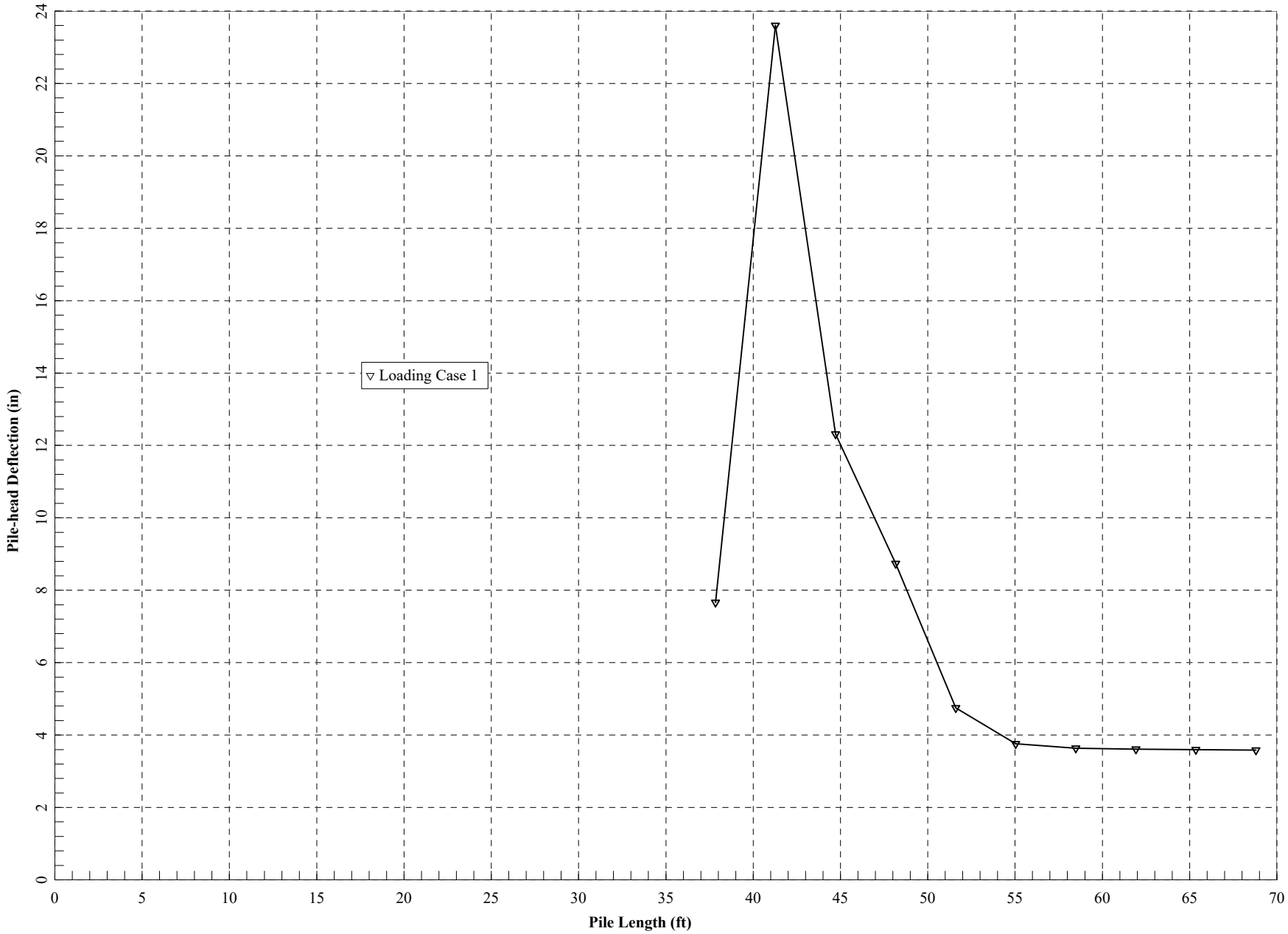
The 175-LT wall model analysis was then run using the UA Slope procedure as a template. A point load was added at a height approximately 1/3 of the distance from the proposed ground surface to the slip surface. The force-per-shaft load from UA Slope was reduced to a force per foot of wall to be applied to SlopeW. SlopeW indicated a FS of 3.51 (compared to 5.04 provided by UA Slope for the same load). The magnitude of the point load was then reduced until the factor of safety as generated by SlopeW was at or above 1.3. As this magnitude is a unit point load, the result was multiplied by the respective shaft spacing to determine the force per drilled shaft.

As UA Slope and SlopeW did not produce the same Factors of Safety, (5.04 and 3.51, respectively) for similar point loads, the calculated resistance load determined in SlopeW was proportionally scaled and converted to an equivalently UA Slope Load.

LPILE Service Load Design

4' Diameter, 4' CTC Spacing


Lateral Pile Deflection (inches)
-1
0
1
2
3
Dist. from Pile Head (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Load Case 1
Bending Moment (in-kips)
-5000
0
5000
1E04
1.5E04
2E04
Dist. from Pile Head (ft)
Shear Force (kips)
-300
-200
-100
0
100
200
Dist. from Pile Head (ft)
Stf. Cl. NW
Sand
Stf. Cl. NW
Stf. Cl. NW
Stf. Cl. NW
Weak Rock


Pile-head Deflection (in)
Pile Length (ft)
Loading Case 1
0
2
4
6
8
10
12
14
16
18
20
22
24
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

```
================================================================================

                     LPile for Windows, Version 2022-12.009

                  Analysis of Individual Piles and Drilled Shafts
                 Subjected to Lateral Loading Using the p-y Method
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--------------------------------------------------------------------------------
                             Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\ODOT-District 10 GES\Task 10-11 MEG-33-13.96\Working\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\4' Center-Center Spacing\

Name of input data file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12d

Name of output report file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12o

Name of plot output file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12p

Name of runtime message file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12r



--------------------------------------------------------------------------------
                             Date and Time of Analysis
--------------------------------------------------------------------------------
```

Date: October 7, 2024 Time: 18:18:22

Problem Title

Project Name: MEG-33-13.96

Job Number:

Client: ODOT D10

Engineer: HDR

Description: Drilled Shaft Retaining Wall Design (Low Rock)

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed	=	500
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in
- Number of pile increments	=	70

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Analysis uses p-y modification factors for p-y curves
- Analysis uses layering correction (Method of Georgiadis)
- Analysis includes loading by one distributed lateral load acting on pile
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 68.800 ft
Depth of ground surface below top of pile = -6.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	48.0000
2	68.800	48.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile
Cross-sectional Shape = Circular Pile
Length of section = 68.800000 ft
Width of top of section = 48.000000 in
Width of bottom of section = 48.000000 in
Top Area = 77.000000 sq. in
Bottom Area = 77.000000 sq. in
Moment of Inertia at Top = 17900. in^4
Moment of Inertia at Bottom = 17900. in^4
Elastic Modulus = 29000000. psi

Soil and Rock Layering Information

The soil profile is modelled using 7 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	-6.00000 ft
Distance from top of pile to bottom of layer	=	15.500000 ft
Effective unit weight at top of layer	=	125.000000 pcf
Effective unit weight at bottom of layer	=	125.000000 pcf
Undrained cohesion at top of layer	=	2500. psf
Undrained cohesion at bottom of layer	=	2500. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000

Top of Drilled Shaft Elevation to be 6 feet below proposed surface elevation

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	15.500000 ft
Distance from top of pile to bottom of layer	=	16.500000 ft
Effective unit weight at top of layer	=	135.000000 pcf
Effective unit weight at bottom of layer	=	135.000000 pcf
Friction angle at top of layer	=	38.000000 deg.
Friction angle at bottom of layer	=	38.000000 deg.
Subgrade k at top of layer	=	225.000000 pci
Subgrade k at bottom of layer	=	225.000000 pci

Layer 3 is stiff clay without free water

Distance from top of pile to top of layer	=	16.500000 ft
Distance from top of pile to bottom of layer	=	28.200000 ft
Effective unit weight at top of layer	=	57.600000 pcf
Effective unit weight at bottom of layer	=	57.600000 pcf
Undrained cohesion at top of layer	=	1400. psf
Undrained cohesion at bottom of layer	=	1400. psf
Epsilon-50 at top of layer	=	0.007000
Epsilon-50 at bottom of layer	=	0.007000

Layer 4 is stiff clay without free water

Distance from top of pile to top of layer	=	28.200000 ft
Distance from top of pile to bottom of layer	=	34.900000 ft
Effective unit weight at top of layer	=	57.600000 pcf
Effective unit weight at bottom of layer	=	57.600000 pcf
Undrained cohesion at top of layer	=	930.000000 psf
Undrained cohesion at bottom of layer	=	930.000000 psf
Epsilon-50 at top of layer	=	0.010000
Epsilon-50 at bottom of layer	=	0.010000

Layer 5 is stiff clay without free water

Distance from top of pile to top of layer	=	34.900000 ft
Distance from top of pile to bottom of layer	=	38.800000 ft
Effective unit weight at top of layer	=	62.600000 pcf
Effective unit weight at bottom of layer	=	62.600000 pcf
Undrained cohesion at top of layer	=	1650. psf
Undrained cohesion at bottom of layer	=	1650. psf
Epsilon-50 at top of layer	=	0.007000
Epsilon-50 at bottom of layer	=	0.007000

Layer 6 is stiff clay without free water

Distance from top of pile to top of layer	=	38.800000 ft
Distance from top of pile to bottom of layer	=	48.800000 ft
Effective unit weight at top of layer	=	72.600000 pcf
Effective unit weight at bottom of layer	=	72.600000 pcf
Undrained cohesion at top of layer	=	3300. psf
Undrained cohesion at bottom of layer	=	3300. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000

Layer 7 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	48.800000 ft
Distance from top of pile to bottom of layer	=	78.800000 ft
Effective unit weight at top of layer	=	150.000000 pcf
Effective unit weight at bottom of layer	=	150.000000 pcf
Uniaxial compressive strength at top of layer	=	150.000000 psi
Uniaxial compressive strength at bottom of layer	=	150.000000 psi
Initial modulus of rock at top of layer	=	14600. psi
Initial modulus of rock at bottom of layer	=	14600. psi
RQD of rock at top of layer	=	0.0000 %
RQD of rock at bottom of layer	=	0.0000 %
k rm of rock at top of layer	=	0.0005000
k rm of rock at bottom of layer	=	0.0005000

(Depth of the lowest soil layer extends 10.000 ft below the pile tip)

**** Warning - Possible Input Data Error ****

Values entered for effective unit weight of rock were outside the limits of
50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 150.00 pcf

This data may be erroneous. Please check your data.

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	RQD %	E50 or krm	kpy pci	Rock Mass Modulus psi
1	Stiff Clay	-6.000	125.0000	2500.	--	--	--	0.00500	--	--
	w/o Free Water	15.5000	125.0000	2500.	--	--	--	0.00500	--	--
2	Sand	15.5000	135.0000	--	38.0000	--	--	--	225.0000	--
	(Reese, et al.)	16.5000	135.0000	--	38.0000	--	--	--	225.0000	--
3	Stiff Clay	16.5000	57.6000	1400.	--	--	--	0.00700	--	--
	w/o Free Water	28.2000	57.6000	1400.	--	--	--	0.00700	--	--
4	Stiff Clay	28.2000	57.6000	930.0000	--	--	--	0.01000	--	--
	w/o Free Water	34.9000	57.6000	930.0000	--	--	--	0.01000	--	--
5	Stiff Clay	34.9000	62.6000	1650.	--	--	--	0.00700	--	--
	w/o Free Water	38.8000	62.6000	1650.	--	--	--	0.00700	--	--
6	Stiff Clay	38.8000	72.6000	3300.	--	--	--	0.00500	--	--
	w/o Free Water	48.8000	72.6000	3300.	--	--	--	0.00500	--	--
7	Weak	48.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.
	Rock	78.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.

Modification Factors for p-y Curves

Distribution of p-y modifiers with depth defined using 4 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.1500	1.0000
2	33.700	0.1500	1.0000
3	33.700	0.6400	1.0000
4	48.800	0.6400	1.0000

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading Used For All Load Cases

Distributed lateral load intensity defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	0.000
2	33.700	1819.000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	-6.000	0.00	N.A.	No	0.00	1049469.
2	15.5000	15.9268	No	No	1049469.	142591.
3	16.5000	32.9715	No	No	1192060.	589350.
4	28.2000	61.7214	Yes	No	1781410.	224794.
5	34.9000	44.7317	Yes	No	2006204.	231878.
6	38.8000	31.3961	Yes	No	2238082.	1135259.
7	48.8000	54.8000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	3.5834	1.49E-05	0.00	-0.00620	2.00E-08	5.19E+11	-395.706	651.1998	13.2627
0.9829	3.5103	-26600.	-4363.	-0.00620	35.6647	5.19E+11	-410.392	1379.	53.0510
1.9657	3.4372	-102908.	-8350.	-0.00620	137.9770	5.19E+11	-424.869	1458.	106.1019
2.9486	3.3641	-223558.	-11881.	-0.00620	299.7423	5.19E+11	-439.133	1540.	159.1529
3.9314	3.2909	-383154.	-14953.	-0.00621	513.7266	5.19E+11	-453.175	1624.	212.2038
4.9143	3.2176	-576271.	-17563.	-0.00622	772.6545	5.19E+11	-466.989	1712.	265.2548
5.8971	3.1441	-797451.	-19710.	-0.00624	1069.	5.19E+11	-480.565	1803.	318.3057

6.8800	3.0705	-1041201.	-21389.	-0.00626	1396.	5.19E+11	-493.894	1897.	371.3567
7.8629	2.9965	-1301997.	-22599.	-0.00628	1746.	5.19E+11	-506.963	1995.	424.4076
8.8457	2.9222	-1574277.	-23335.	-0.00632	2111.	5.19E+11	-519.761	2098.	477.4586
9.8286	2.8475	-1852442.	-23595.	-0.00636	2484.	5.19E+11	-532.273	2205.	530.5095
10.8114	2.7723	-2130851.	-23375.	-0.00640	2857.	5.19E+11	-544.483	2316.	583.5605
11.7943	2.6965	-2403825.	-22671.	-0.00645	3223.	5.19E+11	-556.375	2434.	636.6114
12.7771	2.6201	-2665638.	-21480.	-0.00651	3574.	5.19E+11	-567.930	2557.	689.6624
13.7600	2.5429	-2910517.	-19798.	-0.00657	3902.	5.19E+11	-579.127	2686.	742.7134
14.7429	2.4650	-3132640.	-17619.	-0.00664	4200.	5.19E+11	-589.943	2823.	795.7643
15.7257	2.3862	-3326132.	-21899.	-0.00672	4460.	5.19E+11	-1780.	8800.	848.8153
16.7086	2.3066	-3649201.	-24465.	-0.00680	4893.	5.19E+11	-405.492	2073.	901.8662
17.6914	2.2259	-3903221.	-18276.	-0.00688	5233.	5.19E+11	-401.901	2130.	954.9172
18.6743	2.1442	-4080314.	-11419.	-0.00697	5471.	5.19E+11	-398.162	2190.	1008.
19.6571	2.0615	-4172580.	-3891.	-0.00707	5595.	5.19E+11	-394.263	2256.	1061.
20.6400	1.9776	-4172096.	4310.	-0.00716	5594.	5.19E+11	-390.189	2327.	1114.
21.6229	1.8926	-4070917.	13185.	-0.00725	5458.	5.19E+11	-385.926	2405.	1167.
22.6057	1.8065	-3861069.	22738.	-0.00734	5177.	5.19E+11	-381.460	2491.	1220.
23.5886	1.7193	-3534552.	32971.	-0.00743	4739.	5.19E+11	-376.774	2585.	1273.
24.5714	1.6312	-3083335.	43886.	-0.00750	4134.	5.19E+11	-371.853	2689.	1326.
25.5543	1.5423	-2499353.	55486.	-0.00757	3351.	5.19E+11	-366.679	2804.	1379.
26.5371	1.4528	-1774506.	67774.	-0.00762	2379.	5.19E+11	-361.235	2933.	1432.
27.5200	1.3627	-900658.	80754.	-0.00765	1208.	5.19E+11	-355.502	3077.	1485.
28.5029	1.2724	130368.	95238.	-0.00765	174.7949	5.19E+11	-212.338	1968.	1538.
29.4857	1.1821	1345867.	111214.	-0.00764	1805.	5.19E+11	-208.468	2080.	1592.
30.4686	1.0922	2753757.	127864.	-0.00759	3692.	5.19E+11	-204.386	2207.	1645.
31.4514	1.0031	4361986.	145188.	-0.00751	5848.	5.19E+11	-200.081	2353.	1698.
32.4343	0.9151	6178531.	163190.	-0.00739	8284.	5.19E+11	-195.540	2520.	1751.
33.4171	0.8288	8211405.	179589.	-0.00723	11010.	5.19E+11	-190.755	2715.	1417.
34.4000	0.7446	1.04E+07	182145.	-0.00702	13964.	5.19E+11	-792.396	12551.	0.00
35.3829	0.6633	1.25E+07	168667.	-0.00676	16770.	5.19E+11	-1493.	26552.	0.00
36.3657	0.5853	1.44E+07	151327.	-0.00645	19298.	5.19E+11	-1447.	29163.	0.00
37.3486	0.5111	1.61E+07	134543.	-0.00610	21556.	5.19E+11	-1399.	32282.	0.00
38.3314	0.4413	1.76E+07	118340.	-0.00572	23554.	5.19E+11	-1349.	36042.	0.00
39.3143	0.3762	1.89E+07	95837.	-0.00531	25299.	5.19E+11	-2467.	77358.	0.00
40.2971	0.3161	1.98E+07	67097.	-0.00487	26585.	5.19E+11	-2406.	89774.	0.00
41.2800	0.2614	2.05E+07	39130.	-0.00441	27421.	5.19E+11	-2336.	105424.	0.00
42.2629	0.2121	2.08E+07	12043.	-0.00394	27822.	5.19E+11	-2257.	125508.	0.00
43.2457	0.1684	2.07E+07	-14051.	-0.00347	27802.	5.19E+11	-2168.	151845.	0.00
44.2286	0.1302	2.04E+07	-39030.	-0.00300	27378.	5.19E+11	-2068.	187292.	0.00
45.2114	0.09755	1.98E+07	-62763.	-0.00255	26568.	5.19E+11	-1956.	236558.	0.00
46.1943	0.07017	1.89E+07	-85104.	-0.00211	25393.	5.19E+11	-1832.	307884.	0.00
47.1771	0.04788	1.78E+07	-105836.	-0.00169	23876.	5.19E+11	-1684.	414788.	0.00
48.1600	0.03035	1.64E+07	-124625.	-0.00130	22046.	5.19E+11	-1502.	583830.	0.00
49.1429	0.01723	1.49E+07	-155373.	-9.43E-04	19935.	5.19E+11	-3712.	2540308.	0.00
50.1257	0.00810	1.28E+07	-200948.	-6.29E-04	17132.	5.19E+11	-4017.	5850823.	0.00
51.1086	0.00239	1.01E+07	-246189.	-3.69E-04	13579.	5.19E+11	-3655.	1.81E+07	0.00
52.0914	-6.11E-04	6969998.	-256711.	-1.75E-04	9345.	5.19E+11	1871.	3.61E+07	0.00
53.0743	-0.00174	4072402.	-218181.	-4.95E-05	5460.	5.19E+11	4663.	3.16E+07	0.00
54.0571	-0.00178	1823430.	-159226.	1.75E-05	2445.	5.19E+11	5334.	3.54E+07	0.00
55.0400	-0.00133	316478.	-94987.	4.18E-05	424.3284	5.19E+11	5559.	4.94E+07	0.00
56.0229	-7.92E-04	-417176.	-38958.	4.07E-05	559.3420	5.19E+11	3942.	5.87E+07	0.00

57.0057	-3.69E-04	-602481.	-3854.	2.91E-05	807.7956	5.19E+11	2011.	6.43E+07	0.00
57.9886	-1.07E-04	-508079.	11731.	1.65E-05	681.2228	5.19E+11	631.9674	7.00E+07	0.00
58.9714	1.95E-05	-325767.	14721.	6.98E-06	436.7819	5.19E+11	-124.889	7.56E+07	0.00
59.9543	5.82E-05	-160827.	11620.	1.46E-06	215.6340	5.19E+11	-400.967	8.12E+07	0.00
60.9371	5.38E-05	-51664.	6938.	-9.58E-07	69.2703	5.19E+11	-393.011	8.61E+07	0.00
61.9200	3.56E-05	2829.	3087.	-1.51E-06	3.7931	5.19E+11	-260.031	8.61E+07	0.00
62.9029	1.82E-05	21150.	771.5378	-1.24E-06	28.3581	5.19E+11	-132.586	8.61E+07	0.00
63.8857	6.37E-06	21028.	-284.645	-7.61E-07	28.1946	5.19E+11	-46.515	8.61E+07	0.00
64.8686	2.16E-07	14436.	-568.271	-3.58E-07	19.3556	5.19E+11	-1.580	8.61E+07	0.00
65.8514	-2.07E-06	7624.	-488.459	-1.07E-07	10.2218	5.19E+11	15.1144	8.61E+07	0.00
66.8343	-2.31E-06	2914.	-299.692	1.24E-08	3.9070	5.19E+11	16.8955	8.61E+07	0.00
67.8171	-1.78E-06	554.4803	-123.535	5.18E-08	0.7434	5.19E+11	12.9761	8.61E+07	0.00
68.8000	-1.09E-06	0.00	0.00	5.81E-08	0.00	5.19E+11	7.9721	4.30E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     3.58344276 inches
Computed slope at pile head      =     -0.0061983 radians
Maximum bending moment           =      20750744. inch-lbs
Maximum shear force              =       -256711. lbs
Depth of maximum bending moment  =    42.26285714 feet below pile head
Depth of maximum shear force     =    52.09142857 feet below pile head
Number of iterations             =             37
Number of zero deflection points =              3
```

Pile-head Deflection vs. Pile Length for Load Case 1

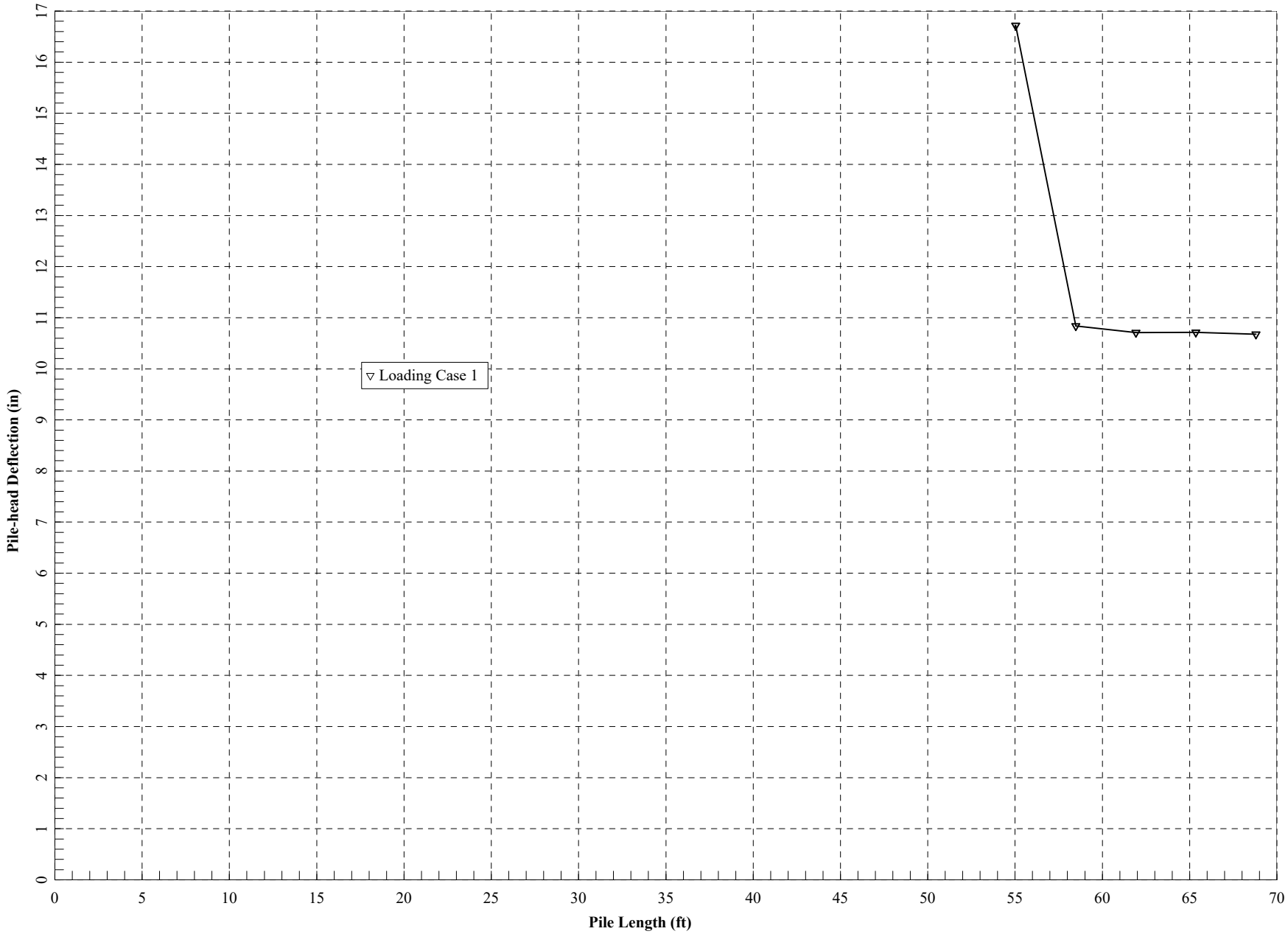
Boundary Condition Type 1, Shear and Moment

```
Shear      =              0. lbs
Moment     =              0. in-lbs
Axial Load =              0. lbs
```

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
68.80000	3.58344276	20750744.	-256711.
65.36000	3.59838599	20790232.	-255599.
61.92000	3.61200112	20869885.	-255823.
58.48000	3.63573657	20914625.	-258953.
55.04000	3.76002587	20628763.	-276797.
51.60000	4.75098332	15647934.	-216015.

```
   48.16000    8.73584395     -7843955.       143436.
   44.72000   12.31502771     -9302266.       129763.
   41.28000   23.60034693     -9785263.       118691.
   37.84000    7.66351890     -9131647.       117563.

--------------------------------------------------------------------------------
            Summary of Pile-head Responses for Conventional Analyses
--------------------------------------------------------------------------------

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians


Load Load                Load                 Axial    Pile-head  Pile-head  Max Shear Max Moment
Case Type   Pile-head    Type     Pile-head   Loading  Deflection Rotation    in Pile    in Pile
 No.  1      Load 1       2        Load 2       lbs      inches    radians      lbs      in-lbs
---- ----- ---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------
  1  V, lb       0.00  M, in-lb        0.00       0.00     3.5834   -0.00620   -256711.   2.08E+07


Maximum pile-head deflection = 3.5834427599 inches
Maximum pile-head rotation   = -0.0061983480 radians = -0.355139 deg.

The analysis ended normally.
```

LPILE Strength Load Design


Pile-head Deflection (in)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Loading Case 1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Pile Length (ft)

==

LPile for Windows, Version 2022-12.009

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

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Files Used for Analysis

Path to file locations:
\ODOT-District 10 GES\Task 10-11 MEG-33-13.96\Working\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\4' Center-Center Spacing\

Name of input data file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12d

Name of output report file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12o

Name of plot output file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12p

Name of runtime message file:
Option 2_10' Rockfill_4' CTC_UA Slope_Drilled Shaft (Low Rock).lp12r

----
Date and Time of Analysis

Date: October 7, 2024 Time: 18:16:17

Problem Title

Project Name: MEG-33-13.96

Job Number:

Client: ODOT D10

Engineer: HDR

Description: Drilled Shaft Retaining Wall Design (Low Rock)

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 70

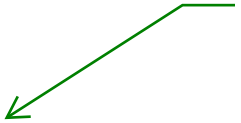
Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - Analysis includes loading by one distributed lateral load acting on pile
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

```
--------------------------------------------------------------------------------
                    Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                        =            1
Total length of pile                                   =       68.800 ft
Depth of ground surface below top of pile              =      -6.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

            Depth Below           Pile
Point        Pile Head          Diameter
 No.            feet             inches
-----      -------------     -------------
  1             0.000           48.0000
  2            68.800           48.0000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is an elastic pile
   Cross-sectional Shape                               =   Circular Pile
   Length of section                                   =    68.800000 ft
   Width of top of section                             =    48.000000 in
   Width of bottom of section                          =    48.000000 in
   Top Area                                            =    77.000000 sq. in
   Bottom Area                                         =    77.000000 sq. in
   Moment of Inertia at Top                            =       17900. in^4
   Moment of Inertia at Bottom                         =       17900. in^4
   Elastic Modulus                                     =    29000000. psi



--------------------------------------------------------------------------------
                      Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 7 layers

Layer 1 is stiff clay without free water

   Distance from top of pile to top of layer           =     -6.00000 ft
   Distance from top of pile to bottom of layer        =    15.500000 ft
   Effective unit weight at top of layer               =   125.000000 pcf
```

Top of Drilled Shaft Elevation to be 6 feet below proposed surface elevation



```
   Effective unit weight at bottom of layer           =   125.000000 pcf
   Undrained cohesion at top of layer                 =        2500. psf
   Undrained cohesion at bottom of layer              =        2500. psf
   Epsilon-50 at top of layer                         =     0.005000
   Epsilon-50 at bottom of layer                      =     0.005000


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =    15.500000 ft
   Distance from top of pile to bottom of layer       =    16.500000 ft
   Effective unit weight at top of layer              =   135.000000 pcf
   Effective unit weight at bottom of layer           =   135.000000 pcf
   Friction angle at top of layer                     =    38.000000 deg.
   Friction angle at bottom of layer                  =    38.000000 deg.
   Subgrade k at top of layer                         =   225.000000 pci
   Subgrade k at bottom of layer                      =   225.000000 pci


Layer 3 is stiff clay without free water

   Distance from top of pile to top of layer          =    16.500000 ft
   Distance from top of pile to bottom of layer       =    28.200000 ft
   Effective unit weight at top of layer              =    57.600000 pcf
   Effective unit weight at bottom of layer           =    57.600000 pcf
   Undrained cohesion at top of layer                 =        1400. psf
   Undrained cohesion at bottom of layer              =        1400. psf
   Epsilon-50 at top of layer                         =     0.007000
   Epsilon-50 at bottom of layer                      =     0.007000


Layer 4 is stiff clay without free water

   Distance from top of pile to top of layer          =    28.200000 ft
   Distance from top of pile to bottom of layer       =    34.900000 ft
   Effective unit weight at top of layer              =    57.600000 pcf
   Effective unit weight at bottom of layer           =    57.600000 pcf
   Undrained cohesion at top of layer                 =   930.000000 psf
   Undrained cohesion at bottom of layer              =   930.000000 psf
   Epsilon-50 at top of layer                         =     0.010000
   Epsilon-50 at bottom of layer                      =     0.010000


Layer 5 is stiff clay without free water

   Distance from top of pile to top of layer          =    34.900000 ft
   Distance from top of pile to bottom of layer       =    38.800000 ft
   Effective unit weight at top of layer              =    62.600000 pcf
   Effective unit weight at bottom of layer           =    62.600000 pcf
   Undrained cohesion at top of layer                 =        1650. psf
   Undrained cohesion at bottom of layer              =        1650. psf
   Epsilon-50 at top of layer                         =     0.007000
   Epsilon-50 at bottom of layer                      =     0.007000
```

Layer 6 is stiff clay without free water

Distance from top of pile to top of layer	=	38.800000 ft
Distance from top of pile to bottom of layer	=	48.800000 ft
Effective unit weight at top of layer	=	72.600000 pcf
Effective unit weight at bottom of layer	=	72.600000 pcf
Undrained cohesion at top of layer	=	3300. psf
Undrained cohesion at bottom of layer	=	3300. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000

Layer 7 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	48.800000 ft
Distance from top of pile to bottom of layer	=	78.800000 ft
Effective unit weight at top of layer	=	150.000000 pcf
Effective unit weight at bottom of layer	=	150.000000 pcf
Uniaxial compressive strength at top of layer	=	150.000000 psi
Uniaxial compressive strength at bottom of layer	=	150.000000 psi
Initial modulus of rock at top of layer	=	14600. psi
Initial modulus of rock at bottom of layer	=	14600. psi
RQD of rock at top of layer	=	0.0000 %
RQD of rock at bottom of layer	=	0.0000 %
k rm of rock at top of layer	=	0.0005000
k rm of rock at bottom of layer	=	0.0005000

(Depth of the lowest soil layer extends 10.000 ft below the pile tip)

**** Warning - Possible Input Data Error ****

Values entered for effective unit weight of rock were outside the limits of
50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 150.00 pcf

This data may be erroneous. Please check your data.

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	RQD %	E50 or krm	kpy pci	Rock Mass Modulus psi
-----	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

1	Stiff Clay	-6.000	125.0000	2500.	--	--	--	0.00500	--	--
	w/o Free Water	15.5000	125.0000	2500.	--	--	--	0.00500	--	--
2	Sand	15.5000	135.0000	--	38.0000	--	--	--	225.0000	--
	(Reese, et al.)	16.5000	135.0000	--	38.0000	--	--	--	225.0000	--
3	Stiff Clay	16.5000	57.6000	1400.	--	--	--	0.00700	--	--
	w/o Free Water	28.2000	57.6000	1400.	--	--	--	0.00700	--	--
4	Stiff Clay	28.2000	57.6000	930.0000	--	--	--	0.01000	--	--
	w/o Free Water	34.9000	57.6000	930.0000	--	--	--	0.01000	--	--
5	Stiff Clay	34.9000	62.6000	1650.	--	--	--	0.00700	--	--
	w/o Free Water	38.8000	62.6000	1650.	--	--	--	0.00700	--	--
6	Stiff Clay	38.8000	72.6000	3300.	--	--	--	0.00500	--	--
	w/o Free Water	48.8000	72.6000	3300.	--	--	--	0.00500	--	--
7	Weak	48.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.
	Rock	78.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.

Modification Factors for p-y Curves

Distribution of p-y modifiers with depth defined using 4 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.1500	1.0000
2	33.700	0.1500	1.0000
3	33.700	0.6400	1.0000
4	48.800	0.6400	1.0000

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading Used For All Load Cases

Distributed lateral load intensity defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	0.000
2	33.700	2728.000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

---

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	-6.000	0.00	N.A.	No	0.00	1049469.
2	15.5000	15.9268	No	No	1049469.	142591.
3	16.5000	32.9715	No	No	1192060.	589350.
4	28.2000	61.7214	Yes	No	1781410.	224794.
5	34.9000	44.7317	Yes	No	2006204.	231878.
6	38.8000	31.3961	Yes	No	2238082.	1135259.
7	48.8000	54.8000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	10.6755	7.95E-05	2.81E-07	-0.01993	1.07E-07	5.19E+11	-506.250	279.6522	19.8905
0.9829	10.4404	-33828.	-5511.	-0.01993	45.3554	5.19E+11	-527.750	596.1878	79.5618
1.9657	10.2053	-130001.	-10455.	-0.01994	174.3024	5.19E+11	-549.250	634.7711	159.1237
2.9486	9.9701	-280442.	-14714.	-0.01994	376.0118	5.19E+11	-570.750	675.1765	238.6855
3.9314	9.7349	-477076.	-18288.	-0.01995	639.6545	5.19E+11	-592.250	717.5396	318.2474
4.9143	9.4995	-711824.	-21168.	-0.01996	954.4015	5.19E+11	-612.138	760.0092	397.8092
5.8971	9.2640	-976388.	-23329.	-0.01998	1309.	5.19E+11	-629.617	801.5865	477.3711
6.8800	9.0282	-1262129.	-24757.	-0.02001	1692.	5.19E+11	-646.744	844.8979	556.9329
7.8629	8.7920	-1560363.	-25446.	-0.02004	2092.	5.19E+11	-663.505	890.0763	636.4948
8.8457	8.5555	-1862355.	-25392.	-0.02008	2497.	5.19E+11	-679.886	937.2697	716.0566
9.8286	8.3184	-2159315.	-24590.	-0.02012	2895.	5.19E+11	-695.870	986.6439	795.6185
10.8114	8.0807	-2442400.	-23036.	-0.02018	3275.	5.19E+11	-711.439	1038.	875.1803
11.7943	7.8424	-2702708.	-20725.	-0.02024	3624.	5.19E+11	-726.576	1093.	954.7422

12.7771	7.6034	-2931276.	-17651.	-0.02030	3930.	5.19E+11	-741.258	1150.	1034.
13.7600	7.3636	-3119080.	-13810.	-0.02037	4182.	5.19E+11	-755.463	1210.	1114.
14.7429	7.1230	-3257029.	-9194.	-0.02044	4367.	5.19E+11	-769.168	1274.	1193.
15.7257	6.8814	-3335960.	-9684.	-0.02052	4473.	5.19E+11	-1780.	3051.	1273.
16.7086	6.6390	-3485463.	-7814.	-0.02059	4673.	5.19E+11	-528.162	938.2830	1353.
17.6914	6.3957	-3520289.	2407.	-0.02067	4720.	5.19E+11	-523.254	964.9327	1432.
18.6743	6.1514	-3428688.	13625.	-0.02075	4597.	5.19E+11	-518.185	993.5325	1512.
19.6571	5.9062	-3198887.	25843.	-0.02083	4289.	5.19E+11	-512.942	1024.	1591.
20.6400	5.6601	-2819090.	39062.	-0.02090	3780.	5.19E+11	-507.513	1058.	1671.
21.6229	5.4133	-2277474.	53284.	-0.02095	3054.	5.19E+11	-501.888	1093.	1750.
22.6057	5.1659	-1562188.	68513.	-0.02100	2095.	5.19E+11	-496.052	1133.	1830.
23.5886	4.9180	-661355.	84750.	-0.02102	886.7324	5.19E+11	-489.992	1175.	1909.
24.5714	4.6700	436938.	101998.	-0.02102	585.8384	5.19E+11	-483.693	1222.	1989.
25.5543	4.4221	1744633.	120260.	-0.02100	2339.	5.19E+11	-477.142	1273.	2069.
26.5371	4.1746	3273708.	139540.	-0.02094	4389.	5.19E+11	-470.323	1329.	2148.
27.5200	3.9281	5036182.	159840.	-0.02085	6752.	5.19E+11	-463.219	1391.	2228.
28.5029	3.6829	7044108.	182219.	-0.02071	9445.	5.19E+11	-276.960	886.9571	2307.
29.4857	3.4395	9334464.	206662.	-0.02052	12515.	5.19E+11	-272.267	933.6132	2387.
30.4686	3.1987	1.19E+07	232100.	-0.02028	15981.	5.19E+11	-267.371	985.8498	2466.
31.4514	2.9611	1.48E+07	258536.	-0.01998	19856.	5.19E+11	-262.261	1045.	2546.
32.4343	2.7274	1.80E+07	285971.	-0.01961	24157.	5.19E+11	-256.926	1111.	2626.
33.4171	2.4986	2.16E+07	310985.	-0.01916	28901.	5.19E+11	-251.359	1187.	2124.
34.4000	2.2755	2.54E+07	315852.	-0.01862	33993.	5.19E+11	-1048.	5430.	0.00
35.3829	2.0593	2.90E+07	297985.	-0.01801	38890.	5.19E+11	-1982.	11352.	0.00
36.3657	1.8508	3.24E+07	274916.	-0.01731	43417.	5.19E+11	-1930.	12298.	0.00
37.3486	1.6509	3.55E+07	252476.	-0.01654	47585.	5.19E+11	-1876.	13399.	0.00
38.3314	1.4606	3.83E+07	230689.	-0.01570	51403.	5.19E+11	-1819.	14688.	0.00
39.3143	1.2806	4.09E+07	200198.	-0.01480	54881.	5.19E+11	-3351.	30867.	0.00
40.2971	1.1115	4.31E+07	161003.	-0.01385	57734.	5.19E+11	-3295.	34962.	0.00
41.2800	0.9540	4.47E+07	122529.	-0.01285	59973.	5.19E+11	-3229.	39921.	0.00
42.2629	0.8085	4.60E+07	84889.	-0.01182	61609.	5.19E+11	-3154.	46006.	0.00
43.2457	0.6753	4.67E+07	48200.	-0.01076	62658.	5.19E+11	-3068.	53582.	0.00
44.2286	0.5546	4.71E+07	12590.	-0.00970	63134.	5.19E+11	-2971.	63181.	0.00
45.2114	0.4465	4.70E+07	-21804.	-0.00863	63056.	5.19E+11	-2862.	75595.	0.00
46.1943	0.3510	4.66E+07	-54836.	-0.00757	62444.	5.19E+11	-2740.	92053.	0.00
47.1771	0.2680	4.57E+07	-86264.	-0.00652	61322.	5.19E+11	-2590.	113978.	0.00
48.1600	0.1973	4.45E+07	-115683.	-0.00549	59716.	5.19E+11	-2399.	143433.	0.00
49.1429	0.1384	4.30E+07	-166679.	-0.00450	57663.	5.19E+11	-6249.	532326.	0.00
50.1257	0.09116	4.06E+07	-246918.	-0.00355	54444.	5.19E+11	-7358.	951917.	0.00
51.1086	0.05476	3.72E+07	-337483.	-0.00266	49854.	5.19E+11	-8000.	1722934.	0.00
52.0914	0.02832	3.26E+07	-432275.	-0.00187	43771.	5.19E+11	-8075.	3362540.	0.00
53.0743	0.01063	2.70E+07	-523123.	-0.00119	36182.	5.19E+11	-7331.	8132053.	0.00
54.0571	1.74E-04	2.03E+07	-570466.	-6.56E-04	27226.	5.19E+11	-697.213	4.74E+07	0.00
55.0400	-0.00484	1.35E+07	-529271.	-2.72E-04	18140.	5.19E+11	7683.	1.87E+07	0.00
56.0229	-0.00624	7821282.	-430491.	-2.91E-05	10487.	5.19E+11	9068.	1.72E+07	0.00
57.0057	-0.00553	3374628.	-320062.	9.80E-05	4525.	5.19E+11	9658.	2.06E+07	0.00
57.9886	-0.00392	271468.	-206197.	1.39E-04	363.9791	5.19E+11	9651.	2.90E+07	0.00
58.9714	-0.00224	-1489256.	-95769.	1.26E-04	1997.	5.19E+11	9075.	4.78E+07	0.00
59.9543	-9.59E-04	-1987581.	-3279.	8.61E-05	2665.	5.19E+11	6609.	8.12E+07	0.00
60.9371	-2.10E-04	-1566604.	44727.	4.58E-05	2100.	5.19E+11	1532.	8.61E+07	0.00
61.9200	1.20E-04	-932525.	48601.	1.74E-05	1250.	5.19E+11	-875.030	8.61E+07	0.00
62.9029	2.00E-04	-420167.	34844.	2.00E-06	563.3519	5.19E+11	-1458.	8.61E+07	0.00
63.8857	1.67E-04	-110596.	19061.	-4.03E-06	148.2853	5.19E+11	-1219.	8.61E+07	0.00
64.8686	1.05E-04	29455.	7374.	-4.96E-06	39.4931	5.19E+11	-763.129	8.61E+07	0.00

65.8514	5.00E-05	63351.	720.0769	-3.90E-06	84.9405	5.19E+11	-365.239	8.61E+07	0.00
66.8343	1.25E-05	46441.	-1972.	-2.65E-06	62.2671	5.19E+11	-91.278	8.61E+07	0.00
67.8171	-1.26E-05	16833.	-1969.	-1.94E-06	22.5695	5.19E+11	91.8351	8.61E+07	0.00
68.8000	-3.32E-05	0.00	0.00	-1.74E-06	0.00	5.19E+11	242.0194	4.30E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

Pile-head deflection = 10.67551246 inches
Computed slope at pile head = -0.0199344 radians
Maximum bending moment = 47087382. inch-lbs
Maximum shear force = -570466. lbs
Depth of maximum bending moment = 44.22857143 feet below pile head
Depth of maximum shear force = 54.05714286 feet below pile head
Number of iterations = 36
Number of zero deflection points = 3

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs
Moment = 0. in-lbs
Axial Load = 0. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
68.80000	10.67551246	47087382.	-570466.
65.36000	10.71188963	47048658.	-572743.
61.92000	10.70817317	47012671.	-569793.
58.48000	10.83724681	46801384.	-590653.
55.04000	16.71655886	40278301.	-579261.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	0.00	10.6755	-0.01993	-570466.	4.71E+07

Maximum pile-head deflection = 10.6755124608 inches
Maximum pile-head rotation = -0.0199343856 radians = -1.142156 deg.

The analysis ended normally.

4' Diameter, 5' CTC Spacing
Drilled Shaft Design

UA Slope Results

UA Slope Program Version 2.3 - C:\Users\MOMOHAMMED\Desktop\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\Option 2_10' Rockfill_UA Slope_Proposed FOS=0.94 (Low Rock).ua3*

File Run Options Help

Calculated Results

Factor of Safety: 0.94
Force per Shaft: 0.000 lb
Acting Point X: 0.000 ft Y: 0.000 ft

Analysis Unit System

(•) English ( ) Metric

Number of Vertical Sections and Soil Layers

Vertical Section Num: 20 Soil Layer Num: 10

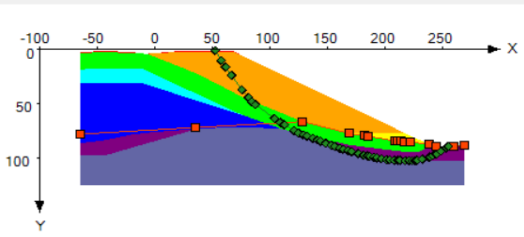
Analysis Method

( ) Total Stress (•) Effective Stress

Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	0.1	0.0	250.0
Layer2	250.0	28.0	125.0
Layer3	0.0	38.0	135.0
Layer4	265.0	19.0	120.0
Layer5	175.0	25.0	130.0
Layer6	215.0	27.0	140.0
Layer7	235.0	19.0	120.0
Layer8	125.0	23.0	125.0
Layer9	185.0	26.0	135.0
Layer10	4000.0	45.0	140.0

Chart (Double-Click for More Options)



Slope Profile Vertical Sections

	Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7	Section 8	Section 9	Section 10	Section 1
X (ft)	-64.90	-42.00	-20.30	-12.00	-6.90	26.00	35.70	52.50	69.00	77.00	110.10
Y1 (ft)	2.30	1.70	2.40	3.90	4.20	1.20	1.00	1.10	1.80	6.80	23.40
Y2 (ft)	3.30	2.70	3.40	3.90	4.20	2.20	2.00	2.10	2.80	6.80	23.40
Y3 (ft)	3.30	2.70	3.40	3.90	4.20	17.90	22.30	30.90	40.00	44.40	58.60
Y4 (ft)	3.30	2.70	3.40	3.90	4.20	17.90	22.30	30.90	40.00	44.40	58.60
Y5 (ft)	18.40	18.00	17.60	17.40	19.90	36.00	40.70	48.90	57.00	60.90	73.20
Y6 (ft)	31.50	31.20	31.00	30.90	32.60	43.70	47.00	52.60	58.20	60.90	73.20
Y7 (ft)	86.40	83.30	78.50	77.40	76.70	74.00	73.50	72.40	72.00	71.50	73.20
Y8 (ft)	96.90	97.20	90.60	88.00	86.50	76.50	73.50	72.40	72.00	71.50	73.20
Y9 (ft)	100.70	100.20	95.00	93.00	91.70	83.80	81.50	77.40	73.40	71.50	81.30

Coordinates of Crest X: 69.00 ft Y: 2.80 ft Coordinates of Toe X: 240.00 ft Y: 88.00 ft

Drilled Shaft Information

(•) Calculate without Drilled Shaft
( ) Automatic Load Transfer Factor
( ) Manually Defined Load Transfer Factor
[ ] Anchor (On/Off)

Anchor force: 0.00 lb
Anchor angle: 0.00
Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.000 (n)
Xmin 0.00 Diameter: 0.30 ft
Xmax 0.00 CTC Spacing: 0.00 ft
XDelta 0.00 X Coordinate: 0.00 ft

[ ] Auto Save Data

Run

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14
X (ft)	-64.90	35.70	127.90	168.80	182.50	185.30	208.65	210.60	213.60	217.30	222.00	237.90	244.00	260.00
Y (ft)	78.00	72.00	66.50	77.30	79.50	80.00	84.13	84.20	84.50	84.80	85.50	87.30	89.20	89.50

Slip Surface

	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14
X (ft)	52.50	57.56	61.36	66.50	75.75	81.19	84.33	87.38	103.92	108.93	112.33	121.06	124.81	128.95
Y (ft)	1.10	10.27	16.17	24.01	37.41	44.29	48.26	50.88	63.67	67.19	69.32	74.78	76.97	78.60

Note: Values modified as necessary to calibrate factor of safety with SlopeW

UA Slope Program Version 2.3 - C:\Users\MOMOHAMMED\Desktop\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\5' Center-Center Spacing\Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).ua3*

File Run Options Help

Calculated Results

Factor of Safety: 2.87
Force per Shaft: 1010988.489 lb
Acting Point X: 175.000 ft Y: 82.382 ft

Analysis Unit System

(•) English ( ) Metric

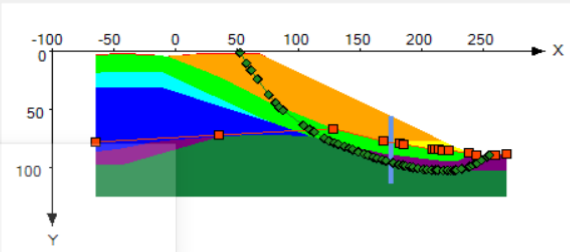
Number of Vertical Sections and Soil Layers

Vertical Section Num: 20 Soil Layer Num: 10

Analysis Method

( ) Total Stress (•) Effective Stress

Chart (Double-Click for More Options)



Soil Properties

	Cohesion (psf)	Friction Angle	Total Unit Weight (pcf)
Layer1	0.1	0.0	250.0
Layer2	250.0	28.0	125.0
Layer3	0.0	38.0	135.0
Layer4	265.0	19.0	120.0
Layer5	175.0	25.0	130.0
Layer6	215.0	27.0	140.0
Layer7	235.0	19.0	120.0
Layer8	125.0	23.0	125.0
Layer9	185.0	26.0	135.0
Layer10	4000.0	45.0	140.0

Slope Profile Vertical Sections

	Section 11	Section 12	Section 13	Section 14	Section 15	Section 16	Section 17	Section 18	Section 19	Section 20
X (ft)	10.10	127.40	168.90	190.00	217.90	228.90	237.90	244.00	254.90	269.30
Y1 (ft)	3.40	32.00	52.80	63.30	77.30	82.80	87.30	89.20	89.30	87.90
Y2 (ft)	3.40	32.00	52.80	63.30	77.30	82.80	87.30	89.20	89.30	87.90
Y3 (ft)	8.60	66.30	77.30	77.30	77.30	82.80	87.30	89.20	89.30	87.90
Y4 (ft)	8.60	66.30	77.30	80.70	84.90	86.30	87.30	89.20	89.30	87.90
Y5 (ft)	3.20	78.00	88.00	90.80	94.40	94.60	90.20	90.20	90.00	89.60
Y6 (ft)	3.20	78.00	88.00	90.80	94.40	94.60	90.20	90.20	90.00	89.60
Y7 (ft)	3.20	78.00	88.00	90.80	94.40	94.60	90.20	90.20	90.00	89.60
Y8 (ft)	3.20	78.00	94.30	102.60	102.60	102.60	102.60	102.60	102.60	102.60
Y9 (ft)	1.30	86.40	98.80	105.10	105.10	105.10	105.10	105.10	105.10	105.10

Coordinates of Crest X: 69.00 ft Y: 2.80 ft Coordinates of Toe X: 240.00 ft Y: 88.00 ft

Drilled Shaft Information

( ) Calculate without Drilled Shaft
(•) Automatic Load Transfer Factor
( ) Manually Defined Load Transfer Factor
[ ] Anchor (On/Off)

Anchor force: 0.00 lb
Anchor angle: 0.00
Anchor spacing: 0.00 ft

Auto ( ) On (•) Off 0.052 (n)
Xmin 0.00 Diameter: 4.00 ft
Xmax 0.00 CTC Spacing: 5.00 ft

[ ] Auto Save Data

Pore Water Pressure

Pore Pressure Options: ( ) No Pore Pressure ( ) Constant Ratio (•) Specified phreatic surface

	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8	Point 9	Point 10	Point 11	Point 12	Point 13	Point 14	Point 15
X (ft)	.70	127.90	168.80	182.50	185.30	208.65	210.60	213.60	217.30	222.00	237.90	244.00	260.00	269.30
Y (ft)	.00	66.50	77.30	79.50	80.00	84.13	84.20	84.50	84.80	85.50	87.30	89.20	89.50	87.90

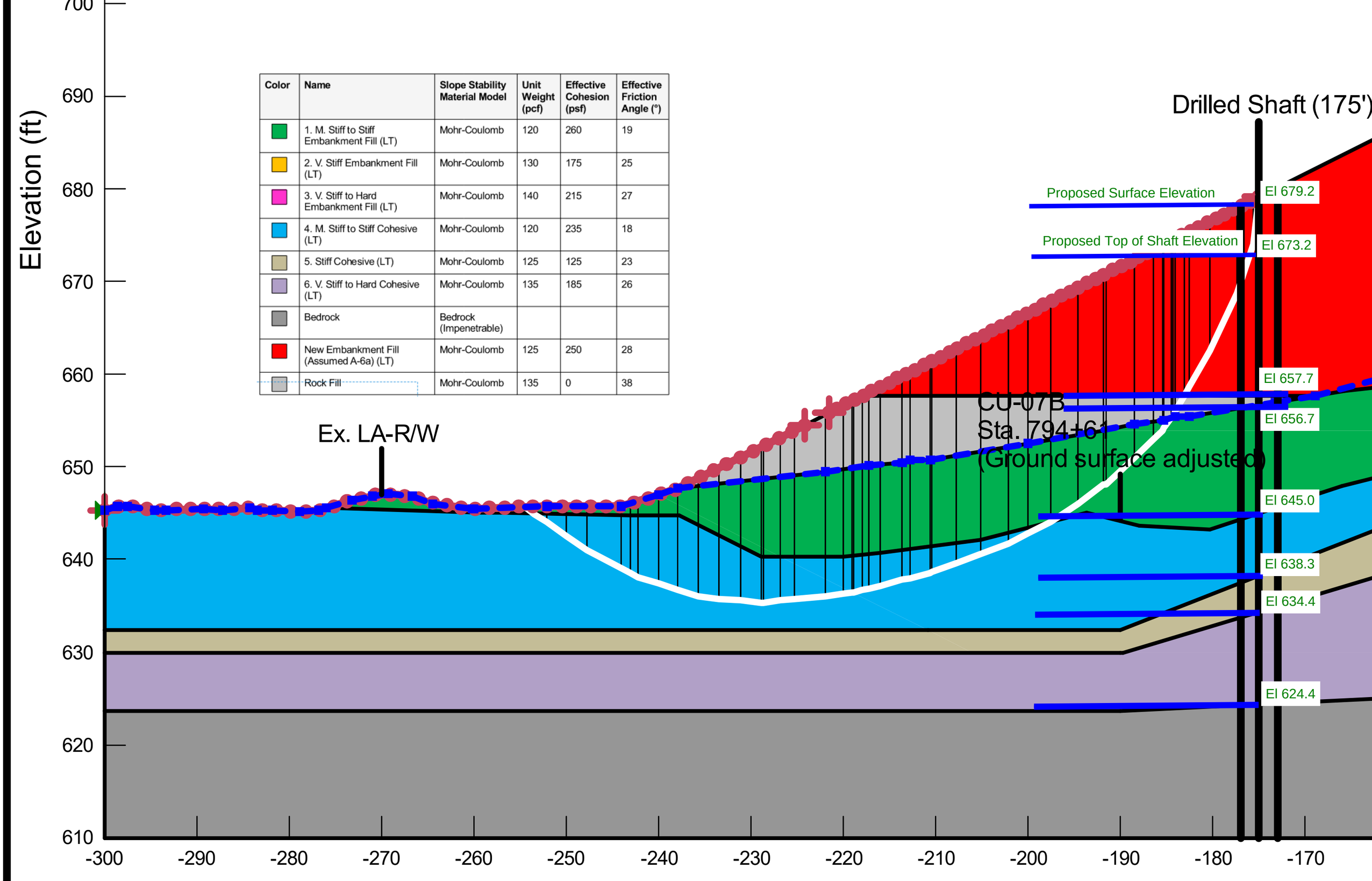
Slip Surface

	Point 38	Point 39	Point 40	Point 41	Point 42	Point 43	Point 44	Point 45	Point 46	Point 47	Point 48	Point 49	Point 50
X (ft)	7.60	221.00	223.50	226.05	227.85	232.45	237.85	238.95	241.50	244.60	248.65	252.98	254.90

Note: Values modified as necessary to calibrate factor of safety with SlopeW

LPILE Inputs

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38



Geometry

	Elevation (ft)	
Top of Backfill =	732.2	*at Outside Edge of Shoulder*
Top of Wall =	673.2	*at C/L of Wall*
Existing Ground Surface =	679.2	*at C/L of Wall*
Maintenance Bench =	673.2	*at C/L of Wall*
Slip Plane =	639.5	*at C/L of Wall*

	Horiz. Distance from C/L (ft)	
Start of Wall Backfill =	69.0	*at Outside Edge of Shoulder*
Wall =	175.0	*at C/L of Wall*
Backfill Slope Angle =	2.0	H:1V

Wall Loading Profile

	Top Elev.	Thickness (ft)	Cohesion (psf)	Phi (deg)	Unit Wt (pcf)
New Embankment Fill (Assumed A-6a)	673.2	15.5	250	28	125
Rock Fill	657.7	1.0	0	38	135
Medium Stiff to Stiff Embankment Fill	656.7	11.7	260	19	120
Medium Stiff to Stiff Cohesive	645.0	6.7	235	18	120
Stiff Cohesive	638.3	3.9	125	23	125
Very Stiff to Hard Cohesive	634.4	10.0	185	26	135
Top of Rock	624.4				
Weighted Value		48.8	-	-	-

Earth Pressure Coefficients

	Deg		
Shear Resistance, Φ =	-		
Wall Friction , δ^A =	0.0		
Wall Slope, θ =	90		
Backfill Slope, β =	26.57		
Revised Backfill Slope, β =	26.57		
Backfill Condition	INFINITE		
Horz. Backslope Dist.	106.0	feet	*(C/L of Wall - Edge of Shoulder)*
Wall Height (H)	0.0	feet	*(Top of Wall - Maintenance Bench)*
Slope Height (h)	59.0	feet	*(Top of Backfill - Top of Wall)*
I =		degrees	

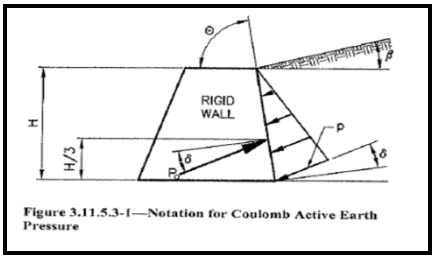


Figure 3.11.5.3-1—Notation for Coulomb Active Earth Pressure

Active Earth Coefficient

$$K_a = \frac{\sin^2(\theta+\Phi)}{(\sin^2(\theta)*\sin(\theta-\delta)*[1+\sqrt{(\sin(\Phi+\delta)*\sin(\Phi-\beta))/(\sin(\theta-\delta)*\sin(\theta+\beta))}]^2)}$$

K_a = -

At-Rest Earth Coefficient

$K_o = (1- \sin(\phi))*(1+\sin(\beta))$

K_o = -

Notes:

A. *Wall friction neglected*

B. *Figure and Equation for Active Earth Pressure from AASHTO 3.11.5.3 (LRFD Design Manual).*

C. *#VALUE!*

Soil Lateral Design Profile

	Top Elev	Depth (ft)	Depth Below Top of Shaft	Cohesion (psf)	Phi (deg)	Unit Wt (pcf)	ε50	k
New Embankment Fill (Assumed A-6a)	679.2	0.0	-6.0	2500	0	125	0.005	N/A
Rock Fill	657.7	21.5	15.5	0	38	135	N/A	225
Medium Stiff to Stiff Embankment Fill	656.7	22.5	16.5	1400	0	57.6	0.007	N/A
Medium Stiff to Stiff Cohesive	645	34.2	28.2	930	0	57.6	0.01	N/A
Stiff Cohesive	638.3	40.9	34.9	1650	0	62.6	0.007	N/A
Very Stiff to Hard Cohesive	634.4	44.8	38.8	3300	0	72.6	0.005	N/A
Bedrock	624.4	54.8	48.8	N/A	N/A	N/A	N/A	N/A

Bedrock Lateral Design Profile

	Top Elev	Depth (ft)	qu (psi)	Em (psi)	Unit Wt (pcf)	RQD (%)	krm
Siltstone/Claystone	624.4	54.8	150	14600	150	0	0.0005

* Rock strength parameters indicate a RQD of 9%, however RQD of 0% was used for LPILE analyses

Depths referenced below the top of wall, starting at the lowered ground surface. ε50 and k values per LPile Technical Manual.

Wall Loading Computations

Earth Pressure Model = CONVENTIONAL *(Conventional or UA SLOPE)* UA SLOPE

1) Soil Unit Weight = - pcf *Weighted Average Along Cantilevered Wall Height*

2) Determine Coefficient of Earth Pressure (K)

Restraint Condition = ACTIVE *(Active or At-Rest)*
Ka = -

3) Determine Equivalent Fluid Weight (G_H)

G_H = $(\gamma_m) * (K_a)$
G_H = - *For application to CONVENTIONAL Earth Pressure Model*

4) Artificially Lowered Ground Surface (ODOT GDM Section 903.3.2, pg. 9-14) for FS_{dh} < 1.30

Consider Lowered G. S.? NO
Lowered Ground Surface (ft) = 0.0 = dt (tan(β_{dh})
β_{dh} = 26.57 = steepness of the slope downhill of the drilled shaft
FS_{dh} = 1.30 = Factor of Safety down slope of the proposed wall
d_t = 33.7 = depth below bench to the shear surface at the location of the drilled shaft

5) Modification of p-y curves (ODOT GDM Section 903.2, pg. 9-13)

P_m = $0.64*(S/D)^{0.34}$ *(Ref: Reese, Isenhower, & Wang - 2006)*
D = 4 feet *(shaft diameter or pile flange width)*
Assumed Shaft Spacing = 5 feet *(center-to-center pile spacing)*
P_m = 0.69 *For retaining wall, applies from top of wall to top of rock/bottom of drilled shafts*
For a row of drilled shafts, applies below shear plane to top of rock/bottom of drilled shafts
Reduce p-multiplier? YES *For application above shear plane if using a row of spaced drilled shafts instead of a retaining wal*
FS_{UAS} = 1.30 = Factor of Safety from UASlope including shafts
p-multipler = 0.16 = (P_m - P_m/FS_{UAS}) *From top of wall to bottom of shear plane*

6) Determine Lateral Thrust

Conventional Earth Pressure Theory *UA SLOPE*

Exposed Wall Height (H) = 0 feet Depth from T/Wall to Slip Plane = 33.7 feet
Wall Height (H) + GS_{AL} = 0.0
P = $1/2 * G_H * H^2$
P = - lbs/foot
P_{SH} = P*(Shaft Spacing) *(earth loading)*
P_{SH} = - lbs/shaft Force Per Shaft = 525397 lbs/shaft (See Attached)

7) Resolve horizontal earth force to distributed triangular load (for LPILE)

w = $2*P_{SH}/H$
w = - lbs/foot per shaft (Earth - Service Limit) 31181 lbs/foot per shaft
w = - lbs/inch per shaft (Earth - Service Limit) 2598 lbs/inch per shaft
γ_E = 1.5 *Earth Load Factor*
w = $(2*P_{SH}/H)*\gamma_E$
w = - lbs/inch per shaft (Earth - Strength Limit) 3898 lbs/inch per shaft

8) Determine live-load traffic surcharge force (P_s)

Include traffic surcharge? NO

Surcharge Pressure (q_s) = NA psf
P_s = Ka * qs * H
P_s = NA lbs/foot *(surcharge resolved to distributed load)* NA lbs/foot
P_s = NA lbs/shaft NA lbs/shaft

9) Resolve surcharge to distributed rectangular load (for LPILE)

w = P_S/H
w = 0 lbs/foot per shaft (surcharge - unfactored) 0 lbs/foot per shaft
w = 0 lbs/inch per shaft (surcharge - unfactored) 0 lbs/inch per shaft
γ_S = 1.75 *Surcharge Load Factor - Strength I*
w = $(P_S/L)*\gamma_S$
w = 0 lbs/inch per shaft (Surcharge - Strength I) 0 lbs/inch per shaft

Distributed Lateral Loads for LPILE

CONVENTIONAL

Depth (ft.)	Service (lb/in)	Strength-I (lb/in)
0	0	0
0.0	-	-

Distributed Lateral Loads for LPILE

UA SLOPE

Depth (ft.)	Service (lb/in)	Strength-I (lb/in)
0	0	0
33.7	2598	3898

Steel Beam and Cross-Section Properties

Assumed Pile Shape W 36x395

Pile Availability

AISC Member Producers	1
Non-Member Producers	1

Shaft Geometry

Shaft Diameter	48	in
Longest Beam Dimension	41.914198	in
Clear Distance	3.042901	in

Steel Beam Geometry

Beam Depth (D)	38.4	in
Web Thickness (t_w)	1.22	in
Flange Width (B_f)	16.8	in
Flange Thickness (t_f)	2.2	in
Area of Steel (A_s)	116	in^2

Steel Properties

Yield Strength of Steel	50	ksi
Moment of Inertia (I_{xx}) of Steel	28500	in^4
Modulus of Elasticity of Steel (E)	29000	ksi
Modulus of Elasticity of Steel (E)	29000000	psi
EI (Steel Only)	8.265E+11	$lb*in^2$
Section Modulus (S_x)	1490	in^3
Section Modulus (Z_x)	1710	in^3
Shear-Buckling Coefficient (k)	5	
Ratio of Shear-Buckling Resistance (C)	1	
D/t_w	31.47541	
$1.12\sqrt{E}k/F_{yw}$	60.313846	
$1.40\sqrt{E}k/F_{yw}$	75.392307	

Determined by AASHTO LRFD Bridge Specifications Eqn's 6.10.9.3.2-4, 6.10.9.3.2-5, and 6.10.9.3.2-6

Shear Capacity Calculation

$V_u \le \phi V_{cr}$

$\phi_v =$ 1 *AASHTO LRFD Bridge Design Spec's 6.5.4.2*

$V_u =$ *shear in web due to factored permanent and construction loads applied to noncompact section (kips)*

$V_{cr} =$ *shear buckling resistance determined from Equation 6.10.9.3.3-1 (AASHTO LRFD Bridge Design Spec's)*

$V_n = V_{cr} = CV_p$

$V_p = 0.58F_{yw}Dt_w$

$V_p =$ *plastic shear force (kips)*

$C =$ *ratio of shear-buckling resistance to shear yield strength determined by AASHTO Eqn's 6.10.9.3.2-4, 6.10.9.3.2-5, 6.10.9.3.2-5, or 6.10.9.3.2-6*

$V_p =$ 0.58 * 50 * 38.4 * 1.22

$V_p =$ 1358.6 kips

$\phi V_{cr} = \phi * C * V_p$

$\phi V_{cr} =$ 1 * 1 * 1358.6

$\phi V_{cr =}$ 1358.6 kips

$V_u =$ 1048.1 kips *(from LPILE)*

kips *(from PYWALL)*

$V_u < \phi V_{cr}$ **OK**

Flexure Capacity Calculation

$M_u \le \phi M_n$

$\phi_b =$ 1 *AASHTO LRFD Bridge Design Spec's 6.5.4.2*

$M_u =$ *Moment due to the factored loads*

$M_n =$ *Nominal flexural resistance of a section*

$S_x =$ *Elastic section modulus about the x-axis*

$\phi M_n = \phi * F_y * S_x$

$\phi M_n =$ 1 * 50 * 1490

$\phi M_n =$ 74500 in*kips

$M_u =$ 97700 in*kips *(from LPILE)*

$M_u =$ in*kips *(from PYWALL)*

$M_u < \phi M_n$

Minimum Pile Length

Top of Wall to Slip Plane =	33.7	ft	
Minimum Pile Length Below Slip Plane =	10	ft	*ODOT Minimum Required Length*
Minimum Required Pile Length =	43.7	ft	

Deflection Criteria

Pile Length Above Rock =	48.8 ft	Exposed Wall Height =	0 ft
Pile Length Above Rock =	585.6 in	Exposed Wall Height =	0 in

1.) *Per the ODOT GDM, pile-head deflection in the service limit state limited to 1% or less of the shaft length above bedrock, or 1% of total drilled shaft length if not embedded in bedrock.*

2.) *Following industry acceptance criteria, limit wall deflection to 1% of exposed wall height where ODOT landslide criteria does not govern. Alternatively, limit wall deflection to 1.5% of the exposed wall height in accordance with NCDOT guidelines. Use 1.5% wall deflection for PYWALL software.*

ODOT Landslide Criteria Governs YES

Drilled Shafts Located Within 10 feet of Edge of Pavement NO

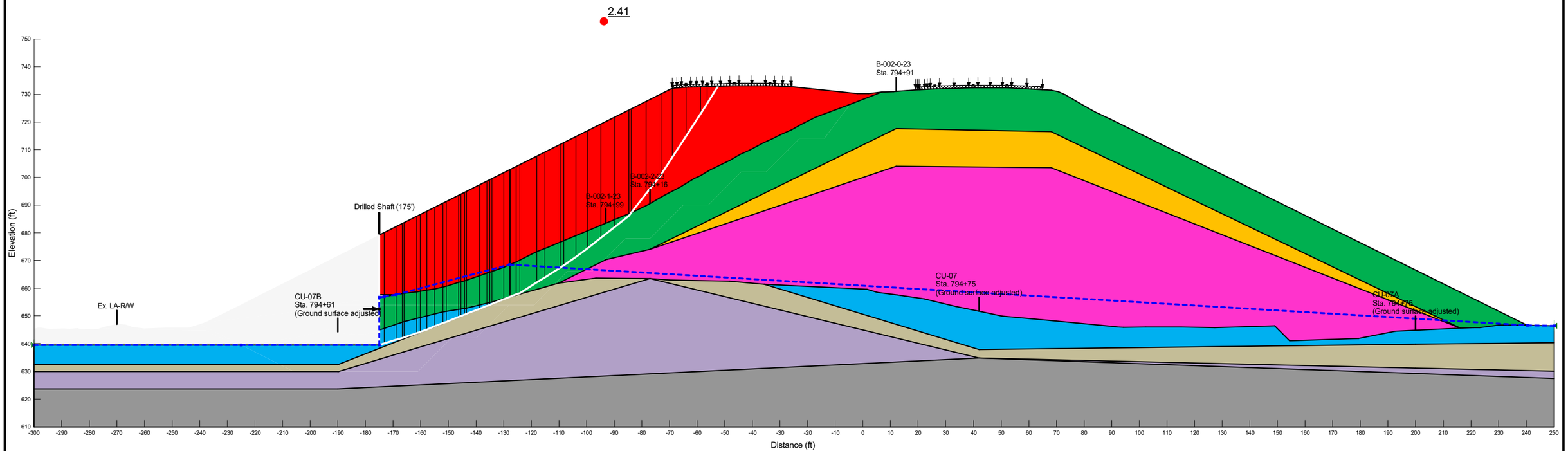
1% Wall Height **OR** 2 inches- LPILE	5.856 in	$\delta =$	6.419 in	*(from LPILE)*
1.5% Wall Height - PYWALL	in	$\delta =$	in	*(from PYWALL)*

A W36x395 beam is the biggest W-beam that could fit inside a 48" diameter shaft. W36x395 does not meet allowable deflection, shear, nor flexure capacity

Slope/W and UA Slope Incorporation

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38

Point Load
Coordinate: (-175, 652.618) ft
Magnitude: 213,289 lbf

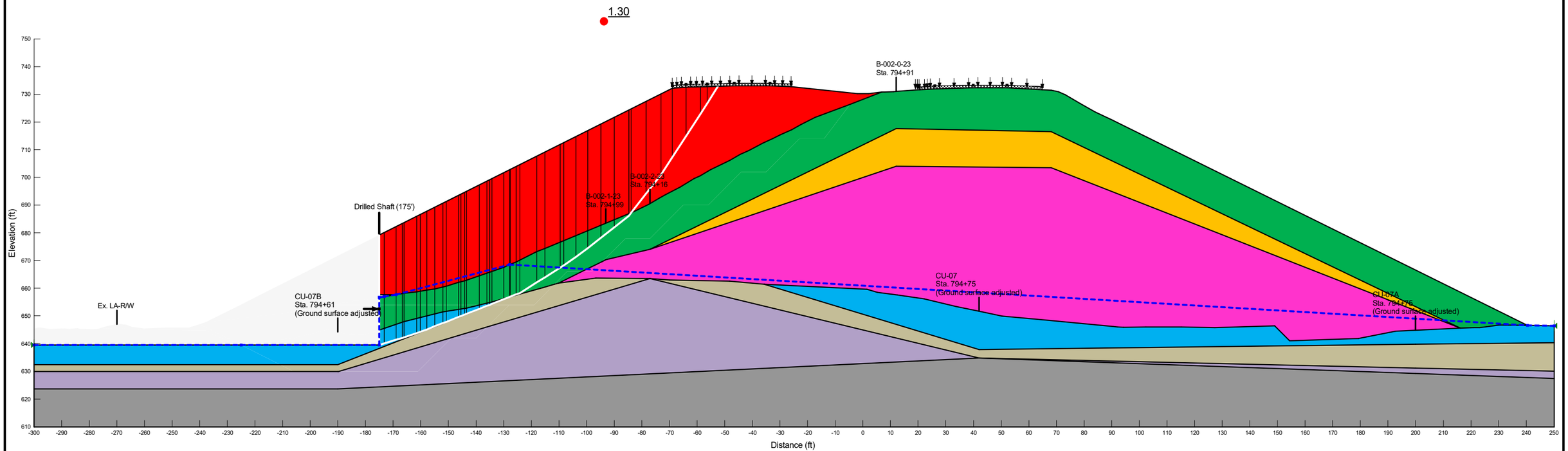


01. Sta. 794+00 Option 2 (Lowered Rock) (10' Rock fill) (4)	
Sta. 794+00 LT Slope Stability.gsz	
10/07/2024	1:423

Required point load to achieve a Factor of Safety of 1.30

Point Load
Coordinate: (-175, 652.618) ft
Magnitude: 132,000 lbf

Color	Name	Slope Stability Material Model	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (°)
	1. M. Stiff to Stiff Embankment Fill (LT)	Mohr-Coulomb	120	260	19
	2. V. Stiff Embankment Fill (LT)	Mohr-Coulomb	130	175	25
	3. V. Stiff to Hard Embankment Fill (LT)	Mohr-Coulomb	140	215	27
	4. M. Stiff to Stiff Cohesive (LT)	Mohr-Coulomb	120	235	18
	5. Stiff Cohesive (LT)	Mohr-Coulomb	125	125	23
	6. V. Stiff to Hard Cohesive (LT)	Mohr-Coulomb	135	185	26
	Bedrock	Bedrock (Impenetrable)			
	New Embankment Fill (Assumed A-6a) (LT)	Mohr-Coulomb	125	250	28
	Rock Fill	Mohr-Coulomb	135	0	38



01. Sta. 794+00 Option 2 (Lowered Rock) (10' Rock fill) (3)	
Sta. 794+00 LT Slope Stability.gsz	
10/07/2024	1:423

UA Slope (Results)

Elevation Origin =	735	ft
Force X-Coordinate =	175	ft
Force Y-Coordinate =	82.382	ft
Diameter =	4	ft
CTC Spacing =	5	ft
Load Transfer Factor =	5.2%	%
Force per Shaft =	1010989	lbf
Factor of Safety =	2.87	
Force per Foot of Wall =	213289	lbf (Point Load per foot of wall @ 100% Load Transfer Factor to be used in SlopeW)

$$Force\ per\ Foot\ of\ Wall(lb) = \frac{Force\ per\ Shaft\ (lb)}{CTC\ Spacing\ (ft) * (1 - Load\ Transfer\ Factor)}$$

Slope/W (Inputs)

Point Load X-Coordinate =	-175	ft (-1 = Failure from Right to Left, 1 = Failure from Left to Right)
Point Load Y-Coordinate =	652.618	ft
Point Load =	213289	lbf
Direction =	180	degrees (180 = Load applied right direction, 0 = Load applied left direction)

Slope/W (Results/Calculations)

Calculated Factor of Safety =	2.41	(Calculated Factor of Safety in Slope/W due to applied point load at 2/3 below existing ground surface at shaft location)
Resistance Force (FOS = 3.51) =	213289	lbf (Resistance Force to Achieve a Factor of Safety of 3.51)
Driving Force (FOS = 3.51) =	88502	lbf (Calculated Driving Force to Achieve a Factor of Safety of 3.51)

$$Factor\ of\ Safety = \frac{Resistance\ Force\ (lbf)}{Driving\ Force\ (lbf)}$$

Calculate Resistance Force to Achieve a Desired Factor of safety (Slope/W)

Factor of Safety =	1.3	
Driving Force =	88502	lbf (Calculated Driving Force from Slope/W)
Resistance Force (FOS = 1.30) =	115052	lbf (Resistance Force to Achieve a Factor of Safety of 1.30)
Back Calculated Resistance Force (From Slope/W) =	132,000	lbf (Resistance Force to Achieve a Factor of Safety of 1.30 in Slope/W)

$$Resistance\ Force\ (UA\ Slope) = \frac{Factory\ of\ Safety\ (Slope/W)}{Factory\ of\ Safety\ (UA\ Slope)}$$

Convert Calculated Resistance Force to Achieve a Desired Factor of safety from Slope/W to UA Slope

Resistance Force (UA Slope) =	110843	lbf (Converted Resistance Force per Foot of Wall @ 100% Load Transfer Factor to Achieve a Desired Factor of safety from Slope/W to UA Slope)

* Higher of Resistance Forces to Achieve a Factor of Safety of 1.30 Adopted

Convert Resistance Force per Foot of Wall @ 100% Load Transfer Factor to Force per Shaft (UA Slope)

Force per Shaft (FOS = 1.30) =	525397	lbf (Calculated Force per Shaft to achieve a Factor of Safety of 1.30 in UA Slope)

$$Force\ per\ Shaft = Resistance\ Force\ (lbf, UA\ Slope) * CTC\ Spacing\ (ft) * (1 - Load\ Transfer\ Factor)$$

The UA Slope 2.3 software was utilized to provide the per shaft loading along the proposed drilled shaft wall. However, the factor of safety provided by UA Slope (FS = 5.04) exceeded the required 1.3, indicating the resistance exceeded the applied load. As UA Slope does not allow for a reduction in loading or factor of safety, additional analyses were performed in SlopeW.

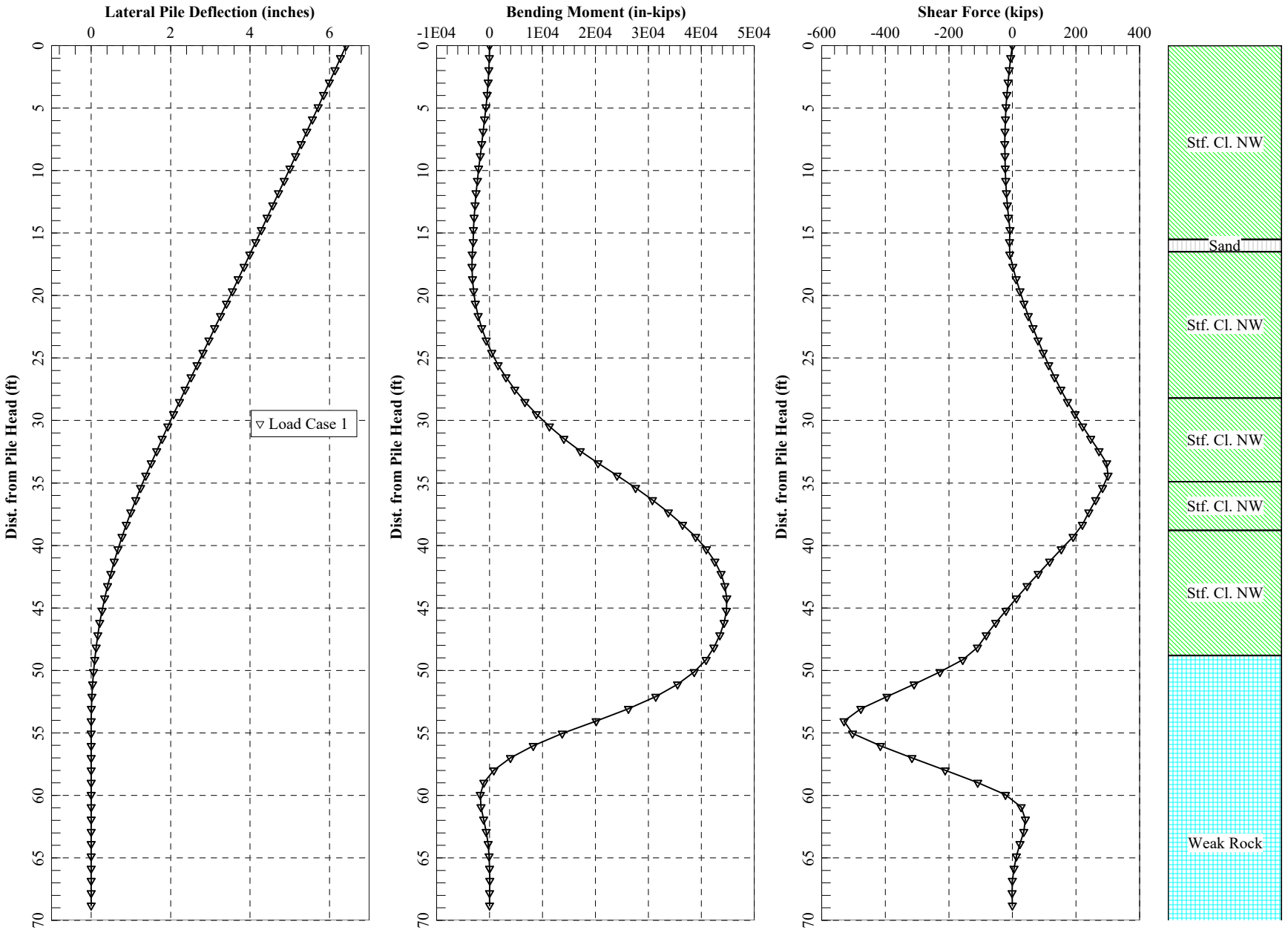
This was accomplished by assigning the proposed slope geometry SlopeW stability model with the proposed fill material used to determine the soil strength parameters and failure surface as the “Parent” analysis. A subsequent model created based on the proposed slope geometry with the drilled shaft wall located at 175 feet left. By assigning the Proposed Slope Geometry SlopeW stability model as the “Parent” analysis, the failure surface was directly translated to the 175-LT wall model, similar to applying the failure surface in UA Slope.

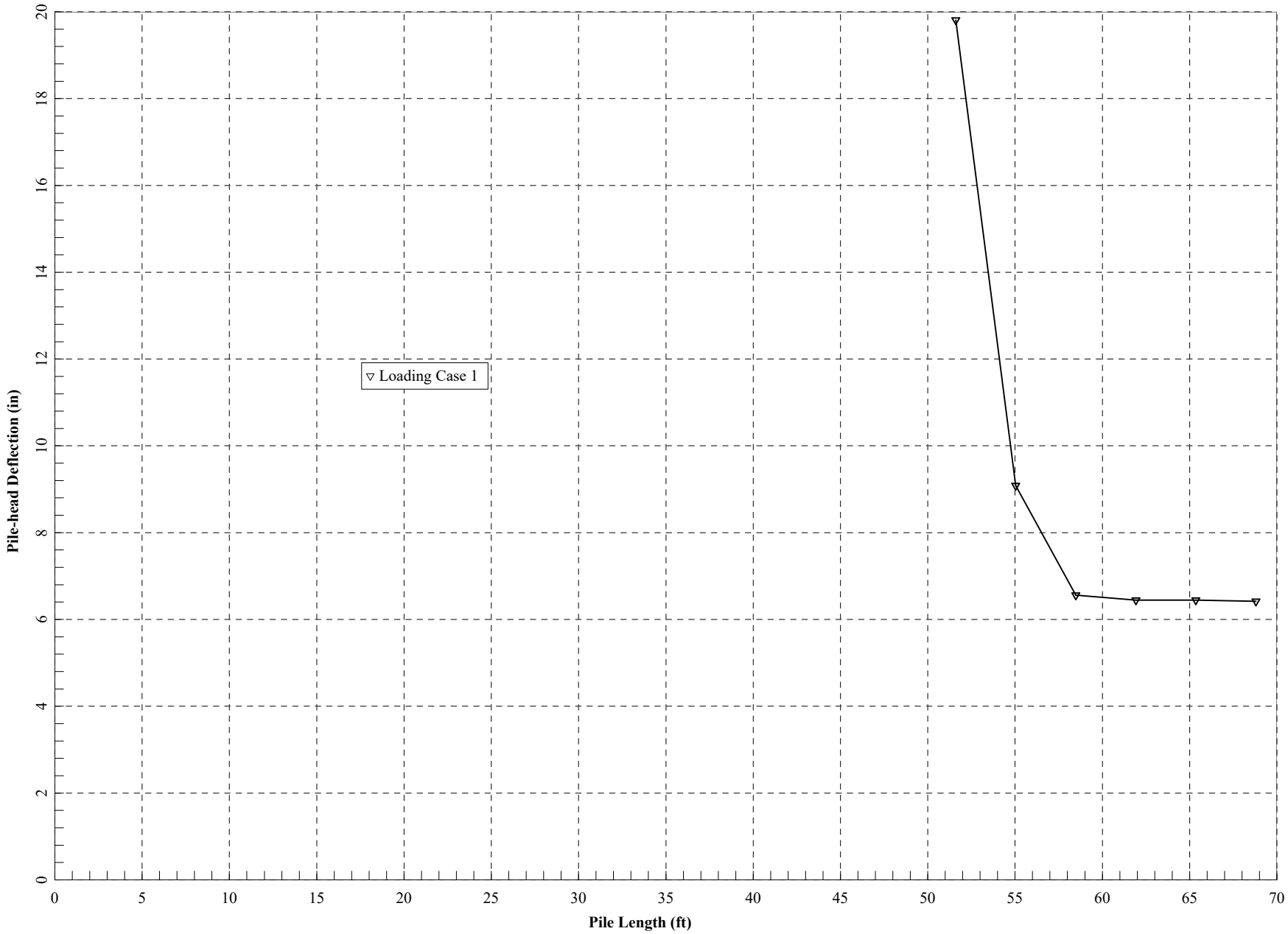
The 175-LT wall model analysis was then run using the UA Slope procedure as a template. A point load was added at a height approximately 1/3 of the distance from the proposed ground surface to the slip surface. The force-per-shaft load from UA Slope was reduced to a force per foot of wall to be applied to SlopeW. SlopeW indicated a FS of 3.51 (compared to 5.04 provided by UA Slope for the same load). The magnitude of the point load was then reduced until the factor of safety as generated by SlopeW was at or above 1.3. As this magnitude is a unit point load, the result was multiplied by the respective shaft spacing to determine the force per drilled shaft.

As UA Slope and SlopeW did not produce the same Factors of Safety, (5.04 and 3.51, respectively) for similar point loads, the calculated resistance load determined in SlopeW was proportionally scaled and converted to an equivalently UA Slope Load.

LPILE Service Load Design

4' Diameter, 5' CTC Spacing


Lateral Pile Deflection (inches)
0
2
4
6
Dist. from Pile Head (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Load Case 1
Bending Moment (in-kips)
-1E04
0
1E04
2E04
3E04
4E04
5E04
Dist. from Pile Head (ft)
Shear Force (kips)
-600
-400
-200
0
200
400
Dist. from Pile Head (ft)
Stf. Cl. NW
Sand
Stf. Cl. NW
Stf. Cl. NW
Stf. Cl. NW
Stf. Cl. NW
Weak Rock


Pile-head Deflection (in)
Pile Length (ft)
Loading Case 1
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

```
================================================================================

                     LPile for Windows, Version 2022-12.009

                  Analysis of Individual Piles and Drilled Shafts
                 Subjected to Lateral Loading Using the p-y Method
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--------------------------------------------------------------------------------
                             Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\ODOT-District 10 GES\Task 10-11 MEG-33-13.96\Working\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\5' Center-Center Spacing\

Name of input data file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12d

Name of output report file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12o

Name of plot output file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12p

Name of runtime message file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12r



--------------------------------------------------------------------------------
                             Date and Time of Analysis
--------------------------------------------------------------------------------
```

Date: October 7, 2024 Time: 18:35:03

Problem Title

Project Name: MEG-33-13.96

Job Number:

Client: ODOT D10

Engineer: HDR

Description: Drilled Shaft Retaining Wall Design (Low Rock)

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed	=	500
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in
- Number of pile increments	=	70

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Analysis uses p-y modification factors for p-y curves
- Analysis uses layering correction (Method of Georgiadis)
- Analysis includes loading by one distributed lateral load acting on pile
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 68.800 ft
Depth of ground surface below top of pile = -6.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	48.0000
2	68.800	48.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is an elastic pile
Cross-sectional Shape = Circular Pile
Length of section = 68.800000 ft
Width of top of section = 48.000000 in
Width of bottom of section = 48.000000 in
Top Area = 116.000000 sq. in
Bottom Area = 116.000000 sq. in
Moment of Inertia at Top = 28500. in^4
Moment of Inertia at Bottom = 28500. in^4
Elastic Modulus = 29000000. psi

Soil and Rock Layering Information

The soil profile is modelled using 7 layers

Layer 1 is stiff clay without free water

Distance from top of pile to top of layer	=	-6.00000 ft
Distance from top of pile to bottom of layer	=	15.500000 ft
Effective unit weight at top of layer	=	125.000000 pcf
Effective unit weight at bottom of layer	=	125.000000 pcf
Undrained cohesion at top of layer	=	2500. psf
Undrained cohesion at bottom of layer	=	2500. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000

Top of Drilled Shaft Elevation to be 6 feet below proposed surface elevation

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	15.500000 ft
Distance from top of pile to bottom of layer	=	16.500000 ft
Effective unit weight at top of layer	=	135.000000 pcf
Effective unit weight at bottom of layer	=	135.000000 pcf
Friction angle at top of layer	=	38.000000 deg.
Friction angle at bottom of layer	=	38.000000 deg.
Subgrade k at top of layer	=	225.000000 pci
Subgrade k at bottom of layer	=	225.000000 pci

Layer 3 is stiff clay without free water

Distance from top of pile to top of layer	=	16.500000 ft
Distance from top of pile to bottom of layer	=	28.200000 ft
Effective unit weight at top of layer	=	57.600000 pcf
Effective unit weight at bottom of layer	=	57.600000 pcf
Undrained cohesion at top of layer	=	1400. psf
Undrained cohesion at bottom of layer	=	1400. psf
Epsilon-50 at top of layer	=	0.007000
Epsilon-50 at bottom of layer	=	0.007000

Layer 4 is stiff clay without free water

Distance from top of pile to top of layer	=	28.200000 ft
Distance from top of pile to bottom of layer	=	34.900000 ft
Effective unit weight at top of layer	=	57.600000 pcf
Effective unit weight at bottom of layer	=	57.600000 pcf
Undrained cohesion at top of layer	=	930.000000 psf
Undrained cohesion at bottom of layer	=	930.000000 psf
Epsilon-50 at top of layer	=	0.010000
Epsilon-50 at bottom of layer	=	0.010000

Layer 5 is stiff clay without free water

Distance from top of pile to top of layer	=	34.900000 ft
Distance from top of pile to bottom of layer	=	38.800000 ft
Effective unit weight at top of layer	=	62.600000 pcf
Effective unit weight at bottom of layer	=	62.600000 pcf
Undrained cohesion at top of layer	=	1650. psf
Undrained cohesion at bottom of layer	=	1650. psf
Epsilon-50 at top of layer	=	0.007000
Epsilon-50 at bottom of layer	=	0.007000

Layer 6 is stiff clay without free water

Distance from top of pile to top of layer	=	38.800000 ft
Distance from top of pile to bottom of layer	=	48.800000 ft
Effective unit weight at top of layer	=	72.600000 pcf
Effective unit weight at bottom of layer	=	72.600000 pcf
Undrained cohesion at top of layer	=	3300. psf
Undrained cohesion at bottom of layer	=	3300. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000

Layer 7 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	48.800000 ft
Distance from top of pile to bottom of layer	=	78.800000 ft
Effective unit weight at top of layer	=	150.000000 pcf
Effective unit weight at bottom of layer	=	150.000000 pcf
Uniaxial compressive strength at top of layer	=	150.000000 psi
Uniaxial compressive strength at bottom of layer	=	150.000000 psi
Initial modulus of rock at top of layer	=	14600. psi
Initial modulus of rock at bottom of layer	=	14600. psi
RQD of rock at top of layer	=	0.0000 %
RQD of rock at bottom of layer	=	0.0000 %
k rm of rock at top of layer	=	0.0005000
k rm of rock at bottom of layer	=	0.0005000

(Depth of the lowest soil layer extends 10.000 ft below the pile tip)

**** Warning - Possible Input Data Error ****

Values entered for effective unit weight of rock were outside the limits of
50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 150.00 pcf

This data may be erroneous. Please check your data.

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	RQD %	E50 or krm	kpy pci	Rock Mass Modulus psi
1	Stiff Clay	-6.000	125.0000	2500.	--	--	--	0.00500	--	--
	w/o Free Water	15.5000	125.0000	2500.	--	--	--	0.00500	--	--
2	Sand	15.5000	135.0000	--	38.0000	--	--	--	225.0000	--
	(Reese, et al.)	16.5000	135.0000	--	38.0000	--	--	--	225.0000	--
3	Stiff Clay	16.5000	57.6000	1400.	--	--	--	0.00700	--	--
	w/o Free Water	28.2000	57.6000	1400.	--	--	--	0.00700	--	--
4	Stiff Clay	28.2000	57.6000	930.0000	--	--	--	0.01000	--	--
	w/o Free Water	34.9000	57.6000	930.0000	--	--	--	0.01000	--	--
5	Stiff Clay	34.9000	62.6000	1650.	--	--	--	0.00700	--	--
	w/o Free Water	38.8000	62.6000	1650.	--	--	--	0.00700	--	--
6	Stiff Clay	38.8000	72.6000	3300.	--	--	--	0.00500	--	--
	w/o Free Water	48.8000	72.6000	3300.	--	--	--	0.00500	--	--
7	Weak	48.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.
	Rock	78.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.

Modification Factors for p-y Curves

Distribution of p-y modifiers with depth defined using 4 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.1600	1.0000
2	33.700	0.1600	1.0000
3	33.700	0.6900	1.0000
4	48.800	0.6900	1.0000

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading Used For All Load Cases

Distributed lateral load intensity defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	0.000
2	33.700	2598.000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	-6.000	0.00	N.A.	No	0.00	1049469.
2	15.5000	15.9268	No	No	1049469.	142591.
3	16.5000	32.9715	No	No	1192060.	589350.
4	28.2000	61.7214	Yes	No	1781410.	224794.
5	34.9000	44.7317	Yes	No	2006204.	231878.
6	38.8000	31.3961	Yes	No	2238082.	1135259.
7	48.8000	54.8000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	6.4193	-5.28E-06	0.00	-0.01198	4.44E-09	8.26E+11	-488.313	448.5936	18.9426
0.9829	6.2780	-32646.	-5306.	-0.01198	27.4913	8.26E+11	-506.228	951.0269	75.7704
1.9657	6.1368	-125171.	-10041.	-0.01198	105.4069	8.26E+11	-523.862	1007.	151.5408
2.9486	5.9955	-269487.	-14087.	-0.01198	226.9366	8.26E+11	-541.208	1065.	227.3112
3.9314	5.8542	-457468.	-17443.	-0.01198	385.2366	8.26E+11	-558.257	1125.	303.0816
4.9143	5.7128	-680946.	-20105.	-0.01199	573.4281	8.26E+11	-574.998	1187.	378.8521
5.8971	5.5713	-931708.	-22068.	-0.01200	784.5964	8.26E+11	-591.420	1252.	454.6225

6.8800	5.4297	-1201500.	-23330.	-0.01202	1012.	8.26E+11	-607.512	1320.	530.3929
7.8629	5.2878	-1482019.	-23885.	-0.01204	1248.	8.26E+11	-623.262	1390.	606.1633
8.8457	5.1457	-1764917.	-23731.	-0.01206	1486.	8.26E+11	-638.654	1464.	681.9337
9.8286	5.0033	-2041794.	-22862.	-0.01209	1719.	8.26E+11	-653.675	1541.	757.7041
10.8114	4.8606	-2304201.	-21275.	-0.01212	1940.	8.26E+11	-668.307	1622.	833.4745
11.7943	4.7174	-2543631.	-18964.	-0.01215	2142.	8.26E+11	-682.532	1706.	909.2449
12.7771	4.5739	-2751525.	-15924.	-0.01219	2317.	8.26E+11	-696.332	1796.	985.0153
13.7600	4.4298	-2919261.	-12151.	-0.01223	2458.	8.26E+11	-709.686	1890.	1061.
14.7429	4.2853	-3038158.	-7640.	-0.01228	2558.	8.26E+11	-722.571	1989.	1137.
15.7257	4.1403	-3099467.	-9248.	-0.01232	2610.	8.26E+11	-1899.	5410.	1212.
16.7086	3.9947	-3256296.	-8627.	-0.01236	2742.	8.26E+11	-496.183	1465.	1288.
17.6914	3.8486	-3302965.	1187.	-0.01241	2781.	8.26E+11	-491.582	1506.	1364.
18.6743	3.7020	-3228296.	11950.	-0.01246	2719.	8.26E+11	-486.831	1551.	1440.
19.6571	3.5548	-3021085.	23663.	-0.01250	2544.	8.26E+11	-481.917	1599.	1515.
20.6400	3.4071	-2670111.	36329.	-0.01254	2249.	8.26E+11	-476.831	1651.	1591.
21.6229	3.2589	-2164125.	49950.	-0.01258	1822.	8.26E+11	-471.561	1707.	1667.
22.6057	3.1104	-1491855.	64528.	-0.01260	1256.	8.26E+11	-466.094	1767.	1743.
23.5886	2.9616	-641999.	80065.	-0.01262	540.6312	8.26E+11	-460.417	1834.	1818.
24.5714	2.8127	396771.	96564.	-0.01262	334.1230	8.26E+11	-454.518	1906.	1894.
25.5543	2.6639	1635817.	114028.	-0.01261	1378.	8.26E+11	-448.383	1985.	1970.
26.5371	2.5154	3086532.	132459.	-0.01257	2599.	8.26E+11	-441.998	2072.	2046.
27.5200	2.3673	4760345.	151861.	-0.01252	4009.	8.26E+11	-435.347	2169.	2122.
28.5029	2.2201	6668720.	173228.	-0.01243	5616.	8.26E+11	-260.312	1383.	2197.
29.4857	2.0740	8846546.	196547.	-0.01232	7450.	8.26E+11	-255.919	1455.	2273.
30.4686	1.9294	1.13E+07	220812.	-0.01218	9520.	8.26E+11	-251.337	1536.	2349.
31.4514	1.7867	1.41E+07	246026.	-0.01200	11836.	8.26E+11	-246.555	1628.	2425.
32.4343	1.6464	1.71E+07	272191.	-0.01178	14407.	8.26E+11	-241.564	1731.	2500.
33.4171	1.5089	2.05E+07	296049.	-0.01151	17243.	8.26E+11	-236.356	1847.	2023.
34.4000	1.3749	2.41E+07	300714.	-0.01119	20288.	8.26E+11	-995.856	8543.	0.00
35.3829	1.2449	2.76E+07	283729.	-0.01082	23216.	8.26E+11	-1884.	17851.	0.00
36.3657	1.1196	3.08E+07	261796.	-0.01041	25924.	8.26E+11	-1835.	19330.	0.00
37.3486	0.9995	3.37E+07	240457.	-0.00995	28416.	8.26E+11	-1784.	21047.	0.00
38.3314	0.8850	3.65E+07	219736.	-0.00944	30700.	8.26E+11	-1730.	23057.	0.00
39.3143	0.7767	3.89E+07	190728.	-0.00891	32781.	8.26E+11	-3189.	48421.	0.00
40.2971	0.6749	4.10E+07	153431.	-0.00834	34489.	8.26E+11	-3136.	54798.	0.00
41.2800	0.5801	4.25E+07	116810.	-0.00774	35829.	8.26E+11	-3074.	62509.	0.00
42.2629	0.4923	4.37E+07	80968.	-0.00713	36809.	8.26E+11	-3004.	71951.	0.00
43.2457	0.4120	4.45E+07	46018.	-0.00650	37437.	8.26E+11	-2923.	83683.	0.00
44.2286	0.3391	4.48E+07	12078.	-0.00586	37723.	8.26E+11	-2832.	98507.	0.00
45.2114	0.2738	4.47E+07	-20724.	-0.00522	37677.	8.26E+11	-2730.	117620.	0.00
46.1943	0.2160	4.43E+07	-52250.	-0.00459	37312.	8.26E+11	-2616.	142860.	0.00
47.1771	0.1656	4.35E+07	-82275.	-0.00396	36639.	8.26E+11	-2476.	176311.	0.00
48.1600	0.1226	4.24E+07	-110416.	-0.00335	35677.	8.26E+11	-2296.	220940.	0.00
49.1429	0.08668	4.09E+07	-156736.	-0.00275	34446.	8.26E+11	-5558.	756290.	0.00
50.1257	0.05767	3.87E+07	-228212.	-0.00218	32564.	8.26E+11	-6562.	1341976.	0.00
51.1086	0.03517	3.55E+07	-309139.	-0.00165	29913.	8.26E+11	-7161.	2401693.	0.00
52.0914	0.01864	3.14E+07	-394260.	-0.00118	26423.	8.26E+11	-7273.	4601489.	0.00
53.0743	0.00740	2.62E+07	-476634.	-7.66E-04	22081.	8.26E+11	-6695.	1.07E+07	0.00
54.0571	5.66E-04	2.01E+07	-529540.	-4.36E-04	16955.	8.26E+11	-2276.	4.74E+07	0.00
55.0400	-0.00288	1.37E+07	-503193.	-1.94E-04	11563.	8.26E+11	6744.	2.77E+07	0.00
56.0229	-0.00401	8264766.	-415545.	-3.70E-05	6960.	8.26E+11	8119.	2.39E+07	0.00

57.0057	-0.00375	3928393.	-315993.	5.00E-05	3308.	8.26E+11	8763.	2.76E+07	0.00
57.9886	-0.00283	810933.	-211884.	8.39E-05	682.8908	8.26E+11	8892.	3.71E+07	0.00
58.9714	-0.00177	-1069647.	-109001.	8.20E-05	900.7551	8.26E+11	8555.	5.70E+07	0.00
59.9543	-8.93E-04	-1760246.	-22297.	6.18E-05	1482.	8.26E+11	6148.	8.12E+07	0.00
60.9371	-3.12E-04	-1595591.	27374.	3.79E-05	1344.	8.26E+11	2275.	8.61E+07	0.00
61.9200	8.10E-07	-1114523.	40753.	1.85E-05	938.5453	8.26E+11	-5.913	8.61E+07	0.00
62.9029	1.26E-04	-634276.	35310.	6.06E-06	534.1273	8.26E+11	-917.127	8.61E+07	0.00
63.8857	1.44E-04	-281607.	23715.	-4.77E-07	237.1427	8.26E+11	-1049.	8.61E+07	0.00
64.8686	1.14E-04	-74865.	12605.	-3.02E-06	63.0446	8.26E+11	-834.974	8.61E+07	0.00
65.8514	7.25E-05	15727.	4562.	-3.44E-06	13.2437	8.26E+11	-528.918	8.61E+07	0.00
66.8343	3.32E-05	32744.	14.6193	-3.10E-06	27.5738	8.26E+11	-242.186	8.61E+07	0.00
67.8171	-5.91E-07	16072.	-1388.	-2.75E-06	13.5341	8.26E+11	4.3168	8.61E+07	0.00
68.8000	-3.17E-05	0.00	0.00	-2.63E-06	0.00	8.26E+11	231.0729	4.30E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

Pile-head deflection = 6.41928568 inches
Computed slope at pile head = -0.0119751 radians
Maximum bending moment = 44796435. inch-lbs
Maximum shear force = -529540. lbs
Depth of maximum bending moment = 44.22857143 feet below pile head
Depth of maximum shear force = 54.05714286 feet below pile head
Number of iterations = 33
Number of zero deflection points = 3

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs
Moment = 0. in-lbs
Axial Load = 0. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
68.80000	6.41928568	44796435.	-529540.
65.36000	6.44350257	44783914.	-531609.
61.92000	6.44577515	44772656.	-526751.
58.48000	6.55792114	44396228.	-556699.
55.04000	9.08758832	36127385.	-512229.
51.60000	19.81196213	25888780.	-344933.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

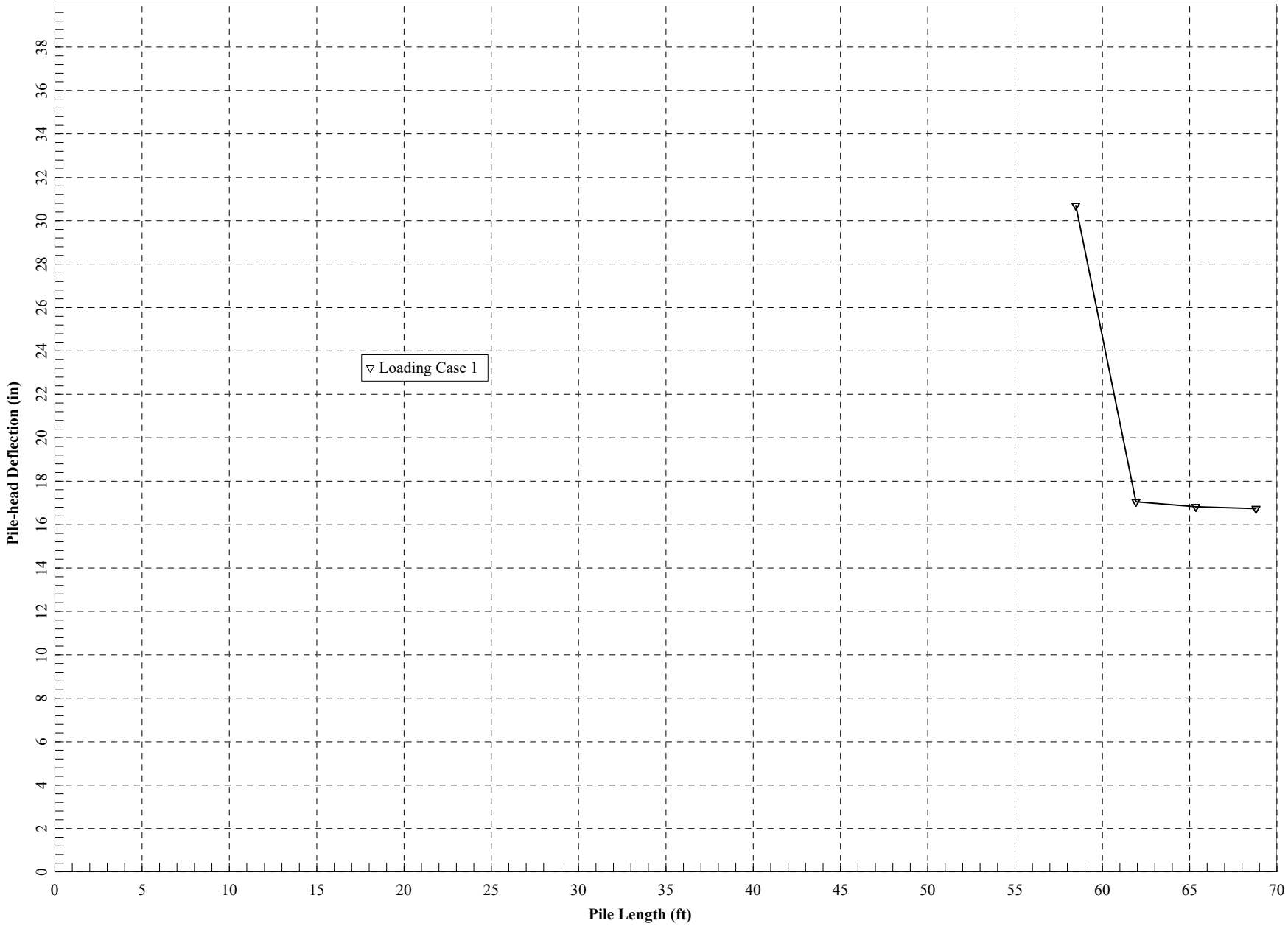
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	0.00	6.4193	-0.01198	-529540.	4.48E+07

Maximum pile-head deflection = 6.4192856790 inches
Maximum pile-head rotation = -0.0119750608 radians = -0.686120 deg.

The analysis ended normally.

LPILE Strength Load Design


Pile-head Deflection (in)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
Loading Case 1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Pile Length (ft)

```
================================================================================

                    LPile for Windows, Version 2022-12.009

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method
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--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
\ODOT-District 10 GES\Task 10-11 MEG-33-13.96\Working\MEG-33-13.96_Sta. 794+00 LT\Low Rock\Option 2\10' Rock Fill\5' Center-Center Spacing\

Name of input data file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12d

Name of output report file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12o

Name of plot output file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12p

Name of runtime message file:
Option 2_10' Rockfill_5' CTC_UA Slope_Drilled Shaft (Low Rock).lp12r



--------------------------------------------------------------------------------
                            Date and Time of Analysis
--------------------------------------------------------------------------------

               Date:  October 7, 2024             Time:  18:31:15
```

Problem Title

Project Name: MEG-33-13.96

Job Number:

Client: ODOT D10

Engineer: HDR

Description: Drilled Shaft Retaining Wall Design (Low Rock)

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 70

Loading Type and Number of Cycles of Loading:
 - Static loading specified

 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - Analysis includes loading by one distributed lateral load acting on pile
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

```
--------------------------------------------------------------------------------
                    Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Number of pile sections defined                        =            1
Total length of pile                                   =       68.800 ft
Depth of ground surface below top of pile              =      -6.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

            Depth Below          Pile
Point        Pile Head         Diameter
 No.            feet            inches
-----      ------------     ------------
  1             0.000          48.0000
  2            68.800          48.0000


Input Structural Properties for Pile Sections:
----------------------------------------------

Pile Section No. 1:

   Section 1 is an elastic pile
   Cross-sectional Shape                               =   Circular Pile
   Length of section                                   =    68.800000 ft
   Width of top of section                             =    48.000000 in
   Width of bottom of section                          =    48.000000 in
   Top Area                                            =   116.000000 sq. in
   Bottom Area                                         =   116.000000 sq. in
   Moment of Inertia at Top                            =       28500. in^4
   Moment of Inertia at Bottom                         =       28500. in^4
   Elastic Modulus                                     =    29000000. psi



--------------------------------------------------------------------------------
                      Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 7 layers

Layer 1 is stiff clay without free water

   Distance from top of pile to top of layer           =     -6.00000 ft
   Distance from top of pile to bottom of layer        =    15.500000 ft
   Effective unit weight at top of layer               =   125.000000 pcf
```

Top of Drilled Shaft Elevation to be 6 feet below proposed surface elevation

```
   Effective unit weight at bottom of layer           =   125.000000 pcf
   Undrained cohesion at top of layer                 =        2500. psf
   Undrained cohesion at bottom of layer              =        2500. psf
   Epsilon-50 at top of layer                         =     0.005000
   Epsilon-50 at bottom of layer                      =     0.005000


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer          =    15.500000 ft
   Distance from top of pile to bottom of layer       =    16.500000 ft
   Effective unit weight at top of layer              =   135.000000 pcf
   Effective unit weight at bottom of layer           =   135.000000 pcf
   Friction angle at top of layer                     =    38.000000 deg.
   Friction angle at bottom of layer                  =    38.000000 deg.
   Subgrade k at top of layer                         =   225.000000 pci
   Subgrade k at bottom of layer                      =   225.000000 pci


Layer 3 is stiff clay without free water

   Distance from top of pile to top of layer          =    16.500000 ft
   Distance from top of pile to bottom of layer       =    28.200000 ft
   Effective unit weight at top of layer              =    57.600000 pcf
   Effective unit weight at bottom of layer           =    57.600000 pcf
   Undrained cohesion at top of layer                 =        1400. psf
   Undrained cohesion at bottom of layer              =        1400. psf
   Epsilon-50 at top of layer                         =     0.007000
   Epsilon-50 at bottom of layer                      =     0.007000


Layer 4 is stiff clay without free water

   Distance from top of pile to top of layer          =    28.200000 ft
   Distance from top of pile to bottom of layer       =    34.900000 ft
   Effective unit weight at top of layer              =    57.600000 pcf
   Effective unit weight at bottom of layer           =    57.600000 pcf
   Undrained cohesion at top of layer                 =   930.000000 psf
   Undrained cohesion at bottom of layer              =   930.000000 psf
   Epsilon-50 at top of layer                         =     0.010000
   Epsilon-50 at bottom of layer                      =     0.010000


Layer 5 is stiff clay without free water

   Distance from top of pile to top of layer          =    34.900000 ft
   Distance from top of pile to bottom of layer       =    38.800000 ft
   Effective unit weight at top of layer              =    62.600000 pcf
   Effective unit weight at bottom of layer           =    62.600000 pcf
   Undrained cohesion at top of layer                 =        1650. psf
   Undrained cohesion at bottom of layer              =        1650. psf
   Epsilon-50 at top of layer                         =     0.007000
   Epsilon-50 at bottom of layer                      =     0.007000
```

Layer 6 is stiff clay without free water

Distance from top of pile to top of layer	=	38.800000 ft
Distance from top of pile to bottom of layer	=	48.800000 ft
Effective unit weight at top of layer	=	72.600000 pcf
Effective unit weight at bottom of layer	=	72.600000 pcf
Undrained cohesion at top of layer	=	3300. psf
Undrained cohesion at bottom of layer	=	3300. psf
Epsilon-50 at top of layer	=	0.005000
Epsilon-50 at bottom of layer	=	0.005000

Layer 7 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	48.800000 ft
Distance from top of pile to bottom of layer	=	78.800000 ft
Effective unit weight at top of layer	=	150.000000 pcf
Effective unit weight at bottom of layer	=	150.000000 pcf
Uniaxial compressive strength at top of layer	=	150.000000 psi
Uniaxial compressive strength at bottom of layer	=	150.000000 psi
Initial modulus of rock at top of layer	=	14600. psi
Initial modulus of rock at bottom of layer	=	14600. psi
RQD of rock at top of layer	=	0.0000 %
RQD of rock at bottom of layer	=	0.0000 %
k rm of rock at top of layer	=	0.0005000
k rm of rock at bottom of layer	=	0.0005000

(Depth of the lowest soil layer extends 10.000 ft below the pile tip)

**** Warning - Possible Input Data Error ****

Values entered for effective unit weight of rock were outside the limits of
50 pcf to 150 pcf.

The maximum input value, in layer 1, for effective unit weight = 150.00 pcf

This data may be erroneous. Please check your data.

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	RQD %	E50 or krm	kpy pci	Rock Mass Modulus psi
-----	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

1	Stiff Clay	-6.000	125.0000	2500.	--	--	--	0.00500	--	--
	w/o Free Water	15.5000	125.0000	2500.	--	--	--	0.00500	--	--
2	Sand	15.5000	135.0000	--	38.0000	--	--	--	225.0000	--
	(Reese, et al.)	16.5000	135.0000	--	38.0000	--	--	--	225.0000	--
3	Stiff Clay	16.5000	57.6000	1400.	--	--	--	0.00700	--	--
	w/o Free Water	28.2000	57.6000	1400.	--	--	--	0.00700	--	--
4	Stiff Clay	28.2000	57.6000	930.0000	--	--	--	0.01000	--	--
	w/o Free Water	34.9000	57.6000	930.0000	--	--	--	0.01000	--	--
5	Stiff Clay	34.9000	62.6000	1650.	--	--	--	0.00700	--	--
	w/o Free Water	38.8000	62.6000	1650.	--	--	--	0.00700	--	--
6	Stiff Clay	38.8000	72.6000	3300.	--	--	--	0.00500	--	--
	w/o Free Water	48.8000	72.6000	3300.	--	--	--	0.00500	--	--
7	Weak	48.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.
	Rock	78.8000	150.0000	--	--	150.0000	0.00	5.00E-04	--	14600.

Modification Factors for p-y Curves

Distribution of p-y modifiers with depth defined using 4 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.1600	1.0000
2	33.700	0.1600	1.0000
3	33.700	0.6900	1.0000
4	48.800	0.6900	1.0000

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Distributed Lateral Loading Used For All Load Cases

Distributed lateral load intensity defined using 2 points

Point No.	Depth X ft	Dist. Load lb/in
1	0.000	0.000
2	33.700	3898.000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	0.0000000	Yes	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Moment-curvature properties were derived from elastic section properties

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Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	-6.000	0.00	N.A.	No	0.00	1049469.
2	15.5000	15.9268	No	No	1049469.	142591.
3	16.5000	32.9715	No	No	1192060.	589350.
4	28.2000	61.7214	Yes	No	1781410.	224794.
5	34.9000	44.7317	Yes	No	2006204.	231878.
6	38.8000	31.3961	Yes	No	2238082.	1135259.
7	48.8000	54.8000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*H lb/inch	Distrib. Lat. Load lb/inch
0.00	16.7397	1.69E-04	0.00	-0.03165	1.42E-07	8.26E+11	-540.000	190.2344	28.4212
0.9829	16.3663	-35582.	-5666.	-0.03165	29.9635	8.26E+11	-562.934	405.6740	113.6848
1.9657	15.9930	-133656.	-10430.	-0.03165	112.5525	8.26E+11	-585.867	432.0560	227.3696
2.9486	15.6197	-281599.	-14123.	-0.03166	237.1364	8.26E+11	-608.800	459.6998	341.0543
3.9314	15.2463	-466788.	-16745.	-0.03166	393.0844	8.26E+11	-631.734	488.6989	454.7391
4.9143	14.8728	-676597.	-18298.	-0.03167	569.7657	8.26E+11	-654.667	519.1568	568.4239
5.8971	14.4992	-898403.	-18780.	-0.03168	756.5496	8.26E+11	-677.600	551.1881	682.1087
6.8800	14.1255	-1119581.	-18191.	-0.03170	942.8055	8.26E+11	-700.534	584.9199	795.7935
7.8629	13.7516	-1327509.	-16533.	-0.03171	1118.	8.26E+11	-723.467	620.4937	909.4783
8.8457	13.3775	-1509562.	-13804.	-0.03173	1271.	8.26E+11	-746.400	658.0671	1023.
9.8286	13.0031	-1653115.	-10004.	-0.03176	1392.	8.26E+11	-769.334	697.8164	1137.
10.8114	12.6284	-1745546.	-5134.	-0.03178	1470.	8.26E+11	-792.267	739.9388	1251.
11.7943	12.2534	-1774229.	805.6683	-0.03181	1494.	8.26E+11	-815.200	784.6560	1364.

12.7771	11.8781	-1726541.	7816.	-0.03183	1454.	8.26E+11	-838.134	832.2172	1478.
13.7600	11.5026	-1589858.	15897.	-0.03185	1339.	8.26E+11	-861.067	882.9041	1592.
14.7429	11.1268	-1351556.	25048.	-0.03187	1138.	8.26E+11	-884.001	937.0351	1705.
15.7257	10.7507	-999011.	29419.	-0.03189	841.2725	8.26E+11	-1899.	2083.	1819.
16.7086	10.3745	-657600.	36630.	-0.03190	553.7685	8.26E+11	-629.885	716.0886	1933.
17.6914	9.9981	-134969.	52699.	-0.03191	113.6582	8.26E+11	-624.093	736.2103	2046.
18.6743	9.6218	585502.	70179.	-0.03191	493.0543	8.26E+11	-618.135	757.7041	2160.
19.6571	9.2455	1520456.	89071.	-0.03189	1280.	8.26E+11	-612.002	780.7151	2274.
20.6400	8.8695	2686560.	109377.	-0.03186	2262.	8.26E+11	-605.682	805.4082	2387.
21.6229	8.4940	4100507.	131100.	-0.03181	3453.	8.26E+11	-599.166	831.9708	2501.
22.6057	8.1191	5779019.	154241.	-0.03174	4867.	8.26E+11	-592.443	860.6167	2615.
23.5886	7.7452	7738844.	178805.	-0.03165	6517.	8.26E+11	-585.502	891.5909	2728.
24.5714	7.3726	9996762.	204792.	-0.03152	8418.	8.26E+11	-578.330	925.1749	2842.
25.5543	7.0017	1.26E+07	232206.	-0.03136	10585.	8.26E+11	-570.915	961.6935	2956.
26.5371	6.6330	1.55E+07	261049.	-0.03116	13031.	8.26E+11	-563.244	1002.	3069.
27.5200	6.2668	1.87E+07	291326.	-0.03091	15770.	8.26E+11	-555.304	1045.	3183.
28.5029	5.9037	2.23E+07	324305.	-0.03062	18818.	8.26E+11	-332.415	664.0871	3297.
29.4857	5.5445	2.64E+07	359969.	-0.03027	22212.	8.26E+11	-327.238	696.1059	3411.
30.4686	5.1896	3.08E+07	397036.	-0.02986	25968.	8.26E+11	-321.872	731.5051	3524.
31.4514	4.8400	3.57E+07	435509.	-0.02939	30099.	8.26E+11	-316.308	770.7902	3638.
32.4343	4.4964	4.11E+07	475390.	-0.02884	34619.	8.26E+11	-310.538	814.5602	3752.
33.4171	4.1597	4.70E+07	511787.	-0.02821	39542.	8.26E+11	-304.554	863.5268	3036.
34.4000	3.8309	5.32E+07	520304.	-0.02750	44785.	8.26E+11	-1287.	3961.	0.00
35.3829	3.5110	5.92E+07	498317.	-0.02670	49878.	8.26E+11	-2442.	8203.	0.00
36.3657	3.2011	6.49E+07	469847.	-0.02581	54684.	8.26E+11	-2386.	8791.	0.00
37.3486	2.9022	7.03E+07	442045.	-0.02485	59211.	8.26E+11	-2328.	9462.	0.00
38.3314	2.6151	7.54E+07	414938.	-0.02381	63465.	8.26E+11	-2268.	10231.	0.00
39.3143	2.3406	8.01E+07	376785.	-0.02270	67453.	8.26E+11	-4201.	21170.	0.00
40.2971	2.0797	8.43E+07	327508.	-0.02152	70949.	8.26E+11	-4155.	23562.	0.00
41.2800	1.8329	8.78E+07	278836.	-0.02030	73959.	8.26E+11	-4099.	26375.	0.00
42.2629	1.6009	9.08E+07	230880.	-0.01902	76488.	8.26E+11	-4033.	29714.	0.00
43.2457	1.3842	9.33E+07	183757.	-0.01771	78545.	8.26E+11	-3958.	33720.	0.00
44.2286	1.1832	9.52E+07	137592.	-0.01636	80138.	8.26E+11	-3871.	38585.	0.00
45.2114	0.9982	9.65E+07	92517.	-0.01500	81278.	8.26E+11	-3773.	44575.	0.00
46.1943	0.8295	9.73E+07	48673.	-0.01361	81976.	8.26E+11	-3662.	52069.	0.00
47.1771	0.6771	9.77E+07	6318.	-0.01222	82245.	8.26E+11	-3520.	61318.	0.00
48.1600	0.5412	9.75E+07	-34071.	-0.01083	82102.	8.26E+11	-3329.	72538.	0.00
49.1429	0.4217	9.69E+07	-101255.	-0.00944	81568.	8.26E+11	-8064.	225542.	0.00
50.1257	0.3185	9.51E+07	-208130.	-0.00807	80090.	8.26E+11	-10059.	372519.	0.00
51.1086	0.2313	9.20E+07	-335079.	-0.00674	77434.	8.26E+11	-11468.	584814.	0.00
52.0914	0.1596	8.72E+07	-476067.	-0.00546	73434.	8.26E+11	-12440.	919574.	0.00
53.0743	0.1025	8.07E+07	-625605.	-0.00426	67977.	8.26E+11	-12918.	1486333.	0.00
54.0571	0.05904	7.24E+07	-777291.	-0.00317	61007.	8.26E+11	-12804.	2557934.	0.00
55.0400	0.02777	6.24E+07	-922906.	-0.00221	52537.	8.26E+11	-11888.	5049416.	0.00
56.0229	0.00700	5.07E+07	-1048054.	-0.00140	42674.	8.26E+11	-9334.	1.57E+07	0.00
57.0057	-0.00524	3.77E+07	-1046899.	-7.69E-04	31718.	8.26E+11	9529.	2.14E+07	0.00
57.9886	-0.01115	2.60E+07	-916818.	-3.15E-04	21879.	8.26E+11	12529.	1.33E+07	0.00
58.9714	-0.01268	1.60E+07	-760407.	-1.52E-05	13507.	8.26E+11	13994.	1.30E+07	0.00
59.9543	-0.01151	8044107.	-591253.	1.57E-04	6774.	8.26E+11	14690.	1.51E+07	0.00
60.9371	-0.00898	2092412.	-418283.	2.29E-04	1762.	8.26E+11	14641.	1.92E+07	0.00
61.9200	-0.00611	-1822598.	-253542.	2.31E-04	1535.	8.26E+11	13294.	2.57E+07	0.00
62.9029	-0.00354	-3888285.	-106751.	1.90E-04	3274.	8.26E+11	11598.	3.87E+07	0.00
63.8857	-0.00162	-4340697.	17916.	1.31E-04	3655.	8.26E+11	9543.	6.94E+07	0.00
64.8686	-4.36E-04	-3465665.	92977.	7.57E-05	2918.	8.26E+11	3186.	8.61E+07	0.00

65.8514	1.65E-04	-2147512.	104670.	3.56E-05	1808.	8.26E+11	-1203.	8.61E+07	0.00
66.8343	4.04E-04	-996652.	80168.	1.32E-05	839.2856	8.26E+11	-2952.	8.61E+07	0.00
67.8171	4.76E-04	-256466.	42251.	4.27E-06	215.9714	8.26E+11	-3477.	8.61E+07	0.00
68.8000	5.05E-04	0.00	0.00	2.44E-06	0.00	8.26E+11	-3687.	4.30E+07	0.00

* The above values of total stress are combined axial and bending stresses.

Output Summary for Load Case No. 1:

Pile-head deflection = 16.73965737 inches
Computed slope at pile head = -0.0316520 radians
Maximum bending moment = 97665869. inch-lbs
Maximum shear force = -1048054. lbs
Depth of maximum bending moment = 47.17714286 feet below pile head
Depth of maximum shear force = 56.02285714 feet below pile head
Number of iterations = 42
Number of zero deflection points = 2

Pile-head Deflection vs. Pile Length for Load Case 1

Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs
Moment = 0. in-lbs
Axial Load = 0. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
68.80000	16.73965737	97665869.	-1048054.
65.36000	16.82161438	97566943.	-1044426.
61.92000	17.04852291	96814038.	-1096802.
58.48000	30.70645096	85944765.	-1139089.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	0.00	16.7397	-0.03165	-1048054.	9.77E+07

Maximum pile-head deflection = 16.7396573678 inches
Maximum pile-head rotation = -0.0316520038 radians = -1.813526 deg.

The analysis ended normally.